

Fall 12-5-2012

# Meaningful Use of Animation and Simulation in the Science Classroom

Kevin T. Swain

*The College at Brockport*, [Kswail@u.brockport.edu](mailto:Kswail@u.brockport.edu)

Follow this and additional works at: [http://digitalcommons.brockport.edu/ehd\\_theses](http://digitalcommons.brockport.edu/ehd_theses)

 Part of the [Education Commons](#)

To learn more about our programs visit: <http://www.brockport.edu/ehd/>

---

## Repository Citation

Swain, Kevin T., "Meaningful Use of Animation and Simulation in the Science Classroom" (2012). *Education and Human Development Master's Theses*. 143.

[http://digitalcommons.brockport.edu/ehd\\_theses/143](http://digitalcommons.brockport.edu/ehd_theses/143)

This Thesis is brought to you for free and open access by the Education and Human Development at Digital Commons @Brockport. It has been accepted for inclusion in Education and Human Development Master's Theses by an authorized administrator of Digital Commons @Brockport. For more information, please contact [kmyers@brockport.edu](mailto:kmyers@brockport.edu).

Meaningful Use of Animation and Simulation in the Science Classroom.

by

Kevin T. Swain

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

Submitted on December 5th, 2012

Meaningful Use of Animation and Simulation in the Science Classroom.

by

Kevin T. Swain

APPROVED BY:

---

Advisor

---

Date

---

Director, Graduate Programs

---

Date

## Table of Contents

Chapter One: Introduction	5
Chapter Two: Review of Literature	7
<i>History of Science Education in America</i>	7
The Role of Technology in Science Education Reform	8
<i>Using Animations and Simulations to Foster Higher Levels of Cognition</i>	9
<i>Science Misconceptions</i>	10
Using Animations and Simulations to Overcome Misconceptions	13
<i>Animations</i>	15
Animations Effect on Perceptions/Motivation	15
Animations Effect on Student Achievement/Understanding	16
How Animations Promote Increases in Content Knowledge	18
<i>Simulations</i>	20
Computer Simulations in Support of Instruction	20
Simulations and Achievement	21
Simulations and Perception/Motivation	24
<i>Barriers and Considerations for implementation</i>	25
Chapter Three: Application	27
Project: Lesson Plans	29
Chapter Four: Conclusion	123
References	125

### **Abstract**

Meaningful Use of Animation and Simulation in the Science Classroom.

by

Kevin T. Swain

Science classes should place a strong emphasis on incorporating educational technologies, such as animations, interactive computer programs and various other technologies into the classroom. The use of animations and computer based simulations throughout instruction increases student understanding and achievement (Rosen, 2009). The use of educational technology in the science classroom, not only helps with student understanding of content, but also positively impacts students' engagement in lessons and their attitudes towards learning (Shu-Nu, Yau-Yuen & May, 2009).

Studies have shown that instruction in a science classroom should incorporate students being actively engaged in the material in order for maximum achievement to occur. Students need to be able to take concepts from the science classroom and apply them to their everyday lives. Through the use of animations and simulations this connection can be bridged more effectively than through traditional instruction. The incorporation of computer animations and models provide enhancement and relevance to science learning.

Incorporating more educational technology such as animations and computer-based simulations is of ever increasing importance because federal legislation mandates an emphasis on technology integration in all areas of K-12 education (U.S. Department of Education, 2002). Under this mandate, education leaders at the state and local levels are expected to develop plans to effectively utilize educational technologies, such as simulations in the classroom.

## **Ch. 1: Introduction**

This paper will serve as an overview and evaluation of the intended impact of incorporating educational technology into the science classroom. Literature related to educational technology was reviewed to investigate the impact of animations and simulations on student engagement, perceptions, and learning. Using educational technologies, such as animations, interactive computer programs and various other technologies throughout instruction increases student understanding and achievement in content knowledge (Rosen, 2009). The use of educational technology in the science classroom, not only helps with student understanding of content, but also positively impacts students' engagement in lessons and their attitudes towards learning (Shu-Nu, Yau-Yuen & May, 2009). Throughout my own personal experiences in the classroom, I feel that when technology is used, students are more interested and engaged in the content.

