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Revitalizing the Physics Curriculum: Introducing Game-Based Learning as an Effective Educational Technique in the Physics Curriculum

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**Revitalizing the Physics Curriculum:
Introducing Game-Based Learning as an Effective
Educational Technique in the Physics Curriculum**

David Yochum

A project submitted to the Department of Education and Human Development
of the State University of New York College at Brockport
for the partial fulfillment for the requirements for the
degree of Master of Science in Education

**Revitalizing the Physics Curriculum:
Introducing Game-Based Learning as an Effective
Educational Technique in the Physics Curriculum**

by
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APPROVED BY:

Advisor

Date

Director, Graduate Programs

Date

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Introduction

Science and technology each represent broad areas that form the basic building blocks of human progression. For centuries, man has continued to evolve both in its understanding of the natural world from the availability of newer forms of technology that provide far better ways of observing and analyzing scientific phenomena. The subject of physics, in particular, covers a vast amount of information, including concepts such as sub-atomic particles, which cannot be seen with the naked eye. The content associated with this level of material demands teachers to research other methods of instruction or alternative ways of modeling these “invisible” concepts (Efe, 2011). This is where technology plays a role; by enabling scientists to view abstract phenomena in a different format, thus helping them to hopefully understand why matter behaves in specific patterns.

However, in order to sustain our knowledge and the development of further innovations a greater demand is needed for younger generations to acquire and retain current understandings of science. In fact, many of the challenges that we face presently, such as renewable energy and disease treatment and prevention can only be resolved through the assistance of science and technology. Therefore, educational institutions have now begun to place a stronger emphasis on the need for individuals knowledgeable in science, technology, and mathematics (National Research Council, 2012). In all, this is no easy task to accomplish. Our traditional methods of instruction in science are not adequate enough to achieve the desired goals for students. Thus, the responsibility of preparing newer generations of learners falls to science teachers, who must devise ways

of imparting the knowledge and skills that are necessary to succeed in this rapidly evolving world. Educators aim to use technology to enhance individual learning as well as to achieve widespread education and expect the technology to blend with their individual approach to instruction. However, most educators are not fully aware of the benefits that may be obtained by proactively mastering the available technologies and how they might be able to influence further improvements through systematic feedback and suggestions (Gee and Hayes, 2012).

Game-based learning (GBL) is one such method that offers educators a unique and engaging way to approach scientific content. GBL refers to an approach to learning that incorporates the use of educational computer or software programs to deliver content, practice or apply content, and assess student understanding (Tang, Hanneghan, & El-Rhalibi, 2009). Games have been a commonplace part of the K-12 experience for a long time, with early titles introducing students to fundamental science, math, history, and problem solving concepts just as games do today. Games are also extremely popular in various cultures, including the United States. According to a report from the Entertainment Software Association in 2012, the average U.S. household owns at least one dedicated game console, pc or smartphone.

It has been argued that young people, raised playing video games, have changed in ways that turn them off to conventional instruction (Gee and Hayes, 2012). One of the major differences between commercial games and game-based learning is the content, which should be integrated in such a way that it provides engaging game play while helping achieve the desired learning outcomes by delivering skills and knowledge

effectively to the end user (Tang, Hanneghan, & El-Rhalibi, 2009). While the graphics of many popular education games (*Oregon Trail*, *Math Blasters*, etc.) and simulations may not have been great, they helped to engage a generation of kids with technology and laid a solid foundation for the educational games that were to come. “Though times have changed, one thing has remained the same: the best educational games are not just tools for teaching” (Spires et al 2011). They show kids that education can be fun and instill a love of learning that will carry on throughout their lives. Historically, games have been associated with play outside of school contexts, but in light of low testing scores and increasing rates of high school dropouts, many are looking to games for educational benefits in schools (Spires et al 2011). The focus of this project will be to identify effective strategies for using game-based learning within a physics classroom.

Reasons for Games: Student Motivation and Engagement

Despite the ability to perform demonstrations and the use of experiments to reinforce science concepts, students lack interest in pursuing science courses in school and science careers. Traditional instructional methods have made it difficult for students to concentrate and develop a desire to learn about science. Being engaged in the content is the first step towards learning that content, and that begins with motivating students to crave knowledge. Motivation is a key aspect of effective learning but it needs to be sustained through feedback, reflection and active participation in order for the intended learning to take place (Garris et al, 2002). Therefore the key challenge for effective

learning with games is for the learner to be motivated, supported, and interested with not only the activity but with the content that is trying to be learned.

Game-based learning is a relatively new instructional approach that is inherently engaging and the potential to motivate students to learn. The teacher is charged with the task of developing games that not only compel and entertain the learner, but also teach through role play and other techniques that tap into the intrinsic motivation of the learner. One example of such a game is *Super Delivery*, an educational online game that was developed to target sixth grade students' knowledge about conserving electrical power. In a study conducted by Fu-Hsing, Kuang-Chao, and Hsien-Sheng (2012) it was found that most students who played the game became "immersed in the game play" and demonstrated full engagement with the activity. Furthermore, games also inspire competition, which is a strong intrinsic motivator whether between students, the computer or oneself. However, Fu-Hsing (et al, 2012) also acknowledges that interest and motivation with the game did not necessarily translate to engaging behavior towards learning. Therefore, it is imperative that teachers structure games such that they map closely to desired learning expectations.

Overall, if students are actively focused on a topic they will stand a higher chance of knowledge acquisition. Hence it stands to reason that games could be used as an activity to hook students into a particular topic or to spark interest in physics. The shifting of the classroom culture in the direction of an engaging and highly community of inquiry where students feel and identify themselves with the endeavor of science making, is a positive result of a game-based learning curriculum (Che & Tan, 2012).

Reasons for Games: Social Aspects of Games

Learning physics (or any science discipline for that matter) is a complex process, not just a simple transfer of knowledge from instructors to students which is typically associated with the traditional lecture-based instructional approach. In addition, Sahin (2010) argues that learning physics is not merely an individual activity, but an endeavor that requires social participation and practice. The general presumption with the use of games is that they are designed solely to help with individual learners and are restrictive in social interaction skills. Yet, role-playing games are considered highly social. An emerging genre in the gaming world is massively multi-player online role-playing (MMORP) games, where multiple players participate simultaneously over the internet. For this style of gaming, players step into specific roles and undertake challenges that can only be completed through collaboration and strategic planning with other players (Dickey, 2006). The ability to work well with others in this genre transgresses into real world situations as well. Thus, the game promotes positive group collaboration and problem solving skills as opposed to inspiring players to shy away from others. Still, the development of MMORP games, specifically for learning, are still several years away from being used by educational institutions due primarily to a lack of interest by game designers towards such a market (New Media Consortium, 2011).

In addition, some games provide interactive learning environments that require learners to construct meaningful knowledge by networking with narrative content (Dickey, 2006). One example of this can be found with the educational game *Quest Atlantis*, was designed to engage students in complex socio-scientific inquiry while also

helping them learn ecological science concepts like erosion, eutrophication, and hypothesis testing (Hickey, Ingram-Goble, & Jameson, 2009). In this game, learning is accomplished via interaction with virtual characters and data that allows students to evaluate competing explanations for declining fish populations in the Taiga River. This essentially places students in the role of a scientific investigator that must seek out information from external sources (other characters, in-game literacy resources, etc.) greatly encouraging the importance of social interaction with science related activities. Whether the learner is playing games, training on a simulation, watching films or television, surfing on the internet or listening to music, it is their approach to that activity, and the support of peers, mentor or tutor that frames how and when learning will take place.

Reasons for Games: Changing the Classroom Culture

The current extent that digital games are currently being used in everyday classrooms is what Chee and Tan (2012) refer to as an “educational resource model”. This implies that educational games are used for the sole purpose of playing the role of a technology resource to enhance the basic classroom lesson. Mostly, the game is simply used as a form of drill-and-practice activity with a more engaging digital format. However, Chee and Tan (2012) predict that game-based learning can provide an even greater assistance than this current role; by helping students to learn a complete curriculum or curricular unit. For such learning to exist, the classroom culture must be changed from an instruction-centered environment to a more learning-centered

environment. Given the emphasis toward fostering subject content mastery, teachers expend a great deal of time and effort “telling” students about domain content (Chee and Tan, 2012). Teachers “tell” students with the anticipation of expanding learner knowledge and comprehension thereby advancing their ability to think. But in terms of applying what they have been told in a real-world scenario, this traditional mode of teaching inevitably ends in breakdown. However, through game-based learning design, students are able to experience science as a lived and always dynamic process. By relating how science impacts students’ lives, educators are able to help them realize the significance of what they learn and how it can be applied in real-world situations. In short, they see how science is relevant to them on a personal level thus further sparking interest with the subject. In an empirical study conducted by Chee and Tan (2012), two middle school chemistry classes comprising of 39 (22 boys and 18 girls) and 38 students were placed into a game-based learning classroom and a traditional lecture-based classroom with the main intention of examining changes in students’ perceptions of their identity, their beliefs, their dispositions toward science inquiry, and of classroom culture. Students in the traditional classroom were taught using PowerPoint presentations and lectures, while students in the GBL classroom used the *Legends of Alkhimia* program involving six levels of game play. Using a combination of pre- and posttest surveys, researchers were able to compare responses from a class of 39 students who learned chemistry using the Alkhimia curriculum with 38 students who learned chemistry through traditional classroom instruction. The findings of the study based on a pre-post survey of student perceptions and a summative chemistry separation task, showed that the

Alkhimia learning program effectively fosters a dynamic shift in the classroom culture. Students appeared to be more self-aware and self-regulatory in their thinking. They express a deeper curiosity about science and are also more cautious and perceptive about textbook knowledge. As part of the desired cultural shift in the classroom, students express their understanding of the importance to speak, to be heard, and to be open to multiple points of view. Hence, it is apparent that games possess the ability to promote a positive classroom environment when compared to traditional forms of instruction.

Limitations for game-based instruction

However, for effective realization of a methodology such as game-based learning, science teachers are still wary of using games as educational tools. Thus, it is necessary to know the main limitations that are associated with such a revolutionary strategy. Like with all forms of technology, there are factors that must be satisfied in order to even attempt to use GBL in the science classroom. In a study conducted by Efe (2012), it was determined that many future science educators value educational technology and intend to incorporate it in their classrooms, yet they lack the experience and confidence to actually implement such devices in their instruction. These same attitudes are held by some educators regarding the use of games as effective teaching tools and not as a non-sequitur activity. Efe (2012) further indicates that additional instruction and practice with the implementation of these devices will provide teachers the assistance they require. Educators must understand what conditions game-based learning can be used effectively to avoid misconceptions with the content and reductions in engagement.

Additionally, there are still several factors that have the potential to affect the ability of students to learn from such activities as games. Fu-Hsing (et al 2012) studied the characteristics of *Super Delivery* to determine what features were most influential on students' ability to learn. A group of 8 sixth grade students, 4 boys and 4 girls were selected at random from a public primary school in Kaohsiung City, Taiwan. After familiarizing students with the game, all participants were trained individually to think aloud for two sessions (40 minutes each) while playing the game evenly spread out over 6 weeks. By thinking aloud, students were able to express their cognitive processes and emotional situations when interacting with the game, while researchers took notes to observe their verbal and nonverbal behavior. The participants' think-aloud verbal statements were recorded and the game screen was also recorded as audio and video files using screen capture software. Though no pre-test was given since knowledge of electricity was new for all participants, a paper-based performance test composed of 5 multiple-choice items and 5 constructed-response items that was based on the learning goals of the game, was distributed to the participants at the end of the six weeks. Finally, each student was interviewed individually with questions being tailored to their learning perceptions and knowledge of electricity. The findings from the experiment determined that students' learning motivation, learning ability, and playing skill were all potential key factors that collectively influence the effectiveness of knowledge acquisition from the game (Fu-Hsing et al, 2012). Evidence from the study suggests that students with high learning motivation and high learning ability were the most successful in their ability to learn from the game. The findings from this study may assist teachers in

considering ways to effectively utilize an educational game for enhancing students' learning effectiveness, such as providing adequate training time for students to become familiar with how to navigate through the game or relating the game to aspects that are important to students' lives. However, there are several weaknesses of this study that must be remedied with further testing to achieve a deeper understanding of the effective nature of the game *Super Delivery*. For example, it is acknowledged by Fu-Hsing (et al, 2012) that no pre-test was used to evaluate student prior knowledge to the material that would be learned using the game. Although this was done purposefully, it creates an inconvenience in the ability of researchers to accurately determine students' prior knowledge of the content before using the digital game. Therefore, results may be inaccurate in portraying the role of prior knowledge on game-based learning. Further still, the population used for this particular experiment was very small (only eight students). In order to support the claims that were discussed by Fu-Hsing (et al, 2012), additional testing may be required with a larger and more diverse population. Using such participants would enable researchers a much broader way of observing the characteristics of games that benefit learners.

Furthermore, there is a noticeable lack of research surrounding the overall effective potential of games. This may be due to the inability of researchers to produce convincing evidence of increased achievement, which has resulted in the restriction of research funding and reduction of the utilization of educational games and simulations as classroom resources (Hickey, Ingram-Goble, & Jameson, 2009). Hence, in order to encourage the effective nature of GBL it is imperative that additional studies be

conducted to further support the implementation of such a revolutionary instructional technique.

Considerations for implementation: Inclusion of Problem Based Learning

The purpose of education is to prepare students with the knowledge and skills necessary to function effectively in society. Active learning strategies that engage students in physical and mental activities such as inquiry are methods that allow students to develop these skills and become a fully functioning individual outside of school (Pease & Kuhn, 2011). Problem based learning (PBL) is another attractive learning approach since it enables positioning students in a simulated real professional world, with tasks often not well defined and requiring original and creative thinking. As identified by Gee and Hayes (2012), PBL is a key element in games, whereby students can step into specific roles as they navigate through the game scenarios. Students are challenged to solve problems, think critically, make choices and face consequences. In a study developed by Sahin (2010), a group of 142 students, 25 female and 117 male, who were enrolled in the Electrical and Electronics Engineering (EEE) and the Computer Engineering (CE) departments at a state university in Turkey were observed to determine the effect of a problem-based learning approach on students' conceptual understanding of energy and momentum as well as their learning attitudes. Each class utilized different teaching approaches with students in the EEE department using a PBL approach and students in the CE department using a traditional lecture-style approach to learning. Two separate testing instruments were used for comparison: a 25 item multiple-choice test of

energy and momentum concepts (MEMC) and the Colorado learning attitudes about science survey (CLASS) which consisted of 42 (agree or disagree) Likert-like statements. At the end of both the MEMC and CLASS, a correlational analysis was conducted to determine if conceptual understandings of physics are connected to epistemological beliefs of the subject. Based on pre-test measurements, neither the PBL nor lecture-based groups differed significantly in their epistemological beliefs and conceptual understanding of physics. However, a comparison of post-test scores revealed that groups did have noticeable differences in both categories at the end of instruction. Specifically, the MEMC scores increased by more than 20 points with the PBL group, while an increase of only 10.61 points was determined for the traditional group (Sahin, 2010). The post-test scores from the CLASS also showed slight increases in belief scores among each group with the PBL students demonstrating a larger improvement than traditional students. In terms of gender, the results indicated that males possessed significantly higher expert-like beliefs about physics than female students, however given the lack of female participants further research should be recommended to determine the validity of such claims. Still, Sahin indicates from his research that instruction that geared towards improving learning beliefs of students allows for greater gains in conceptual understandings. PBL instruction allows for a greater capacity for instructors to tie in content back to students' personal lives. Using this component in games could therefore be very beneficial in improving students' epistemological beliefs.

Furthermore, it was also determined that the problem based learning also inspires positive attitudes towards science education. To measure changes in student attitudes

toward science and perceptions of their learning environment, Ferreira and Trudel (2012) administered a pre- and post-5-point Likert-type survey/questionnaire containing 22 statements to a group consisting of 48 male high school chemistry students from a Jesuit Catholic school located in a Detroit, Michigan. Participants in the study were required to share their experiences in provided journals while being taught using a PBL format. The findings from the study indicated that the PBL model greatly impacted students' abilities to solve problems and work together with peers in addition to generating positive attitudes and perceptions of science. As students achieved the realization that science is a part of their daily lives, their appreciation and interest in science was increased (Ferreira and Trudel, 2012). Granted the population was strictly male, the positive outcomes resulting from the introduction of a problem based learning approach can still be acknowledged. Given this success, it can be suggested that using a PBL component should be desired in educational games in order to instill relevancy of the content back to student's lives. Furthermore, while the findings from this study indicated positive gains in students' appreciation for science, problem solving abilities, and ability to work in a social format, the results also appear to indicate that there might have been some difficulties with knowledge transfer. Particularly with the problem-solving skills such as listing known facts and brainstorming possible solutions after research, student gains were especially low. Ferreira and Trudel (2012) suggest that this discrepancy may exist due to the participating chemistry teacher's inability to guide the students through some areas of PBL. Thus, the importance of preparing for any possible misconceptions or difficulties that could arise from using such a format should not be underestimated.

In addition, educational games have the potential to create active and engaging environments for learning, supporting problem-solving, communication and group activities. Above all, games provide safe and cost-effective spaces, in which learners can play, explore, experiment, and have fun (Gee and Hayes, 2012). However, finding appropriate games for specific educational contexts is often problematic and mastery of such digital programs or software requires time and practice to avoid hindering student learning. Hence, the importance of testing the game out and determining its effectiveness before devising ways of implementing it into the classroom should not be disregarded. For example, In a study conducted by Hickey (et al, 2009), a standards-oriented achievement test consisting of randomly sampled externally developed items and performance assessment to evaluate gains in individual understanding were both administered to 54 students enrolled in two sixth grade classrooms of a Midwestern school in the United States of America. Using the data collected by these instruments, researchers were able to compare and contrast gains in learning between traditional lecture-based instruction and a game-based learning design featuring the *Quest Atlantis* game. The results found by Hickey (et al, 2012) demonstrated that students obtained larger gains in understanding and achievement while using the game as opposed to traditional lecture-based classes, which used an expository text to learn the same concepts and skills. However, these positive outcomes in learning were only accomplished after revisions were made to the formative feedback process of the *Quest Atlantis* game. First, the development of a new 3-point scoring rubric for teachers to use when evaluating their students' submissions and then secondly, the addition of a new feedback routine which

advised students, after having their initial quest submissions rejected, to seek out an in-game computer-controlled character known as the “Lab Technician” (Hickey et al, 2012) for help in revising their submission. After these improvements were made, the findings from the study indicated a significant increase in student knowledge and understanding of the problem. Hence, the importance of testing and continuously searching for ways to improve the function of a game can be acknowledged. This comes as no small surprise however, since educators should be adopting this practice with all methods of instruction.

