


12-2005

# A Middle School Standards-based Science Curriculum Handbook

Eleanor B. Hess

Follow this and additional works at: <http://digitalcommons.library.umaine.edu/etd>

 Part of the [Science and Mathematics Education Commons](#), and the [Teacher Education and Professional Development Commons](#)

---

## Recommended Citation

Hess, Eleanor B., "A Middle School Standards-based Science Curriculum Handbook" (2005). *Electronic Theses and Dissertations*. 479.  
<http://digitalcommons.library.umaine.edu/etd/479>

This Open-Access Thesis is brought to you for free and open access by DigitalCommons@UMaine. It has been accepted for inclusion in Electronic Theses and Dissertations by an authorized administrator of DigitalCommons@UMaine.

**A MIDDLE SCHOOL STANDARDS-BASED  
SCIENCE CURRICULUM HANDBOOK**

By

Eleanor B. Hess

B.A. Colby College, 1975

A THESIS

Submitted in Partial Fulfillment of the

Requirements for the Degree of

Master of Arts

(in Liberal Studies)

The Graduate School

The University of Maine

December, 2005

Advisory Committee:

Edward Brazee, Professor of Education, Advisor

Susan Hunter, Associate Provost for Undergraduate Education

Herman Weller, Associate Professor of Science Education

# A MIDDLE SCHOOL STANDARDS-BASED SCIENCE CURRICULUM HANDBOOK

By

Eleanor B. Hess

Thesis Advisor: Dr. Edward Brazee

An Abstract of the Thesis Presented  
in Partial Fulfillment of the Requirements for the  
Degree of Master of Arts  
(in Liberal Studies)  
December, 2005

As teachers implement the *National Science Education Standards* (1996) many must change the instructional methods they have used throughout their careers. This handbook will assist teachers to be facilitators in inquiry-based classrooms. The nine units of this handbook have been implemented for three years in an eighth grade classroom and have been used and modified by three different teachers to meet their own needs. The units in this handbook were chosen by MSAD #3, Unity, Maine, to reflect the curriculum requirements of *The State of Maine Learning Results* (1997). Included in this handbook are physics units covering motion, forces, work, and energy, with an in-depth study of electromagnetic and chemical energy, and a unit in human anatomy and physiology. An emphasis is placed on teens and their health during the discussion of the systems of the body.

This handbook relies on the mandate from *Benchmarks for Science Literacy* (1993) and *National Science Education Standards* (1996) for science education to be inquiry-based. Students must “do” science - which means students observe, collect, compare, hypothesize, experiment, interpret, classify, and communicate what they learn. Learning science becomes an active process of students interacting with materials and sharing conversations about their discoveries. The guided inquiries of this handbook reflect this recommendation. The classroom that follows this handbook will be an active classroom of engaged students exploring the tools and techniques of a scientist.

The inquiry units in this handbook are a compilation of my classroom experiences and readings from the internet, workshops attendance, and textbooks gleanings. Every unit in this handbook is explained in full with the goals and objectives of the unit and an explanation

of the pitfalls and strengths of each activity. The guided inquiries form the backbone of the units, but projects and presentations along with end-of-the-unit lab practicums form other forms of assessments. Throughout the set of nine units, there are ample opportunities for students to communicate their findings.



## TABLE OF CONTENTS

### CHAPTER

1. BACKGROUND ON THE CURRICULUM HANDBOOK.....	1
2. LITERATURE REVIEW FOR A STANDARDS-BASED SCIENCE CURRICULUM.....	3
History of the Middle School.....	3
Young Adolescent Development.....	4
Standards for Science Literacy.....	5
Standards-Based Classroom.....	6
Standards-Based Assessment.....	8
3. BUILDING A MODEL STANDARDS-BASED CURRICULUM.....	10
Organization of the Handbook's Teaching Units.....	10
Computers, Assessment, and Classroom Details.....	11
4. FINDINGS.....	14
Implementing a Model Standards-Based Science Curriculum.....	14
Reflections from Teachers and Students.....	14
Organization for Open-Ended Lab Reports.....	16
Assigning Grades for Assessment.....	17
5. FINAL REFLECTIONS ON A STANDARDS-BASED SCIENCE CURRICULUM HANDBOOK.....	19
6. OVERVIEW OF THE HANDBOOK'S CURRICULUM UNITS.....	21
REFERENCES.....	23
APPENDICES.....	25
Appendix A. Scope and Sequence.....	26
Appendix B. Unit I: Introduction to Science.....	27
Appendix C. Unit II: Measurement and Metric System.....	38
Appendix D. Unit III: Motion.....	67
Appendix E. Unit IV: Forces.....	83
Appendix F. Unit V: Fluid Mechanics.....	111
Appendix G. Unit VI: Work, Power, Machines, and Energy.....	135
Appendix H. Unit VII: Electricity and Magnetism.....	174
Appendix I. Unit VIII: Chemistry.....	206
Appendix J. Unit IX: Human Anatomy and Physiology.....	268
BIOGRAPHY OF AUTHOR.....	327

## Chapter 1

### BACKGROUND ON THE CURRICULUM HANDBOOK

Engage every student in meaningful learning. This is a mandate to all educators who touch the life of a student in some fashion. The challenge for educators is to define what constitutes “meaningful learning” and implement it for each and every student in each and every classroom.

I was given the “gift of time,” a sabbatical year to study and reflect on my goals and aspirations as an educator in a rural school district in the state of Maine through my school district’s contract for the academic year 2000-2001. Maine Governor Angus King had proposed the Maine Learning Technology Initiative (MLTI) to the state legislature. *The State of Maine Learning Results (1997)* had been passed with implementation proceeding throughout the state. And middle level education methodologies, design, and practices were being actively pursued for middle level educators to understand and assimilate. My primary interest during the sabbatical year focused on designing a science education curriculum for the middle level student within the parameters of my school district, to engage every student in what I could understand as “meaningful learning.”

As so many other educators, I too have struggled with what to do with the student who is a “square peg in a round hole” classroom situation. I do not accept the trivial comments from school leadership “to just get through the year because next year the child will go to high school.” This assumption of a certain number of acceptable “educational casualties” is no longer viable in today’s world, “because to be an educational casualty is now, more often than not, to be a social and economic casualty as well” (Felner, Kasak, Mulhall, & Flowers, 1997). Economic studies report the high costs to society for welfare, incarceration, and retraining of the educational casualty. The questions for educators become: what educational practices (one size does not fit all!) do we implement so that all children and youth are nurtured and challenged in ways that lead them to be highly effective learners and healthy responsible citizens? How does an entire school enterprise focus intensively on establishing an attentive school environment with the goal that every child will succeed? And what do we do with “at risk” students who have not bought into the idea of the elitist educational system that has become traditional?

Good teaching is a complex combination of art, craft, and science. It requires expertise in knowledge of the discipline, skill in knowing how to teach, and practice to determine which technique to use in the varying situations of topic, student, and setting.

Teachers must rise to a higher level of expectation to develop their individual most effective teaching practices in order to guide students to a higher level of performance (Mizell, 1999). *The National Science Education Standards* (NRC, 1996) clearly describe and mandate that the classroom be inquiry based. Each child becomes responsible to do what a scientist does: ask questions, experiment and analyze data, and communicate an explanation from the data and research. Within this framework teachers strive for effective teaching practices that provide meaningful daily experiences to every student with engaging, worthwhile activities.

The sabbatical year, as a gift of time to reflect on my own teaching practices and read about other models of teaching, provided me a clear vision of why educators should change what they do in the classroom to an inquiry curriculum model as described in *The National Science Education Standards* (NRC, 1996). Many resources are available for teachers to acquire the skills and incentives necessary to develop an action plan to change to a teaching approach that involves exploring the world, asking questions, making discoveries, and communicating information. This project develops a concrete program for a year-long middle school science class based on the student inquiry method.

## Chapter 2

### LITERATURE REVIEW FOR A STANDARDS-BASED SCIENCE CURRICULUM

#### History of the Middle School

The predominate 19th Century school configuration was a two-tiered system. The local elementary school housed grades 1 through 8, followed by a high school, that housed grades 9 to 12. The elementary school served the educational needs of the children by providing basic skills development, while the high school was for the small number of students who would attend college. Vocational training would occur through apprenticeships.

The early years of the 20th Century saw the junior high movement's birth. Columbus, Ohio was the site of the first three-year junior high school for grades 7 to 9. It had a two-fold purpose. The first purpose was to enrich the academic programs for the college bound and the second purpose was to provide vocational programs for students headed directly to the job market. Eventually a third purpose evolved to meet the unique needs of this age level through social, personal, and academic programming (Manning, 2000).

In 1950, Bay City, Michigan, was the site for the first middle school that embraced the practices of a middle level philosophy. During the 1960s this philosophy started to take root as the movement spread across the nation. Important to the needs of the early adolescent are a core curriculum, guidance programs, exploratory experiences, team teaching, and interdisciplinary learning (Manning, 2000). *Turning Points: Preparing Youth for the 21st Century* (1989), an influential report that focused attention on the middle school years, provides a critical vision for young adolescents. It encouraged schools to produce young people who embody competence, compassion and promise; young people who will be intellectually reflective, capable of meaningful work, caring, ethical, and healthy as they take seriously the responsibility of good citizenship (Carnegie Council on Adolescent Development, 1989, p. 15). The National Middle School Association (NMSA) conceptualizes a middle school that enhances "the healthy growth of young adolescents as lifelong learners, ethical and democratic citizens, and increasingly competent, self-sufficient young people who are optimistic about the future (NMSA, 2003, p.1)." The National Middle School Association frames this concept in 14 characteristics. The first eight characteristics describe a successful school culture and the remaining six describe the programmatic characteristics. If an educator prepares and values working with this age

group, then the curriculum choices must be relevant and challenging to the young adolescent (NMSA, 2003, p.7).

### Young Adolescent Development

Young adolescents, ages 10 - 15 years, undergo more changes in their physical, intellectual, social, emotional, and moral make-ups than at any other time-with the exception of the first few months of life. For instance this means an 85-pound eighth grader sits in the same classroom with a 230-pound peer standing more than a foot taller. Self-image becomes of primary importance as some students become trapped in a perceived sense of inadequacy. They display a constant need to compare themselves to their peers whether in appearance or in social and academic acceptance. The middle school students need to become involved in meaningful activities with others that engage them and help them feel capable. Classrooms can serve as “laboratories of living” for students in this transition rather than places in which teachers stand and talk and students sit and listen (Lounsbury, 1991, p. 5)

Middle school programs must be sympathetic to the reorganization the student’s brain is going through in the areas associated with processes such as social behavior and impulse control. The nerve cells undergo a major period of pruning just after puberty when fibers are cut away and more efficient networks form in the prefrontal cortex, an area responsible for “executive functions.” These functions include the ability to set goals, plan, organize, and curb impulse behaviors. The young adolescent has a very difficult time to assess the risk in a given activity so this is a time of risk-taking, making accidents the leading cause of death among adolescents. A vast majority of alcoholics and smokers get started in their teen years. A quarter of all people with HIV contract it before age 21 (Crenson, 2000).

“The challenge for educational and related institutions is to help provide the building blocks of adolescent development and preparation for adult life” (Carnegie Council on Adolescent Development, 1989, p. 2). The young adolescent’s change in intellectual ability means growing from the capacity for concrete thought to a capacity for abstract thinking with an attendant ability to consider multiple ideas and planning steps for learning. Heightened by hormonal shifts, physical changes bring changes in body image yet health choices are often inappropriate and the adolescent is exposed to inadequate nutrition. Outside social forces influence the young adolescent’s moral principles through peer acceptance and media factors. The developmentally responsive middle school will

select educational goals and curriculum that grows out of an awareness and respect for these distinctive young adolescents (Carnegie Council on Adolescent Development, 1989, p. 6). The middle school must be developmentally responsive, providing an inviting, supportive, and safe environment with a curriculum that is relevant, challenging, integrative, and exploratory (NMSA, 2003, p.7). A well-devised inquiry-based science curriculum should take this into account.

### Standards for Science Literacy

*A Nation at Risk* (1983) was a warning that for the United States to remain globally competitive, we must educate to create a scientifically-literate population. By 1993, Project 2061 released *Benchmarks for Science Literacy*, establishing specific thresholds for science literacy goals across grade level clusters. In 1991, the National Science Teachers Association (NSTA) requested that the National Research Council (NRC) coordinate the development of national standards for science education. Through major funding from the U. S. Department of Education and National Science Foundation, *The National Science Education Standards* were published in 1995. The *Standards* represent a consensus of divergent viewpoints with a shared commitment. Four committees worked on separate sections to create the *Standards*. Content standards address what should be taught, program standards address how to teach, assessment standards address the issue of knowing when the standard has been attained, and professional development standards address how to make change happen. The *Standards* provide a vision.

The *Standards* were developed under the guidance of four principles: 1) Science must be for all students and accessible according to individual needs; 2) Learning science is an active process of students interacting with materials and sharing conversations about their discoveries; 3) School science must reflect the intellectual and cultural traditions of our contemporary society so students will develop an active involvement in a critical analysis of community, national, and global issues, and; 4) Improving science education is part of a systemic education reform involving all stake holders of the school community (Rakow, 2000, p. 1). The *Standards* provide a blueprint for teachers to help **all** students become scientifically literate, not just a select few. Our nation needs the general public to be able to think scientifically and have the critical ability to relate science concepts to daily life and to current social issues.

Together, the *Benchmarks* and the *Standards* provide a vision for science education. Science is for all students in all grades. In the middle school the science program must be

developmentally appropriate, interesting, and relevant to all students. In an inquiry-centered curriculum, the central strategy encourages students to generate questions from their own experiences. A school that is responsive to the early adolescent will provide an authentic, worthwhile experience with ways to honor individual interests. As middle level students move from concrete thinking to more abstract ways of thought, they need to engage in an active exploration of their world by firsthand interactions with people, objects, and tools. The school honors their need for physical exercise and freedom to move about during activities, both indoors and outside. As they experience genuine learning, they are able to make or rethink their understanding of concepts through a set of activities. The inquiry model is dynamic, not a curriculum for passive receptivity and obedient regurgitation (Stevenson, 1998, p. 74 - 114). While still addressing all the requisite content issues, learning science can focus students on their own individual needs and interests.

We need to teach students to become scientifically literate, which means to acquire an understanding of the nature of science. Individuals come to understand that observations made by others are constrained by personal perceptions and by the tools that are used. Hence scientific knowledge is tentative, subject to change with new observational abilities. The theories that are developed from collected observations are both a product of the human imagination to invent an explanation and a product of the social and cultural context of the observers (Fouad Abd-El-Khalick, 1998). Galileo's observations and explanations for the movement of the planets around the sun, for example, were ill received in the cultural context of his time.

#### Standards-Based Classroom

The *Standards* classroom provides students with lots of experiences to become actively involved in doing science, requires students to formulate a hypothesis, collect data, and provide an explanation from the data. Many middle school students tend to invoke their own personal experience or think that the evidence from what is already known or from what someone else has told them is sufficient. It is often novel for them to use information they have produced through their own experiments (American Association for the Advancement of Science, 1993, p. 361). "Scientific literacy enhances the ability of a person to observe events perceptively, reflect on them thoughtfully, and comprehend explanations offered for them" such that the person can question and make sense of many of the ideas, claims, and events that they encounter everyday (American Association for the

Advancement of Science, 1993, p. 322). The middle school student should be encouraged to ask 'How do we know that's true?'

Students' investigations make up a significant part of the total science experience. Students need to have numerous opportunities to make observations and learn to distinguish between observation and inference, which are guesses made, but not necessarily based on their observations (Rakow, p. 34). When similar investigations are conducted, students need the experience of deciding if the differences in the data are trivial or significant. This teaches students to question their own work and evaluate their processes which perhaps will lead them to repeat the investigation. Students always need to realize that what they may expect to be the outcomes of the investigation may affect what they observe. Students need to recognize the importance of scientific honesty in describing their procedures, recording their data, and reporting their conclusions (American Association for the Advancement of Science, 1993, p. 12).

The teacher guides students through a framework of year-long and short-term goals in the inquiry-based science program. The teacher provides guidelines for the project, assists in choosing questions to explore, monitors design plans and provides examples of effective ways to make observations and organize data for the inquiry. Where appropriate, the teacher helps students develop their skills and techniques in the use of technology and tools. Since students learn at different paces and through different styles, instruction must be flexible and sensitive to these differences. As the teacher discovers the preconceptions, misconceptions, and knowledge the students already have about the topic, concrete experiences must continually be provided to help the students develop and create new understanding with the appropriate useful vocabulary. Allow time and encourage students to question as they build new knowledge or rethink their preconceptions (Rakow, p. 8). "The student who learns how to question, explore, find answers, and solve problems is on the path to learning" (Rakow, p. 118).

The number of topics covered in the science curriculum need to be reduced and replaced by an emphasis on the acquisition of understanding. Open-ended questions such as "What if? What happens next? What should we do? Tell me more." replace the 'yes-no' questions. Students have to take an active role in their own learning by constructing their own knowledge base, making connections to what they already know. With a variety of science activities (including field trips, interviews, individual, and team projects) accurate information and data are collected and communicated through the student's writing, oral reports, drawings, diagrams, models, and multimedia presentations (Rakow, p. 46). Hence,



care is always taken not to stop the time needed for the curiosity required to pursue scientific questions, while attempting to cover a broad range of content. De-emphasize the memorization of isolated facts in favor of a more in-depth and relevant curriculum that builds for understanding.

Hand and Kelp (1999) developed a guide for creating effective laboratory reports through a set of questions that students must answer as they are involved in their inquiry. The students begin by developing a concept map of their own prior understanding of the topic to confront their own current ideas. This may set the stage for a discrepant event in which the student must make a shift from their prior understanding when confronted with the new observations. The first step in the lab report is the beginning idea and asks “What are my questions?” The students must brainstorm ideas, questions, and any initial observations. The next step is the actual lab activity which could either be created by the students or provided with assistance from someone else. The students clearly write to the question “What did I do?” With the observations and data carefully organized in the form of data charts, the students answer the question “What did I see?” Then the students are required to reflect on the observations and develop meaning from the data. Through discussion and sharing with their lab group the students answer the questions “What can I claim?” and “How do I know these claims?” Finally the students must make connections between the question, the evidence, conversations with others, and readings of related articles to answer the questions “How do my ideas compare to others?” and “How have my prior ideas changed?” Through these seven guided questions the students confront their preconceived ideas, describe and perform a lab exercise, discuss and share results with classmates, research other information through readings, and finally present their findings in the lab report. The students are placed in situations where they must debate, discuss, research, and share their findings (Colburn, 2000).

#### Standards-Based Assessment

Appropriate assessment in an inquiry-based classroom must be ongoing and occur through a range of exhibits such as projects and portfolios that represent students’ knowledge and growth. The assessment must be fair and unbiased as it accommodates the differences of individual students and provides tasks that are within reach of their ability. Students should be provided with ample assistance to be sure that they advance their understanding. Provide students with rubrics and a system for self checking as they strive towards a finished product. The rubric should clearly state standards of expectations for

what is acceptable work. There should be a goal of providing constructive feedback in a way that provides every student with an opportunity for success as they work towards the finished product (Luft, 1999). To have a valuable assessment there must be a valuable learning experience to assess. Assignments must be enriching, addressing science standards, and hence not just something for the students to do. Assessment takes a form that represents the important thinking and problem solving skills of the discipline such that the students are provided the opportunity to conference with peers for help toward a finished product. Learning is an active process of making sense of data and conveying the construct to others. The assessment process should reflect this active process. As Luft (1999) pointed out, assessments should be summative for the students' understandings of concepts, formative as the assessment guides the students to becoming better learners, educative towards teaching how to learn, and evaluative in terms of providing information to the teacher about instruction.

It will not be easy to change from a traditional chalk and talk lecture format to an inquiry-based classroom. Science teachers who are committed to changing their instruction can make some changes easily, while others take more time. Teachers need support from their colleagues, administration, and parents as they progress towards an emphasis on student-centered classes and asking higher-order questions (Luft, 1999). Teachers who are dependent on textbooks will find the present textbooks confined to confirmation of concepts and structure through cookbook labs and demonstrations. Students are not encouraged to formulate hypotheses or problems, nor do they have the opportunity to design investigations in which they predict their results and present to others. Pizzini and Shepardson(1992) found that 90% of the commercially published activities and texts tend to verify concepts and principles, thus portraying science as a static field of facts. Students do not learn to do scientific inquiry. As teachers become involved in ordering instructional materials they should look for materials that involve students in testing hypotheses and formulating new questions, designing their procedures, analyzing underlying assumptions and predicting results with development of their own questions based on their own body of prior knowledge. All instructional materials should attempt to link their own experiences to activities, science concepts, and principles. Until these types of instructional materials come into the hands of the classroom teacher, it is the responsibility of the teacher to include open-inquiry activities in the curriculum. Students should engage in and reflect on natural phenomena. All students should observe, organize, experiment, and communicate (Rakow, p. 118). Inquiry is the thread that binds science courses and all programs together.

### Chapter 3

## BUILDING A MODEL STANDARDS-BASED CURRICULUM

The MSAD #3 science curriculum committee, with representation from grades K through 12, mapped out a curriculum for the school district using *The Maine Learning Results* (1997). *The Maine Learning Results* (1997) are cross-referenced to the *National Science Education Standards* (1996) and to *Project 2061: Benchmarks for Science Literacy* (1993). This standards-based science curriculum master's project reflects the decisions made by the MSAD #3 curriculum committee for the science content to be taught to each of the middle grades (5-8) and focuses on content standards and performance indicators specific to Grade 8. The essential skills of a science curriculum that include problem solving, inquiry, reasoning, communication, and an understanding for the implications of the societal impact of science and technology, are embedded within this curriculum project.

#### Organization of the Handbook's Teaching Units

Each of the nine teaching units of this curriculum project contain a list of *Unit Objectives* that are tied to the *Learning Results* (1997) performance indicators. The specified *Classroom Activities* provide a detailed daily resource for the materials and methods specific to the knowledge and skills necessary to meet the unit objectives. *Minute Questions* posed to the students for an individual written exercise are designed to be discrepant events for many of the students. They are presented at the start of a class discussion and their intent is to force students to think about and write out possible solutions to the event which reflects their beliefs. As daily classroom activities progress, students should refer back to their solutions to the minute questions. Also included with each teaching unit is a listing of the activities that form the *Assessment* within the teaching unit. Included with each unit is a narrative that provides ideas for how to approach a topic or ways to trouble shoot possible problems that may arise.

*Classroom activities* represent a range of engaging activities for the middle level student and address a variety of learning styles. The cornerstone is the guided inquiry. Each guided inquiry requires a formal lab report and provides a question to be explored. Students design a procedure to tell what they did to answer the question of the inquiry and design an organization for their data and observations. Often student groups are required to share their procedure and data organization in a full class presentation to help other students who are reluctant to create their own ideas. Students write their own conclusions which

address what they can claim based on their data. They also write a researched segment that compares their ideas to what others claim. Also included with *Classroom Activities* are directed labs which provide the procedure and data tables along with specific questions to answer in a conclusion. *Classroom Activities* allots time for directed classroom teaching and includes class demonstrations, readings, and discussions. *Save-It Sheets* help students organize their notes from class discussions and the concepts and important information discovered during labs and inquiries. The purpose of the *Save-It Sheets* is to give the students time during the class discussions to organize all the information garnered from the various activities and collect that information in one place. Often this is referred to as a study guide, but due to the number of misplaced papers, they are referred to as a *Save-It Sheet*. (Alas some students call it their lose-it sheet.) Other *Classroom Activities* provide the opportunity for students to make projects, create models, and put together presentations on their laptops.

#### Computers, Assessment, and Classroom Details

Although this curriculum project has not directly addressed the Maine Learning Technology Initiative and the use of the laptops in the classroom, they were certainly an important tool for the students. Basic use levels for the laptop included writing lab reports and e-mailing them to the teacher. Teachers were able to e-mail back suggestions with additional Web sites to check out. Time is spent teaching students how to search for information on their inquiries, with constant reminders to start with the basic information found in the *World Book Encyclopedia* before doing an Internet search. Students are also encouraged to use *MARVEL*, Maine's electronic library. Although there is access to digital cameras, few students used pictures in their reports. Students created class presentations, using *Appleworks* slideshow, and once during the year presented to an invited audience of parents. The middle school students definitely enjoy putting together a colorful show. Within this flexible curriculum are many places for integration of technology, with technology being a tool for the engaged learner. There is always the distinctive line between science learned by doing science versus science learned by reading about science in a textbook or on a Google search. This curriculum focuses on science learned by doing science with the reading about science placed in the secondary role of searching for what other scientists say about the student's own inquiry.

Since the curriculum is based on lab work this model does not use a formal "pencil and paper" assessment or test format. In place of a "test" is a *lab practicum* that occurs

about every other unit. The classroom is set up with activity stations, through which students rotate. Each activity is based on what they have already done during a lab or inquiry. Students are required to collect data and draw a conclusion at the stations. There are also questions that deal directly with concepts that need to be explained based on their own understandings from classroom activities. Students are expected to work alone, but in this format the teacher can move about the room and encourage students who may be stymied. There must be enough lab stations for the number of students in the class or a way to double up students at stations.

*Classroom Groupings* become important because of the many inquiry and lab activities. The classroom is set up with lab tables with either two or three students to a table. Students are assigned to their seats but they are given a say with whom they sit. At the start of each rank, students turn in names of two students with whom they think they can work well and one student who would not be helpful to their progress. Based on this information the teacher sorts out the classroom seating chart. When a lab requires minimal lab equipment, their lab partner is their table mate. For labs that are more complicated, groups are formed of three students. If students want to work as a group of four, generally it is required that they split into two groups of two, since four to a lab group too often gives one or two of the students an opportunity to take a passive role. For major ongoing projects, students are usually given the chance to pick any partner from anywhere in the room with progress monitored daily. Students must be respected for their choice of a partner, yet held accountable to their group.

Since Mr. View Junior High School science rooms do not contain separate lab areas, care must be taken for a room arrangement that is conducive to lab activities. Lab tables are arranged both individually and in pairs facing each other. The pairing of lab tables reduces the amount of floor space needed and makes possible for two groups of students to share materials and equipment. A central classroom lab table contains the supplies needed for the labs and inquiries. Each group gathers up their own materials. This gives the students a chance to have some movement within the classroom space and forces the student to think about what materials they need to complete the answers for the inquiry. This also gives the student groups a chance to see what other lab groups are doing to complete the questions which may help them with their own ideas. Middle level students are social but usually are able to quickly get back to their own lab station.

This inquiry-based curriculum model has attempted to implement for each and every student a meaningful and engaging learning experience. Consideration is given to the

unique characteristics of middle level students through choice in student groupings, student interaction with materials around the room or even outside, and appropriate time for shared conversations with peers. Students are asked to engage in their own learning and reflect on their conclusions. This model has included a broad range of assessment tasks with suggested grading rubrics to help guide the student toward a finished product. Technology is embedded in this model as a tool that students are encouraged to access for research through to a presentation. The classroom is an active place for learning.

## Chapter 4

### FINDINGS

#### Implementing a Model Standards-Based Science Curriculum

This curriculum project has been implemented successfully for two years. The format (students spending three to four days per week on lab projects with only one or two days for whole class instruction) has been a breath of fresh air to my teaching experience. The classroom experience of working with a roomful of engaged students far outweighs the extra work of preparing and gathering materials. My role has become that of facilitator as I move about the lab groups. This approach to teaching science through inquiry results in a high energy level classroom experience. Students move freely about the room to collect materials. Students have the opportunity to talk during the entire class as they work within their lab group and compare results with other lab groups. Students work on different tasks within the classroom setting.

#### Reflections from Teachers and Students

I worked with two other eighth grade science teachers over the two years that this curriculum has been implemented. The first teacher would attempt a few of the activities and adapt them to her classroom needs, but then would revert back to teacher-directed teaching with worksheets, quiet textbook reading time, and answering questions in each section to fill up classroom time. This inquiry model stretched her comfort level as she found it hard to organize materials for the students and organize her need for a quiet classroom. Her compromise was to alternate between the two styles of teaching as she sought to stretch her comfort level. The second teacher embraced this project and the vision of what it means to be a middle level science teacher as defined by the *National Science Education Standards* (1996). She was highly motivated to work in a classroom that had active students. She came to Mt. View Junior High School from a different school system in a foreign country and had already developed projects that she enjoyed doing with the students. She found it easy to modify her projects into inquiries. It was professionally uplifting to work with her and receive her feedback on what went well and how she modified activities to fit her teaching style yet maintain the philosophy to keep students actively engaged in worthwhile activities.

All curricula must focus on the needs of the students. Assigning seats each ranking period that respect students' wishes alleviated the anxiety some students get when asked to

form a group. For more entailed projects, students were allowed to self select which meant at those times I had to be sensitive to the child that was left out and advocate for that child to be included in a group.

The special education students greatly benefited from this curriculum. They were given the gift of time to process the activity and talk with partners about how to form data charts, collect lab information, form meaningful conclusions, and prepare required presentation. Educational Technicians were assigned to about half the classes. They have indicated they prefer to be the coach for the activities as opposed to the notetaker, which happens to them in the more traditional classrooms. The self-contained students (or life skills classes) were mainstreamed into my classroom with an Ed Tech, and this was the only academic class they attended. Their teacher was happy her students were engaged in using lab materials and technology and I liked the feedback when the students talked about what happened in science class. The only classroom experience they skipped were the lab practicums. The positive approach that the Ed Tech brings to the room for engaging students in their own learning (no matter at what level) makes this experience a bonus. I also must compliment the regular education students who remained helpful and supportive to this group of mainstreamed students in our science classroom.

It was extremely important to have a variety of strategies to engage the students. As adults we have those meetings where the facilitator wants us in a group to do an activity and sometimes our first reaction is "just let us sit and listen" and other times we are more willing to jump in and do the activity. I saw that with the students. Most of the activities in this curriculum were guided inquiry, but interspersed with them were the more "cookbook" type labs that had predictable results. For those students who liked to take on a more passive role periodically, there were days of full-class instruction to complete the *Save-It Sheets*. I have seen students come into study hall with worksheets to complete and I know that students found them extremely satisfying because all they needed to do is fill in a blank with some word or number the teacher wanted (or they made up nonsense answers if they knew the teacher only looked to see that blanks were filled in). In the case of worksheets the students always knew when they were done...every blank was filled in. The few activities that were included in this curriculum that were analogous to worksheets were learning the metric system, memorizing element symbols, or bones of the body. I was always amazed when these activities were assigned that the students jumped to complete them. But they knew the paper was completed when they got to the bottom, whereas the lab



reports were open ended and required a personal decision as to when the report was completed and fully researched.

#### Organization for Open-Ended Lab Reports

The Middle school students often have a difficult time writing thoughtful lab reports about their inquiries. There were many hurdles to overcome. The task of answering the question of “what did I do” in the form of describing the materials and methods, required the students to use concise language to organize their descriptions for what they in fact did to get the data. More often than not, the students wanted to tell what they did and also explain what they saw. Since organization of thought is still developing in the adolescent, I provided examples of classmates’ reports that showed good techniques and also problem areas; in this manner, students know what they are working towards when putting together an explanation for their experiments.

Middle school students are notorious for losing things from one day to the next and even within the same class. That includes the data they have had to collect during the course of their inquiry. Students hear the repeated message that data cannot be created from what they think will happen or what they think they remember happening, but rather data must be based on true observations. Yet when there is lost data, they create it or copy it from someone else. It is important to talk about the issue of honest observations and offer to collect lab data at the end of each day to avoid lost data.

Answering the question of “what can I claim” requires middle school students to synthesize the data and look for patterns. Some students are able to work in this intellectual realm and others are not yet mature enough. Again, examine data as a class to help students learn to look for patterns and decide what is a significant difference in the data and what is a trivial difference due to variations in the tools used to collect it. From these conclusions about the data, students need to build this new information onto their present schema. This is very difficult for some adolescents who, even though they see a problem with their preconceived notions, still maintain their preconceived notions because that is what someone told them was true, or, they know they read it somewhere. This fact was clearly illustrated by a student who came in concerned because her father let her know that the class was studying the urinary system incorrectly. The father (the authority source) said urine is formed in the intestinal system when someone drinks a fluid and most certainly is not collected from the blood by the kidneys. The student was open enough to look at the diagrams shown her, but wanted to believe her dad. Another very common belief is that

there is no gravity on the moon's surface. Students watched a video of astronauts jumping up and coming back down on the moon's surface and could state that they came down due to gravity, yet ten seconds later they will still say the moon has no gravity, perhaps confusing the concept of "no gravity" with "less gravity" than earth.

The last hurdle in writing a complete lab report is to address the question of "how do my ideas compare to other research." This required students to use resources at hand, in our case the laptop computer they each were issued by the State of Maine. Students were to read more on topics in the digital encyclopedia or from a Web search. This separated the motivated students from the less motivated students who did not want to put in the extra effort that research required. Yet within their own lab reports, students worked to their own intellectual and motivational abilities. This became part of the assessment process available to evaluate the growth of all students during the year.

#### Assigning Grades for Assessment

Several pieces of evidence were used to determine students' grades at the end of each grading rank. Mt. View Junior High School uses letter grades with comments and one grade must be given from all the pieces of evidence. The classes are all heterogeneously grouped and composed of a broad range of abilities. Each student grade was determined individually from his/her own baseline data and the grade reflected individual progress. The important difference in the method used for grade determination was that grades reflected how well the student was doing compared to himself/herself and not how well the student was doing compared to classmates. Every assessed item was graded on a rubric that students submitted with their papers. The raw score was kept in the grade book and was referred to as the number of points earned for that item. At the end of the ranking period, the points were added together for a total score, turned into a percentage of the total possible points one could earn, and compared to prior ranks' percentage of points earned. Baseline points were determined by the first rank's total percentage earned. If the percentage of points earned increased so did the grade; if decreased, so was the grade. Unfortunately, getting papers completed and passed in was still a very difficult process for many students, so missing papers represented no points earned, with grades reflecting the missing work.

Assignments were not modified for special education students since all assignments gave students a target. Each student was graded against himself/herself, reflecting the progress made towards attaining a greater percentage of points. Therefore, a lower

functioning student was not penalized for not being able to synthesize data or complete extra research since writing a “materials and methods” and creating a data chart with well-collected data may be what the student needed to work towards perfecting.

Many students just needed to work on passing all papers in on time and to understand that they receive credit for that task. Students’ eyes lit up when they finally understood that passing in all papers with an honest attempt to complete as much as they were capable would indeed get them an “A” in class. Unfortunately many students who have continually failed in the school system were unwilling to at least try to complete assignments “because they’d fail anyway.” Another part of the assessment process was that all students were allowed to redo papers and improve their grades. Unfortunately, too few students try for a better grade. Perhaps this is attributed to a sense that they’ve already passed their work in and so the paper is complete with no need to work again to improve it. In less kind words, it reminds me of the phrase “been there, done that.”

A final piece to the assessment process encouraged family involvement in their child’s education. To encourage this piece a place was left on rubrics for the parents to make a comment and sign that they had read their child’s paper and made suggestions for improvement. Not only could parents be involved, but any adult whom the child trusted was allowed to help. Again, very few students seemed to want to earn the bonus points by asking for help to improve their work. Yet every rank students would ask what extra work they could do to earn bonus points to improve their grade. The adolescent has a very difficult time making connections with information and following up with a practical implementation of the information.

On many days students were observed working in their groups on their inquiries. I marvel at the engagement level of the students. The classroom (or out-of-doors) became an active place of exploration as students manipulated the tools of scientists. Students were able to work through their projects and usually were very capable of handling the job of following a timeline for on-time completion. Of course, every class had the reluctant learner who waited for others in the group to just give them the data so they could record it. It was important to encourage the group to find ways to include this student in active participation. However, the overwhelming majority of students were focused on their projects. A silent classroom can no longer be justified for the adolescent who must be allowed to explore, and manipulate, and talk, and ask questions about the task at hand.

**Chapter 5**  
**FINAL REFLECTIONS ON A STANDARDS-BASED**  
**SCIENCE CURRICULUM HANDBOOK**

As I compare the last three years in the classroom since my sabbatical to my prior nine years in the classroom, I know that I have undergone a rejuvenation in my approach to teaching. I had always thought of myself as a hands-on teacher involving the students in many labs and activities. I now realize that I was still approaching science as a justification of facts. Now I work towards approaching science as discovery. The majority of class time is spent in engaged, active learning where the students interact with the materials and share conversations about what they are doing. Very little time is spent in teacher demonstrations or teacher-led discussions. I am no longer on center stage...the students are.

This instructional method is flexible for any content area and any student ability level. Find the essential questions of the curriculum content with the students and guide students into their exploration with this method. Students have a variety of opportunities to be challenged to become learners. In a heterogeneously grouped classroom there is no concern that some students are holding other students behind because all students have the opportunity to make connections with their experiences at their own level of understanding.

Certainly some students have a much higher ability for independent observations and thoughts. I find myself reminding students that they are prejudiced and have become close-minded when they make observations based upon what they thought would happen or by what they have heard would happen. It requires a great deal of effort to help the students to get out of their intellectual confinement and truly observe what occurs before them. I associate this pattern of thinking with a comfort zone for the students or a fear to say something that could be perceived as wrong. For some students the notion that what they observe has value, is a new concept. When students have previously been asked to memorize facts and information, they have learned to de-value their own observations. It is definitely easier to write down what someone else said would be observed because now you are no longer responsible to make your own observations and draw your own conclusions!

The next step I envision in my growth in teaching science is to move beyond the guided inquiries that form the foundation of this curriculum to more emphasis on open inquiries. The Inquiry Learning Forum at <http://ilf.crlt.indiana.edu/> was developed to help teachers design inquiry-based classrooms, yet most all of the submitted examples are at the guided inquiry level, a place to start the classroom transformation. Embedded in many of

the curriculum units of this paper are open-ended student researched projects that relate to the content of the unit or small-group projects that ask the group to create models from their required research. Student design and conduct of an original experiment that ties to their content topic is the missing piece in these projects. The hurdle for me to get over for open inquiries is that of classroom resources and management of classroom space, in a setting where classes of students come and go every 55 minutes during the day. I have a vision of how open inquiries would look in a self-contained team taught classroom. As my level of skill and my resources change, this will become part of my action plan for future years.

Teaching is an art which evolves. The middle level student entering the classroom should demand an educator who provides meaningful and engaged learning. The student deserves to learn actively and to think creatively and independently. I encourage teachers to please ignore the fact that one certain student may always be pencilless and instead cherish the unique qualities of that individual engaged in his or her own meaningful learning in the classroom.

## Chapter 6

### OVERVIEW OF THE HANDBOOK'S CURRICULUM UNITS

This science curriculum handbook is divided into nine units of study that are appropriate to use in the middle school. The first page of the handbook provides a listing of the scope and sequence for all nine units. All the units have been used successfully for three years in an eighth grade heterogeneously-grouped science classroom. The chemistry unit has also been used for one year in a seventh grade heterogeneously-grouped class. The units chosen for this handbook correspond to MSAD #3 science curriculum topics that were mapped for eighth grade topics using the *State of Maine Learning Results*. The ordering of the units provides a logical sequence for the physics topics of motion, forces, work, and energy. Although this handbook provides complete units on two forms of energy, chemical and electrical, there are other energy units that could be developed in more detail, such as light and sound. It was the decision of the MSAD #3 curriculum committee to insert the study of human anatomy and physiology, with an emphasis on health topics, in the eighth grade. It is taught after the physical science units, and relies heavily on the new knowledge gained through the study of chemistry.

Most all of the activities found in this handbook have been developed through my decade of teaching, but some of the ideas have also come from the many workshops and readings that I've completed. National Aeronautical And Space Administration (NASA) provides an extensive library of activities for teachers. NASA's Teacher's Guide on Rockets is heavily cited in the unit on forces ([quest.arc.nasa.gov/index.html](http://quest.arc.nasa.gov/index.html)). The Exploratorium in San Francisco has an Internet site with a wealth of activities that can grab a class's attention ([www.exploratorium.edu](http://www.exploratorium.edu)). I had the opportunity to preview Michigan Science Education Resources Project from the Michigan Department of Education, *New Directions Teaching Units, Chemistry that Applies*. It is a carefully designed standards-based curriculum that contains well-designed inquiries for chemistry at the middle level. This document was invaluable as I developed the sequence of inquiries for this curriculum handbook's unit in chemistry.

Each of the nine units are designed using the same format. Each unit starts with an outline sheet that lists the objectives, activities, and assessments. This is followed by a two to three page summary that highlights the implementation of the activities and inquiries of the unit. Descriptions of how I problem solved any encountered difficulties during implementation and basic explanations of lab set-ups are included in this narrative. This

narrative is followed by each unit's *Save-It Sheet* for student use with an answer *Save-It Sheet* for the teacher's use. The inquiries, labs, and activity pages are formatted so that they may be reproduced for the student's use. Generally I photocopy all the labs as two-sided pages. Since the rubric is part of each lab description, these lab pages are handed in with the completed student written lab reports. I've gone online to clip drawings for many of the *Save-it Sheets* and lab pages and these are cited on the pages. Occasionally I've included articles from the Internet that I found interesting for class discussions. These ideas should be a springboard for the many possibilities for developing critical reading skills as part of any science curriculum.

MSAD #3 encourages reading strategies to be taught across the curriculum. Readings that enhance topics of study are included with some of the units and have been taken from the Internet through Google searches. Since outside research is expected for most all the lab reports in this handbook, reading for research is an integral part of the assessment process. I still must consciously strive to balance the lab activities with allotted class time devoted to helping students gain better research skills on the use of the Internet and discussing the readings they research online.

## REFERENCES

- Abd-El-Khalick, F., Bell, R. L., & Lederman, N. G. (1998). The nature of science and instructional practice: Making the unnatural natural. *Science Education*, 18, 417-436.
- American Association for the Advancement of Science. (1993). *Benchmarks for science literacy*. New York, NY: Oxford University Press, Inc.
- Carnegie Council on Adolescent Development. (1989). *Turning points: Preparing American youth for the 21st century*. Washington, D.C.: Carnegie Corporation.
- Center for Research on Learning and Technology. (1999). The inquiry learning forum project. Indiana University. Retrieved November 23, 2005, from <http://ilf.crlt.indiana.edu/>
- Colburn, A. (2000). Constructivism: Science education's 'grand unifying theory.' *Clearing House*, 74(1), 9-12. Retrieved February 13, 2001, from <http://search.epnet.com.prxy2.ursus.maine.edu/login.aspx?direct=true&db=aph&an=3537008>
- Crenson, M. (December 31, 2000). Changes, not hormones, explains many adolescent behaviors. *South Coast Today*. Retrieved September 15, 2003, from <http://www.s-t.com/daily.12-00/12-31-00/e05li127.htm>
- Felner, R. D., Kasak, D., Mulhall, P., & Flowers, N. (1997). The project on high performance learning communities. *Phi Delta Kappan*, 78(7), 520-527.
- Hand, B. & Kelp, C. (1999). Inquiry investigations: A new approach to laboratory reports. *Science Teacher*, 66(4), 27-29.
- Lounsbury, J. H. (1991). A fresh start for middle school curriculum. *Middle School Journal*, 23(2), 3-7.
- Luft, J. (1999). Challenging myths. *Science Teacher*, 66(4), 40-43.
- Maine Department of Education. (1997). *State of Maine learning results*. Augusta, ME.
- Manning, M. Lee. (3/1/2000). A brief history of the middle school. *Clearing House*, 0009-8655, 73(4). Retrieved September 4, 2005, from [http://web27.epnet.com.prxy2.ursus.maine.edu/citation.asp?tb=1&\\_ug=sid+45442F84%2D6D7D%2D460D%2DA3DD%2D2839D16030B0%40sessionmgr3+db+eric+4F8F&\\_us=frn+1+hd+False+hs+False+or+Date+fn+False+ss+SO+sm+ES+sl+%2D1+dstb+ES+mh+l+ri+KAAACBXC00019499+E556&\\_usmtl=ftv+True+137E&\\_uso=hd+False+tg%5B2+%2D+tg%5B1+%2D+tg%5B0+%2D+st%5B2+%2D+st%5B1+%2D+st%5B0+%2D%22history++of++the++middle++school%22+clv%5B0+%2DY+db%5B0+%2Deric+cli%5B0+%2DFT+op%5B2+%2DAnd+op%5B1+%2DAnd+op%5B0+%2D+0B1E&bk=S&EBSCOContent=ZWJY7zl7XePprRrwtvva6Gmr4CPp7eFoKy5e6WWxpjDpfKDqK%2BygKinrbacp7F51N7uvuMA&rn=1&fn=1&db=aph&ai=2873290&sm=&cf=1](http://web27.epnet.com.prxy2.ursus.maine.edu/citation.asp?tb=1&_ug=sid+45442F84%2D6D7D%2D460D%2DA3DD%2D2839D16030B0%40sessionmgr3+db+eric+4F8F&_us=frn+1+hd+False+hs+False+or+Date+fn+False+ss+SO+sm+ES+sl+%2D1+dstb+ES+mh+l+ri+KAAACBXC00019499+E556&_usmtl=ftv+True+137E&_uso=hd+False+tg%5B2+%2D+tg%5B1+%2D+tg%5B0+%2D+st%5B2+%2D+st%5B1+%2D+st%5B0+%2D%22history++of++the++middle++school%22+clv%5B0+%2DY+db%5B0+%2Deric+cli%5B0+%2DFT+op%5B2+%2DAnd+op%5B1+%2DAnd+op%5B0+%2D+0B1E&bk=S&EBSCOContent=ZWJY7zl7XePprRrwtvva6Gmr4CPp7eFoKy5e6WWxpjDpfKDqK%2BygKinrbacp7F51N7uvuMA&rn=1&fn=1&db=aph&ai=2873290&sm=&cf=1)
- Michigan Department of Education. (1999). *Chemistry that Applies*. New directions teaching units. Lansing, MI.
- Mizzell, M. H. (1999). *Thirty and counting*. Middle grades education conference, Southern Regional Education Board. Atlanta, Georgia. Retrieved September 13, 2005 from <http://www.middleweb.com/HMsouth.html>



- National Commission of Excellence in Education. (1983). *A nation at risk: The imperative for educational reform*. Washington, DC: U.S. Department of Education.
- National Middle School Association. (2003). *This we believe: Developmentally responsive middle level schools*. Westerville, Ohio.
- National Research Council. (1996). *National science education standards*. Washington, DC: National Academy Press.
- Pizzini, E. L., Abell, S. K., & Shepardson, D. P. (1992). The inquiry level of junior high activities: Implications to science teaching. *Journal of Research in Science Teaching*, 28(2), 11-121.
- Rakow, S. J., (Ed.). (2000). *National Science Teachers Association pathways to the science standards: Guidelines for moving the vision into practice*. Middle School Edition. Arlington, VA: NSTA Press.
- Stevenson, C. (1998). *Teaching ten to fourteen year olds*. New York, NY: Addison Wesley Longman, Inc.

## APPENDICES

Appendix A

**SCOPE AND SEQUENCE**

<b>Units of Study</b>	<b>Time Allotment</b>
<p>Unit I. Introduction to Science: Students will use correct safety practices while utilizing the scientific method to apply inquiry and problem solving approaches in the lab and classroom. (MLR Inquiry and Problem Solving J, Scientific Reasoning K, Communication L, Implications of Science and Technology M)</p>	<p>On- going all year</p>
<p>Unit II. Measurement and Metric System: Students will utilize the appropriate metric tools and collect data using the metric units. (MLR Structure of Matter E: 1)</p>	<p>September (3 weeks and on going)</p>
<p>Unit III. Motion: Students will be able to use a frame of reference in describing speed, acceleration, and momentum. (MLR Motion I: 2)</p>	<p>September (2 weeks)</p>
<p>Unit IV. Forces: Students will demonstrate that a force is a push or a pull that effects the motion of objects. (MLR Motion I: 1,2)</p>	<p>October (3 weeks)</p>
<p>Unit V. Fluid Mechanics: Students will study the forces found in fluids that effect the motion of objects. (MLR Structure of Matter E: 1,2; Motion I: 3)</p>	<p>Oct. - Nov. (3 weeks)</p>
<p>Unit VI. Work, Power, Machines, and Energy: Students will demonstrate that energy is required to create a force which can be applied to a machine to cause motion and do work. (MLR Motion I: 3; Energy H: 1, 2, 3, 5, 6)</p>	<p>Nov. - Dec. (4 weeks)</p>
<p>Unit VII. Electricity and Magnetism: Students will demonstrate and quantify the properties of static and current electricity and the relationship between magnetism and electricity. (MLR Energy H: 1, 3, 4, 5)</p>	<p>January (5 weeks)</p>
<p>Unit VIII. Chemistry: Students will describe the structure of matter and the changes that matter undergoes in physical and chemical processes. (MLR Energy H: 6, Structure of Matter E: 2, 3, 4, 5, 6, 7, 8)</p>	<p>Feb. - March (6 weeks)</p>
<p>Unit IX. Human Anatomy and Physiology: Students will describe how cells are the basic unit of life and are organized into the tissues, organs, and organ systems within the human body. (MLR Cells C: 1, 3, 4, 5)</p>	<p>April - June (9 weeks)</p>

## **UNIT 1: INTRODUCTION TO SCIENCE**

### Unit Objectives:

1. Be able to describe what it means to do science
2. Be able to demonstrate and describe the responsibilities of being a student
3. Be able to understand the responsibilities of being a student

### Classroom Activities:

1. Cooperative games
  - \*Corners game
  - \*Change seat game
  - \*Call home slips to include 3 personal goals for the science year
2. Cooperative group activities
  - \*Brainstorm a list of 5 ideas for "What does it mean to DO SCIENCE?"
  - \*Brainstorm at least 5 ideas for "What are the responsibilities of a Mt. View Jr. High student"
3. Inquiry: What are the typical behaviors of a Mt. View Jr. High student?
4. Inquiry: How do you identify two unknown white powders?

### Assessment:

1. Inquiry: What are the typical behaviors of a Mt. View Jr. High student?
2. Inquiry: How do you identify two unknown white powders?

## Unit I: Introduction to Science

Unit I, Introduction to Science, should set the tone for the academic year. This unit brings the student into the science classroom through cooperative activities and simple inquiries. Often, the first couple of days of school are composed of modified schedules, so this approach will support the start of the year activities. Whether your students are looping or you are starting with a “new to you” group of students, there needs to be a transition period from the summer routine to the school routine. Of course the major focus of the early adolescent is making connections to his or her peers, so introductory lessons must allow time for those connections to be made by both physical activity and group processing.

Many teachers have their own store of cooperative games. Push the desks away for the first couple of days and place the chairs in a circle. Be aware that for many students not having a desk to “hide behind” decreases their comfort factor, so activities should involve students such that no one student feels singled out for any length of time.

- The Corners Game involves numbering the 4 classroom corners and then having students move to the corner of their choice that best suits the solution to the question asked. Come prepared with a list of questions and four possible solutions. Questions could involve “go to corner 1 if you stayed in Maine all summer, go to corner 2 if you traveled out of the state but stayed east of the Mississippi River, go to corner 3 if you traveled west of the Mississippi River, and go to corner 4 if you traveled out of the country (Canada counts). Simpler concepts in the corners game can involve favorite summer ice cream flavors.
- The Change Seat Game involves a leader to stand in the circle of seated students, thereby making one less chair than total number of participants. The teacher may start the game as the first leader. The leader thinks of something she/he has done/worn/enjoys and so says something like “Everyone change seats who went tubing over the summer.” Everyone who has participated in the same activity must get up and change seats while the leader tries to slide into one of the emptied seats. The student left standing is the next leader.

Cooperative games can be played as long as the teacher feels that the students are involved.

Many teachers like to have the convenience of maintaining a file of student phone numbers, home emails, and names of the contact people in the home. Make call home slips that not only contain home contact information but also a list of 3 goals for the year. This list provides a place to start a home telephone conversation, whether the teacher is calling about a concern or a strength.

Transitioning to a more academic role, students can work as a cooperative group on a question such as “What does it mean to do science?” After each group reports out their results, the teacher can emphasize the major points that scientists 1) collect data through observations, 2) scientists draw conclusions, 3) scientists share their data with other scientists, 4) scientists read and explore for new information, and 5) scientists write reports recognizing where a bias may appear in the results.

Another cooperative group question pinpoints behaviors that a teacher is looking for in their students, “What are the responsibilities of a Mt. View Jr. High student?” or “What are the responsibilities of being a teacher?” A master list can be generated, signed by the students, and posted for future reference. For a more entailed activity, students could actually become the “teacher” to a paired “student” and be given about 15 minutes every day for a week to teach an activity as simple as calligraphy or as complicated as chords on a guitar or dribbling a field hockey ball. Students then must present what they learned to the class.

The two suggested introductory inquiries emphasize the use of observation, data collection, and sharing data. A favorite activity of an early adolescent is watching his or her peers. The first inquiry gives them that opportunity. Students place a slip of paper with their names on it into a box and then draw out a name. They will shadow that classmate, making observations at regular intervals over the next 3 days or whatever time is agreed on by the classes. Because students at many schools are on different schedules, a student may not see their classmate but for science class, at lunch or in the halls. This provides a good opportunity for a discussion around data collection, biases that may be built into data collection, and other limitations that are imposed on a scientific investigation. Students are to maintain secrecy, until on the last day of the study, they reveal their partner, followed by time to give an interview during class time. Since data collection and interviewing are usually new skills, it is important to discuss with the students what should be in the data chart and types of questions to ask in the interview. Successful data charts utilized in the past are set up in columns with date, time, place of observation, and description of what the subject is doing at the time. Successful interview questions ask for rich detail, not simply “yes or no” answers. It is suggested that students prepare a formal lab report.

During the days the students are working on their shadow study, the Unknown White Powders Inquiry is completed during class time. Again skills are needed to set up data charts so, as a class, a comprehensive data chart can be generated. Microscopes are available to record the crystal shapes, diluted iodine is available to record a color change in the presence of a starch, vinegar is available for those substances that chemically react, water is available for

those substances that can dissolve, and heat is available to test substances that burn. For those classes where students have not had much time in the lab to learn to use a flame safely, this experiment should be performed by the teacher. It can be done simply by putting a sample on a hot plate. Once all the tests have been performed, each group is provided a container of 2 white substances mixed together. Then the students repeat the tests again. A favorite and easily identified substance is the baking soda that fizzes in the vinegar. In order to help students learn how to write a formal lab report, this report is completed as a group. Since scientists share their research, this inquiry is recommend to be presented before the class. The presentation should highlight the lab techniques and the conclusions drawn about the unknown powders.

This introductory unit includes cooperative games, brainstorming, and inquiries. Class discussions have centered around observation, data collection, and issues concerning biased data. Finally, the students have learned to share their research through written reports and oral presentations. This two week long introductory unit brings the student in from summer vacation mode to thinking like a scientist.

## HUMAN BRAIN GROWTH SPURTS

Beginning around age 11, the brain undergoes major reorganization in an area associated with things like social behavior and impulse control. Neuroscientists figured this out only in the last few years, and the discovery has led them to see adolescence as a period when the developing brain is vulnerable to traumatic experiences, drug abuse and unhealthy influences. "The adolescent brain is different. It's still growing," says Fulton Crews.

Not long ago, neuroscientists thought that the brain stopped growing by the time a child entered nursery school. By then, it was thought, nearly all the brain's wiring had been connected and the only remaining task was to program that hardware. But researchers have detected brain growth throughout childhood and well into adolescence. Because their brains are not yet mature, adolescents do not handle social pressure, instinctual urges and other stresses the way adults do. That may explain in part why adolescents are so prone to unsavory or reckless behavior. "The adolescent brain is just in a different state than the adult brain."

This year researchers presented a series of time-lapse images depicting brain growth from age three to 15. The images showed a tangle of nerve cells sprouting in the part of the brain that sits above the eyes, then a period of "pruning" after puberty, when about half of the new fibers are cut away to create an efficient network of circuits. All this action happens in a part of the brain known as the prefrontal cortex, an area responsible for the "executive functions." Those functions are practically a laundry list of the qualities adolescents often lack -- goal-setting, priority-setting, planning, organization and impulse inhibition.

Adolescence is a time of risk-taking. "A big part of adolescence is learning how to assess the risk in an activity," Ponton says. "Part of the reason teen-agers aren't good at risk-taking is that the brain isn't fully developed." Looked at that way, it is no big surprise that accidents are the leading cause of death among adolescents, or that teens are more likely to become crime victims than any other age group. It's no wonder that the vast majority of alcoholics and smokers get started during their teen years, or that a quarter of all people with HIV contract it before age 21. It's no big secret that things like criminal records and sexually transmitted diseases can really mess up your life. But neuroscientists are learning that less serious stuff can have lasting effects, too.



## SCIENCE RESEARCH ON ANIMALS

Scientists conduct most of their research on adolescent brain development using animals, because it would be unethical to experiment with human teens. Animals don't all go through a transitional period between childhood and adulthood, but most mammals do exhibit some kind of adolescence. "They don't hang out at malls and spike their hair and stuff, but their social behavior and social structure changes dramatically." Adolescent rats, for example, show more interest than adults do when strange objects are put into their cages. They start hanging out with their peers more, exploring their surroundings intensely and flitting from one activity to the next.

Craig Ferris says that in the wild his study subjects enter adolescence when they are ejected from the nest at about 25 days of age. For about two weeks they wander the wheat fields of Syria, looking for a nest that will take them in or founding one of their own. Ferris' experiments show that a golden hamster's experiences during this stage can determine how it will behave for the rest of its life. If an adolescent golden hamster is put in a cage with an aggressive adult for an hour each day, it will grow up to become a bully that picks on animals smaller than itself. But it will cower in fear around hamsters its own size. Those golden hamsters raised in the presence of aggressive adults also grow up to have lower than normal levels of vasopressin, a chemical associated with aggression, in the brain's hypothalamus. And they sprout more receptors in the hypothalamus for serotonin, a chemical that blocks vasopressin.