In all sciences, but particularly earth science, students hold deeply rooted misconceptions. The misconceptions that our students hold are greatly due to misrepresentation in textbooks and various other classroom materials. According to King (2010), surveys of the earth science content of all secondary (high school) science textbooks and related publications used in England and Wales have revealed high levels of error/misconception. The 51 textbooks surveyed showed poor coverage of National Curriculum earth science and contained a mean level of one earth science error/misconception per page. Science syllabuses and examinations surveyed also showed

errors/misconceptions. Overall, more than 500 instances of misconception were identified through the surveys. For instance, the diagrams in astronomy that display the sun to earth distance and also the slightly elliptical orbit of the earth around the sun are just a few examples. Many textbooks display the earth with a misrepresented orbit, with the earth being much closer to the sun in the Northern hemisphere's winter and farther away in the summer. However, in reality the earth's orbit is only slightly elliptical. Using appropriate representations through animations and computer simulations will help to dispel these deeply rooted misconceptions.

In order to understand how educational technologies such as animations may dispel misconceptions and increase student achievement and understanding, the role of animation and computer simulation must be defined. According to Barak, Ashkar, & Dori (2011) "An animation is conceptualized as the act, process, or result of imparting life. It relates to the art or process of preparing animated movies that involves the illusion of movement on a screen. In the context of learning, animation is effective especially in visualizing processes that cannot be seen or that are difficult to explain in class." (p.840). According to de Jong and van Joolingen (1998) a computer simulation is a program that contains a model of a system (natural or artificial; e.g., equipment) or a process.

Gardner stated that students have multiple intelligences, and that not all students learn best through traditional teacher centered, verbal instruction. Perhaps the greatest significance to education is that the theory of multiple intelligences requires teachers to expand their repertoire of teaching tools and strategies, breaking free from the traditional linguistic and logical approaches. According to Sulaiman (2011) the use of visual animation and interactive simulations can serve not only as a specific remedy to one-

sidedness in teaching, but also as an organizational tool that facilitates and complements existing educational pedagogy. The use of interactive simulations is an approach to teach children at risk for learning difficulties because of it requires active participation, is multi-sensory in nature, and has the ability to peak the interest of all children.

Studies have shown that instruction in a science classroom should incorporate students being actively engaged in the material in order for maximum achievement to occur. Students need to be able to take concepts from the science classroom and apply them to their everyday lives. Effective instruction needs to be relevant to students' lives, not just facts that must be memorized for a test. Through the use of animations and simulations this connection can be bridged more effectively than through traditional instruction. The effectiveness of educational technology and the belief that animations and simulations helps foster student engagement, perceptions and learning, will be investigated in this paper. The incorporation of computer animations and models provide enhancement and relevance to science learning.

## **Chapter 2: Review of Literature**

### **History of Science Education in America**

During the Cold War era, technology and science education were thrust to the forefront of national conversation. The American government began to realize that the rigor of math and science programs in the nation's public schools were less than that in Japanese, German and Soviet schools (Johanningmeier, 2010). The American government started an initiative that led to more technology in American classrooms to



help students become more competitive in a global economy. However, the United States educational system is still dealing with these issues today. Studies have shown that American students are falling behind other countries when it comes to math and science. We are no longer the leader in creating the world's great scientists and thinkers.

Education Secretary Arne Duncan stated the results of an international standardized test in which U.S. students ranked from 15th to 25th worldwide in science, reading and math. This test is called the Program for International Student Assessment or PISA. It's given to 15-year-old students by the Organization for Economic Cooperation and Development. According to Koretz (2009) the U.S. science average is far below the science averages of the highest-scoring countries, and it is not only East Asian countries that dominate the list. The highest-scoring group includes Finland (by a substantial margin, the best), Hong Kong, Canada, Taiwan, New Zealand, and Australia. The U.S. average is roughly similar to that of Norway, Spain, and Iceland.

### **The Role of Technology in Science Education Reform.**

Federal legislation mandates an emphasis on technology integration in all areas of K-12 education (U.S. Department of Education, 2002). Under this mandate, education leaders at the state and local levels are expected to develop plans to effectively utilize educational technologies, such as simulations, in the classroom. In addition, the education system is expected to produce technologically literate students. "The directive to integrate instructional technology into the teaching and learning equation results from the following fundamental beliefs: (1) that learning is enhanced through the use of

technology and (2) that students need to develop technology skills in order to be productive members of society” (Davies, 2011, p.46).

A major focus of current science teaching is to promote student understanding and application of scientific knowledge and inquiry processes with an outcome that students become good problem solvers (American Association for the Advancement of Science [AAAS] 1993). Yang and Heh (2007) state that to achieve this goal, science educators must attempt to find a well-developed computer- assisted learning environment that integrates the rationales of pedagogy and cognitive-approach psychology with computers to improve science learning.