Although commercial entertainment games are primarily designed for enjoyment, and may not map closely to desired learning outcomes, and the majority of educators do not have the time or the experience to see how the game could be modified (Fu-Hsing et al, 2012). In order for game-based learning to be effective, teachers must inform students of the true goals of these exercises: to learn and apply what they learn to real-world scenarios. The purpose of this project will be to identify ways pre-existing games can be used with instruction as well as creating new games to assist in the formation of an active learning environment with all chief topics of the NYS Physics Curriculum.

Analysis of what is to follow: The following is a compilation of six personally designed lessons that utilize educational games and simulations pertaining to the New York State Physics curriculum. Each lesson will be listed below and formatted to include the following:

- **An overview of what takes place in the lesson and a description of the simulation or game being used**
- **The desired goals and outcomes to accomplish with the lesson**
- **The unit that this lesson will be applied to**
- **NYS standards that apply to the lesson**
- **A strong summary of expected tasks that teachers and students will strive to complete in order.**
- **Rationale for using the specific game or simulation**
- **The benefits of choosing a game or simulation activity over a traditional demonstration as seen in research provided in the attached literature review**
- **Possible misconceptions that may arise from using this educational game or simulation and precautions to recognize before having students use the game (i.e. need for a computer or internet connection).**
- **Further recommendations/notes for each lesson (i.e. whether students can work in groups, access and availability of computers/programs for each student, etc.)**
- **Materials associated with the game (i.e. corresponding activity sheets). Note: the lessons will not include copies of notes as the focus of this project is on the implementation of games and simulations into the classroom.**

Lesson 1

| | |
|---|--|
| Title: | Acceleration and Velocity (Analyzing Graphs) |
| Type (Simulation or Game): | Game |
| Materials Needed: | <ul style="list-style-type: none"> • Computers with internet access (enough for each individual student). • http://www.theuniverseandmore2.blogspot.com/ • Warm-up activity worksheet. • Graphing Challenge worksheet. |
| Additional Resources: (e.g. Web, books, etc.) | <ul style="list-style-type: none"> -Smartboard -Regents Physics Reference Tables -Calculators (or show students how to use computer calculator program) -Videos of Energy Conservation examples (dependent on time available) |
| Unit: | Motion |
| Overview: | To create a fun, SAFE, and engaging way for students to view graphing representations of the concepts of velocity and acceleration. The digital game Graphing Challenge contains several levels through which students can test their mathematical skills necessary for calculating slope as well as their ability to read and analyze information from mathematical graphs. |
| NYS Standard: (21 st Century NYS Standards and NGSS) | <p>Standard 1- Analysis, Inquiry, and Design, Key Idea 1: Abstraction and symbolic representation are used to communicate mathematically, using algebraic and geometric representations to describe and compare data.</p> <p>Standard 1- Analysis, Inquiry, and Design, Key Idea 3: Critical thinking skills are used in the solution of mathematical problems.</p> |
| Concepts: Velocity Acceleration | <p>Standard 4- The Physical Setting, Performance Indicator 5.1: Students can explain and predict different patterns of motion of objects.</p> <p>-Process Skill 5.1i: Students can construct and interpret graphs of position, velocity, or acceleration versus time.</p> <p>-Process Skill 5.1ii: Students can determine and interpret slopes</p> |

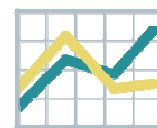
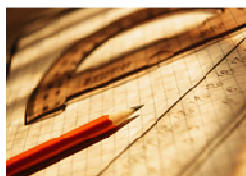
| | |
|--|---|
| <p>Equations:</p> $a = (v_{\text{final}} - v_{\text{initial}})/t$ $v = d/t$ | <p>and areas of motion graphs</p> <p>-5.1d: An object in linear motion may travel with a constant velocity* or with acceleration.</p> <p>Standard 6- Interconnectedness, Key Idea 5.1: Mathematical models such as graphs and equations can be used to predict the behavior of physical systems.</p> |
| <p>Objectives: (Specify skills/information that will be learned.)</p> | <p>-Students will be able to identify and use the appropriate equations located on their Physics Reference Table to solve for unknown variables.</p> <p>-Students will be able to read and analyze information from graphs.</p> <p>-Students will be able to predict and sketch the velocity and acceleration of objects.</p> |
| <p>Information: (Give and/or demonstrate necessary information.)</p> | <p>-Students will hand in homework that was assigned class (if any) to the appropriate bin.</p> <p>-Students will take out notes on velocity and acceleration that were completed last class. (Note: If notes were not completed, this plan may be altered to ensure that notes are completed prior to beginning today's activity).</p> <p>-Students will pick up warm-up activity sheet and login to computers as they enter class. The teacher will have written these instructions on the smartboard, chalkboard or whiteboard already.</p> <p>-Teacher will have objectives for today's activities written on the smartboard, chalkboard, or whiteboard.</p> |
| <p>Activity: (Describe the independent activity/activities to reinforce this lesson.)</p> | <p>-Students will be assessed on their ability to analyze information from graphs, their understanding of the slope formula, and their understanding of velocity using a warm-up activity that will encompass the first 10-12 minutes of class.</p> <p>-Teacher will go over activity with students. (8 minutes).</p> <p>-Teacher will also hand out Graphing Challenge worksheet and explain the purpose of today's activity. (5-8 minutes).</p> <p>-Students will work independently and will follow the directions on the activity sheet. They will demonstrate their knowledge and understanding of projectile motion by completing each level on</p> |

| | |
|---|--|
| | <p>the game while showing their work and answers on the corresponding work sheet. (18-22 minutes).</p> <p>Teacher will monitor student progress and assist students with questions. If there is a general confusion about a specific question, the teacher may grab the attention of the class to discuss the question. However it is important that students work on this individually.</p> |
| Summary (Last few minutes of class): | <p>-Students will log out and hand in worksheets. (3min).</p> <p>-Ticket out the door: Teacher will ask for worksheets to be handed in at the end of class so that student work can be assessed.</p> <p>HW: None</p> |
| Rationale: | <p>Graphing and analyzing graphs of the physical concepts: velocity and acceleration can be an arduous task. This game was chosen specifically for its ability to show students a physical object moving and a corresponding graph of its motion.</p> <p>The game is ideal for helping students discern information from graphs and vice versa. It also provides a fun and interactive way for students to test their understanding and skills that is simply not possible in a traditional (lecture-based) setting.</p> |
| Possible Misconceptions: | N/A |
| Recommendations: | <p>-Make sure that there is an adequate number of computers in the classroom or use specialized computer room if provided by school.</p> <p>-Make sure to emphasize that students do not open additional windows or tabs with their browser as it distracts them and their fellow classmates from their current tasks. Remind them that if they are caught on additional tabs they will lose computer privileges for the rest of class and will have to make up the activity after school with the teacher.</p> <p>Remind students that they must show all work and answers (with correct units) on the corresponding worksheet.</p> <p>-Make sure you have access to website and use a dependable internet browser (Mozilla Firefox does not work well).</p> |

Name: _____

Date: _____

WARM UP ACTIVITY: GRAPHING CHALLENGE LEVEL 1, 2 + 3



Objective: Last class we began working with velocity and acceleration symbols and formulas to represent these science concepts. Today we shall be introduced to another representation of velocity and acceleration using graphs.

Directions: Grab a computer and login. Open up the internet browser and type in the following URL address: <http://www.theuniverseandmore2.blogspot.com/>

Do not open any other tabs. Click “Play” to begin graphing challenge game. Begin with world 1 level 1 (the box marked “1” in the upper left hand corner of the screen) and complete level 1, 2, + 3 on the top row.

Answer all questions on this worksheet located below and SHOW ALL CALCULATIONS AND WORK in the space provided. YOU HAVE 10-15 MINUTES!

World 1:

Lvl 1: Follow the directions and complete the task the game asks of you.

a.) Identify and record the x and y-axis of this graph below:

x-axis:

y-axis:

b.) Record your initial position and initial velocity for this level:

c.) Can you identify what the slope or the rate of change of this graph? Explain your reasoning.

d.) What would happen to the shape of our graph if we increase the initial velocity? What about decreasing the initial velocity?

e.) Calculate the total distance traveled by object below.

Lvl 2: Click the green arrow icon after completing level 1 to access level 2. Follow the directions and complete the task the game asks of you. Practice using the mouse to select specific points on the graph.

a.) Record the initial position for this graph.

b.) Using the slope formula (rise/run), calculate the velocity for this graph.

c.) What other ways can we represent the concept of velocity?

Lvl 3: Click the green arrow icon to access level 3. Follow the directions and complete the task the game asks of you.

a.) Determine the values for initial position and initial velocity needed to grab all the ice cream. SHOW ALL WORK and record your answers in the space provided below:

Name: _____ Date: _____

WARM UP ACTIVITY (KEY): **GRAPHING CHALLENGE LEVEL 1, 2 + 3**

Objective: Last class we began working with velocity and acceleration symbols and formulas to represent these science concepts. Today we shall be introduced to another representation of velocity and acceleration using graphs.

Directions: Grab a computer and login. Open up the internet browser and type in the following URL address: <http://www.theuniverseandmore2.blogspot.com/>

Do not open any other tabs. Click “Play” to begin graphing challenge game. Begin with world 1 level 1 (the box marked “1” in the upper left hand corner of the screen) and complete level 1, 2, + 3 on the top row.

Answer all questions on this worksheet located below and SHOW ALL CALCULATIONS AND WORK in the space provided. YOU HAVE 10-15 MINUTES!

World 1:

Lvl 1: Follow the directions and complete the task the game asks of you.

a.) Identify and record the x and y-axis of this graph below:

x-axis: *Clock Reading or time*

y-axis: *Position*

b.) Record your initial position and initial velocity for this level: *3m and 0m/s*

c.) Can you identify what the slope or the rate of change of this graph? Explain your reasoning.

The slope is velocity since we having changing positions which is our distance traveled over changing times which is our time elapsed. Hence $v = d/t = m = \text{change in } y / \text{change in } x$.

d.) What would happen to the shape of our graph if we increase the initial velocity? What about decreasing the initial velocity?

Increase would make graph slope steeper and upwards. Decrease would make slope steeper and downwards.

d.) Calculate the total distance traveled by object below.

0m. Object does not move.

Lvl 2: Click the green arrow icon after completing level 1 to access level 2. Follow the directions and complete the task the game asks of you. Practice using the mouse to select specific points on the graph.

a.) Record the initial position for this graph. $0m$

b.) Using the slope formula (rise/run), calculate the velocity for this graph.

Take two points:

At 1 second we have gone down to $-1m$

At 2 seconds we have gone down to $-2m$

Slope = $m = -2m - -1m / 2s - 1s = -1m/s = \text{velocity}$

c.) What other ways can we represent the concept of velocity?

$V = d/t$, $v = \text{velocity}$

Lvl 3: Click the green arrow icon to access level 3. Follow the directions and complete the task the game asks of you.

a.) Determine the values for initial position and initial velocity needed to grab all the ice cream. SHOW ALL WORK and record your answers in the space provided below:

Initial position: $0m$

Initial velocity: Take points for each ice cream and find slope:

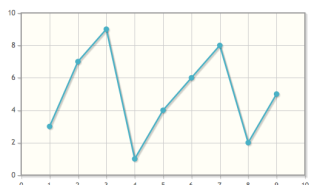
White: $2m$ at 1 sec

Brown: $6m$ at 3 sec

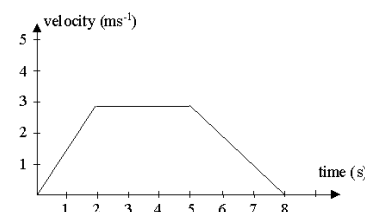
Pink: $10m$ at 5 sec

Slope = $6m - 2m / 3s - 1s = 4m / 2s = 2m/s = \text{initial velocity}$

Name: _____ Date: _____



GRAPHING CHALLENGE ACTIVITY:
**Learning how to interpret and
 construct velocity and acceleration
 graphs**



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Do not open any other tabs, if you do you will immediately be asked to log off and will have to complete the activity after school.

Click “Play” to begin graphing challenge game. Begin with world 1 level 4 (where you left off from the warm-up) and complete the following levels: **World 1: 8, 9, 10, 15, 16; World 2: 1, 2, 8, 9, 15, 16; World 3: 1, 2, 3, 4, 5, 7, 8**

Answer all questions on this worksheet located below and SHOW ALL CALCULATIONS AND WORK in the space provided. YOU HAVE 10-15 MINUTES!

World 1: Follow the directions and complete the task the game asks of you.

Lvl 8:

a.) Identify and record the x and y-axis of this graph below:

x-axis:

y-axis:

b.) Record your initial position and initial velocity for this level:

c.) According to this graph at what time will the orange accelerate? Explain your answer.

d.) Calculate and record the slope at this time using the correct units?

e.) Calculate the total distance traveled by object in the space below.

Lvl 9:

a.) Record your initial position this level:

b.) Calculate the initial velocity of the orange using the slope of this graph

c.) According to this graph at what time will the orange change speed? Does the orange decelerate or accelerate? Explain your reasoning. (*Hint: watch the orange above the graph for this problem*)

d.) Calculate and record the slope after this time using the correct units?

e.) Calculate the total distance traveled by object in the space below.

Lvl 10:

- a.) Record your initial position this level:
- b.) Determine the initial velocity of the alien needed to rescue the falling ice cream, include direction.
- c.) According to this graph at what time will the alien change speed? Does the alien decelerate or accelerate? Explain your reasoning.
- d.) Calculate and record the speed of the alien necessary to save the remaining ice cream scoops at this time using the correct units.
- e.) Calculate the total distance traveled by alien in the space below.

Lvl 15:

- a.) Calculate and record your initial position and initial velocity for this level:
- b.) According to this graph at what time(s) will the orange change speed? Does the orange decelerate or accelerate? Explain your reasoning.
- c.) Calculate and record the speed of the orange at these times using the correct units.
- d.) Calculate the total distance traveled by orange in the space below.
- e.) Can you predict what may have caused the orange to behave the way it does at 4 seconds? What causes the slope to go flat? (*What stops something from rolling?*)

Lvl 16:

- a.) Calculate and record your initial position and initial velocity for this level:
- b.) According to this graph at what time(s) will the ball change speed? Does the ball decelerate or accelerate? Explain your reasoning.
- c.) Calculate and record the speed of the ball at these times using the correct units.
- d.) Calculate the total distance traveled by ball in the space below.
- e.) Can you predict what may have caused the orange to behave the way it does at 1 second? What causes the slope to become steep? (*What makes something accelerate?*)

World 2: Follow the directions and complete the task the game asks of you.**Lvl 1:**

- a.) Identify and record the x and y-axis of this graph below (Include units!):

x-axis:

y-axis:

- b.) Record your initial position this level:
- c.) Does the graph show an acceleration or deceleration? Explain your reasoning.
- d.) Determine and record the initial acceleration of the graph, include direction.
- f.) How far has the orange traveled from 0 to 4s?

Lvl 2:

- Record your initial position this level:
- Does the graph show an acceleration or deceleration? Explain your reasoning.
- Determine the initial acceleration of the graph, include direction.
- How far has the ball traveled from 0 to 6s?

Lvl 8:

- Record your initial position this level:
- Does the graph show an acceleration or deceleration? Explain your reasoning.
- Determine the initial acceleration of the ball, include direction.
- Does the ball ever accelerate or decelerate at another point? Explain your reasoning.
- How far has the ball traveled from 0 to 6s?

**Lvl 9:**

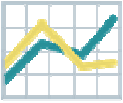
- Record your initial position this level:
- Does the graph show an acceleration or deceleration? Explain your reasoning.
- Determine the initial acceleration and velocity of the graph, include direction.
- Does the graph ever accelerate or decelerate at another point? Explain your reasoning.
- How far has the ball traveled from 0 to 6s?
- **f.) From levels 8 and 9, what is the purpose of the negative sign that is attached to some of these numbers? We already know we can't travel a negative distance so why do we include the negative sign?

Lvl 15:

- Record your initial position this level:
- What is happening to the orange? Explain your reasoning.
- Determine the initial acceleration of the orange, include direction.
- Does the ball ever accelerate or decelerate at another point? Explain your reasoning.
- How far has the ball traveled from 0 to 6s?
- What might cause the orange to behave in such a way? Explain your reasoning.

Lvl 16:

- Record your initial position this level:
- What is happening to the ball?
- Determine the initial velocity and acceleration of the ball, include direction. Explain your reasoning for your answer.
- Find the solution to track the ball's graph movement. Does the ball ever accelerate or decelerate at another point? Explain your reasoning.
- What happens at 3 seconds to the ball?
- How far has the ball traveled from 0 to 6s?

World 3: Follow the directions and complete the task the game asks of you.**Lvl 1:**

a.) Identify and record the x and y-axis of this graph below:

x-axis:

y-axis:

b.) Can you identify what the slope or the rate of change of this graph? Explain your reasoning.

c.) Calculate and record your initial position and initial velocity for this level, *show all work*:

d.) Determine the acceleration for this graph. *Show all work*.

e.) What is the total distance traveled by the orange?

Lvl 2:

a.) Calculate and record your initial position and initial velocity for this level, *show all work*:

b.) Determine the acceleration for this graph. *Show all work*.

c.) What is the total distance traveled by the ball?

d.) Assuming the same acceleration rate, find how fast this ball will be going after 1 minute?

Lvl 3:

a.) Calculate and record your initial position and initial velocity for this level, *show all work*:

b.) Is the orange accelerating or decelerating? Explain your reasoning.

c.) Determine the value for the acceleration for this graph. *Show all work*.

d.) What is the total distance traveled by the ball?

e.) Assuming the same acceleration rate, what would happen if we went past 4 seconds?