Ferris and his colleagues aren't sure yet exactly what to make of the chemical changes they observe. But they are certain that at least for golden hamsters, the experience of being intimidated by an adult during adolescence has permanent effects. "The take-home of all this stuff is that the brain is constantly interacting with the environment," Ferris says.

During adolescence the developing brain picks up cues from the environment and uses them to help determine "normal" behavior. "If the environment provokes or encourages aberrant behaviors, those behaviors become the norm," says Jordan Grafman.

## ADDICTIVE BEHAVIOR AND ADOLESCENCE

To neuroscientists, one of the most disturbing behaviors among today's adolescents is binge drinking. Studies have already shown that alcohol exposure in utero can have devastating effects on the developing brain, and many researchers fear the period of vulnerability could extend through childhood and into adolescence. Researchers at the University of North Carolina recently decided to test the sensitivity of the adolescent brain to binge drinking by subjecting rats to an alcohol bender. Four times a day for four days, they gave both adolescent and adult rats 10 grams of alcohol per kilogram of body weight. After the rats had sobered up, the researchers looked for brain damage and found more in adolescent rats compared to adults. Most importantly, the adolescents sustained damage in brain regions associated with addiction. "My hypothesis is that this damage is a component of the development of alcoholism," says Crews.

Researchers who study cigarette smoking tell a similar story. The vast majority of smokers start during their teen years, but until recently nobody had thought to look at how the adolescent brain responds to nicotine. When they did, researchers at Duke University found that adolescent brains respond more intensely to nicotine. The scientists injected rats with nicotine every day for more than two weeks, a dose comparable to what a typical smoker receives. In all of the rats the number of chemical receptors dedicated to nicotine increased -- a sign of addiction. But in adolescents, the number of nicotine receptors increased twice as much compared to adults. "What we found is that the adolescent brain gets a lot more bang for the buck," says Theodore Slotkin.

A follow-up study published in the October issue of *Brain Research* showed that adolescent nicotine exposure caused permanent behavioral problems as well, especially for females. Even after two weeks with no nicotine, female rats were less interested in moving around and raising their young than counterparts who had never been exposed. That may be because nicotine retards cell division in the hippocampus, a brain region that continues growing into adulthood in females, but not males. It may also be that the nicotine-exposed rats were depressed. Nicotine decreases the brain's production of norepinephrin and dopamine, two chemicals that tend to be lower in depressed people. And epidemiological studies have shown that smoking early in life greatly increases a person's chances of suffering depression later on.

That doesn't mean that people who begin smoking at a young age are doomed to live out their days depressed and in thrall to nicotine. "A person isn't a slave to one's genes or biology," Ferris says. But even at this early stage of research, he added, it is clear that things like violence and drugs can permanently alter a teen-ager's brain. And that may make an often difficult period even tougher.

Name: \_\_\_\_\_

## Inquiry Question

### What are the Typical Behaviors of an 8th Grade Student?

*You will shadow a student for three days. Your role is to remain unknown to this student. You must take observations on this student at least 3 times in the classes you share. Other observation places should include the hall, lunchroom, and bus, if you share a bus. Set up a data chart on which to record observations. Your data chart will include:*

Date   Time   Place   What my subject is doing or saying

*Your responsibilities are*

*1) to make the observations on a regular basis 2) reveal and interview your subject on the last day, 3) complete a written report.*

This inquiry will be Graded on these expectations:

Rubric: **What are the Typical Behaviors of an 8th Grade Student?**

I. Observations, interview, and paper are completed on time and student maintained secrecy

0 to 5 points

---

II. **Written report clearly provides**

**\*Introduction that explains the problem to be solved in this lab with information on good behaviors**

**\*Materials and Methods used to gather the data: list of observational places**

**\*Data chart well organized showing the observations made**

**\*Interview questions and answers provided**

**\*Conclusion that uses examples from the data to describe characteristics of an 8th grade student. The conclusion must compare your observations of your subject to the list of responsibilities of being a student that is posted in the classroom.**

10-All five sections of the lab report are provided

5-Lab report sections are not present

1-Lab report not complete in requirements

---

III. Interesting Format to read

5-High interest reading, additional researched information provided about adolescent behavior and brain development

3- Interesting to read, but little extra information provided

1-Made an attempt to make it interesting; no additional researched details added

---

IV. Language Arts: Grammar/Sentence Structure/Spelling

5-Few errors for the length of the paper

1-Many errors and hard to read and understand

---

Parent Comments about this paper and signature that the paper was proofread: bonus 5 points

Name: \_\_\_\_\_

### **The Life and Times of a Teacher**

- 1) Present a diary for each of the four days describing what you planned to teach and how your student responded to what you planned.
- 2) Describe some of the methods you tried to use when teaching your student.
- 3) Describe what you had hoped your student would learn in the four days and what really happened for those four days.
- 4) Describe what you would do differently to improve your teaching for the next time.
- 5) Describe what went well with your teaching. Tell about the day your student showed the class what was learned.

### **The Life and Times of a Student**

- 1) Present a diary for each of the four days describing what you did for your teacher.
- 2) Describe what methods your teacher tried to use in order to do a good job of teaching you.
- 3) Describe what your teacher could have done better in order to teach you the skill. Think about how well prepared your teacher was and how many different ways your teacher showed you the skill.
- 4) Describe what it was like to have one of your classmates as a teacher and how hard you tried to follow the directions.
- 5) Tell about your presentation to the class to show what your teacher taught you. Tell how hard you tried to learn the skill so that your teacher was successful or unsuccessful at teaching you.

Name: \_\_\_\_\_

## Inquiry Question

### If I Know the Chemical Characteristics of 6 Known White Powders, How can I Identify 2 Unknown White Powders?

*You will be given 6 known white powders on which you must perform chemical tests. Afterwards you will be given a mixture of 2 unknown powders. You must determine their properties and then identify them.*

Group size: No more than 3 students

Assessment: With your group you will present to the class how you performed the experiment, organized your data, and determined your conclusion for the identification of the two unknown white powders. Your group will pass in one scientific paper. You will have these sections in your paper: (1) Introduction (2) Materials and Methods (3) Data chart (4) Conclusion

Materials Provided:

Powders: baking soda, flour, sugar, salt, plaster of Paris, corn starch  
Microscope, heat source, water, iodine, vinegar, test tubes, eye droppers, petri dishes

This inquiry will be Graded on these expectations:

Rubric: If I know the chemical characteristics of 6 white powders, how can I identify 2 unknown powders?

- I. Lab is completed on time by group with each member working together  
5-Lab is completed and student helped fairly  
3-Lab is completed and student helped just some  
1-Lab is completed but student did not help the group

- II. Group Oral presentation to the class explaining the procedure and results  
5-You spoke clearly and had an equal part in the presentation  
3-You spoke clearly and had a small part in the presentation  
1-You did very little in the presentation

**III. Group Written report clearly provides**

**\*Introduction that explains the problem to be solved in this lab**

**\*Materials and Methods used to gather the data**

**\*Data chart well organized showing the observations made**

**\*Conclusion that uses the data to explain how to identify unknown substances.**

**The answer to the inquiry question is given.**

- 10-All four sections of the lab report are provided  
5-Lab report sections are not present  
1-Lab report not complete in requirements

Name: \_\_\_\_\_

IV. Interesting Format to read

5-High interest reading, additional researched information provided

3- Interesting to read, but little extra information provided

1-Made an attempt to make it interesting but no additional researched details added

\_\_\_\_\_

V. Language Arts: Grammar/Sentence Structure/Spelling

5-Few errors for the length of the paper

1-Many errors and hard to read and understand

\_\_\_\_\_

VI. Paper is passed in on time (0 to 5 points)

\_\_\_\_\_

Parent Comments about this paper and signature that the paper was proofread: bonus 5 points

**UNIT II: MEASUREMENT AND METRIC SYSTEM**Unit Objectives:

1. Be able to measure accurately using the tools of the metric system
2. Be able to correctly use the metric system: terminology, unit conversions, magnitude of the basic units
3. Be able to explain density when describing matter

Classroom Activities:

1. Introductory small group guessing activity for factoids based on biased opinion
2. Lab: small group activity in the correct use of the meter stick, triple beam balance, and graduated cylinder
3. Lab: Uncertainty of Measurements. Emphasis on accuracy of measurement and significant error
4. Save-It sheet for science: Division and multiplication patterns using powers of 10, Metric unit conversions, the meaning of 0°C, 100°C, 1 g, 1 m, and 1 liter
5. Lab: How long is a meter?
6. Inquiry: What is the mass of water? Does mass remain the same?
  - \*Show bottle containing turpentine and colored water and generate questions about the layers
  - \*Place a closed ended straw into various liquids to mark the distance it sinks: water, oil, alcohol
7. Lab (optional): Determining the Density of solids
8. Inquiry: Why don't all heavy objects sink and all lighter objects float? Why do some objects float higher in the water than other objects.
  - \*Place a colored ice cube in water, then in alcohol
  - \*Submerge a diet soda in water, then a non-diet soda in water
  - \*Place a colored melting ice cube in a jar of cooking oil
  - \*Show the class 10 objects and predict their order from lightest to heaviest. Then obtain their actual mass. After that have them hypothesize which will float, how high, and which will sink. (examples: egg, plastic toy, orange, marble, styrofoam ball, nail, wooden block, iron wood, watermelon, potato, apple)
9. Final project (optional): Build a cement/plaster of paris boat that floats
10. Inquiry: What is the density of an eighth grade student?

Minute questions:

- \*Why was time standardized?
- \*Why do we need to measure accurately?
- \*Why was the metric system developed?
- \*What are the characteristics of the metric system compared to the English system?

Assessment:

1. Daily journal writings: "What happened today in class?" "What questions do you have?" "What did you learn today that you disagree with or that surprised you?"
2. Directed lab activities and inquiries
  - \*activity sheet for practice in using the meter stick, triple beam balance, and graduated cylinder
  - \*Uncertainty of measurements
  - \*Metric conversion worksheet
  - \*Lab: How long is a meter?
  - \*Inquiry: What is the Mass of Water?
  - \*Inquiry: Why don't all heavy objects sink and all lighter objects float?
  - \*Inquiry: What is the density of a typical eighth grade student?
  - \*Metric system review worksheet
3. Performance assessment: Lab practical on using metric tools correctly



## Unit II: Measurement and Metric System

Unit II, Measurement, introduces the students to the metric system. Students learn to accurately use four metric tools with the units for mass, length, volume, and temperature. This unit provides the groundwork for further use in future curriculum units. Another aspect when learning to measure is to acquire an understanding for what these measurements feel or look like. Several activities emphasize the sense of a measurement and the magnitude of numbers. After an exercise in using powers of 10 and the patterns generated by the movement of the decimal point, unit conversions are introduced. Finally this unit wraps up with providing the students a sense of the definition of density. This gives the students experience in dealing with combination units that appear throughout their introduction to physics. The final assessment is a lab practical; some students feel comfortable doing an activity to obtain an answer, but other students who are not comfortable with manipulating lab equipment find a lab practical to be a challenge. The attempt is made to make this experience as least intimidating as possible.

The first unit activity is a guessing activity. Have the students just guess what the cardinal values are for the factoids. A great discussion can be generated over the news media that plays up certain of these statistics while others, that are not in the news, turn out to be a much greater problem. The carnage on our highways is a passing news item, but a plane crash is in the news for days. Biases are easily created. The national budget deals with numbers in the trillions and the federal school lunch program with numbers in the billions. A good math extension is to use the U.S. population figure to calculate per capita costs. There are always a few middle level students who understand that statistic and show interest in the federal use of money.

The first two labs suggested for this unit get the students to use the scales and think about the accuracy of the scales. Calipers give even more precise measurements. A discussion about measuring should be generated over "what is close enough." Post results obtained by each lab group for the whole class to use for answers for the Uncertainty of Measurements Lab. A chart can be made on a large sheet of paper for each group to fill in as they complete the data. Most students have not had much experience in statistical analysis of data they generate, so take the time to look at the data and find the range of results in each measurement. Discuss the difficulties encountered when striving for accuracy.

The Save-It Sheet and follow-up lab provide basic exercises in metrics. Some students are not comfortable with the use of a calculator, so watch for fingers that persistently push the wrong buttons or for those students who don't understand the importance of

pushing the buttons in the correct order for division. Many students are not familiar with the pattern of the decimal movement when dealing with powers of 10. Once the manipulation of units is understood, then it is important to also understand the magnitude of the units. If I told students I ran 100 miles in 10 seconds, they would immediately respond to the impossibility of that feat. So, likewise, it would not make sense to run 100 km in 10 seconds, but running 100 meters in 10 seconds is feasible.

Two demonstrations are suggested that relate to the mass of water. For the first demonstration, either use commercial variations of density bottles or mix colored alcohol and water or turpentine and colored water in a glass bottle. Place a plastic pen cap in the bottle since it floats between the layers. Students clamor to know what is in the bottles, but direct their focus on explanations for why one liquid always floats above the other liquid. For the second demonstration, make a closed ended straw weighted with BB's and place it into various liquids to check for depth of submersion. A definite impression will be made that objects do float at different levels depending on the liquid in which they are placed. Check out the load line markings on ships that sail between fresh and salt waters, or tropical and temperate waters.

Before starting the inquiry to find the mass of water, allow students time to think of a procedure. Let the students present their various ideas and then help the whole class to come up with a feasible procedure. The simplest involves weighing an empty graduated cylinder and then reweighing it with any amount of water in it. Math skills are utilized as students realize that each milliliter of water has a mass of 1 gram. If time permits, a graph can be generated from all the group's data and then extrapolated for the mass of 1 ml. A computer spreadsheet generates the graph very quickly.

Once the mass of water is determined, followed by a possible extension activity that may involve finding the mass of other liquids, the focus is on an understanding of density. The inquiry on the concept of floating as a function of density, not mass, gives students their own practice in understanding the concept of density. Again, allow students time to come up with a procedure and then share that procedure with the class so that each student group has an idea of what to do before proceeding. Students can supply their own items with which to experiment, but have available a classroom supply. A sample of iron wood is a stumper since this is one of the few woods that sinks. The one limitation for the experimental objects is the size of the overflow apparatus for any irregularly shaped objects. If an object floats, students must hold it under water to get the entire volume, but avoid getting their fingers' volumes that hold the object down!

The final inquiry, to find their own density, is fun for this age. Most students think they are quite dense, so get their guesses before proceeding. There are usually a couple of students in the class who make the connection that people do float so must have a density of less than 1 g/ml. Allow time for that discussion. First send home permission slips for the students who volunteer to be the subjects. They must be willing to be weighed and submerged in a garbage can! I suggest that on the day of the inquiry they bring a bathing suit, shirt, and towel. The bathroom scale (students convert pounds to kilograms) gets their mass. The volume is trickier. Place a garbage can filled to the brim with (warm) water in a kiddie pool to catch the overflow water. Students must slowly slide into the garbage can and completely submerge, heads too! Then use a sump pump for a fast way to pump the water from the kiddie pool into a kitchen bucket with the 10 liter line marked onto it and dump the water back into the garbage can. Students keep track of the number of liters needed to refill the garbage can. As the can comes closer to the fill line, start measuring to the nearest liter, using a graduated cylinder from the lab. In an hour class, it is possible to repeat this process for about 6 subjects. This provides a day's worth of data with which students can work to calculate their density. It is also important to point out places of error. Statistically speaking, the data is rich. Provide the definitions for mean, median, mode, and range. Let the students decide how they want to work with the data. At day's end, the sump pump comes in handy to empty the garbage can out the window or down the sink!

Name: \_\_\_\_\_

SAVE-IT SHEET for Science

Measurement

I. What piece of equipment would you use to find:

Mass: \_\_\_\_\_ Temperature: \_\_\_\_\_

Volume of a liquid: \_\_\_\_\_ Length: \_\_\_\_\_

II. **Mass** of an object it is measured in \_\_\_\_\_

**Length** of an object it is measured in \_\_\_\_\_

**Volume** of an object it is measured in \_\_\_\_\_

**Temperature** of an object it is measured in \_\_\_\_\_

III. Write down what you have learned these abbreviations stand for:

g \_\_\_\_\_ m \_\_\_\_\_ l \_\_\_\_\_ cm \_\_\_\_\_

mm \_\_\_\_\_ km \_\_\_\_\_ kg \_\_\_\_\_

$\mu$ g \_\_\_\_\_ ml \_\_\_\_\_  $^{\circ}$ C \_\_\_\_\_

IV. Use a calculator and follow the directions:

multiply each of these numbers by 10: 23.5 \_\_\_\_\_ 4.567 \_\_\_\_\_

12 \_\_\_\_\_ 15.4 \_\_\_\_\_ 35.67 \_\_\_\_\_ 30 \_\_\_\_\_

Look for a pattern and write down what you think the pattern is:

---

multiply each of these numbers by 100: 23.5 \_\_\_\_\_ 4.567 \_\_\_\_\_

12 \_\_\_\_\_ 15.4 \_\_\_\_\_ 35.67 \_\_\_\_\_ 30 \_\_\_\_\_

Look for a pattern and write down what you think the pattern is:

---

multiply each of these numbers by 1000: 23.5 \_\_\_\_\_ 4.567 \_\_\_\_\_

12 \_\_\_\_\_ 15.4 \_\_\_\_\_ 35.67 \_\_\_\_\_ 30 \_\_\_\_\_

Look for a pattern and write down what you think the pattern is:

---

do these divisions:  $23.5 \div 10$  \_\_\_\_\_  $4.567 \div 10$  \_\_\_\_\_

$12 \div 10$  \_\_\_\_\_  $15.4 \div 10$  \_\_\_\_\_  $35.67 \div 10$  \_\_\_\_\_  $30 \div 10$  \_\_\_\_\_

Look for a pattern and write down what you think the pattern is:

Name: \_\_\_\_\_

do these divisions:  $23.5 \div 100$  \_\_\_\_\_  $4.567 \div 100$  \_\_\_\_\_  
 $12 \div 100$  \_\_\_\_\_  $15.4 \div 100$  \_\_\_\_\_  $35.67 \div 100$  \_\_\_\_\_  $30 \div 100$  \_\_\_\_\_

:Look for a pattern and write down what you think the pattern is:

\*\*\*\*\*

do these divisions:  $23.5 \div 1000$  \_\_\_\_\_  $4.567 \div 1000$  \_\_\_\_\_  
 $12 \div 1000$  \_\_\_\_\_  $15.4 \div 1000$  \_\_\_\_\_  $35.67 \div 1000$  \_\_\_\_\_  $30 \div 1000$  \_\_\_\_\_

Look for a pattern and write down what you think the pattern is:

\*\*\*\*\*

Now try these without using a calculator by using the pattern you discovered:

$14.5 \times 10 =$	$2567.89 \times 100 =$	$23 \times 10 =$	$54.3 \times 100 =$
$2 \times 1000 =$	$13 \times 10 =$	$42.9 \times 100 =$	$19.2 \times 1000 =$
$345 \div 10 =$	$12.7 \div 10 =$	$24.78 \div 100 =$	$45.578 \div 1000 =$
$1865 \div 1000 =$	$1245.32 \div 100 =$	$32.54 \div 10 =$	$6.7 \div 1000 =$

Using a meter stick, find the following:

How many centimeters in a meter? \_\_\_\_\_

How many millimeters in a meter? \_\_\_\_\_

How many millimeters in a centimeter? \_\_\_\_\_

How many metersticks do you think are needed to make a kilometer? \_\_\_\_\_

Find 18 cm and count how many millimeters \_\_\_\_\_

Find 3.5 cm and count how many millimeters \_\_\_\_\_

Find 32 cm and count how many millimeters \_\_\_\_\_

Find 2 cm and count how many millimeters \_\_\_\_\_

Find 79.5 cm and count how many millimeters. \_\_\_\_\_

Find 200 cm and count how many millimeters. \_\_\_\_\_

Find 135 cm and count how many millimeters \_\_\_\_\_

Find 20 mm and count how many centimeters \_\_\_\_\_

Find 570 mm and count how many centimeters \_\_\_\_\_

Find 345 mm count how many centimeters \_\_\_\_\_

Find 10 mm and count how many centimeters \_\_\_\_\_

Name: \_\_\_\_\_

- \_\_\_\_\_ meter \_\_\_\_\_
- 1) 435 cm = \_\_\_\_\_ m    2) 54.7 cm = \_\_\_\_\_ m    3) 72.5 km = \_\_\_\_\_ m  
4) 827.5 m = \_\_\_\_\_ km    5) 2.7 cm = \_\_\_\_\_ mm    6) 4.59 km = \_\_\_\_\_ m  
7) 8575 m = \_\_\_\_\_ km    8) 923 m = \_\_\_\_\_ mm    9) 45.873 mm = \_\_\_\_\_ m  
10) 1.468 g = \_\_\_\_\_ mg    11) 54328 mg = \_\_\_\_\_ g    12) 20 ml = \_\_\_\_\_ l

How cold is 0 °C? \_\_\_\_\_

How hot is 100 °C? \_\_\_\_\_

How heavy is 1 gram? \_\_\_\_\_

How long is 1 meter? \_\_\_\_\_

How much volume is 1 liter? \_\_\_\_\_

## Number Factoids

<u>Ordinal Rank</u>	<u>Factoid</u>	<u>Cardinal Rank</u>
	1) The number of people that live in the state of Maine in 2000 census.	
	2) The number of people that live in the United States in 2000 census.	
	3) The number of murders in the United States in 1999.	
	4) The number of Americans that died from AIDS in 1995.	
	5) The number of Americans that died in the Vietnam War that went from 1961 to 1975.	
	6) The number of people that died in U.S. commercial airline crashes in 2001.	
	7) The number of Americans that die yearly in auto accidents.	
	8) The number people in attendance at a typical baseball game.	
	9) The amount of money the United States government plans to spend in 2004.	
	10) The amount of money the United States government plans to spend on the school hot lunch and breakfast programs.	

## Number Factoids

<u>Ordinal Rank</u>	<u>Factoid</u>	<u>Cardinal Rank</u>
7	1) The number of people that live in the state of Maine in 2000 census.	1,275,000
8	2) The number of people that live in the United States in 2000 census.	281,427,000
2	3) The number of murders in the United States in 1999.	15,533
4	4) The number of Americans that died from AIDS in 1996.	36,000
6	5) The number of Americans that died in the Vietnam War that went from 1961 to 1975.	58,000
1	6) The number of people that died in U.S. commercial airline crashes in 2001.	530
5	7) The number of Americans that die yearly in auto accidents.	42,815
3	8) The number people in attendance at a typical baseball game.	35,000
10	9) The amount of money the United States government plans to spend in 2004.	\$2,230,000,000,000
9	10) The amount of money the United States government plans to spend on the school hot lunch and breakfast programs.	\$8,482,000,000



Name: \_\_\_\_\_

### Metric Tools in the Classroom

METER STICK: carefully measure the length of 10 objects at your table. Include units!

object	length	object	length

When the lab table was measured by 10 groups, the following answers were gotten. Look at their data, and then write down 2 reasons the answers are different.

182 cm    182 cm    181.5 cm    181.3 cm    180 cm    181.5 cm  
151 cm    181.4 cm    180 cm    179 cm

Reason 1:

Reason 2:

TRIPLE BEAM BALANCE: carefully find the mass of 8 objects at your table. Include units!

object	mass	object	mass

When the mass of a shell was found by 10 groups, the following answers were gotten. Look at their data and write down 2 reasons the measurements are different.

5.2 g    0.56 g    4.9 g    4.1 g    4.9 g    5.5 g    4.8 g    5 g    4.7 g    5.5 g

Reason 1:

Reason 2:

Name: \_\_\_\_\_

GRADUATED CYLINDERS: carefully find the volume of water in 9 graduated cylinders. Include units!

cylinder #	volume	cylinder #	volume	cylinder #	volume

When the volume of water was found by 10 groups, the following answers were gotten. Look at their data and write down 2 reasons the measurements are different.

42 ml 40.2 ml 42 ml 43 ml 43 ml 40.3 ml 39 ml 46 ml 42 ml 38 ml

Reason 1:

Reason 2:

Ask any 3 groups in the class their reasons that mistakes are made when using metric tools. Write down any ideas that you did not think of.

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.
- 7.

## UNCERTAINTY OF MEASUREMENTS

### Introduction

How accurately can matter be measured? This lab provides practice in careful measuring using the thermometer, graduated cylinder, meter stick, and triple beam balance. The tools used and effort on exactness determine how accurately matter can be measured. This lab will also determine what is an acceptable range of measurements when using the metric tools. The results that each lab group obtains will be compared for accuracy.

### Materials and Methods

Be sure to obtain only one item at a time as the equipment must be shared among classmates. Assign one person in the group to obtain the materials and return them when the measurements are done. All lab partners must fill in their own data and pass the lab in on time with the questions completed. Be sure to give the units on each measurement.

Meter stick: Measure the length and width of the lab table

Graduated cylinders: Record the volume of the colored liquids in the 4 numbered graduated cylinders.

Triple beam balance: Exactly record the mass of the following 4 items  
                           rock                   court TV pencil                   sponge                   shell

Thermometer: Record the temperature of the jar of water and the armpit temperature of all the members of your group

Volume: Use the overflow can and graduated cylinder to find the volume of 10 nails

**Post your data on the class master data sheet so that the conclusion questions may be completed.**

### Data

TABLE LENGTH \_\_\_\_\_ TABLE WIDTH \_\_\_\_\_

COLORED WATER #1 \_\_\_\_\_ #2 \_\_\_\_\_ #3 \_\_\_\_\_ #4 \_\_\_\_\_

MASS: ROCK \_\_\_\_\_ TV PENCIL \_\_\_\_\_ SPONGE \_\_\_\_\_ SHELL \_\_\_\_\_

TEMPERATURE: WATER \_\_\_\_\_ PARTNER #1 \_\_\_\_\_ #2 \_\_\_\_\_ #3 \_\_\_\_\_

VOLUME OF 10 NAILS: \_\_\_\_\_

### Conclusion

1. Do all the lab groups have the same measurements?
2. Which lab problem(s) had the most nearly alike answers?  
 Why do you think the lab groups could measure these accurately?
3. Which lab problem(s) had the most different answers?  
 What do you think lab groups did wrong to get inaccurate measurements?

Name: \_\_\_\_\_

## How Long is the Meter?

Find a part of your body that is about one centimeter long: \_\_\_\_\_

Find a section of your body that is about one meter long: \_\_\_\_\_

Find a part of your body that is about one millimeter long: \_\_\_\_\_

**Put the ruler away. Fill in the first column with good guesses for an estimate of the lengths.**

Then get out the ruler and complete the chart accurately.

**Think!** If you know the length in cm, do you need to remeasure in meter and cm?

Estimate centimeter	Object	Length centimeter	Length meter	Length millimeter
	Your height			
	Your hand span			
	Your foot length			
	Tabletop length			
	Your pencil length			
	Room height			

1. Were your estimates close to the actual answers? Explain

2. How can you use the length of your foot or hand span to estimate lengths of objects?

Fill in the prefix chart and then perform the conversions:

\_\_\_\_\_ meter \_\_\_\_\_

34 m = \_\_\_\_\_ cm    93.4 cm = \_\_\_\_\_ mm    2.56 mm = \_\_\_\_\_ cm

167 km = \_\_\_\_\_ cm    8934 mm = \_\_\_\_\_ m    675.43 cm = \_\_\_\_\_ m

56.4 m = \_\_\_\_\_ cm    38.5 m = \_\_\_\_\_ mm    4 km = \_\_\_\_\_ mm

Name: \_\_\_\_\_

## INQUIRY

### WHAT IS THE MASS OF WATER?

1. With your lab group, decide on the data that is needed to be collected in order to determine the mass of water. Remember that water must be placed in a container.
2. Discuss with your lab group a procedure to determine the mass of water. Your group will share the procedure with the rest of the class.
3. With your lab group perform the experiment. You must maintain a data chart for all data collected. Each lab group member will write up their report that clearly shows all 4 parts of the lab report (Introduction, Materials and Methods, Data, Conclusion). Remember that the conclusion will clearly state what you discovered to be the mass of water. The conclusion will also discuss any problems you had in order to obtain this information.

This inquiry will be Graded on these expectations:

Rubric: **What is the mass of water?**

I. Lab is completed on time by group with each member working together

5-Lab is completed and student helped fairly

3-Lab is completed and student helped just some

1-Lab is completed but student did not help the group

\_\_\_\_\_

II. Quick oral presentation to the class briefly explaining the procedure and clearly providing the results

5-You spoke clearly and had an equal part in the presentation

3-You spoke clearly and had a small part in the presentation

1-You did very little in the presentation

\_\_\_\_\_

Name: \_\_\_\_\_

**III. Written report clearly provides**

**\*Introduction explaining the problem to be solved, why it is important to know this answer, and what you already know about the property of mass**

**\*Materials and Methods used that describes what you did during the lab**

**\*Data chart of the measurements taken; data chart is clearly labeled with units and shows what you found out**

**\*Conclusion that explains what you learned from the data. This will explain the definition of mass, provide the answer to the mass of water, and tell why it is important to know the mass of water as it relates to the metric system. Discuss any problems or inaccuracies that may be in your data.**

**10-All four sections of the lab report are provided**

**5-Lab report sections are not present**

**1-Lab report not complete in requirements**

\_\_\_\_\_

**IV. Interesting Format to read, clearly written, and evidence of research on the internet about what other scientists know**

**5-High interest reading, additional information provided**

**3- Interesting to read, but little extra information provided**

**1-Made an attempt to make it interesting/no details added**

\_\_\_\_\_

**V. Language Arts: Grammar/Sentence Structure/Spelling**

**5-Few errors for the length of the paper**

**1-Many errors and hard to read and understand**

\_\_\_\_\_

**VI. Paper is passed in on time (0 to 5 points)**

\_\_\_\_\_

Parent Comments about this paper and signature that the paper was proofread:  
bonus 5 points

Name: \_\_\_\_\_

## Determining the Density of Solids Introduction

Density is an important property of matter. The periodic table of elements provides the density for all the elements at a standard temperature. Density is a property of matter that compares its mass to its volume. This means how heavy the object is for its size. Think about how big a feather pillow is in order to weigh a pound compared to the size of a rock to weigh a pound. In this lab, the technique to find density will be learned.

**Place the following 6 items in order from least dense to most dense**

Marbles      Book              Water              Sponge              Wood block              Iron nails

**Least** **Most**

---

### Materials and Methods

This lab will find the density of the following six items: 10 marbles, a book, a sponge, a wooden block, water, and 15 nails. Since density compares the mass of an object to its size, then the data collected must be the mass and the volume. Mass is found by simply weighing the object on the triple beam balance and the volume will be found by the overflow method, using a graduated cylinder to collect the overflow volume. For regular solids, such as the book, sponge, or block that don't fit in the overflow can, the volume can be found mathematically by multiplying the length times the width times the height.

#### Data

Object	Mass (g)	Volume (ml or cc)				Density (M÷ V)
water						
15 nails						
10 marbles						
sponge		length	width	height	<b>volume</b>	
wood block						
book						

Name: \_\_\_\_\_

### Conclusion

1. What is the correct order of the 6 objects from least dense to most dense?
2. Describe how your lab results compare to what you thought would be the correct order you wrote in the introduction of this lab. What did you think density meant when you wrote your original order?
3. Explain what you learned is the meaning of density.
4. When you know the density of an object, how can you tell if it will sink or float?
5. From your data, which objects will float in water:

From your data, which objects will sink in water:



Name: \_\_\_\_\_

INQUIRY QUESTIONS:

WHY DON'T ALL HEAVY OBJECTS SINK AND  
ALL LIGHTER OBJECTS FLOAT?  
WHY DO SOME OBJECTS FLOAT HIGHER IN THE  
WATER THAN OTHER OBJECTS?

1. With your lab group, decide on several objects to study. This should include objects that sink or float. List the objects you will study:
2. Discuss with your lab group the measurements you think are needed to make in order to answer these two questions. Explain why you will take these measurements:
3. With your lab group develop a procedure to do the experiment to find the solution to the questions. Your group will share with the class what you plan to do and why. Briefly describe what you will do to answer the questions:

This inquiry will be Graded on these expectations:

Rubric: **WHY DON'T ALL HEAVY OBJECTS SINK AND ALL LIGHTER OBJECTS FLOAT? WHY DO SOME OBJECTS FLOAT HIGHER IN THE WATER THAN OTHER OBJECTS?**

I. Lab is completed on time by group with each member working together

5-Lab is completed and student helped fairly

3-Lab is completed and student helped just some

1-Lab is completed but student did not help the group

---

II. Quick oral presentation to the class briefly explaining the procedure and clearly providing the results

5-You spoke clearly and had an equal part in the presentation

3-You spoke clearly and had a small part in the presentation

1-You did very little in the presentation

---

Name: \_\_\_\_\_

**III. Written report clearly provides**

**\*Introduction explaining the problem to be solved, why it is important to understand this answer, and any information you already know about what it means to float**

**\*Materials and Methods used that describes how you did the lab**

**\*Data chart of the measurements taken; data chart is clearly labeled with units**

**\*Conclusion that uses the data to explain density. This will explain why objects float in water, why objects sink in water, and why some objects float high or float low. Can you use the word "density?" Find out how a submarine can change its depth and even float to the surface. Discuss any problems or inaccuracies in your data collection.**

**10-All four sections of the lab report are provided**

**5-Lab report sections are not present**

**1-Lab report not complete in requirements**

\_\_\_\_\_  
**IV. Interesting Format to read, clearly written, and evidence of research on the internet**

**5-High interest reading, additional information provided**

**3- Interesting to read, but little extra information provided**

**1-Made an attempt to make it interesting/no details added**

\_\_\_\_\_  
**V. Language Arts: Grammar/Sentence Structure/Spelling**

**5-Few errors for the length of the paper**

**1-Many errors and hard to read and understand**

\_\_\_\_\_  
**VI. Paper is passed in on time (0 to 5 points)**

\_\_\_\_\_  
Parent Comments about this paper and signature that the paper was proofread: bonus 5 points

Name: \_\_\_\_\_

Inquiry  
**What is the Density of an Eighth Grade Student?**

1. Student volunteers will be submerged in a barrel of water in order to find their volume.
2. The same volunteer will be weighed in order to find their mass.
3. Each student is responsible for recording the class data and writing a formal lab report based on the class data and your own observations.

This inquiry will be Graded on these expectations:

Rubric: **What is the density of an eighth grade student?**

**I. Written report clearly provides**

- \*Introduction explaining the problem to be solved**
- \*Materials and Methods observed and used in the class**
- \*Data chart of the measurements taken**
- \*Conclusion that uses the data to explain the density of students. This will explain what the density means for the human ability to float. Explain any errors made during data collection.**

**10-All four sections of the lab report are provided**

**5-Lab report sections are not present**

**1-Lab report not complete in requirements**

**II. Interesting Format to read, with researched information on human density**

5-High interest reading, additional information provided

3- Interesting to read, but little extra information

1-Made an attempt to make it interesting/no details added

**III. Language Arts: Grammar/Sentence Structure/Spelling**

5-Few errors for the length of the paper

1-Many errors and hard to read and understand

**IV. Paper is passed in on time (0 to 5 points)**

Parent Comments about this paper and signature that the paper was proofread:  
bonus 5 points

Name: \_\_\_\_\_

### METRIC CONVERSIONS

KILOMETER	HECTOMETER	DEKAMETER	METER	DECIMETER	CENTIMETER	MILLIMETER
			500			
			1000			
						80
8						
3						
					39.4	
						830
			1			
50						
0.5						
				10		
				2.5		
						425
					172	
					43.87	
7.5						

1) 33.7 cm = \_\_\_\_\_ mm

2) 47.8 m = \_\_\_\_\_ km

3) 956 mm = \_\_\_\_\_ m

4) 18.7 km = \_\_\_\_\_ m

5) 983.4 m = \_\_\_\_\_ km

6) 49 cm = \_\_\_\_\_ mm

7) 83.7 km = \_\_\_\_\_ m

8) 43 mm = \_\_\_\_\_ m

9) 0.854 dam = \_\_\_\_\_ cm

10) 4.9 hm = \_\_\_\_\_ m

Name: \_\_\_\_\_

## Homework Review Sheet

I. Perform the following conversions:

- |                        |                        |
|------------------------|------------------------|
| 1) 23.6 cm = _____ m   | 7) 354 ml = _____ l    |
| 2) 4538.8 g = _____ kg | 8) 2397 m = _____ km   |
| 3) 75 mg = _____ g     | 9) 2 l = _____ ml      |
| 4) 24.8 kg = _____ mg  | 10) 32.97 m = _____ cm |
| 5) 1395.4 ml = _____ l | 11) 239 cm = _____ m   |
| 6) 390 mm = _____ m    | 12) 3 m = _____ mm     |

II. What base unit do you use for:

mass \_\_\_\_\_ Volume \_\_\_\_\_ Length \_\_\_\_\_

III. Perform the following conversions assuming that we are using water:

- |                       |                      |
|-----------------------|----------------------|
| 1) 43.5 ml = _____ g  | 4) 18 g = _____ ml   |
| 2) 22 kg = _____ l    | 5) 22.5 l = _____ kg |
| 3) 2357.8 g = _____ l | 6) 2 l = _____ g     |

IV. Choose from the following to best describe these lengths:

- |                    |                  |                  |          |
|--------------------|------------------|------------------|----------|
| hand span          | person's height  | driving distance | bug size |
| 1) 23.7 cm _____   | 6) 1.6 cm _____  |                  |          |
| 2) 203 mm _____    | 7) 1.3 km _____  |                  |          |
| 3) 1.67 m _____    | 8) 1650 mm _____ |                  |          |
| 4) 1650 km _____   | 9) 0.234 m _____ |                  |          |
| 5) 0.0016 km _____ | 10) 0.18 m _____ |                  |          |

Name: \_\_\_\_\_

$24.56 \times 100$		$34.472 \times 10$	
$425 \times 10$		$969.23 \div 100$	
$3.8572 \div 1000$		$243.1 \div 10$	
$97.428 \div 10$		$38.19 \div 100$	
$72.5 \times 1000$		$2892 \times 100$	

Name: \_\_\_\_\_

$24.56 \times 100$		$34.472 \times 10$	
$425 \times 10$		$969.23 \div 100$	
$3.8572 \div 1000$		$243.1 \div 10$	
$97.428 \div 10$		$38.19 \div 100$	
$72.5 \times 1000$		$2892 \times 100$	

Name: \_\_\_\_\_

## Unit conversions

gram  
meter  
liter

- |                       |                       |
|-----------------------|-----------------------|
| 1) 45.7 g = _____ mg  | 6) 2.45 km = _____ m  |
| 2) 150 ml = _____ l   | 7) 345 kg = _____ g   |
| 3) 3,462 m = _____ km | 8) 19 mm = _____ cm   |
| 4) 18 l = _____ ml    | 9) 32.5 km = _____ mm |
| 5) 167 mm = _____ m   | 10) 250 mg = _____ g  |

### Convert between mass and volume of water

- |                      |                      |
|----------------------|----------------------|
| 1) 18.5 g = _____ ml | 5) 5 l = _____ kg    |
| 2) 23.4 ml = _____ g | 6) 34.7 kg = _____ l |
| 3) 2345 g = _____ l  | 7) 45.52 l = _____ g |
| 4) 3 g = _____ ml    | 8) 23.6 ml = _____ g |

choose the best answer:

A = bug size

B = tree height

C = your height

D = Driving distance

- |                 |                    |
|-----------------|--------------------|
| 1) 1.3 cm _____ | 5) 167 cm _____    |
| 2) 8 m _____    | 6) 167 km _____    |
| 3) 19 mm _____  | 7) 0.0023 km _____ |
| 4) 1.5 m _____  | 8) 1,675 mm _____  |

Name: \_\_\_\_\_

## LAB PRACTICAL REVIEW

### Triple Beam Balance

- 1) read the scale: \_\_\_\_\_
- 2) weigh the rock: \_\_\_\_\_
- 3) read the scale: \_\_\_\_\_
- 4) weigh the book: \_\_\_\_\_
- 5) read the scale: \_\_\_\_\_
- 6) weigh the bone: \_\_\_\_\_

### Graduated cylinders

- 1) read the scale: \_\_\_\_\_
- 2) read the scale: \_\_\_\_\_
- 3) read the scale: \_\_\_\_\_
- 4) read the scale: \_\_\_\_\_
- 5) read the scale: \_\_\_\_\_
- 6) read the scale: \_\_\_\_\_

### Density station

- 1) Find the density of the golf ball. Create a data chart:
  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
- 2) Find the density of the dolphin. Create a data chart:

### Meter stick

- 1) record the length of the string: \_\_\_\_\_
- 2) record the height of your chair: \_\_\_\_\_
- 3) how many centimeters in a meter: \_\_\_\_\_ mm in a meter: \_\_\_\_\_ mm in a cm: \_\_\_\_\_
- 4) record the dimensions of the box: length \_\_\_\_\_ width \_\_\_\_\_ height \_\_\_\_\_



Name \_\_\_\_\_ Remember to use units when writing down numbers. Start the answer sheet with the number of the station in front of you.

1 & 2) Perform the unit conversions and place your answer sheet in the box.

3) Record the mass of the wood block: \_\_\_\_\_

4) volume #1: \_\_\_\_\_ mass: \_\_\_\_\_ volume #2: \_\_\_\_\_

5) record the length of the book: \_\_\_\_\_

6) record the mass of the bone: \_\_\_\_\_

7) mass: \_\_\_\_\_ length: \_\_\_\_\_

8) length of paper in centimeters and millimeters: \_\_\_\_\_cm \_\_\_\_\_mm

9) explain what you see using the word density:

10) volume: \_\_\_\_\_

11 & 12 & 13) Record the volume of the rock: \_\_\_\_\_

14) record the mass of the telephone: \_\_\_\_\_

15) what happens at 0°C? \_\_\_\_\_

what happens at 100°C? \_\_\_\_\_

16) height of box in centimeters and meters: \_\_\_\_\_cm \_\_\_\_\_m

17 & 18 & 19 & 20) Choose any **one** item on this table and find its density: record any data you need to take:

21) Room temperature: \_\_\_\_\_ What is your body temperature? \_\_\_\_\_

Name: \_\_\_\_\_

Choose the best answer:

A=Hand span      B = Your height      C= Distance car drives  
D = Fingernail size

- |                 |                 |
|-----------------|-----------------|
| 1) _____ 1.7 m  | 2) _____ 155 cm |
| 3) _____ 1.3 cm | 4) _____ 167 mm |
| 5) _____ 4.5 km | 6) _____ 19 mm  |

Name: \_\_\_\_\_

\_\_\_\_\_ meter \_\_\_\_\_

Perform the conversions. Use the above chart to help you:

- |                       |                       |
|-----------------------|-----------------------|
| 1) 45.7 g = _____ mg  | 2) 4.2 m = _____ cm   |
| 3) 5432 l = _____ ml  | 4) 92 kg = _____ g    |
| 5) 15.4 cm = _____ mm | 6) 2.76 km = _____ mm |

If you measure out 140 ml of water, what will be the water's mass? \_\_\_\_\_

Performance Assessment:

- 1) The student will be able to utilize and read the tools of a science laboratory.
- 2) The student will be able to use the metric system and convert between units
- 3) The student will be able to find the density of an object and explain density

Room arrangement for this assessment is by students moving approximately every 2 minutes from one station to the next station on command from the teacher. No two students should be at the same station at the same time. Stations that take extra time are allotted more than one station number. Students are provided an answer sheet and directions for the activity at each station. Each station has the materials and lab equipment needed.

- 1 & 2: enclosed paper is provided
- 3: wood block and triple beam balance
- 4: graduated cylinder with 12.5 ml water, triple beam balance with weights on 167.4 g, graduated cylinder with 59 ml water
- 5: meter stick and textbook
- 6: triple beam balance and bone
- 7: triple beam balance with weights on 50.2 g, meter stick marked with taped on arrow pointing to 44.7 cm
- 8: piece of paper and meter stick
- 9: glass jar sealed by glue containing blue water, pen cap, and turpentine which forms density layers
- 10: graduated cylinder with 16.2 ml water
- 11 & 12 & 13: rock, graduated cylinder, triple beam balance, overflow can, beaker, water
- 14: triple beam balance and telephone
- 15: thermometer
- 16: box and meter stick
- 17 - 20: battery, golf ball, candle, overflow can, water, beaker, graduated cylinder, triple beam balance, calculator
- 21: thermometer

Scoring: The unit conversion sheet is given one point each for 13 points  
The other stations are scored one point for correct number, one point for correct units, station 9 is worth 2 points, and station 17 - 20 is worth 3 points for a total of 37 points.

Overall test is worth 50 points.

**UNIT III: MOTION**Unit Objectives:

1. Be able to determine a definition for motion in terms of a frame of reference
2. Be able to calculate speed, acceleration, and momentum in lab exercises and problems
3. Be able to graph collected data for speed and acceleration
4. Be able to use physics equations to calculate rates using units correctly

Classroom Activities:

1. Minute questions: "What does it mean to be motionless? Give an example of something that is motionless and explain your choice"
  - \*Star picture (time lapsed): ask for feedback as to what the picture depicts
  - \*Calculations: present globe to class. Ask how fast we are moving while sitting at our desks.
2. Discussion: How do we measure motion if we are on a moving planet?  
Introduce "Frame of Reference"
  - \*Graphs of motion- students draw the rough graph of a subject moving across the classroom, slow, fast, stopping and going, acceleration, constant speed
  - \*Mini-lab for students to practice obtaining the speed of various rolling or moving toys from the speed formula that was intuitively obtained. Supply stop watches and meter sticks
3. Inquiry: How can we determine the speed of various activities? outside activity
4. Demonstration: Calculate the speed of sound (outside activity)
5. Activity: Finding the acceleration of a biker. Outside space students 5 meters apart along the track with stop watches. The biker accelerates from the start mark past each of the students that record the time to pass. Graph the motion from this collected data
6. Lab: What is the acceleration due to gravity and how is it graphed?
7. What is Momentum?
  - \*Shipping news article about ships and momentum
  - \*Momentum of a bullet thrown vs fired from a gun
  - \*Ping pong ball gently tossed at wooden block vs. thrown hard
  - \*Newton's cradle
  - \*Tennis ball dropped on top of basketball (outside!)
8. Save-It sheet: Physics problems
9. Motion puzzlers(optional)

Minute questions:

- \*Why is it impossible to be motionless?
- \*How can we measure motion on a moving planet?
- \*If my friend and I are biking side by side are we moving relative to each other?

Why?

\*If I'm on a bus traveling 25 m/s and walk up the aisle at 2 m/s, how fast am I moving relative to the students sitting on the bus? How fast am I moving relative to the person standing by the road?

Assessment:

1. Daily journal writings: "What happened today in class?" "What questions do you have?" "What did you learn today that you disagree with or that surprised you?"
2. Science minute questions
3. Directed lab activity and inquiry
  - \*Inquiry: How can we determine the speed of various activities
  - \*Lab: What is acceleration due to gravity

### Unit III: Motion

Unit III introduces a physics problem of Galileo's time, the definition of motion. Through this unit, students should gain a sense of the importance of defining motion in terms of a frame of reference. Students will quantify motion using their own data from velocity and acceleration experiments. Several activities require going outside, optimally to a track area.

The unit begins with a question to ponder, "What does it mean to be motionless?" Follow this question and student responses with a time lapsed image of stars that appear to revolve around the North Star and ask for their ideas of what the picture depicts. Many students have not yet been exposed to time lapsed photography, but often a student does offer that solution. Most students at this age know that it is the Earth's, not the star's, rotation that gives the impression shown by the picture. Lead other students to an understanding that we think of the Earth as motionless, but indeed it is not motionless. So now rethink our original question.

The calculation for the speed of our rotation at the equator can be easily completed once students find out the Earth's circumference is 24,000 miles and that we take 24 hours for a full rotation. Depending on the sophistication of the class, a discussion can follow on the speed of rotation at the poles, but it is not recommended to get into those calculations unless a student asks. From the rotational speed many students then jump to another one of Earth's movements, the speed of our revolution about the sun. The numbers are big but most students have had enough math to know that circumference equals  $\pi$  times diameter. Using 92 million miles as the radius from Earth to sun, and 365 days times 24 hours, we get approximately 66,000 miles/hr. Supply calculators and encourage students to work along. At this point it is convenient to post the speed of sound, 760 mi/hr, and the speed of light, 186,000 mi/sec (670 million mi/hr). Some students may go to the next step that our solar system rotates within the Milky Way galaxy which is part of an expanding universe. Again ask students to describe something that is motionless.

Most students now realize that nothing is stationary. This comment leads to the importance of a frame of reference in order to talk about motion. Have students walk together across the room and discuss from the two possible frames of reference where there is motion. Think about sharing snacks in a car moving 60 mi/hr along the highway or walking down the aisle of a jet going 600 mi/hr. Intuitively teach students how to draw a time-distance graph for speed. Draw the labeled axes on the board and then walk at a constant speed across the room and ask them to graph that motion. Check for accuracy. Usually at least one

student can do this activity; allow that student to explain the results. Then repeat the process, but vary the walking speed; start with a fast speed and change to a slow speed. Look for accuracy and explanations of student work. Repeat the activity but add a period of time the subject is stopped. Some students realize that the distance does not change but time does continue to pass, so the graph takes a zero slope at that point until the subject walks again. Graphs will appear as follows:



By this time students should realize that the measurements needed to calculate speed are distance and time. Pass out meter sticks, stop watches, and calculators. Have a supply of items that can move (whether wind up toys or balls rolling down a ramp) and give the students time to practice setting up a data chart, collecting data, and calculating speed. Rain gutter sections make good ramps that keep toys from rolling away.

After students have had some experience with the toys indoors, pass out the inquiry on finding speed. Again give student groups time to come up with a procedure and data chart. Then give time for class discussion about the materials and methods necessary before heading out the door. Each student group needs a stop watch and a long meter tape or trundle wheel. Some of the activities students have come up with are throwing fast balls, running, riding a bike, timing cars passing the school, and even frisbee tossing. It takes time to generate accurate data. More sophisticated students will realize they are calculating average speed.

As a culmination to finding the speed of the student activities, the speed of sound can be done with a cooperative group of students. The distance is best if you have access to a visible length that is more than a football field. Provide a set of woodblocks from the band teacher (or any object that has a visual signal when the sound is made) to a pair of students that stand at the far end of the measured distance while the rest of the class with stop watches stands at the other far end within sighting distance. On a hand signal from the teacher, the student hits the wood block with the mallet held over his head so the students with the stop watches can see this moment and start the timing. The sound arrives immediately so students must be ready to hit the stop almost instantaneously. Record the data and repeat the process at least 5 times so the students can get the idea of the speed. It is best to have another teacher

coordinate the students with the wood block since it becomes useless data if the student continuously hits the wood block or does not make it obvious when the block is struck. Sound travels at 760 mi/hr which is about 1100 ft/sec, so ideally students are at least 500' apart.

Activities so far have actually calculated average speed. The demonstration to find acceleration of a biker begins discussion about the definition of changing speed, or acceleration. By spacing students along the track at 5 meter intervals, students can time how long from the start it takes the biker to pass them. Post this data on the board and discuss that even though the distances between students remains the same, the time interval decreases. Graph the data using either the spreadsheet function or by hand.

This intuitive activity leads to the lab on the acceleration due to gravity of falling objects. In this case, the dots on the accelerometer tape are placed at equal time increments, yet the distance between the dots becomes greater as the object accelerates through its fall. This lab leads to discussion around issues of terminal velocity and the effects of air resistance, or lack thereof, if skydiving on the moon.

Momentum looks at velocity and mass. Students can relate to momentum as the ability to do damage to whatever the object hits. The newspaper article discusses the difficulties of slowing down a barge; a bullet thrown at a hunted deer does little damage compared to a bullet moving out of a gun; a wooden block is not budged by a slowly tossed ping-pong ball, but can be pushed away by a thrown ping pong ball; Newton's cradle demonstrates the transfer of momentum; a tennis ball dropped simultaneously on top of a basketball receives the momentum from the basketball and is bounced up high due to the mass of the tennis ball being much less than the basketball. Velocity must be increased to maintain the momentum of the system.

There are practice physics problems provided on the Save-it sheet. Emphasize the 4 steps, as this attention to detail will benefit students when more complicated physics formulae are taught. It is imperative for students to learn to write the formula first before trying to substitute in values. For many students, replacing unknowns with a known value is a new concept, especially when one of the knowns appears after the equal sign. In some math curricula students have dealt with "empty boxes" to fill in with numbers. Teach students to check for units agreement. The final activity is the interesting motion puzzlers. Set up a classroom atmosphere that is conducive to thinking through the puzzlers and allows for student led discussion. Get out the bicycle and toss balls to verify some of the problems encountered.



Name: \_\_\_\_\_

**SAVE-IT SHEET for SCIENCE: Motion & Physics Problems**

To solve these problems follow these 4 steps

- 1\*\*Write down the formula
- 2\*\*Write numbers with their units below the matching formula letters
- 3\*\*Solve the math problem for the missing letter
- 4\*\*Check that the number answer contains the correct units

Formulae you need

$$\text{Speed} = \text{Distance} \div \text{Time}$$

$$\mathbf{S = d \div t}$$

$$\text{Acceleration} = \frac{\text{final speed} - \text{original speed}}{\text{time}} \quad \mathbf{a = \frac{V_f - V_o}{t}}$$

$$\text{Momentum} = \text{mass} \times \text{velocity}$$

$$\mathbf{M = m \times v}$$

1. What speed did an airplane fly if it went 1760 meters in 8 seconds?
  
  
  
  
  
  
  
  
  
  
2. Find a car's speed if the car traveled 100 km in 2 hours.
  
  
  
  
  
  
  
  
  
  
3. Find the speed of migrating geese if they traveled 75 km in 8.5 hours.
  
  
  
  
  
  
  
  
  
  
4. Bryan ran in the track meet 250 m in 30 sec. What was his average speed?

Name: \_\_\_\_\_

5. Brittany drove 200 miles from Boston to Freedom in 4 hours. What was her average speed?

6. If Morgan ran at a speed of 8 miles/hour, how far did she run in 2 hours?

7. Find the acceleration for a airship traveling at 800 m/sec that takes 20 seconds to speed up to 1200 m/sec.

8. Find the acceleration for a car that goes from zero to 40 m/sec in 10 seconds.

9. Find the acceleration for the car going 45 mi/hr to 60 mi/hr in 3 seconds.

Name: \_\_\_\_\_

10. Find the acceleration of the runner who takes from the start of the race 5 seconds to get to a speed of 10 m/sec.

11. Find the momentum of a 1 g snail traveling 3 mm/sec.

12. Find the momentum of a 1250 kg car traveling at 100 m/sec.

13. Find the momentum of a 500 kg car traveling at 250 km/hr.

14. Find the momentum of a 1000 kg truck traveling at 83 km/hr.  
Does the car in #13 or this truck have more momentum?

CAREFUL, THE FORMULAS ARE ALL MIXED UP in the following problems!!!!

15. Find the average speed of the duck that took 4 hours to fly 100 miles.

16. Find the acceleration of my Lamborghini that goes from 45 mi/hr to 85 mi/hr in 4 seconds!

Name: \_\_\_\_\_

17. What momentum does a 2 g snail have when traveling at 5 cm/sec?
  
  
  
  
  
  
  
  
  
  
18. What is the jogger's speed if she ran the first 1000m in 250 sec?
  
  
  
  
  
  
  
  
  
  
19. The Space Shuttle travels in orbit at 21,000 km/hr. How far does it go after 5 hours?
  
  
  
  
  
  
  
  
  
  
20. A car accelerates from 0 to 72 km/hr in 8 seconds. What is the car's acceleration?
  
  
  
  
  
  
  
  
  
  
21. You discovered an old mining shaft and drop a rock down the hole. After 3 seconds you hear the rock hit bottom. If the rock falls at an acceleration of 9.8 m/sec/sec, what was its final speed when it hit bottom?
  
  
  
  
  
  
  
  
  
  
22. A space ship is traveling at 20,000 m/sec. The computer program accelerates the space ship to a final speed of 24,000 m/sec taking 50 seconds. What is the acceleration of the spaceship? What will the astronauts feel from inside the shuttle?

Name: \_\_\_\_\_

INQUIRY  
**HOW CAN WE DETERMINE THE SPEED OF VARIOUS  
ACTIVITIES?**

1. With your lab group, decide on five activities to study for their speed. It can be such activities as group members' walking and running speeds, the speed of a bicycle, the speed of a batted ball, or the speed of the cars going down the road. Each member should participate in some activity.
2. Discuss with your group the measurements you need to find speed. Explain why you think these measurements are needed.

Explain how you will take these measurements and how you will calculate the speed. Think about what you will use for start and finish lines for a frame of reference.