### **Using Animations and Simulations to Foster Higher Levels of Cognition**

Extensive research has shown that students have difficulty in learning abstract phenomenon and processes that can't be seen or felt. Educational technology, such as animations has been shown to address students' issues with learning these abstract phenomenon and processes. Extensive studies have shown that animations are employed for enhancing the transitions from abstract to concrete mental operations and vice versa. “These transitions may promote higher order thinking skill. Among the various higher order thinking skills, reasoning and explanation abilities are fundamental for the development of learners' critical thinking, and thus, for meaningful learning of science” (Barak, Ashkar, & Dori, 2011, p.840). Najjar (1998) examined the use of animations and simulations among learners and found that when more visualized means are used, the better the learning process become. The study showed that the best method for teaching dynamic processes is through the use of computerized animation.

According to Mayer's cognitive theory (2002) knowledge is represented and manipulated through two cognitive channels: visual-pictorial and auditory-verbal. Animated movies are a combination of the two channels. The written text and the animated characters created the visual-pictorial channel and the characters' voices formed the auditory-verbal channel. Following the definition of multimedia, the students who studied with the use of animations, applied three learning styles: visual, auditory and kinesthetic, and used three senses: seeing, hearing, and touching. "Research shows that the usage of multi-senses for the construction of knowledge, promotes meaningful learning" (Barak, Ashkar, & Dori, 2011, p.844).

Mayer's cognitive theory (2002) also states that students are more likely to engage in productive cognitive processing when corresponding words and pictures are presented at the same time. Simultaneous presentation increases the chances that corresponding words and pictures will be in working memory at the same time, thereby enabling the learner to construct mental connections between them. This cognitive processing results in deeper understanding as reflected in measures of problem-solving transfer. Simultaneous presentation results in deeper learning than successive presentation, therefore students learn more deeply from multimedia presentations in which animation and narration are presented simultaneously.

### **Science Misconceptions**

There are many student misconceptions involving all science fields, but in particular earth science. A large reason for many misconceptions is because of misrepresented information and diagrams in textbooks. This misinformation in textbooks

can cause reinforcement of prior student misconceptions that they come into the classroom with. Not only do textbooks often convey wrong information to students, but a study by King (2010) carried out amongst 150 science teachers teaching earth science in England and Wales showed that teacher educational backgrounds in earth science were poor and that science textbooks were key sources of information for them. Too often teachers are reinforcing their own misconceptions through the use of misrepresented texts and conveying their misconceptions to their students. According to the study by King (2010) a high level of errors/misconceptions were revealed in the 51 high school earth science textbooks that were analyzed in England and Wales. Of the topics in the textbooks the majority of “errors/oversimplifications” related to rocks and rock-forming processes (40%), particularly to sedimentary rocks and processes (24%). High percentages were also found in the earthquake, earth’s structure and plate tectonic categories (29%). A few examples include, weathering is the wearing down of stones by weather, earth’s plates float on top of the mantle, and the rock cycle makes rocks.

Studies by Gazit, Yair & Chen (2005) have reported that students of all ages as well as teachers hold intuitive misconceptions about astronomy. For example, most students hold intuitive models that view the changes of the Earth’s distance from the Sun as the cause for the annual cycle of the seasons. The lunar phases and the eclipse phenomena also are an area of difficulty for students because they involve the Earth, the Moon, and the Sun, which have different positions and relative motions in 3D space. Several studies have found that students confused the moon’s position at full moon with the moon’s lunar eclipse position.

Many Science misconceptions are related to abstract ideas and issues of scale. The American Association for the Advancement for Science's (AAAS) report, *Benchmarks for Science Literacy* noted that a proper understanding of scale is critical to understanding, "the immense size of the cosmos, the minute size of molecules, and the enormous age of the earth" (AAAS, 1993, p. 276). The *Benchmarks* volume states that by the end of the eighth grade, students should know that: The sun is many thousands of times closer to the earth than any other star. Light from the sun takes a few minutes to reach the earth, but light from the next nearest star takes a few years to arrive... Some distant galaxies are so far away that their light takes several billion years to reach the earth. (AAAS, 1993, p. 64). However, there are many studies that show U.S students have many misconceptions about astronomical distances. A study by Miller and Brewer (2010) shows that the majority of participants overestimated the distance from the Earth to the Moon, moderately underestimated the distance to the Sun, and dramatically underestimated the distances to the nearest star and to the nearest galaxy. "Participants gave a median estimate of the distance from the Earth to the Sun that was less than half the physical distance. The median distances to the nearest star was underestimated by more than five orders of magnitude, while the distance to the nearest galaxy was underestimated by more than eight orders of magnitude" (p.1556).