Lvl 4:

a.) Calculate and record your initial position and initial velocity for this level, *show all work*:

b.) Is the melon accelerating or decelerating? Explain your reasoning.

c.) Determine the value for the acceleration for this graph. *Show all work*.

d.) What is the total distance traveled by the ball?

e.) Look at both levels 3 and 4, how do they compare?

**f.) After 10 seconds, which fruit (watermelon or orange) from levels 4 and 3 do you think will have the fastest velocity? Explain your reasoning below. (*Hint: ignore direction*)

Lvl 5:

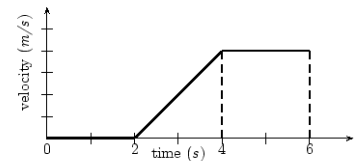
- a.) Calculate and record your initial position and initial velocity for this level, *show all work*:
- b.) Calculate and record your final position and final velocity for this level, *show all work*:
- c.) Determine the value for the acceleration for this graph. *Show all work*.
- d.) At what time does the bowling ball change direction? What happens to the ball after that time?
- e.) What is the total distance traveled by the ball?

Lvl 7:

- a.) Calculate and record your initial position and initial velocity for this level, *show all work*:
- b.) Determine the value for the initial acceleration for this graph. *Show all work*.
- c.) Does the orange change acceleration again at a certain point? If so, does it decelerate or accelerate? Record the new acceleration value and when it occurs below:
- d.) What is the total distance traveled by the ball?

Lvl 8:

- a.) Calculate and record your initial position and initial velocity for this level, *show all work*:
- b.) Determine the value for the initial acceleration for this graph. *Show all work*.
- c.) Does the orange change acceleration again at a certain point? If so, does it decelerate or accelerate? Record the new acceleration value and when it occurs below:
- d.) What is the total distance traveled by the ball? *Show all work*.



Name: _____ **KEY** _____ Date: _____

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World 1: Follow the directions and complete the task the game asks of you.

Lvl 8:

a.) Identify and record the x and y-axis of this graph below:

x-axis: *time in seconds*

y-axis: *position in meters*

b.) Record your initial position and initial velocity for this level:

2m and 0m/s

c.) According to this graph at what time will the orange accelerate? Explain your answer.
At 2 seconds, since the graph's slope gets steeper which means a change in speed.

d.) Calculate and record the slope at this time using the correct units?

Change in y/change in x = 3m-2m/3s-2s = 1m/s

e.) Calculate the total distance traveled by object in the space below.

Use the velocity formula, $v = d/t$

From 0 to 2s, $v = 0$ so the orange has not gone any distance.

From 2s to 5s, $v = 1m/s$ so for 3seconds the orange is moving 1m/s.

$v = d/t$ rewritten is $v \cdot t = d$

Total distance: $1\text{m/s} \cdot 3\text{s} = 3\text{m} = d$ (Watch the orange's movement! It only moves from 2m to 5m!)

Lvl 9:

- a.) Record your initial position this level: 0m
- b.) Calculate the initial velocity of the orange using the slope of this graph
 3m/s
- c.) According to this graph at what time will the orange change speed? Does the orange decelerate or accelerate? Explain your reasoning. (Hint: watch the orange above the graph for this problem)

At 3 seconds, the orange changes speed and turns around. It does not decelerate or accelerate since the magnitude of the oranges speed stays the same, but the direction changes.

- d.) Calculate and record the slope after this time using the correct units?
 -3m/s

- e.) Calculate the total distance traveled by object in the space below.

From 0s to 3s, $v = 3\text{m/s}$

$d = v \cdot t = 3\text{m/s} (3\text{s}) = 9\text{m}$ travelled

From 3s to 6s, the ball goes the opposite direction back to 0 ($d = 9\text{m}$ travelled)

Hence, the total distance is $9\text{m} + 9\text{m} = 18\text{m}$

Lvl 10:

- a.) Record your initial position this level: 0m
- b.) Determine the initial velocity of the alien needed to rescue the falling ice cream, include direction. -1m/s
- c.) According to this graph at what time will the alien change speed? Does the alien decelerate or accelerate? Explain your reasoning.
At 5 seconds, the alien changes speed and turns around. It accelerates since the magnitude of its speed increases along with the direction changing.
- d.) Calculate and record the speed of the alien necessary to save the remaining ice cream scoops at this time using the correct units.
 3m/s
- e.) Calculate the total distance traveled by alien in the space below.
From 0 to 5s, $v = -1\text{m/s}$
 $d = v \cdot t = -1\text{m/s}(5) = 5\text{m}$ (why do we get rid of negative sign? Because we just want magnitude not direction!)

From 5s to 8s, $v = 3m/s$

*$d = 3m/s * 3s = 9m$*

Hence total distance = $9m + 9m = 18m$ traveled

Lvl 15:

a.) Calculate and record your initial position and initial velocity for this level: *-4m and 0m/s*

b.) According to this graph at what time(s) will the orange change speed? Does the orange decelerate or accelerate? Explain your reasoning.

At 2 seconds, the orange speeds up because graph gets steeper in upward direction.

At 4 seconds, the speed decreases to 0m/s because it does not change position beyond that point.

c.) Calculate and record the speed of the orange at these times using the correct units.

At 2s, $v = 4m/s$

At 4s, $v = 0m/s$

d.) Calculate the total distance traveled by orange in the space below.

From 0 to 2s, $d = 0$

*From 2 to 4s, $d = 4m/s * 2s = 8m$*

From 4s to 6s, $d = 0$ since it is not moving

Total distance is 8m

e.) Can you predict what may have caused the orange to behave the way it does at 4 seconds? What causes the slope to go flat? (*What stops something from rolling?*)

Wall or another obstacle will be acceptable.

Lvl 16:

a.) Calculate and record your initial position and initial velocity for this level:

8m and -2m/s

b.) According to this graph at what time(s) will the ball change speed? Does the ball decelerate or accelerate? Explain your reasoning.

At 1s, the ball accelerates in the negative direction because the slope gets steeper.

At 3s, the ball decelerates because the slope of the graph gets significantly less steeper.

c.) Calculate and record the speed of the ball at these times using the correct units.

At 1s, $v = -5m/s$

At 3s, $v = -2m/s$

d.) Calculate the total distance traveled by ball in the space below.

From 0 to 1s, $d = 2m$

*From 1s to 3s, $d = -5m/s * 2s = 10m$*

*From 3s to 4s, $d = -2m/s * 1s = 2m$*

Total distance is 12m

- e.) Can you predict what may have caused the orange to behave the way it does at 1 second? What causes the slope to become steep? (*What makes something accelerate?*)
The ball goes downhill on a ramp of some kind

World 2: Follow the directions and complete the task the game asks of you.

Lvl 1:

- a.) Identify and record the x and y-axis of this graph below (Include units!):
x-axis: *time (s)*
y-axis: *position (m)*
- b.) Record your initial position this level: *0m*
- c.) Does the graph show an acceleration or deceleration? Explain your reasoning.
Acceleration, the slope is steepening.
- d.) Determine and record the initial acceleration of the graph, include direction. *1 m/s²*
- e.) How far has the orange traveled from 0 to 4s? *8m*

Lvl 2:

- a.) Record your initial position this level: *10m*
- b.) Does the graph show an acceleration or deceleration? Explain your reasoning.
Acceleration but in the opposite direction, the slope is steepening.
- c.) Determine the initial acceleration of the graph, include direction. *-1 m/s²*
- d.) How far has the ball traveled from 0 to 6s? *18m*

Lvl 8:

- a.) Record your initial position this level: *10m*
- b.) Does the graph show an acceleration or deceleration? Explain your reasoning.
Acceleration initially, but then the speed stays the same. Slope starts steep and stay consistent after 2 seconds.
- c.) Determine the initial acceleration of the ball, include direction. *1 m/s²*
- d.) Does the ball ever accelerate or decelerate at another point? Explain your reasoning.
It decelerates to 0m/s² at 2 seconds.
- e.) How far has the ball traveled from 0 to 6s? *18m*

Lvl 9:

- a.) Record your initial position this level: *10m*
- b.) Does the graph show an acceleration or deceleration? Explain your reasoning.

Initially there is no acceleration, but the speed changes at 4s because the graph begins to get flatter. The ball is slowing down at this point indicating a deceleration.

c.) Determine the initial acceleration and velocity of the graph, include direction.

0 m/s² and -2m/s

d.) Does the graph ever accelerate or decelerate at another point? Explain your reasoning.

It decelerates by 1m/s² at 4 seconds. Since graph is getting flatter and ball is slowing down.

e.) How far has the ball traveled from 0 to 6s? *10m*

**f.) From levels 8 and 9, what is the purpose of the negative sign that is attached to some of these numbers? We already know we can't travel a negative distance so why do we include the negative sign?

The negative sign is used for direction. It tells which way we are traveling.

Lvl 15:

a.) Record your initial position this level: *-4m*

b.) What is happening to the orange? Explain your reasoning.

Acceleration initially, then deceleration. Slope loops up and curves down like a hill.

c.) Determine the initial acceleration of the orange, include direction. *1 m/s²*

d.) Does the ball ever accelerate or decelerate at another point? Explain your reasoning.

It decelerates to 0m/s² at 2 seconds.

And decelerates again at 4 seconds to -1m/s²

e.) How far has the ball traveled from 0 to 6s? *8m*

f.) What might cause the orange to behave in such a way? Explain your reasoning.

Friction from going on a different surface or going uphill is acceptable. Multiple answers will apply depending on reasoning.

Lvl 16:

a.) Record your initial position this level: *5m*

b.) What is happening to the ball?

The ball is moving at constant speed because the slope of the graph is a straight line going downward. Then the ball slows down and changes directions and continues going at a constant speed the other way because the line becomes straight but going up.

c.) Determine the initial velocity and acceleration of the ball, include direction. Explain your reasoning for your answer.

-2m/s and 0 m/s² because the ball is traveling at constant speed due to the straight line point down.

d.) Find the solution to track the ball's graph movement. Does the ball ever accelerate or decelerate at another point? Explain your reasoning. *It decelerates at 2 seconds to 2m/s² because the graph begins to curve and change direction. Then it decelerates at 4 seconds to 0m/s² because the slope becomes a straight line again.*

e.) What happens at 3 seconds to the ball? *The ball changes direction and begins traveling in the opposite direction.*

f.) How far has the ball traveled from 0 to 6s? *10m*

World 3: Follow the directions and complete the task the game asks of you.

Lvl 1:

a.) Identify and record the x and y-axis of this graph below:

x-axis: *time (seconds)*

y-axis: *velocity (m/s)*

b.) Can you identify what the slope or the rate of change of this graph? Explain your reasoning.

Slope is acceleration because it is similar to the acceleration formula: $a = \text{change in velocity} / \text{time}$.

c.) Calculate and record your initial position and initial velocity for this level, *show all work: -10m and 4m/s*

d.) Determine the acceleration for this graph. *Show all work. 0m/s²*

e.) What is the total distance traveled by the orange? *20m*

Lvl 2:

a.) Calculate and record your initial position and initial velocity for this level, *show all work: -10m and 0m/s*

b.) Determine the acceleration for this graph. *Show all work. 1m/s²*

c.) What is the total distance traveled by the ball? *12.5m*

d.) Assuming the same acceleration rate, find how fast this ball will be going after 1 minute? *60m/s*

Lvl 3:

a.) Calculate and record your initial position and initial velocity for this level, *show all work: -10m and 8m/s*

b.) Is the orange accelerating or decelerating? Explain your reasoning.

Decelerating because the orange is slowing down to a stop.

- c.) Determine the value for the acceleration for this graph. *Show all work. -2m/s^2*
 d.) What is the total distance traveled by the ball? *16m*
 e.) Assuming the same acceleration rate, what would happen if we went past 4 seconds?
The orange would change direction and accelerate in the opposite direction.

Lvl 4:

- a.) Calculate and record your initial position and initial velocity for this level, *show all work: 10m and -5m/s*
 b.) Is the melon accelerating or decelerating? Explain your reasoning.
Decelerating because the melon is slowing down to a stop.
- c.) Determine the value for the acceleration for this graph. *Show all work. 1m/s^2*
 d.) What is the total distance traveled by the ball? *12.5m*
 e.) Look at both levels 3 and 4, how do they compare?
Both levels show an object that is decelerating or slowing down, but each level shows the deceleration in the opposite direction. Level 4 decelerates at 1m/s and level 3 decelerates at -2m/s .
- **f.) After 10 seconds, which fruit (watermelon or orange) from levels 4 and 3 do you think will have the fastest velocity? Explain your reasoning below. (*Hint: ignore direction*)*The orange since it has a greater acceleration rate.*

Lvl 5:

- a.) Calculate and record your initial position and initial velocity for this level, *show all work: -10m and 9m/s*
 b.) Calculate and record your final position and final velocity for this level, *show all work: -10m and -9m/s*
 c.) Determine the value for the acceleration for this graph. *Show all work. -3m/s^2*
 d.) At what time does the bowling ball change direction? What happens to the ball after that time?
3s, the bowling ball accelerates in the opposite direction.
- e.) What is the total distance traveled by the ball? *12.5m*

Lvl 7:

- a.) Calculate and record your initial position and initial velocity for this level, *show all work: -10m and 6m/s*
 b.) Determine the value for the initial acceleration for this graph. *Show all work. 0m/s^2*
 c.) Does the orange change acceleration again at a certain point? If so, does it decelerate or accelerate? Record the new acceleration value and when it occurs below: *at 2 seconds,*

the orange decelerates by 2m/s^2 .

d.) What is the total distance traveled by the ball? *21m*

Lvl 8:

a.) Calculate and record your initial position and initial velocity for this level, *show all work: 10m and 0m/s*

b.) Determine the value for the initial acceleration for this graph. *Show all work. -2m/s^2*

c.) Does the orange change acceleration again at a certain point? If so, does it decelerate or accelerate? Record the new acceleration value and when it occurs below: *at 2 seconds, the orange decelerates to 0m/s^2 .*

d.) What is the total distance traveled by the ball? *Show all work. 12m*

Lesson 2

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|--|--|
| Title: | Using Physics to Combat Enemies |
| Type (Simulation or Game): | Game |
| Software Used: | Interactive Physics |
| Materials Needed: | <ul style="list-style-type: none"> • Computers with Interactive Physics installed. • Defense Against Invaders game levels already installed on all computers. • Warm-up activity worksheet. • Defense Against Invaders worksheet. • Angry Birds Game Demo. |
| Additional Resources: (e.g. Web, books, etc.) | <ul style="list-style-type: none"> -Computers (with internet connection and Windows XP or higher installed) -Smartboard -Regents Physics Reference Tables -Calculators (or show students how to use computer calculator program) |
| Unit/Topic: | Projectile Motion |
| NYS Standard: (21st Century NYS Standards and NGSS) Concepts: Motion of Projectiles Equations: $d = V_i t - \frac{1}{2} a t^2$ $V_f^2 = V_i^2 + 2ad$ $V = d/t$ $g = 9.81 \text{m/s}^2$ | <p>Standard 1- Analysis, Inquiry, and Design, Key Idea 3: Critical thinking skills are used in the solution of mathematical problems.</p> <p>Standard 4- The Physical Setting, Performance Indicator 5.1: Students can explain and predict different patterns of motion of objects.</p> <p>-5.1f The path of a projectile is the result of the simultaneous effect of the horizontal and vertical components of its motion; these components act independently.</p> <p>-5.1g A projectile's time of flight is dependent upon the vertical component of its motion.</p> <p>-5.1h The horizontal displacement of a projectile is dependent upon the horizontal component of its motion and its time of flight.</p> |
| Overview: | Defense Against Invaders is a computer simulation/game |

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|---|---|
| | <p>that requires students to apply their knowledge of projectile motion to specific scenarios. Students take on the role as defenders, and they must determine how to combat invading enemies! Students are able to control only the velocity of their cannonball projectile and sometimes the firing angle. Each scenario will provide students with information necessary to solve in order to combat the enemy, including acceleration due to gravity (a constant 9.81m/s^2), distance from attackers, height above attackers, or time it takes for projectile to land.</p> <p>The game is broken up into several tiers or levels with varying levels difficulty, but all focused on having students use their knowledge of projectile motion to succeed. This game provides students with an OPPORTUNITY to see how physics can be applied.</p> |
| <p>Objectives: (Specify skills/information that will be learned.)</p> | <ul style="list-style-type: none"> -Students will be able to identify and use the appropriate equations located on their Physics Reference Table to solve for unknown variables. -Students will be able to identify and define the different components that affect the motion of projectiles. -Students will be able to predict and sketch the pathway of projectiles. -Students will be able to apply their knowledge of projectile motion in several digital gaming scenario in which they must defend against invading enemies. |
| <p>Information: (Give and/or demonstrate necessary information.)</p> | <ul style="list-style-type: none"> -Students will hand in homework that was assigned class (if any) to the appropriate bin. -Students will take out notes on projectile motion that were completed last class. (Note: If notes were not completed, this plan may be altered to ensure that notes are completed prior to beginning today's activity). -Students will pick up warm-up activity sheet and login to computers as they enter class. The teacher will have written these instructions on the smartboard, chalkboard or whiteboard already. -Teacher will have objectives for today's activities written |

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| | on the smartboard, chalkboard, or whiteboard. |
| Activity: (Describe the independent activity/activities to reinforce this lesson.) | <p>Students will be assessed on their understanding projectile motion from the notes taken from last class using a warm-up activity that will encompass the first 5-10 minutes of class.</p> <p>-Teacher will go over activity with students. (5 minutes.)</p> <p>-Teacher will show demo of Angry Birds Game and will compare it with projectile motion and highlight the objectives for today's class. Teacher will also hand out Defense Against Invaders worksheet and explain the purpose of today's activity. (5-8 minutes).</p> <p>-Students will break into groups of 2 or 3 and will follow the directions on the activity sheet. They will demonstrate their knowledge and understanding of projectile motion by completing each level on the digital format and showing their work and answers on the corresponding work sheet. (15-20 minutes).</p> |
| Summary: | <p>-Students will log out and hand in worksheets. They must make sure to include who else was in their group next to their own name. (3 minutes).</p> <p>-Ticket out the door: Teacher will ask for worksheets to be handed in at the end of class so that student work can be assessed.</p> <p>HW: Projectile motion review problems due next class.</p> |
| Rationale: | <p>Projectile motion is an important component of the NYS Physics curriculum, however, it can be very difficult to develop laboratory activities that enable students to apply their knowledge.</p> <p>This game assists students by:</p> <p>-Providing real-life scenarios for students to apply what they have learned.</p> <p>-Creating a fun, SAFE, engaging, and interactive way to approach a science concept.</p> <p>-Helping students to make connections between what they</p> |