3. Develop a procedure to do the experiment to find the solution to this inquiry.

This inquiry will be Graded on these expectations:

Rubric: **How can we determine the speed of various activities?**

I. Lab is completed on time by group with each member working together. This requires cooperation while outside.

- 5-Lab is completed and student helped fairly
  - 3-Lab is completed and student helped just some
  - 1-Lab is completed but student did not help the group
- 

II. Oral presentation to the class explaining the procedure and results of your data

- 5-You spoke clearly and had an equal part in the presentation
  - 3-You spoke clearly and had a small part in the presentation
  - 1-You did very little in the presentation
-

Name: \_\_\_\_\_

**III. Written report clearly provides**

- \*Introduction explaining the problem to be solved**
- \*Materials and Methods used by the group to find the speed**
- \*Data chart of the measurements taken, clearly labeled, and organized**
- \*Bar graph to compare the results of the speed of the activities**
- \*Conclusion that explains what is speed and how it is measured. Look at your data and find the fastest, slowest, and most surprising results and write about what you learned.**

**10-All five sections of the lab report are provided**

**5-Lab report sections are not present**

**1-Lab report not complete in requirements**

---

**IV. Interesting Format to read and researched**

**5-High interest reading, additional information provided from research on speed and how it is determined**

**3- Interesting to read, but little extra information provided**

**1-Made an attempt to make it interesting/no details added**

---

**V. Language Arts: Grammar/Sentence Structure/Spelling**

**5-Few errors for the length of the paper**

**1-Many errors and hard to read and understand**

---

**VI. Paper is passed in on time (0 to 5 points)**

---

Parent Comments about this paper and signature that the paper was proofread:  
bonus 5 points

Name: \_\_\_\_\_

## MEASURING ACCELERATION DUE TO GRAVITY

### Introduction

This lab will answer the question for what is the shape of the graph for acceleration. When objects are dropped in a free fall, they accelerate as they fall until they reach terminal velocity. Terminal velocity is due to the friction from the air through which the object falls. In this lab, the object will fall from a short distance, so air resistance will not be an experimental factor.

### Materials and Methods

A piece of lab equipment, called the accelerometer, will be used to record the acceleration of the falling object, in this case a lab weight. The lab weight is taped at one end of two meters of accelerometer tape. Thread the tape through the accelerometer and hold the accelerometer and weight about two meters above the floor. Turn the accelerometer on and let the weight fall freely to the floor, pulling the tape behind it.

Remove the tape from the weight. Label the first dot "0", and successively number every other dot along the tape. Measure the distance from dot "0" to each of the dots and record the data. Using the data generated, create a graph with time on the horizontal axis and distance on the vertical axis.

<u>Data</u>			
DOT	DISTANCE	DOT	DISTANCE
1		14	
2		15	
3		16	
4		17	
5		18	
6		19	
7		20	
8		21	
9		22	
10		23	
11		24	
12		25	
13		26	

Name: \_\_\_\_\_

Conclusion

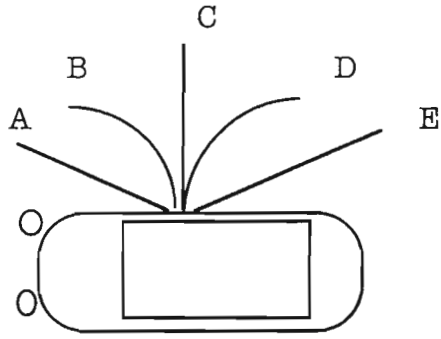
1. What were the units used to record time?
2. Explain what you observe about the spacing of the dots along the tape?
3. Look at the graph. Does the falling weight move smoothly, or does it jerk as it is falling? How can you tell by looking at the graph?
4. Explain how you can tell from looking at the graph if the weight was falling at a constant speed, accelerating as it fell, or decelerating as it fell.



Name: \_\_\_\_\_

### MOTION PUZZLERS

1. You are standing on a bridge over a highway. When a car passes below you, someone throws a baseball sideways out the window. Which path below best describes the motion from your point of view?



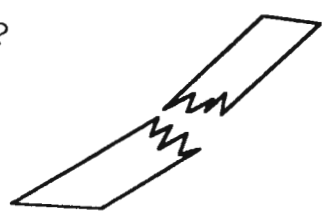
2. You are in an elevator on the top floor of a tall building standing on a bathroom scale. Suddenly the elevator moves downward. What will your weight appear to do?

What will your weight appear to do when the elevator slows down?

What will your weight appear to do when the elevator lifts you up again?

3. A large hot-air balloon with a basket suspended below is seen moving along at a high altitude. Do the passengers feel any wind?

4. When a high smokestack is knocked over by dynamite it often breaks as it falls like this. Why?



5. A man, a horse, and a car are lined up for a 30-foot race. Who wins?

Name: \_\_\_\_\_

6. A man is walking at 5 km/hr along the top of a train moving at 100 km/hr. If he is walking toward the front of the train, what is his velocity from the frame of reference of the Earth?

7. If I throw a bullet at a can, it will not do as much damage as when I shoot the bullet from a gun at the same can. Why?

8. You are standing on the platform of a train station when a train passes by at 100 km/hr. Just then a man standing on the rear of the train throws a baseball backwards at 100 km/hr. As the man on the train passes in front of you, where will the ball strike the tracks? What path will the ball take?

9. When a man-made satellite is launched into space, they usually are launched from west to east at points near the equator. Why is this done?

10. When you go around a curve in a car you are "thrown" against the outside of the curve that the car is turning. Why aren't astronauts thrown against the outside of the curve of their spaceship as they circle the earth?

11. Explain what the unit 10 mi/hr/hr means.

12. Why do astronauts orbiting in the space shuttle appear to be weightless from the space shuttle's frame of reference?

13. Units for: speed \_\_\_\_\_ distance \_\_\_\_\_ time \_\_\_\_\_  
acceleration \_\_\_\_\_ momentum \_\_\_\_\_ mass \_\_\_\_\_

1. Path A, because the ball will continue to move forward with the car and sideways due to the direction of the toss.
2. Downward motion: Lose weight    Slows down: gain weight    Lifts up: gain weight
3. Passengers do not feel any wind as they are moving with the wind.
4. The farther up you are on the smokestack, the further the distance to fall through the arc to the ground so the greater the speed you must have to keep up with the shorter radius distance. Yet all objects fall at the same speed due to the acceleration from gravity. Since the top of the smokestack can't fall any faster to catch up to the shorter arc distance of the lower section, stresses form and the smokestack breaks.
5. The man wins since the horse and car have greater inertia to overcome for the initial acceleration. The car will win in a longer race given enough time to accelerate to its maximum speed.
6. The man is walking 105 km/hr total with reference to the earth.
7. Since momentum is mass times velocity, the greater the velocity the more momentum.
8. The ball will land on the tracks right in front of you as it falls straight down to the track.
9. The Earth turns from west to east. The Earth's surface moves fastest at the equator where the Earth's surface is farthest from the axis of rotation. Satellites possess this speed at their launch sites.
10. As the car goes around the curve, the passengers tend to continue in a straight line path and bump against the side of the car. The car supplies the force to keep the passengers moving in the arc. In a spaceship, the inward force is supplied by gravity, not the spaceship. So together the spaceship and astronauts fall around the curve of the Earth's surface, pulled into the curve by gravity.
11. 10 mi/hr/hr means an acceleration at the increasing rate of speed of 10 mi/hr as each hour passes.
12. The space shuttle and astronauts have the same acceleration and together they are falling around the Earth. This causes the astronauts to never appear to "fall down" from the frame of reference of the shuttle. If the shuttle should change its speed then the astronauts would indeed "bump" against the sides of the shuttle until they are "pushed" into the new speed of the shuttle.

**UNIT IV: FORCES**Unit Objectives:

1. Observe that a force is a push or a pull that changes the motion of an object
2. Apply Sir Isaac Newton's 3 laws of Motion to rocketry study
3. Understand the Law of universal gravitation and projectile and orbital motion

Classroom activities:

1. Classroom setup: Set a strong magnet up high and tie a paper clip to a long string that is attached to the floor. Suspend paper clip close enough to the magnet so the paper clip is held up in the air by the force of magnetism. Discuss.
2. Classroom activity: Hold a weighted bicycle tire at the hub. Spin it and move around the room or while sitting in a freely rotating chair
3. Save-It sheet for Science. Discuss and define what is a force
  - a) Fill in Save-It sheet for Forces
  - b) Divide class into 3 groups. Read articles about athletes, friction, and equipment design. Present the information to the rest of the class.
 Wrap-up classroom activity: Place dishes on cloth and have students flick cloth out from under dishes
4. Define Newton's Laws of Motion on Save-It sheet through activities
  - a) Law #1 Inertia class activities: flick coin on card/wood block, flick cloth from beneath dishes, bicycle tire spin, toss ball up while riding a bicycle, toss ball to passerby while riding a bicycle, roll a creamy soup vs a liquid soup down a ramp
  - b) Law #2 Unbalanced forces ( $4.5 \text{ N} = 1 \text{ lb}$ )  $F = m \times a$  class activities: weigh then hit a pool ball against racket ball, Newton's cradle, bounce a tennis ball on top of a basketball, push a student sitting in a wagon with 5 pounds of force (push against a bathroom scale on their back) to show the acceleration that occurs.
  - c) Law #3 Forces act in pairs class activities: step off a skateboard (you go one way and board other), Place a board on top of 8 basketballs and walk, balloon pinwheel made by a balloon attached to bent straw that is pinned horizontally to a pencil eraser
5. Inquiries: How can we design a rocket and keep it stable in flight?
 

Divide class into 5 groups to explore rocketry after demonstrating the activities and generating the questions to explore; see Teachers Guide on Rockets

  - #1 Balloon car (reduce friction, placement of balloon straw)
  - #2 Newton Car (mass thrown off and distance it goes, number of rubber bands)
  - #3 Hero engine (spin rate, hole design)
  - #4 Rocket antacid film canister (tablet amount, pieces, hot water, amount of water)
  - #5 Paper rockets blown with straw (center of mass, center of pressure, fin

angle, weight in cone)

Groups then report out results which are used to build and design own soda bottle rocket; be sure to explain center of mass/pressure. Soda bottle rockets are launched under air pressure from bicycle pump and added water. Flight may be timed to compare designs.

<http://quest.arc.nasa.gov/space/teachers/rockets/act11.html>

6. Define Universal Law of Gravitation: Before providing the answers on Save-It sheet get student feedback on what they think.

a. Class activity: demonstrate Einstein's rubber sheet model that gravity is due to a curvature in space.

b. Mini-lab: using Newton's second law of motion students will find "What is the acceleration due to gravity?"

7. Save-It sheet:  $F = m \times a$  physics problems

On Earth we accelerate at 9.8 m/sec/sec (32 ft/sec/sec); Gravity causes planets and objects to orbit (5 mi/sec or 17,000 mi/hr); Gravity creates projectile motion from forward inertia

8. Classroom demonstrations:

a) free fall: discrepant event: ask students to explain if you let go of a hammer and feather standing on moon or standing on the Earth which will land first? Then show clip from NASA film

drop crumpled piece of paper, ping pong ball, rock, wood block together

drop a can with a hole in bottom side and filled with water (will water come out?)

drop the balloon pop-it gadget (will balloon pop while the contraption is falling?)

b) Terminal velocity: sky divers are 120 mi/hr spread eagle & headfirst at 190 mi/hr

c) Projectile motion: shoot the projectile forward inertia vs gravity pull. Forward toss and at same time drop another basketball

d) Orbital motion: to orbit Earth, object must go 5 mi/sec which is 17,000 mi/hr at 180 mi high (need 7 mi/sec to escape Earth's gravity)

9. Show NASA film of astronauts living and working in space

10. (Optional) Isaac Asimov Science fiction story *The Billiard Ball* dealing with the notion of the possibility of no gravity and the effect on motion

11. (Optional) Toys in Space program and video For excellent information see this site: (or do a google search for "NASA" "Toys in Sapce" )

<http://216.239.39.104/search?q=cache:M0OttUHLuvcJ:spacelink.nasa.gov/Instru ctional.Materials/NASA.Educational.Products/Toys.In.Space.II/Toys.In.Space.II.pdf+%22NASA%22+%22Toys+in+Space%22&hl=en&ie=UTF-8>

12. Lab practical - performance assessment

Minute Questions:

- \*How does a parachute work on Earth
- \*How does a parachute work on the Moon
- \*What is a black hole
- \*If there is gravity in space, why do the astronauts look weightless?

Assessment:

1. Daily science minute questions
2. Mini-inquiries for rocket design activity
3. Mini-inquiry: What is the acceleration due to gravity?
4. Physics problems worksheet
5. Lab practical performance assessment

## Unit IV: Forces

Unit IV focuses on Newton's Laws of Motion and with it the concept that all changes in motion are due to a force acting on the object. The classroom is set up with an interesting problem. To the students it appears as if a paper clip is suspended from a string up from the floor, not the expected hanging down from a ceiling. Questions are generated about the impossibility of this problem. Eventually the strong magnet that attracts the paper clip is revealed. The Save-it sheet continues with physics equations for Newton's Second Law. As earth-bound creatures, the force of gravity and effects of friction dominate all motion. It becomes a leap of mind to get students to start thinking about what happens to motion in an environment without friction. Likewise it is a leap of mind for students to realize that space travel is dominated by gravity. The misconception that space is a zero gravity environment is difficult to overcome. In honor of the recognition Sir Isaac Newton has received for making space travel possible, this unit teaches motion and forces with rockets. The resource used in developing this unit is a NASA publication, *Rockets, A Teacher's Guide with Activities in Science, Mathematics, and Technology*. This resource is also found on the internet.  
<http://quest.arc.nasa.gov/spaceteachers/rockets>

The classroom magnet setup activity and classroom demonstration activities are designed to start students thinking about what they take for granted. There are forces other than gravity (magnetism in this example) and objects that continue traveling in the same direction (the bicycle tire) or stay at rest if already at rest (the dishes on the table). Finally friction is the force that opposes all motion, which athletes work hard in both skill and equipment to use to their benefit.

There are several suggested demonstrations for Newton's Laws. The First Law teaches the concept of inertia. Once an object has motion it will continue to move the same way, or in the absence of motion, it will stay at rest.

- First set a coin on a playing card over a tin can and flick the card out from beneath; then change to a 5" length of a 2" by 4" to dispel the notion that the coin falls down because the card weighed less than the coin. An interesting discussion follows the demonstration of the different speeds at which the creamy vs. the watery soup rolls down a ramp.
- The watery soup in the can does not turn with the can like the creamy soup does.
- Use a coordinated biker and move outside. Have the biker ride while tossing a ball straight up and down. The students will see from their frame of reference that indeed

the ball arches forward. Have the biker toss a ball sideways to a student. The students will see that the ball continues to arch forward.

To demonstrate Newton's Second Law, a large massive object's slow acceleration will force a less massive object into a rapid acceleration.

- The light weight tennis ball is quickly accelerated by the more massive basketball. To get this effect, it takes practice to drop the two balls simultaneously such that the tennis ball rests squarely on top of the basketball as they fall together. Rocket design utilizes rapidly expelled lighter fuel to generate a force capable to accelerate the massive rocket to lift off. As the fuel is used up, the mass of the rocket decreases so that the acceleration rapidly increases, especially as rocket stages are dropped.
- Acceleration is interesting to show as the result of a constant force applied to a mass. With a student seated in a wagon or on a skateboard, another student pushes against a bathroom scale placed against the back of the seated student. The pusher must work to keep the scale on the same number, and as that is accomplished the seated student in the wagon accelerates around the track as the pusher must run faster to keep the scale on the same value. This relates to the lab from the prior unit that shows all falling objects accelerate due to the constant force of gravity.

For Newton's Third Law students can compare the difficulty of running in sand versus a hard surface.

- Place a piece of plywood on top of 8 or so basketballs. With lots of spotters, have another student stand on the board and then try to take a step. Be careful as the board can easily go flying out the back.
- A safer demonstration is to place an inflated balloon on one end of a flexible straw, run a pin through the side of the straw at the center into a pencil eraser, and bend the neck of the straw. Let go of the balloon and as the air goes out the end of the straw in one direction the straw rotates in the opposite. Many students have the misconception that this is due to the expelled air pushing against the classroom air. Get the students to think about how this principle works in space where there is no air to push against; the expelled air pushes against the straw/rocket forcing it to move in the opposite direction.

For the rest of the unit students work in small groups on aspects of rocket design. Explain each of the five inquiry activities and let groups decide which activity they would like to try and report on. If there is access to a loading ramp with rollers, try to use that instead of the rolling dowels for the Newton car experiment. Teach students how to find the center of mass by finding the balance point when their rocket is wrapped in a string loop and how to



find the center of pressure by drawing an outline of their rocket on a flat piece of paper and again finding the balance point. To design a stable rocket, the center of mass must be in front of the center of pressure. The lessons students learn from the five inquiries should be applied when they build their soda bottle rocket. Have students test their rockets for the center of mass and center of pressure to ensure stable flight. With cooperation from the industrial arts program, the launching platform is easily constructed. Directions are found at this website. <http://quest.arc.nasa.gov/space/teachers/rockets/act10.html> There are ways to approximate the altitude of the rockets as described at this site, <http://quest.arc.nasa.gov/space/teachers/rockets/act9.html> or use a stop watch for the longest timed flight. Either use an air compressor or a bicycle pump with a pressure gauge to record launching pressures. Launching a soda bottle high into the air is pretty impressive.

The unit closes with activities about the universal law of gravitation. An explanation for the cause of gravity eludes science.

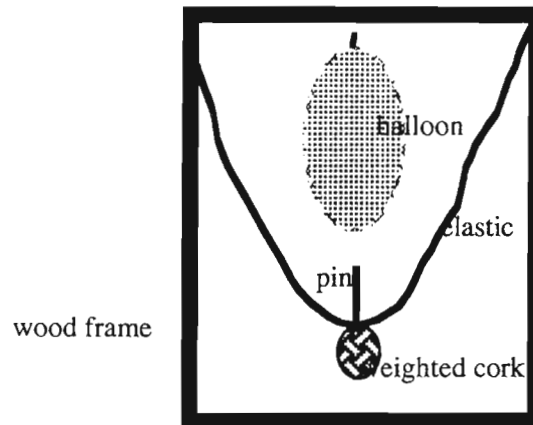
- Einstein's rubber sheet model is an interesting demonstration. Use a large rubberized sheet stretched out between students making it as flat as possible. Place different weights in the sheet and notice the differing impression depths formed. Place a ball onto the rubber sheet and note how it rolls into these impressions like all objects fall. If the ball is rolled with an initial speed it will dip in and out of impressions just as objects are affected by gravity fields as they move through space.
- The mini-lab to find acceleration due to gravity is a mathematical activity. The students will find the mass and weight of various objects, solve for the acceleration value, and find the average. The last problem on the lab is solved using the value they calculated for acceleration, about 9.8 m/sec/sec. With that value, the force generated is 2.45 Newtons. The 0.5 kg rocket weighs 4.9 Newton's ( $F = .5 \text{ kg} \times 9.8 \text{ m/sec}^2$ ).

Therefore the force from the fuel is not enough to lift the rocket. The lab leads into the problems on the Save-it sheet for Newton's Second Law.

As a wrap-up to this unit, there are many demonstrations for gravity that defy intuition. Students struggle with the concept that mass does not effect the rate of fall, but air resistance does.

- The can of water with a hole near its base is an interesting demonstration. After the vote is taken on what will happen, drop the can into a bucket. Before dropping the can let the students see that water can easily flow out, then stop the flow with your finger and let it drop.
- The balloon drop pop-it gadget is another counter-intuitive example, especially after

seeing the water can drop. It involves a cork weighted down with a needle stuck in the cork aimed at the balloon. The weighted cork is slung in a frame by an elastic. A balloon is attached to the frame right above the needle. When the gadget is dropped, the elastic is no longer stretched down (everything is now falling) so the weighted cork comes up and pops the balloon long before the gadget hits the ground. Intuitive thought is that the balloon will perhaps pop when the gadget hits the floor.



NASA puts out many films on living and working in space. The Isaac Asimov story, *The Billiard Ball*, is excellent and addresses the fascinating idea of what would happen if gravity could be turned off. It ends in a carefully planned murder. The Toys in Space program is a great way to get students thinking about the forces involved to make toys work and how to modify the toys to play with them in a micro-gravity environment. The final assessment is the lab practical that covers both the motion and forces units.

Name: \_\_\_\_\_

SAVE-IT SHEET for Science

**FORCES**

I. What does a **FORCE do?**

1.

2.

3.

II. Sir Isaac **Newton**, in 1660, defined how forces affect the motion of objects.

**NEWTON'S LAWS OF MOTION**

First Law of Motion:

Second Law of Motion:

Third Law of Motion:

III. (a) What is **Gravity**?

(b) What causes Gravity?

(c) What does Gravity cause to happen?

(d) Can you think of a place where there is no gravity?

Name: \_\_\_\_\_

What is the Universal Law of Gravitation?

### **PHYSICS PROBLEMS for Forces**

acceleration of a falling object (falls because of gravity) = 9.8 m/sec/sec

new formula:

$$\text{Force} = \text{mass} \times \text{acceleration} \quad \mathbf{F = m \times a}$$

To do these problems, use the 4 step method and formulae from your  
Motion Save-it Sheet

1. What force is required to accelerate a 40 kg mass at 4 m/sec/sec?
2. How large is the mass of the rocket if a force of 100 N is required to accelerate it up into the sky by 1 m/sec/sec?
3. What acceleration can a force of 1 N give a 1 kg object?
4. When I drop two metal balls that are the same size but of two different masses, does one ball hit the ground before the other ball?

Name: \_\_\_\_\_

5. Find the deceleration of Mike's car traveling at 30 m/sec which slows down to 10 m/sec in 5 seconds.

6. Find the speed of Ashlie running a distance of 100 m for 20 seconds.

7. Find Ryan's mass if he can accelerate on his roller skates at a rate of 2 m/sec/sec with a force of 100 Newtons.

8. Astronaut Nicole has a mass of 50 kg on Earth. What is her weight before liftoff?

9. Derek rolls a bowling ball with a force of 15 Newtons and accelerates it at 3 m/sec/sec. Find the mass of the bowling ball.

10) Find the force needed to push 65 kg Will with an acceleration of 2 m/sec/sec.

Name: \_\_\_\_\_

11) If 40 kg Malin is pushed by Edwin at an acceleration of 5 m/sec/sec, how much force is being used?

12) A 3000 kg airplane is launched from Scott's aircraft carrier by a force of 385,000 N. What is the acceleration of the airplane?

13) If the mass of your lab table is 15 kg, what is its weight?

14) What is the mass of 430 N Heather?

15) What is the speed of Devan's bicycle that takes 20 seconds to go 100 m?

IV. What are the four forces in the universe, what do they do, and what causes them?

SAVE-IT SHEET for Science  
FORCES

I. What does a **FORCE** do?

1. A force is a push or a pull on an object (forces due to gravity, electricity, magnetism, mechanical)
  2. A force may start, stop, or change the direction of motion of an object
  3. Forces determine the motion of all objects, including us, our toys and our solar system.
- All forces are opposed by friction

II. Sir Isaac **Newton** in 1660 defined how forces affect the motion of objects.

**NEWTON'S LAWS OF MOTION**

First Law of Motion: Inertia

An object in motion tends to stay in the same motion. An object at rest will stay at rest. Only unbalanced forces can affect the object's motion.

Second Law of Motion: Unbalanced forces  $F = m \times a$ 

An unbalanced force accelerates an object in the direction of that force

Third Law of Motion: Forces act in pairs.

For every action there is an equal and opposite reaction

III. (a) What is **Gravity**?

A force that causes objects to be attracted together. It occurs instantaneously between objects even when at a distance.

## (b) What causes Gravity?

Scientists do not know but have proposed the graviton particle theory

## (c) What does Gravity cause to happen?

Causes objects to attract each other and fall at a constant acceleration (attains terminal velocity)

Causes projectile motion in objects with a forward force and the downward pull of gravity

Causes orbital motion as object falls around the planet (17,000 mi/h ..5 mi/s...at 150 miles altitude on Earth) Need a launch escape velocity of 25,000 mi/h...7 mi/sec... to leave Earth's gravity pull

## (d) Can you think of a place where there is no gravity?

Gravity is instantaneous and everywhere

## What is the Universal Law of Gravitation?

All objects in the universe attract each other by the force of gravity. The size of the force increases as the size of the masses increase. The size of the force decreases as the distance between the objects increases.

## IV. What are the four forces in the universe, what do they do, and what causes them?

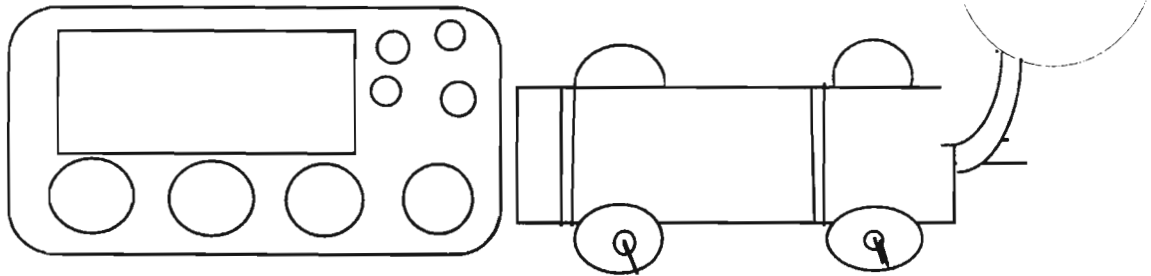
- |  |            |
|--|------------|
| 1. Gravitation: attracting force between 2 bodies that have mass | Graviton   |
| 2. Electromagnetic: creates light, magnetism, and electricity    | Photon     |
| 3. Strong (nuclear): Holds nucleus of atom together              | Z Bosom    |
| 4. Weak force: Nuclear decay                                     | W particle |

Name: \_\_\_\_\_

### ROCKET CAR

**INQUIRY: HOW CAN I CONSTRUCT A CAR PROPELLED BY A BALLOON?**

**INTRODUCTION: YOU WILL DEMONSTRATE NEWTON'S THIRD LAW OF MOTION BY CONSTRUCTING A BALLOON POWERED CAR FROM A STYROFOAM TRAY. YOU MUST EXPERIMENT ON WAYS TO KEEP THE CAR IN STRAIGHT LINE MOTION, WAYS TO MOUNT THE BALLOON AND DIRECT THE EXHAUST OF AIR, AND WAYS TO REDUCE FRICTION. THE TRIAL RUNS OF THE CAR ARE EXPERIMENTING FOR WAYS TO GAIN THE GREATEST TRAVEL DISTANCE.**



**MATERIALS AND METHODS: YOU WILL BE PROVIDED WITH A STYROFOAM TRAY, PINS, STRAW, AND BALLOON. USE THE SUGGESTED IDEAS TO BUILD THE CAR. VARY THE SIZE OF THE WHEELS THAT ARE HELD IN PLACE WITH PINS, VARY THE LENGTH OF THE CAR BODY, AND LOOK FOR WAYS TO REDUCE FRICTION ESPECIALLY BY ALIGNING THE WHEELS.**

**DATA: (SAMPLE IDEA)**

<u>TRIAL NUMBER</u>	<u>WHEEL SIZE</u>	<u>BODY LENGTH</u>	<u>BODY WIDTH</u>	<u>DISTANCE TRAVELED</u>
---------------------	-------------------	--------------------	-------------------	--------------------------

**CONCLUSION: FROM THE DATA, DECIDE ON THE BEST WAY TO GET THE MOST DISTANCE FROM THE CAR. DESCRIBE WAYS THAT YOU REDUCED FRICTION IN THE CAR DESIGN. DESCRIBE HOW NEWTON'S THIRD LAW OF MOTION APPLIES TO THE CAR; APPLIES TO ROCKET FLIGHT.**

*<http://quest.arc.nasa.gov/space/teachers/rockets/act2.html>*

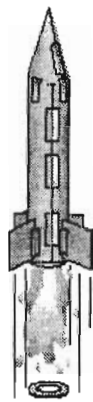


Name: \_\_\_\_\_

### 3-2-1- POP!

**INQUIRY: HOW CAN I CONSTRUCT A ROCKET THAT HAS STABLE FLIGHT AND FLIES THE HIGHEST?**

**INTRODUCTION: YOU WILL DEMONSTRATE NEWTON'S LAWS OF MOTION BY CONSTRUCTING A PAPER ROCKET AROUND A FILM CANISTER FILLED WITH WATER AND ANTACID TABLET. YOU MUST EXPERIMENT TO FIND OUT HOW THE AMOUNT OF WATER AND ITS TEMPERATURE, HOW THE AMOUNT OF TABLET, AND HOW THE AMOUNT OF ROCKET MASS ALL EFFECT THE FLIGHT.**



**FIND THE CENTER OF MASS**

**FIND THE CENTER OF PRESSURE**

**MATERIALS AND METHODS: YOU WILL BE PROVIDED WITH A FILM CANISTER, ANTACID TABLET, AND CONSTRUCTION PAPER TO BUILD A ROCKET. YOU CAN VARY THE LENGTH OF THE ROCKET, THE NUMBER OF FINS, THE TEMPERATURE OF THE WATER, AND SIZE OF TABLET USED. MAKE SLITS IN WHICH TO INSERT AND ATTACH THE FINS. CUT OUT A PAC MAN SHAPE TO MAKE THE CONE. BE SURE TO TAPE THE FILM CANISTER TO THE ROCKET, WITH THE LID FACING DOWN. TO LAUNCH THE ROCKET, FILL THE CANISTER TO DESIRED DEPTH, DROP IN AMOUNT OF TABLET TESTED, SNAP LID ON QUICKLY, STAND ROCKET ON LAUNCH PLATFORM, AND STAND BACK. MEASURE HOW HIGH THE ROCKET TRAVELS.**

**DATA : (SAMPLE IDEA)**

**TRIAL NUMBER   ROCKET MASS   FIN NUMBER   WATER TEMP   TABLET SIZE   HEIGHT TRAVELED**

**CONCLUSION: FROM THE DATA, DECIDE ON THE BEST STRUCTURE FOR THE ROCKET AND BEST FUEL FOR THE HIGHEST FLIGHT. DESCRIBE HOW NEWTON'S LAWS OF MOTION APPLY TO THE ROCKET FLIGHT.**

*<http://quest.arc.nasa.gov/space/teachers/rockets/act3.html>*

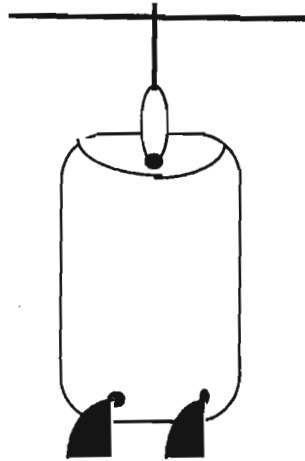
Name: \_\_\_\_\_

## POP CAN HERO ENGINE

**INQUIRY: HOW CAN I MAKE A SODA CAN HAVE MORE SPINS BY USING THE FORCE OF FALLING WATER?**

**INTRODUCTION: YOU WILL DEMONSTRATE NEWTON'S THIRD LAW OF MOTION BY USING THE FORCE OF FALLING WATER TO CAUSE A SODA CAN TO SPIN. YOU MUST EXPERIMENT ON SEVERAL CANS TO FIND THE BEST SIZE HOLES, NUMBER OF HOLES, AND ANGLE OF HOLES PUNCHED THAT WILL INCREASE THE NUMBER OF SPINS OF THE CAN.**

**A SOFT DRINK CAN SUSPENDED BY A STRING SPINS BY THE FORCE CREATED WHEN WATER STREAMS OUT OF THE SLANTED HOLES NEAR THE CAN'S BOTTOM.**



**MATERIALS AND METHODS: YOU WILL BE PROVIDED WITH DIFFERENT DIAMETER NAILS TO PUNCH HOLES NEAR THE CAN'S BASE. AS YOU PUNCH THE HOLE WITH THE NAIL, PUSH THE NAIL TO THE SIDE TO BEND THE HOLE. DECIDE HOW MANY HOLES WILL BE PUNCHED, THEIR SPACING APART, AND THE DISTANCE UP FROM THE BASE. ATTACH FISHING LINE TO THE PULL TAB. DIP THE CAN INTO THE WATER UNTIL IT FILLS AND PULL THE CAN OUT BY THE STRING. COUNT THE NUMBER OF SPINS THE CAN COMPLETES.**

**DATA: (SAMPLE IDEA)**

**TRIAL NUMBER   NUMBER OF HOLES   HOLE SIZE   DISTANCE FROM BASE   NUMBER OF SPINS**

**CONCLUSION: FROM THE DATA, DECIDE ON THE BEST WAY TO GET THE MOST SPINS. EXPLAIN NEWTON'S THIRD LAW OF MOTION IN TERMS OF CAUSING THE CAN TO SPIN; IN TERMS OF ROCKET FLIGHT.**

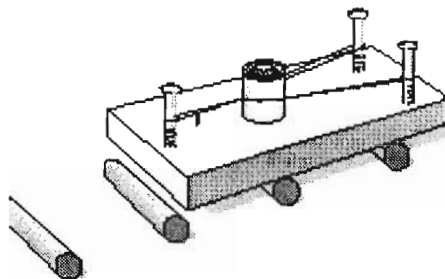
*<http://quest.arc.nasa.gov/space/teachers/rockets/act1.html>*

Name: \_\_\_\_\_

### NEWTON CAR

**INQUIRY: HOW CAN I PROPEL A NEWTON CAR BY A MASS THROWN FROM IT?**

**INTRODUCTION: YOU WILL DEMONSTRATE NEWTON'S LAWS OF MOTION BY CONSTRUCTING A NEWTON CAR THAT IS DESIGNED TO BE PROPELLED BY A SLING SHOT DEVICE. THE SLINGSHOT IS LOADED WITH A VARYING AMOUNT OF WEIGHTS, HELD IN PLACE BY A STRING WHICH WILL BE CUT THROUGH A LAUNCH TIME.**



**MATERIALS AND METHODS: CUT A 1"x4" ABOUT 8" LONG. USE EITHER WOOD SCREWS OR WOODEN DOWELS AS SHOWN ABOVE. TIE 6 EQUAL LOOPS OF STRING ALL 5" LONG. LOOP RUBBER BANDS THROUGH A LOOP OF STRING AND SET THE SLINGSHOT. USE VARYING AMOUNTS OF WEIGHT IN THE FILM CANISTER (WATER, SAND, SHOT) AND VARYING NUMBER OF RUBBER BANDS IN EACH TRIAL. QUICKLY CUT THE STRING LOOP TO RELEASE THE SLINGSHOT. RECORD THE DISTANCE THE CAR ROLLS OVER PENCILS OR DOWELS PLACED 6 CM APART ACROSS THE FLOOR.**

**DATA: (SAMPLE IDEA)**

	NUMBER OF RUBBER BANDS	DISTANCE TRAVELED
Mass of 1:		
Mass of 1:		
Mass of 1:		
Mass of 2:		
Mass of 2:		
Mass of 2:		

**CONCLUSION: FROM THE DATA, DECIDE WHICH RESULTS GIVE THE BEST TRAVEL DISTANCE. EXPLAIN THIS ANSWER IN TERMS OF NEWTON'S LAWS OF MOTION. EXPLAIN HOW THIS INFORMATION APPLIES TO ROCKET FLIGHT.**

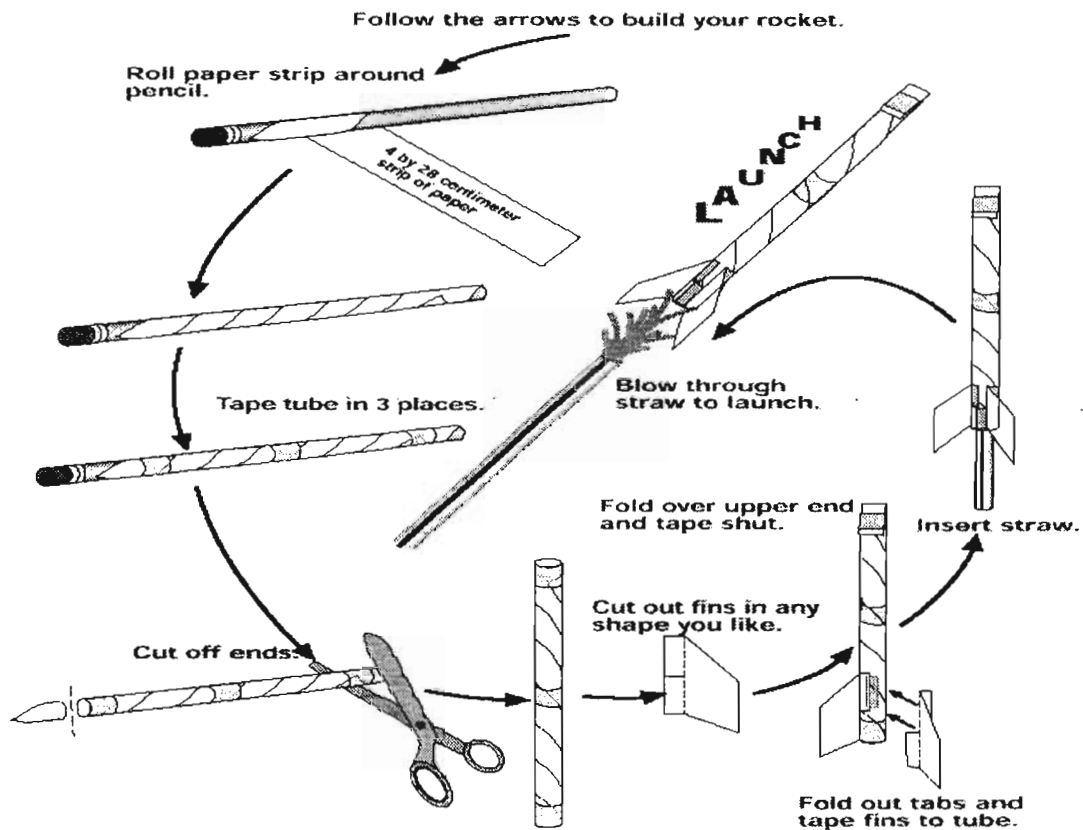
<http://quest.arc.nasa.gov/space/teachers/rockets/act6.html>

Name: \_\_\_\_\_

## PAPER ROCKETS

**INQUIRY:** HOW CAN I DESIGN AND CONSTRUCT A PAPER ROCKET THAT WILL TRAVEL IN A STABLE FLIGHT THE GREATEST DISTANCE ACROSS THE FLOOR?

**INTRODUCTION:** YOU WILL DEMONSTRATE NEWTON'S LAWS OF MOTION AS YOU DESIGN A PAPER ROCKET FOR STABLE FLIGHT. A ROCKET WITHOUT FINS IS MUCH MORE DIFFICULT TO CONTROL THAN A ROCKET WITH FINS. STUDENTS WILL LEARN ABOUT THE CENTER OF MASS AND THE CENTER OF PRESSURE AS FINS ARE DESIGNED FOR THESE PAPER ROCKETS.



**MATERIALS AND METHODS:** WRAP A PAPER STRIP WRAP ABOUT A PENCIL AS SHOWN ABOVE. SHAPE THE CONE AT THE TOP END. ADD FINS AT THE BASE. LAUNCH THE ROCKET BY BLOWING THROUGH A STRAW. MEASURE FOR DISTANCE.

**DATA:** (SAMPLE IDEA)

<u>TRIAL NUMBER</u>	<u>NUMBER OF FINS</u>	<u>FIN DESIGN</u>	<u>ROCKET MASS</u>	<u>CENTER OF MASS</u>	<u>CENTER OF PRESSURE</u>	<u>FLIGHT DISTANCE</u>
---------------------	-----------------------	-------------------	--------------------	-----------------------	---------------------------	------------------------

**CONCLUSION:** USING THE DATA, EXPLAIN WHAT FIN ARRANGEMENT AND ROCKET MASS GAVE THE LONGEST FLIGHT. DESCRIBE HOW NEWTON'S LAWS OF MOTION APPLY TO YOUR ROCKET.

<http://quest.arc.nasa.gov/space/teachers/rockets/act5ws1.html>

Name: \_\_\_\_\_

INQUIRY  
**HOW CAN WE DESIGN A ROCKET  
AND KEEP IT IN STABLE FLIGHT?**

1. With your lab group, decide on which activity to study. Choose and list the questions you are going to experiment with to answer.
  
2. Design the setup of your activity. Develop procedures for each question:
  
3. Create a data table to record measurements in each problem.
  
4. Create an oral presentation with a chart that explains what you discovered. Include in your presentation Newton's Laws of Motion that apply to your design.
  
5. With the information from each of the class groups, you will then design a rocket using a soda bottle. <http://quest.arc.nasa.gov/space/teachers/rockets/act11.html>

This inquiry will be Graded on these expectations:

Rubric: **HOW CAN WE DESIGN A ROCKET AND KEEP IT IN STABLE FLIGHT?**

1. Lab is completed on time by group with each member working together. This requires cooperation on the different activities
  - 5-Lab is completed and student helped fairly
  - 3-Lab is completed and student helped just some
  - 1-Lab is completed but student did not help the group

Name: \_\_\_\_\_

- II. Oral presentation to the class explaining the procedure and results of your data
- 5-You spoke clearly and had an equal part in the presentation
  - 3-You spoke clearly and had a small part in the presentation
  - 1-You did very little in the presentation
- 

**III. Written report clearly provides**

- \*Introduction explaining the problem to be solved**
  - \*Materials and Methods used by the group to design the experiments**
  - \*Data chart of the measurements taken, clearly labeled and organized**
  - \*Conclusion that explains the best rocket design and a discussion on Newton's Laws of Motion and how they apply to your rocket experiment**
- 10-All four sections of the lab report are provided**
  - 5-Lab report sections are not present**
  - 1-Lab report not complete in requirements**
- 

IV. Interesting Format to read and researched

- 5-High interest reading, additional information provided from research on rocketry principles for stable rocket flights
  - 3- Interesting to read, but little extra information provided
  - 1-Made an attempt to make it interesting/no details added
- 

V. Language Arts: Grammar/Sentence Structure/Spelling

- 5-Few errors for the length of the paper
  - 1-Many errors and hard to read and understand
- 

VI. Paper is passed in on time (0 to 5 points)

---

Parent Comments about this paper and signature that the paper was proofread: bonus 5 points

Name: \_\_\_\_\_

MINI-LAB  
**IF WEIGHT IS A FORCE DUE TO GRAVITY, WHAT IS THE  
ACCELERATION THAT IS DUE TO GRAVITY?  
NEWTON'S SECOND LAW OF MOTION**  
 **$F = m \times a$**

**Introduction:** From Newton's second law it is possible to calculate the acceleration due to gravity if you know the mass and weight of an object. The acceleration will be found for planet Earth.

**Materials and Methods:** Choose at least 4 objects to find their mass in grams on the triple beam balance and their weight in Newtons with the spring scale. It will be necessary to change grams to kilograms to calculate the acceleration.

**Data:**

<u>OBJECT</u>	<u>MASS</u>		<u>WEIGHT (N)</u>	<u>ACCELERATION (m/sec/sec)</u>
	<u>gram</u>	<u>kilogram</u>		

Find the average acceleration from your data. This figure is how fast objects accelerate as they fall, whether off the table, or out of the sky!

**Conclusion:** Use  $F = m \times a$  to solve these two problems.

1. If you have 0.25 kg of fuel that accelerates out of your rocket at 50 m/sec/sec, what is the force that is available now to lift the rocket?

Calculate to find out if this force is enough to lift a 0.5 kg rocket off the ground? (find the rocket's weight)

Name: \_\_\_\_\_

**Lab Practical Review:**

1) Save-it sheet MOTION & FORCES- redo the physics problems. The formulas you need are: speed = distance / time

$$\text{acceleration} = \frac{\text{final velocity} - \text{original velocity}}{\text{time}}$$

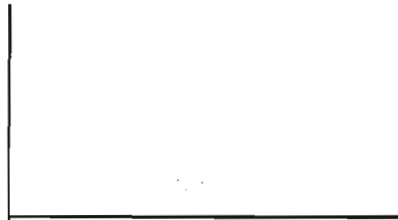
$$\text{momentum} = \text{mass} \times \text{velocity}$$

$$\text{force} = \text{mass} \times \text{acceleration}$$

2) Draw a picture for a graph of acceleration:



Draw a graph of an object going at a slow constant speed and a fast constant speed:



3. What is the most common frame of reference: \_\_\_\_\_

Why is a frame of reference important to determine motion:

4. Describe Newton's First Law of Motion and give an example:

Describe Newton's Second Law of Motion and give an example:

Describe Newton's Third Law of Motion and give an example:

5. How do you find an object's speed?

an object's weight?

an object's mass?

$$6. \quad 4.3 \text{ kg} = \text{_____ g} \quad 17 \text{ cm} = \text{_____ mm} \quad 49.68 \text{ l} = \text{_____ ml}$$

$$4892 \text{ m} = \text{_____ km} \quad 0.25 \text{ mg} = \text{_____ g} \quad 467 \text{ mm} = \text{_____ m}$$



**Answer sheet**

**Name:** \_\_\_\_\_

Remember to always use units whenever writing down answers. Start with the number on your answer sheet the same as the number of the station in front of you

1) There are two graphed motions. Describe the motion pictured on each graph.

Graph #1:

Graph #2:

2-3) Roll the object down the ramp. Use the equipment provided to find the object's speed. Be sure to make a data table and show your work and equations.

4-5-6-7) Perform the physics problems, show all work, and put the paper in the box when completed.

8) Using the supplied equipment, get the data needed to predict which of these rockets would have a longer flight.

Data:

Explanation why:

9) Answer the questions at the station:

#1:

#2:

10) Answer the question at the station:

**What happened:**

**Why is this Newton's Second Law:**

**Answer sheet**

**Name:** \_\_\_\_\_

11) Answer the question at the station:  
**Why is this Newton's First Law:**

12) Answer the question at the station:  
**Cause of lift-off:**

**Why is this Newton's Third Law:**

13) Give the **weight** of the object: \_\_\_\_\_

14) Answer the questions at the station:  
#1:

#2: Earth: \_\_\_\_\_ Moon: \_\_\_\_\_  
Why:

15-16-17) Complete this chart using the numbered pieces of equipment:

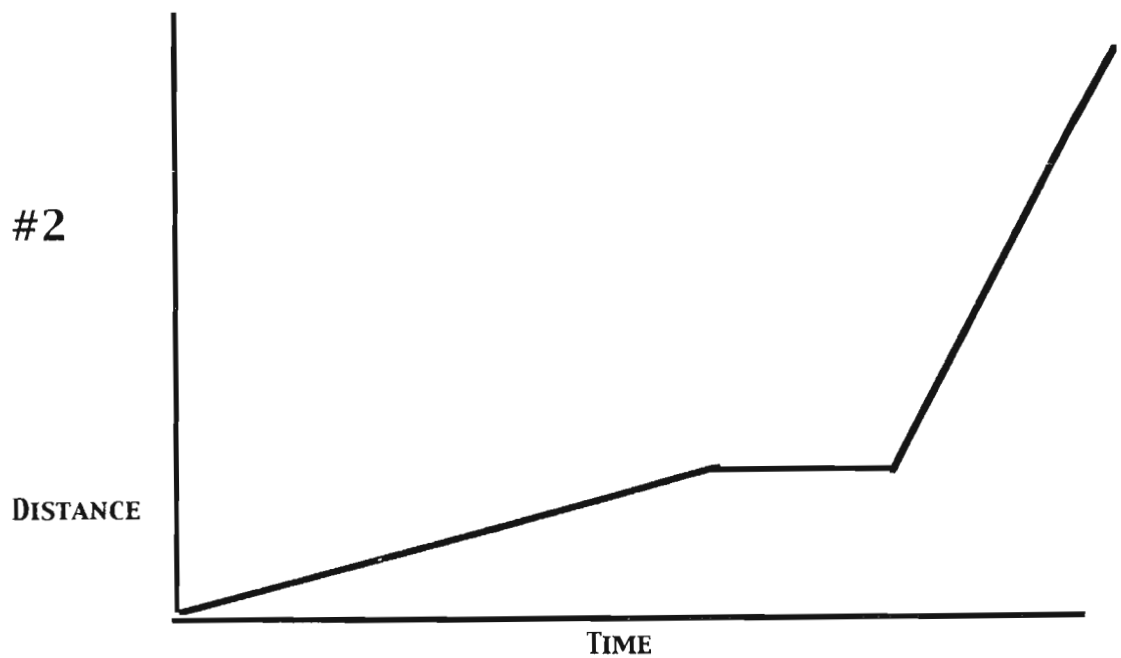
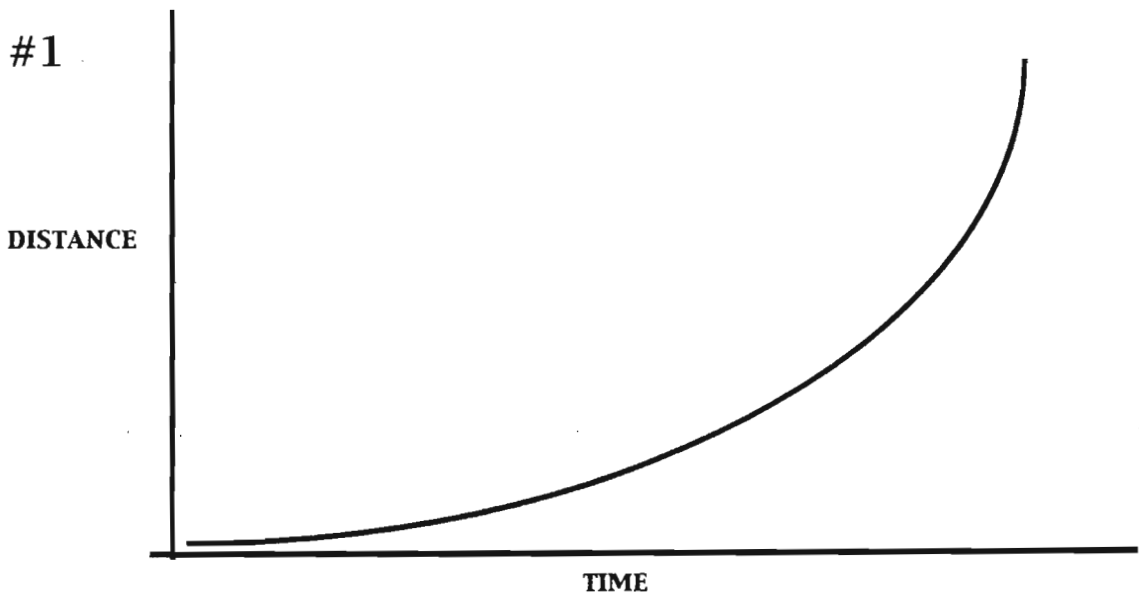
<b>Name of equipment</b>	<b>What does it measure?</b>	<b>What units are used?</b>

18-19) Fill in the unit conversion sheet. Put the answer sheet in the box.

20) Answer the questions at the station:

20) THINK ABOUT GRAVITY. GIVE TWO WAYS THAT PROVES TO US THAT THERE IS GRAVITY IN SPACE.

EXPLAIN WHY I HAVE WEIGHT WHEN STANDING ON THE EARTH, BUT I DO NOT HAVE WEIGHT WHEN I AM IN THE SPACE SHUTTLE IN SPACE.



4-5-6-7) Perform these physics problems. The formulae are on the front wall.

Name: \_\_\_\_\_

**1) WHAT FORCE WILL BE REQUIRED TO PULL OUT GOOFY'S 0.25 KG TOOTH WITH AN ACCELERATION OF 3M/SEC/SEC?**

**2) A 50 KG ASTRONAUT INSIDE THE SPACE SHUTTLE MUST FIRE THE ROCKETS TO DODGE AN ASTEROID. THE SHUTTLE ACCELERATES AT 15 M/SEC/SEC. WHAT FORCE DID ASTRONAUT ANDREA FEEL AS HER HEAD RAMMED INTO THE WALL OF THE SHUTTLE?**

**3. WHAT FORCE IS NEEDED TO PUSH A 1100 KG YELLOW VOLKSWAGEN AT AN ACCELERATION OF 2 M/SEC/SEC?**

**4) FIND THE ACCELERATION OF A FORD MUSTANG THAT GOES FROM REST TO 14 M/SEC IN 7 SEC.**

**5) WHAT IS THE MOMENTUM OF 45 KG ALBERT COLLIDING WITH ANGELA AT A VELOCITY OF 3 M/SEC?**

**6) WHAT SPEED IS DERRICK GOING IF HE TAKES 5 SECONDS TO COVER 26 METERS?**

**9)**

**#1: WHY IS IT IMPOSSIBLE TO BE MOTIONLESS?**

**#2: WHY IS IT IMPORTANT TO USE A FRAME OF REFERENCE?**

**10) DESCRIBE WHAT HAPPENED TO THE MOTION OF THE TENNIS BALL WHEN BOUNCED WITH AND HIT BY THE BASKETBALL. WHY DOES THIS DEMONSTRATE NEWTON'S SECOND LAW OF MOTION?**

**11) WHEN WE PUT DISHES ON A CLOTH AND QUICKLY REMOVE THE CLOTH THE DISHES STAY IN PLACE (ALMOST). WHY DOES THIS DEMONSTRATE NEWTON'S FIRST LAW OF MOTION?**

**12) TELL WHAT CAUSES ROCKETS TO LIFT OFF THE GROUND. EXPLAIN THIS USING NEWTON'S THIRD LAW OF MOTION.**

14)

**#1 NEWTON'S FIRST LAW OF MOTION STATES THAT WHEN AN OBJECT IS IN MOTION IT WILL STAY IN THAT SAME MOTION. WHY IS THAT LAW DIFFICULT TO DEMONSTRATE ON EARTH?**

**#2 IF I DROP A SHEET OF PAPER AND A BASKETBALL ON THE EARTH AT THE SAME TIME, WHICH LANDS FIRST? \_\_\_\_\_  
IF I DROP A SHEET OF PAPER AND A BASKETBALL ON THE MOON AT THE SAME TIME WHICH LANDS FIRST? \_\_\_\_\_**

**EXPLAIN WHY:**

**NAME: \_\_\_\_\_**

**18-19) UNIT CONVERSION:**

1) 4.7 KG = \_\_\_\_\_G      2) 17 CM = \_\_\_\_\_MM

3) 49.68 L = \_\_\_\_\_ML      4) 0.25 MG = \_\_\_\_\_G

5) 467 MM = \_\_\_\_\_M      6) 4892 M = \_\_\_\_\_KM

## Performance assessment for Motion and Forces: Explanation

Room set-up: Stations are numbered from 1 to 19. Students are assigned to a specific station to start their lab practical. No more than one student per station except at the problem stations.

Timing: allow approximately 2 minutes at each station.

Station 1 present the enclosed graphs to analyze.

Station 2: Provide a stop watch, meter stick, calculator. Have ball (or some other toy) move down the ramp.

Station 8: Provide 2 different size/mass of paper rockets. Provide meter stick and triple beam balance to get data.

Station 13: Provide a block of wood, Spring scale, triple beam balance.

Station 15-16-17: Number pieces of lab equipment from 1 to 5. Use: triple beam balance, spring scale, thermometer, graduated cylinder, stop watch.

At all other stations: Provide students with the given question for which they fill in the answer on their own answer sheet.

**UNIT V: FLUID MECHANICS**

Overarching question: If forces effect the motion of an object, what are the forces in fluids that effect the motion of an object?

Unit Objectives:

1. Find the weight of a fluid (air and water) to demonstrate how fluids exert pressure
2. Demonstrate the ability of fluids to effect the motion of an object
3. Find that the buoyant force of water is related to the mass of volume displaced and relate that to the buoyant force for all fluids
4. Relate that fluids create lift due to pressure changes which are proportional to the velocity of a moving fluid
5. Relate that pressure is equally transmitted throughout a fluid with an application to hydraulics systems
6. Describe how fluids are used in technology
7. Calculate physics problems dealing with pressure

Classroom activities:

1. Continuous throughout unit: Fill-in Save-It sheet as the appropriate sections are discussed

## FLUID PRESSURE INTRODUCTORY ACTIVITIES

2. Discrepant events:

- \*Ask students to crush a milk jug without touching it. Then pour hot water in the jug, recap, and wait
- \*Ask students to pull a baggie out of a jar that has been tightly rubber banded to the inside lip of the jar
- \*Madgeburg hemispheres: Ask students to try to pull them apart. Then place them inside the vacuum chamber and carefully shake them apart
- \*Place an inflated balloon inside vacuum chamber. Get predictions before pumping out air
- \*Place a marshmallow inside vacuum chamber. Get predictions before pumping out air
- \*Set up a siphon and get explanations
- \*Place balloon over mouth of glass bottle that has about 1/4 cup of boiling water inside, and allow to cool.
- \*Try to pour water into a flask through a funnel in a one hole stopper
- \*Poke a hole in milk jug, cover with finger and fill with water, replace lid and release
- \*Crush heated soda cans that contain about 1/4 cup water by inverting into pan of water
- \*Compare diameter of balloon held in deep water to that out of water
- \*Turn beaker of water over with acetate covering beaker...how much or little water can the acetate hold?
- \*Quickly lift a sheet of newsprint that has been spread over a meter stick placed along the center crease



3. Inquiry: Find the mass of air over our heads and the weight of this air  
 Facts: air pressure at sea level=14.7 lb/sq.in., 1 kg/sq cm  
 1 cu ft air weighs 30 g, 1 cu ft water weighs 62.5 lb/64 lb (salt water)
4. Save-it Sheet: Physics problems on pressure

### BUOYANCY INTRODUCTORY ACTIVITIES

5. Discrepant events:
  - \*Dancing raisins; place raisins in glass of carbonated clear drink
  - \*Cartesian Diver made from test tube inverted in sealed soda bottle of water
  - \*Helium balloon in the vacuum chamber
  - \*Find the weight of an object that sinks, then the object's weight when suspended in water, and then the weight of the overflow water
  - \*Place an ice cube in water, then in alcohol
6. Directed lab activity: Archimedes Hypothesis (200 B.C.)
7. Mini-demonstration: Set up weighted straws in water, then alcohol, oil, and sea water and mark the float level

### LIFT INTRODUCTORY ACTIVITIES

8. Discrepant events:
  - \*Blow between 2 bottles placed on separate cardboard squares resting on straws
  - \*Blow between 2 sheets of paper held parallel and vertically in front of your mouth
  - \*Blow over the top of a paper air foil suspended on a pencil
  - \*Suspend ping pong ball over hair dryer air flow
9. Read article about lift created for ski jumper in "V" position  
<http://magma.nationalgeographic.com/ngexplorer/0201/articles/mainarticle.html>
10. Directed lab activity (optional): design a paper airplane for greatest flight time and distance  
<http://users.ifiendly.com/fourfarrs1/other/planes.htm>

### HYDRAULICS INTRODUCTORY ACTIVITIES

11. Discrepant events:
  - \*Connect two different size water filled syringes by tubing to show that pressure is exerted in all directions in a fluid as students push alternately on the small and large plungers
  - \*Lift a pile of books with a baggie by placing it under the books and inflating the baggie with a straw
12. Inquiry: How do fluids effect how people live and work?

#### Minute Questions:

- \* How does air pressure change as you drive up a mountain? What is the reason for this change?
- \* How do your ears feel when you swim to the pool bottom? Why? How can

- you change the way your ears feel?
- \* As you weigh yourself in shallow water and slowly move to deeper water, what will the readings on the bathroom scale show about your weight?
- \* What causes a helium balloon to move up to the ceiling in the classroom?
- \* Why does a hot air balloon carry 7 people when lofted in the Imperial Valley which is 30' below sea level, but when the same balloon is lofted in Denver, Co at 5500' above sea level it can only lift 5 people?

Assessment:

1. Daily science minute questions
2. Inquiry: What is the weight of air?
3. Lab: Archimedes Hypothesis
4. Inquiry: How do fluids effect how people live and work?
5. Physics equations work

## Unit V: Fluid Mechanics

Unit V explores three strands within fluid forces: pressure, buoyancy, and lift. Fluid pressure is generated from the combination of the fluid's weight and the fluid's ability to flow around the object. Buoyancy is an upward force on an object submerged in a fluid and is equal to the weight of the fluid displaced by the submerged object. Lift is generated when a fluid flows past an object and creates unbalanced fluid pressures. Hydraulics are considered a special application of fluid pressures. The unit closes with a group project researching the effects of fluids on our living environment.

Access to a vacuum chamber will provide the opportunity for many demonstrations about the effects of fluid pressure. Fluid pressure is pervasive, just as gravity was pervasive in the previous unit. Demonstrations that remove air pressure are very startling to students. Constantly remind the students that objects move in the direction of the greater force so any movement seen must be explained by a force. This unit has many suggestions for creating discrepant events. Follow up each event with full class discussions.

- A plastic milk jug with a tightly fitting lid collapses inward as the hot water poured inside cools and contracts reducing the inside air pressure. The greater outside air pressure crushes the jug.
- The same effect can be shown with a baggy placed inside a beaker with the neck of the baggy tightly held to the neck of the beaker by a rubber band. When the students reach inside the beaker and slowly pull the baggy out, it does look as if a weight is pushing down on the baggy making it impossible to pull the baggy out without tearing it. They are seeing the pile of air pressing down on the baggy.
- The Madgeburg hemispheres are another great science room gadget. Let the students examine them before putting them together and sealing them with the vacuum pump. Now let students try to pull them apart. It is possible to do so, albeit with difficulty. With the students, calculate the total weight on the sphere that had to be overcome by multiplying the surface area ( $4\pi r^2$ ) by air pressure (14.7 lb/sq. in).
- If you can place the hemispheres inside the vacuum chamber, then an interesting demonstration can be done. After the air is removed from the vacuum chamber with the sealed hemispheres placed in the chamber, they will just fall open. Then let the air back into the chamber, remove the resealed hemispheres and again let a student try to pull them apart.
- Place a balloon and then a marshmallow inside the vacuum chamber, ask for predictions, and have students explain what happens.

- The siphon works in the presence of air pressure and stops when there is no air pressure.
- It is impossible to pour water through a funnel inserted through a one hole stopper into a flask with air trapped inside the flask.
- The soda can crushing demonstration is dramatic. Place about 1/4 cup of water into an empty soda can and heat to a boil. With tongs quickly turn the soda can upside down into a container of water. The water does two things: it acts to seal the opening from air reentering the hole and also rapidly cools the can. The air pressure inside the can quickly decreases when cooled in the water bath. This allows the outside air pressure to crush the can.
- Students are also amazed with the newspaper demonstration. When they quickly push down on the end of the meter stick that sticks out from under one sheet of newspaper, they are unable to budge the newspaper which is held down by air.

All of these activities should support the fact that air has weight.

The suggested inquiry is contrived to find the mass of an air column over our head. It does show that air piled up in 50 miles of balloons does have a significant amount of weight and the lab also provides a method to calculate air pressure. Many students predict that a balloon without air weighs less than a balloon with air, so that is the first discrepant event for them in this lab. Relate the calculated weights back to what the students saw happen in the opening demonstrations. Students always are curious as to why they don't "feel" this weight. Of course they do every time they breathe, or drive up a mountain and feel their ears pop,. We are submerged in the air column just as we are submerged in water whenever we go swimming. We do feel the effects on our ears when we dive deep.

There are several suggested activities to demonstrate buoyancy in fluids. Buoyancy is the upward force on an object that is submerged in the fluid.

- The dancing raisins generate an interesting discussion as the raisins rise to the surface of the carbonated drink and sink again. Some students will eventually see the bubbles that aggregate on the raisins' surfaces and pop when the raisins rise to the surface. With the bubbles, the raisins displace more volume and generate a greater buoyant force causing them to rise. When the bubbles burst, the displacement decreases as does the buoyant force so the force of gravity causes them to sink.
- To make the Cartesian Diver, fill a test tube about 2/3 of the way with water and invert it into a filled to the brim soda bottle. If the test tube sinks, then add less water on your next try. If the test tube sticks up out of the soda bottle more than about an inch, then

add more water on your next try. Once the correct amount of water is added to the test tube, recap the soda bottle. Squeeze the sides of the soda bottle. You will notice that water rises up inside the test tube making the test tube heavier, thus sinking due to the greater force of gravity. Release the sides of the soda bottle, and the water flows back out of the test tube, making it lighter and thus rising due to the greater force of buoyancy. Have several soda bottles with Cartesian Divers prepared for the class to play with and give time for students to explain the phenomenon. Remind students not to tip or turn the soda bottles over as water will then displace the air trapped inside the upside down test tubes.

- If the vacuum chamber is big enough, place a helium balloon inside. Two things will happen as the air is removed, the balloon will expand, but also sink. Students may think the balloon sinks because it is getting heavier as it expands. Remind students that no new air is being added to make it heavier. Have students visualize themselves in a leaking swimming pool and as the water level goes down, they too would go down. Equate that to the balloon “going down” because the air that held it up (buoyant force) is no longer there to hold up the balloon.
- The mini-lab demonstration gathers preliminary data. Find the weight of an object out of water. Then hang the object off a piece of string taped to a triple beam balance in a beaker of water without touching the sides or bottom of the beaker. Next using the overflow apparatus find the weight of water displaced by the object. With careful work, the buoyant force on the object (apparent loss in weight) is equal to the weight of the water displaced by the object (overflow water). Hopefully some mathematically astute students will see this data correlation.
- The lab on Archimedes Hypothesis will reinforce this principal that the buoyant force on an object is equal to the the weight of the water (fluid) displaced by the object. Since all of the objects suggested to use float, then the apparent weight of the object in the water becomes zero, and the overflow water should equal the mass of the dry object. Remind students to carefully place the floating objects into the overflow apparatus and not to push the objects under the water. This lab compares the displaced water mass to the object’s mass. This lab can be expanded to use objects that do sink, showing that the apparent loss in mass (upward force) is equal to the mass of the displaced water.
- The mini-demonstration’s purpose is to show that the less a fluid weighs (the lower the density), the smaller the buoyant force it can generate, such that an object sinks deeper

in the less dense fluids. Partially fill test tubes with the suggested variety of liquids, water, alcohol, oil, and sea water. Have each student group plug one end of a straw with modeling clay and place into each liquid. Mark the depth to which the straw sinks in each liquid. If the straw needs more weight for this demonstration, pour in a couple of BB's. Be sure the students discuss the results of this demonstration, what it means in terms of commercial shipping between fresh and saltwater, and the purpose of the load lines.

Lift is generated when there are unequal pressures on an object, thus causing the object to move in the direction of the greater pressure. The lift discrepant events are counterintuitive.

- Place two soda bottles side by side on their own square of cardboard placed on rounded pencils so that it is possible for the bottles to freely roll. Blow between the bottles. The bottles move together due to the lowered air pressure between the bottles.
- Hang two sheets of paper face to face sideways in front of your mouth. Blow between the papers. They will move together.
- Create an airfoil and blow across the top of the foil. The foil lifts up against gravity, pushed up by the greater air pressure under the foil.
- Aim a hair dryer to blow straight up and place a ping pong ball in the air stream. Let go. The fast moving air around the ball creates a low pressure zone such that the air around the ball rushes in and holds the ball in the air stream.
- The suggested article to read on the internet discusses the forces on the ski jumper including the additional gain in lift by holding the skis in a 'V' rather than the traditional parallel position. When the first skier tried this new position at the Olympics, points were deducted for form although the skier gained distance due to increased lift.
- The final lift activity suggests a web site to explore for designing a paper airplane. There are many more web sites; encourage students to explore on their own. Supply lots of scrap paper, give a time limit, and have the contest for longest distance and greatest time aloft. Some of the models may also have a height element to their design which could also be encouraged in one of the categories.

The mechanically inclined students may have basic knowledge of hydraulic systems. It is fun to have students see how much weight they can lift with a baggy and their own breath. Tightly seal one end of a straw inside a large baggy, place books on top of the baggy, and start blowing. Students enjoy the challenge of lifting as many books as possible and even

a classmate sitting on top of the pile of books. If you can have access to various sized needle syringes, pair together different sized syringes with 18" of plastic tubing (sold at hardware stores), fill the smaller syringe with water, attach the depressed larger syringe to the tubing, and have students experiment with whether it is the large piston or the small piston that gains the greater weight lifting advantage. Compare the distances the pistons move in the paired system. Be prepared for lots of squirting water when the hydraulic line between the syringes bursts!

The culminating activity is a partnered research project on how fluids effect our daily lives. This project gives students the time to research how design projects are effected by fluids whether you are a race car driver, a SCUBA diver, or a bridge builder. Hot air ballooning is a science based on buoyant forces; the density of the air at the lift site will determine the number of passengers the balloon is capable of lifting. NASA has worked on an interesting project to build a plane capable of both space and subspace flight. This fluids project is rich in information. Discuss the job of an engineer as a project designer and how the designs are positively and negatively impacted by the fluids of our home planet. Work with students on using their computers for research and preparation of a power point presentation, complete with a script, that can be presented to an invited audience of parents and school personnel.

Name: \_\_\_\_\_

SAVE-IT SHEET for Science:  
Fluid Mechanics

I. What are the fluids? \_\_\_\_\_  
What are properties of fluids?

II. What is meant by pressure?

III. What is the reason that fluids exert pressure?

What does this pressure cause to happen

\*to your ears?

\*to a submarine that dives too deep?

\*to an airplane with passengers that flies up high?

\*to a SCUBA diver?

IV. What does the word buoyancy mean?

What does **Archimedes' Principle** tell you about buoyancy?

Will a hot air balloon "float up" on the moon? Explain your answer.

When you design a ship or hot air balloon how do you know how "big" to build it?



Name: \_\_\_\_\_

V. What does **Bernoulli's Principle** tell you about fluid pressure?

VI. How do hydraulics work in a piece of machinery?

Name: \_\_\_\_\_

### Physics Problems

Pressure = force  $\div$  area

$$P = F \div A$$

Area = length X width

$$A = l \times w$$

Force = mass X accelera

$$F = m \times a$$

1. A 600 Newton block measures 30 cm. in length, 40 cm. in width, and 12 cm in height. What pressure does it exert on the floor on which it rests?
  
  
  
  
  
  
  
  
  
  
2. A 2000 Newton piano stands on the floor on 4 legs, each leg measuring 3 cm. long and 2 cm wide. What pressure does the piano exert on the floor?
  
  
  
  
  
  
  
  
  
  
3. What is the pressure applied by a piston exerting a force of 10 Newtons in an engine with a surface area of 10 sq. cm?
  
  
  
  
  
  
  
  
  
  
4. Find the force exerted by a 1000 kg car that accelerates into a wall at 100 m/sec/sec. Find the pressure on the wall if the car's front end is 2.5 m by 0.5 m.

Name: \_\_\_\_\_

5. What pressure does a 1000 kg water bed exert on the floor if it measures 1.5 m by 2.2 m?

6. A 0.7 kg mass measures 5 cm in width and 10 cm in length. It is resting on a wooden floor. What pressure does the floor feel?

Now the box is turned on its side so that the sides which are 5 cm by 2 cm rests on the floor. What pressure now does the floor feel?

Does the weight of the box change by putting the box on end?

Does the pressure of the box against the floor change by turning the box on end?

7. A cube with equal sides of 10 cm is filled with 0.7 kg of oil. What is the weight (or force) of the box? (You need to remember the value for acceleration due to gravity.)

What is the density of the oil?

What is the pressure of the box against the floor?

SAVE-IT SHEET for Science:  
Fluid Mechanics

- I. What are the fluids? gasses liquids  
What are properties of fluids?

**Fluids take the shape of the container**

**Fluids can flow around the object**

- II. What is meant by pressure?

**Pressure is weight pressing down on an area of a certain size (cm<sup>2</sup> or in<sup>2</sup>)**

**Air pressure at sea level = 14.7 lb/sq in = 1 kg/sq. cm.**

- III. What is the reason that fluids exert pressure?

**1-Fluids have weight and -2-fluids can flow around the object to exert weight on the object.**

**1 cu.ft. air weighs 30 g (approximately 1 oz); 1 cu.ft. water weighs 62.5 lb.**

What does this pressure cause to happen

\*to your ears? **Moves the ear drum inward causing pain**

\*to a submarine that dives too deep? **crushes the submarine**

\*to an airplane with passengers that flies up high? **Lowered air pressure so planes must be pressurized**

\*to a SCUBA diver? **Presses extra Nitrogen gas through the lungs into the blood system so the diver must come up slowly to avoid the bends and exhale continuously to avoid destroyed lungs from expanding gasses in the lungs**

- IV. What does the word buoyancy mean?

**Force of a fluid that pushes up on the object submerged in the fluid**

What does Archimedes' Principle say about buoyancy? (lived 287 BC to 212 BC)

**The buoyant force equals the weight of the fluid displaced by the object**

Will a hot air balloon "float up" on the moon? Explain your answer.

**No, because there is no fluid (air) to push the balloon up.**

When you design a ship or hot air balloon how do you know how "big" to build it?

**For every cubic foot of air you gain 30 g (1 oz) of lift. For the balloon to lift you, calculate your weight in ounces and that is the number of cu. ft needed to just lift you. The balloon also weighs something.**

V. What does Bernoulli's Principle tell you about fluid pressure? (1700's Swiss Mathematician)

**As velocity of the fluid decreases the pressure of the fluid increases.  
Moving air decreases pressure so object moves in direction of greater pressure**

(draw an airplane wing showing the directions of the four forces of lift, drag, weight, and thrust.)

VI. How do hydraulics work in a piece of machinery? (Pascal's Law)

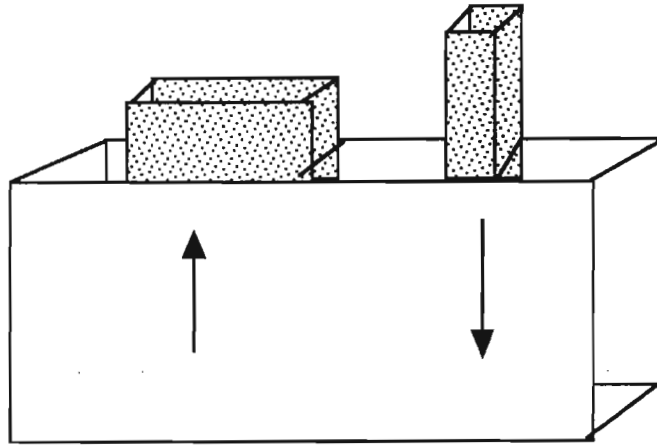
**A fluid in a container transmits pressure equally in all directions.**

If

1 sq cm = 3 N pressure

Then

5 sq cm = 15 N pressure



#### Physics Problems

Pressure = force ÷ area    Area = length X width    Force = mass X acceleration

$$P = F \div A$$

$$A = l \times w$$

$$F = m \times a$$

1. A 600 Newton block measures 30 cm. in length, 40 cm. in width, and 12 cm in height. What pressure does it exert on the floor on which it rests?

$$A = l \times w$$

$$P = F \div A$$

$$A = 30 \text{ cm} \times 40 \text{ cm} = 1200 \text{ sq cm}$$

$$P = 600 \text{ N} \div 1200 \text{ sq cm} = 0.5 \text{ N/sq cm}$$

2. A 2000 Newton piano stands on the floor on 4 legs, each leg measuring 3 cm. long and 2 cm wide. What pressure does the piano exert on the floor?

$$A = l \times w$$

$$4 \text{ legs} = 24 \text{ sq cm}$$

$$P = F \div A$$

$$= 3 \text{ cm} \times 2 \text{ cm} = 6 \text{ sq cm}$$

$$= 2000 \text{ N} \div 24 \text{ sq cm} = 83.3 \text{ N/ sq cm}$$

3. What is the pressure applied by a piston exerting a force of 10 Newtons in an engine with a surface area of 10 sq. cm?

$$P = F \div A$$

$$= 10 \text{ N} \div 10 \text{ sq cm} = 1 \text{ N/ sq cm}$$

4. Find the force exerted by a 1000 kg car that accelerates into a wall at 100 m/sec/sec. Find the pressure on the wall if the car's front end is 2.5 m by 0.5 m.

$$\begin{array}{lll}
 F = m \times a & P = F \div A & A = l \times w \\
 = 1000 \text{ kg} \times 100 \text{ m/sec/sec} & = 100,000\text{N} \div 1.25 \text{ sq m} & = 2.5 \text{ m} \times .5 \text{ m} \\
 = 100,000 \text{ N} & = 80,000 \text{ N/ sq m} & = 1.25 \text{ sq m}
 \end{array}$$

5. What pressure does a 1000 kg water bed exert on the floor if it measures 1.5 m by 2.2 m?

$$\begin{array}{lll}
 A = l \times w & P = F \div A & F = m \times a \\
 = 2.2 \text{ m} \times 1.5 \text{ m} & = 9800 \text{ N} \div 3.3 \text{ sq m} & = 1000 \text{ kg} \times 9.8 \text{ m/s/s} \\
 = 3.3 \text{ sq m} & = 2969.7 \text{ N/ sq m} & = 9800 \text{ N}
 \end{array}$$

6. A 0.7 kg mass measures 5 cm in width and 10 cm in length. It is resting on a wooden floor. What pressure does the floor feel?

$$\begin{array}{lll}
 P = F \div A & A = l \times w & F = m \times a \\
 = 6.86 \text{ N} \div 50 \text{ sq cm} & = 5 \text{ cm} \times 10 \text{ cm} & = .7 \text{ kg} \times 9.8 \text{ m/sec/sec} \\
 = 0.137 \text{ N/sq cm} & = 50 \text{ sq cm} & = 6.86 \text{ N}
 \end{array}$$

Now the box is turned on its side so that the sides which are 5 cm by 2 cm rests on the floor. What pressure now does the floor feel?  $P = F \div A$

$$\begin{array}{l}
 = 6.86 \text{ N} \div 10 \text{ sq cm} \\
 = .686 \text{ N/ sq cm}
 \end{array}$$

Does the weight of the box change by putting the box on end? **NO**

Does the pressure of the box against the floor change by turning the box on end? **YES**

7. A cube with equal sides of 10 cm is filled with 0.7 kg of oil. What is the weight (or force) of the box? (You need to remember the value for acceleration due to gravity)

$$\begin{array}{l}
 F = m \times a \\
 = .7 \text{ kg} \times 9.8 \text{ m/ sec/sec} \\
 = 6.86 \text{ N}
 \end{array}$$

What is the density of the oil?

$$\begin{array}{ll}
 D = m \div V & V = l \times w \times h \\
 = .7 \text{ kg} \div 1000 \text{ cu cm} & = 10 \text{ cm} \times 10 \text{ cm} \times 10 \text{ cm} \\
 = 0.0007 \text{ kg/ cu cm} = 0.7 \text{ g/cu cm} & = 1000 \text{ cm}^3
 \end{array}$$

What is the pressure of the box against the floor?

$$\begin{array}{ll}
 P = F \div A & A = l \times w \\
 = 6.86 \text{ N} \div 100 \text{ sq cm} & = 10 \text{ cm} \times 10 \text{ cm} \\
 = 0.0686 \text{ N/sq cm} & = 100 \text{ sq cm}
 \end{array}$$

Name: \_\_\_\_\_

INQUIRY

IF THE AIR AROUND US CAN CRUSH OBJECTS,  
THEN IT MUST HAVE WEIGHT. WHAT IS THE  
WEIGHT OF AIR?

1. With your lab group, develop a procedure to determine the weight of air over our heads. Think about the fact that when you found the mass of water, you put the water in a container. Therefore you must put air into a container. Also develop a procedure to find the pressure of this air.
2. Discuss with your group the measurements you need to find the weight and pressure of air.
3. Develop a procedure to do the experiment to find the solution to this inquiry. Your group will share with the class what you plan to do and why. Briefly describe what you will do to answer the question.

From the mass of the air in the container that you used, calculate the weight in pounds of the air on Earth going up over your head as a pile of those containers. We will assume that the air goes above our heads for 50 miles. To calculate the value use the following formula:

$$\frac{\text{-----?-----g}}{\text{-----?-----inches}} * \frac{\text{kg}}{1000\text{g}} * \frac{2.2 \text{ pound}}{\text{kg}} * \frac{12 \text{ in}}{\text{ft}} * \frac{5280 \text{ ft}}{\text{mile}} * 50 \text{ miles} =$$

This inquiry will be Graded on these expectations:

Rubric: **What is the weight of air?**

I. Lab is completed on time by group with each member working together. This requires cooperation.

5-Lab is completed and student helped fairly

3-Lab is completed and student helped just some

1-Lab is completed but student did not help the group

\_\_\_\_\_

Name: \_\_\_\_\_

II. Written report clearly provides

**\*Introduction explaining the problem to be solved**

**\*Materials and Methods used by the group to find the weight and pressure of the air**

**\*Data chart of the measurements taken, clearly labeled and organized**

**\*Clear calculation for the weight and pressure of the air above your head**

**\*Conclusion that explains what is weight and pressure of air, where errors can be found in your lab work**

**10-All five sections of the lab report are provided**

**5-Lab report sections are not present**

**1-Lab report not complete in requirements**

---

III. Interesting Format to read and researched

5-High interest reading, additional information provided from research on mass and air pressure and how it is determined

3- Interesting to read, but little extra information provided

1-Made an attempt to make it interesting/no details added

---

IV. Language Arts: Grammar/Sentence Structure/Spelling

5-Few errors for the length of the paper

1-Many errors and hard to read and understand

---

V. Paper is passed in on time (0 to 5 points)

---

Parent Comments about this paper and signature that the paper was proofread: bonus 5 points



Name: \_\_\_\_\_

### ARCHIMEDES HYPOTHESIS

**PURPOSE:** To compare the mass of an object that floats to the mass of the water overflowed by the object when submerged in the water.

**HYPOTHESIS:**

**MATERIALS:** Triple beam balance      Overflow set-up      water  
Experimental objects that float: plastic jar, glass jar, candle, apple, wood, ball

**PROCEDURE:**

1. Record the mass of the beaker.
2. Choose an object and record the mass in column 1.
3. Place the object in the overflow set-up and catch the overflow water in the beaker.
4. Record the mass of the beaker with the overflow water in column 2.
5. Repeat steps 2, 3, and 4 for four more objects.
6. Complete columns 3 and 4 of the data table.

**DATA:**

Mass of Beaker: \_\_\_\_\_ g

Object	Column 1 Mass of object (g)	Column 2 Mass of beaker with overflow water (g)	Column 3 Mass of water (g)	Column 4 Mass of object - mass of water  (col 1 - col 3)

Name: \_\_\_\_\_

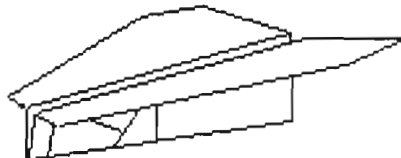
CONCLUSION:

1. Which objects had a mass greater than the mass of the water it overflowed?
2. Which objects had a mass less than the mass of the water the object overflowed?
3. Out of the five objects with which you experimented, how many of the objects were within 2 g of having the same mass as the water the object overflowed?
4. Based on the results of your data, what principle did Archimedes form from doing this experiment? Compare your data for the mass of the object out of the water to the mass of water that overflowed when the object was placed in water.

## PAPER AIRPLANE DESIGN

### INTRODUCTION

Four forces act upon an airplane: thrust, drag, lift, and gravity. Paper airplanes have many different design elements. In this lab, we will be designing a paper airplane for greatest flight distance or for greatest flight time. An online search provides many sites for folding paper airplanes. Try some of these suggested designs before creating a design of your own.



<http://users.ifiendly.com/fourfarrs1/other/planes.htm>

This is a very stable plane. It can fly straight with little adjustment. Curve the elevators up for loops.

### MATERIALS AND METHODS

Research and build several of the suggested models of airplanes from the above site and other sites of your own choosing. Using the best design characteristics, design your own paper airplane using the provided paper. Airplanes will be judged for distance, flight time, and design originality. Airplanes may be decorated for the flight contest.

### DATA

Data will be kept on your own flight design, flight time, and flight distance. Drawings of designs used will be helpful. Describe what worked well and what was changed for better flights.

### CONCLUSION

1. What are the four forces that act on an airplane? What direction do these forces act on the plane?
2. Describe the plane design that your group used in the competition. What worked well in this design?
3. Describe the plane that did not work well for your group. What in the design caused problems?

Name: \_\_\_\_\_

**INQUIRY**  
**HOW DO FLUIDS EFFECT HOW PEOPLE**  
**LIVE AND WORK?**

1. With your partner, choose an activity that people do that involves a fluid. Find out how the fluid effects the activity. Describe the design modifications necessary to utilize the fluid safely and effectively. Create a display, model, or example of the activity.

**2. TOPIC IDEAS:**

<b>WATER</b>	<b>AIR</b>	<b>HYDRAULICS</b>
SCUBA diving bends, pressure, nitrogen, lungs	Race Car design: fins, aerodynamics, Newton's Laws	Mechanical systems: design of hydraulic lines, pressure
Submarine: safe depths buoyancy, ballast, decompression	Airplane design, oxygen masks, pressurized cabins air pressure	Hydraulically operated machines
Shipping between fresh and salt water load lines	Airplane design for safe take-off: lift and drag	Your own idea!
Bridge building techniques for underwater supports construction, piers, pilings decompression chamber	Hot air/Helium balloon travel air pressure, lift, buoyancy	Hydraulic lifts and elevators
Animal survival techniques during deep ocean dives and quick ascents	X-30 project: combination subspace/outer space travel	

3. Research with your partner:      [www.google.com](http://www.google.com)      [www.mamma.com](http://www.mamma.com)  
What are the questions your group will answer?

4. What will your group use for the visual display to explain what you learned?  
slide show, model, painting/poster, object, your own ideas

Name: \_\_\_\_\_

This inquiry will be Graded on these expectations:

Rubric: **How do fluids effect how people live and work?**

I. Project is completed on time by group with each member sharing researched information.  
This requires cooperation.

- 5-Project is completed and student helped with researched information and model
- 3-Project is completed and student helped just some
- 1-Project is completed but student did not help the group

II. Oral Presentation completed to the class explaining the project and results

- 5- You spoke clearly and had an equal part in the presentation
- 3-You spoke clearly but you took a a small part in the presentation
- 1-You did very little in the presentation

III. Group Report clearly provides

\*Introduction explaining the questions and problems to be researched about how people live and work in the fluid

\*Information on what your group found out about the problems and your questions

\*Conclusion to the report that clearly ties together what you learned

- 10-All sections of the report are provided
- 5-Researched information for the report is not complete
- 1-Very little researched information. Does not explain how people live and work in the fluid of your topic

IV. Interesting Format to read with well researched information

- 5-High interest reading, well researched information
- 3- Interesting to read, but incomplete information provided
- 1-Made an attempt to make it interesting/little researched details added

V. Language Arts: Grammar/Sentence Structure/Spelling

- 5-Few errors for the length of the paper
- 1-Many errors and hard to read and understand

VI. Paper is passed in on time (0 to 5 points)

Parent Comments about this paper and signature that the paper was proofread: bonus 5 points

Self check list

Name: \_\_\_\_\_

Partner: \_\_\_\_\_

## HOW DO FLUIDS EFFECT HOW PEOPLE LIVE AND WORK?

### How may partners help each other?

- \_\_\_\_\_ 1. Prepare questions about the topic that is to be researched
- \_\_\_\_\_ 2. Research information and share notes: google.com, askjeeves.com, excite.com, yahoo.com information.net
- \_\_\_\_\_ 3. Prepare the display such as a model, poster, slide show, demonstration
- \_\_\_\_\_ 4. Prepare oral presentation and present together
- \_\_\_\_\_ 5. Prepare written report together; divide up the tasks

### What should the display contain?

- \_\_\_\_\_ 1. The display should be part of the oral presentation to make your researched information clearer to the class
- \_\_\_\_\_ 2. It should be large enough that it can be used in the oral presentation and be seen clearly by the class
- \_\_\_\_\_ 3. It should enhance information you discovered when you researched your project.
- \_\_\_\_\_ 4. It should clearly illustrate your report

### What should your oral presentation be like?

- \_\_\_\_\_ 1. You should know in advance how you and your partner will divide the presentation
- \_\_\_\_\_ 2. You should speak clearly and be prepared so as not to just read your report
- \_\_\_\_\_ 3. You should use your display during the presentation
- \_\_\_\_\_ 4. You may prepare an activity in which the class may participate
- \_\_\_\_\_ 5. You should be well prepared because a panel of parents may also listen

### What should your written report look like?

- \_\_\_\_\_ 1. It should have a clear introduction explaining what the report is about and the major questions that are researched
- \_\_\_\_\_ 2. It should have researched information that answers the questions about how fluids are involved
- \_\_\_\_\_ 3. It should draw a clear conclusion about your research
- \_\_\_\_\_ 4. It should list from where you got your researched materials and any interviews you used to research the information. This may be in the form of a bibliography or a closing statement. Your research should use the internet, magazines, encyclopedia, and interviews when possible
- \_\_\_\_\_ 5. You should have someone proofread your report to help you correct the grammar and spelling. Use spell check on the computer
- \_\_\_\_\_ 6. When you proofread your report, ask yourself if it is interesting and has supporting details

Name of Project: \_\_\_\_\_

Name of presenters: \_\_\_\_\_

II. Oral Presentation completed to the class explaining the project and results

5- Student spoke clearly and had an equal part in the presentation

3-Student spoke clearly but you took a a small part in the presentation

1-Student did very little in the presentation

\_\_\_\_\_

Describe at least three things you learned from the oral presentation:

1:

2:

3:

Explain what you liked about the poster, model, or demonstration that helped to make the presentation clearer:

What could be improved in this project and presentation?

1:

2:

Signed (optional) \_\_\_\_\_

**UNIT VI: WORK, POWER, MACHINES, AND ENERGY**Unit Objectives:

1. Describe and quantify work and power
2. Describe and quantify mechanical advantage in reference to simple machines
3. Analyze the ways that energy is transmitted
4. Analyze the energy transformations in a system and the attendant loss of energy from the system
5. Define and categorize energy sources as renewable or non-renewable

Classroom Activities:

1. Demonstration for work and power: Have two different strength students each move a very heavy object (full paper carton box) across the room. Talk about the work they did. Talk about the power displayed. How can this be quantified?
2. Demonstration for 1 watt: Have students work as partners to determine the definition for a watt of power by moving a 1 N object, 1 meter in 1 second.
3. Inquiry: What is my Power? Provide student pairs with objects of known weights (sack of potatoes, grain, paper carton, another student, cinder block, etc.) to lift, timed by a stop watch to generate data in order to calculate their power. As an extension, compare their power to a horsepower (750 watts or 550 ft-lb/sec).
4. Physics problems on Save-It sheet: Generate work and power formulae and units with the students
5. Worksheet: How do machines make my work easier? Use this worksheet to help students analyze their work input and the machine's work output in context of the six simple machines.
6. Inquiry: How do machines make my work easier? Students describe the force applied and the distance the force is applied through diagrams and descriptions. They should begin to use vocabulary such as effort force, resistance force, and mechanical advantage. Provide several hand machines to discuss what they do for the amount of effort needed to move an object: pulley, lever, broom, come-along, jack, hammer, screw driver, pencil sharpener, screw jack, lug bolt remover, door handle, scissors, crow bar, bat, wheel barrow, nut cracker, knife, hand drill.
7. Mini-Lab activity: Mechanical advantage for levers. Using a 2 x 4, set up the 3 classes of levers across a lab table laid on its side. Sit a student on the board and decide the best location for the easiest lift. Refer to the previous inquiry to identify levers. Identify the fulcrum, effort force, resistance force. Decide the positions of best mechanical advantage. Actually measure the forces and distances to understand the work the lever does and the work the operator does.
8. Lab: Simple machines: Levers
9. Lab: Simple machines: Pulleys



10. SAVE-IT sheet: Define the 6 types of energy. Discuss that energy is necessary to create a force that causes a change which generates all motion. Therefore energy provides the ability to do work. Energy is measured in joules or calories.

11. Inquiry: What are the types of energy that cause a change and generates motion? What are energy conversions? What happens as energy is converted to other forms? Provide students with appliances to decide the forms of energy used and the transformations involved. Include discussion of conservation of energy. (radio: battery or plug-in; mixer; toaster; light bulb; telephone; candle; motor hooked to solar panel; plant; butane burner; water wheel; wind mill; electric pencil sharpener; radiometer; etc.)

12. American energy use facts sheet: Give students time in small groups to write down their thoughts on each statement before going into whole class discussion.

13. Save-it sheet: Discussion of kinetic and potential energy transformations.

14. Save-it sheet: Albert Einstein and unification of energy and mass.

15. Lab practical

#### Minute Questions:

- \* What does it mean to be "doing work?"
- \* What does it mean to "have power" in the context of machinery?
- \* What is energy? What is "out of energy?"

#### Assessment

1. Daily science minute questions
2. Inquiry: What is my Power?
3. Save-It Sheet: Work and Power problems
4. Inquiry: How do machines make work easier? What are the types of energy used that causes a change in motion?
5. Lab: Lever
6. Lab: Pulley
7. Mini-lab: Diagrams of levers locating fulcrum, effort force, and resistance force.
8. Inquiry: What are the types of energy, what are energy conversions and transmissions, and what is renewable or non-renewable energy?
9. Lab practical

## Unit VI: Work, Power, Machines, and Energy

Unit VI relates energy to work. Energy is necessary to accomplish work. For work to be accomplished there must be a force moving over a distance. Power is how fast the work is accomplished. Simple machines prove useful by providing mechanical advantage but with a resultant loss in efficiency when accomplishing work. This unit provides an overview of these topics along with exploring five basic forms of energy. Two additional units address electrical and chemical energies in more detail.

The introductory minute questions address the preconceptions students hold in regards to the words “work” and “power.” In conjunction with their written definitions, the first activity gives the students a working knowledge of the distinction between what is called work and what is referred to as power. The watt is a new metric unit for students, so the initial activity should give students a reference point for what a watt feels like. When introducing the first inquiry to find each student’s power, have students talk about small engines they use and their horsepower. The inquiry requires a supply of heavy items that students need to lift which could also be compared to their power when lifting lighter items. If a scale that measures in pounds is used in this lab to get the force, use 4.4 N/lb as a conversion factor.

With the understanding that work occurs by moving a weight through a distance, students now move to how a machine can make work easier. Supply a variety of hand tools for the students to analyze and record the work they do to the machine compared to the work the machine does. As students carefully examine the two aspects of work (work input and work output), they should get an appreciation that although generally they must move the machine a greater distance they are able to apply a smaller force against the machine compared to the object. Once students have completed the introductory activity, they are ready to move into the inquiry. Some students begin to understand that machines do not usually decrease the amount of work, only the applied force.

The next concept is a working definition for mechanical advantage. Students are already aware of their applied force compared to the resistance force, or the weight of the object they wish to move. A lever easily demonstrates mechanical advantage. Due to safety concerns, the lever demonstration is done as a full class. Use outside playground seesaws if available and free to manipulate into the three classes of levers. To compare applied and actual forces, use a bathroom scale to push against on the board, and measure the forces in pounds. There are two labs, one for levers and the other for pulleys, for students to practice calculating mechanical advantage. Although the issue of ideal and actual mechanical

advantage may be discussed, the majority of middle school students miss the significance of this distinction.

The concept of energy is very difficult for middle school students to grasp so the inquiry provides a working vocabulary for students to discuss energy transformations in terms of common appliances. Students are to further their research and discussion on what is meant by renewable energy sources and ways to generate electricity. This inquiry is rich in information and should be used as a place to start when discussing the forms of energy and energy lost from a system, especially in terms of overheated appliances. The factoids sheet is to be approached after students have had time to provide their own thoughts on each of the statements. The unit wraps up with a lab practical for the final assessment activity and covers inquiries from this unit and the unit on fluid forces.

Name: \_\_\_\_\_

SAVE-IT SHEET for SCIENCE  
**Work, Power, Machines, and Energy**

I. What is **work**? \_\_\_\_\_

\_\_\_\_\_

II. What is **power**?

\_\_\_\_\_

\_\_\_\_\_

III. What was your approximate power: \_\_\_\_\_

What did James Watt calculate to be a **horsepower**? \_\_\_\_\_

\_\_\_\_\_

IV. What does a machine do? \_\_\_\_\_

\_\_\_\_\_

V. Why is it important to know the **mechanical advantage** of a machine?

\_\_\_\_\_

\_\_\_\_\_

How can you improve the mechanical advantage

for a **lever**: \_\_\_\_\_

for a **pulley**: \_\_\_\_\_

for a **wheel and axle**: \_\_\_\_\_

for an **inclined plane, screw, wedge**: \_\_\_\_\_

\_\_\_\_\_

Name: \_\_\_\_\_

**ENERGY IS NECESSARY TO CREATE A FORCE....**

**A FORCE IS NECESSARY TO CREATE MOTION....**

**MOTION IS NECESSARY TO ACCOMPLISH WORK...**

**THEREFORE ENERGY IS NECESSARY FOR WORK!!!**

VI. What is energy? \_\_\_\_\_

---

---

---

People use 5 forms of energy for their energy needs. List the forms and describe from where the energy comes.

1.

2.

3.

4.

5.

Name: \_\_\_\_\_

VII. What are examples of energy sources that are **renewable**:

What are examples of energy sources that are **nonrenewable**:

### **KINETIC ENERGY and POTENTIAL ENERGY**

\*A 250 kg rock falls off a cliff and comes to rest on the ground, which is 40 meters below the cliff. When is the rock's **potential energy** at a maximum?

---

When is the rock's **kinetic energy** at a maximum?

---

Name: \_\_\_\_\_

VIII. Albert Einstein unified **mass** and **energy**. What does that mean?

SAVE-IT SHEET for SCIENCE  
**Work, Power, Machines, and Energy**

I. What is **work**?  $W = F \times d$  Units are Newton-meter or joule. Applying a force to an object which causes the object to move over a distance \_\_\_\_\_

II. What is **power**?  $P = w \div t$  or  $P = (F \times d) / t$  Units are Newton-meter per second or watt. Power is how fast the work is done \_\_\_\_\_

III. What was your approximate power: \_\_\_\_\_

What did James Watt (1736-1819) calculate to be a **horsepower**? *Introduced the age of steam. Worked in Scotland especially in the coal mines to pump out water and move coal. Watt determined that a strong horse could move a 165 lb object 200 feet in one minute = 33,000 ft-lbs/min. Changing to the metric units, this is 745.56 watts* \_\_\_\_\_

IV. What does a machine do? *Decreases the amount of effort force needed to move the resistance force or changes the direction of the force* \_\_\_\_\_

V. Why is it important to know the **mechanical advantage** of a machine? *The mechanical advantage tells you how many times your effort force is multiplied which is important for moving the resistance force* \_\_\_\_\_

How can you improve the mechanical advantage

for a lever: *For class 1 & 2, move the weight closer towards the fulcrum or increase length of the lever bar.* \_\_\_\_\_

for a pulley: *increase number of wheels to increase number of wraps* \_\_\_\_\_

for a wheel and axle: *increase the diameter of the wheel* \_\_\_\_\_

for an inclined plane, screw, wedge: *decrease ramp height, sharpen the wedge or increase the number of turns on the screw* \_\_\_\_\_

ENERGY IS NECESSARY TO CREATE A FORCE....

A FORCE IS NECESSARY TO CREATE MOTION....

MOTION IS NECESSARY TO ACCOMPLISH WORK...

THEREFORE ENERGY IS NECESSARY FOR WORK!!!!

VI. What is energy? *1. the ability to do work 2. energy causes a change 3. measured in the units joules or calories for food 4. occurs in many forms and is converted from one form to another* \_\_\_\_\_  
*Energy can not be created nor destroyed but is changed from one form to another*

People use 5 forms of energy for their energy needs. List the forms and describe from where the energy comes. (have available for students to see: candle, radiometer, phone, matches, plant, solar panel, electrically powered appliance, calculator, heating pad, battery operated object and give students time to think about the starting and ending energies)

1. Mechanical: energy transferred by moving objects

sound, water, wind, belts, pistons, machines turning, muscles moving

2. Heat (thermal): energy transferred by moving molecules.

The faster the molecules move the more energy they have which means they feel hotter, freezer, stove, refrigerator, hot springs, expanding gasses



3. *Chemical: Energy transferred when bonds that hold atoms together are broken and reattached to form new chemical substances*

*plants, battery, fire, fuels, wood, animals (and us)*

4. *Electromagnetic: energy from electrons moving*

*Electrical: plug-in appliances*

*Light (radiant): solar panels*

5. *Nuclear: energy from the nucleus of the atom which binds the nucleus of the atom together*

*Uranium fuel is formed into ceramic pellets size of finger tip = 120 gallons of oil, radioactive for 1000 years in spent fuel rods*

VII. What are examples of energy sources that are **renewable**:

*Renewable energy sources mean the supplies do not run out and are continuously available.*

*Biomass, geothermal, hydropower, solar, wind, tidal*

What are examples of energy sources that are **nonrenewable**:

*Nonrenewable supplies are used up such that more must be shipped in for use.*

*coal, oil, gas, nuclear, whale oil*

### **KINETIC ENERGY and POTENTIAL ENERGY**

*Kinetic energy is energy of a moving object. The faster the object moves, the more kinetic energy the object has*

*Potential energy is stored energy due to the position of the object*

*springs (set mouse trap), elastics, top of a hill, matches, battery, tank of gas*

\*A 60 Newton rock falls off a cliff and comes to rest on the ground, which is 40 meters below the cliff.

When is the rock's **potential energy** at a maximum?        *When the rock is on top of the cliff's edge just before it starts to fall*       

When is the rock's **kinetic energy** at a maximum?        *Just before the rock hits the ground when the rock is falling the fastest*       

VIII. Albert Einstein unified **mass** and **energy**. What does that mean?

*(1879 - 1955) Theory of Relativity (1905)*

**ENERGY CAN NOT BE DESTROYED NOR CREATED BY ORDINARY MEANS**

*A small amount of mass can turn into a very large amount of energy and a large amount of energy can turn into a small amount of mass so mass and energy are two forms of the same thing.*

*$E = mc^2$   $c = 300,000,000$  m/sec which is 186,000 mi/sec*

*From this equation a small amount of matter is a very large amount of energy that can be released when matter changes form to energy.*

*$10^{14}$  J is energy output per day of power plant*

*$10^{26}$  J is U. S. annual energy consumption*

*Pythagorus proved math could be applied to the real world*

*Newton discovered that both planets move and apples fall due to the same force called gravity*

*Maxwell unified magnetism and electricity*

Name : \_\_\_\_\_

**SAVE-IT SHEET for SCIENCE**

**PHYSICS PROBLEMS in WORK and POWER**

FORMULA FOR WORK: \_\_\_\_\_ UNITS: \_\_\_\_\_

FORMULA FOR POWER: \_\_\_\_\_ UNITS: \_\_\_\_\_

1. Kurtis used a force of 300 N to push Allen in a wagon for 500 m. How much work did Kurtis do?

2. A force of 120 N was used by Stephanie to move a rock 20 m. How much work did Stephanie do?

3. How much work did Mrs. Hess do when she pushed a desk 5 m across the room with a force of 20 N?

4. What is the power of a 900 N force applied over a distance of 40 m for 45 seconds?

5. Alesha weighs 500 N and climbed the 8 meter rope in 20 seconds. What is Alesha's power?

Name : \_\_\_\_\_

6. Abby ran her 480 N self a distance of 5 m in 2.5 seconds. What is Abby's power?

7. A force of 10,000 N is applied to the wall by Charles but the wall does not move. How much work did Charles perform?

8. Skydiver Nathan who weighs 950 N jumps from an altitude of 3000 m. What is the total work performed by skydiver Nathan?

9. A bulldozer run by Allen performs 80,000 N-m of work by pushing dirt over a distance of 16 m. What is the force (weight) of the dirt?

10. An ant does 1 N-m of work carrying a 0.0020-N grain of sugar. How far did the ant carry the sugar?

Name : \_\_\_\_\_

11. A horse performs 15,000 joules of work pulling a wagon for 20 seconds. What is the horse's power?

12. The 750-N pole vaulter, Eben, lifts himself 5 m high in 2.5 seconds. What is Eben's power?

13. A pump drains a small pond by performing 120,000 joules of work. The power rating of the pump is 1000 watts. How long does it take to drain the pond?

14. A tow truck driven by Amanda pulls a car out of a ditch in 6.5 seconds. If 6000 watts of power is use, how much work is performed by the truck driven by Amanda?

15. An elevator lifts 5 passengers 30 meters in 24 seconds. The power is 15,000 watts. What is the total weight of the elevator and passengers?

Name : \_\_\_\_\_

16. How much work is done by a crane operated by Dustin that lowers 1000 N of material a distance of 150 m?

17. How much work is done when a 9.8 N mass is raised a vertical distance of 1 m

18. A 49 N rock is lifted 2 meters in 5 seconds by Malin.  
How much work was done by Malin?

How much power did Malin have?

19. Chris, the weight lifter, lifts a 1470 N barbell above his head from the floor to a height of 2 m. Chris holds the barbell there for 5 seconds. How much work did Chris do while holding the barbell during the 5 second interval?

20. If 4000 Joules are used to raise a 294 N mass by Korei, how high did Korei lift the mass?

Name: \_\_\_\_\_

## INQUIRY

### WHAT IS MY POWER?

1. With your lab partner decide on the data needed to collect in order to determine your power. List the lab equipment you'll need to collect the data on power.
2. Discuss with your lab partner a procedure to determine your power. Your procedure will be shared with the class.
3. With your lab partner perform the experiment. Make and maintain a data chart for all data collected. Each lab partner will write up their report that clearly shows all 4 parts of the lab report (Introduction, Materials and Methods, Data, Conclusion) Remember that the conclusion will clearly state what you discovered to be your power in watts. You will compare your power to a horsepower knowing that there are 750 watts in a horsepower. Find out what is power lifting.

This inquiry will be Graded on these expectations:

Rubric: **What is my power?**

- I. Lab is completed on time by each partner working together
  - 5-Lab is completed and student helped fairly
  - 3-Lab is completed and student helped just some
  - 1-Lab is completed but student did not help the group

---

#### II. Written report clearly provides

**\*Introduction explaining the problem to be solved. This will explain what you already know about power.**

**\*Materials and Methods used. This will explain what you did to get the data needed to find your power.**

**\*Data chart of the measurements taken in each experiment.**

**\*Conclusion that explains what the data teaches you. This will explain what you learned about your own power and your partner's power. This will explain what data is important to determine power.**

**10-All four sections of the lab report are provided**

**5-Lab report sections are not present**

**1-Lab report not complete in requirements**

---

III. Interesting Format to read

5-High interest reading, additional researched information provided. This will include what you learned about James Watt and a horsepower. This will compare the power of various machines.

3- Interesting to read, but little extra information provided

1-Made an attempt to make it interesting/no details added

---

IV. Language Arts: Grammar/Sentence Structure/Spelling

5-Few errors for the length of the paper

1-Many errors and hard to read and understand

---

V. Paper is passed in on time (0 to 5 points)

---

Parent Comments about this paper and signature that the paper was proofread: bonus 5 points

Name: \_\_\_\_\_

### How Do Machines Make Work Easier?

1. List the six simple machines and draw an example:


2. You will be given machines to examine. Draw its picture. List all the **simple machines** present. Label/describe the **work input** and the **work output**.

*Name of machine *Simple machines present	*Picture of the machine with <u>work input</u> and <u>work output</u> labeled



Name: \_\_\_\_\_

Conclusion:

1. What is the definition of work?
2. What part of work do most machines make easier for the person?
3. What part of work do most machines make harder for the person?
4. Look up machine in World Book. Read about and explain the definition of efficiency.
5. What force makes it impossible for a machine to be 100% efficient?
6. Read about a perpetual motion machine. Describe what this is.
7. Read about and explain the definition for mechanical advantage.

Name: \_\_\_\_\_

## INQUIRY

### HOW DO MACHINES MAKE WORK EASIER?

You will be given machines to examine and to draw their diagrams that are clearly labeled to show **where you push on the machine** and **where the machine pushes on the object**. Make a data chart similar to the one below to draw and explain what you learn about each machine and work.

To do work there must be a force that moves an object over a distance. In this inquiry you are to compare for each machine the **work you do** to the **work the machine does**. **To figure out the work you do think about where you push on the machine and the distance you must twist or turn the machine (gadget) with your hands and compare that to the distance the machine lifts or moves the object.**

Write a conclusion to this lab about how a machine makes work easier. Think about the fact that work is force X distance. Does a machine make the **distance** you push or turn with your hands on the machine shorter or longer than just not using the machine. Does the machine make the **force** less or more for you to do the work on the object?

The Six Simple Machines: lever, pulley, wheel and axle, screw, wedge, and inclined plane.

**Type of simple machine  
and labeled picture**

**What work does the machine do?**  
(Look at what you are moving)

**What work do you do?**  
(Look at where your hand moves)


This inquiry will be Graded on these expectations:

Rubric: **How do machines make work easier?**

- I. Lab is completed on time by each partner working together
    - 5-Lab is completed and student helped fairly
    - 3-Lab is completed and student helped just some
    - 1-Lab is completed but student did not help the group
- 

**II. Written report clearly provides**

- \*Introduction explaining the problem to be solved. This will explain what you already know about work and the six types of simple machines**
  - \*Materials and Methods used. This will explain how you went about looking at the simple machines for the work you did, and the work the machine did**
  - \*Data chart of each machine you examined clearly drawn and labeled with explanation**
  - \*Conclusion that explains what the data teaches you. This will explain what you learned about how a machine makes work easier. This will explain why machines are useful in doing work**
    - 10-All four sections of the lab report are provided**
    - 5-Lab report sections are not present**
    - 1-Lab report not complete in requirements**
- 

**III. Interesting Format to read**

- 5-High interest reading, additional researched information provided. This will include what you learned about the definition of work and the six simple machines
  - 3- Interesting to read, but little extra information provided
  - 1-Made an attempt to make it interesting/no details added
- 

**IV. Language Arts: Grammar/Sentence Structure/Spelling**

- 5-Few errors for the length of the paper
  - 1-Many errors and hard to read and understand
- 

**V. Paper is passed in on time (0 to 5 points)**

---

Parent Comments about this paper and signature that the paper was proofread: bonus 5 points

Name: \_\_\_\_\_

## SIMPLE MACHINES: LEVERS

**PURPOSE:** How does changing the positions of the effort force, resistance force, and fulcrum affect the mechanical advantage of a lever?

**MATERIALS and METHODS:**

1. Record the weight of the wood block; it will be the resistance force for this lab
2. Set up a first class lever with the fulcrum on the 50 cm mark. Place the wood block and the spring balance at the distances from the fulcrum indicated in DATA TABLE 1. Record the effort force needed to balance the lever
3. Calculate the **actual mechanical advantage (AMA)** and record in data chart
4. Repeat these steps for all the positions in Data Table 1
5. Set up a second class lever with the fulcrum 10 cm from the end of the meter stick. Place the weight and the spring scale at the distances indicated from the fulcrum in Data Table 2
6. Set up the third class lever by placing the end of the meter stick on the tabletop which will act as the fulcrum. Place the weight and the spring scale at the distance indicated in Data Table 3.

**DATA:**

$F_R$  = Weight of wood block: \_\_\_\_\_ N

**DATA TABLE 1 FIRST CLASS LEVER, FULCRUM AT 50 CM**

Position	Effort Distance	Resistance Distance	Effort Force $F_E$	Mechanical Advantage $\frac{F_R}{F_E}$
A	40 cm	40 cm		
B	40 cm	20 cm		
C	40 cm	10 cm		
D	20 cm	40 cm		

**DATA TABLE 2 SECOND CLASS LEVER: FULCRUM AT 10 CM**

Position	Effort Distance	Resistance Distance	Effort Force $F_E$	Mechanical Advantage $\frac{F_R}{F_E}$
A	50 cm	40 cm		
B	50 cm	25 cm		
C	50 cm	10 cm		

Name: \_\_\_\_\_

**DATA TABLE 3 THIRD CLASS LEVER: FULCRUM ON END OF METER STICK**

Position	Effort Distance	Resistance Distance	Effort Force $F_E$	Mechanical Advantage $\frac{F_R}{F_E}$
<b>A</b>	<b>20 cm</b>	<b>80 cm</b>		
<b>B</b>	<b>40 cm</b>	<b>80 cm</b>		
<b>C</b>	<b>60 cm</b>	<b>80 cm</b>		

**CONCLUSION:**

1. For the first class lever in Position A, how did the effort force compare to the resistance force?

What was the mechanical advantage for Position A? \_\_\_\_\_

What did this First Class lever change about the direction of the effort force compared to the direction the resistance force moved?

2. For the second class lever, how does the effort force change as the weight was moved closer to the fulcrum?

How did the mechanical advantage change?

3. For the third class lever, how did the effort force change (spring scale) as the effort force was placed closer to the wood block?

How did the mechanical advantage change?

4. Draw a picture of a first class lever placing the effort force (spring scale), resistance force (wood block), and fulcrum in the position for the highest Mechanical Advantage (M.A.)

5. Repeat for a Second Class Lever

Repeat for a Third Class Lever

6. On a separate sheet of paper make a list of 6 items in your home that are levers. Draw the levers, identify the fulcrum, effort force and resistance force. Tell the class of each lever.

Name: \_\_\_\_\_

## SIMPLE MACHINES: PULLEYS

**PURPOSE:** To find out how to use a pulley system to raise an object and how to calculate the mechanical advantage of the pulley system.

**MATERIALS and METHODS:**

1. Record the weight of the wood block which will be the resistance force during this lab
2. Set up a single fixed pulley system as shown. Find and record the effort force needed to lift the wood block with this system.
3. Set up a single movable pulley as shown. Find and record the effort force needed to lift the block.
4. Set up the next 3 pulley systems and for each system record the effort force needed to lift the block of wood.
5. Calculate the actual mechanical advantage (A.M.A.) for each pulley system
6. Determine the Ideal Mechanical Advantage (I.M.A.) for each pulley system by counting the number of rope segments that support the weight.

**DATA:**

**DATA TABLE**

<b>Pulley System</b>	<b>Resistance force (wood block weight)</b>	<b>Effort Force (<math>F_E</math>)</b>	<b>A.M.A. (<math>F_R/F_E</math>)</b>	<b>I.M.A. (support ropes)</b>
<b>Single Fixed</b>				
<b>Single Movable</b>				
<b>Single fixed/single movable</b>				
<b>Double fixed/single movable</b>				
<b>Double fixed/double movable</b>				

Name: \_\_\_\_\_

Conclusion:

1. Compare the Actual Mechanical Advantage for the single fixed pulley to the single movable pulley. Even though only one pulley was used for both systems, explain why the values that you got were different. (Hint: look at the Ideal Mechanical Advantage.)
2. As you added pulleys to the system, what happened to the amount of effort force needed to raise the weight?
3. What happened to the actual mechanical advantage as pulleys were added?
4. Which type of pulley system had a mechanical advantage of 1? \_\_\_\_\_  
Think of a practical place where this type of system is used and why this system is of practical use? (Hint: think of something that stands in front of the school)
5. Why do you think the A.M.A. is less than the I.M.A for the pulley systems?
6. When we used the hydraulic system, the force used to push on the small piston was less than on the big piston, but we discovered we had to push the small piston a further distance to raise the big piston a little distance. Think about what increased on each pulley system as we added pulleys and as the effort force used to lift the weight decreased?
7. Set up any one of the 5 systems and lift the block. Calculate the work you did by measuring the effort force needed to lift the weight and measuring how far you pulled the rope. Since work equals force times distance, you need to measure these two quantities.

Then calculate the work the machine did by multiplying the weight of the block by the distance the block was lifted. Compare these two values. Explain why they are different.

Name: \_\_\_\_\_

INQUIRY  
WHAT are the TYPES of ENERGY, WHAT is an ENERGY  
CONVERSION,  
HOW is ENERGY TRANSMITTED, and  
WHICH ENERGY SOURCES are RENEWABLE or  
NONRENEWABLE?

1. In your lab group, you will be provided with various objects and appliances that use an energy source to operate, and then converts the energy to another type of energy that you can use.
  
2. You will decide with your group the starting energy which is the type of energy that is needed to operate the object or appliance and the energy conversion which the type of energy that is usable to you. Whenever there is an energy conversion there is a loss of energy from the system. What is the type of energy that is lost when the object is used?
  