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| | know and how it can be used. |
| Possible Misconceptions: | <p>This game is meant to simulate projectile motion. Unfortunately, software limitations make it difficult to accurately demonstrate the effect of wind/air resistance on projectiles. Thus, students may not be able to accurately predict the motion of projectiles in reality.</p> <p>Another problem with Interactive Physics is its inability to use angle values in degrees. It only uses angles in radians. Hence, it is important that the instructor specifically demonstrate how to convert angles from degrees to radians, in order to successfully play through game levels. This step must be show on corresponding worksheet as well.</p> <p>Students must be made aware that this component is not included in the game and they must be made to acknowledge the significance of wind/air resistance on projectiles.</p> |
| Recommendations: | <ul style="list-style-type: none"> -Could work well for groups of two or individually. The instructor will need to briefly explain the game objectives and how to control projectiles. -Make sure you have an adequate number of computers in the classroom. -Make sure to emphasize that students must not save changes to program and they must show all work and answers (with correct units) on the corresponding worksheet. -Make sure your computers are compatible with Interactive Physics Software. -Make sure you have access to show Angry Birds Demo. |

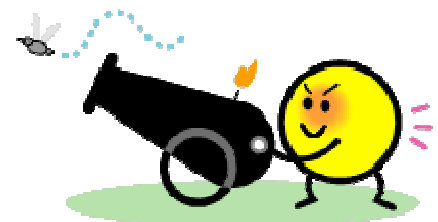
Name: _____ Date: _____



WARM UP ACTIVITY: **DEFENSE AGAINST INVADERS** **LEVEL 1**

Directions: Grab a computer and login. Go to the desktop and click on projectile motion. Click on defense against invaders lvl1. Answer all questions. Make sure to show your work. **YOU HAVE 5-10 MINUTES!**

- 1.) Predict the pathway the boulder will take when it is pushed off the cliff. Sketch your prediction in the space below.
- 2.) Run the simulation. Sketch the actual pathway the boulder takes. Was your prediction correct?
- 3.) Why do you think the boulder traveled this way?
- 4.) Now try adjusting the speed. Describe what happens to the boulder when you increase the speed.
- 5.) Using the distance formula that we learned last class ($d = vit + 1/2at^2$) determine the initial speed necessary to hit the blue barbarian object. **(USE THE BACK OF THIS SHEET TO SHOW YOUR WORK).**



Name: _____ KEY _____ Date: _____

WARM UP ACTIVITY: DEFENSE AGAINST INVADERS LEVEL 1

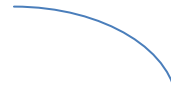
Directions: Grab a computer and login. Go to the desktop and click on projectile motion. Click on defense against invaders lvl1. Answer all questions. Make sure to show your work. YOU HAVE 5-10 MINUTES!

1.) Predict the pathway the boulder will take when it is pushed off the cliff. Sketch your prediction in the space below.

Answer: N/A.

2.) Run the simulation. Sketch the actual pathway the boulder takes. Was your prediction correct?

Answer: Should be an upside down parabola shape.



3.) Why do you think the boulder traveled this way?

Answer: Gravity acting on boulder pulls it down.

4.) Now try adjusting the speed. Describe what happens to the boulder when you increase the speed.

Answer: As speed increases boulder goes further horizontally and the pathway is stretched to the right.

5.) Using the distance formula that we learned last class ($d = vit + 1/2at^2$) determine the initial speed necessary to hit the blue barbarian object. **(USE THE BACK OF THIS SHEET TO SHOW YOUR WORK).**

Answer: $d = vit + 1/2at^2$

Begin with the vertical component (y-direction/UP or Down component):

Height is $3m = d_{y\text{-direction}}$

Initial falling velocity (v_i) = 0, since there is no downward or upward initial velocity on the boulder.

$a = g = 9.81m/s^2$

Plug in what we know and solve for time when boulder hits the ground:

$$3\text{m} = (0)t + \frac{1}{2}(9.81\text{m/s}^2)t^2$$

$$3\text{m} = 4.905\text{m/s}^2(t^2)$$

$$\text{Square root}(3\text{m}/4.905\text{m/s}^2) = t$$

$$t = .782\text{s}$$

Now we can plug this value for time back into our original equation ($d = vit + 1/2at^2$), and we can also input our horizontal (side to side) distance value of 5m in for (d). Now we can solve the equation for the initial velocity we need to make boulder hit the invader:

$$d = vit + \frac{1}{2}at^2$$

$$2.87\text{m} = vi(.782\text{s}) - \frac{1}{2}(9.81\text{m/s}^2)(.612\text{s}^2)$$

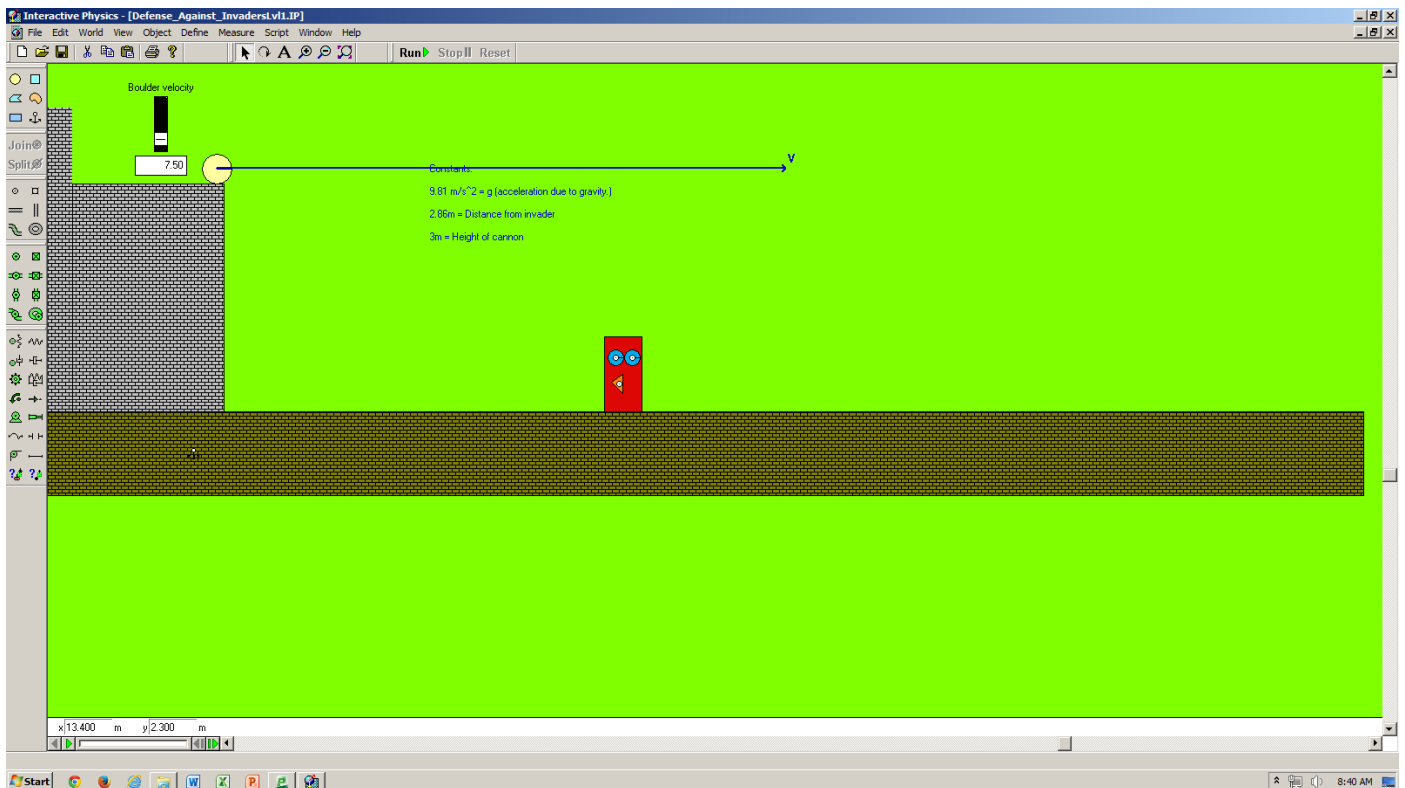
Remember: the 9.81 is the downward acceleration due to gravity and is there for a negative quantity in this equation now.

$$2.87\text{m} = vi(.782\text{s}) - 3.00\text{m}$$

$$+3.00\text{m} \qquad +3.00\text{m}$$

$$5.87\text{m} = vi(.782\text{s})$$

After dividing by .782s on both sides we are left with our answer: $vi = 7.5\text{m/s}$



Above: Level 1 from Defense Against Invaders Game.

Name: _____

Date: _____

Partner(s): _____



Defense Against Invaders Activity: **Applying Knowledge and Skills of** **Projectile Motion**



Directions: You should already be logged onto a computer after completing the warm-up activity. Now you will be completing the following corresponding levels of Defense Against Invaders. The purpose of this gaming activity is to provide you with scenarios with which to test your knowledge and skills that were learned last class. **YOU MUST FOLLOW ALL DIRECTIONS PRECISELY AND ANSWER ALL QUESTIONS. Make sure to show your work, including correct units for each answer you give. YOU HAVE 15-20 MINUTES! THIS SHEET WILL BE SUBMITTED AT THE END OF CLASS FOR A GRADE.** (You may use a calculator).

Level 2:

- 1.) Predict the pathway of the projectile before selecting the “Run” command above. Sketch this prediction below.
- 2.) Run the simulation. Sketch the actual pathway the projectile takes. Was your prediction correct?
- 3.) You run the game more slowly using the “step function” located on the bottom left hand corner of the screen (It’s the green arrow pointing to the right). Use this to see a step-by-step look at the projectile’s path. Note the two velocity graphs on the right while you use this function. Describe what you are seeing for each velocity graph. What do you think the V_x and V_y stand for?

 $V_x =$ $V_y =$

Description:

- 4.) Now try adjusting the speed and angle using the sliders. Describe what happens to the projectile when you increase the speed or angle.

- 5.) Find the lowest velocity and angle needed to hit the enemy soldier.
- 6.) Find the total distance the enemy is standing away from us. All necessary equations are provided.

Level 3:



- 1.) Find the lowest velocity and lowest angle needed to knock the invader off the platform. Record your answers in the space below:
- 2.) In this scenario you are standing 20ft away from the invader. How much time passes from the moment the projectile is fired to when it hits the enemy? Show work below.
- 3.) Draw the pathway of your projectile once you find the correct values of velocity and angle needed to hit the enemy. How does this pathway differ from projectile pathways of Level 1 and Level 2? Why does this occur?
- 4.) Try launching the projectile at a 90 degree angle. (**You will need to convert 90 degrees to radians. Use the equation provided on the program**). Sketch the pathway below. Why does the projectile behave in such a manner?

Level 4:

- 1.) Type 12.0 into the initial firing speed text box, this speed will not be adjustable for this level. Now determine the firing angle necessary to hit the invader and record it below.
- 2.) After recording firing angle, determine how long it will take the cannonball to reach the enemy and how far away the defender is. **Show all work.**

Level 4a:

- 1.) Use 3.5m/s as the initial firing speed text box, this speed will not be adjustable for this level. Now determine the firing angle necessary to hit the invader and record it below.
- 2.) After recording firing angle, determine how long it will take the cannonball to reach the enemy and how far away the defender is. **Show all work.**

Level 4b:

- 1.) Type 3.5 m/s into the initial firing speed text box, this speed will not be adjustable for this level. Now determine the firing angle necessary to hit the invader and record it below.



2.) After recording firing angle, determine how long it will take the cannonball to reach the enemy and how far away the defender is. **Show all work.**

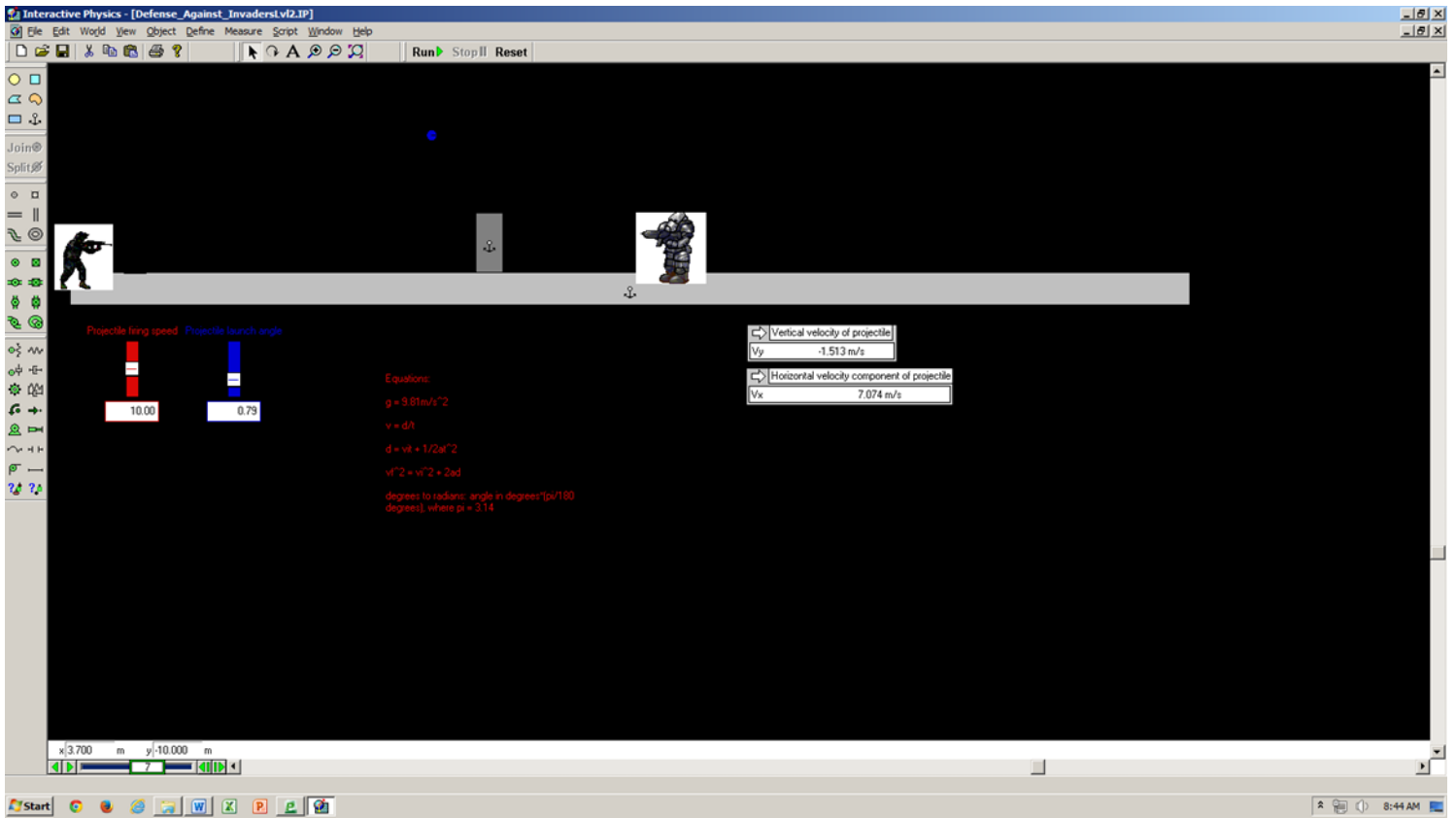
Level 5: The Alliance Falls

You and your partner will now test your skills against each other. The objective of this level will be to knock each other's opposing commander off the platform. **(Hint for Player 2: Your angle values are different because you start at 90 degrees. So you will have to add 90 degrees to each angle to get the desired pathway. For example, a 45 degree angle for player one would be equivalent to a 135 degree angle for you (90 degrees + 45 degrees = 135 degrees). Calculate, showing all work the total distance away you are from each other when one victor has been decided.**

Level 6:

- 1.) Find the respective projectile speed and angle needed to dispatch each invading enemy. Record these values below.
- 2.) Now determine the distance that each enemy is from you. **Show your work below.**





Above: Level 2 scenario from Defense Against the Invaders.
 Below: Level 5 scenario



Lesson 3

| | |
|---|---|
| Title: | Intro to Newton's Laws and Forces |
| Type (Simulation or Game): | Game and Simulation |
| Materials Needed: | <ul style="list-style-type: none"> • Computers with internet access. • http://www.mrmont.com/games/catchinspace.html • http://www.mrmont.com/games/docktherocket2.html • Notes on Newton's Laws and Forces • Warm-up Activity • HW: A review of Newton's Laws and Forces. |
| Additional Resources: (e.g. Web, books, etc.) | <ul style="list-style-type: none"> -Smartboard -Regents Physics Reference Tables -Calculators (or show students how to use computer calculator program) |
| Unit: | Newton's Laws and Forces |
| Overview: | <p>To create a fun and engaging way for introducing Newton's Laws of Motion to students. Two games will be used as "icebreaker" activities in order to grab students' attention straight away. The rocket docking game will be used to simulate a NASA Shuttle docking with a space station as students attempt to dock successfully without damage the shuttle or the station. The second game/simulation models a scenario in which two astronauts place catch in space, giving students the ability to adjust the speed of the throws, the mass of the ball, and the mass of each astronaut. These digital activities will introduce students to Newton's three laws of linear motion and the components of a force.</p> |
| NYS Standard: (21st Century NYS Standards and NGSS) | <p>Standard 4- The Physical Setting, Key Idea 5: Energy and matter interact through forces that result in changes in motion.</p> <ul style="list-style-type: none"> -Performance Indicator 5.1: Students can explain and predict different patterns of motion of objects. -Performance Indicator 5.1d: An object in linear motion may travel with a constant velocity or with acceleration. -Performance Indicator 5.1i: According to Newton's First Law, the inertia of an object is directly proportional to its mass. An |