3. Decide with your lab group how the energy travels to the object so the object can "run" and how the energy is transmitted from the object to you for your use.
  
4. Decide with your group whether the source of energy to operate the object is renewable or nonrenewable and why. Be sure to review how electrical energy is produced.
  
5. Your data must be organized so that each object has a clear explanation for the above questions. Organize your observations in a data chart and use pictures to make the explanations clearer.

This inquiry will be Graded on these expectations:

Rubric: **What are the types of energy, what is an energy conversion, how is energy transmitted, and which energy sources are renewable or nonrenewable?**

- I. Lab is completed on time by each partner working together
  - 5-Lab is completed and student helped fairly
  - 3-Lab is completed and student helped just some
  - 1-Lab is completed but student did not help the group



Name: \_\_\_\_\_

**II. Written report clearly provides**

**\*Introduction explaining the problem to be solved. This will explain what you already know about energy, the types of energy, and what are energy conversions. You could research the generation of electricity.**

**\*Materials and Methods used. This will explain what appliances you examined and what you did to get the data to understand energy.**

**\*Data chart of the diagrams made with explanations of each appliance examined.**

**\*Conclusion that explains what the data teaches you. This will explain what you learned about energy, energy conversions, and renewable energy sources from using the appliances. Explain the energy that is lost from the system.**

**10-All four sections of the lab report are provided**

**5-Lab report sections are not present**

**1-Lab report not complete in requirements**

---

**III. Interesting Format to read**

**5-High interest reading, additional researched information provided. This will include what you learned about energy, energy transmission, and renewable sources before you started the lab. Research sources of renewable energy that are being now used by our power company and people in our area. Research how electricity is generated.**

**3- Interesting to read, but little extra information provided**

**1-Made an attempt to make it interesting/no details added**

---

**IV. Language Arts: Grammar/Sentence Structure/Spelling**

**5-Few errors for the length of the paper**

**1-Many errors and hard to read and understand**

---

**V. Paper is passed in on time (0 to 5 points)**

---

Parent Comments about this paper and signature that the paper was proofread: bonus 5 points

Home appliances consume one-third of the electricity made in the United States plus 50% of the oil and gas imported from foreign countries.

**What can we change about our behavior?**

Up to half the electricity used by a refrigerator goes to cool the motor. Keep the motor and coils cleaned to help the refrigerator run efficiently. Refrigerators use 7% of the nation's total electricity produced.

Televisions in the United States, even when turned off, use the energy produced by one power plant.

Waterbeds in the United States use the energy produced by four large power plants.

**What can we Americans change about our behavior?**

Energy Efficient lighting can save 50 to 90% of the lighting costs now used in the United States.

90% of the electrical energy used to light a light bulb changes to heat energy. Only 10% of the electrical energy used goes to making light energy.

**What can we Americans Change about our behavior?**

Each year in the United States about \$13,000,000,000 worth of energy, in the form of heated or air conditioned air, escapes through holes and cracks in homes

**What can we change about our behavior?**

Transportation uses 40% of the energy in the United States each year which is nearly 75% of the petroleum. Americans drive more than 1,000,000,000,000 miles each year, which would get us 364 round trips to Pluto.

**What can we change about our behavior?**

Each day Americans use 16,000,000 barrels of oil out of a total of 68,000,000 produced in the world. This is 22% of the oil produced used by only 5% of the World's population. OPEC charges about \$28.00 per barrel.

**What can we change about our behavior?**

In one year, Americans spend an average of 1,000,000,000 hours stuck in traffic jams wasting about 3,000,000,000 gallons of gas, which is the lifetime supply of gas for about 600,000 American cars.

Half of all trips Americans take are made by one person alone in a car.

**What can we change about our behavior?**

An estimated \$300 billion per year brings on extra driving costs due to road building and maintenance, police, fire and ambulance services, environmental pollution and health care costs due to pollution and accidents.

**What can we change about our behavior?**

name: \_\_\_\_\_

Lab Practical Review:  
Fluid Mechanics, Work, Power, Simple Machines, Energy

1. List the 6 simple machines Provide an example

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.

2. Beside each quantity, write the correct units that are used:

speed: \_\_\_\_\_ acceleration: \_\_\_\_\_

distance: \_\_\_\_\_ time: \_\_\_\_\_ temperature: \_\_\_\_\_

work: \_\_\_\_\_ power: \_\_\_\_\_ energy: \_\_\_\_\_

pressure: \_\_\_\_\_ mass: \_\_\_\_\_ force: \_\_\_\_\_

3. Define and describe how you would calculate each of these quantities

Work input:

Work output:

Actual Mechanical advantage:

Work:

Power:

Buoyancy:

Lift:

Pressure:

4. List each of the 5 types of energies and The Origin of this energy

- 1.
- 2.
- 3.
- 4.
- 5.

name: \_\_\_\_\_

5. Draw and label the 3 classes of levers with fulcrum, EF, RF

Name: \_\_\_\_\_

### Answer Sheet

Remember to always use units whenever writing down answers. Start with the number on your answer sheet the same as the number of the station in front of you.

- 1) Scissors: \_\_\_\_\_  
Screwdriver: \_\_\_\_\_  
Can opener: \_\_\_\_\_  
Crowbar: \_\_\_\_\_  
Loading ramp: \_\_\_\_\_  
Knife: \_\_\_\_\_

2) At this station fill in the worksheet by matching the correct units to the quantity. Place the answer sheet in the box.

3) Explain what you observed: \_\_\_\_\_

---

---

4) Formula for finding pressure: \_\_\_\_\_  
Data: \_\_\_\_\_

Pressure of jug on table: \_\_\_\_\_

5, 6) Complete the physics problems. Place the answer sheet in the box.

7) Complete the MEA questions. Place your answer sheet in the box.

8) Answer the questions at the station about machines:

A) \_\_\_\_\_

B) \_\_\_\_\_

9) Formula for work: \_\_\_\_\_

Data: \_\_\_\_\_

Name: \_\_\_\_\_

Answer Sheet

10) Ideal Mechanical Advantage:  
#1 \_\_\_\_\_ #2 \_\_\_\_\_ #3 \_\_\_\_\_ #4 \_\_\_\_\_

Explain why the actual mechanical advantage would be less than the ideal mechanical advantage: \_\_\_\_\_

11, 12)

**OBJECT** Label a Picture of object with Fulcrum, RF, EF Class of Lever

paper hole punch		
bottle opener		
baseball bat		
nut cracker		

13, 14) Data Chart with calculations to find the buoyant force on this object:

15, 16) Use the equipment provided to set up a first class lever.  
Diagram of positions:

Weight of object: \_\_\_\_\_ Effort force used to lift object with lever: \_\_\_\_\_

Lever's Actual Mechanical Advantage: \_\_\_\_\_

17)

object	Starting energy	Ending Energy	Renewable or nonrenewable energy?
#1			
#2			
#3			

Name: \_\_\_\_\_

**Answer Sheet**

18) Explanation: \_\_\_\_\_  
\_\_\_\_\_

19) Explanation of what you would do:

20) Explanation of what you could change:



Name: \_\_\_\_\_ Physics Problems: Work, Power, Pressure  
Formulae are on poster in front of room!

**1) WHAT PRESSURE DOES A BOX THAT WEIGHS 600 NEWTONS AND MEASURES 40 CM WIDE AND 30 CM LONG, EXERT ON THE FLOOR?**

**2) WHEN THE GASOLINE EXPLODES INSIDE THE CAR ENGINE IT EXERTS A FORCE OF 30 NEWTONS IN AN AREA OF 10 SQ. CM. WHAT IS THE PRESSURE?**

**3. FIND THE WORK DONE BY MRS. HESS WHEN SHE PUSHES ON THE CAR WITH A FORCE OF 400 NEWTONS THAT DOES NOT MOVE THE CAR OUT OF THE 1.7 M SNOW BANK.**

**4) A HORSE PERFORMS 15,000 JOULES OF WORK PULLING A WAGON FOR 20 SEC. WHAT IS THE POWER OF THIS HORSE?**

**5) FIND ALBERT'S WORK WHEN HE PUSHED THE TABLES 50 METERS WITH A FORCE OF 80 NEWTONS.**

**6) IF A TOW TRUCK USES 6000 WATTS OF POWER TO PULL A CAR OUT OF THE DITCH IN 6 SECONDS, WHAT WORK DID THE TOW TRUCK DO?**

Name: \_\_\_\_\_ Physics Problems: Work, Power, Pressure

**PLACE THE CORRECT UNITS IN THE BLANKS NEXT TO THE QUANTITY.  
MORE THAN ONE WORD MAY BE PLACED INTO THE BLANKS AND A  
WORD MAY BE USED MORE THAN ONCE!!**

<u>METER</u>	<u>NEWTON</u>	<u>JOULE</u>	<u>NEWTON-METER</u>
<u>SECOND</u>	<u>KILOGRAM</u>	<u>WATT</u>	<u>°CELSIUS</u>
<u>CALORIE</u>	<u>M/SEC</u>	<u>HOURL</u>	<u>JOULES/SEC</u>
<u>M/SEC/SEC</u>			

WORK: \_\_\_\_\_ POWER: \_\_\_\_\_ ENERGY: \_\_\_\_\_

MASS: \_\_\_\_\_ FORCE (WEIGHT): \_\_\_\_\_

DISTANCE: \_\_\_\_\_ TIME: \_\_\_\_\_ TEMPERATURE: \_\_\_\_\_

SPEED: \_\_\_\_\_ ACCELERATION: \_\_\_\_\_

### Station #1

There are 6 simple machines:

LEVER PULLEY WHEEL AND AXLE INCLINED PLANE WEDGE SCREW

On your answer sheet, for each tool provided, list all the simple machines present.

### Station #2

Fill in the paper and place your answer sheet in the box on the table.

### Station #3

Try to pull the baggy out of the beaker. Explain why this is difficult.

### Station #4

Calculate the pressure this jug of water exerts on the table top when sitting on the table.

### Station #5, 6

Complete the physics problems and place the answer sheet in the box on the table.

### Station #7

Complete the MEA problems and put your answer sheet in the box.

### Station #8

A. We've studied many machines in class. What does work input mean and what does work output mean?

B. What do machines usually make easier about the work that people do when they use a machine?

### Station #9

Find the work you do when you drag this box across the length of the table.  
Record all data.

### Station #10

Examine each pulley system to determine their Ideal Mechanical Advantage.  
Record that number on your answer sheet.

Explain why the Actual Mechanical Advantage must be less than the Ideal Mechanical Advantage.

### Station #11 - 12

For each of the 4 levers, draw a rough sketch of it and identify the location of the effort force, resistance force, and the fulcrum. Then identify the class of lever for the machine.

### Station #13 - 14

Archimedes taught us a method to calculate the predicted buoyant force on an object. Find the buoyant force of the water exerted on this object.

### Station #15 - 16

Design a first class lever with the provided equipment. Draw a picture of your design.

Lift the provided object with this lever and calculate the Actual Mechanical Advantage of your lever.

### Station #17

Fill in the data chart for each of the numbered gadgets. Think about the type of energy used to start the gadget, the type of energy to which it is converted so we can use the gadget, and whether or not the energy source is renewable.

### Station #18

Blow across the top of the airfoil. Describe the principle that explains why the airfoil moves up.

### Station #19

Read the transportation data sheet. Pick one or two of the facts that you could easily do something about and tell what you would do to decrease our transportation energy waste.

### Station #20

Read the electricity use data sheet. Pick one or two of the facts that you did not know and describe what it teaches you to do differently to decrease your use of electricity.

Performance assessment for Fluid Mechanics, Work, Power, Simple Machines, and Energy: Explanation

Room setup: Stations are numbered from 1 to 20. Students are assigned to a specific station to start their lab practical. No more than one student per station.

Timing: allow approximately 2.5 minutes at each station.

Station 1: Have available to students the tools: Scissors, screwdriver, can opener, and crowbar

Station 2: Provide worksheets and a box in which to place the completed papers.

Station 3: Have a baggy rubber banded inside a beaker jar.

Station 4: Material provided: Milk jug half filled with water tied to a string, meter stick, spring scale, calculator.

Station 5,6: Provide worksheets and box in which to place the completed papers.

Station 7: Provide worksheets and box in which to place the completed papers.

Station 8: Provide some sample tools to look at while answering questions.

Station 9: Loaded down box with a string tied to it, meter stick, spring scale, calculator

Station 10: Four numbered pulley systems set up, all with different IMA.

Station 11, 12: Provide the 4 types of levers for students to observe.

Station 13, 14: Materials provided: overflow can, water, graduated cylinder, object such as a rock, golf ball, or weights

Station 15, 16: spring scale, meter stick, calculator, object to lift

Station 17: Provide power gadgets run off of various energy sources such as battery, solar panel, or electricity.

Station 18: Airfoil suspended on a pencil

Station 19: Have a transportation data sheet available to read

Station 20: Have an electricity data sheet available

## UNIT VII: ELECTRICITY AND MAGNETISM

### Unit Objectives:

1. Describe the origin of static electricity in terms of the structure of an atom
2. Demonstrate and explain the behavior of static electricity, including lightning
3. Design both parallel and series circuits for current electricity
4. Demonstrate the use of an ammeter and voltmeter to describe the properties of current electricity
5. Design and use several home made batteries and describe the basic design of a battery
6. Provide the explanation for magnetism
7. Demonstrate magnetic properties including the ability of some metals to become magnetized
8. Navigate using a compass
9. Demonstrate that current electricity induces a magnetic field and a moving magnetic field induces an electric current
10. Build a simple electric motor, explain the parts, and the use of an electric motor in an appliance.

### Classroom Activities:

#### **Electricity**

1. Static electricity
  - \*Lay a piece of Plexiglas over supports so that it lays about 1" off the table. Under the Plexiglas, place bits of styrofoam, glitter, shredded paper and rub the Plexiglas with a piece of wool
  - Lab: Static Electricity
  - \*Construct an electrophorus and use it
  - \*Newspaper articles on static electricity and can cans to read and review in the groups
2. Current electricity
  - \*Supply students with wire, bulb, and battery. Ask students to light the bulb.
  - \*Build a rheostat with pencil lead conducting the current between 2 nail probes
  - \*Show students symbols for a circuit and have them put together a series and parallel circuit using wiring diagrams
  - \*Supply ammeter and voltmeter and demonstrate correct wiring in circuit
  - \*Lab: Current electricity
3. Batteries
  - \*Take apart an old D-cell battery (not alkaline or rechargeable) for the class and identify the parts of the battery
  - \*Lab: Batteries Supply students with materials to build a battery. Measure the current with a galvanometer
4. Save-it sheet and Physics problems on electricity

#### **Magnetism**

5. Classroom demonstration: Suspend a paperclip on a string close to a magnet on a different string. Place various materials between them hypothesizing if there is a way to block a magnetic force. (test: paper, glass, cardboard,

aluminum, cookie pan, record, etc.)

6. Demonstrate magnetic field lines using iron filings sprinkled on a piece of acetate laying on top of a bar magnet.
7. Lab: Magnetism Rotate the class through the various station activities  
[http://www.exploratorium.edu/snacks/stripped\\_down\\_motor.html](http://www.exploratorium.edu/snacks/stripped_down_motor.html)  
[http://www.exploratorium.edu/snacks/eddy\\_currents.html](http://www.exploratorium.edu/snacks/eddy_currents.html)
8. Magnetizing, full class demonstrations: Before and after stroking a pin with a magnet, lay the pin across a cork floating in water and look for the pin's alignment. Magnetize a nail and pick up paperclips. Magnetize a screw driver; try other objects.
9. Practice using a compass to navigate the school yard with students following provided directions.
10. Demonstrate the motor effect that a wire carrying a current is deflected when placed between opposite magnetic poles. Prove the presence of the magnetic field with the compass. Demonstrate magnetic suction.  
[http://www.exploratorium.edu/snacks/motor\\_effect.html](http://www.exploratorium.edu/snacks/motor_effect.html)  
[http://www.exploratorium.edu/snacks/magnetic\\_suction.html](http://www.exploratorium.edu/snacks/magnetic_suction.html)
11. Using the simple electric motor built in the magnetism lab, explain the parts and how they work. Correspond the homemade motor parts to an electric motor. Demonstrate the generator by attaching a small DC electric motor to a galvanometer and spin the shaft. Attach a miniature Christmas bulb to the motor's electrodes and roll the shaft quickly on the table's edge to light the bulb. Attach the motor's electrodes to another motor, roll the shaft on the table's edge to cause the second motor to spin.
12. Inquiry: How does an electric motor change electric energy to mechanical ?

#### Minute Questions:

1. What is electricity?
2. From where do electrons come?
3. Describe static electricity.
4. What causes magnetism?
5. What can block a magnet's force so it won't stick to the refrigerator?
6. Explain how a compass can be used on the moon.

#### Assessment:

1. Minute questions
2. Lab: Static electricity
3. Lab: Current electricity
4. Lab: Battery
5. Lab: Magnetism
6. Inquiry: How does an electric motor change electric energy to mechanical?



## Unit VII: Electricity and Magnetism

Unit VII continues the study of electromagnetic energy in greater detail, and emphasizes the relationship between electricity and magnetism. Students explore the properties of static and current electricity and magnetism before finishing the unit with an inquiry into the structure of an electric motor. As an extra bonus, this unit ties directly into the Maine Energy Education Program (MEEP) that sponsors model solar car races for the middle school student. Although this unit does not directly include this program, it is well worth the time and effort to bring your school into this nationwide program. The following web address supplies contact information for those interested in participating in the Junior Solar Sprint program. <http://www.nesea.org/education/jss/coordinators.html> This program provides teachers with the resources for their own classroom design and construction of the model solar cars in order to participate in the car races within their state.

The first lab on static electricity starts with a review of what students may already know about the structure of an atom. Students need this background information to understand that it is in the particles of an atom that objects gain or lose a charge. The static lab requires the construction and acquisition of various objects.

- An electroscope can be easily constructed by wrapping around a straw a layer of aluminum foil that is held in place with glue. Cut off 1/2" sections to form the "pith balls" and suspend them from the ends of a thin strip of aluminum foil that is draped over a straw and suspended inside a flask as pictured on the lab paper. When an uncharged object is brought near the electroscope the pith balls remain stationary, but when a charged object is brought near to the electroscope the pith balls move apart. In this case the pith balls acquire a like charge when the charged object repels a charge down the strip of aluminum foil onto the pith balls.
- The Leyden jar is simply a film canister obtained for free at film developers. Students can develop a large charge on the Leyden jar and experience an effective shock. The Leyden jar will hold the charge for several days if left charged up and undisturbed. Students can experiment around with how long it holds a charge.
- Radio Shack carries the light bulbs (Neon lamps, 1.8mA) that students can light from static electricity. An effective way to do this is to have one student vigorously wiggle around in his plastic chair until he develops a charge and then while one student holds one prong of the light bulb, the charged student grabs the other prong. Charged up balloons can also be touched to one of the prongs while another student holds the other prong. Have students experiment on the best way to light the bulb.

The lab for current electricity is also a directed lab. Prior to starting the lab, have students try completing circuits with only one length of wire, a battery, and a bulb. Many students spend time shorting out the battery before they figure out how to correctly complete the circuit by touching the light bulb base to the battery and the side of the base to the wire and back again to the other end of the battery. Also have students practice using a voltmeter and ammeter with circuit diagrams before moving into the directed lab. Inexpensive materials, which aid the ease of setting up circuits, include alligator clips and light bulb bases. Switches tend to be one more thing to hook up and are not necessary for the lab. Allow plenty of time (two to three days) for students to experiment with the equipment and set up their circuits. To avoid an unnecessary number of burned out bulbs, ask that students use no more than two batteries in their circuits. Students especially enjoy seeing how bright a bulb will burn with the addition of batteries until suddenly the whole circuit blows! It is difficult for many students to correctly place the ammeter into each branch of the parallel circuit, so take time to carefully explain how to measure the amps of each branch of the circuit. A quick glance at data tells whether or not students accomplished the task correctly.

The construction of batteries becomes a shared class experience when the class is divided up into five different groups. Students need access to galvanometers to read the small currents generated by the batteries. Compare the results of each experiment and emphasize the parts of the battery that bring about a flow of charge, or electricity. Students like to see the insides of a D cell battery. Choose old dried up non-alkaline batteries and save the zinc casing for the battery experiments. For safety reasons, the dissection of a battery is done as a whole class demonstration.

Students enjoy the magic of very powerful magnets. Obtain a magnet that can lift five to ten pounds. I place my magnet near the edge of a high cabinet in the front of the room and cover it by a cloth. Then I tie a paper clip to a string attached to a table placed near the cabinet and bring the paper clip near enough to the magnet so it appears to be held up into the air by the 4' or so length of string. It does not take long for an entering class of students to notice a paper clip dangling from a string up into the air and they want the solution to this anomaly. This sets the stage for a discussion of what they already know about magnetism and magnetic field lines. The final directed lab of the unit covers magnetism and its relationship to electricity. This lab contains seven stations for pairs or groups of three students to rotate through and complete the activities. Students may miss the fine subtleties of some of the stations so move amongst the students and ask questions such as "What happens when...," "Tell me more about...," and "What if you change this ...." An additional

activity includes compass navigation about the school yard. To add more interest, include treasures at the end of a successfully completed path.

Small electric motors from toys and gadgets provide an endless array of activities to demonstrate the workings of an electric motor and electric generator. The culminating inquiry requires students to comb their cellars and garages for broken electric appliances that had parts that moved by a motor. This inquiry requires a set of tools and several days. Students should research the parts of an electric motor and figure out the names and parts of their motor when they take the motor apart. Maintaining clear diagrams and carefully explained observations is often a challenge to the impulsive middle school student, but overall, most students do enjoy the total destruction of an appliance.

Name: \_\_\_\_\_

SAVE-IT SHEET for Science

**Electricity and Magnetism**

1. **Electricity** is made possible because of the special structure of the atom. Draw the structure of the atom. What particle of the atom is needed to have **electricity**?

**Static Electricity**

2. Whenever there is **static electricity** the particles of the atom have changed. What particles of the atom have changed that cause the atom now to have a charge?

3. How does lightning get formed?

**Current Electricity**

4. Draw the symbols used for an **electric circuit**. Draw a circuit and label the parts that are needed to make electricity flow.

Name: \_\_\_\_\_

5. Draw a series circuit with 2 batteries and 3 light bulbs:

6. Draw a parallel circuit with 2 batteries and 3 light bulbs:

7. Think about the lab you did on parallel and series circuits. How does the brightness of the bulbs compare between the two circuits? Explain the difference.

If one bulb is unscrewed in the series circuit what happens and why?

If one bulb is unscrewed in the parallel circuit what happens and why?

### **Batteries**

8. What did you discover a battery to be made of in order for it to make electrons move (create electricity) to cause the battery-operated object to work?

Name: \_\_\_\_\_

9. What do you think happens when a battery "dies?"

**Physics Problems: Electricity**

**Voltage = Current X Resistance**    V = voltage    I = amperes    R = ohms

$$\mathbf{V = I \times R} \qquad \qquad \mathbf{V} \qquad \qquad \mathbf{A} \qquad \qquad \mathbf{\Omega}$$

1. What current do I draw down when I plug in my 60  $\Omega$  mixer on my 120 volt circuit?

2. My electric stove requires a 220 volt circuit and 40 amps of current. What is the resistance?

3. What is the voltage on a current of 6 amps carrying a 10 ohm resistor?

4. My lamp on the 110 volt circuit has a resistance of 22 ohms. What current does the lamp draw down?

Name: \_\_\_\_\_

5. What is the current flowing through an electric circuit if it has 120 V across it and  $10\ \Omega$  of resistance?

6. It requires 220 V to drive a 5 A current through an appliance. Find the resistance.

7. What is the voltage if there is a 6 A current and a  $10\ \Omega$  resistor?

8. A 120 V lamp draws 0.25 A of current. What resistance does the bulb have?

9. There is a  $22\ \Omega$  resistance in the heating element of a coffee maker. If it is plugged into a 110 V circuit, how much current does it use?

10. What is a lamp's resistance if it uses a 115 V circuit and draws 0.25 A?

Name: \_\_\_\_\_

**Magnetism**

10. Why are some objects naturally magnetized?

11. Name some materials or objects that are affected by a magnetic force:

Name some materials or objects that are not affected by a magnetic force:

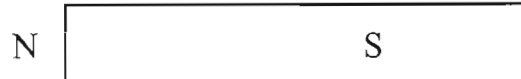
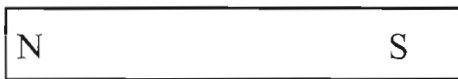
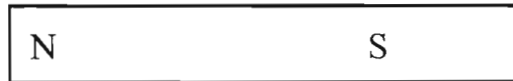
What must the object be made of in order to be affected by a magnetic force?

12. List ways to magnetize an object. Why does this magnetize the object?

List ways for an object to lose their magnetic force.

13. Why can we use a compass for navigation on the Earth? Will a compass help with navigation on the moon? What about other planets?

14. What does the magnetic field around a magnet look like?





Name: \_\_\_\_\_



**Electric Motors**

15. Why does an electric motor spin?

Draw a picture of an electric motor and label the major parts:

Explain how the motor in the appliance you took apart made the appliance move.

SAVE-IT SHEET for Science  
**Electricity and Magnetism**

1. **Electricity** is made possible because of the special structure of the atom. Draw the structure of the atom. What particle of the atom is needed to have **electricity**? *electrons*

*draw the Bohr model of the atom:*

**Static Electricity**

2. Whenever there is **static electricity** the particles of the atom have changed. What particles of the atom have changed that cause the atom now to have a charge?

*Atom is charged by conduction, induction, and friction. In all these cases the electron negative charge does not balance the proton positive charge since electrons have moved away from or to the atom.*

3. How does lightning get formed?

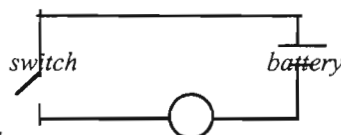
*Regions of positively charged particles develop in clouds as electrons move from ice crystals to water droplets so that the bottom of the cloud becomes negative and the top icy part is positive. By induction the ground becomes charged. When the electrical voltage builds up between the ground and the cloud the electrons move.*

*18,000 °Fahrenheit is temperature of air when the lightning passes*

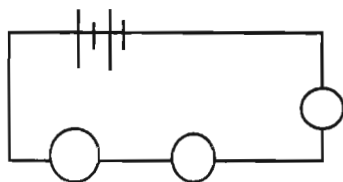
**Current Electricity**

4. Draw the symbols used for an **electric circuit**. Draw a circuit and label the parts that are needed to make electricity flow.

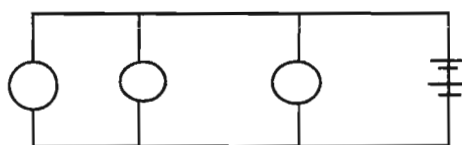
*bulb: battery: voltmeter  
 ammeter: resistance: switch:  
 current:*



5. Draw a series circuit with 2 batteries and 3 light bulbs:



6. Draw a parallel circuit with 2 batteries and 3 light bulbs:



7. Think about the lab you did on parallel and series circuits. How does the brightness of the bulbs compare between the two circuits? Explain the difference.

*parallel: the bulbs all remain same brightness since the electrons take different paths and the voltage remains*

*series: the bulbs become dimmed since the voltage drops as the electrons follow the same path*

*If one bulb is unscrewed in the series circuit what happens and why? bulbs go out since circuit is broken*

*If one bulb is unscrewed in the parallel circuit what happens and why? bulbs stay lit since the electrons have other paths to follow*

### Batteries

8. What did you discover a battery to be made of in order for it to make electrons move (create electricity) to cause the battery-operated object to work? *Zinc case becomes anode with negative charge in chemical reaction*

*Carbon rod loses electrons and is positive cathode; chemicals inside from a paste  $NH_3Cl$ ,  $ZnCl$ ,  $O_2$*

*alkaline cell: steel casing passes electrons to manganese and steel nail collects electrons from zinc*

9. What do you think happens when a battery "dies?" *The chemicals can no longer react*

### Physics Problems: Electricity

**Voltage = Current X Resistance**      V = voltage   I = amperes   R = ohms

$$V = I \times R \qquad \qquad \qquad V \qquad \qquad A \qquad \qquad \Omega$$

1. What current do I draw down when I plug in my 60  $\Omega$  mixer on my 120 volt circuit?
2. My electric stove requires a 220 volt circuit and 40 amps of current. What is the resistance?
3. What is the voltage on a current of 6 amps carrying a 10 ohm resistor?
4. My lamp on the 110 volt circuit has a resistance of 22 ohms. What current does the lamp draw down?
5. What is the current flowing through an electric circuit if it has 120 V across it and 10  $\Omega$  of resistance
6. It requires 220 V to drive a 5 A current through an appliance. Find the resistance.
7. What is the voltage if there is a 6 A current and a 10  $\Omega$  resistor?
8. A 120 V lamp draws 0.25 A of current. What resistance does the bulb have?
9. There is a 22  $\Omega$  resistance in the heating element of a coffee maker. If it is plugged into a 110 V circuit, how much current does it use?
10. What is a lamp's resistance if it uses a 115 V circuit and draws 0.25 A?

### **Magnetism**

10. Why are some objects naturally magnetized?

*spin of unpaired electrons*

11. Name some materials or objects that are affected by a magnetic force: *iron, magnetite, nickel, cobalt,*

Name some materials or objects that are not affected by a magnetic force: *plastic, aluminum, copper, glass*

What must the object be made of in order to be affected by a magnetic force? *iron, alnico,*

12. List ways to magnetize an object. Why does this magnetize the object?  
*stroking the metal with a magnet*

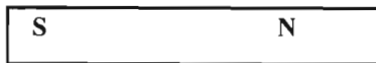
List ways for an object to lose their magnetic force.

*heating, striking the metal very hard with a hammer*

13. Why can we use a compass for navigation on the Earth? Will a compass help with navigation on the moon? What about other planets?

*The Earth has a natural magnetic field to which the compass needles align. The moon has no magnetic field and only planets with a magnetic field will a compass be useful Mercury, Jupiter and some moons, Saturn, Uranus, Neptune.*

14. What does the magnetic field around a magnet look like?



### Electric Motors

15. Why does an electric motor spin?

*armature becomes magnetized as current flows through the wires which interacts with the magnetic field of the field magnet setting up forces of repulsion and attraction. The commutator delivers the current through the brushes to the armature so that the magnetic field always reverses.*

Draw a picture of an electric motor and label the major parts:

Explain how the motor in the appliance you took apart made the appliance move.

Name: \_\_\_\_\_

## PROPERTIES of STATIC ELECTRICITY

### Introduction

Atoms are composed of a positively charged nucleus surrounded by a cloud of negatively charged electrons. When certain objects are rubbed together, electrons may move off of one of the objects onto the other object. The object that now has extra electrons has a negative charge and the object that lost electrons has a positive charge. Since opposite charges attract and like charges repel, this imbalance of negative charges creates a force between the two objects. This force is due to these electrostatic charges.

**Draw a picture for this explanation:**



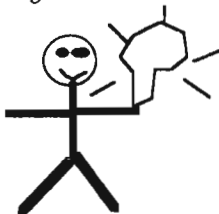
### Materials and Methods

1. An electroscope detects electrostatic charges. Construct an electroscope using the flask and straw from which an aluminum foil strip is suspended into the flask with "pith balls" at the ends of the foil.
2. You are supplied with items to rub to move electrons from one item to another by friction. Use the electroscope to detect the electrostatic charges.



3. You are supplied with items to build a capacitor, a Leyden jar, from a film canister. Wrap the outside of the film canister with aluminum foil. Fill the canister about 2/3 with water and push a nail through the center of the lid so that the nail just touches the water.

4. As a final activity you will hold a light bulb and make it light with your own static electricity!



Name: \_\_\_\_\_

Data

**Charging by friction:**

1. Bring the rubber rod near the electroscope to check for a charge. Now rub the rubber rod with the wool and bring it near the electroscope again.
2. Repeat with a comb that you run through your hair.

Describe what you saw happen in each case:

Explain what the electrons did in each case:

**Charging by induction:**

1. Charge a balloon by friction by rubbing it on your hair. Now bring the balloon near to torn up little pieces of paper or styrofoam peanuts.
2. Bring the charged balloon near to the electroscope without touching the electroscope.

Describe what you saw happen in each case when you brought the charged object near to the uncharged object.

Explain what the electrons did in the uncharged object to respond to the electrostatic force of the charged object.

**Charging by conduction:**

1. Charge up your Leyden jar. Charge the styrofoam plate by friction with a wool cloth. Place the aluminum pie pan on the styrofoam plate and briefly touch the pie pan. Hold the Leyden jar in one hand and pick up the pie pan by the styrofoam cup "handle" (do not touch the metal pan) with your other hand and touch the plate to the nail on the Leyden jar. Repeat several times.
2. Now test your Leyden jar for a charge. While holding the Leyden jar, touch the nail with the other hand.

Describe what you felt happen:

Explain how the charge got into the Leyden jar.

Name: \_\_\_\_\_

**Like charges...opposite charges**

1. Hold 2 overhead projector sheets next to each other. Now charge up both sheets by friction method by rubbing them against your hair (or some other means).

Describe what happened:

Explain why this happened:

2. Charge by friction method two balloons tied to a string. Let the balloons hang next to each other. Try to turn another side of one balloon to the other balloon.

Describe what happened:

Explain why this happened:

3. Charge up a rubber rod with wool and a glass rod with silk. Bring the rods near to the balloons.

4. Try other experiments with the balloons and rods. Describe what you did and what happened:

**Lighting the light bulb!**

Build up a charge in your own body by friction. Hold one prong of the light bulb and have a friend hold the other prong. Watch carefully and see how long you can keep the light lit. Watch for brightness!

Name: \_\_\_\_\_

Conclusion

1. Draw a picture of a model of the atom.

Explain the part of the atom that causes electrostatic charges:

2. Look up what a **capacitor** does and where it is used in electrical circuits.

3. Look up **electroscope**. Describe how the electroscope works and what it means when the "pith balls" move apart.

4. Describe the three ways to form a static charge on an object.

5. If two objects have the same charge, what will happen when the objects are brought close together?

6. If two objects have opposite charges, what will happen when the objects are brought close together?

7. Explain at least three things you have learned about static electricity. Use examples from this lab.



Name: \_\_\_\_\_

## PROPERTIES of CURRENT ELECTRICITY

### Introduction

Current electricity is electrostatic charges, specifically electrons, moving through a wire. The negative electrons will only move if they can be attracted to a positive charge. So we place in the **circuit** a source of electrons and a positive charge. A battery has both of these properties as does the plug with its two prongs. We also place in the circuit an electrical appliance, which acts as a resistance, so that the electrons flowing through the wire are forced through the appliance. It is the energy from these electrons that “runs” the appliance.

**Draw a picture for this explanation:**

An **ammeter** counts how many electrons pass through the ammeter per second. There is 1 amp of current if 6,240,000,000,000,000 (6.24 x 10<sup>18</sup>) electrons go by each second. Mr. Coulomb figured out this number so we call this big number a coulomb of electrons.

A **voltmeter** measures the voltage of the current. This means how much force there is on the electrons to make them move through the circuit. If you have 1 volt of force, that means 1 amp of electrons can flow through an appliance that is resisting the flow of electrons with a resistance of 1 ohm.

This lab will demonstrate how to make a circuit, how to use a voltmeter and ammeter in the circuit, and then how to rearrange the circuit to have a **parallel** or a **series** circuit. You will learn to recognize these two types of circuits and the differences between these circuits.

### Materials and Methods

You will have the opportunity to experiment with wires, bulbs, batteries, ammeter, and voltmeter. Set up the circuit diagrams and answer the questions.

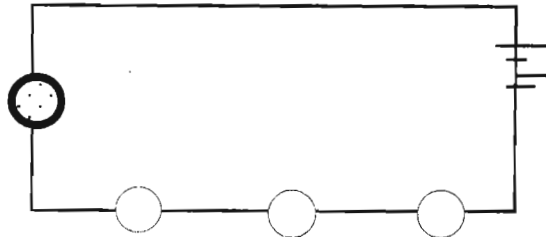
Name: \_\_\_\_\_

Data

**Series Circuit:**

1. Build a series circuit as follows. Start with one bulb in the circuit and then add additional bulbs, one at a time, up to 4 bulbs.

How many batteries are indicated: \_\_\_\_\_

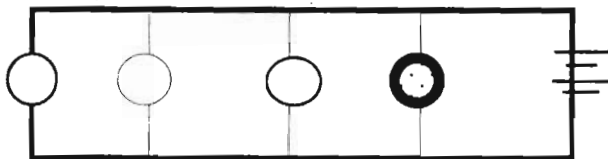


2. What happened to each of the bulb's brightness as you added an additional bulb?

3. What happened when you unscrewed one light bulb in this circuit?

**Parallel Circuit:**

1. First build the circuit with one bulb, then add additional bulbs, one at a time, up to 4 bulbs.

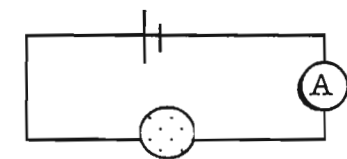


2. What happened to each of the bulb's brightness as you added an additional bulb?

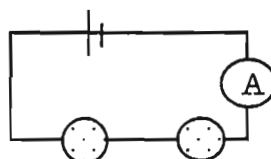
3. What happened to the other light bulbs when you unscrewed one light bulb?

**Using the ammeter:**

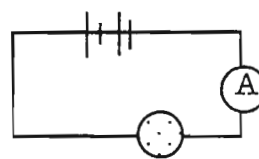
The ammeter is wired into the circuit in series to the other appliances, in this case, light bulbs. Carefully examine and build these series circuits.



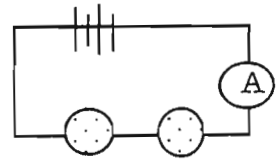
\_\_\_\_\_ amp



\_\_\_\_\_ amp



\_\_\_\_\_ amp



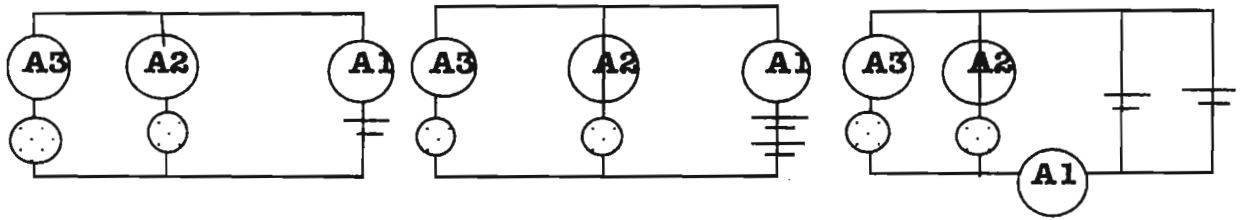
\_\_\_\_\_ amp

How do the number of amps change as batteries are added?

How do the number of amps change as light bulbs are added?

Name: \_\_\_\_\_

Set up these parallel circuits that each contains 2 light bulbs. You will move the ammeter around the circuit according to the number for each ammeter location.



1 \_\_\_\_\_ amp  
2 \_\_\_\_\_ amp  
3 \_\_\_\_\_ amp

1 \_\_\_\_\_ amp  
2 \_\_\_\_\_ amp  
3 \_\_\_\_\_ amp

1 \_\_\_\_\_ amp  
2 \_\_\_\_\_ amp  
3 \_\_\_\_\_ amp

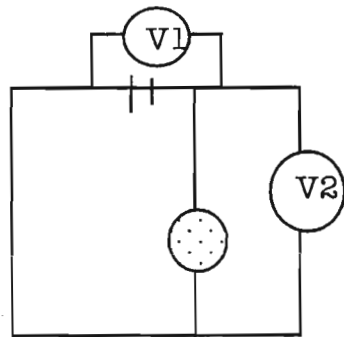
**Examine the first circuit.**

What was the total number of amps coming out of the battery (A1)? \_\_\_\_\_

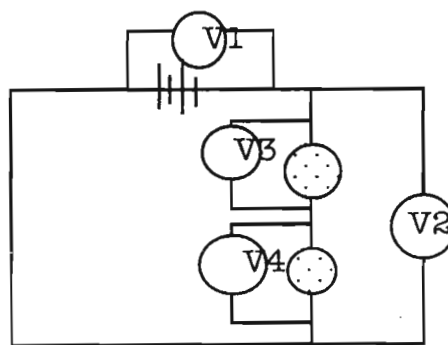
What was the total number of amps for position 2 and 3 added together? \_\_\_\_\_

**Using the Voltmeter**

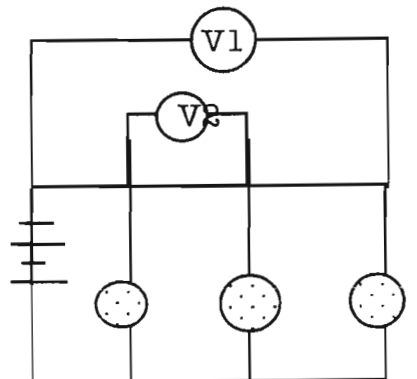
The voltmeter is wired into the circuit in parallel to the appliance, in this case the light bulb. Carefully examine the circuit diagrams and set the circuits for each of the positions numbered for the voltmeter.



1 \_\_\_\_\_ volts  
2 \_\_\_\_\_ volts



1 \_\_\_\_\_ volts  
2 \_\_\_\_\_ volts  
3 \_\_\_\_\_ volts  
4 \_\_\_\_\_ volts



1 \_\_\_\_\_ volts  
2 \_\_\_\_\_ volts

Describe any pattern you see in the voltage changes as you moved the voltmeter around the circuit:

Name: \_\_\_\_\_

Conclusion

1. Provide at least 3 facts you discovered as to the differences between a series circuit and a parallel circuit.
2. Look up what an **ammeter** measures, how it is used in electrical circuits, and name at least 2 patterns about current you observed from your data.
3. Look up **voltmeter**. Describe how the voltmeter is used in electrical circuits, and name at least 2 patterns about voltage you observed from your data.
4. Find out whether homes are wired in series or parallel circuits. Explain why the type of circuit used in homes supports the data from your lab.
5. Observe the circuit breaker or fuse box in your home. Find out the purpose of this box and how it works to protect your home.

Name: \_\_\_\_\_

## PROPERTIES of a DRY CELL

### Introduction

In this lab you will discover how a dry cell is made and build your own battery. All dry cells must create a chemical reaction that releases electrons at one electrode, the anode, and attracts electrons to the other electrode, the cathode. When the positively charged cathode is wired to the negatively charged anode, the electrostatic force causes the electrons to move through the wire creating a current that passes through whatever appliance comes between the anode and cathode.

**Draw a picture for this explanation from what you learned when you took apart the dry cell:**

### Materials and Methods

You will have the opportunity to put together various batteries and cells. You will use a galvanometer to detect the current in milliamps! You can also try to light a light bulb in the circuit, or test the current with your sensitive tongue.

### Data

Group 1: Zinc-Copper-Electrolyte battery

\*The electrolyte in this battery is a piece of felt soaked in dissolved ammonium chloride.

\*The electrodes in this battery are Zinc and Copper.

1. Clean completely the surfaces of the 6 squares of zinc and copper with steel wool. Soak the 6 squares of felt in the electrolyte solution and squeeze out extra solution before assembling the battery.
2. Form the battery by layering copper-felt-zinc-copper-felt-zinc and ending with zinc on top.
3. Secure this pile with a rubber band.
4. Connect each end to the wire and attach to the galvanometer/light bulb or across your tongue if you dare!

Record the current:

Observations:

Name: \_\_\_\_\_

### Group 2: Copper-Aluminum-electrolyte battery

\*The electrolyte in this battery is a piece of folded paper towel soaked in lemon juice.

\*The electrodes in this battery are copper and aluminum or a penny and a dime.

1. Clean completely the surfaces of the 10 coins with steel wool.
2. Form the battery by layering dime-towel-penny-dime-towel-penny ending with the penny.
3. Secure this pile with a rubber band.
4. Connect the ends to the galvanometer/light bulb or hold the ends with your wetted fingers.

Record the current:

Observations:

### Group 3: Wet cell

\*The electrolyte in this wet cell is vinegar.

\*The electrodes are aluminum and copper.

1. Clean completely the surface of the copper with the steel wool.
2. Line the inside of a beaker with Aluminum foil, place a pencil across the top of the beaker and suspend the copper strip so that it hangs into the beaker without touching the foil.
3. Pour enough vinegar into the beaker to reach and cover the copper strip and aluminum foil at the same time.
4. Connect wires to the foil and copper and then to the galvanometer/light bulb, or if you dare across your tongue!

Record the current:

Observations:

5. Remove the aluminum foil from the beaker and suspend a lead strip into the vinegar so that it does not touch the copper strip.

Record the current:

Observations:

Name: \_\_\_\_\_

#### Group 4: Apple battery

\*The electrolyte in this cell is an apple and other fruit

\*The electrodes are a paper clip and copper strip

1. Clean the paper clip and copper strip with the steel wool. Straighten the paper clip.
2. Embed the copper and paper clip into the apple so as not to let them touch.
3. Connect two wires to the electrodes and to the galvanometer.

Record the current:

Observations:

4. Make 4 more apple cells and connect the apples in series and to the galvanometer.

Record the current:

5. Reconnect the 5 apple cells in parallel and to the galvanometer.

Record the current:

6. Replace the apple and use a potato, lemon, and orange.

Record the current for each fruit.

#### Group 5: Wet cell

\*The electrolyte in this cell is water with added chemicals

\*The electrodes in this cell are zinc and copper

1. Clean the zinc and copper well with steel wool.
2. Lay a pencil across the top of the beaker and from it suspend the zinc and copper strips so that they do not touch.
3. Pour water into the beaker so that the electrodes are submerged.
4. Connect wires from the electrodes to the galvanometer.

Record the current:

5. Add and stir in 3 tablespoons of salt to the water.

Record the current:

6. Replace the salt water with soda drink.

Record the current:

7. Replace the soda drink with water dissolved with 3 tablespoons of baking soda

Record the current:





Name: \_\_\_\_\_

## PROPERTIES of MAGNETISM

### Introduction

In this lab you will investigate some of the properties of magnetism. A magnetic field can be represented by a drawing showing the lines of force. Since electricity running through a wire creates a magnetic field and a moving magnetic field creates electricity, many of the investigations will look for that relationship. The compass will be the tool used in this lab to visualize the direction of these lines of force because the compass detects a magnetic field.

**Draw a picture of the magnetic field experienced by these two magnets:**



### Materials and Methods

You will rotate through stations as you experiment with the relationship between magnetism and electricity. Do the activities at each station and record the data.

### Data

Station 1: Cow Magnet Drop

[http://www.exploratorium.edu/snacks/eddy\\_currents.html](http://www.exploratorium.edu/snacks/eddy_currents.html)

1. Bring the magnet near to the copper tube to check for magnetic attraction.
2. Hold the copper tube vertically and drop the cow magnet through the copper tube.

What seemed to happen as the magnet dropped down the copper tube?

Provide an explanation of what you observed that happened:

Name: \_\_\_\_\_

Station 2: Electricity and lines of magnetic force

1. Use the compass to observe the direction of the Earth's magnetic north
2. Place horizontally over the compass a section of wire such that it lies perpendicular to the compass needle
3. Hook the wire ends up to the battery and observe the compass needle's direction.
4. Reverse the battery (electrodes) and now observe the compass needle's directions.

What did the compasses do in response to the wire when electricity was running through the wire?

What relationship did you discover about the direction of the current and the direction of the north magnetic needle?

Station 3: Electromagnet

1. Touch the nail to the paperclips and try to lift the paperclips.
2. Wrap the wire around the nail in a close coil, hold the ends of the wire to the battery terminals, and touch the nail again to the paperclips.
3. Try to lift the paperclips.

What were your results each time you tried to lift paperclips with the nail?

Provide an explanation of your observation.

Station 4: Earth's magnetic field

1. Carefully place the pin across the surface of the cork floating in the water.
2. Observe the pin's alignment after the cork stops turning.
3. Remove the pin and again place the pin across the cork and observe the pin's alignment after the cork stops turning.
4. Look at the compass and compare the pin's alignment to the compass needle.

What were the results each time you waited for the cork to stop spinning in the water?

Provide an explanation of your observation.

Name: \_\_\_\_\_

Station 5: Magnetic force versus gravity force

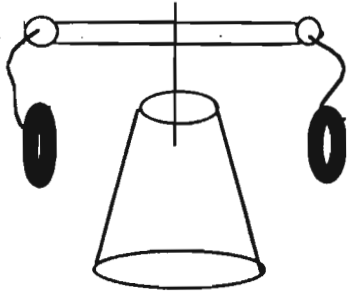
1. Swing the pendulum with the magnet at the end and observe the path.
2. Arrange piles of magnets in a circle in the swing area. Observe the swing pattern.
3. Rearrange the magnet piles in the swing area. Observe the swing pattern.

Results observed:

Provide an explanation of your observations.

Station 6: Magnetic force to mechanical energy

1. Observe the apparatus with the freely rotating arms with magnets at each end.
2. Use the third magnet and without touching the magnets in the arm, cause the apparatus to rotate.
3. Challenge: Get the apparatus rotating, then hold your magnet in one spot and try to continue the rotation of the apparatus. (Hint: flip the magnet sides as the arms approach and then pass by.)



Explain your results and the success you had to get the arm to rotate.

Explain how you were able to obtain these results:

Station 7: Electric motor simplified

[http://www.exploratorium.edu/snacks/stripped\\_down\\_motor.html](http://www.exploratorium.edu/snacks/stripped_down_motor.html)

1. Observe the basic parts of an electric motor
  - \*stationary magnet (magnet held to cup)
  - \*source of electrons (battery)
  - \*freely rotating armature made of a coil of wire
2. Place the armature in the paper clip supports. You may have to give a little push to the armature to get it to spin.

Explain what you observed happen.

Explain why this phenomenon happened.

Name: \_\_\_\_\_

Conclusion

1. Read about magnetism in World Book Encyclopedia. Write down and explain 5 pieces of information from this article. Tell how this information was demonstrated by the experiments you did.

Name: \_\_\_\_\_

INQUIRY  
HOW DOES AN ELECTRIC MOTOR  
CHANGE ELECTRICAL ENERGY TO MECHANICAL ENERGY ?

1. With your lab partner carefully take apart an electric appliance that runs with an electric motor. As you take apart the appliance, carefully observe and draw how the shaft of the motor connects to the mechanical part of the appliance to cause the motion.
  
2. Carefully take apart the switch to figure out how the circuit is completed or interrupted to start and stop the motor. Carefully draw pictures of what you discovered.
  
3. Carefully take apart the electric motor. For many of the smaller motors, you will have to remove the cap from the metal casing to get inside the motor. Draw pictures and identify the parts of the motor using resources you have found in World Book Encyclopedia and on the internet.
  
4. Each lab partner is expected to do further research and include that information this lab report for the history and development of the electric motor. Bonus research could include information on how a generator generates electricity.

This inquiry will be Graded on these expectations:

Rubric: **How does an electric motor change electrical energy to mechanical energy?**

I. Lab is completed on time by each partner working together on drawing pictures and taking the appliance apart.

5-Lab is completed and student helped fairly

3-Lab is completed and student helped just some

1-Lab is completed but student did not help the group

---

**II. Written report clearly provides**

**\*Introduction explaining the problem to be solved. This will explain what you already know about an electric motor, the parts of the motor, and how the relationship between magnetism and electricity make possible the electric motor. The research you did on electric motor history should be included here.**

**\*Materials and Methods used. This will explain what type of appliance you took apart.**

Name: \_\_\_\_\_

**\*Data chart of the drawings and observations you made when taking the appliance apart.**

**\*Conclusion that explains what the drawings and observations teach you. This will explain what you learned about how an electric motor operates, how the parts of the electric motor make the motor turn, and how the appliance you took apart changes the spinning motor shaft into movement of the appliance. Your conclusion will provide information you learned on how a switch operates in this appliance.**

**10-All four sections of the lab report are provided**

**5-Lab report sections are not present**

**1-Lab report not complete in requirements**

---

III. Interesting Format to read

5-High interest reading, researched information required on an electric motor and its invention.

3- Interesting to read, but little extra information provided

1-Made an attempt to make it interesting/no details added

---

IV. Language Arts: Grammar/Sentence Structure/Spelling

5-Few errors for the length of the paper

1-Many errors and hard to read and understand

---

V. Paper is passed in on time (0 to 5 points)

---

Parent Comments about this paper and signature that the paper was proofread: bonus 5 points

**UNIT VIII: CHEMISTRY**Unit Objectives:

1. Be able to identify and explain the characteristics of matter
2. Create a graph of a phase change to describe the three states of matter and the processes of condensation, evaporation, sublimation, freezing, and melting
3. Describe characteristics of a mixture and a pure substance
4. Use the Law of the Conservation of Mass to predict if both the mass and volume are additive when a solute is dissolved in a solvent and also if additive when two substances chemically react
5. Demonstrate an understanding for the development of atomic theory and the model of an atom
6. Describe characteristics of elements that are metals and nonmetals and locate these two groups on the Periodic Table
6. Construct models of compounds to write empirical formulae
7. Describe reactants and products in a chemical reaction

Classroom Activities:

1. Inquiry: What is Matter?    Preactivity: Melt glass
2. Demonstration: What happens to matter when we heat it? heat salt (no change), moth balls (melt), Cu(II)Carbonate  $\rightarrow$  CuO + CO<sub>2</sub> (chemical decomposition), heat metal ball and ring (expands).
3. Minute questions 1 to 7 done as a jigsaw as a pre-activity to Save-It sheet inquiry part III on phase changes.
4. Save-It sheet parts I and II review. Complete part III inquiry to collect the data to make the graph of a phase change. Review student jigsaw activity answers. Recollect some boiled off water. Ask: What is the condensate on cold glasses? From where did the condensate come?
5. Demonstration: Place 70° C water in a syringe to about 1/4 full. Pull out the plunger. Or place a cup of warm water in a vacuum chamber. This should boil. Why?
6. Inquiry: How can you tell if something is a pure substance or a mixture? Have a hot plate available for students to check for dissolved minerals.
7. Demonstration: Place sugar in water. Ask 1) What is happening to the sugar (melt/dissolve)? 2) Does the total volume change? 3) Does the total mass change? 4) Are new substances formed? 5) If new substances are not formed, how can we get the sugar back?
8. Inquiry: What is the law of conservation of matter? (Use at least 25 ml water and ethanol @). Dissolve 3.8 g CaCl<sub>2</sub> in 50 ml water and 5.9 g KCO<sub>3</sub> in 50 ml water.
9. Follow-up demonstration: Place baking soda and vinegar in separate open containers on a 3-beam balance and balance. Next pour baking soda into the

open vinegar container and watch the balance. Next place baking soda and vinegar in a test tube/balloon apparatus (or soda bottle with tight lid) and balance on the scale. Then mix contents. Ask: 1) Does the mass change? 2) Does the volume change? 3) Are new substances formed? 4) What's in the bubbles?

10. Research Project: Exhibit Cube of an every day object

11. Demonstration: Electrolysis of water. Splint test for oxygen, burning splint test for hydrogen. Ask: 1) Are new substances formed? 2) What was the booster to make the reactions go? (electricity and sodium sulfate)

12. Minute questions 8, 9,&10. Save-It sheet for atoms, elements, compounds and atomic theory

13. Element Search Project: Choose an element and research the basic chemistry of that element

14. Save-It sheet: Periodic table of elements introduction to abbreviations and symbols

15. Lab: What properties are used to group elements? Metals and nonmetals

16. Mini-lab: Construction of models of molecules

17. Electroplating key activity: Pour vinegar into container so to submerge key. Add 1T salt and continue adding and stirring until no more can dissolve. Hang a copper strip into the vinegar and connect to + battery terminal. Connect - terminal to key in vinegar. Wipe hydrogen gas off key to continue electroplating activity

18. Inquiry: What is the evidence when a chemical reaction occurs?

19. Demonstration follow-up: Weigh a ping-pong size piece of steel wool in a beaker. Hold the steel wool with tongs (or from a ring stand) in a darkened room over the butane flame until it glows...about 5 minutes; turn off burner and wait. Observe product. Place back into beaker and reweigh. Predict if steel wool while "burning" will gain or lose weight

20. Worksheet: Building molecules and chemical reaction equations

21. Lab: Where does matter go?

22. Lab Practical

#### Minute Questions:

1. How does the weight of a glass of water with an ice cube in it change as the ice cube melts and disappears?

2. How can we make spaghetti cook faster?

3. Why does ice melt?

4. Are things that are boiling always hot? Provide examples to prove your answer.

5. Are things that are frozen always cold? Provide examples to prove your answer.

6. If the freezing point of water is 0° C (32°F) what is water's melting point?



7. What's in the bubbles when water boils?
8. What makes substances different even though sometimes they may look alike?
9. What is an element? List examples.
10. What is a compound? List examples.
11. How might a salt molecule be different from a sugar molecule? vinegar from water?
12. Write a list of 10 items made of molecules. Write a list of 10 items made of atoms. Pretend you are standing on your desk and are shrunk to the size of a molecule. Draw a picture of what you see as you look around from the top of the desk.

### Assessment

1. Minute questions
2. Inquiries:
  - What is Matter?
  - How can you tell if something is a pure substance or a mixture?
  - What is the Law of Conservation of Mass?
  - What is the evidence for a chemical reaction occurring?
3. Labs:
  - How are elements grouped in the Periodic Table?
  - Molecule models
  - Where does matter go?
4. Worksheets:
  - Molecules and chemical reactions
  - Naming compounds
5. Projects:
  - Everyday object
  - Element search
6. Lab Practical

## Unit VIII: Chemistry

Unit VIII is an introductory study to chemistry, the characteristics of matter and atomic theory. Students will create models of atoms and use these models to construct the law of conservation of mass. They will begin a rudimentary study of the Periodic Table and the usefulness of the data that is incorporated within the table.