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| <p><u>Concepts:</u></p> <p>Newton's 3 Laws of Motion</p> <p><u>Equations:</u></p> <p>Force = mass*acceleration</p> | <p>object remains at rest or moves with constant velocity, unless acted upon by an unbalanced force.</p> <p>-Performance Indicator 5.1k: According to Newton's Second Law, an unbalanced force causes a mass to accelerate.</p> <p>Standard 6- Interconnectedness: Common Themes, Key Idea 4: Equilibrium is a state of stability due either to a lack of change (static equilibrium) or a balance between opposing forces (dynamic equilibrium).</p> <p>Standard 7- Interdisciplinary Problem Solving, Performance Indicator 1.2: Physics can be used in solving problems on many scales, including on a national or global level.</p> |
| <p>Objectives: (Specify skills/information that will be learned.)</p> | <p>-Students will be able to identify and use the appropriate equations located on their Physics Reference Table to solve for unknown variables.</p> <p>-Students will be able to define and apply Newton's 1st, 2nd, and 3rd Laws of Linear Motion.</p> <p>-Students will be able design free body diagrams to represent the forces present in a given scenario.</p> |
| <p>Information: (Give and/or demonstrate necessary information.)</p> | <p>-Students will hand in homework that was assigned class (if any) to the appropriate bin.</p> <p>-Students will pick up an activity sheet and a new set of unit notes as they enter class. They will then take a seat at a computer and login.</p> <p>-Students will be expected to complete today's warm-up activity which will be featured on the smartboard, chalkboard, or whiteboard already.</p> <p>-The teacher will have written today's objectives and instructions on the smartboard, chalkboard, or whiteboard already.</p> |
| <p>Activity: (Describe the independent activity/activities to</p> | <p>-Students will be evaluated on their current level of understanding pertaining to Newton's Laws and Forces by completing a warm-up activity. The activity in question will utilize two games: one that will ask students to dock a shuttle to</p> |

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| reinforce this lesson.) | <p>a space station and another that simulates to astronauts playing catch in space. Students will be asked to complete the corresponding activity sheet that they picked up, interacting with the game. This activity will encompass no more than 12-18 minutes.</p> <p>-Students will then switch with another student and grade each other's work as the teacher goes over the answers. The teacher will collect these warm-up activities afterwards and students will log off computers. (6-12 minutes)</p> <p>-Students will take out notes and complete sections that the teacher goes over (approx. 10-15 minutes).</p> |
| Summary (Last few minutes of class): | <p>-Students will receive homework. (3min).</p> <p>-<u>Ticket out the door:</u> None (Students will be assessed on their understanding of today's lesson via the HW sheet they will complete).</p> <p><u>HW:</u> The assignment will be a review of today's lesson pertaining to Newton's Laws of Linear Motion and the force equation ($F = ma$).</p> |
| Rationale: | <p>Newton's three laws of linear motion are an essential component of the NYS Physics curriculum. It cannot be taught through lectures, but rather requires a more interactive approach. Both games/simulations assist students by:</p> <p>-Providing real-life scenarios for students to demonstrate what they know about Newton's Laws.</p> <p>-Creating an engaging, inexpensive, and interactive way to approach a new unit of physics.</p> <p>-Helping students to see the properties of motion in an environment that is not realistically possible to view in person.</p> |
| Possible Misconceptions: | <p>These games/simulations are meant to demonstrate Newton's Three Laws of Linear Motion in space. It is important that the teacher emphasize this point, as students may assume that objects in linear motion may behave similarly on earth. However this is not the case, as other forces that are present on the planet will affect the motion of objects.</p> |

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| Recommendations: | <p>-Make sure that there is an adequate number of computers in the classroom or use specialized computer room if provided by school.</p> <p>-Make sure to emphasize that students do not open additional windows or tabs with their browser as it distracts them and their fellow classmates from their current tasks. Remind them that if they are caught on additional tabs they will lose computer privileges for the rest of class and will have to make up the activity after school with the teacher.</p> <p>Remind students that they must show all work and answers (with correct units) on the corresponding worksheet.</p> <p>-Make sure you have access to website and use a dependable internet browser (Mozilla Firefox and Internet Explorer do not work well).</p> |

Name: _____

Date: _____

Partner: _____



PHYSICS IN SPACE!!!!

Directions: Login to computer and click on the Mozilla Firefox icon.

Type in the following URL address:

<http://www.mrmont.com/games/docktherocket2.html>

Using this game, students will answer the following questions below on this worksheet individually. **All worksheets will be submitted, so be sure to SHOW ALL WORK (including units) and to reply to questions with complete sentences.** Once you have access to the game, read the instructions first before trying the controls out.

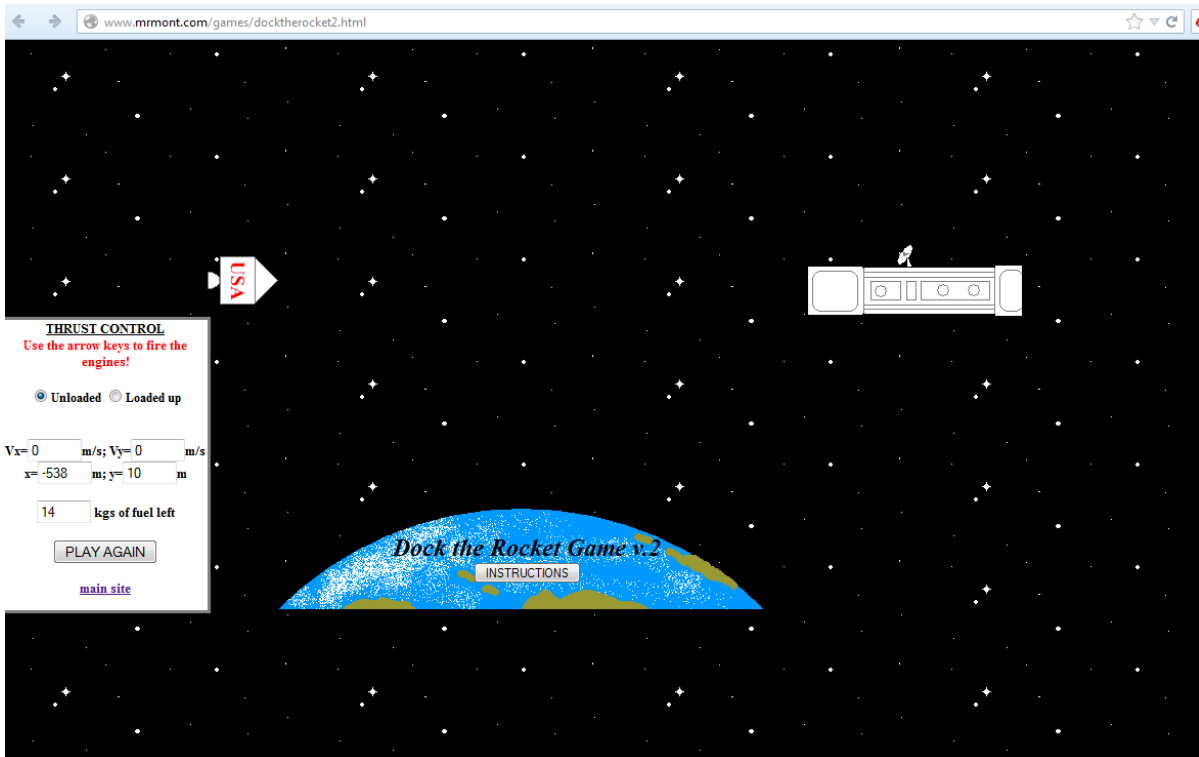
Part 1: Shuttle Docking

1. The objective of this game is to dock the shuttle safely with the space station in orbit. The position of the space station docking point is (0,0) or $x = 0$; $y = 0$. In the space below, record your shuttle's starting point. Then determine the distance needed for the shuttle to reach its destination. (*Hint: we are focused on magnitude not direction*)

Starting horizontal distance (x):

Starting vertical distance (y):

Distance needed to reach docking point from starting position:



2. **Make sure that you have selected the option “Unloaded” on the control screen to the left before continuing on.** If the shuttle was traveling with a speed of 2m/s traveling to the right how long would it take the shuttle to reach the docking point?
3. Test out the arrow keys: when you hit the right arrow key which direction is the thruster pushing the shuttle? What about the “up” arrow key? What do you notice about the direction of the thruster and the direction that the shuttle goes as a result of using the thruster?
4. Hit “Play again”, you will notice that one tap on an arrow key will result in the consumption of 1kg of gas. What happens to the shuttle after tapping the left arrow key once?
5. Try to get the rocket to stop moving using the controls. Describe what you have to do to stop the shuttle in the space below:
6. What would happen if we kept pressing on an arrow key? Predict how the shuttle would move.
7. Hit “Play again”, and try this out. Describe what happens. Were you correct in your prediction? Why do you think it behaves in such a way?
8. Hit “Play again”. Now try getting the shuttle to the docking point without using up your gas. Is the task difficult easy or difficult? Why?
9. Using what you know about space and forces; identify all the forces acting on the shuttle as it moves to its docking point. How does this differ from the forces acting on a plane as it flies through the air?



Part 2: Just a typical game of catch... in space

For this next activity, type in the following URL address:

<http://www.mrmont.com/games/catchinspace.html>

The purpose of this simulation is to demonstrate what would happen if two astronauts started a game of catch in space. Using this game, students will answer the following questions below on this worksheet individually. **All worksheets will be submitted, so be sure to SHOW ALL WORK (including units) and to reply to questions with complete sentences.**

1. Before starting the simulation, record the current mass of each astronaut and the ball below:

Mass of Astronaut 1:

Mass of Astronaut 2:

Mass of the ball:

Playing Catch in Space

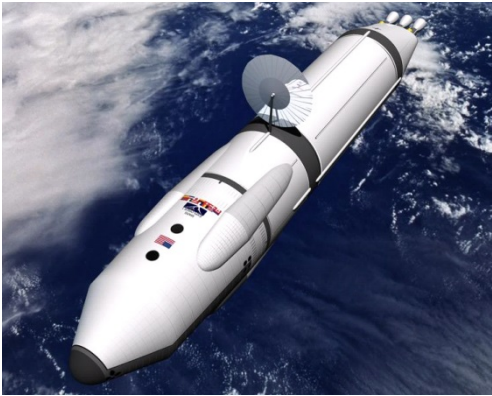
| Left Astronaut | Ball | Right Astronaut |
|----------------|-------------|-----------------|
| Mass: 100 | Mass: 25 | Mass: 100 |
| Velocity: 0 | Velocity: 0 | Velocity: 0 |

Throw the ball: faster

START RESET

[main site](#)

2. Make sure you select the “slow” option the “Throw the ball” slider. Now, start the simulation. Describe what happens as the astronauts toss the ball back and forth.
3. Why do you think the astronauts move in opposite directions?
4. How could the astronauts stop themselves? What could they do?
5. Hit the “Reset” button. Now, change the mass of one astronaut and run the simulation just like before. What impact (if any) does the added mass have on this scenario? Why do you think that is?
6. Hit the “Reset” button. What do you think would happen if you changed the mass of the ball in this situation? Predict what would happen.
7. Increase the mass of the ball and run the simulation. Was your prediction correct? Why do you think this happens?
8. What do you think would happen if one astronaut did not catch the ball?



Lesson 4

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| Title: | Intro to Momentum |
| Type (Simulation or Game): | Game |
| Software Used: | Interactive Physics |
| Materials Needed: | <ul style="list-style-type: none"> • Computers with an internet connection or access to phet simulations. • http://phet.colorado.edu/sims/collision-lab/collision-lab_en.html • Momentum Warm-up activity worksheet. • Momentum Notes |
| Additional Resources: (e.g. Web, books, etc.) | <p>-Computers (with internet connection and Windows XP or higher installed)</p> <p>-Smartboard</p> <p>-Regents Physics Reference Tables</p> <p>-Calculators (or show students how to use computer calculator program)</p> |
| Unit/Topic: | Momentum |
| NYS Standard: (21st Century NYS Standards and NGSS) Concepts: Conservation of Momentum <u>Equations:</u> $p = m \cdot v$ Total $p_{\text{before}} = \text{Total } p_{\text{after}}$ | <p>Standard 1- Analysis, Inquiry, and Design, Key Idea 3: Critical thinking skills are used in the solution of mathematical problems.</p> <p>Standard 4- The Physical Setting, Performance Indicator 5.1: Students can explain and predict different patterns of motion of objects.</p> <p>-5.1i According to Newton's First Law, the inertia of an object is directly proportional to its mass. An object remains at rest or moves with constant velocity, unless acted upon by an unbalanced force.</p> <p>-5.1r Momentum is conserved in a closed system.</p> <p>Students who demonstrate understanding can:</p> <p>-HS-PS2-2: Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.</p> |
| Overview: | The purpose of this lesson is to use introduce the concept of momentum to students. At the opening of this lesson, students' |

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| | <p>prior knowledge and understanding of momentum will be evaluated by having them complete a warm-up activity that uses a PHET simulation. The teacher will follow this up by going over the activity and explaining this behavior with detailed notes.</p> |
| <p>Objectives: (Specify skills/information that will be learned.)</p> | <ul style="list-style-type: none"> -Students will be able to identify and use the appropriate equations located on their Physics Reference Table to solve for unknown variables. -Students will be able to define and give examples of the law of conservation of linear momentum in a collision of two objects. -Students will be able to predict the speed and mass of moving objects after a collision based on mathematical analysis. -Students will be able identify examples of elastic and inelastic collisions and compare and contrast between the two. |
| <p>Information: (Give and/or demonstrate necessary information.)</p> | <ul style="list-style-type: none"> -Students will hand in homework that was assigned class (if any) to the appropriate bin. -Students will pick up an activity sheet and a new set of unit notes as they enter class. They will then take a seat at a computer and login. -Students will be expected to complete today's warm-up activity which will be featured on the smartboard, chalkboard, or whiteboard already. -The teacher will have written today's objectives and instructions on the smartboard, chalkboard, or whiteboard already. |
| <p>Activity: (Describe the independent activity/activities to reinforce this lesson.)</p> | <ul style="list-style-type: none"> -Students will be assessed on their prior knowledge and understanding of momentum using a warm-up activity that will encompass the first 12-17 minutes of class. -After students have exchanged papers with another member of the class, the teacher will go over activity with students. Students will correct each other's paper. (8-13 minutes.) -Students will log out and hand in momentum warm-up sheets after being graded. Students will take out the new unit notes on momentum that they picked up before class. The teacher will |

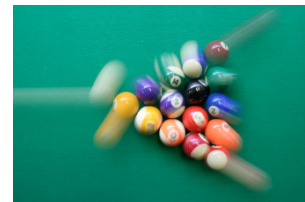
| | |
|---------------------------------|--|
| | give notes, while students record the information. (15-20 minutes). |
| Summary: | - Ticket out the door: None HW: Momentum review questions. |
| Rationale: | This activity will provide students with an engaging experience with the properties of conservation. As they interact and observe the motion of masses, the corresponding work sheet will be prompting students to think about the behavior of matter, specifically how objects with momentum behave before and after collisions. The phet simulation was chosen specifically for range of information provided and the factors that are able to be manipulated (i.e mass, velocity, etc.). Rather than demoing for the students, this simulation allows students to be the observers and determine the components that affect momentum of an object. |
| Possible Misconceptions: | The set-up of vectors indicating the direction the objects are moving in this set-up could confuse students as it roughly resembles the free body diagrams they were using in the previous unit to show the direction of force. Students may incorrectly associate force and not velocity is a direct component of momentum. It will be important to draw attention to this while discussing the answers and indicating that these arrows represent the velocity of the object and not the force. |
| Recommendations: | -Make sure that there is an adequate number of computers in the classroom or use specialized computer room if provided by school. -Make sure to emphasize that students do not open addition windows or tabs with their browser as it distracts them and their fellow classmates from their current tasks. Remind them that if they are caught on additional tabs they will lose computer privileges for the rest of class and will have to make up the activity after school with the teacher. -Remind students that they must show all work and answers (with correct units) on the corresponding worksheet. -Make sure you have access to website and use a dependable internet browser that works well with phet simulations (Mozilla Firefox does not work well). |

Name: _____

Date: _____



Momentum Warm-up



Directions: Login to computer and click on the Internet Explorer icon. Type in the following URL address: http://phet.colorado.edu/sims/collision-lab/collision-lab_en.html.

Using this simulation, students will answer the following questions below on this worksheet individually. **All worksheets will be submitted, so be sure to SHOW ALL WORK (including units).**

Momentum:

1. What is momentum? In your own words define what you think this term refers to.
2. Record the equation for momentum (p) from your Reference Table below:
3. Hit the “Reset all” button to begin and then click the tab below that says “More Data”. Record the mass and velocity of each object below:

| | |
|---------------------------|-------------------------------|
| <i>Mass (red ball):</i> | <i>Velocity (red ball):</i> |
| <i>Mass (green ball):</i> | <i>Velocity (green ball):</i> |
4. Determine the momentum of each object at their present simulation.
5. Now run the simulation and hit the pause button after the two balls collide or hit each other. Record the new mass and velocity values for each ball after this collision below:

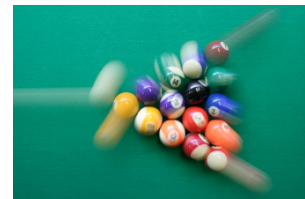
| | |
|---------------------------|-------------------------------|
| <i>Mass (red ball):</i> | <i>Velocity (red ball):</i> |
| <i>Mass (green ball):</i> | <i>Velocity (green ball):</i> |
6. Calculate the momentum of each object using these new values for mass and velocity.
7. What changes (if any) did you observe to the mass, velocity, and momentum of each ball after the collision?
8. Now calculate the total momentum before and after the collision of these objects. You can obtain these values by adding the momentum of each object together. Record these sums below:
9. Compare both of these total momentum values. What do you observe?
10. Click “Reset All” again. Now, using the gauge on the side that says “Inelastic” and “Elastic” adjust the gauge so that it reads “100% Inelastic”. Now run the simulation. How does the simulation change from before?

Name: _____

Date: _____



Momentum Warm-up(Key)



Directions: Login to computer and click on the Internet Explorer icon. Type in the following URL address: http://phet.colorado.edu/sims/collision-lab/collision-lab_en.html.