The first inquiry asks students to discover some very fundamental properties of matter. The inquiry is set up in 6 stations and asks the students to explore matter and space with changes of state, changes in mass, changes in volume, and changes in shape. Station 2 must be rechecked on the second day after the jar of water has frozen. Be sure to wipe the frozen condensate off the outside of the jar before reweighing. Station 3 can be set up for dramatic results. Have available at the station both a bowl of icy water and a pot of hot water. Students are provided with a flask of colored water sealed by a one hole stopper through which runs a short glass tube. When the flask is placed in the pot of hot water, the water rises up the glass tube and when placed in the icy water, the water falls back down the glass tube. Station 5 always catches at least one unsuspecting student. Run a funnel through a one hole stopper that is tightly placed into a test tube. When the student pours the water into the funnel, the water quickly overflows the funnel. Provide plenty of rags to clean up the overflow. At the conclusion of this inquiry students should be able to describe properties of matter. This acts as a springboard for the entire unit as students are asked to explore the fundamental composition of matter and chemical reactions.

Upon completion of the mini-lab for the graph of a phase change as described on their Save-It sheet, students should understand that the energy from the heat is used to complete the phase change and not until the change is complete does the energy from the heat cause a change in temperature. An increase in heat does not always cause things to get “hotter.”

This phase change mini-lab is followed by the inquiry for pure and mixed substances. Students explore physical means of separating substances from a mixture of substances through filtering, magnetism, evaporation, and chromatography. You may choose to let students evaporate a small sample of their experimental sample on a hot plate or you may do that as a whole class demonstration. This will depend on the safety considerations of your classroom set-up.

The inquiry for the Law of Conservation of Mass requires various chemicals. To show that the volume for two substances mixed is not additive, yet mass is additive, use at least 25 ml of water and 25 ml of ethanol. For the chemical reaction, provide each lab group

about 10 ml of each solution made by combining 7.5 g Calcium chloride dihydrate (5.5 g anhydrous Calcium chloride) with enough water to make 100 ml and 11.8 g Potassium carbonate with enough water to make 100 ml. When combined, these chemicals will form a precipitate. Encourage students to create a data chart; there is a data chart suggestion provided.

After an introduction to elements, atoms, compounds, and atomic theory, students will proceed to a basic organizational characteristic of the periodic table, the line between metals and non-metals. Students should use the periodic table to locate the elements used in this lab and to obtain the density of the elements. Or allow students to experimentally obtain the density. Provide wires, battery, and light bulb and demonstrate to the students how to place the element in the circuit to check for electrical conductivity. From the data the students collect, they should make a determination as to whether the element is a metal or a non-metal and after charting this data on the periodic table, most students are able to make the connection with the line stair stepping on the chart as the division between metals and non-metals.

Molecule kits that contain colored wooden spheres to represent atoms and wooden dowels to represent the bonds are excellent to use for a visual representation for the appearance of molecules. These work better than marshmallows and toothpicks since the wooden spheres are predrilled for the correct bonding angles found in molecules. As the students work to put together the molecules in this min-lab, use the words “compounds”, “molecules”, “elements,” and “atoms”. Encourage students to make the connection that each molecule has a particular appearance as the elements bond to form the molecules. This is a key lab for helping students to understand that there is a lot of empty space between atoms and molecules of substances and hence the reason that when combining two substances their volumes are not additive. Throughout the rest of this unit on chemistry, refer back to these models and use them to demonstrate chemical reactions the students will encounter in the next few labs. I like to show them what plants do for photosynthesis, adding 6 water molecules to 6 carbon dioxide molecules and creating sugar!

There are many relatively safe chemical experiments that can be done in the middle school classroom. The assortment chosen for the inquiry for what is the evidence for when a chemical reaction occurs represent various outcomes. Many students are looking for an explosion in chemistry; alas this is not the case for this set of experiments. The assortment of experiments represents both endothermic and exothermic reactions, precipitate and gas

formations, and color changes. Discuss the differences between a chemical reaction and a physical change. Use the molecule models in your discussion.

The final three worksheets of this unit reteach the concept of symbols used in chemistry. Students should begin to know element abbreviations, system of numbering for atoms and compounds, and simple equations used to represent a chemical reaction. Also included is a worksheet on basic compound nomenclature. At least expose students to the fact that there is a pattern in chemistry and a reason for the symbolic language used by all chemists. Many common household substances are given common names. For example “salt” is not called “sodium chloride”. A fun spoof is to give the students the fact sheet on “dihydrogen oxide”. The worksheet to balance atoms during a chemical reaction is a challenge for those students who like to puzzle out solutions.

The final lab on where does “IT” go wraps up the concept that all matter is made of atoms that are combined in an infinite number of ways with other atoms to form the huge variety of substances of our universe. These atoms are recycled in our environment to form an organism, then become part of another organism when ingested, then become parts of objects we may use, and then become part of another object as the atoms are recycled. Every atom must be accounted for, even when it appears to “go up in smoke.”

The final assessment for the two energy units is a lab practical. Students use the wooden molecule models for building and interpreting molecule structures. Students use the periodic table for information on an element’s atomic structure, and watch experiments to interpret whether they are a chemical or physical change. An easy chemical experiment is to place a galvanized nail in a solution of acid and an easy physical change is to provide a melting ice cube. Students observe parallel and series circuits. This lab practical asks students to synthesize the concepts studied throughout the chemistry and electricity units.

Name: \_\_\_\_\_

SAVE-IT SHEET for SCIENCE  
**Chemistry, The study of Chemical Energy**

I. What is **matter**? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

II. What happens to **matter** when we heat matter?

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_

III. What does the graph of a phase change look like? With your lab group you will be given icy water to heat. Every 20 seconds you will record the temperature of the substance. After the phase changes are completed you will graph the results and share the information with the class.

Explain your results: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

IV. What is a **pure substance**? \_\_\_\_\_  
\_\_\_\_\_

Name: \_\_\_\_\_

What is a **mixture**? \_\_\_\_\_

What are some tests to perform to make this determination between a pure substance and a mixture? \_\_\_\_\_

V. What is the **Law of Conservation of Matter**? \_\_\_\_\_

Is volume conserved when matter is combined in a mixture...What is your proof?

Is mass conserved when matter is combined in a mixture .....What is your proof?

VI. What is the structure of matter?

Scientists cannot see the smallest piece of matter. By experimenting and reasoning, scientists have developed a theory and a model for what they believe are the properties and the appearance of the smallest pieces of matter.

**Greek model, Democritus 400 B.C.:**

**Dalton's model 1803:**

Name:

Thomson's model 1897:

Rutherford's model 1908:

Bohr's model 1913:

Wave model:

ATOMS

ELEMENTS

COMPOUNDS

VII. The Periodic Table of Elements:

Element	Symbol	Atomic Number # of protons	Atomic Mass # of protons+ # of neutrons	State of matter at room Temperature	Melting point	Boiling Point	Density
Gold							
Hydrogen							
Nitrogen							
Mercury							
Sodium							

Name: \_\_\_\_\_

1. What are the most basic ingredients used to make all matter?
2. How many basic ingredients are there on Earth that are used to make all matter? \_\_\_\_\_

Elements are the basic ingredient used to build all matter. Chemists have devised a list of unique abbreviations to represent each of the elements. Beside each abbreviation determine the name of the element. You will be expected to know the following 24 abbreviations!

H _____	He _____	Li _____
C _____	N _____	O _____
Na _____	Mg _____	Al _____
Si _____	S _____	Cl _____
K _____	Ca _____	Zn _____
Ag _____	Sn _____	Au _____
Hg _____	Pb _____	U _____
Fe _____	Ni _____	Cu _____

**List the ingredients needed to make each one of these common items:**

Table salt:  $\text{NaCl}$  \_\_\_\_\_

Sugar:  $\text{C}_6\text{H}_{12}\text{O}_6$  \_\_\_\_\_

Water:  $\text{H}_2\text{O}$  \_\_\_\_\_

Butane gas:  $\text{C}_4\text{H}_{10}$  \_\_\_\_\_

Propane gas:  $\text{C}_3\text{H}_8$  \_\_\_\_\_

Rust:  $\text{Fe}_2\text{O}_3$  \_\_\_\_\_

Vinegar:  $\text{HC}_2\text{H}_3\text{O}_2$  \_\_\_\_\_

Baking soda:  $\text{NaHCO}_3$  \_\_\_\_\_

Deodorant:  $\text{Al}(\text{OH})_3$  \_\_\_\_\_

Antacid tablet:  $\text{Mg}(\text{OH})_2$  \_\_\_\_\_

Battery acid:  $\text{HCl}$  \_\_\_\_\_



SAVE-IT SHEET for SCIENCE  
**Chemistry, The study of Chemical Energy**

I. What is **matter**?*Takes up space, has mass**3 Phases: solid, liquid, gas**Does not change mass as it changes state but changes volume as it is heated or cooled*II. What happens to **matter** when we heat matter?

1. Expands (metal ball and ring)
2. Phase change (moth balls)
3. Chemical change, thermal decomposition (CullCarbonate, sugar)

III. What does the graph of a phase change look like? With your lab group you will be given icy water to heat. Every 20 seconds you will record the temperature of the substance. After the phase changes are completed you will graph the results and share the information with the class.

Explain your results:

*Until all the substance passes from one phase to another, heat continues to go into the system although the temperature remains steady.*

IV. What is a **pure substance**? Matter that contains the same substance with the same physical and chemical properties

What is a **mixture**? Matter that contains two or more substances with different chemical and physical properties

What are some tests to perform to make this determination between a pure substance and a mixture? magnetism, solubility, melting points, crystal structure, evaporation, density layers

V. What is the **Law of Conservation of Matter**? When matter is combined the atoms of matter are conserved and accounted for in the reactants and products. Mass is conserved.

Is volume conserved when matter is combined in a mixture...What is your proof?

Volume is not additive as shown when alcohol and water was combined

Is mass conserved when matter is combined in a mixture ....What is your proof? Mass is conserved as shown when the chemicals were added and the precipitate formed

## VI. What is the structure of matter?

Scientists cannot see the smallest piece of matter. Through experiments and reasoning, scientists have developed a theory and a model for what they believe are the properties and the appearance of the smallest pieces of matter.

**Greek model, Democritus 400 B.C.:**

*Matter can not be divided into smaller and smaller pieces. The atom is the smallest piece and can not be cut. The atom is indivisible*

**Dalton's model 1803:***All elements are made of atoms that are indestructible**All atoms of the same element are just alike**Atoms of different elements are different**Compounds form by joining atoms of 2 or more elements***Thomson's model 1897:**

*Plum pudding model. It was discovered that a neutral atom gave off charged particles so therefore the atom must be balanced with positive charges to get a neutral atom. The charges are evenly distributed throughout the atom.*

**Rutherford's model 1908:**

*The nucleus of an atom has a dense positively charged center equivalent to a marble in a baseball field.*

The negative charged particles are outside the nucleus at the atoms' edges so the atom is mostly empty space.

**Bohr's model 1913:**

Electrons move in a definite orbit from the nucleus. The energy levels are like planets around the sun.

**Wave model:**

The electrons move around the nucleus in a path impossible to predict and the location is based on how much energy the electron has.

ATOMS

\*Made of a nucleus of neutrons and positive protons surrounded by negative electrons

ELEMENTS

\*90 naturally occurring elements  
\*Contain all the same type of atoms with the same number of protons and possibly differing # of neutrons

COMPOUNDS

\*Every pure substance has its own kind of molecule which are different from the molecules of all other substances  
\*Composed of molecules of more than two types of elements

VII. The Periodic Table of Elements:

Element	Symbol	Atomic Number # of protons	Atomic Mass #of protons+ # of neutrons	State of matter at room Temperature	Melting point	Boiling Point	Density
Gold							
Hydrogen							
Nitrogen							
Mercury							
Sodium							

1. What are the most basic ingredients used to make all matter?

Elements

2. How many basic ingredients are there on Earth that are used to make all matter? 90

Elements are the basic ingredient used to build all matter. Chemists have devised a list of unique abbreviations to represent each of the elements. Beside each abbreviation determine the name of the element. You will be expected to know the following 24 abbreviations!

- |          |          |          |
|----------|----------|----------|
| H _____  | He _____ | Li _____ |
| C _____  | N _____  | O _____  |
| Na _____ | Mg _____ | Al _____ |
| Si _____ | S _____  | Cl _____ |
| K _____  | Ca _____ | Zn _____ |
| Ag _____ | Sn _____ | Au _____ |
| Hg _____ | Pb _____ | U _____  |
| Fe _____ | Ni _____ | Cu _____ |

List the ingredients needed to make each one of these common items:

Table salt:  $\text{NaCl}$  sodium, chlorine

Sugar:  $\text{C}_6\text{H}_{12}\text{O}_6$  carbon, hydrogen, oxygen

Water:  $\text{H}_2\text{O}$  hydrogen, oxygen

Butane gas:  $\text{C}_4\text{H}_{10}$  carbon, hydrogen

Propane gas:  $\text{C}_3\text{H}_8$  carbon, hydrogen

Rust:  $\text{Fe}_2\text{O}_3$  iron, oxygen

Vinegar:  $\text{HC}_2\text{H}_3\text{O}_2$  hydrogen, carbon, oxygen

Baking soda:  $\text{NaHCO}_3$  sodium, hydrogen, carbon, oxygen

Deodorant:  $\text{Al}(\text{OH})_3$  aluminum, oxygen, hydrogen

Antacid tablet:  $\text{Mg}(\text{OH})_2$  magnesium, oxygen, hydrogen

Battery acid:  $\text{HCl}$  hydrogen, chlorine

Name:

## INQUIRY WHAT IS MATTER?

1. With your lab group you will rotate through stations and conduct mini-experiments to help you answer the following questions. The following questions must be answered in your lab report's conclusion.

- \*If we change the shape of matter, does it change its mass?**
- \*Can matter take up the same space with other matter?**
- \*What are the states of matter?**
- \*How does matter go through a change of phase, which means to change from one state to another state?**
- \*When matter changes temperature or phase, does the matter change mass?**
- \*When matter changes temperature or phase, does the matter change volume?**

2. Discuss with your lab group the best way to record data at each station. Make a data chart to record information at each station.

This inquiry will be Graded on these expectations:

Rubric: **What is matter?**

I. Lab is completed on time by group with each member working together

5-Lab is completed and student helped fairly

3-Lab is completed and student helped just some

1-Lab is completed but student did not help the group

---

II. Written report clearly provides

**\*Introduction explains the problem to be solved and what you already know about matter**

**\*Materials and Methods used which clearly describes the stations and what you did**

**\*Data chart of the information taken at each station and what you observed**

**\*Conclusion that explains what you learned from the data. The conclusion must clearly answer the questions asked at the beginning of this lab and conclude with a clear definition of matter.**

10-All four sections of the lab report are provided

5-Lab report sections are not present

1-Lab report not complete in requirements

Name:

III. Interesting Format to read

5-High interest reading. Paper clearly shows that student did research on the topic of matter and adds what other scientists say about matter

3-Interesting to read, but little extra information provided

1-Made an attempt to make it interesting/no details added

\_\_\_\_\_

IV. Language Arts: Grammar/Sentence Structure/Spelling

5-Few errors for the length of the paper

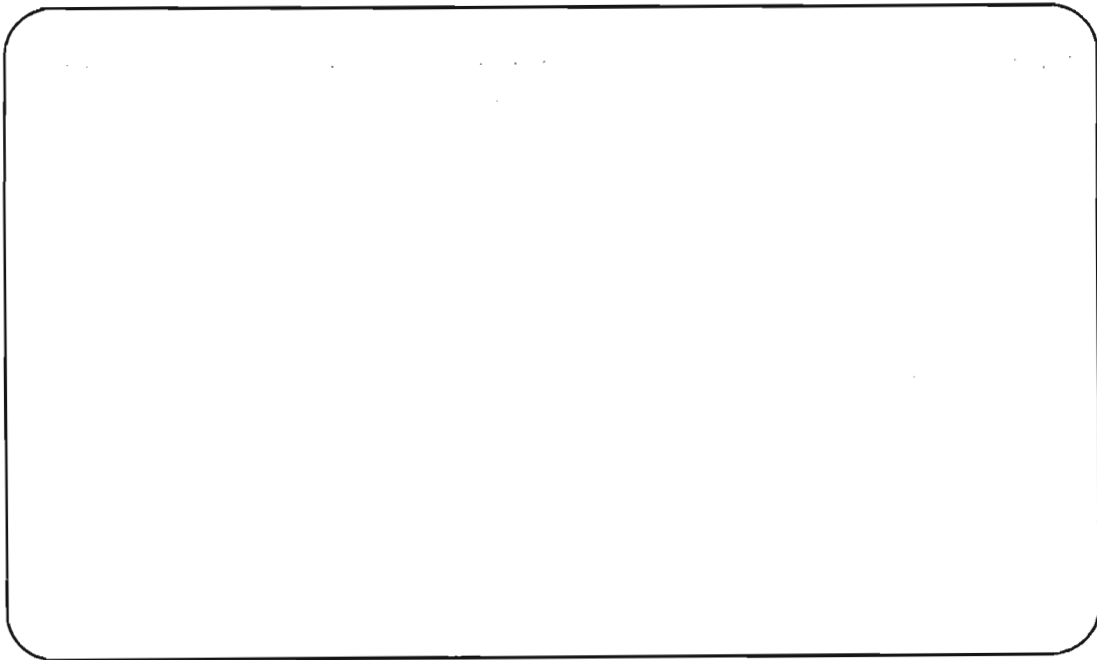
1-Many errors and hard to read and understand

\_\_\_\_\_

V. Paper is passed in on time (0 to 5 points)

\_\_\_\_\_

Parent Comments about this paper and signature that the paper was proofread:  
bonus 5 points



Name: \_\_\_\_\_

### **When Matter Changes its Shape Does it Change its Mass?**

Original mass of matter: \_\_\_\_\_ (aluminum foil) Change of shape mass: \_\_\_\_\_

Original mass of paper: \_\_\_\_\_ Change of shape paper mass: \_\_\_\_\_

Explanation for observation

### **Can Matter Take Up the Same Space with Other Matter?**

\*Water poured into test tube through the funnel

What is in the test tube before you pour the water in: \_\_\_\_\_

What happened when you tried to pour the water in?

\*Wood block put inside a book

What is in the book before you tried to place block into book: \_\_\_\_\_

What happened when you tried to close the book on the wood block?

Explanation for observation

### **What are the States of Matter?**

State of matter of vinegar: \_\_\_\_\_ State of matter of baking soda: \_\_\_\_\_

State of matter created in the test tube: \_\_\_\_\_

### **How does Matter Change from one State to Another?**

Object in petri dish: \_\_\_\_\_ State of matter: \_\_\_\_\_

To what state is the object changing: \_\_\_\_\_

Explain how it is possible for the object to change states of matter:

### **Does Matter Change its Mass when it Changes its State?**

Mass of water in the jar: \_\_\_\_\_ Mass of ice in the jar: \_\_\_\_\_

Conclusion:

### **Does Matter Change its Volume when it Changes its Temperature?**

What happened to the height of the water in the tube when placed in cold water bath:

What happened to the water in the tube when placed in hot water bath:

Explain your observations:

### **When Matter Changes its Shape Does it Change its Mass?**

Using the materials provided, record the mass of a sample of matter. Next change the shape of the matter. Record its mass. Note any changes. Repeat for another sample of matter.

provide: paper to weigh flat and balled up  
aluminum foil to weigh flat and balled up

### **Can Matter Take Up the Same Space with Other Matter?**

Check for the ability of matter to take up the same space with matter already present in that space. Try to make a liquid fit where a gas is already present. Try to make a solid fit where a solid is already present.

provide: water to be poured into funneled flask  
beaker to be turned over into water with wad of paper inside  
wood block to be placed inside textbook

### **What are the States of Matter?**

Record the states of matter of vinegar and baking soda. Half fill the test tube with vinegar. Now add two pinches of baking soda to the vinegar. What state of matter is created?

Provide: test tube, vinegar, baking soda

**How does Matter Change from one State to Another?**

Record the state of matter of the object in the petri dish. Record the state of matter to which it changes. Explain how this process happens.

Provide: petri dish with ice cube

**Does Matter Change its Mass when it Changes its State?**

Label a container with your groups names. Place water in the container and cover. Record the mass. Place into freezer. Tomorrow be prepared to record the mass again.

Provide: plastic container with lid, water, triple beam balance

**Does Matter Change its Volume when it Changes its Temperature?**

Place the flask of colored water in the cold water bath. Let set and observe what happens. Place flask in warm water. Let set and observe what happens.

Provide: cold and warm water baths, flask with single hole stopper and glass tube in the hole, colored water in the flask



Name:

INQUIRY  
**HOW CAN YOU TELL IF SOMETHING IS A PURE SUBSTANCE  
OR  
A MIXTURE OF SUBSTANCES?**

1. With your lab group you will rotate to stations. Each station has science apparatus and samples that are labeled with a number. Your data chart should be organized with the numbered samples and a description of what experiments you performed on the samples and an explanation for your decision as to whether the sample is a pure substance or a mixture.
  
2. Discuss with your lab group the best way to record data at each station. Make a data chart to record information at each station that also clearly describes your decision.
  
3. Paper chromatography:
  - \*Quickly dip a green marker end into water and make a dot on the filter paper. Hang the paper over the edge of a beaker containing some water that touches the bottom of the filter paper. Observe.
  - \*Quickly dip a red, a brown, and a black marker into water, and with each marker make separate dots on the filter paper and hang the paper over the edge as described above.
  - \*Your data chart will clearly describe the observations about the ink in the markers. Tell the reasons for whether you believe the marker ink is a mixture or a pure substance.

This inquiry will be Graded on these expectations:

Rubric: **How can you tell if something is a pure substance or a mixture of substances?**

- I. Lab is completed on time by group with each member working together
    - 5-Lab is completed and student helped fairly
    - 3-Lab is completed and student helped just some
    - 1-Lab is completed but student did not help the group
-

Name:

**II. Written report clearly provides**

**\*Introduction explaining the problem to be solved and what you already know**

**\*Materials and Methods used which clearly describes the stations and your activities**

**\*Data chart of the information taken at each station that tells what you found out**

**\*Conclusion that explains what you learned from the data and answers the lab problem. The conclusion must list the various tests you performed when determining if a substance is pure or a mixture. The conclusion must include information you learned about ink used in a marker.**

**10-All four sections of the lab report are provided**

**5-Lab report sections are not present**

**1-Lab report not complete in requirements**

---

**III. Interesting Format to read**

**5-High interest reading. Paper clearly shows that student did research on the topic of mixtures, pure substances, or paper chromatography and found out additional information on these topics**

**3-Interesting to read, but little extra information provided**

**1-Made an attempt to make it interesting/no details added**

---

**IV. Language Arts: Grammar/Sentence Structure/Spelling**

**5-Few errors for the length of the paper**

**1-Many errors and hard to read and understand**

---

**V. Paper is passed in on time (0 to 5 points)**

---

Parent Comments about this paper and signature that the paper was proofread: bonus 5 points

Name: \_\_\_\_\_

**Data Chart: Pure Substance or Mixtures of Substances?**

Station 1: Use available tools to decide if the following items are pure or a mixture

#1: \_\_\_\_\_ Why:

#2: \_\_\_\_\_ Why:

#3: \_\_\_\_\_ Why:

Station 2: Use available tools to decide if a pure substance or mixture

#4: \_\_\_\_\_ Why:

#5: \_\_\_\_\_ Why:

#6: \_\_\_\_\_ Why:

Station 3: Use available tools to decide if pure substance or mixture

#7: \_\_\_\_\_ Why:

#8: \_\_\_\_\_ Why:

#9: \_\_\_\_\_ Why:

Station 4: Observe items in the test tube to decide if a pure substance or a mixture

#10: \_\_\_\_\_ Why:

#11: \_\_\_\_\_ Why:

#12: \_\_\_\_\_ Why:

Station 5: Paper chromatography observations

**Use the materials provided to experiment and describe.  
Then decide for each sample if it is a  
pure substance or a mixture.**

These are the samples, or types of samples, placed at each station. Do not tell students what the samples are until the inquiry is completed. Have a central place for students to test for dissolved substances by evaporation

Station 1: #1 granite #2 slate #3 sand  
apparatus provided: hand lens

Station 2: #4 shaving cream #5 iron filings and pepper #6 10X sugar and salt  
apparatus provided: magnet, microscope, hand lens

Station 3: #7 sand in water #8 salt in water #9 flour in water  
apparatus provided: filter paper

Station 4: #10 mixture of oil, water and detergent #11 water and food coloring  
#12 soda water

Station 5: Chromatography activity  
Materials: markers, beaker, filter paper

#12 separate CO<sub>2</sub> from soda pop. Place one hole stoppered flask of soda water in warm water bath. Fill a beaker with water and invert into a pan of water. Run aquarium tubing from flask hole to inside overturned beaker. The gas will displace the water. To prove it is CO<sub>2</sub>, put a lid across the beaker mouth and turn it right side up as you remove beaker from water. Put a lit match into the glass, or pour contents over a candle, or lower a candle attached to a wire holder in a vertical position into glass so the flame will rise above the candle. Carbon dioxide gas will extinguish the flame.

Name: \_\_\_\_\_

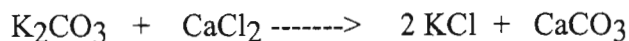
## INQUIRY

### WHAT IS THE LAW OF CONSERVATION OF MATTER?

\*A mixture contains two or more substances that are different in physical and chemical properties. With your lab group you will experiment to find out if when two substances are combined to form a mixture, are the mass and volume of the two substances additive.

To find the answer to this problem your lab group will be provided with 1) two liquids to combine and 2) a solid and a liquid to combine. The liquids to combine are ethanol and water. The solid, salt will be combined with the liquid water. With your lab group decide on a procedure to answer the question and what data measurements must be taken before and after forming the mixture. Be prepared to report this procedure to the class.

\*A chemical reaction occurs when two substances react to form new substances. You will experiment to find out if when two substances are combined and chemically react to form new substances (products), do the new substances have an additive mass and volume from the original substances (reactants). You will combine a solution of potassium carbonate with a solution of calcium chloride to form potassium chloride and calcium carbonate. With your lab group carefully record the mass and volume of the reactants. After the reaction you will record the mass and volume of the products to answer this lab question.



Create a data chart to record the needed information from all three experiments.

This inquiry will be Graded on these expectations:

Rubric: **What is the Law of Conservation of Matter?**

- I. Lab is completed on time by group with each member working together
  - 5-Lab is completed and student helped fairly
  - 3-Lab is completed and student helped just some
  - 1-Lab is completed but student did not help the group

Name: \_\_\_\_\_

**II. Written report clearly provides**

- \*Introduction explaining the problem to be solved and what you already know**
- \*Materials and Methods used which clearly describes the mixtures and what you did during the lab**
- \*Data chart clearly labeled that tells what you found out**
- \*Conclusion that uses the data to tell what you learned about the change in mass and volume when creating a mixture or creating a chemical reaction. The conclusion must clearly answer the questions posed for this lab and conclude with a clear definition for the Law of Conservation of Matter.**

**10-All four sections of the lab report are provided**

**5-Lab report sections are not present**

**1-Lab report not complete in requirements**

---

**III. Interesting Format to read**

5-High interest reading. Paper clearly shows that student did research on the topic of conservation of matter in chemical reactions and mixtures and researched other scientists' ideas

3-Interesting to read, but little extra information provided

1-Made an attempt to make it interesting/no details added

---

**IV. Language Arts: Grammar/Sentence Structure/Spelling**

5-Few errors for the length of the paper

1-Many errors and hard to read and understand

---

**V. Paper is passed in on time (0 to 5 points)**

---

Parent Comments and signature that the paper was proofread: 5 points

Name: \_\_\_\_\_

**What is the Law of Conservation of Matter:**

**Data Chart**

Part I. Mixtures

Ethanol Volume	Water Volume	Separate Mass	Combined Mass	Combined Volume
Salt Volume	Water Volume	Separate Mass	Combined Mass	Combined Volume

Part II. Chemical reactants

Calcium chloride volume	Potassium carbonate volume	Separate Mass	Combined Mass	Combined volume

Observe what happened during the chemical reaction. Write down your observations:

Name: \_\_\_\_\_

## THE EVERYDAY OBJECT CUBE

Choose an everyday object: \_\_\_\_\_

\*Function of the object: \_\_\_\_\_

\_\_\_\_\_

<b>*Major materials used to make the object</b>	<b>*Function &amp; reason for material</b>
1. _____	1. _____
2. _____	2. _____
3. _____	3. _____
4. _____	4. _____

\*Origin of **one** of the above materials (tell how the material is obtained and changed to become part of the object): \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\*History of the object (tell how this object was invented): \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Project: With the information from the five starred items, build a cube such that each side represents that information and gives a clear explanation with pictures.



Name: \_\_\_\_\_

## What Properties are Used to Group Elements?

### Introduction:

Elements are grouped according to their properties. Two major groupings of elements are the metals and the non-metals. In this lab, you will test six elements to determine whether each is a metal or a non-metal. You will then locate each element on the periodic table to get an understanding for where the metals and non-metals are located on the periodic table.

### Materials and Methods:

Your lab group will be provided with Iron, Copper, Sulfur, Carbon, Zinc, and Aluminum. You will test these elements for their density, electrical conductivity, flexibility, and record their phase at room temperature. Use the following table of properties for metals and non-metals to determine each element's group according to your test results.

PROPERTY	METALS	NON-METALS
PHASE AT ROOM TEMPERATURE	SOLID	GASSES & LIQUIDS (A FEW SOLIDS)
DENSITY	HIGH	LOW
ELECTRICAL CONDUCTIVITY	GOOD	POOR
FLEXIBILITY	GOOD	BRITTLE

### Data:

ELEMENT	IRON	COPPER	SULFUR	CARBON	ALUMINUM	ZINC
ROOM TEMPERATURE PHASE						
DENSITY						
ELECTRICAL CONDUCTIVITY						
FLEXIBILITY						

Name: \_\_\_\_\_

Conclusion:

Based on the data, explain into which group you would place each of these elements. Locate these elements on the periodic table and decide where the division is located between the metal and non-metal groups. Draw the line that divides the two groups. Pass in the data, periodic table with the line between the metals and non-metals and your conclusion that describes the properties for metals and non-metals.

Name: \_\_\_\_\_

## ELEMENT SEARCH

www.chemicalelements.com

www.webelements.com

Choose an element: \_\_\_\_\_ Symbol: \_\_\_\_\_

Origin of its name: \_\_\_\_\_  
\_\_\_\_\_

State of matter when element is at room temperature: \_\_\_\_\_

Boiling point: \_\_\_\_\_

Freezing/melting point: \_\_\_\_\_

Density: \_\_\_\_\_

Atomic Mass: \_\_\_\_\_ Atomic Number: \_\_\_\_\_

Number of protons: \_\_\_\_\_ Number of neutrons: \_\_\_\_\_

Physical appearance of the element:

Describe the process used to extract this element for use:

List and describe a least three uses of this element in your home or for industry:

Explain at least three interesting facts about this element:

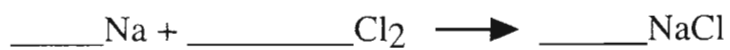
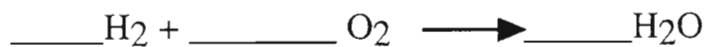
Extra Credit: Create a model of this element showing the nucleus and electron rings that can be hung in the classroom.

Name: \_\_\_\_\_

Models of Molecules

<u>Common Name</u>	<u>Molecular Structure</u>	<u>Picture</u>
Ammonia	NH <sub>3</sub>	
Salt	NaCl	
Water	H <sub>2</sub> O	
Propane Gas	C <sub>3</sub> H <sub>8</sub>	
Hydrochloric Acid	HCl	
a Seashell	CaCO <sub>3</sub>	
Glass	SiO <sub>2</sub>	

Chemical reactions:



Name:

### Building Molecules

Molecule(s)    Number of Molecules    Elements Used    Atoms Used of each Element

Sand:  $4\text{SiO}_2$

Rust:  $2\text{Fe}_2\text{O}_3$

Seashell:  $2\text{CaCO}_3$

Salt:  $3\text{NaCl}$

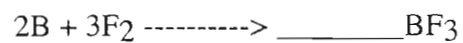
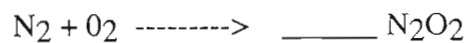
Car emissions:  $7\text{CO}$

Propane gas:  $2\text{C}_3\text{H}_8$

Fool's gold:  $\text{FeS}_2$

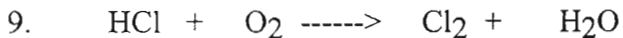
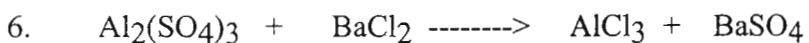
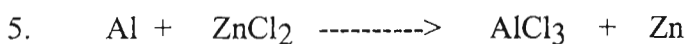
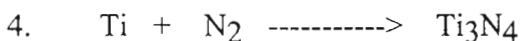
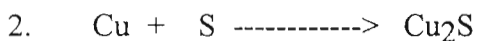
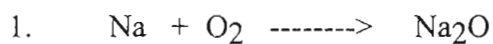
Aspirin:  $\text{C}_9\text{H}_8\text{O}_4$

Lighter Fluid:  $2\text{C}_4\text{H}_{10}$

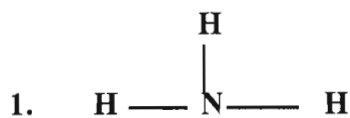


Name:

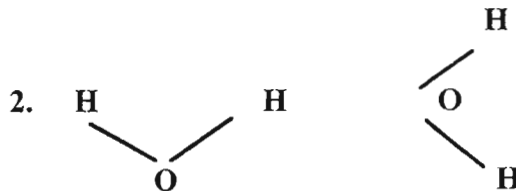
**Balance the chemical equations for the atoms of each element:**



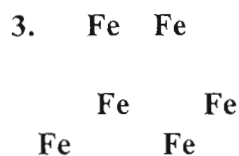
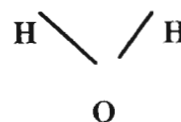
**Write the Chemical formula for the following molecule pictures:**



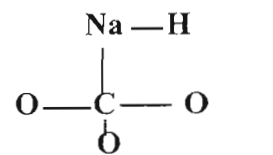
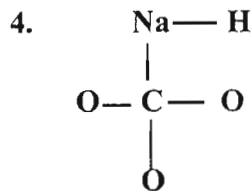
\_\_\_\_\_



\_\_\_\_\_



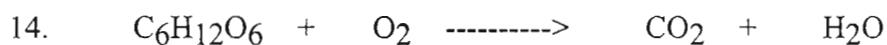
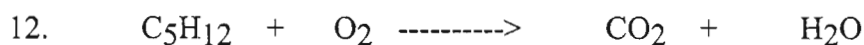
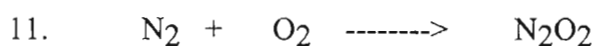
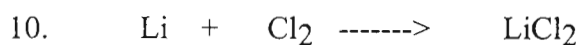
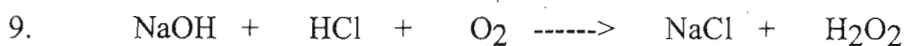
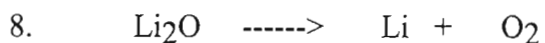
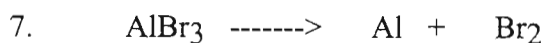
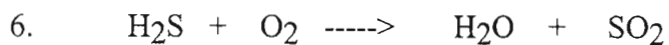
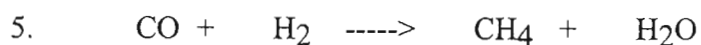
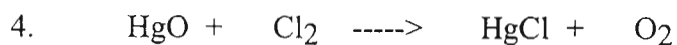
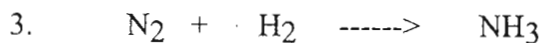
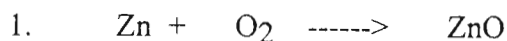
\_\_\_\_\_



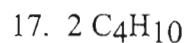
\_\_\_\_\_

Name:

**Balance the Chemical Reactions for the atoms of each element**



**Draw the models of these molecules**



Name: \_\_\_\_\_

## Naming Compounds

1. Zinc oxide: \_\_\_\_\_
2. Mercury chloride: \_\_\_\_\_
3. Aluminum chloride: \_\_\_\_\_
4. Lithium oxide: \_\_\_\_\_
5. Lithium chloride: \_\_\_\_\_
6. Carbon dioxide: \_\_\_\_\_
7. Carbon monoxide: \_\_\_\_\_
8. Sodium chloride: \_\_\_\_\_
9. Calcium chloride: \_\_\_\_\_
10. Sodium sulfide: \_\_\_\_\_
11.  $MgCl_2$ : \_\_\_\_\_
12.  $KCl$ : \_\_\_\_\_
13.  $CaO$ : \_\_\_\_\_
14.  $Fe_2O_3$ : \_\_\_\_\_
15.  $FeS_2$ : \_\_\_\_\_
16.  $SO_2$ : \_\_\_\_\_
17.  $HgO$ : \_\_\_\_\_
18.  $NO_2$ : \_\_\_\_\_
19.  $MgBr_2$ : \_\_\_\_\_

$OH$ =Hydroxide       $NO_3$ =Nitrate       $SO_4$ =Sulfate       $CO_3$ =Carbonate

20.  $NaOH$ : \_\_\_\_\_
21.  $CaCO_3$ : \_\_\_\_\_
22.  $MgSO_4$ : \_\_\_\_\_



**This page is only for people who wish to ban dihydrogen oxide because of its toxic properties.**

- \* Causes excessive sweating and vomiting
- \* A major component of acid rain
- \* Can cause severe burns in the gaseous state
- \* Accidental inhalation can kill you
- \* Primary contributor to erosion
- \* Decreases effectiveness of automobile brakes
- \* Has been found in tumors of terminal cancer patients
- \* May dissolve metal ions especially in the presence of road salt

### **Frequently Asked Questions About Dihydrogen Monoxide (DHMO)**

#### **What is Dihydrogen Monoxide?**

Dihydrogen Monoxide (DHMO) is a colorless and odorless chemical compound, also referred to by some as Dihydrogen Oxide, Hydrogen Hydroxide, Hydronium Hydroxide, or simply Hydric acid. Its basis is the unstable radical Hydroxide, the components of which are found in a number of caustic, explosive and poisonous compounds such as Sulfuric Acid, Nitroglycerine and Ethyl Alcohol.

#### **Should I be concerned about Dihydrogen Monoxide?**

Yes, you should be concerned about DHMO! Although the U.S. Government and the Centers for Disease Control (CDC) do not classify Dihydrogen Monoxide as a toxic or carcinogenic substance (as it does with better known chemicals such as hydrochloric acid and saccharine), DHMO is a constituent of many known toxic substances, diseases and disease-causing agents, environmental hazards and can even be lethal to humans in quantities as small as a thimbleful.

Research conducted by award-winning U.S. scientist Nathan Zohner concluded that roughly 86 percent of the population supports a ban on dihydrogen monoxide. If more people knew the truth about DHMO then studies like the one he conducted would not be necessary.

A similar study conducted by U.S. researchers Patrick K. McCluskey and Matthew Kulick also found that nearly 90 percent of the citizens participating in their study were willing to sign a petition to support an outright ban on the use of Dihydrogen Monoxide in the United States.

#### **What are some of the dangers associated with DHMO?**

Each year, Dihydrogen Monoxide is a known causative component in many thousands of deaths and is a major contributor to millions upon millions of dollars in damage to property and the environment. Some of the known perils of Dihydrogen Monoxide are:

- \* Death due to accidental inhalation of DHMO, even in small quantities.
- \* Prolonged exposure to solid DHMO causes severe tissue damage.

- \* Excessive ingestion produces a number of unpleasant though not typically life-threatening side-effects.
- \* Gaseous DHMO can cause severe burns.
- \* Leads to corrosion and oxidation of many metals.
- \* Contamination of electrical systems often causes short-circuits.
- \* Often associated with killer cyclones in the U.S. Midwest and elsewhere.
- \* Thermal variations in DHMO are a suspected contributor to the El Nino weather effect.

### **What are some uses of Dihydrogen Monoxide?**

Despite the known dangers of DHMO, it continues to be used daily by industry, government, and even in private homes across the U.S. and worldwide. Some of the well-known uses of Dihydrogen Monoxide are:

- \* as an industrial solvent and coolant,
- \* in nuclear power plants,
- \* by the U.S. Navy in the propulsion systems of some older vessels,
- \* by elite athletes to improve performance,
- \* in the production of Styrofoam,
- \* in biological and chemical weapons manufacture,
- \* as a spray-on fire suppressant and retardant,
- \* in abortion clinics,
- \* as a major ingredient in many home-brewed bombs,
- \* as a byproduct of hydrocarbon combustion in furnaces and air conditioning compressor operation
- \* in World War II prison camps in Japan, and in prisons in China, for various forms of torture,
- \* by many terrorist organizations,
- \* in community swimming pools to maintain chemical balance,
- \* in animal research laboratories, and
- \* in pesticide production and distribution.

What you may find surprising are some of the products and places where DHMO is used, but which for one reason or another, are not normally made part of public presentations on the dangers to the lives of our family members and friends. Among these startling uses are:

- \* as an additive to food products, including jarred baby food and baby formula, and even in many soups, carbonated beverages and supposedly "all-natural" fruit juices
- \* in cough medicines and other liquid pharmaceuticals,
- \* in spray-on oven cleaners,
- \* in shampoos, shaving creams, deodorants and numerous other bathroom products,
- \* in bathtub bubble products marketed to children,
- \* as a preservative in grocery store fresh produce sections,

- \* in the coffee available at major coffee houses in the US and abroad,
- \* in Formula One race cars, although its use is regulated by the Formula One Racing Commission

One of the most surprising facts recently revealed about Dihydrogen Monoxide contamination is in its use as a food and produce "decontaminant." Studies have shown that even after careful washing, food and produce that has been contaminated by DHMO remains tainted by DHMO.

### **What is the link between Dihydrogen Monoxide and school violence?**

A recent stunning revelation is that in every single instance of violence in our country's schools, including infamous shootings in high schools in Denver and Arkansas, Dihydrogen Monoxide was involved. In fact, DHMO is often very available to students of all ages within the assumed safe confines of school buildings. None of the school administrators with which we spoke could say for certain how much of the substance is in use within their very hallways.

### **Are there groups that oppose a ban on Dihydrogen Monoxide?**

In spite of overwhelming evidence, there is one group in California that opposes a ban on Dihydrogen Monoxide. The Friends of Hydrogen Hydroxide is a group that believes that the dangers of DHMO have been exaggerated. Members claim that Dihydrogen Monoxide, or the less emotionally charged and more chemically accurate term they advocate for it, "Hydrogen Hydroxide," is beneficial, environmentally safe, benign and naturally occurring. They argue that efforts to ban DHMO are misguided.

Friends of Hydrogen Hydroxide is supported by the Scorched Earth Party, a radical and loosely-organized California-based group. Sources close to the Scorched Earth Party deny any outside funding from government, industry or pro-industry PACs.

### **Is it true that using DHMO improves athletic performance?**

Absolutely! With the numerous allegations of amateur and professional athletes using anabolic steroids and/or blood doping to enhance performance, virtually no attention has been paid to the performance enhancing properties of Dihydrogen Monoxide. It is perhaps the sporting world's dirtiest of dirty little secrets that athletes regularly ingest large quantities of DHMO in an effort to gain a competitive edge over an opponent. One technique commonly used by endurance athletes in sports such as distance running and cycling is to take a large amount of DHMO immediately prior to a race. This is known within racing circles to dramatically improve performance.

Sports-medicine physicians warn that ingesting too much Dihydrogen Monoxide can lead to complications and unwanted side-effects, but do acknowledge the link to improved performance. DHMO is not currently considered a banned substance, so post-race urine tests do not detect elevated or abnormal levels of DHMO.

### **What are the symptoms of accidental Dihydrogen Monoxide overdose?**

You may not always recognize that you have been a victim of accidental DHMO overdose, so here are some signs and symptoms to look for. If you suspect Dihydrogen Monoxide overdose, or if you exhibit any of these symptoms, you should consult with your physician or medical practitioner. The data presented here is provided for informational purposes only, and should in no way be construed as medical advice of any sort.

#### **Watch for these symptoms:**

- \* Excessive sweating
- \* Excessive urination
- \* Bloated feeling
- \* Nausea
- \* Vomiting
- \* Electrolyte imbalance
- \* Hyponatremia (serum hypotonicity)
- \* Dangerously imbalanced levels of ECF and ICF in the blood
- \* Degeneration of sodium homeostasis

A recently noted medical phenomenon involves small amounts of DHMO leaking or oozing from the corners of the eyes as a direct result of causes such as foreign particulate irritation, allergic reactions including anaphylactic shock, and sometimes severe chemical depression.

I came across this recently and could not help but share it.

As we have often heard, when polled Americans continue to say they care deeply about the environment. But, what is that belief built upon? On sound science and careful environmental analysis? Or, is it the results of flimsy or non-existent evidence coupled with carefully crafted rhetoric and scare tactics?

Peter Sparber, a Washington D.C. business lobbyist, conducted a simple experiment to find the answers to those questions. The results from Mr. Sparber's efforts were reported in the October 10, 1995 issue of the "Journal of Commerce" in an article written by Peter M. Tischwell.

Mr. Sparber has a simple theory, which is this: Many Americans can be tricked into believing an environmental crisis exists without any facts whatsoever. To test this theory, Mr. Sparber put together a mailing list of people who support banning pesticides and sent them a letter from a fictitious group he called "Stop the Silent Killer Foundation". Here is the entire text of the letter:

Dear Mr. Smith,

You have been identified as a person who cares deeply about the future of our fragile planet, the health of our children and the quality of our nation's leadership. If we are right, we need your help, and we need it immediately.

As you have undoubtedly read, DIHYDROGEN OXIDE has been found to be a

major threat to the environment and to humans and animal health. Here are the facts:

In 1991, the most recent year for which statistics are available, 4,100 Americans, many of them under the age of 10, died from excessive dosages of dihydrogen oxide commonly found in many homes and recreation areas.

Our polluted lakes, rivers, and oceans are known to contain vast quantities of dihydrogen oxide. On this, there is no controversy! Contaminated ground water? Same tragic situation.

In California, Missouri and Georgia, families have lost their homes due to dihydrogen oxide contamination.

In some applications, dihydrogen oxide is a major contributor to injuries from falls. In other applications, dihydrogen oxide is a major cause of burns.

Why does America endure this wasteful destruction of our planet, our children and ourselves? Greed. Simple greed and stupidity.

We need your help now. In the next 24 hours, we need you to demand an end to the production and use of dihydrogen oxide. Please write: The Dihydrogen Oxide Institute, P.O. Box 7178, Washington DC 20044-7178.

On behalf of future generations, I thank you.

Sincerely,  
John Alan Waterman

And, what is this heinous product, Dihydrogen Oxide? Does H<sub>2</sub>O or water ring a bell?

Well, as you might guess, responses to Mr. Waterman's letter immediately came pouring in to Mr. Sparber's fictitious Dihydrogen Oxide Institute.

For instance, a couple from Portland, Maine wrote:  
We're writing to state a demand to end production and use of dihydrogen oxide. This is a major threat to the environment and to humans and animal health. Do the right thing and don't let \$\$ always speak.

A woman from Lyndon, Washington, sent in this response:  
What is going on here? You people must really believe the world will come to an end in the year 2000. Why else would you be poisoning the planet and its inhabitants with dihydrogen oxide.

I know producing this poison is how you make your living. You must also realize that this same poison is what causes some people's deaths. How in God's name can you live with yourselves? Stop production and get a job you can be proud of - one that won't ruin your karma.

From New York, New York:  
For the sake of other's lives, please stop the production of dihydrogen oxide! More than 4,100 Americans died from excessive dosages. Since 1991, there are no more statistics, but I surmise the total deaths must be about 13,000 more! You are polluting our water. Stop your greed. Stop production.

Mr. Waterman Sparber received many other responses all asking for an immediate end to dihydrogen oxide production. Didn't know water could be so dangerous. But every year thousands of American slip and fall on ice. More are burned by scalding water; and in 1991, 4,100 American drowned. Water can be a truly dangerous substance.

The lesson in all this should be disturbing for a farmer seeking sound environmental policy. Farm Bureau members nationwide want reform of the Clean Water Act, Endangered Species Act, the Delaney Clause but are fighting an uphill battle against environmental groups who use skewed, distorted or non-existent evidence promising imminent environmental disaster if Farm Bureau supported reforms are enacted.

It's easy to create fear. It's difficult to allay those fears and disprove negative statement. The reason they continue is because they are effective, and there is no penalty whatsoever for publishing false, misleading statements on the environment.

AFBF President Dean Kleckner, in his annual meeting address, challenged Farm Bureau members nationwide to challenge every shoddy piece of "environmental science". If we don't, farm practices will be governed by people easily fooled by the environmental scare of the week rather than by science and what makes sense down on the farm. Utah Farm Bureau News.

Name: \_\_\_\_\_

## INQUIRY

# WHAT IS THE EVIDENCE WHEN A CHEMICAL REACTION OCCURS?

With your lab group you will combine chemicals that will result in a chemical reaction. Observe and record temperature changes, changes in the appearance of the reactants and products from before and after the experiment, the production of a precipitate, or release or uptake of a gas. Be sure to write careful descriptions based on your observations.

- \*Which reactions did not change in temperature?**
- \*Which reactions were exothermic-released heat so solutions got hotter?**
- \*Which reactions were endothermic-took in heat so solutions got colder?**
- \*Which reactions produced a gas?**
- \*Which reactions formed a precipitate?**
- \*Which reactions changed color?**

This inquiry will be Graded on these expectations:

Rubric: **What is the evidence when a chemical reaction occurs?**

- I. Lab is completed on time by group with each member working together
- 5-Lab is completed and student helped fairly
  - 3-Lab is completed and student helped just some
  - 1-Lab is completed but student did not help the group

---

II. Written report clearly provides

- \*Introduction explaining the problem to be solved and what you already know about chemical reactions**
  - \*Materials and Methods used which clearly describes the seven experiments you did. This will tell what you did in this inquiry.**
  - \*Data chart describing the reactants and products, colors, the states of matter, any temperature changes or other significant observations. This will describe what you saw.**
  - \*Conclusion that explains what you learned from the data. The conclusion must clearly answer the question posed for this lab and conclude with a clear description of the evidence for when a chemical reaction occurs and a new substance is created.**
- 10-All four sections of the lab report are provided
  - 5-Lab report sections are not present
  - 1-Lab report not complete in requirements

Name: \_\_\_\_\_

III. Interesting Format to read

5-High interest reading. Paper clearly shows that student did research on the topic of chemical reactions and describes what other scientists know about chemical reactions.

3-Interesting to read, but little extra information provided

1-Made an attempt to make it interesting/no details added

\_\_\_\_\_

IV. Language Arts: Grammar/Sentence Structure/Spelling

5-Few errors for the length of the paper

1-Many errors and hard to read and understand

\_\_\_\_\_

V. Paper is passed in on time (0 to 5 points)

\_\_\_\_\_

Parent Comments about this paper and signature that the paper was proofread: bonus 5 points



Name: \_\_\_\_\_

## ***What is the Evidence for When a Chemical Reaction Occurs?***

*Experiment # 1 Wear safety glasses*

### **Methods and Materials:**

\_\_\_\_\_ \*Measure out 50 mL of distilled water in a graduated cylinder

\_\_\_\_\_ \*Into a beaker weigh out 2.5 g CuCl<sub>2</sub>

\_\_\_\_\_ \*Pour the distilled water into the beaker with the CuCl<sub>2</sub>

\_\_\_\_\_ \*Place a thermometer into the beaker

\_\_\_\_\_ \*Cut out a piece of Aluminum foil that is 10 cm by 10 cm, roll it around your pencil and carefully place this into the beaker, end up

### **Observations:**

Starting temperature: \_\_\_\_\_ Ending temperature: \_\_\_\_\_

Starting color: \_\_\_\_\_ Ending color: \_\_\_\_\_

Was a gas produced? \_\_\_\_\_ Was a precipitate produced? \_\_\_\_\_

\_\_\_ Al + \_\_\_ CuCl<sub>2</sub> + \_\_\_ H<sub>2</sub>O ---> \_\_\_ CuO + \_\_\_ H<sub>2</sub> + \_\_\_ AlCl<sub>3</sub>

### **Conclusion:**

*What is the evidence that a chemical reaction occurred?*

*Experiment #2*

### **Materials and Methods:**

\_\_\_\_\_ \*Measure 20 mL of 0.1 M citric acid solution into a beaker

\_\_\_\_\_ \*Place a thermometer into the beaker

\_\_\_\_\_ \*Measure 1 g of NaHCO<sub>3</sub> (baking soda) onto a square of paper

\_\_\_\_\_ \*Carefully pour the baking soda into the beaker

### **Observations:**

Starting temperature: \_\_\_\_\_ Ending temperature: \_\_\_\_\_

Starting color: \_\_\_\_\_ Ending color: \_\_\_\_\_

Was a gas produced? \_\_\_\_\_ Was a precipitate produced? \_\_\_\_\_

### **Conclusion:**

*What is the evidence that a chemical reaction occurred?*

Name: \_\_\_\_\_

*Experiment #3*

**Methods and Materials:**

\_\_\_\_\_ \*Measure 5 mL of  $\text{NH}_4\text{OH}$  (ammonia) into a graduated cylinder

\_\_\_\_\_ \*Measure 5 mL  $\text{CuSO}_4$  (1%) solution into another graduated cylinder

\_\_\_\_\_ \*With an eyedropper and one drip at a time, drop the ammonia into the  $\text{CuSO}_4$  solution



**Observations:**

Starting color: \_\_\_\_\_ Ending color: \_\_\_\_\_

Was a gas produced? \_\_\_\_\_ Was a precipitate produced? \_\_\_\_\_

**Conclusion:**

*Describe the evidence that a chemical reaction occurred.*

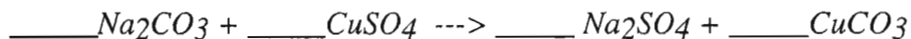
*Experiment #4*

**Methods and Materials:**

\_\_\_\_\_ \*Measure 5 mL of  $\text{Na}_2\text{CO}_3$  (washing soda) into a graduated cylinder

\_\_\_\_\_ \*Measure 5 mL  $\text{CuSO}_4$  (1% solution) in a graduated cylinder

\_\_\_\_\_ \*With an eyedropper and one drop at a time, drip the washing soda into the  $\text{CuSO}_4$  solution



**Observations:**

Starting color: \_\_\_\_\_ Ending color: \_\_\_\_\_

Was a gas produced? \_\_\_\_\_ Was a precipitate produced? \_\_\_\_\_

**Conclusion:**

*Describe the evidence that a chemical reaction occurred.*

Name: \_\_\_\_\_

*Experiment #5*

**Methods and Materials:**

- \_\_\_\_\_ \*Measure 30 mL of water into a beaker
- \_\_\_\_\_ \*Stir in one Tablespoon of white glue into the water, mix thoroughly
- \_\_\_\_\_ \*Stir one Tablespoon of borax into the beaker, stir until gelled
- \_\_\_\_\_ \*Remove from the beaker and knead it with your hands
- \_\_\_\_\_ \* Knead it, stretch it, bounce it and Play

**Conclusion:**

*Describe the evidence that a chemical reaction occurred.*

*Experiment #6*

**Methods and Materials:**

- \_\_\_\_\_ \*Place 1/4 teaspoon yeast into test tube
- \_\_\_\_\_ \*Add 10 mL hydrogen peroxide to the test tube
- \_\_\_\_\_ \*Hold the test tube with your hand

**Observations:**

*Describe the temperature change felt while holding the test tube:* \_\_\_\_\_

*Was a gas produced?* \_\_\_\_\_ *Was a precipitate produced?* \_\_\_\_\_

**Conclusion:**

*Describe the evidence that a chemical reaction occurred.*

*Experiment #7*

**Methods and Materials:**

- \_\_\_\_\_ \*Place 1/2 teaspoon alum into test tube in rack holder
- \_\_\_\_\_ \*Pour 30 mL of water into the test tube and shake to dissolve
- \_\_\_\_\_ \*Slowly add 10 mL of ammonia to the test tube
- \_\_\_\_\_ \*Let stand for a minute and observe

**Observations:**

*Starting color:* \_\_\_\_\_ *Ending color:* \_\_\_\_\_

*Was a gas produced?* \_\_\_\_\_ *Was a precipitate produced?* \_\_\_\_\_

**Conclusion:**

*Describe the evidence that a chemical reaction occurred.*

## Chemical Reaction Teacher Demonstrations

### #1: Weight increase by oxygen uptake

- \*soak coarse or medium steel wool in vinegar for 5 minutes. Dry thoroughly
- \*Weigh a ping-pong size piece
- \*Place into a flask with a deflated balloon placed over the flask
- \*After a length of time observe the products and reweigh the steel wool

Alternative method:

- \*Using two test tubes, one is stuffed with steel wool and the other is left empty
  - \*Invert test tubes into a beaker of water. As oxygen is taken up the water enters
- $$4 \text{ Fe} + 3 \text{ O}_2 \rightarrow 2 \text{ Fe}_2\text{O}_3$$

### #2: Exothermic reaction

- \*Place 1 T iron powder, 1 t sand and 1 mL of salt water into a plastic bag
- \*Weigh the bag
- \*Knead contents for several minutes with bag open
- \*Feel results and reweigh the bag
- \*Close bag and feel results and then reopen the bag and feel results

### #3 Exothermic reaction and H<sub>2</sub> release

- \*Pour HCl to a depth of 5 cm into a test tube held in a holder.
- \*Record temperature
- \*Weigh 2 scoops of iron filings in a beaker with the HCl
- \*Pour the HCl into beaker and reweigh and find the temperature
- \*Collect gas released to perform the burning splint test

### #4 Exothermic reaction and O<sub>2</sub> release

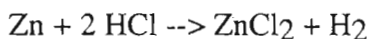
- \*Place fresh ground red potato skin or 2 t yeast into test tube in rack holder
- \*Add hydrogen peroxide and stopper the tube with one holed stopper with plastic tubing leading to submerged test tube in a beaker.
- \*Test gas in beaker with splint and touch the test tube in the rack for temperature

### #5 Gas production SO<sub>2</sub>

- \*Line a pan with Al foil shiny side up.
- \*Add 4 cups water, 1 T baking soda, 1 t salt
- \*Add tarnished Ag and bring to a boil.
- \*Smell gas released

#6 H<sub>2</sub> produced

- \* Place galvanized nail in a glass jar
- \*Place one squeeze dropper full of 3 M HCl on the nail
- \*Cover loosely with lid
- \*After 20 sec try the burning splint test. This can be redone several times.



#7 Precipitate formation (Epson salt: MgSO<sub>4</sub>\*7H<sub>2</sub>O)

- \*Make a solution of 25 g Epson Salt and 100 mL water. Add red food coloring
- \*Dissolve 4 g laundry detergent in 2/3 cup warm water (saturated solution)
- \*Place 1" detergent solution in test tube
- \*With clean eye dropper dispense 5 to 10 drops of Epson Salt solution into test tube without stirring
- \*Observe 10 to 15 minutes later.

#8 Acid Base Indicator (yellow-acid, base-blue)

- \*Place 20 mL Bromothymol blue indicator in solution into beaker
  - \*Students blow into indicator through a straw
- $$\text{CO}_2 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{CO}_3 \text{ carbonic acid}$$
- \*1/2 the students add elodea leaf to the cup and place in sunny window
  - \*1/2 the students leave the cup plain
- $$\text{H}_2\text{O} + \text{CO}_2 \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 \text{ photosynthesis}$$

## Where Does "It" Go?

### Introduction

- \* Where do the materials and substances we use go when we are finished with them and throw them away?
- \* Are new substances really made from the atoms of old substances?
- \* Is it possible that the atoms that make up my body could once have been part of a dinosaur?
- \* Could some of the atoms that make up me now someday be part of a spaceship?
- \* Do materials we throw in the dump rot into nothingness?

### Materials and Methods

Observe and record your observations of a solution of copper chloride made by dissolving a crystal of copper chloride ( $\text{CuCl}_2$ ) in water. Observe and record your observations of a piece of aluminum (Al) cut from an aluminum pie pan. Place a thermometer and the aluminum into the copper chloride solution and observe for several minutes. Record your observations of all the changes that took place.

### Data

### Conclusion

1. Write a description of the product coating the aluminum pie pan. What do you think it is?
  
2. Was this an exothermic reaction (released heat-gets hot) or an endothermic reaction (took in heat-gets colder)?

Name: \_\_\_\_\_

3. Build models of the reactants and products and draw a picture of this reaction from the models.  $3 \text{CuCl}_2 + 2 \text{Al} \rightarrow 2 \text{AlCl}_3 + 3 \text{Cu}$

4. Would every blue solution work like this to form copper? Explain your opinion.

5. What would you get if you did this experiment again but started with a solution of iron chloride instead of copper chloride?

6. What happens to copper wires, jewelry, or pots when you throw them away?

7. Explain what happens to the weight of all the wood in a house when it burns. From where did the heat and light come that was produced while the house burned? Does heat and light have mass?

8. Think about atoms and molecules and how new substances are formed to now answer the five questions in this lab's introduction.

Name: \_\_\_\_\_

Teacher notes:

The copper metal forms on the pie tin and the blue solution becomes clear. The clear solution contains aluminum chloride....can this be evaporated to prove it?

The blue solution must contain copper in a different chemical form from copper metal in order for copper to form during the replacement reaction with aluminum.

When you throw away copper it will eventually react with air, water, etc. and go into a different chemical form. Then it may be dissolved in water and carried away to rivers and oceans to become available again to form copper metal.



Name: \_\_\_\_\_

1. Ni \_\_\_\_\_
2. Magnesium \_\_\_\_\_
3. C \_\_\_\_\_
4. He \_\_\_\_\_
5. Hydrogen \_\_\_\_\_
6. U \_\_\_\_\_
7. Chlorine \_\_\_\_\_
8. Ca \_\_\_\_\_
9. Copper \_\_\_\_\_
10. O \_\_\_\_\_
11. Nitrogen \_\_\_\_\_
12. Na \_\_\_\_\_
13. Tin \_\_\_\_\_
14. S \_\_\_\_\_
15. Zinc \_\_\_\_\_
16. Fe \_\_\_\_\_
17. Gold \_\_\_\_\_
18. Hg \_\_\_\_\_
19. Silver \_\_\_\_\_
20. Potassium \_\_\_\_\_
21. Si \_\_\_\_\_
22. Lithium \_\_\_\_\_
23. Pb \_\_\_\_\_
24. Aluminum \_\_\_\_\_

Name: \_\_\_\_\_

1. Ni \_\_\_\_\_
2. Magnesium \_\_\_\_\_
3. C \_\_\_\_\_
4. He \_\_\_\_\_
5. Hydrogen \_\_\_\_\_
6. U \_\_\_\_\_
7. Chlorine \_\_\_\_\_
8. Ca \_\_\_\_\_
9. Copper \_\_\_\_\_
10. O \_\_\_\_\_
11. Nitrogen \_\_\_\_\_
12. Na \_\_\_\_\_
13. Tin \_\_\_\_\_
14. S \_\_\_\_\_
15. Zinc \_\_\_\_\_
16. Fe \_\_\_\_\_
17. Gold \_\_\_\_\_
18. Hg \_\_\_\_\_
19. Silver \_\_\_\_\_
20. Potassium \_\_\_\_\_
21. Si \_\_\_\_\_
22. Lithium \_\_\_\_\_
23. Pb \_\_\_\_\_
24. Aluminum \_\_\_\_\_

Name: \_\_\_\_\_

1. Ni \_\_\_\_\_
2. O \_\_\_\_\_
3. Nitrogen \_\_\_\_\_
4. Sodium \_\_\_\_\_
5. Tin \_\_\_\_\_
6. Sulfur \_\_\_\_\_
7. Zn \_\_\_\_\_
8. Fe \_\_\_\_\_
9. Gold \_\_\_\_\_
10. Hg \_\_\_\_\_
11. Ag \_\_\_\_\_
12. Magnesium \_\_\_\_\_
13. K \_\_\_\_\_
14. Si \_\_\_\_\_
15. Lithium \_\_\_\_\_
16. Lead \_\_\_\_\_
17. Al \_\_\_\_\_
18. Carbon \_\_\_\_\_
19. He \_\_\_\_\_
20. Hydrogen \_\_\_\_\_
21. U \_\_\_\_\_
22. Chlorine \_\_\_\_\_
23. Ca \_\_\_\_\_
24. Copper \_\_\_\_\_

Name: \_\_\_\_\_

1. Ni \_\_\_\_\_
2. O \_\_\_\_\_
3. Nitrogen \_\_\_\_\_
4. Sodium \_\_\_\_\_
5. Tin \_\_\_\_\_
6. Sulfur \_\_\_\_\_
7. Zn \_\_\_\_\_
8. Fe \_\_\_\_\_
9. Gold \_\_\_\_\_
10. Hg \_\_\_\_\_
11. Ag \_\_\_\_\_
12. Magnesium \_\_\_\_\_
13. K \_\_\_\_\_
14. Si \_\_\_\_\_
15. Lithium \_\_\_\_\_
16. Lead \_\_\_\_\_
17. Al \_\_\_\_\_
18. Carbon \_\_\_\_\_
19. He \_\_\_\_\_
20. Hydrogen \_\_\_\_\_
21. U \_\_\_\_\_
22. Chlorine \_\_\_\_\_
23. Ca \_\_\_\_\_
24. Copper \_\_\_\_\_

1. Understanding the Periodic Table

Element	Symbol	Number of protons	Number of electron energy levels	Number of electrons in outside energy level
Hydrogen				
Chlorine				
Calcium				
Lead				

2. Draw a model of a Chlorine atom.

3. Name 4 changes you may observe during a chemical reaction:

- a.
- b.
- c.
- d.

4.

Compound	# Molecules present	Elements present	Number of atoms of each element
6 NaCl			
4 AgS <sub>2</sub>			
3 NaHCO <sub>3</sub>			
2 Fe <sub>2</sub> O <sub>3</sub>			
Na <sub>2</sub> SO <sub>4</sub>			

Name: \_\_\_\_\_

5. Why were you not able to pour the water through the funnel into the test tube?

6. What is the Law of Conservation of Matter?

7. Write out how you would say these compounds:

NaCl:

AgS<sub>2</sub>:

CuCO<sub>3</sub>:

Fe<sub>2</sub>O<sub>3</sub>:

8. Define these words

Element:

Compound:

Electron:

Nucleus of an atom:

Atom:

Evaporation:

9. Make a model of these compounds and draw their structure

O<sub>2</sub>

C<sub>2</sub>H<sub>6</sub>

H<sub>2</sub>S

CH<sub>3</sub>OH

Name: \_\_\_\_\_

### LAB PRACTICAL ANSWER SHEET

#### 1) Using and Understanding the Periodic Table

Element	Symbol	Number of Protons	Number of electron energy levels	Number of electrons in outside energy level
Tin				
Sulfur				

**Using the information from above draw a model of the sulfur atom:**

#### 2. Physical or Chemical changes

List 3 changes you may see happen during a chemical reaction:

- a.
- b.
- c.

Describe what is happening in experiment #1:

Is this a physical or chemical change? \_\_\_\_\_

Describe what is happening in experiment #2:

Is this a physical or chemical change? \_\_\_\_\_

Name: \_\_\_\_\_

3) Fill in the data chart:

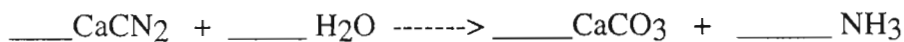
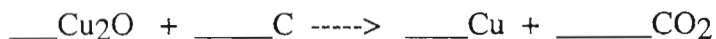
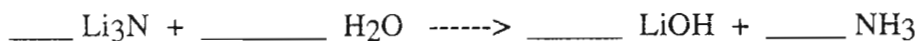
COMPOUND # of MOLECULES PRESENT ELEMENTS PRESENT # OF ATOMS PER ELEMENT

4 HgS			
5 PbCl <sub>2</sub>			
3 NaNO <sub>3</sub>			
2 Cu(OH) <sub>2</sub>			

4) What is the Law of Conservation of Matter?

You must be able to use this law in order to balance the following equations. Why must you count the atoms of each element in order to balance the equations?

Bonus: Balance the following equations



5) Write out how you would say these compounds:

ZnS: \_\_\_\_\_

CaSO<sub>4</sub>: \_\_\_\_\_

KCl: \_\_\_\_\_

CO<sub>2</sub>: \_\_\_\_\_ (continue to next page for more of #5)

Name: \_\_\_\_\_

Write the chemical formula for these compounds:

Silver sulfide: \_\_\_\_\_

Carbon monoxide: \_\_\_\_\_

Sulfur dioxide: \_\_\_\_\_

Mercury sulfide: \_\_\_\_\_

6) Do the crossword puzzle

7) Continue the crossword puzzle

8) Make a model of this compound and draw its structure

$C_3H_8$ :

9) Make a model of this compound and draw its structure

$3 NaCl$ :

10) Read the scales and write down the measurements. Be sure to show units.

#1 thermometer: \_\_\_\_\_

#2 triple beam balance: \_\_\_\_\_

#3 graduated cylinder: \_\_\_\_\_

#4 graduated cylinder: \_\_\_\_\_

#5 triple beam balance: \_\_\_\_\_

11) Find the mass of the following items:

1. Stapler: \_\_\_\_\_

2. Pencil: \_\_\_\_\_

3. Book: \_\_\_\_\_

12) Examine the 3 items setting out to help you describe 3 properties of matter

1;

2;

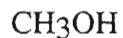
3;

Name: \_\_\_\_\_

13. Make a model of this compound and draw its structure:



14. Make a model of this compound and draw its structure:



15. Using the color keys for the atoms, write down the chemical formula for these models

#1: \_\_\_\_\_ #2: \_\_\_\_\_ #3: \_\_\_\_\_

16. This is the graph you drew when you heated up the water. Describe what is happening at each of the lettered locations on the graph:

17. Take the element quiz. Place paper in the box.

18. Write a sentence for each of these words that clearly uses the word and gives a definition.

Pure substance:

Element:

Compound:



Name: \_\_\_\_\_

### LAB PRACTICAL ANSWER SHEET

1) Using and Understanding the Periodic Table

Element	Symbol	Number of Protons	Number of electron energy levels	Number of electrons in outside energy level
Tin				
Sulfur				

**Use the information from above to draw a model of the sulfur atom:**

2) Fill in the data chart:

COMPOUND # of MOLECULES PRESENT ELEMENTS PRESENT # OF ATOMS PER ELEMENT

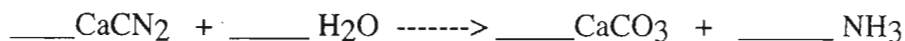
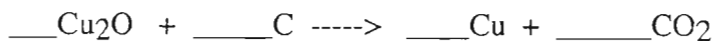
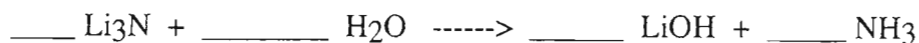
4 HgS			
5 PbCl <sub>2</sub>			
3 NaNO <sub>3</sub>			
2 Cu(OH) <sub>2</sub>			

3) What is the Law of Conservation of Mass?

You must be able to use the law of conservation of mass in order to balance the following equations. Why must you count the atoms of each element in order to balance the equations?

Name: \_\_\_\_\_

Balance the following equations



4) Write out how you would say these compounds:

ZnS: \_\_\_\_\_

CaSO<sub>4</sub>: \_\_\_\_\_

KCl: \_\_\_\_\_

CO<sub>2</sub>: \_\_\_\_\_

Write the chemical formula for these compounds:

Silver sulfide: \_\_\_\_\_

Carbon monoxide: \_\_\_\_\_

Sulfur dioxide: \_\_\_\_\_

Mercury sulfide: \_\_\_\_\_

5) Take the element quiz.

6) Write a sentence for each of these words that clearly uses the word and gives a definition.

Pure substance:

Element:

Compound:

7) This is the graph you drew when you heated up the water. Describe what is happening at each of the lettered locations on the graph:

Name: \_\_\_\_\_

8) Physical or Chemical changes

List 3 changes you may see happen during a chemical reaction:

- a.
- b.
- c.

Describe what is happening in experiment #1:

Is this a physical or chemical change? \_\_\_\_\_

Describe what is happening in experiment #2:

Is this a physical or chemical change? \_\_\_\_\_

9) Make a model of these compounds and draw their structures

$C_3H_8$ :

3 NaCl

$CH_3OH$

10) Read the scales and write down the measurements. Be sure to show units.

#1 thermometer: \_\_\_\_\_

#2 triple beam balance: \_\_\_\_\_

#3 graduated cylinder: \_\_\_\_\_

#4 graduated cylinder: \_\_\_\_\_

Name: \_\_\_\_\_

11) Find the mass of the following items:

1. Stapler: \_\_\_\_\_
2. Pencil: \_\_\_\_\_

12) Use the color keys for the atoms to write down the chemical formula for each model

#1: \_\_\_\_\_ #2: \_\_\_\_\_ #3: \_\_\_\_\_

13) Draw each circuit you see using the electrician symbols

Drawing of #1:

Type of circuit: \_\_\_\_\_

Drawing of #2:

Type of circuit: \_\_\_\_\_

14) Draw the electric motor you see and label the parts:

Describe from where the motor gets a force to spin

## UNIT IX: HUMAN ANATOMY AND PHYSIOLOGY

Overarching question: Since a living organism must be able to ingest and metabolize nutrients, move, grow, develop, respond, and reproduce, what are the systems of the human body that perform these processes?

### Unit Objectives:

1. Describe eight organ systems of the body, the major organs and their functions
2. Research how disease effects the organs of the body and describe preventative behaviors
3. Analyze the use and effect of drug therapies on the body
4. Dissect and identify given organs and structures which may include bones/joints, muscle, heart/lung, eyeball, and whole frog

### Classroom activities:

#### **Introduction to the human body**

1. Fill-in Save-It sheets for each organ system as discussed
2. Overarching project #1: Research a health issue in the family to understand the possible cause, prevention, care, and costs to the individual.
3. Overarching project #2: What does it mean to say "No to drugs" in the American society? Students will analyze the drug advertisement business with a focus on TV and how this affects our society's attitude toward the use of drugs.
4. Overarching project #3: Human body model construction. Students will be part of an organ system construction project based on the health issue they researched.
5. Review with students some major developmental stages of the embryo as major organ systems are formed
6. Review with students the important services a well functioning community needs. Then ask students to relate this to how our body functions by listing organs that perform the tasks. Next provide students with a paper with an outline trace of a human and ask them to place the organs where they think they go.
7. Review with students the 4 tissue types (muscular, connective, nerve, epithelial) and present microscope slides of these tissues to emphasize the unique cell structures that form these tissues.

#### **Skeletal and Muscular System**

1. Provide students with bones, preferably whole from a butcher with joints intact, to examine and ask "What do bones do for the body?"
2. Learn the names and be able to identify 17 bones in the human skeletal system
3. Obtain X-rays for students to examine and identify bones and any problems the X-rays show
4. Look at microscope slides of bone tissue and the three types of muscle tissues

5. Have students make a fist on their table top and then extend one finger at a time from the fist and try to lift the finger. The ring finger is impossible to lift due to the muscle/tendon arrangement
6. Place a chicken bone in vinegar for several days and observe the changes in the bone
7. Dissect chicken wings to emphasize the connection between muscle, bone, ligament, and tendon
8. Videos: Anterior cruciate ligament surgery

### **Digestive System**

1. Provide students with a food diary to maintain and review for caloric intake and balance of nutrients
2. Allow students to dip their fingers in a weak solution of bleach to feel how as their cell membranes break down, they can feel the sliminess of the fat molecules that formed the cell membranes
3. Bring in tripe for students to describe to get a sense of the villi structure of the intestines
4. Place drops of oil on water surface and drop in dish detergent to give students the sense of how bile can break up large globules of fat

### **Respiratory, Circulatory, and Excretory Systems**

1. Review the basic organs and structures of the heart/lungs/kidneys
2. Put a flame under a jar to guess amount of time before it extinguishes...tie to the fact that humans have about a 5 minute supply of oxygen in their blood before they extinguish
3. Check pulse before and after exercising to discuss heart rate changes
4. Do a visual of the percent of blood elements by filling a quart jar partway with water and then adding poker chips to represent WBC, RBC, and platelets
5. Teach about the ABO blood types by using 2 colors of dyed water and which colors can mix without changing the color make-up
6. Place a live goldfish tail fin under the microscope so the students can observe the blood flowing through the veins
7. Obtain heart/lung plucks from the butcher for dissection
8. Video of open heart surgery

### **Nervous System**

1. Review the cellular organization of the nervous system with the sensory organs
2. Obtain an eyeball for students to dissect in small groups
3. Read and discuss articles about how hallucinatory drugs affect the nervous system and the neurotransmitters

### **Reproductive System**

1. Review the basic organs and structures of the male and female reproductive system
2. Project: Incubate chicks and show a video on chicken embryology
3. STI and AIDS education through literature and in conjunction with the school nurse
4. Video: Miracle of Birth

Minute Questions:

Digestion

1. People say that food and water are necessary to stay alive. What does it mean in terms of our body to "stay alive."
2. What does it mean to have "good nutrition" and how does what we eat grow and repair our bodies?
3. How does a cow gain weight to over 800 pounds with just eating grass (salad) with no salad dressing?

Assessment:

Skeletal/Muscular

1. Bone identification
2. Chicken wing dissection lab report

Digestive

1. Food diary

Respiratory, Circulatory, and Excretory

1. Heart/Lung dissection

Nervous

1. Eyeball dissection journal

Projects

1. Family Health Issue
2. Say 'No' to Drugs
3. Human body model construction

## Unit IX: Human Anatomy and Physiology

The anatomy and physiology study is broken down into five mini-units, each covering several body systems. Check to see if your science department or library has a skeleton and a torso that you can keep in the classroom for the duration of this study. Students do like to name these classroom subjects. Another resource for this unit is the butcher. West Gardiner Beef, in Maine (207-724-3378), provides organs at no charge. Fresh parts are so much easier to dissect than the preserved and expensive organs bought through supply companies. If there are hunters in the class, parts could be saved in the freezer for when they are needed. The parts I've had the most experience and dramatic results with include whole legs to teach the joint structure of ligaments, cartilage, and the bursa; heart/lung plucks that include the diaphragm, trachea, and esophagus; and eyeballs that contain optic nerve and muscle tissue. Place a tube down the trachea and blow air in to inflate the lungs. This is by far my most dramatic classroom demonstration of the entire year. Some years, as time permits, the class will do a whole frog dissection to see the relationship of these organs, but I do most prefer the large organs obtained from the butcher.

The 'Operation Channel' has provided my classes with some great surgeries. An open heart surgery lets students observe a beating heart in the patient's chest. A cataract surgery clearly shows the structures of the lens, iris, and cornea. And the anterior cruciate ligament replacement clearly shows the structures that hold a joint firmly in place. There are many other surgeries to pick from. Just preview them for content relationship to what has been discussed in class.

When teaching the reproductive system, include the school nurse or health teacher in your plans. I team teach with the school nurse on the topic of sexually transmitted infections. This gives the students another person to get to know who is in the school and they can talk to for sensitive information.

Many of the microscope activities I do as a whole class. I have a camera that connects to the microscope and students then view it on the television screen. This saves the goldfish from handling by many students all day long. Students do view in amazement the blood coursing through the veins.

The projects are meant to be assigned when appropriate throughout this unit. Some students have problems finding a family health issue to research. I question them about the medical history of grandparents/great-grandparents and if that leads no where, then I go to more minor problems such as near-sightedness or even headaches. Once students start their research on the family health issue, that will determine into which system they should be



assigned for the human body model construction project. The drug advertising project can be done at any time, but would lend itself to the nervous system discussions.

The save-it sheets provide diagrams and places for basic information on the systems. According to the class sophistication, you can decide on how much information should be covered. Students have many misconceptions about how their body's work and have received misinformation. The overriding goal of this unit is to inform students so they develop a healthy respect for their bodies and their personal responsibility in terms of proper hygiene, exercise, and nutrition to prolong the usefulness of their body.

Name: \_\_\_\_\_

## **Research Project**

### **What does it mean to say “NO” to Drugs in this American Society?**

In this project you will watch TV over a 3 evening interval for up to 6 hours and record all the advertisements that are selling some type of medication, either prescription or nonprescription. You will record the purpose for using the drug and the possible side effects from using the drug by listening to the ad. Record the date and time the ad came on the TV.

The next step is to analyze your data. Arrange the drug usage according to the system of the body that it claims it will affect. Does your data show any particular systems of the body more targeted than other systems and for what types of cures? Find out the prices of these drugs, the dosage amount, and number of tablets in the prescription, either through obtaining the information from a pharmacy or from the internet. [www.drugstore.com](http://www.drugstore.com) What do these prices mean in terms of the insurance industry and Social Security?

Does your research and understanding of the systems of the body show that there are other means, other than manufactured drugs, that could be an effective means of prevention or a cure? Could Americans spend their money more wisely by maintaining a more healthy lifestyle and what would a more healthy life style look like? From your analysis of drug advertisements, what message does this give Americans? What do you think about the comment ‘there is a pill for everything.’ What does the quote “Say NO to Drugs” mean to you in the light of all the heavy advertising to take drugs. What questions do you have in terms of these advertisements?

You may do this as a written report or an oral slide show presentation using your laptop. Whichever format you choose to use, be sure to make your voice sound clearly on this issue. Support your comments with research on prescription drug coverage, preventative medicine, and the pharmaceutical industry.

Name: \_\_\_\_\_

**Research Project: Grading rubric**

**What does it mean to say "NO" to drugs in this American Society?**

Essay is completed and answers the questions of this project highlighted by the following points:

- Data chart containing date, time, drug, purpose, side effects, costs
- Analysis of the body system targeted by the drug
- Analysis of other ways, than drug therapy, to maintain health
- Analysis of prescription drug coverage in America
- Analysis of "Say NO to drugs" in America
- Other issues of importance to you in this issue of drugs

25 points \_\_\_\_\_

Comments:

Language Arts grade

5 points \_\_\_\_\_

Comments:

Written report total: \_\_\_\_\_/30

Optional oral presentation \_\_\_\_\_/30

Comments:

Name: \_\_\_\_\_

## **Research Project**

### **What is a Health Problem in my Family or Family Friends?**

In this project you will research a health problem that affects someone you know, preferably a family member. This health problem will involve something that was inherited or developed in their body, not something that is “caught” or is contagious. Since this is a health issue found in your family, you will need to figure out the risk of your developing the problem, and what you can do, if anything, to prevent the health problem. The following topics and questions need to be researched.

- 1) Description of the effects of this health problem on the person who has it. Describe their symptoms and what it is like to live with this health problem.
- 2) Causes of this health problem. Describe what happens in their organ system that the person develops this health problem.
- 3) Treatments for this health problem. Research what your family member is doing and what other treatments are available.
- 4) Find out if there is a cure for the health problem or what research is being done to find a cure.
- 5) Find out how to best prevent ever having to get the health problem.
- 6) Develop interview questions and include an interview of the person you know with this health issue. If the person lives away from you, perhaps you could develop the interview questions and email them, use the phone, or write a letter.

Due dates:

**May 26:** Note cards covering the 5 topics listed above

**June 3:** Rough draft including the interview (5 points)

**June 13:** Final copy

Optional Project: You may do a slide show/movie presentation to the class instead of a final copy. You must follow due dates and pass in your note cards and a rough draft of your slide show.

Name: \_\_\_\_\_

INQUIRY QUESTION:  
WHAT IS A HEALTH ISSUE IN MY FAMILY  
or  
CIRCLE OF FAMILY FRIENDS?

This inquiry will provide you with an understanding of a health issue in your family or circle of family friends. You will be expected to interview this individual to gain an understanding for what it means to live with this particular health problem, the medications that must be taken and their costs, and wherever possible the means of prevention. Before you go for the interview, prepare a set of questions that you will ask.

Along with the interview, you will be expected to further research the effects this health issue has on the body and organ system plus any known causes and treatment regimens other than what your subject does. You are expected to spend homework time on this research. An internet and journal search would provide you with the most up-to-date information.

Finally each student will give a short presentation, preferably as a slide show, that demonstrates they understand the effects of the health issue on the body and organ system, the means of treatment, and the prognosis for the patient with this health issue.

This inquiry will be Graded on these expectations:

Rubric: What is a health issue in my family or circle of friends?

I. Inquiry research is completed with the student using time wisely in the library, in the classroom, and for homework

5-Library/classroom time well used; a complete set of information gained.

3-Library/class time used sometimes; incomplete information

1-Library/class time poorly used for research purposes

Name: \_\_\_\_\_

II. Written report clearly provides

- \*Interview of family member or friend
  - \*Research on the causes of the health problem and what it does to the organ system
  - \*Research on the effects of the health problem to the family member
  - \*Researched information on ways to prevent the health problem
  - \*Researched information on treatment methods or cures for the health issue
- 15-The interview and all information is fully provided with supporting details  
10-The interview and some information is provided with some supporting details  
5-Interview is missing and there is a small attempt to write a report from researched information
- 

III. Oral presentation is completed

- 5-High interest and informative presentation. Visuals are used appropriately. Student spoke clearly with good understanding
  - 3-Interesting to listen to, good visual aids, but student did not speak clearly.
  - 1-Made an attempt to make an interesting presentation, but not well organized.
- 

IV. Language Arts: Grammar/Sentence Structure/Spelling

- 5-Few errors for the length of the paper
  - 1-Many errors and hard to read and understand
- 

V. Paper is passed in on time (0 to 5 points)

---

Parent Comments and signature that the paper was proofread: 5 points

Name: \_\_\_\_\_

### **Construction Project:**

#### **What is the structure, location, and functions of the systems in the body?**

In this project you will build a system of the body with your assigned group. The system your group will build will be according to the family health issue that was researched. For example, if you researched arthritis which affects the joints, you would go in the group to design the skeletal system.

The class will trace a student volunteer and put that traced body poster on the wall. Each group in the class will design their assigned system to hang on the traced body poster. Group members will be responsible for supplying materials needed to build the model. Each group must be able to confer with other groups since all the systems are interrelated. For example, when muscles need to be designed, the skeleton must be in place on which to hang the muscles.

Each group will present their system of the body to the class and explain the important organs, their structure and functions. The group must also be prepared to explain how that system maintains the health of the body.

#### **Each group member must:**

- Maintain a daily journal that describes the decisions made in the group, materials supplied, and progress in the construction (10 points)**
- Help to build the system on the class body poster (5 points)**
- Supply materials that are needed to build the system (5 points)**
- Speak during the oral presentation on an aspect of the body system (10 points)**
- Optional bonus: A written report is prepared and answers the questions to this project (10 points)**

Total points: \_\_\_\_\_

Comments:

Name: \_\_\_\_\_

SAVE-IT SHEET for SCIENCE:

**Human Anatomy: The Reproductive System**

I. Human Anatomy

A. What must every body cell be able to do in order to survive?

B. What four types of cell tissues form the human body?

1. Muscles

2. Nerve

3. Skin

4. Connective

C. These four tissue types are organized into a structure of organ systems that have specific functions in the body

1.

2.

3.

4.

5.

6.

7.

8.

9.

10.



II. Growth and Development at Puberty

1. T F On average, males experience the growth spurt two years later than females.
2. T F The normal sequence of pubertal growth involves, in order, the feet, legs, then torso.
3. T F During the pubertal growth spurt it is unusual if one ear is larger than the other ear.
4. T F An adolescent who is malnourished during the growth spurt will attain full height when an adequate diet is obtained.
5. T F The nutrient most commonly deficient in the diets of adolescent girls is iron.
6. T F Hormones have been found to be linked to certain adolescent behaviors.
7. T F The age of menarche, first menstrual cycle, has no relationship to how soon a female is fertile.
8. T F 55% of all eye problems manifest between the ages of 9 - 18 years.
9. T F Smoking is more harmful to the lungs during adolescence than after full development.
10. T F Girls and boys develop their full lung capacity during adolescence.
11. T F The heart, veins, and arteries develop at the same time.
12. T F Gastro-intestinal pain is common for adolescence.
13. T F Motor vehicle accidents are the major cause of death for teenagers in America.
14. T F Girls attempt suicide more often but boys are more successful.
15. T F Sexually transmitted infections (STI's) are not a serious problem for American teens.

III. Put the following changes in order of their usual sequence of development

IN FEMALES (1 - 10)

- \_\_\_\_\_ Breast development begins
- \_\_\_\_\_ Menarche (first menstrual cycle)
- \_\_\_\_\_ Weight spurt
- \_\_\_\_\_ Height spurt
- \_\_\_\_\_ Uterine muscles grow, vaginal lining thickens, external sex organs grow
- \_\_\_\_\_ Oil, sweat, and odor glands become much more active
- \_\_\_\_\_ Pubic hair begins to grow
- \_\_\_\_\_ Muscle spurt (including heart and lungs)
- \_\_\_\_\_ Gonads produce estrogen and progesterone
- \_\_\_\_\_ Hips widen

Name: \_\_\_\_\_

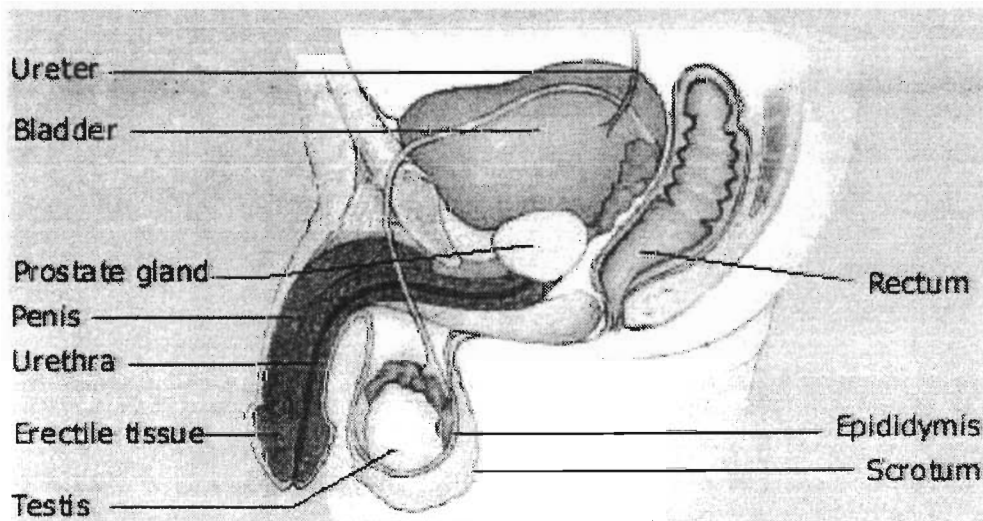
IN MALES (1 - 11)

- \_\_\_\_\_ Height spurt
- \_\_\_\_\_ First pubic hair
- \_\_\_\_\_ Voice changes
- \_\_\_\_\_ Gonads produce testosterone
- \_\_\_\_\_ Ejaculation
- \_\_\_\_\_ Penis growth begins about a year after testes
- \_\_\_\_\_ Muscle spurt
- \_\_\_\_\_ Beard growth
- \_\_\_\_\_ Testes and scrotum grow, and scrotal sac becomes redder, then darker.
- \_\_\_\_\_ Oil, sweat, and odor glands become much more active
- \_\_\_\_\_ Weight spurt

IV. What is fertilization and why is sexual fertilization necessary?

V. What are the parts of the male reproductive system?

<http://www.homehealth-uk.com/index.html?f=body/fr=http://www.homehealth-uk.com/medical/malebodydiagram.html>



Name: \_\_\_\_\_

Testes: Location

Function

Hormone production

External Genitalia:

Semen Production:

Prostate gland

Seminal vesicle

Cowpers Vesicle

Path of sperm from testes to the external body

VI. What are the parts of the female reproductive system?

Ovaries: Location

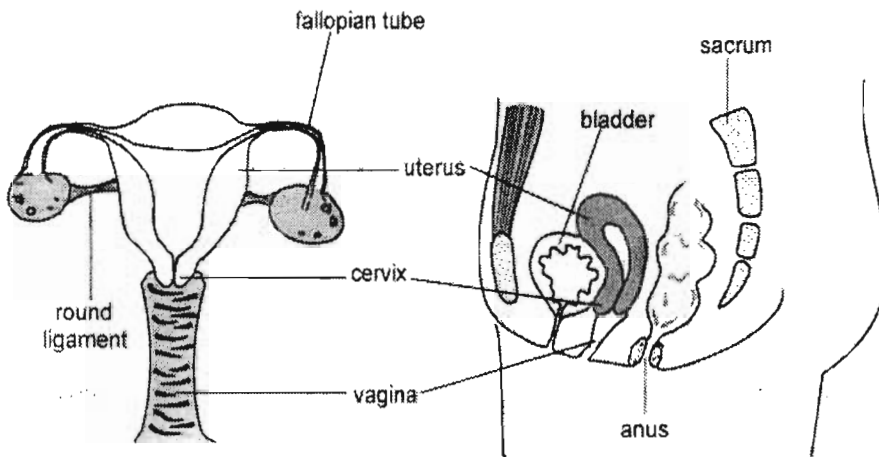
Function

Hormone production

Name: \_\_\_\_\_

Path of egg from ovary to external body

<http://www.patient.co.uk/showdoc/21692476/>

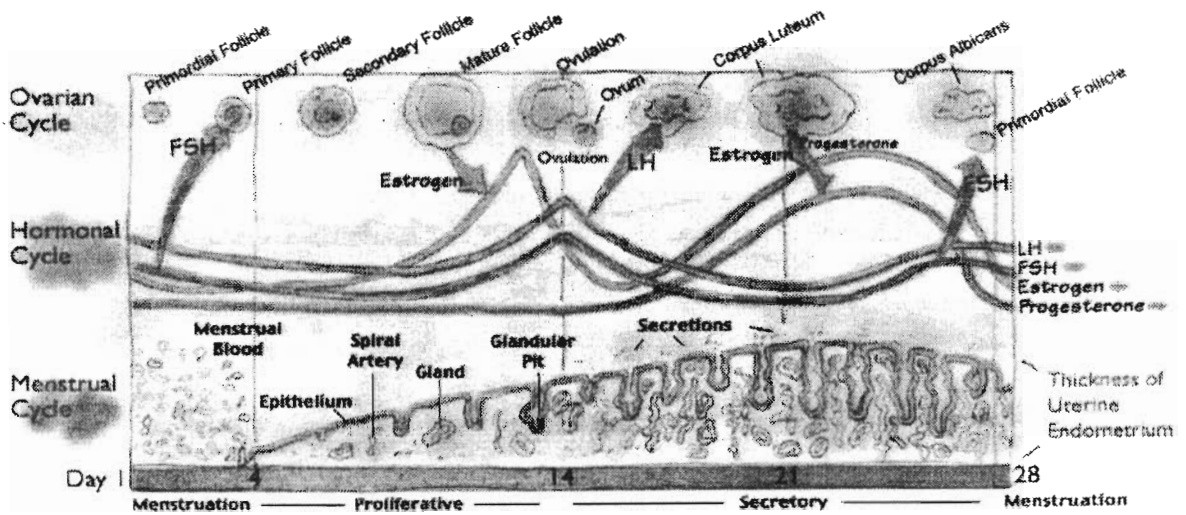


FEMALE REPRODUCTIVE SYSTEM

What is the purpose of the menstrual cycle?

<http://www.vaginaverite.com/reproductivecycle.html>

## Reproductive Cycle



Name: \_\_\_\_\_

VII. What are the responsibilities each person has towards their own reproductive system?

Sexually transmitted Infections

- Honest communication
- Condoms
- Reduce your number of sex partners

	<b>Genital Warts virus</b>	<b>Genital Herpes virus</b>	<b>Chlamydia bacteria</b>	<b>Gonorrhea bacteria</b>	<b>Syphilis bacteria</b>
How do you <b>get it?</b>					
What are the <b>symptoms?</b>					
What does it <b>do to your body?</b>					
How do you <b>find out</b> if you have it?					
How do you <b>treat it?</b>					
Does it have <b>a cure?</b>					
How do you <b>prevent it?</b>					

SAVE-IT SHEET for SCIENCE:**Human Anatomy: The Reproductive System**

## I. Human Anatomy

A. What must every body cell be able to do in order to survive?

*digest and metabolize food, excrete waste, grow, respond to a stimulus, reproduce*

B. What four types of cell tissues form the human body?

1. Muscles: *Only type of cell capable of contracting and relaxing in response to a stimulus*

2. Nerve: *Only type of cell that can transmit messages electrically and chemically to other nerves and muscles*

3. Skin: *Type of cell tissue that forms a protective layer to other cells, intestines, stomach, spinal cord, bladder*

4. Connective: *Type of cell tissue that provides support and connects other body tissues, bones, fat, blood, ligament*

C. These four tissue types are organized into a structure of organ systems that have specific functions in the body

1. *Respiratory: oxygen into blood, carbon dioxide out of blood*

2. *Circulatory: blood flow throughout the body*

3. *Excretory: wastes removal from blood*

4. *Nervous: brain, spinal cord, and sensory organs*

5. *Digestive: nutrients into blood*

6. *Reproductive: formation of gamete cells and fertilization*

7. *Skeletal: bone structure*

8. *Muscular: movement*

9. *Endocrine: hormones*

10. *Integumentary: skin*

## II. Growth and Development at Puberty

1. T F On average, males experience the growth spurt two years later than females.

2. T F The normal sequence of pubertal growth involves, in order, the feet, legs, then torso.

3. T F During the pubertal growth spurt it is unusual if one ear is larger than the other ear.

4. T F An adolescent who is malnourished during the growth spurt will attain full height when an adequate diet is obtained.

5. T F The nutrient most commonly deficient in the diets of adolescent girls is iron.

6. T F Hormones have been found to be linked to certain adolescent behaviors.

7. T F The age of menarche, first menstrual cycle, has no relationship to how soon a female is fertile.

8. T F 55% of all eye problems manifest between the ages of 9 - 18 years.

9. T F Smoking is more harmful to the lungs during adolescence than after full development.

10. T F Girls and boys develop their full lung capacity during adolescence.

11. T F The heart, veins, and arteries develop at the same time.

12. T F Gastro-intestinal pain is common for adolescence.

13. T F Motor vehicle accidents are the major cause of death for teenagers in America.

14. T F Girls attempt suicide more often but boys are more successful.

15. T F Sexually transmitted infections (STI's) are not a serious problem for American teens.

III. Put the following changes in order of their usual sequence of development

IN FEMALES (1 - 10)

- \_\_\_3\_\_\_ Breast development begins
- \_\_\_9\_\_\_ Menarche (first menstrual cycle)
- \_\_\_5\_\_\_ Weight spurt
- \_\_\_7\_\_\_ Height spurt
- \_\_\_2\_\_\_ Uterine muscles grow, vaginal lining thickens, external sex organs grow
- \_\_\_10\_\_\_ Oil, sweat, and odor glands become much more active
- \_\_\_4\_\_\_ Pubic hair begins to grow
- \_\_\_8\_\_\_ Muscle spurt (including heart and lungs)
- \_\_\_1\_\_\_ Gonads produce estrogen and progesterone
- \_\_\_6\_\_\_ Hips widen

IN MALES (1 - 11)

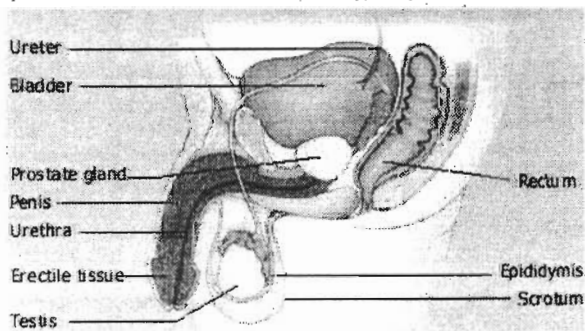
- \_\_\_7\_\_\_ Height spurt
- \_\_\_4\_\_\_ First pubic hair
- \_\_\_9\_\_\_ Voice changes
- \_\_\_1\_\_\_ Gonads produce testosterone
- \_\_\_5\_\_\_ Ejaculation
- \_\_\_3\_\_\_ Penis growth begins about a year after testes
- \_\_\_8\_\_\_ Muscle spurt
- \_\_\_10\_\_\_ Beard growth
- \_\_\_2\_\_\_ Testes and scrotum grow, and scrotal sac becomes redder, then darker.
- \_\_\_11\_\_\_ Oil, sweat, and odor glands become much more active
- \_\_\_6\_\_\_ Weight spurt

IV. What is fertilization and why is sexual fertilization necessary?

*Egg and sperm each contain half the chromosomes of somatic cells, 23 each. The sperm carries to the egg when they join together the full complement of 46 chromosomes. Fertilization occurs when the sperm penetrates the egg and releases its chromosomes which is followed by cell division.*

V. What are the parts of the male reproductive system?

<http://www.homehealth-uk.com/index.html?f=body&fr=http://www.homehealth-uk.com/medical/malebodydiagram.html>



Testes: Location: *located in the scrotum which is an external sac.*

Function: *Testes produce 10's of millions sperm/day which are stored in the epididymis for 3 to 4 days to finish development. If there is no ejaculation, the sperm disintegrate*

Hormone production: *Testosterone promotes growth of genitalia and secondary sexual characteristics such as the growth of larynx and male hair distribution*

External Genitalia: *Penis and scrotum*

*Penis carries both urine and semen through the urethra and contains spongy tissue. During an erection the amount of blood flow increases and is cut off from leaving the penis. After ejaculation the blood flow drains off.*

Semen Production:

Prostrate gland: *provides a fluid that gives the sperm their full motility*

Seminal vesicle: *helps sperm survive the vaginal fluids, stimulates their motility, provides nourishment*

Cowpers Vesicle

Path of sperm from testes to the external body: *from testes, to epididymis, through vas deferens, past glands that release seminal fluids, into the urethra that travels the length of the penis. Sperm can travel in the female body at 3 mm/minute*

VI. What are the parts of the female reproductive system? *All structures are located inside the female body*

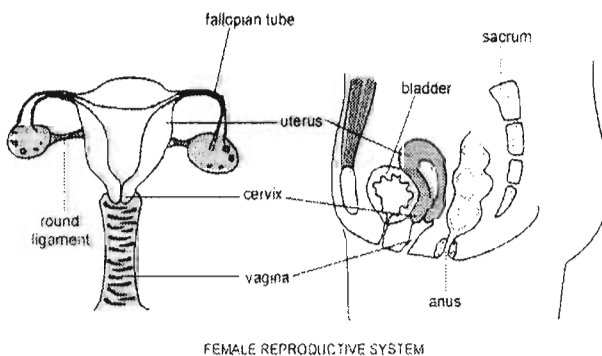
Ovaries: Location

Function: *makes 40,000 to 300,000 immature egg cells and releases about 500 mature eggs in a lifetime. The first egg is released several months to a year after the menarche.*

Hormone production: *makes estrogen that triggers hip widening, breast develop, female hair pattern, and egg maturation.*

Path of egg from ovary to external body: *ovary passed into fallopian tube (where fertilization happens if sperm are present) and pushed through the tube by cilia and peristalsis, to uterus (if egg is fertilized there it implants, if not the egg disintegrates).*

<http://www.patient.co.uk/showdoc/21692476/>

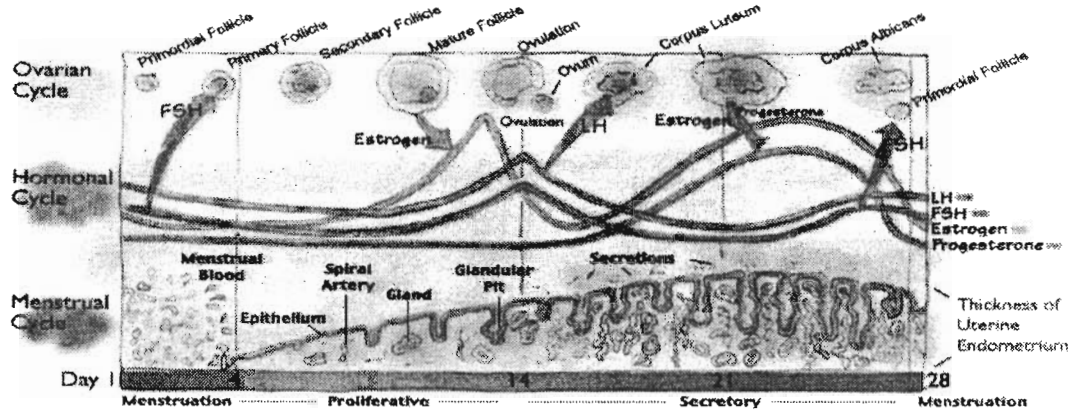


What is the purpose of the menstrual cycle?

<http://www.vaginaverite.com/reproductivecycle.html>



## Reproductive Cycle



*The menstrual cycle is the rhythmic development and release of an egg. Average length of the cycle is 28 days. The endometrium, lining of the uterus, is shed during menstruation. At menopause, around 50 years old, the ovaries shrink and stop releasing eggs. Menstruation stops.*

VII. What are the responsibilities each person has towards their own reproductive system?

*The only safe sex is no sex or self-administered sex. STI's are transmitted through oral, anal, and vaginal sex.*

### Sexually transmitted Infections

- Honest communication
- Condoms
- Reduce your number of sex partners

	<b>Genital Warts virus</b>	<b>Genital Herpes virus</b>	<b>Chlamydia bacteria</b>	<b>Gonorrhea bacteria (Clap)</b>	<b>Syphilis bacteria</b>
<b>How do you get it?</b>	90% to 100% of infected partners transmit this	Skin to skin contact	sexually transmitted	sexually transmitted	sexually transmitted or by kissing if mucus patches are in mouth
<b>What are the symptoms?</b>	Forms warts on the genitalia, mouth, anus. Occurs about 2-3 months after exposure	2 - 12 days after exposure a cluster of painful sores appears on genitals, lips, thighs, rectum. Local swelling. Fever. May disappear and reappear years later	urination pain in men with a clear or whitish discharge. No real symptoms except PID in women	Men- pus like discharge from penis. 20% symptomless. Women- 80% symptomless Burning pain during urination	painless sores, then rash several weeks later, then years later blindness, deafness, insanity, damaged heart
<b>What does it do to your body?</b>	In women may lead to cervical cancer	May cause miscarriage in pregnancies. C-section required for infected Moms as can kill newborns or cause brain damage	Causes inflammation of epididymis-sterile Swelling of fallopian tubes-tubal pregnancies which causes 10% of maternal deaths. 11,000 women/yr become sterile. Babies may be born with eye infections. Causes PID	Causes PID. Infects conjunctiva in babies and causes blindness. Destroys vas deferens and fallopian tubes. Infects the genitals, throat, and rectum	Babies can contract it from their moms
<b>How do you find out if you have it?</b>	Tested	Tested	Tested	Tested	Tested
<b>How do you treat it?</b>	Warts may be removed with acid or frozen, or laser	No sex while lesions are present		antibiotics	penicillin
<b>Does it have a cure?</b>	No, recurs even after therapy	No cure, viral infection. But acyclovir minimizes pain	bacteria, has a cure	yes since a bacteria	Yes
<b>How do you prevent it?</b>	condoms may not cover the warts	condoms may not cover the sores	Condoms	Condoms	Condoms if not in mouth

Name:

SAVE-IT SHEET for Science

**Human Anatomy: Skeletal and Muscular Systems**

I. What are the 5 functions of the Skeletal System?

1.

2.

3.

4.

5.

II. How are bones formed?

---

---

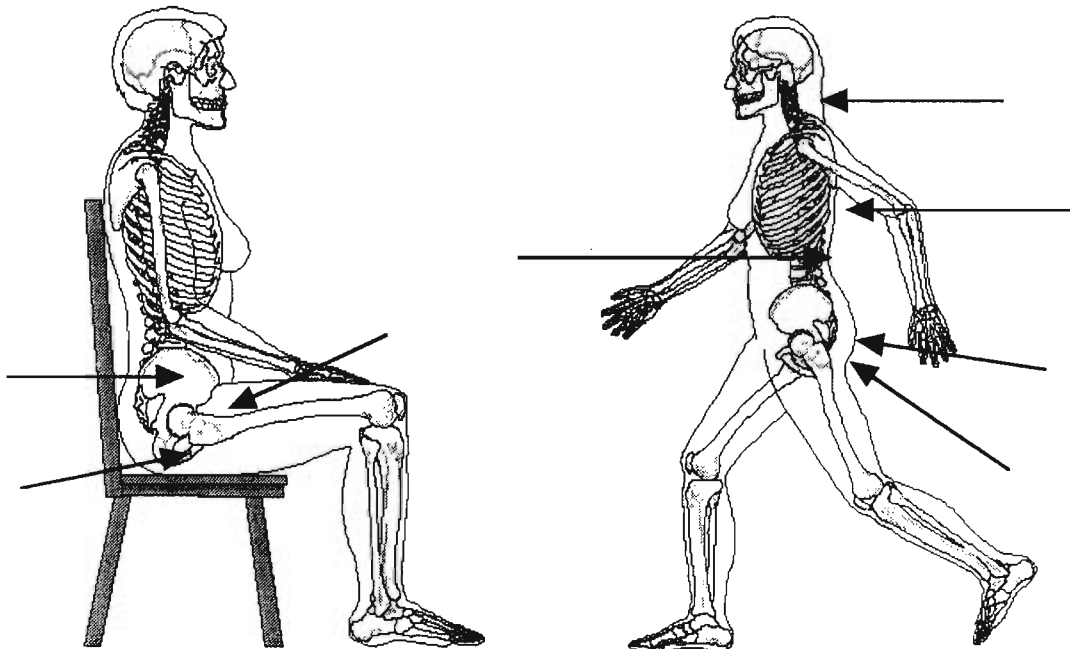
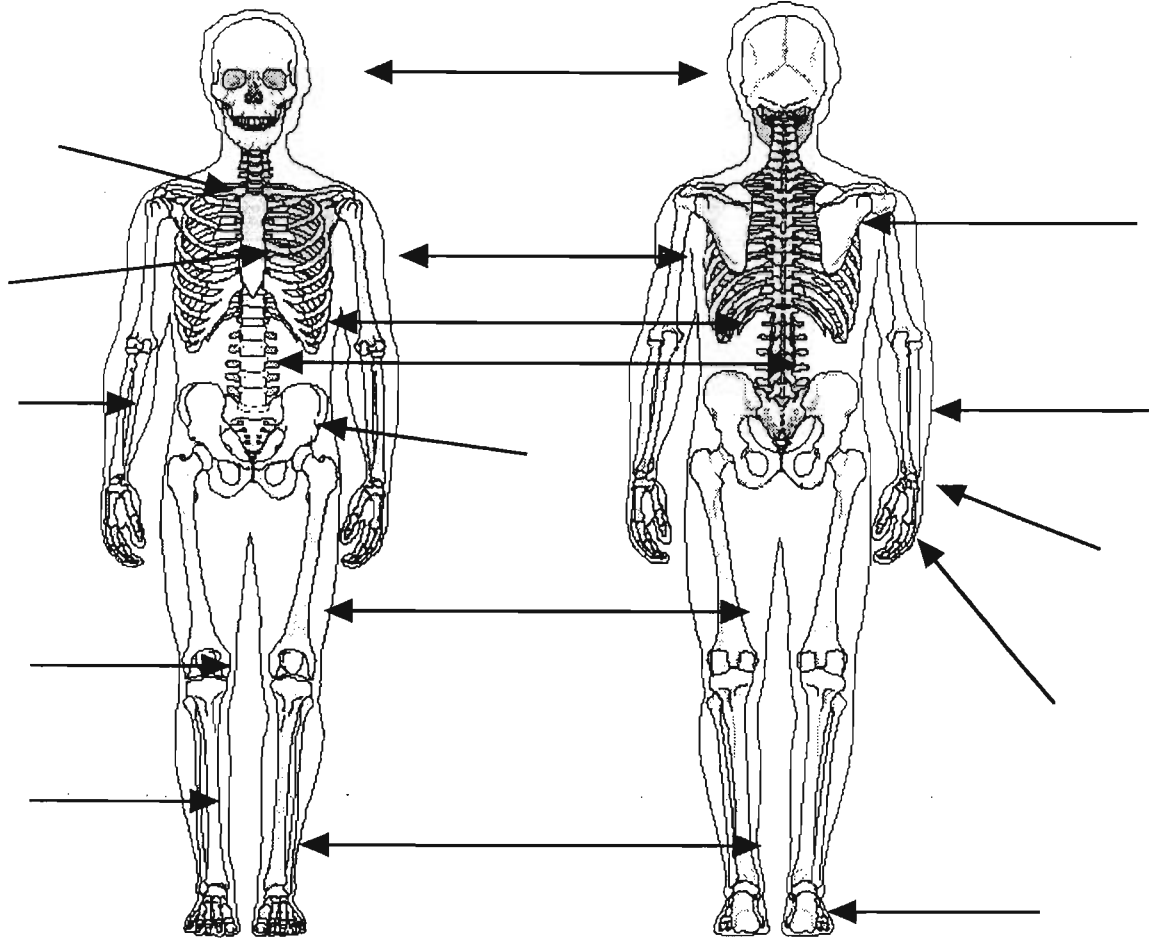
---

---

---

---

Name: \_\_\_\_\_



[http://shs.westport.k12.ct.us/mjvl/anatomy/skeletal/whole\\_skeleton\\_with\\_body\\_outline.gif](http://shs.westport.k12.ct.us/mjvl/anatomy/skeletal/whole_skeleton_with_body_outline.gif)

Name:

III. What is the structure of a bone?

IV. What are examples of the different types of joints? Why are joints important?

V. What are some diseases of the bones?

Name:

VI. What are the 3 types of muscles?

VII. How do muscles move the body?

VIII. What are some diseases of the muscles?

Human Anatomy: Skeletal and Muscular Systems

I. What are the 5 functions of the Skeletal System? *206 bones fastened together by ligaments*

1. *Provide shape and support*
2. *Provide movement through muscle attachment to the bones*
3. *Provide protection: ribs protect the heart, lungs, liver  
Skull protects the brain  
Pelvis protects the kidneys and reproductive organs*
4. *Store minerals: Calcium, Phosphorus, Sodium*
5. *Produce blood cells in the bone marrow*

II. How are bones formed?

\_\_\_\_\_ *In the developing baby all bones begin as cartilage which is flexible. Ossification of the cartilage begins in the uterus and continues to after age 20.*

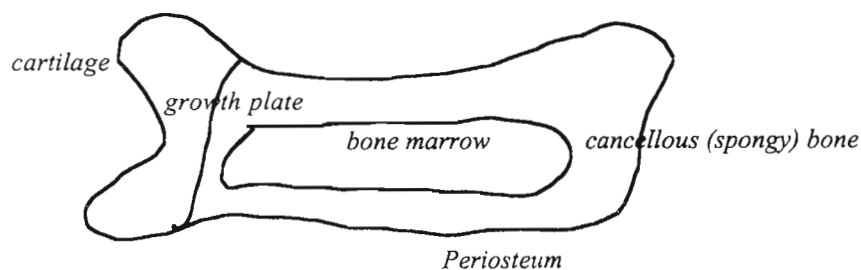
*Two types of bone cells: Osteoblasts lay down the protein fibers and minerals around the cartilage fiber. Osteoclasts break up the minerals and bone matrix during growth or if a break needs to heal. These two cell types work together during orthodontia work!*

*Growth plate is called the epiphyseal plate. This is cartilage and is where the bone cells are actively dividing to add new layers of bone to make the bone grow by extension \_\_\_\_\_*

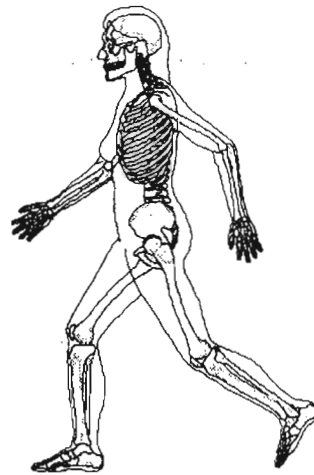
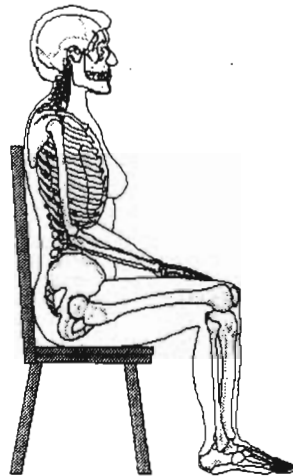
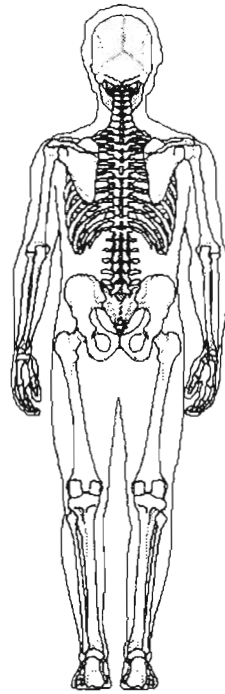
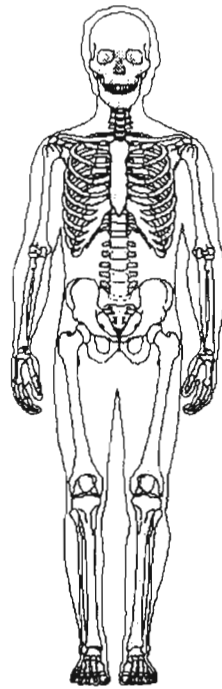
III. What is the structure of a bone?