Using this simulation, students will answer the following questions below on this worksheet individually. **All worksheets will be submitted, so be sure to SHOW ALL WORK (including units).**

Momentum:

11. What is momentum? In your own words define what you think this term refers to.

Momentum can be defined as mass that is moving.

12. Record the equation for momentum (p) from your Reference Table below:

$$\mathbf{P = mv}$$

13. Hit the “Reset all” button to begin and then click the tab below that says “More Data”. Record the mass and velocity of each object below:

Mass (red ball): **.5kg**

Velocity (red ball): **1m/s**

Mass (green ball): **1.5kg**

Velocity (green ball): **0m/s**

14. Determine the momentum of each object at their present simulation.

$$\mathbf{P(\text{red}) = .5kg(1m/s) = .5kgm/s}$$

$$\mathbf{P(\text{green}) = 0kgm/s}$$

15. Now run the simulation and hit the pause button after the two balls collide or hit each other. Record the new mass and velocity values for each ball after this collision below:

Mass (red ball): **.5kg**

Velocity (red ball): **-.5m/s**

Mass (green ball): **1.5kg**

Velocity (green ball): **.5m/s**

16. Calculate the momentum of each object using these new values for mass and velocity.

$$P(\text{red after}) = -.25 \text{ kgm/s}$$

$$P(\text{green after}) = 1.5\text{kg}(.5\text{m/s}) = .75 \text{ kgm/s}$$

17. What changes (if any) did you observe to the mass, velocity, and momentum of each ball after the collision?

Mass did not change. Red ball decreased in velocity and bounced off in opposite direction from green ball which is now moving in positive direction. Red ball has negative momentum and Green ball has positive momentum.

18. Now calculate the total momentum before and after the collision of these objects. You can obtain these values by adding the momentum of each object together. Record these sums below:

$$P_{\text{total before}} = 0 \text{ kgm/s} + .5 \text{ kgm/s} = .5 \text{ kgm/s}$$

$$P_{\text{total after}} = .5$$

19. Compare both of these total momentum values. What do you observe?

Total momentum never changes, it remains the same value before and after collisions.

20. Click “Reset All” again. Now, using the gauge on the side that says “Inelastic” and “Elastic” adjust the gauge so that it reads “100% Inelastic”. Now run the simulation. How does the simulation change from before?

Inelastic the balls stay together after colliding. Elastic balls bounce off after colliding.

Lesson 5

| | |
|---|---|
| Title: | Energy Conservation Day 1 |
| Type (Simulation or Game): | Game and Simulation |
| Materials Needed: | <ul style="list-style-type: none"> • Computers with internet access. • Access to internet • http://www.mathnook.com/fungames/electricbox2.html • Energy Conservation Warm-up activity. • http://www.brainpop.com/games/coastercreator/ • Energy Conservation Activity Sheet. • Notes on Energy Unit from yesterday. |
| Additional Resources: (e.g. Web, books, etc.) | <ul style="list-style-type: none"> -Smartboard -Regents Physics Reference Tables -Calculators (or show students how to use computer calculator program) -Videos of Energy Conservation examples (dependent on time available) |
| Unit: | Energy |
| Overview: | <p>To create a fun, SAFE, and engaging way for students to demonstrate their prior knowledge and understanding of the law of conservation of energy. The “Electric Box” game will provide a hands-on way for students to examine what they already know about the types of energies that exist and how energy is transferred in a game-like format.</p> <p>For the second half of the class, students will be examining the applications of gravitational potential energy, kinetic energy, and the law of conservation of energy to a roller coaster simulation.</p> |
| NYS Standard: (21st Century NYS Standards and NGSS) | <p>Standard 1- Analysis, Inquiry, and Design, Key Idea 3: Critical thinking skills are used in the solution of mathematical problems.</p> <p>Standard 2- Information Systems, Key Idea 1.5: Model solutions to a range of problems in mathematics, science, and technology, using computer simulation software.</p> <p>Standard 4- The Physical Setting, Key Idea 4.1: Energy exists in many forms, and when these forms change energy is conserved. Students will observe and describe transmission of various forms</p> |

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|---|---|
| <p><u>Concepts:</u></p> <p>Law of Energy Conservation</p> <p><u>Equations:</u></p> <p>$E_{\text{Total}} = PE + KE$</p> | <p>of energy.</p> <p>Performance Indicator 4.1a: All energy transfers are governed by the law of conservation of energy.</p> <p>Performance Indicator 4.1b: Energy may be converted among mechanical, electromagnetic, nuclear, and thermal forms.</p> <p>HS-PS3.B: Conservation of Energy and Energy Transfer</p> <p>HS-PS3-4: Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems.</p> |
| <p>Objectives: (Specify skills/information that will be learned.)</p> | <ul style="list-style-type: none"> -Students will be able to identify and use the appropriate equations located on their Physics Reference Table to solve for unknown variables. -Students will be able to identify various types of energy. -Students will be able to identify and explain the energy transfers that take place. -Students will be able to define and give examples of the Law of Conservation of Energy. -Students will be able to describe and explain the exchange between potential energy, and kinetic energy for simple mechanical systems such as a roller coaster. -Students will apply their knowledge and understanding of gravitational potential energy, kinetic energy, and energy conservation to a real world scenario. |
| <p>Information: (Give and/or demonstrate necessary information.)</p> | <ul style="list-style-type: none"> -Students will hand in homework that was assigned class (if any) to the appropriate bin. -Students will take out notes on Energy unit from last class. (Note: If notes were not completed, this plan may be altered to ensure that notes are completed prior to beginning today's activity). -Students will pick up activity sheet and login to computers as they enter class. They will also complete today's warm-up |

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| | <p>activity which will be featured on the smartboard, chalkboard, or whiteboard already.</p> <p>-The teacher will have written today's objectives and instructions on the smartboard, chalkboard or whiteboard already.</p> |
| <p>Activity: (Describe the independent activity/activities to reinforce this lesson.)</p> | <p>-Students will be assessed on their previous knowledge and understanding of energy conservation by completing the warm-up activity. Students will then switch with another student and grade each other's work as the teacher goes over the answers. This activity will encompass no more than 15-16 minutes of class time.</p> <p>-Teacher will go over activity with students which will take approximately 5 minutes. The teacher will collect the warm-up when done.</p> <p>-Students will take out notes on Energy Unit and will follow along as the teacher goes over the Law of Energy Conservation. This will take approximately 5-8 minutes.</p> <p>-Students will then receive Roller Coaster activity worksheet.</p> <p>-Students will work independently or with a partner, following all the directions on the activity sheet. They will record all the necessary information and make sketches with correct labels when asked. (10-15 minutes).</p> <p>-Teacher will monitor student progress and assist students with questions. If there is a general confusion about a specific question, the teacher may grab the attention of the class to discuss the question. However it is important that students try to do accomplish as much as they can.</p> |
| <p>Summary (Last few minutes of class):</p> | <p>-Students will log out and hand in worksheets. (3-5min).</p> <p>-Ticket out the door: Teacher will ask for worksheets to be handed in at the end of class so that student work can be assessed. In the unlikely event that students do not finish their activity they will be asked to make up the activity as soon as possible. It will not be assigned as homework.</p> <p>HW: Energy Conservation Video Assignment</p> |
| <p>Rationale:</p> | <p>The purpose of this lesson is to give students a SAFE and interactive way to explore the principle of energy conservation. Using the follow games/simulations, the main goal is to engage</p> |

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| | <p>and challenge students to use what they know.</p> <p>This activity can be paired with labs/projects that further assess a student's ability to apply their knowledge of conservation of energy to real-world scenario, i.e. a roller coaster design project or a bungee cord design project. The teacher would first introduce the concept of energy conservation utilizing the "Electric Box 2" game as a way for students to explore and investigate the many forms that energy takes on as well as how energy is transferred from one type to the next. The game works as an effective model as it provides a varied amount of energy types that are open for students to identify and interpret how to use.</p> <p>The second half of this activity would reintroduce the concepts of kinetic energy and potential energy (both terms having previously been learned the lesson prior) and explore their relationship with energy conservation in a real-world scenario: a roller coaster simulation. The simulation further allows students to identify the types of energies that take place throughout the ride and the importance of taking these concepts into account when constructing a roller coaster.</p> |
| <p>Possible Misconceptions:</p> | <p>A possible misconception that may develop from using the Electric Box 2 game, is the idea that energy is transferred directly in an electrical circuit. Although in an ideal system this would theoretically be true, it is important to note that in a real-life scenario, the initial starting energy measured would not equal the energy at the end of a circuit. The energy would be transferred into heat energy, due in part to the electrical wire's resistance, and hence heat energy would escape from the system causing a reduction in the total amount of energy observed at the end of the circuit.</p> <p>A similar effect is also present in the roller coaster scenario as well, since the friction from the wheels on the track or the brakes being applied would result in heat energy being released from the system.</p> <p>Hence it should be recommended that instructors take the time to identify this concept to prevent further confusion with projects or labs related to energy conservation.</p> |
| <p>Recommendations:</p> | <p>-Make sure that there is an adequate number of computers in the classroom or use specialized computer room if provided by</p> |

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| | <p>school.</p> <p>-Make sure to emphasize that students do not open addition windows or tabs with their browser as it distracts them and their fellow classmates from their current tasks. Remind them that if they are caught on additional tabs they will lose computer privileges for the rest of class and will have to make up the activity after school with the teacher.</p> <p>Remind students that they must show all work and answers (with correct units) on the corresponding worksheet.</p> <p>-Make sure you have access to website and use a dependable internet browser (Mozilla Firefox does not work well).</p> |
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Name: _____

Date: _____

Energy Activity: Electric Box 2

Directions: Login to computer and click on the Internet Explorer icon. Type in the following URL address: <http://www.candystand.com/play/electric-box-2#?key=304d0ad0-3387-41f8-8f9b-2ab43ebd4ff6>.

Using this game, students will answer the following questions below on this worksheet individually. **All worksheets will be submitted, so be sure to SHOW ALL WORK (including units).** Once you have access to the game, select level 1 to begin.

Level 1: Light

21. Hit "Skip tutorial". The objective of this level is to supply energy to the atomic symbol from the power button. List what tools you have available below (2pts):
22. What type of energy does a light bulb need to work (1pt)?
23. What type of energy does a light bulb provide (1pt)?
24. What type of energy does a solar panel need (1pt)?
25. What type of energy does a solar panel provide (1pt)?
26. Write out the energy transfers that need to take place in order to get energy to the atomic symbol (2 pts).

Level 2: Heat and Mechanical

1. Type in the following URL address:
<http://www.candystand.com/play/electric-box-2#?key=e3ac6bab-c08d-4756-8696-b89bbfbbdf2c>. The objective of this level is to supply energy to the atomic symbol from the power button. List what tools you have available below (2 pts):
2. In the space provided below, create a table listing each tool from the list above and the type of energy (or energies) they provide (3 pts).
3. Write out the energy transfers that need to take place (in order) to get energy to the atomic symbol (3pts).

Level 3: The Musical Hamster

1. Type in the following URL address:
<http://www.candystand.com/play/electric-box-2#?key=304d0ad0-3387-41f8-8f9b-2ab43ebd4ff6>. The objective of this level is to supply energy to the atomic symbol from the power button.
List what tools you have available below (2 pts):
2. **Do not run the simulation yet!** In the space provided below, create a table listing each tool from the list above and the type of energy (or energies) they provide (2 pts).
3. Write out the energy transfers that need to take place (in order) to get energy to the atomic symbol (2pts).

Total points: ___/20 points

Name: _____

Date: _____

Partner(s): _____



Energy Activity: Roller Coaster **Building**



Objectives: The goal of this exercise is for you to take on the role of roller coaster builders. Using your knowledge of gravitational potential energy, kinetic energy, and energy conservation you will construct a cool and SAFE ride for all to enjoy.

Directions: Login to computer and click on the Internet Explorer icon. Type in the following URL address: <http://www.brainpop.com/games/coastercreator/>

Students will follow along and complete all questions below on this worksheet individually or with two additional partners. **All worksheets will be submitted, so be sure to SHOW ALL WORK (including units).**

Step 1: Design

1. Sketch what your roller coaster carts look like below.
2. Do paints or decals affect the amount of energy a cart has? Why or why not? (2pts)

Step 2: Cart Sizes

1. How many carts did you end up using?
2. Record the mass of your carts below in the correct units (1pt):
3. How does the number of carts affect the overall energy available to a coaster? (2pts)

Step 3: Track Design

1. Sketch your track for your coaster in the space provided below. Label each section with the energy type that is taking place (i.e. Gravitational Potential Energy, Kinetic Energy, etc.) (2pts).
2. Where is gravitational potential energy the greatest on your coaster? (1pt)
3. When is kinetic energy the greatest on *any* coaster? (1pt)

4. Record the height of your initial hill on your coaster below. (1pt)
5. Calculate the gravitational potential energy of your coaster at this initial point? (2pts)
6. Calculate the kinetic energy at this point. (1pt)
7. Calculate the total mechanical energy that your coaster possesses. (2pts)
8. Determine the maximum kinetic energy that your coaster can obtain. (2pts)
9. Using the results from question #8, find the maximum speed your coaster will be traveling under ideal conditions. (3pts)

Step 4: Launch

1. List the energy transfers that take place during your coasters run (2pts).
2. Was your coaster successful? Why or Why not? (1pts)
3. How could you improve upon your roller coaster design? (2pts)

Total points: / 25 points

Name: _____ Teacher Copy _____ Date: _____

Partner(s): _____



Energy Activity: Roller Coaster Building



Objectives: The goal of this exercise is for you to take on the role of roller coaster builders. Using your knowledge of gravitational potential energy, kinetic energy, and energy conservation you will construct a cool and SAFE ride for all to enjoy.

Directions: Login to computer and click on the Internet Explorer icon. Type in the following URL address: <http://www.brainpop.com/games/coastercreator/>

Students will follow along and complete all questions below on this worksheet individually or with two additional partners. **All worksheets will be submitted, so be sure to SHOW ALL WORK (including units).**

Step 1: Design

1. Sketch what your roller coaster carts look like below.

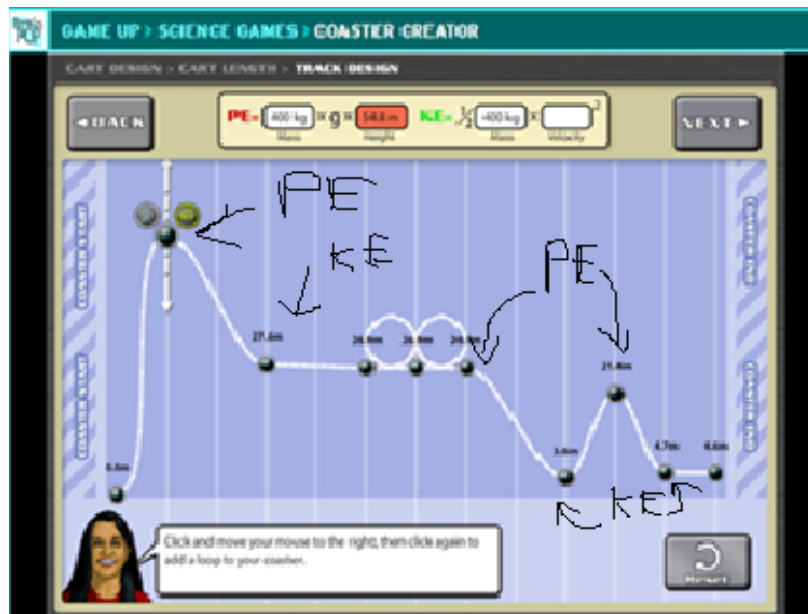
- Do paints or decals affect the amount of energy a cart has? Why or why not? (2pts) *In an ideal system, paints and decals have negligible mass and do not affect energy values for the coaster.*

Step 2: Cart Sizes

- How many carts did you end up using? 4
- Record the mass of your carts below in the correct units (1pt): *400kg*
- How does the number of carts affect the overall energy available to a coaster? (2pts) *It affects the mass of the carts. By increasing the mass, the PEG and KE values increase because they are dependent on mass.*

Step 3: Track Design

- Sketch your track for your coaster in the space provided below. Label each section with the energy type that is taking place (i.e. Gravitational Potential Energy, Kinetic Energy, etc.) (2pts).



- Where is gravitational potential energy the greatest on your coaster? (1pt)
Top of initial hill
- When is kinetic energy the greatest on *any* coaster? (1pt)
When the coaster is traveling its fastest.
- Record the height of your initial hill on your coaster below. (1pt) *54.5m*

5. Calculate the gravitational potential energy of your coaster at this initial point? (2pts)

$$PE_g = mgh = 400\text{kg} * 9.81\text{m/s}^2 * 54.5\text{m} = 213,858 \text{ J}$$

6. Calculate the kinetic energy at this point. (1pt)

$$KE = 1/2mv^2 = 0\text{J no velocity at top of initial hill}$$

7. Calculate the total mechanical energy that your coaster possesses. (2pts)

$$\text{Total Mechanical Energy} = KE + PE_g = 0\text{J} + 213,858 \text{ J} = 213,858 \text{ J}$$

8. Determine the maximum kinetic energy that your coaster can obtain. (2pts)

$$KE_{max} = \text{Total Mechanical Energy} = 213,858 \text{ J}$$

9. Using the results from question #8, find the maximum speed your coaster will be traveling under ideal conditions. (3pts)

$$KE_{max} = 1/2mv^2$$

$$1069.29 \text{ m}^2/\text{s}^2 = v^2$$

$$213,858 \text{ J}/400\text{kg} * 2 = v^2$$

$$v = 32.7\text{m/s is the maximum speed capable by the}$$

coaster

Step 4: Launch

1. List the energy transfers that take place during your coasters run (2pts).

*Electric -> Kinetic -> Gravitational Potential -> Kinetic -> Heat energy
(released by friction from brakes to slow down coaster.*

2. Was your coaster successful? Why or Why not? (1pts)

*The coaster was not successful because it possessed too much energy initially
which led to the coaster being too fast to stop correctly without crashing.*

3. How could you improve upon your roller coaster design? (2pts)

*I could decrease the height of my initial hill or add additional loops and flat
tracks to dissipate the energy.*

Total points: / 25 points

Lesson 6

| | |
|---|---|
| Title: | Designing Circuits and Ohm's Law (Day 2) |
| Type (Simulation or Game): | Simulation |
| Materials Needed: | <ul style="list-style-type: none"> • Computers with internet access. • Access to internet or phet simulations. • http://phet.colorado.edu/en/simulation/circuit-construction-kit-dc-virtual-lab • Circuit Challenge worksheet. • Notes on circuits/ohm's law from yesterday. |
| Additional Resources: (e.g. Web, books, etc.) | <ul style="list-style-type: none"> -Smartboard -Regents Physics Reference Tables -Calculators (or show students how to use computer calculator program) |
| Unit: | Electrical Circuits |
| Overview: | To create a fun, SAFE, and engaging way for students to demonstrate their knowledge and understanding of ohm's law and circuits. The PHET simulation will provide a hands-on way for students to test their knowledge and skills in a game-like format. Students will be rewarded based on their level of comprehension on the topics of circuits, ohm's law, and resistivity as well as their ability to apply that knowledge to real world situations. |
| NYS Standard: (21st Century NYS Standards and NGSS) <u>Concepts:</u> Ohm's Law <u>Equations:</u> Current = voltage/resistance | <p>Standard 1- Analysis, Inquiry, and Design, Key Idea 3: Critical thinking skills are used in the solution of mathematical problems.</p> <p>Standard 2- Information Systems, Key Idea 1.5: Model solutions to a range of problems in mathematics, science, and technology, using computer simulation software.</p> <p>Standard 4- The Physical Setting, Key Idea 4.1: Energy exists in many forms, and when these forms change energy is conserved. Students will observe and describe transmission of various forms of energy.</p> <p>Performance Indicator 4.1n: A circuit is a closed path in which a current* can exist.</p> |

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| | <p>Performance Indicator 4.1o: Circuit components may be connected in series* or in parallel*. Schematic diagrams are used to represent circuits and circuit elements.</p> <p>4-PS3-2: Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat and electric currents.</p> |
| <p>Objectives: (Specify skills/information that will be learned.)</p> | <ul style="list-style-type: none"> -Students will be able to identify and use the appropriate equations located on their Physics Reference Table to solve for unknown variables. -Students will be able to identify and define components of a circuit. -Students will be able design circuits using simulation software. -Students will be able to draw accurate schematic diagrams of their created circuits. -Students will be able to compare and contrast properties of series and parallel circuits. -Students will be able to measure voltage and current across a circuit component using simulation software. |
| <p>Information: (Give and/or demonstrate necessary information.)</p> | <ul style="list-style-type: none"> -Students will hand in homework that was assigned class (if any) to the appropriate bin. -Students will take out notes on ohm's law and circuits that were completed last class. (Note: If notes were not completed, this plan may be altered to ensure that notes are completed prior to beginning today's activity). -Students will pick up activity sheet and login to computers as they enter class. They will also complete today's warm-up activity which will be featured on the smartboard, chalkboard, or whiteboard already. -The teacher will have written today's objectives and instructions on the smartboard, chalkboard or |

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| | <p>whiteboard already.</p> <ul style="list-style-type: none"> -Teacher will have objectives for today's activities written on the smartboard, chalkboard, or whiteboard. -Students will pick up an activity sheet and a new set of unit notes as they enter class. They will then take a seat at a computer and login. -Students will be expected to complete today's warm-up activity which will be featured on the smartboard, chalkboard, or whiteboard already. -The teacher will have written today's objectives and instructions on the smartboard, chalkboard, or whiteboard already. |
| <p>Activity: (Describe the independent activity/activities to reinforce this lesson.)</p> | <ul style="list-style-type: none"> -Students will be assessed on their understanding of ohm's law last class by completing a warm-up problem that will be written on the smartboard. Students will then switch with another student and grade each other's work as the teacher goes over the answers. This activity will encompass no more than 5-8 minutes of class time. -Teacher will go over activity with students. (6 minutes). -Teacher will also hand out Circuit Challenge worksheet and explain the purpose of today's activity. (5-8 minutes). -Students will work independently or with a partner, following all the directions on the activity sheet. They will demonstrate their knowledge and understanding of circuits and ohms law by completing each task and asking the teacher to check them off after each level. The teacher will compile their points together and give them ranking once students are finished. (18-22 minutes). -Teacher will monitor student progress and assist students with questions. If there is a general confusion about a specific question, the teacher may grab the attention of the class to discuss the question. However |

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| | it is important that students try to do accomplish as much as they can. |
| Summary (Last few minutes of class): | <p>-Students will log out and hand in worksheets. (3min).</p> <p>-Ticket out the door: Teacher will ask for worksheets to be handed in at the end of class so that student work can be assessed. In the unlikely event that students do not finish their activity they will be asked to make up the activity as soon as possible. It will not be assigned as homework.</p> <p>HW: None</p> |
| Rationale: | <p>The purpose of this lesson is to give students a SAFE and interactive way to apply the knowledge they learned yesterday. Using this simulation in a game like situation, the expectation is to engage and challenge students to use what they know while preparing them for working with real circuit materials for lab activities to come.</p> <p>Ideally, this activity should be paired with a lab pertaining to the Electricity and Circuits unit. Students would first use this activity as a way to explore and interact with different circuit elements in a simulation before working with real power sources, wires, bulbs, and measuring devices in the laboratory. This simulation is especially useful as it gives students a chance to see how to use the materials without damaging the real items or themselves.</p> <p>In addition, this activity can also be used as a way to assess students understanding of the topic after the previous lesson's notes. Requiring students to check after each "level" with the instructor allows me a way to gauge their level of understanding and opens up the possibility for further teacher-student dialog if needed.</p> <p>Finally, the simulation was adapted as a type of game or contest because it will theoretically inspire competition among students. As discussed in the above literature, competition has been determined to be a positive factor in keeping students engaged and</p> |

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| | <p>on-task. By instilling a similar competitive atmosphere, the teacher will be able to keep students motivated in their desire to learn and succeed in the classroom. The “reward” aspect is also intended as a motivator for students to do well with the simulation.</p> |
| <p>Possible Misconceptions:</p> | <p>It is important to note that the simulation utilizes incandescent light bulbs for the purposes of building the circuit. This detail could be important for instructors who wish to use LEDs for actual labs, as LEDs function differently from the bulbs.</p> <p>In addition, while this activity is meant as a SAFE method for introducing students to electrical circuit design, instructors should not assume that the knowledge of proper use of materials and equipment will automatically be transferred. Hence, it is important that safety is readdressed prior to students working with the real materials.</p> |
| <p>Recommendations:</p> | <ul style="list-style-type: none"> -Make sure that there is an adequate number of computers in the classroom or use specialized computer room if provided by school. -Make sure to emphasize that students do not open additional windows or tabs with their browser as it distracts them and their fellow classmates from their current tasks. Remind them that if they are caught on additional tabs they will lose computer privileges for the rest of class and will have to make up the activity after school with the teacher. -Remind students that they must show all work and answers (with correct units) on the corresponding worksheet. -Make sure you have access to website and use a dependable internet browser (Mozilla Firefox does not work well). |

Name: _____

Date: _____

Partner: _____

CIRCUIT CHALLENGE LAB

Directions: Login to computer and click on the Internet Explorer icon. Type in the following URL address:
<http://phet.colorado.edu/en/simulation/circuit-construction-kit-dc-virtual-lab>. Click on the light green button that says “Run Now” to run the circuit simulation.

This activity can be done individually or with 1 additional partner. Students will complete each of the follow tasks for each level to earn points. **After completing each level, students must seek teacher approval to begin the next level of tasks.**

The group with the highest score at the end of the class will receive a reward for their accomplishments. **All worksheets will be submitted at the end of class. In addition, your score will be based on a combination of the success of a group’s simulation, correct answers to questions, AND the work provided (including units) to arrive towards said answers.**

Level 1:

- a) Make a light bulb light brightly using 4 batteries (1pt).
- b) Sketch a schematic diagram of this circuit in the box below. (3pts)
- c) What type of circuit have you made? Explain in words below. (1pt)
- d) What does the light bulb function as in this circuit? (.5pt)
 - 1) voltage source
 - 2) a switch
 - 3) resistor
 - 4) insulator
- e) Add an on/off switch. Explain using your own words when your circuit is an **open circuit** and when it is a **closed circuit**? (1pt)
- f) If each battery is worth 3 volts (v) what is the total voltage in this circuit? Show equations and work below (2pts):
- g) Determine the total amperage of the circuit if the bulb has a resistance of 13 ohms. Show equations and work below (1.5pts):

Total points for Level 1: /10

Level 2:

- a) Make a circuit with 3 light bulbs burning with equal brightness and a switch that turns on/off 2 of the 3 bulbs. (2pts).
- b) Sketch a schematic diagram of this circuit in the box below. Label the bulbs 1, 2, and 3 (4pts).
- c) What happens when two of the bulbs are shut off? Why does that occur? Explain using complete sentences (2pts).
- d) Use the non-contact Ammeter to check for different currents for each bulb and record them below (1pt):
- e) What would happen if you were to add a resistor to the circuit in between the two light bulbs controlled by the switch? How would the total resistance and total current be affected by this addition? Explain using complete sentences below (2pts):
- f) Change the circuit so 1 switch will turn on/off all the lights and also so that 1 bulb is brighter than the other two. Sketch a schematic diagram of this circuit below (3pts) **[+1 bonus point if you can tell me what type of circuit it is?]:**
- g) Determine and record the values of total resistance, resistance for each bulb, total current, total voltage, and voltage for each bulb in the space below (6pts):

Total points for Level 1: /20

Level 3:

- a.) Design a circuit that supports 4 bulbs each with equal brightness, a switch for each bulb, and a master switch to turn off all 4 bulbs at once. Use as many batteries as you desire. Sketch a schematic diagram of your circuit in the space provided and label your diagram as either a series or a parallel circuit (5pts).
- b.) Use the non-contact ammeter and the voltmeter tools to obtain the voltage and current values of each bulb, and determine the total resistance, total voltage, and total current of your circuit. Show all work below and make sure to use correct units (5pts).
- c.) If you had a job where you had to design the electrical circuit for all the lights in an office building would you use a series circuit or a parallel circuit? Explain your answer using complete sentences (5pts).

Total points for Level 1: /15

Level 4:

- a.) Design a circuit that uses 1 bulb, 1 switch, 1 battery, and 1 wire. Draw a schematic diagram of your circuit below (2pts):
- b.) What would happen if we removed the bulb and the switch from the circuit and added an extra wire? Explain using complete sentences (1pt).
- c.) List 4 ways you can increase the resistance in this circuit (2pts).

Total points for Level 1: /5

TOTAL SCORE: /50

Teacher Ranking: Expert Acceptable Poor

Name: KEY Date: _____

Partner: _____

CIRCUIT CHALLENGE LAB

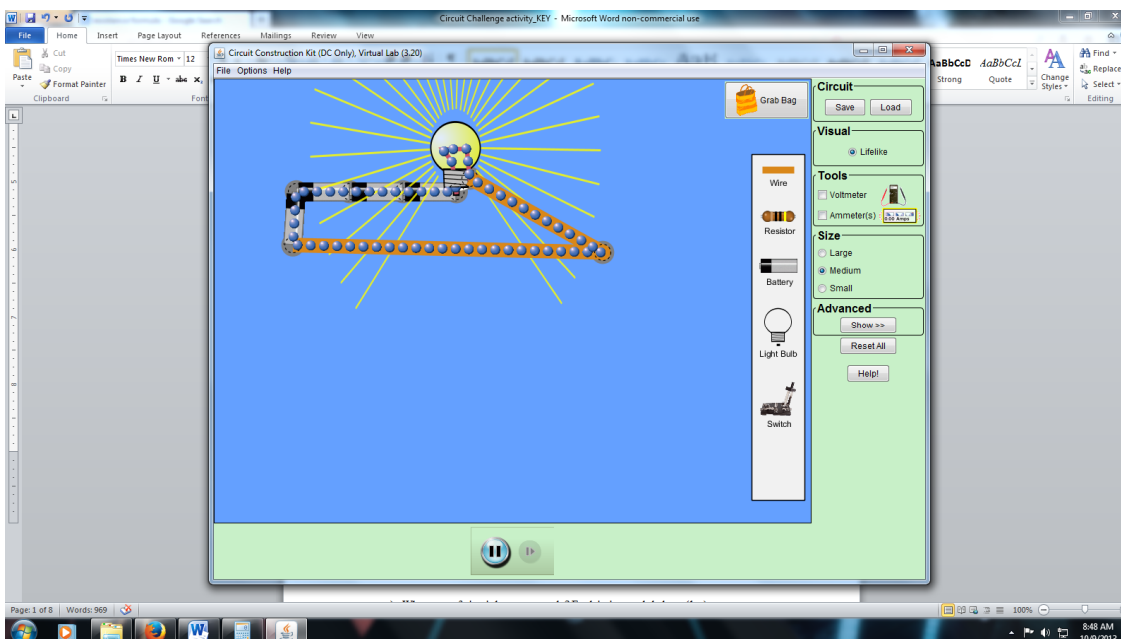
Directions: Login to computer and click on the Internet Explorer icon. Type in the following URL address: <http://phet.colorado.edu/en/simulation/circuit-construction-kit-dc-virtual-lab>. Click on the light green button that says “Run Now” to run the circuit simulation.

This activity can be done individually or with 1 additional partner. Students will complete each of the follow tasks for each level to earn points. **After completing each level, students must seek teacher approval to begin the next level of tasks.**

The group with the highest score at the end of the class will receive a reward for their accomplishments. **All worksheets will be submitted at the end of class. In addition, your score will be based on a combination of the success of a group’s simulation, correct answers to questions, AND the work provided (including units) to arrive towards said answers.**

Level 1:

a) Make a light bulb light brightly using 4 batteries (1pt).



- b) Sketch a schematic diagram of this circuit in the box below. (3pts)
- c) What type of circuit have you made? Explain in words below. (1pt)

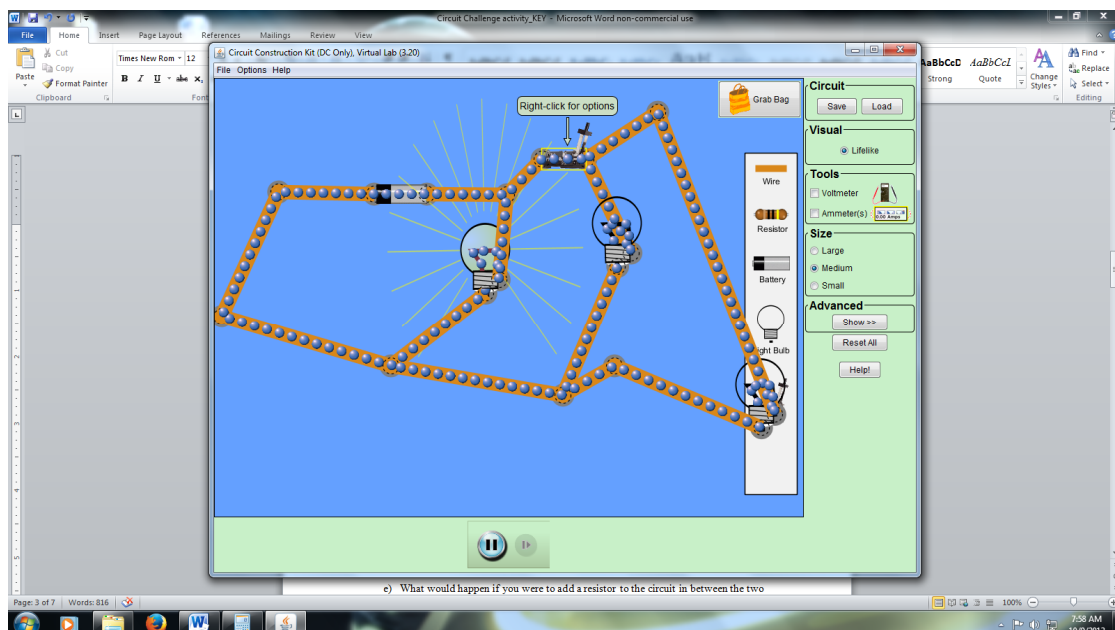
Closed series circuit since all batteries and light bulb are connected together in one complete path.

- d) What does the light bulb function as in this circuit? (.5pt)
- 1) voltage source 3) resistor
2) a switch 4) insulator
- e) Add an on/off switch. Explain using your own words when your circuit is an **open circuit** and when it is a **closed circuit**? (1pt). *Circuit is open when switch is in off position and closed when switch is in on position.*
- f) If each battery is worth 3 volts (v) what is the total voltage in this circuit? Show equations and work below (2pts):
 $V_{tot} = V_1 + V_2 + \dots$ $V_{tot} = 3v + 3v + 3v + 3v = 12volts$
- g) Determine the total amperage of the circuit if the bulb has a resistance of 13 ohms. Show equations and work below (1.5pts): *Amperage aka current = $V_{tot} / R_{tot} = 12v/13ohms = 12/13$ or .92 amps*

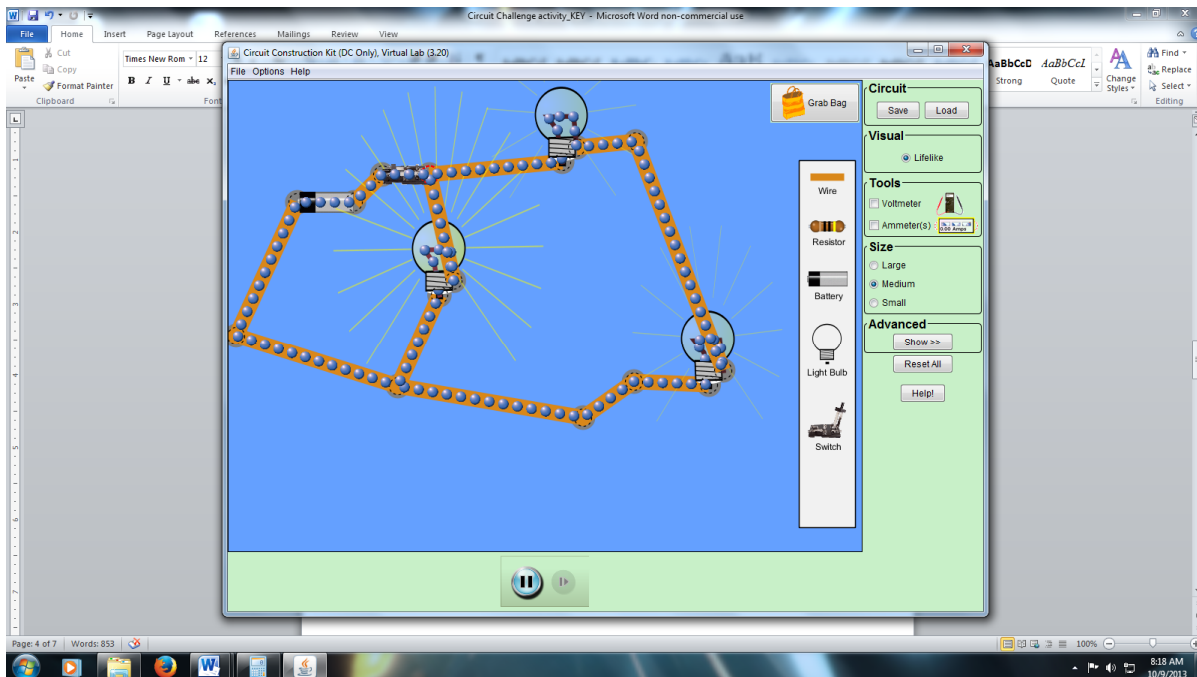
Total points for Level 1: /10

Level 2:

- a) Make a circuit with 3 light bulbs burning with equal brightness and a switch that turns on/off 2 of the 3 bulbs. (2pts).