*Bones are composed of (1) living tissue of cells and collagen protein and (2) mineral material ( $\text{CaCO}_3$  and  $\text{CaPO}_4$ )*

*Haversian Canals are a system of passage ways in the bone matrix that contain blood vessels and nerves which carries nutrients from periosteum to marrow (Havers, England 1800's)*



Save-it Answer sheet: Skeletal/Muscular



[http://shs.westport.k12.ct.us/mjvl/anatomy/skeletal/whole\\_skeleton\\_with\\_body\\_outline.gif](http://shs.westport.k12.ct.us/mjvl/anatomy/skeletal/whole_skeleton_with_body_outline.gif)

IV. What are examples of the different types of joints? Why are joints important?

*Joints are a place where two bones meet so the body can bend. Joints are held together by ligaments*

*To reduce friction where the bones rub together the joints are lined by cartilage and synovial fluids fill the joint in a bursa*

1. *Gliding: vertebrae, wrist, ankle*
2. *Ball and socket: shoulder and hip*
3. *Hinge: knee and elbow*
4. *Pivot: elbow and head*
5. *Immovable: fused joints at the skull and hip*



V. What are some diseases of the bones?

1. *Rickets: Lack of Vit D causing the bones to soften*
2. *Water on the knee: Synovial fluid build up*
3. *Bursitis: Swelling of the bursa*
4. *Rheumatoid arthritis: Destroys joint and may immobilize the joint by setting down fibers and mineral deposits*
5. *Osteoporosis: Bones lose minerals causing the bones to become brittle*

VI. What are the 3 types of muscles? (640 muscles)

*Muscle shapes are circular (sphincters), tubular, and sheet like*

*Muscle cells are long thin fibers (myosin and actin fibers) that increase in diameter with use. They run parallel to each other and are held together by connective tissue*

1. *Skeletal muscle (Voluntary/Striated) are attached to bones by tendons and by their contractions the bone moves. Nerve endings connect to each fiber. Each muscle is surrounded by connective tissue which tapers at each end into a tendon or inserts into the bone*
2. *Smooth muscle (Involuntary) contract slowly and smoothly. they depend on hormones or the autonomic nervous system to cause contractions. they control breathing, digestion, pupils, hairs to go on end, and blood vessels to contract. the smooth muscles react to stretching by contractions as for the bladder.*
3. *Cardiac muscles make the heart beat without tiring*

VII. How do muscles move the body?

*Muscles always work in pairs by contraction and relaxation. Contraction requires energy so lots of mitochondria are in muscle cells which receive the message from the nerves. Strength of contraction depends on the number of fibers that have received the message to contract. There are 100's to millions of fibers per muscle.*

*Muscle action is mechanical energy that releases heat energy and chemical wastes.*

*A flow of Calcium into the muscle cells start the muscular contractions*

VIII. What are some diseases of the muscles?

1. *Muscular Dystrophy: Inherited disorder that causes muscle tissues to be replaced with fat tissue*
2. *Tetanus: Calcium level in the blood is needed for proper nerve impulse to muscles. When the Calcium level drops in the blood the muscles remain contracted and this is Lockjaw.*
3. *Muscle fatigue: Caused by build up of lactic acid during metabolism. The muscles can no longer react to stimulus and cannot contract*

Name: \_\_\_\_\_

**Laboratory: INVESTIGATING MUSCLE TISSUE**

**PURPOSE:** To discover how muscle is attached to the bone, how the joint is held firmly together, and how stable movement is possible.

**MATERIALS:**

Chicken wing            Dissecting pan and tools

**PROCEDURE and OBSERVATIONS:**

1. Epithelial tissue: Draw and describe the skin of the chicken. Be sure to examine the pores.

2. Carefully cut off the skin, being careful not to cut through the muscles under the skin.

What is the clumpy yellowish tissue located just under the skin?

\_\_\_\_\_

3. Observe and draw the structure of the muscle bundles you exposed. Notice how the tendons extend from the muscles and attach to the bone on the other side of the joint.

**Label tendons, muscle, and bones.**

4. Pull gently on a muscle bundle while holding the wing. Pull on other bundles. Observe which bones are moved by the muscle on which you pulled.  
**Describe why tendons are important to a muscle's ability to move a bone:**

5. Draw one muscle you pulled and show the tendons from this muscle and how it attaches to the distant bone. Name bones that you can identify.  
**Label bones, muscle, and tendons:**

6. **Joints:** Carefully examine a joint and look for the **ligaments**, the tiny bands of tissue, that hold the joint together. Carefully cut away the ligaments so the joint opens up and look for ligaments that cross inside the joint.

Draw the arrangement of the ligaments at the joints:

Examine the ends of the joints that you exposed and observe the cartilage. Describe the color, texture, and shape:

**CONCLUSION:**

1. Research and define the following words:

tendon:

ligament:

muscle:

cartilage:

periosteum:

joint:

2. The chicken wing is equivalent to what structure on the human body?

\_\_\_\_\_

List the bones of the chicken wing: \_\_\_\_\_

\_\_\_\_\_

3. On a separate sheet of paper, write at least one page describing at least three things you learned while observing the muscles and bones of the wing. Research and describe how muscles, tendons, joints, and ligaments work together.

Name: \_\_\_\_\_

SAVE-IT SHEET for SCIENCE:  
**Human Anatomy: The Digestive System**

**I. Nutrients**

NUTRIENT	PURPOSE

II. If your diet misses essential nutrients these are illnesses that may result:

1. Scurvy

2. Beriberi:

3. Pellagra:

4. Rickets:

5. Kwashiorkor:

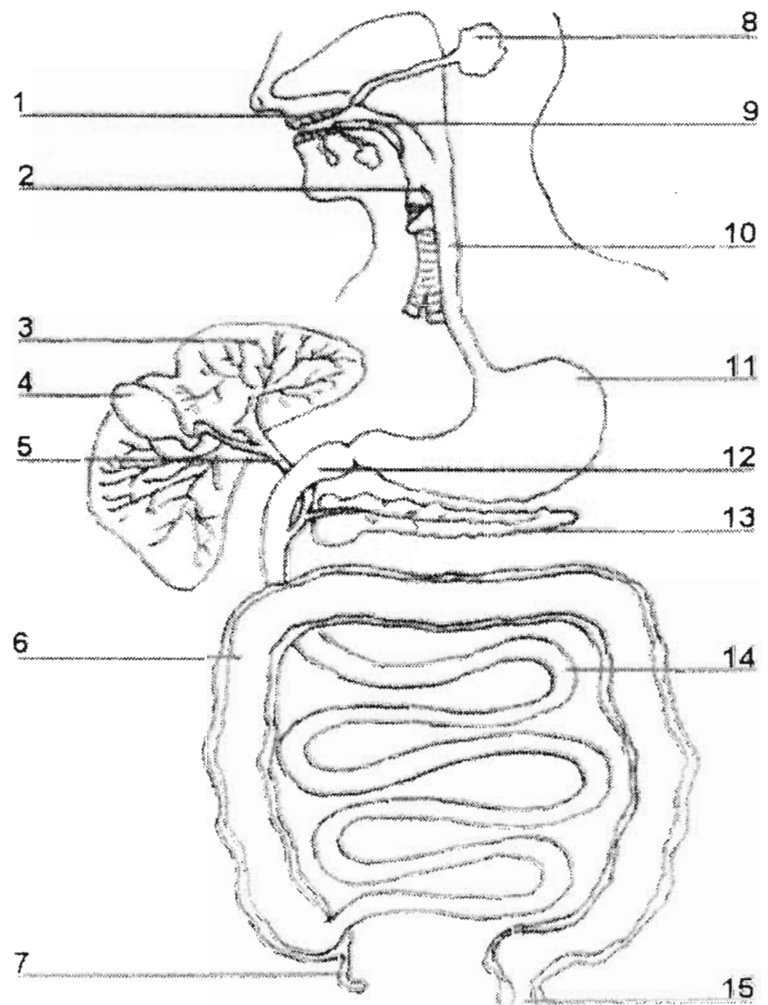
III. Digestion: What is it? What path does food take?

1. Mouth

2. Esophagus

### 3. Stomach

[http://www.lesstutor.com/jm\\_digestive.html](http://www.lesstutor.com/jm_digestive.html)



#### 4. Small Intestine

Liver

Pancreas

#### IV. Nutrients are absorbed from the gut into the blood

1. Small intestine

2. Large intestine

#### V. Leftover nutrients that are not absorbed into the blood



## VI. Disorders of the digestive system

SAVE-IT SHEET for SCIENCE:**Human Anatomy: The Digestive System**

I. **Nutrients** *Parts of your food your body can use to build new tissue and repair damaged and worn out tissue*

NUTRIENT	PURPOSE
<i>Proteins</i>	<p>20% of your caloric intake</p> <ol style="list-style-type: none"> <li>Used to build new tissue and repair damaged tissue as this is an essential constituent of all cells</li> <li>Provide energy for the body at 4 calories per gram</li> <li>Composed of 50 to 5000 amino acids strung together. There are 20 separate AA, 8 of which are essential AA since our body can not manufacture them</li> </ol>
<i>Carbohydrates</i>	<p>45% of caloric need</p> <ol style="list-style-type: none"> <li>Provides energy at 4 cal/gram</li> <li>Two types of carbs that are formed by plants: sugar-glucose/fructose/sucrose/lactose/maltose/cellulose starch-long chains of sugars that take longer to digest (beans, corn, potatoes)</li> <li>Excess energy is stored in muscles, fat cells, liver</li> </ol>
<i>Fats and Oils</i>	<p>35% of your caloric needs</p> <ol style="list-style-type: none"> <li>Provides energy at 9 cal/gram</li> <li>Supports and cushions vital organs</li> <li>Insulates the body from heat loss</li> <li>Builds cell membrane, retina, cell organelles, nerve cell synapses (60% of brain)</li> </ol>
<i>Vitamins</i>	<ol style="list-style-type: none"> <li>Regulates growth and body functions and essential for metabolic reactions</li> <li>Two types *Fat soluble that are stored in fat tissue A D E K *Water soluble that are not stored so must be eaten daily B C</li> </ol>
<i>Minerals</i>	<p>51 metals go into operating our cells</p> <ol style="list-style-type: none"> <li>Regulate body functions: 16 are essential minerals Mg, Ca, P: Bones and teeth, nerves Fe: Red blood cells to carry oxygen to cells Na, K: Nerves and muscle functioning Fl: Prevents tooth decay</li> </ol>
<i>Water</i>	<p>We are 55 to 75% water</p> <ol style="list-style-type: none"> <li>Maintains our body temperature</li> <li>Carries the nutrients in the blood stream</li> <li>Needed as a place in which all chemical reactions take place</li> </ol>

II. If you skip your nutrients these are some of the possible diseases that result:

1. Scurvy: Deficiency in Vit. C. Sailors died of this and learned to take their "limey"  
Symptoms: Bruise easily, wounds don't heal, bleeding gums, hair and teeth fall out, wall of capillaries become weakened, painful joints

2. Beriberi: Lack of Vit B1  
Causes swelling, damage to nerves and heart disease

3. Pellagra: *Lack of Niacin and Vit B complex which come from yeast and protein foods such as meat. If left untreated, insanity results Symptoms: tired, nervous, pale skin, rash if you go in the sun, roughened scaly skin*

4. Rickets: *Deficiency of Ca and Vit D and especially in children under 3 Symptoms: Bones are softened and child becomes bowlegged sweating, weakness, bone pains, flabbiness*

5. Kwashiorkor: *Lack of complete protein which stops or slows growth Symptoms: Muscles waste away, liver is destroyed and abdomen area protrudes*

### III. Digestion: What is it? What path does food take?

*Digestion is the break down of food into its constituent nutrients so to allow absorption into the blood*

1. Mouth: *Lips are the orbicularis oris or sphincter oris*

1. Saliva produced by 3 pairs of salivary glands (parotid, sublingual, submaxillary) at the rate of 1/2 to 1 liter per day

*\*lubricates tongue and cheeks to decrease friction*

*\*salivary amylase enzyme breaks starches into sugars*

2. teeth: *2 incisors cut food, 1 canine shred and tear food, 2 bicuspids, 3 molars grind food grind*

3. Taste buds detect sweet, sour, bitter, salty

4. Epiglottis covers windpipe during swallowing and uvula covers nasal passage when swallowing

2. Esophagus

*9" to 10" tube for carrying food to stomach in approximately 7 seconds*

*mucous membrane makes it slippery*

*peristalsis waves of muscular contractions push the food into the stomach*

3. Stomach *1.5 liter capacity (cows have 300 liter capacity) that holds the food for several hours*

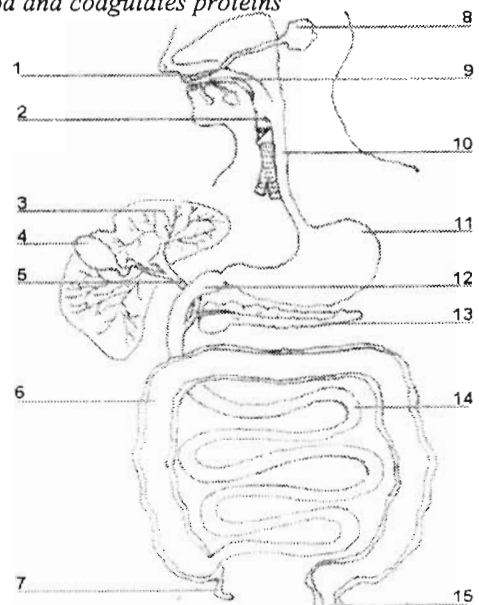
1. Mucous lining protects stomach wall from the 2.5 pH acid level

2. Gastric juices are clear colored and about 1 to 1.5 liters are produced daily

*rennin in children to break down milk*

*pepsin breaks down proteins into AA in acid environment*

*hydrochloric acid destroys bacteria, breaks down food and coagulates proteins*



[http://www.lesstutor.com/jm\\_digestive.html](http://www.lesstutor.com/jm_digestive.html)

4. Small Intestine *Major place of digestion as food is held here 3 hours, 6 m long and 2.5 cm diameter*

*Chyme from stomach enters through the pyloric sphincter*

*Bicarbonate secreted to stop pepsin digestion of AA*

*Secretes lactase, maltase, sucrase to break sugars into simple sugars*

*peptidase to break proteins to AA*

*Lipase to break fats into fatty acids*

*Peristalsis pushes food through small intestine and mixes food with secretions from the liver and pancreas so as to make possible absorption of the nutrients through the villi into the blood system*

*Liver Bile secreted by liver that made it from dead red blood cells and stored it in the gall bladder. Bile is automatically secreted when fats enter the small intestine. Bile breaks fat molecules into smaller molecules that can be absorbed into the blood*

*Pancreas Secretes pancreatic enzymes into the small intestine*

*lipase: breaks fats into droplets*

*trypsin and chymotrypsin breaks proteins down into AA*

*Amylase breaks starches into sugars*

IV. Nutrients are absorbed from the gut into the blood *The blood leaving the gut contains nutrients which are taken directly to the liver for processing and storage*

1. Small intestine *Villi absorb the nutrients into a network of blood vessels*

2. Large intestine *1.5 m long and 6.5 cm in diameter. Food may stay here up to 2 days*

*absorbs: Water and salts*

*Secretes: mucous for ease of passage of drying up feces*

*Bacteria make Vit K and B which are absorbed into the blood*

*Appendix is at the end of the large intestine where the small intestine joins it. In rats and rodents it still functions as an organ of digestion.*

V. Leftover nutrients that are not absorbed into the blood

*Solid wastes are formed and stored in the rectum and released through the anus*

*1/3 is dead bacteria that live in colon 1/3 is undigested food matter (cellulose, fibrous carbohydrates)*

*1/3 is unwanted mineral salts, dead cells, bile*

VI. Disorders of the digestive system

1. *Diarrhea: peristalsis too fast because gut is irritated by infection or foods*

2. *Constipation: Peristalsis too slow due to gut irritation*

3. *Vomiting: peristalsis works backwards due to gut irritation triggered by pregnancy, poisons, sights, smells, movement, taste, heat, fatigue*

4. *Stomach ache: inflammation of stomach wall*

5. *Heartburn: Contents of stomach go into esophagus and irritate esophagus. Prevented by a muscle*

6. *Ulcer: mucous lining fails so gut wall is destroyed*

7. *Appendicitis: inflammation of the appendix*

8. *Gallstones: precipitated out of cholesterol in the gall bladder and may block cystic*

Name: \_\_\_\_\_

SAVE-IT SHEET for SCIENCE:

**Human Anatomy: Circulatory, Respiratory, and Excretory Systems**

**Circulatory System**

I. What is the purpose of the circulatory system? \_\_\_\_\_

---

---

---

II. List the parts that form the circulatory system and tell what they do:

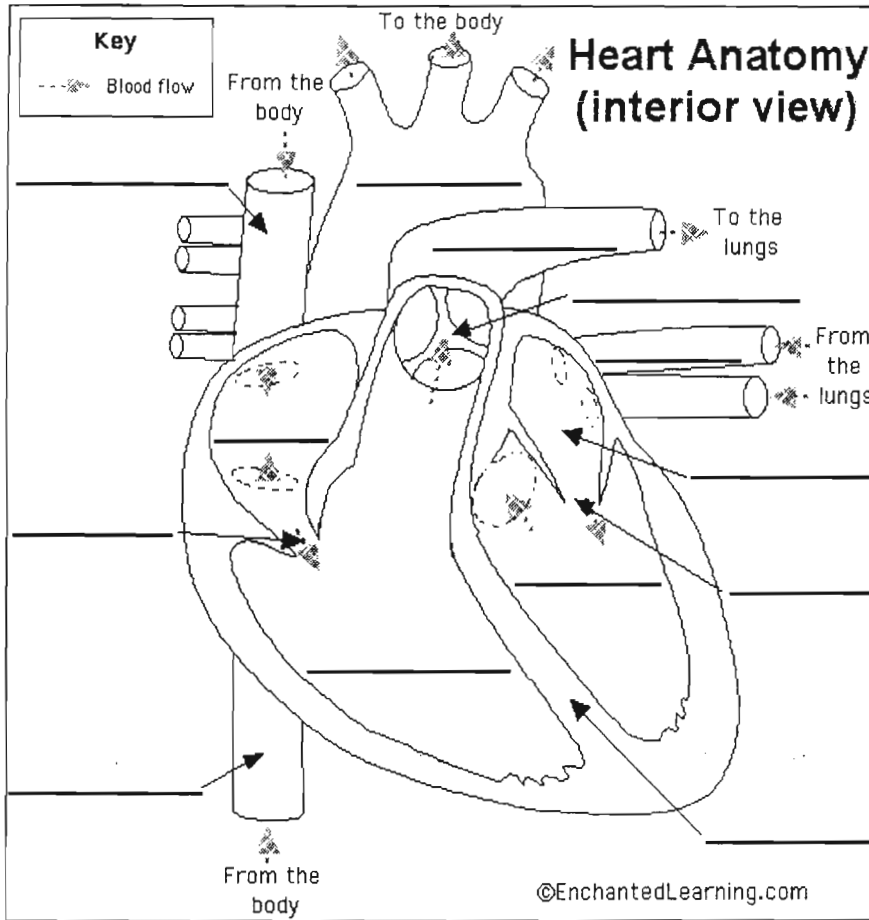
PARTS

FUNCTION

PARTS	FUNCTION

III. What is your blood type? \_\_\_\_\_

IV. What does the heart look like?



1. Diseases of the Circulatory System

Anemia:

Leukemia:

Hemophilia:

## Respiratory System

V. What is the purpose of the respiratory system?

---

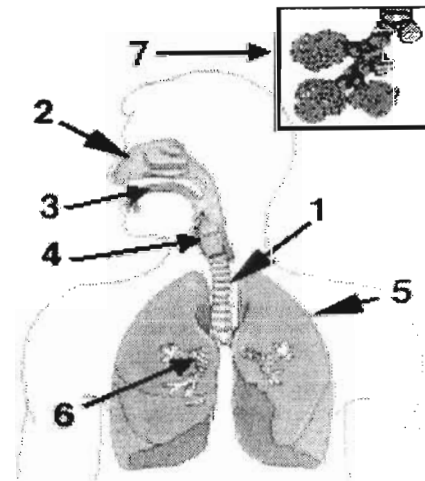


---

VI. List the parts that form the respiratory system and tell what they do:

PARTS	FUNCTION

VII. Draw the structure of the lungs and name their parts:



**bronchial tree** - the system of airways within the lungs, which bring air from the trachea to the lung's tiny air sacs (alveoli).

**diaphragm** - a muscular membrane under the lungs.

**larynx** - a muscular structure at the top of the trachea, containing the vocal cords.

**trachea (windpipe)** - the tube through which air travels from the larynx to the lungs.

1. Protection methods of lung tissue

Nostril Hairs:

Mucus membranes:

Nasal cavity:

Epiglottis:

Alveoli:

2. Diseases of the Respiratory System

Pollution:

Colds:

Asthma:

## **Excretory System**

VIII. What is the purpose of the excretory system? \_\_\_\_\_

Waste products excreted from the body:

Skin: \_\_\_\_\_ Lungs: \_\_\_\_\_ Liver: \_\_\_\_\_ Kidney: \_\_\_\_\_

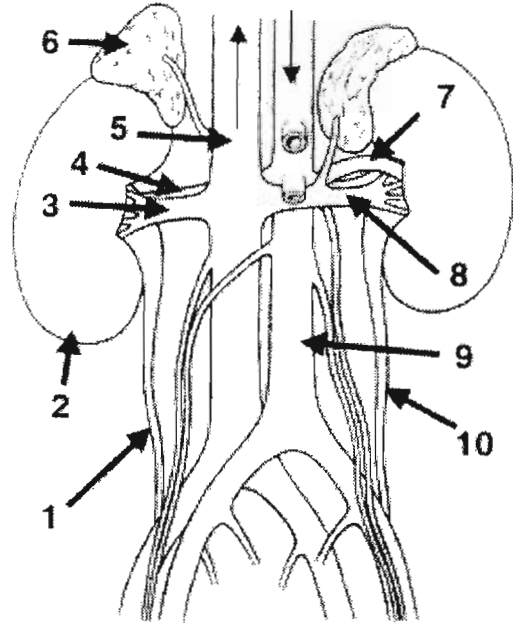
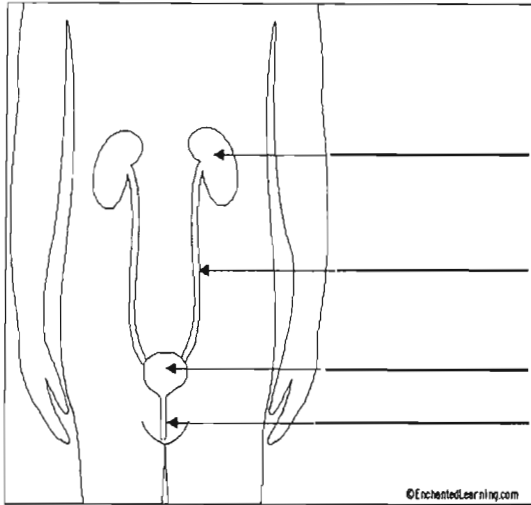
If the Kidneys collect urine from the blood, what are the ingredients of urine:

\_\_\_\_\_

1. Purpose of the kidneys:

2. Structure of the kidneys





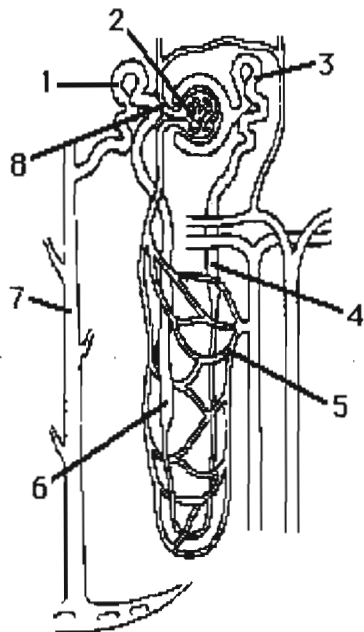
[http://www.msjsensen.gen.umn.edu/webanatomy/wa\\_urinary/wa\\_urinary\\_gross\\_anat\\_3.html](http://www.msjsensen.gen.umn.edu/webanatomy/wa_urinary/wa_urinary_gross_anat_3.html)

**bladder** - a hollow organ that stores urine until it is excreted.

**kidney** - two bean-shaped organs that take waste from the blood and produce urine.

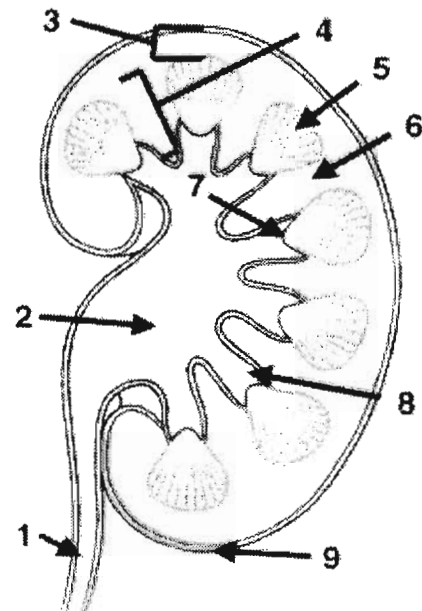
**ureter** - two tubes, each of which carries urine from a kidney to the bladder.

**urethra** - the tube that carries urine from the bladder out of the body.



NEPHRON

[http://www.msjsensen.gen.umn.edu/webanatomy/wa\\_urinary/wa\\_nephron1.html#there%20are%20any](http://www.msjsensen.gen.umn.edu/webanatomy/wa_urinary/wa_nephron1.html#there%20are%20any)



KIDNEY

[http://www.msjsensen.gen.umn.edu/webanatomy/wa\\_urinary/wa\\_kidney\\_xsection\\_1.html](http://www.msjsensen.gen.umn.edu/webanatomy/wa_urinary/wa_kidney_xsection_1.html)

SAVE-IT SHEET for SCIENCE:

**Human Anatomy: Circulatory, Respiratory, and Excretory Systems**

**Circulatory System**

I. What is the purpose of the circulatory system? Brings nutrients, oxygen, hormones to the body's cells and removes carbon dioxide waste from the cell. Immune system destroys invading organisms

II. List the parts that form the circulatory system and tell what they do:

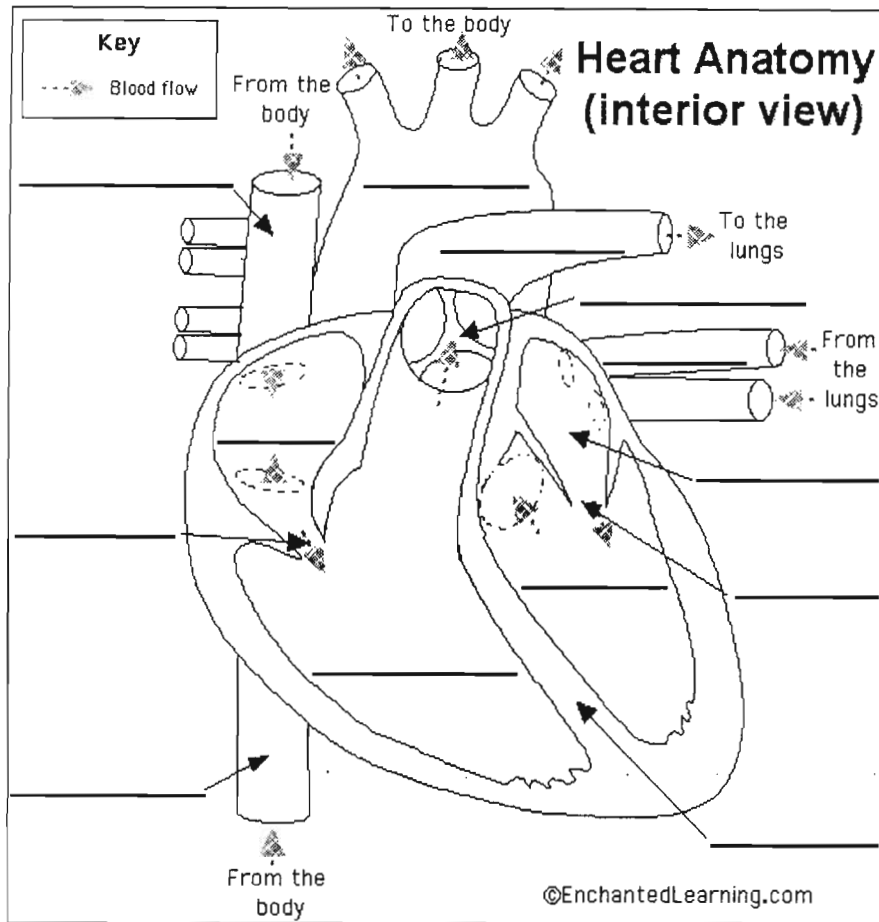
PARTS	FUNCTION
<i>Heart</i>	<i>Pump composed of 4 chambers pumps 4 qt of blood per minute through the body. With exercise this rate can go up to 40 qt per minute</i>
<i>Arteries</i>	<i>Carries blood away from the heart. Have smooth but thick muscular walls that beat with the heart. Arteries can constrict and expand depending on need for blood supply to that part of the body</i>
<i>Capillaries</i>	<i>Very thin walled, microscopic in diameter through which nutrients and oxygen are passed to the body cells. Waste products from the cells (carbon dioxide and urea) enter through the walls of the capillaries into the blood system</i>
<i>Veins</i>	<i>Carries the blood supply back to the heart. Has a low oxygen content and high waste content. Walls are thin compared to arteries and contain valves to direct the blood flow to the heart. Surrounding muscles must help to squeeze the blood back to the heart.</i>
<i>Plasma</i>	<i>Our bodies contain about 1 gallon of blood. About half of this volume is a yellowish liquid that carries dissolved minerals, nutrients, wastes and hormones. Also the plasma distributes heat evenly throughout the body.</i>
<i>Red Blood Cells</i>	<i>Each ml of blood contains about 5,000,000 RBC and each RBC can carry about a billion molecules of oxygen that bind with the hemoglobin molecule. RBC live about 4 months and are flexible enough to squeeze through the capillaries.</i>
<i>White Blood Cells</i>	<i>Each ml of blood contains about 5,000 to 10,000 WBC depending on any infections in the body. They multiply when an infection from bacteria, virus, mold, or yeast invade the body. They may eat the invader or attach themselves to the infection.</i>
<i>Platelets</i>	<i>Pieces of cells that plug leaks in the circulatory system. They form a network of Fibrin threads across the hole to stop the bleeding. A scab is a blood clot on the skin.</i>

III. What is your blood type?

Types	Receiver			
	A	B	O	AB
A	Yes	No	No	Yes
B	No	Yes	No	Yes
AB	No	No	No	Yes
O	Yes	Yes	Yes	Yes

Giver

#### IV. What does the heart look like?



*Right atrium: collects blood from the body through the Superior and Inferior Vena Cava, is dark red in color because low in oxygen content and high in carbon dioxide content.*

*Through Tricuspid valve to*

*Right Ventricle: Pumps blood to the lungs where carbon dioxide is released and oxygen picked up  
To Lungs to*

*Left Atrium: Collects blood from the heart so bright red in color*

*Through Bicuspid (Mitral) Valve to*

*Left Ventricle: Pumps blood to the body through the Aorta so works 6X harder than right side and is much more muscular.*

#### 1. Diseases of the Circulatory System

*Anemia: Low in RBC count so feel tired due to low oxygen levels going to body cells*

*Leukemia: Cancer type. The body overproduces WBC so crowds out other types of blood elements*

*Hemophilia: Lack of Platelets produced so person could bleed to death from simple cut*

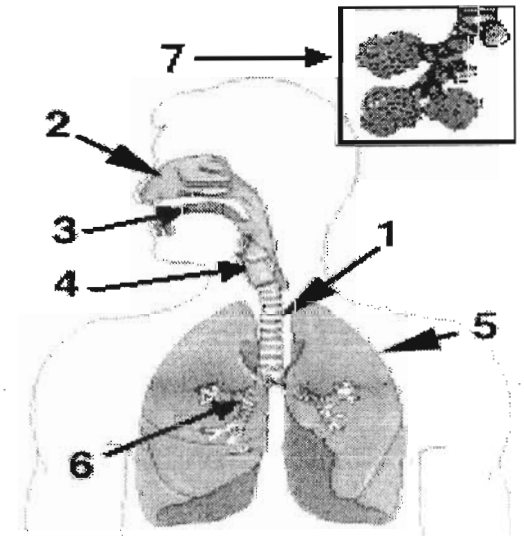
## Respiratory System

V. What is the purpose of the respiratory system? *\_\_To get oxygen into our body's circulatory system and remove carbon dioxide waste. Our oxygen supply comes from rainforest plants and algae of the oceans. For the 15% of organisms that live on land, lungs developed for this task, water organisms use gills or breathe directly through their skin \_\_\_\_\_*

VI. List the parts that form the respiratory system and tell what they do:

PARTS	FUNCTION
Lungs	<i>Soft, spongy tissue composed of 600,000,000 air sacs called alveoli, each surrounded by a network of capillaries where the oxygen and carbon dioxide is exchanged</i>
<i>Trachea, Bronchus, bronchiole tubes</i>	<i>Tubes that are stiffened by cartilage and branch to each alveoli to carry the breathed in outside air to each alveoli. The single trachea splits to form 2 bronchus to each lung which further splits into the millions of bronchiole tubes.</i>
Diaphragm	<i>Muscle that does the work of breathing. Moves up and down and separates the abdomen from the chest</i>
Alveoli	<i>Microscopic air sacs surrounded by capillaries where the oxygen and carbon dioxide are exchanged. The hemoglobin gains oxygen and the blood plasma give up carbon dioxide. This tissue forms the lungs.</i>

VII. Draw the structure of the lungs and name their parts:



**bronchial tree** - the system of airways within the lungs, which bring air from the trachea to the lung's tiny air sacs (alveoli).

**diaphragm** - a muscular membrane under the lungs.

**larynx** - a muscular structure at the top of the trachea, containing the vocal cords.

**trachea (windpipe)** - the tube through which air travels from the larynx to the lungs.

1. Protection methods of lung tissue

Nostril Hairs: *Nostril hairs filter out bugs and dust*

Mucus membranes: *Mucus is formed by the Goblet cells and traps smaller particles and is pushed up by cilia to be coughed, sneezed or swallowed*

Nasal cavity: *curved area that twists and catches particles and also warms and humidifies incoming air*

Epiglottis: *Epiglottis blocks food from entering the trachea through the larynx*

Alveoli: *Alveoli produces no mucus but uses white blood cells to fight off bacteria*

2. Diseases of the Respiratory System

Pollution: *Turns the alveoli black from smoke and chemicals that are stored in the lung tissue. This poisons individual cells. Hg, Pb, Cd, asbestos*

Colds: *Virus becomes established in the mucus membranes of the nose, throat, or sinus*

Asthma: *Bronchiole muscles spasmodically contract so air cannot flow freely. Mucus lining swells due to infection or allergic reaction*

**Excretory System**

VIII. What is the purpose of the excretory system? *\_Remove wastes produced by the body's cells*

Waste products excreted from the body:

Skin: *\_sweat\_* Lungs: *Carbon dioxide\_* Liver: *bile\_* Kidney: *\_Urine\_*

If the Kidneys collect urine from the blood, what are the ingredients of urine:

*\_\_\_\_\_water, salts, urea, ureic acid, hormones\_\_\_\_\_*

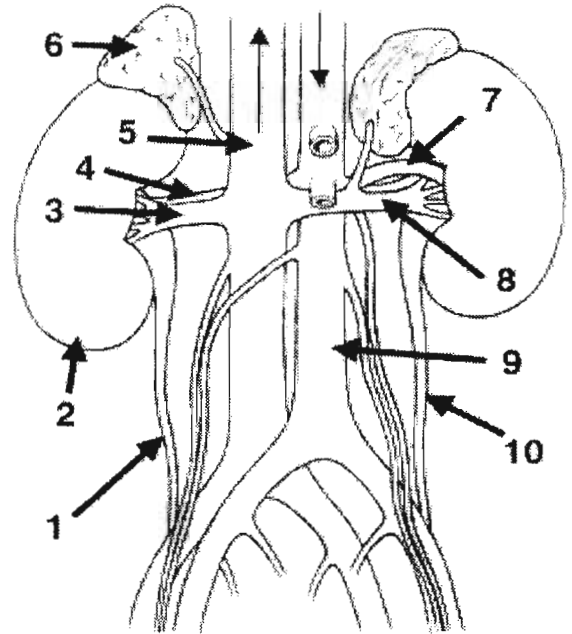
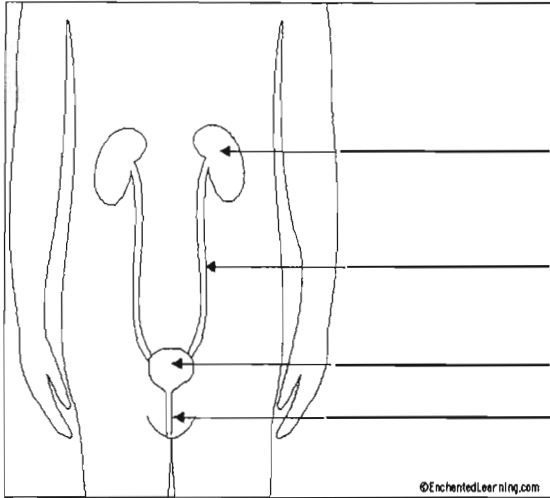
1. Purpose of the kidneys: *Kidneys filter urea from the blood along with excess salts and nutrients forming 1 to 2 quarts of urine daily*

2. Structure of the kidneys *Kidneys are composed of over 2,000,000 nephrons that are the filtering units for all the blood. At any one time about 1/4 of all blood is in the kidneys. Bowman's Capsule removes 180 qts/day of plasma from the glomerulus while the convoluted tubules allow reabsorption of 99% of the plasma along with glucose, AA, salts into the peritubular capillaries.*

*Ureters, 10" to 12" long, carry the urine away from the kidney that is collected in the collecting ducts of each nephron and drained to the pelvis of the kidney.*

*Bladder can hold about 1 pint of urine and is a collapsible bag of elastic muscle that when stretched, nerves send messages to the brain for the need to urinate.*

*Urethra is kept shut by the urethral sphincter muscle and is the final passage to the outside of the body.*



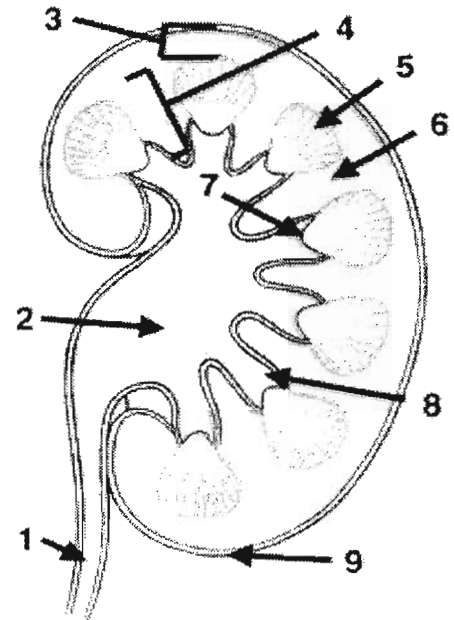
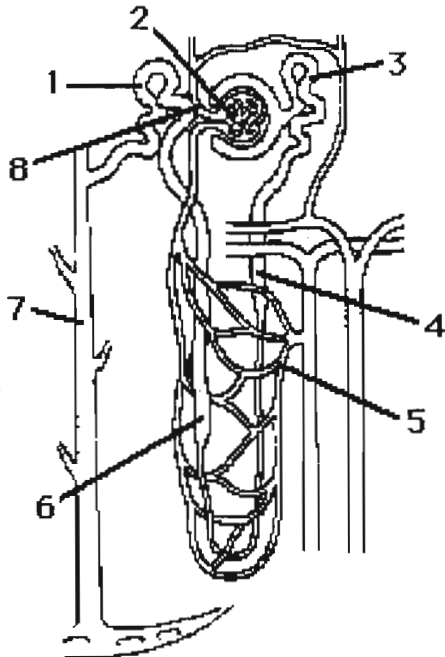
[http://www.msjensen.gen.umn.edu/webanatomy/wa\\_urinary/wa\\_urinary\\_gross\\_anat\\_3.html](http://www.msjensen.gen.umn.edu/webanatomy/wa_urinary/wa_urinary_gross_anat_3.html)

**bladder** - a hollow organ that stores urine until it is excreted.

**kidney** - two bean-shaped organs that take waste from the blood and produce urine.

**ureter** - two tubes, each of which carries urine from a kidney to the bladder.

**urethra** - the tube that carries urine from the bladder out of the body.



[http://www.msjensen.gen.umn.edu/webanatomy/wa\\_urinary/wa\\_nephron1.html#there%20are%20any](http://www.msjensen.gen.umn.edu/webanatomy/wa_urinary/wa_nephron1.html#there%20are%20any)

[http://www.msjensen.gen.umn.edu/webanatomy/wa\\_urinary/wa\\_kidney\\_xsection\\_1.html#there%20are%20any](http://www.msjensen.gen.umn.edu/webanatomy/wa_urinary/wa_kidney_xsection_1.html#there%20are%20any)

Name: \_\_\_\_\_

### **Laboratory: Heart and Lung Dissection**

As you work with your partner, you will be expected to make good observations during the dissection. You are expected to pass in a journal containing information from the lab observations and from your own research. You may choose the best way to set up your journal to provide all the needed information. The following will be expected in your journal:

#### **Part I: Research      20 points**

1. Give a clear description of the purpose of the heart and lungs
2. Provide your own diagram of the heart, clearly labeling all the chambers of the heart and the arteries and veins that connect to the heart
3. Describe the path that blood takes through each of the heart chambers and the blood vessels connected to the heart and lungs and then the general loop of blood vessels through the body

#### **Part II: Dissection      20 points**

1. Provide a labeled diagram of the heart/lung appearance before the dissection. Label the heart, lungs, coronary arteries, diaphragm muscle, trachea, and esophagus
2. Cut off the lungs and cut open the tissue of the lungs. Cut from the trachea following it to the bronchi branch and into the bronchiole tubes. Label the alveoli and the bronchiole tubes within the tissue.
3. Cut about 1" from the apex of the heart. Draw and label the chambers and the septum that are now exposed in these two pieces.
4. Cut a slit from the apex up the side so you can open the heart up to see the inside chambers. Accurately draw the valve and its connections to the heart chambers.
5. Cut open a blood vessel and describe its interior.
6. List and describe the colors, textures, and location of all the important parts you drew in this dissection.
7. Give a personal observation of how you expected the heart and lungs to appear and what you really found out about their appearance.

#### **Part III: Personal insight      5 points**

Describe at least 3 ways that the dissection and research helped you to better understand the functioning and construction of the heart and lungs.

#### **Evaluation:      5 points**

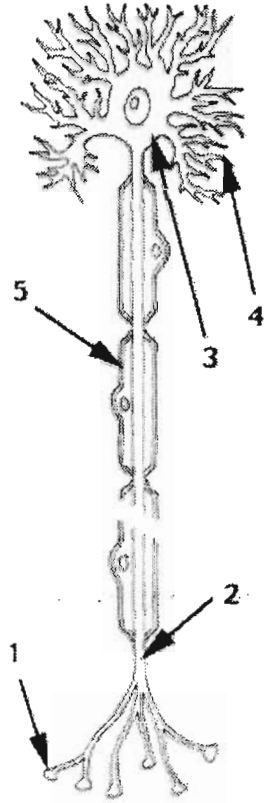
This journal will be graded on your effort based on clarity of information, conciseness of the drawings, and originality in presentation of all three of the required parts.

Name: \_\_\_\_\_

SAVE-IT SHEET for Science  
**Human Anatomy: The Nervous Systems**

A. What is a neuron: Nerve Cell?

1. Parts of a Neuron



[http://www.ms Jensen.gen.umn.edu/webanatomy/wa\\_nervous/wa\\_neuron2.htm](http://www.ms Jensen.gen.umn.edu/webanatomy/wa_nervous/wa_neuron2.htm)

2. What are the types of Neurons:

Sensory neuron

Motor neuron

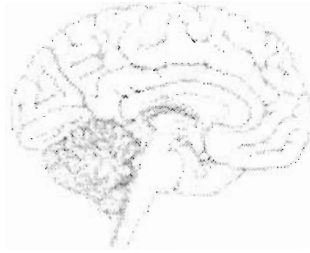
Interneurons



## B. The Central Nervous System: Brain and Spinal Cord

[http://www.msjensen.gen.umn.edu/webanatomy/wa\\_nervous/default.htm](http://www.msjensen.gen.umn.edu/webanatomy/wa_nervous/default.htm)

### 1. Brain



Cerebrum

Cerebellum

Brain Stem

### 2. Spinal Cord

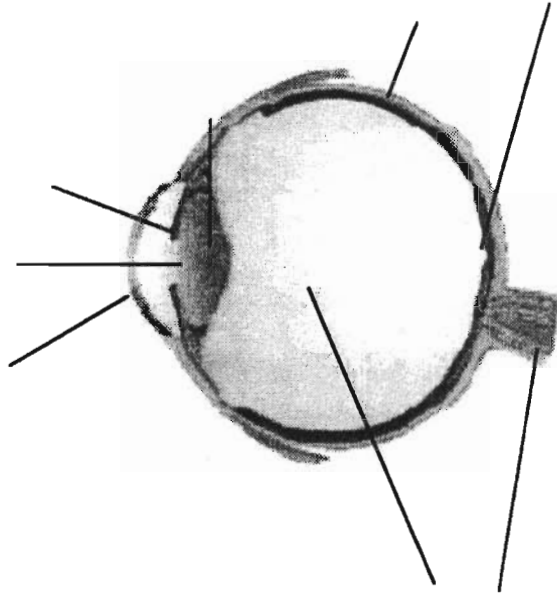
C. How does the **central nervous system** and **peripheral nervous system** work together?

1. Reflexes

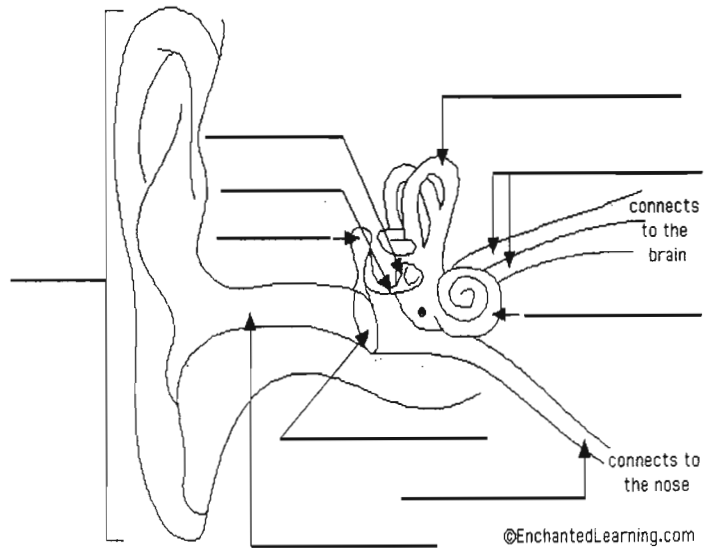
2. Autonomic Nervous System

D. What are the Sensory receptors and where are they located?

1. Vision: <http://www.lesstutor.com/jmeyer.html>



2. Hearing



3. Balance

4. Touch

5. Smell and taste

6. Proprioceptors

SAVE-IT SHEET for Science  
**Human Anatomy: The Nervous Systems**

*The nervous system is composed of the brain, spinal cord, and nerves located throughout the body that controls emotions, reason, and habit*

A. What is a neuron: Nerve Cell?

*The electrical impulse travels down the nerve at 400 ft/sec.*

1. Parts of a Neuron



1-axon endings 2-axon 3-cell body 4-dendrites 5-Schwann cell

[http://www.msjsensen.gen.umn.edu/webanatomy/wa\\_nervous/wa\\_neuron2.htm](http://www.msjsensen.gen.umn.edu/webanatomy/wa_nervous/wa_neuron2.htm)

*Cell body is found in the Central Nervous System and contains the nucleus.*

*Dendrites bring messages from other nerves to the cell body and form multiple connections to other nerves*

*Axon carries electrical impulses through the neuron to other neurons and form multiple connections through the axon endings. May be 30' to 40' long in the legs!*

*Neurotransmitters are chemical messages that pass from the axon endings to the dendrites of the next nerve, at the synapse or gap between 2 neurons.*

*Serotonin: stabilizes good and bad moods. Li enhances its production for manic/depressives*

*norepinephrine: Used as autonomic neurotransmitters*

*acetylcholine: Contact from nerve to skeletal muscle for muscle cell stimulation*

*dopamine: controls muscle activity*

*endorphin: blocks out pain*

*Psychological problems are often due to abnormalities of the neurotransmitters*

2. What are the types of Neurons: *Neurons must be connected to muscle cells that then carry out the response*

Sensory neuron

*Attached to receptors that respond to stimulus such as light, sound, touch, taste, smell, pain (chemicals, oxygen starved, touch, temperature extremes)*

Motor neuron

*Carries message from CNS to the muscles that carry out the orders for either voluntary or involuntary muscle contractions*

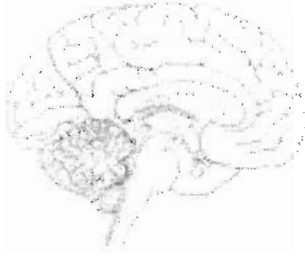
Interneurons

*Go between motor and sensory neurons to analyze, filter, or store information. Decides whether or not to take action about the stimulus*

B. The Central Nervous system: Brain and Spinal Cord

[http://www.msjsensen.gen.umn.edu/webanatomy/wa\\_nervous/default.htm](http://www.msjsensen.gen.umn.edu/webanatomy/wa_nervous/default.htm)

## 1. Brain



*Cerebrum: Sensory information is received and processed. Seat of the brain for thinking and learning.*

*Cerebellum: Regulates balance and muscle coordination and movement*

*Brain Stem: Regulates the autonomic nervous system for basic functions of the body*

## 2. Spinal Cord

*Passes through the vertebrae*

### C. How does the **central nervous system** and **peripheral nervous system** work together?

*The CNS is composed of the brain and spinal cord.*

*The PNS is composed of 31 pairs of spinal nerves that exit from the spinal cord. It contains both motor and sensory neurons. Sensory neurons bring sensory information to the CNS where the CNS must react to the incoming stimulus and send messages out along the motor neurons to the muscles in response to the incoming sensory information*

### 1. Reflexes

*Controlled through the spinal cord so the response happens quicker than when filtered by the brain. The brain kicks in after the emergency so the body then recognizes why it did the reflex reaction.*

### 2. Autonomic Nervous System

*Processes that the body seems to do without thinking are regulated by the ANS. Nerve messages go out to start the process and another set of nerve messages go out to stop the process.*

### D. What are the Sensory receptors and where are they located?

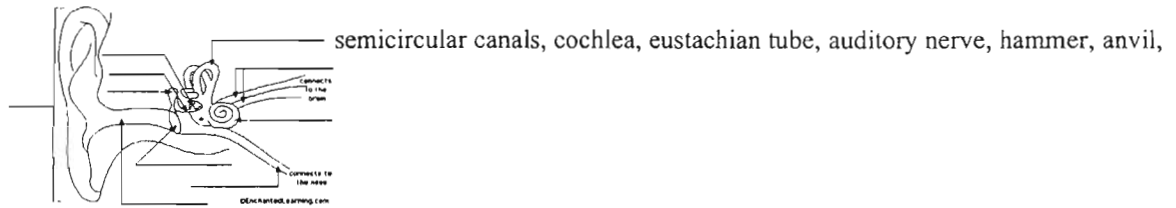
1. Vision: <http://www.lessonstutor.com/jmeyer.html>



*retina, cornea, lens, choroid, sclera, iris, pupil, optic nerve, aqueous humor,*

*vitreous humor*

## 2. Hearing



stirrup

## 3. Balance

*Semicircular canals in the ear are lined by cilia and filled with a jelly-like mass that tips at the cilia as you move your head*

## 4. Touch

*Touch is composed of sensory neurons for pressure, heat, cold, texture, pain  
Pain sensory neurons are all over the body: joints, skin, internal organs, muscles.*

## 5. Smell and taste

*The cells that receive smell and taste are covered in cilia and mucus to trap the molecules that stimulate these chemical receptors.*

*4 tastes + 80 odors = flavors*

## 6. Proprioceptors

*Located in all the joints to sense where your body is located at all times. This provides input to the brain as to the orientation of all the joints.*

**Activities to try to test your sensory receptors:**

- 1) Find the blind spot**
- 2) Find your reaction time by grabbing an upright falling meter stick**
- 3) Write on the chalkboard while swinging your leg in circles**
- 4) Look at brain imaging puzzlers**
- 5) Find complementary color inversions as an afterimage**

Name: \_\_\_\_\_

## Laboratory: Eye Dissection

As you work with your partner, you will be expected to make good observations. You are expected to pass in a journal containing information from the lab observations and from your own research. You may choose the best way to set up your journal to provide all the needed information. The following will be expected in your journal:

### Part I: Research 15 points

1. Give a clear description of the purpose of the eye
2. Provide a diagram of the eye, naming all the major parts
3. Provide a concise explanation of how the parts of the eye work together to produce sight
4. Describe how long you think it would take a person to get "used to the dark" in an underground cave and be able to see his hand. Tell why you think this.

### Part II: Dissection 15 points

1. Provide a labeled diagram of the eye's appearance before opening the eye up
2. Provide a labeled diagram of the eye parts you discovered as you cut through the tissues. Be sure to include the optic nerve, cornea, iris, pupil, retina, sclera, lens, and the fluids of the eye.
3. Make a list of the parts and clearly describe these parts. Describe their appearance, location, and texture; be sure to look at their color
4. Give a personal observation of how you expected the eye to appear and what you really found out that the eye looks like.

### Part III: Personal insight 5 points

Describe at least 3 ways that the dissection and research helped you to better understand the functioning and construction of the eye.

### Evaluation: 5 points

This journal will be graded on your effort. A good effort looks like clearly described information, carefully drawn diagrams, and a neatly put together booklet containing all the information required.

## **BIOGRAPHY OF THE AUTHOR**

Eleanor Hess was born in Annapolis, Maryland on July 1, 1953. She graduated from Annapolis High School in 1971, attended Colby College in Waterville, Maine and graduated in 1975 with a Bachelor's degree in Geology and Geology-Biology. While at Colby College she received her provisional certification to teach both physical and life sciences to grades 7 - 12. She taught mathematics at Unity College and Kennebec Valley Vocational Technical College. In 1991 she began teaching mathematics and science at Mt. View Junior High School in MSAD #3, Unity, Maine.

She took a one year sabbatical leave of absence from teaching and entered the Liberal Studies graduate program at the University of Maine in the fall of 2000 and completed course requirements. She returned from her sabbatical year of study to Mt. View Junior High School. She is a candidate for the Master of Arts degree in Liberal Studies from The University of Maine in December, 2005.