- b) Sketch a schematic diagram of this circuit in the box below. Label the bulbs 1, 2, and 3 (4pts).
- c) What would happen when two of the bulbs are shut off? Why does that occur? Explain using complete sentences (2pts). *Other light bulb stays the same since voltage source is in parallel with all the light bulbs meaning each bulb has the same voltage running to it at any given time when the circuit is closed. When the other two bulbs shut off, this one keeps running without change.*
- d) Use the non-contact Ammeter to check for different currents for each bulb and record them below (1pt): *Bulb not connected: .9amps, bulb 1: 9amps, bulb 2: .9amps*
- e) What would happen if you were to add a resistor to the circuit in between the two light bulbs controlled by the switch? How would the total resistance and total current be affected by this addition? Explain using complete sentences below (2pts): *Third bulb gets dimmer. Resistance would increase.*
- f) Change the circuit so 1 switch will turn on/off all the lights and also so that 1 bulb is brighter than the other two. Sketch a schematic diagram of this circuit below (3pts) [+1 bonus point if you can tell me what type of circuit it is?]: *[composite or combination or parallel and series]*



- g) Determine and record the values of total resistance, resistance for each bulb, total current, total voltage, and voltage for each bulb in the space below. Make sure to show all work! (6pts):

$$1/R_{tot} = 1/10 + 1/20 = 3/20 \quad R_{tot} = 6.66 \text{ ohms} \quad V_{tot} = 9v \quad (\text{far left}) \text{ Bulb 1 } V = 9v$$

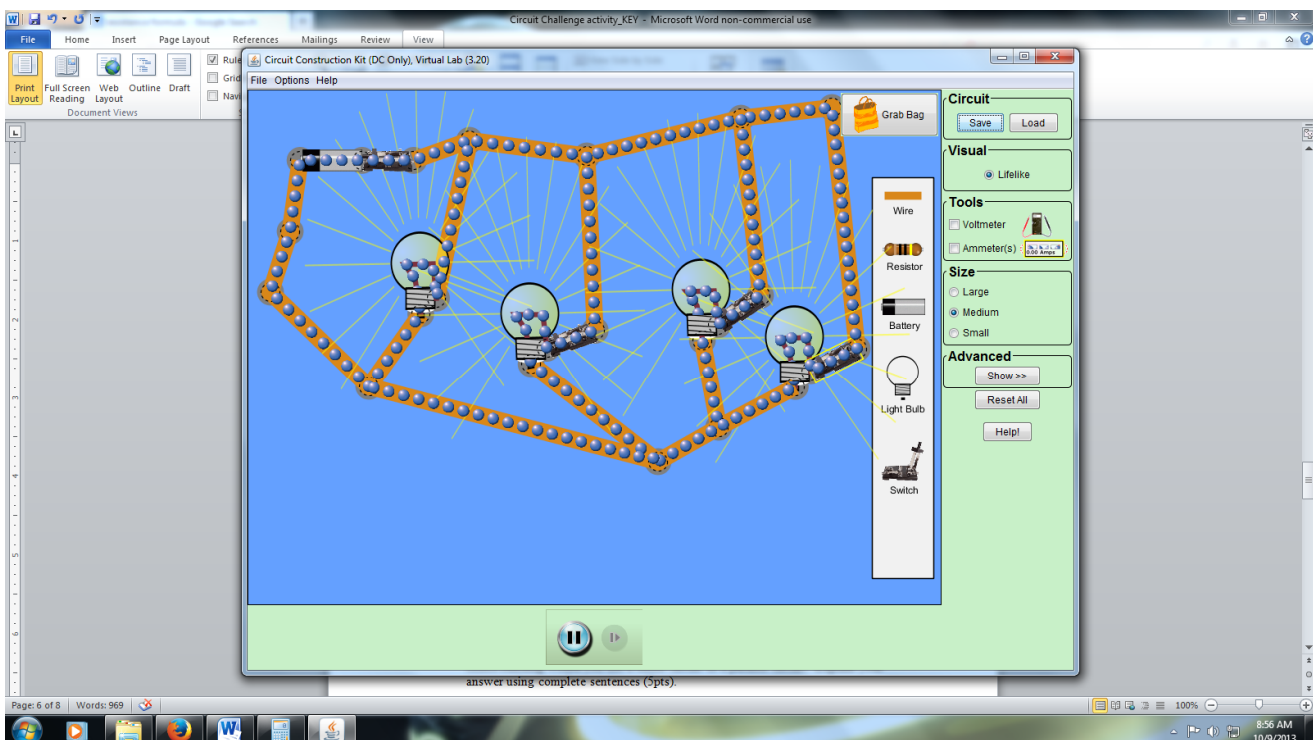
$$\text{Bulb 2 } V = 4.5v$$

$$(\text{far right}) \text{ Bulb 3 } V = 4.5v \quad I_{tot} = 9v/6.66\text{ohms} = 1.35\text{amps}$$

Total points for Level 1: /20

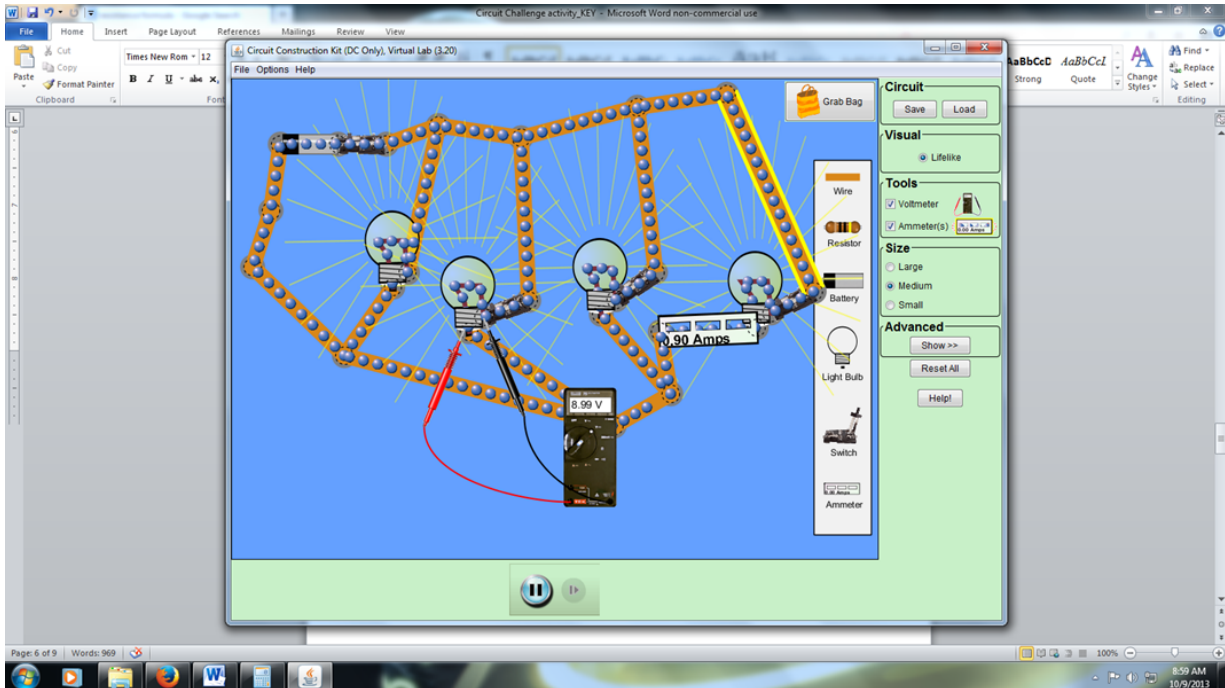
Level 3:

- a.) Design a circuit that supports 4 bulbs each with equal brightness, a switch for each bulb, and a master switch to turn off all 4 bulbs at once. Use as many batteries as you desire. Sketch a schematic diagram of your circuit in the space provided and label your diagram as either a series or a parallel circuit (5pts).



Parallel circuit

- b.) Use the non-contact ammeter and the voltmeter tools to obtain the voltage and current values of each bulb, and determine the total resistance, total voltage, and total current of your circuit. Show all work below and make sure to use correct units (5pts).



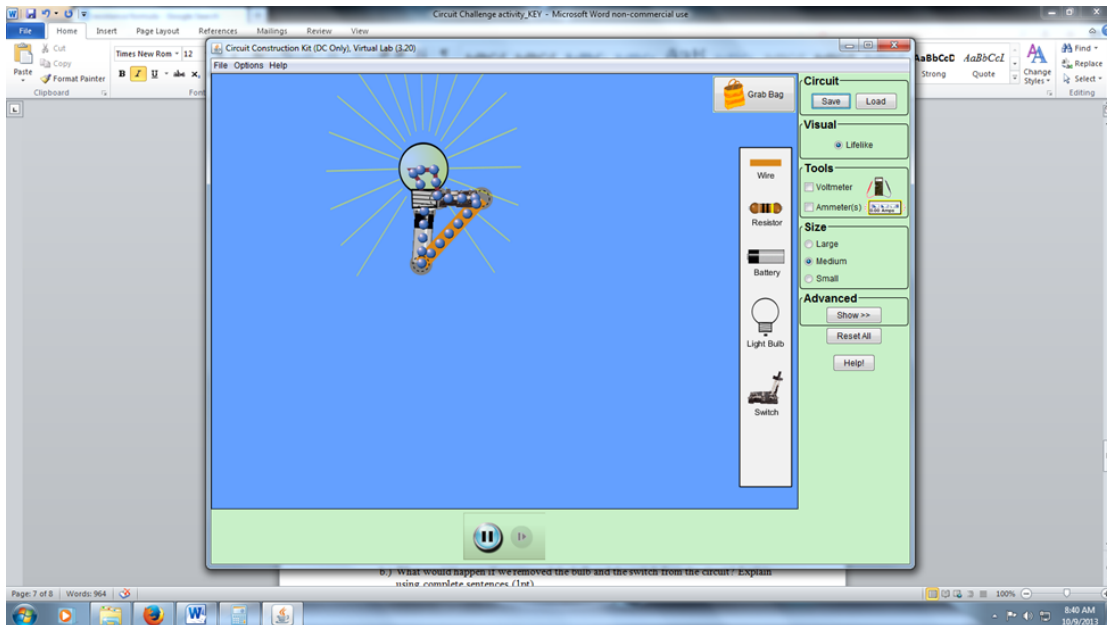
c.) If you had a job where you had to design the electrical circuit for all the lights in an office building would you use a series circuit or a parallel circuit? Explain your answer using complete sentences (5pts).

Most will probably choose parallel circuit because each light would have its own on off switch rather than a master switch turning everything off.

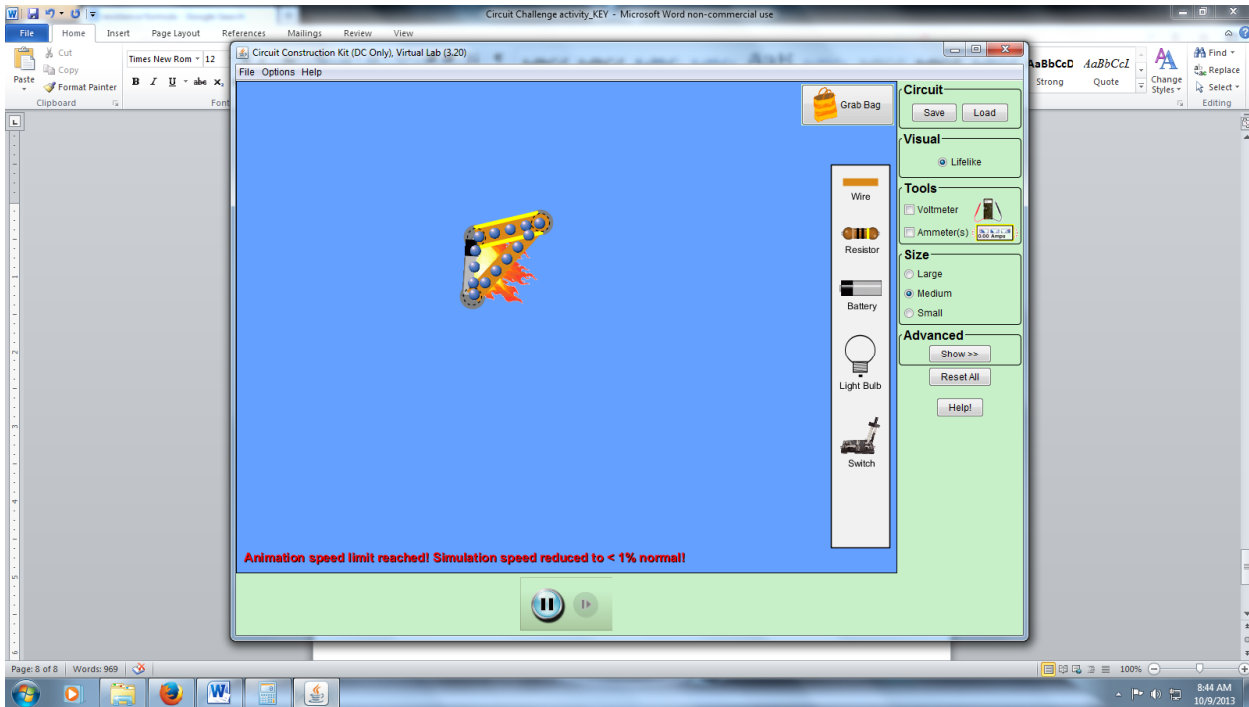
Total points for Level 1: /15

Level 4:

a.) Design a circuit that uses 1 bulb, 1 switch, 1 battery, and 1 wire. Draw a schematic diagram of your circuit below (2pts):



b.) What would happen if we removed the bulb and the switch from the circuit and added an extra wire? Explain using complete sentences (1pt). *The wire burns because there is not enough resistance to the voltage being supplied to the circuit.*



c.) List 4 ways you can increase the resistance in this circuit (2pts).

Use longer wire, Use thinner wire, Use a wire material that has a high resistivity/add an insulator, or Decrease the voltage being supplied.

Total points for Level 1: /5

TOTAL SCORE: /50

Teacher Ranking: Expert Acceptable Poor

Significance of Project:

Games and simulations are popular among a growing number of individuals across the nation. If used effectively within the classroom they have the potential to motivate and foster an interest in physics among students, while providing a fun, engaging and interactive way for students to see how physics concepts are relevant to their daily lives.

The intent for this project was to provide a series of pre-designed lessons that incorporate games and simulations that can be used to hook students into a particular subject or evaluate their knowledge of concepts through creative means. While most games may not be readily accessible to teachers or easy to implement with limited class time, the goal of this project was to give science students (specifically in the realm of physics) alternative ways of looking at the material. Each of the games and simulations used in this project were readily available, inexpensive, and capable of being used within the classroom.

All of these lessons were designed specifically in mind for a typical forty-five minute class with access to an ample number of computers with an internet connection. However, it is reasonable to assume that such conditions may not be available for some schools so it is understandable that additional adjustments may need to be made to accommodate the available resources. Still, in an age where teachers are exchanging their blackboards for smartboards, so to must traditional styles of teaching give way to more interactive methods. Games and simulations, when used correctly, can provide just that.

Summary

Overall, educators are continuously seeking newer instructional methods to ensure that they can assist all types of learners (visual, kinesthetic, auditory, etc.). The transmission of knowledge through oral dictation in education, in which students passively listen to lectures presented by teachers, is neither an engaging nor an effective means for learning. Therefore, it is essential that educators utilize a variety of teaching methods and make use of the technology that is readily available to further enhance their instruction. Educational games provide students with a safe environment in which they can acquire knowledge through direct experiences from a variety of game-related activities, thereby satisfying the needs of a wide range of learners (Tang, Hanneghan, & El-Rhalibi, 2009). Games also have the potential to engage students and foster interest in science and engineering, but only when used effectively in instruction. Game-based learning is one such stratagem that will enable students to build problem solving skills and experience learning science in a fun, interactive way (Fu-Hsing et al, 2012).

Preparing younger generations for jobs not yet identified by focusing on what those jobs might entail is a daunting if not impossible task. Instead, educators can do their part to provide their students with skills and resources that will be valuable to them and applicable in a variety of settings. However, when searching for or creating good problem-based situations, it is essential to find the right balance between maintaining student interest and curricular applicability. In combination with a problem based learning approach, GBL is able to not only assist in the effective transmission of content

knowledge, but in the development of useful skills that will benefit students for the rest of their lives as they enter the work force.

Finally, traditional modes of science education in schools focus on imparting content knowledge to students via instruction. Consequently, students often acquire the misconception that scientific knowledge comprises a fixed body of “proven” facts (Chee and Tan, 2012). Thus, they fail to comprehend that the construction of scientific understanding is a human and social endeavor involving peer review, critique, justification, and argumentation, based on the citation of evidence to support claims. Therefore, it is intuitively obvious that educators should move away from the traditional methods of instruction to further support student interest and appreciation for scientific processes.

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