A review of literature on weather misconceptions by Henriques (2002) revealed that the student misconceptions fell into the following categories: properties of water, phase changes and the water cycle, cloud formation and precipitation, the atmosphere (gases), and greenhouse effect/global warming. A few misconceptions about weather include the expansion of matter being due to the expansion of the particles, rather than

the increase of particle spacing. Water atoms themselves expand or change when ice melts. When water dries (evaporates), it disappears. Condensation on the outside of a container is water that seeped through the container itself. Air neither has mass nor can it occupy space. The H on weather maps stands for hot temperatures, whereas L means cold weather. Absorption by the glass in greenhouses is the main factor responsible for higher temperatures inside.

### **Using Animations and Simulations to Overcome Misconceptions.**

When teachers know what their students think, they can implement instructional activities to challenge existing student ideas. Activities and questions can be planned in advance so teachers can target their students' misconceptions. According to Bakas and Mikropoulos (2003) children enter the classroom with a wide range of misconceptions about planetary phenomena. The authors argue that conventional teaching methods usually cannot overcome these difficulties, in part because of the lack of appropriate teaching aids. Bakas and Mikropoulos (2003) believe that students need an educational virtual environment for the support of the teaching of planetary phenomena, particularly of the movements of the Earth and Sun, the day and night cycle and the change of seasons. Many misconceptions arise because the Solar System is such a highly complex abstract scientific concept that is dynamic in nature, has vast spatial dimensions, and different time scale that cannot be perceived directly by the senses. These difficulties arise concerning the comprehension of planetary phenomena such as the size and shapes of the celestial bodies, the distances between them, the phenomena of alternation of day and night, and of the seasons of the year.

Bakas and Mikropoulos (2003) believe that educational computer simulations support science teaching where abstract ideas and phenomena, impossible to be observed and experienced in other ways, are involved. “In order to understand basic astronomical phenomena such as the day–night cycle, seasonal changes, moon’s phases and eclipses, one must visualize the relative motions and positions of the planetary objects in 3D space, as these may appear from different perspectives simultaneously” (Gazit et al., 2005, p.459). An effective way to overcome these misconceptions is by the use of visual aides, such as animations.

Many animations and computer simulations are being used to enhance students’ conceptual development of abstract scientific phenomena, and not just in the field of astronomy. In a report to the National Science Foundation; Furness, Winn & Yu (1997) discussed the various attributes of computer simulations with respect to learning, and put a special focus on the potential benefits of using simulations in teaching the complex issue of Global Climate Change. Specific variables can be manipulated in simulations for learning about the dynamic processes of global climate change, such as carbon dioxide levels.

Furness et al. (1997) stated as a general principle that simulations improved learning by providing the learners with new, interactive experiences of phenomena they could not have experienced before. Furness et al. (1997) also suggested that simulations are more engaging and seductive, and can teach complex topics with less need to simplify them. In a computer simulation model learners can easily and without effort visit places and view objects from different points of view, and can experiment by manipulating variables that cannot be manipulated in the real world. Gazit et al.(2005) believe this

emphasizes the notion that simulations are ideal for letting students explore things and construct their own knowledge. Winn (1997) further discussed the use of simulations for studying Global Climate Change and concluded that the variety of modalities and symbolic forms simulations offer is likely to reach more students than formal teaching.

## **Animations**

### **Animations Effect on Perceptions/Motivation.**

According to Shu-Nu, Yau-Yuen & May (2009) research has showed the importance of cultivating students' learning interests about science, student motivation level and their relationship to learning achievement. Student attitude and motivation should be considered as an essential indicator of the quality of science education. Ramsden (1998) drew the conclusion that over the past few decades, young people have generally held unfavorable attitudes and beliefs towards science. Osborne, Simon & Collins (2003) confirmed this finding through a comprehensive review of literature from the past 20 years and its implications. They concluded that to remediate the continuing decline in the number of students pursuing further study in science, teachers need to revise/refine their teaching and learning activities so that students' motivation and engagement in science-related activities will be increased.

In order for researchers to understand student attitudes towards science, student motivation levels in science had to be examined. Barak, Ashkar, and Dori (2011) sought to investigate not only the effect of animated movies on students' learning outcomes, but on their motivation to learn. The authors investigated the use of web-based animated movies into the science curriculum of 4th and 5th grade students. These students studied



science while using BrainPop animated movies and supplementary activities at least once a week. The control classes were sampled based on the fact that the students used only textbooks and pictures for learning science.

The findings of the study by Barak, Ashkar, and Dori (2011) indicated that the use of animated movies promoted students' explanation ability and their understanding of scientific concepts. The findings of the study also indicated that students who studied science with the use of animated movies developed higher motivation to learn science. These students developed higher motivation in terms of: self-efficacy, interest and enjoyment, connection to daily life, and importance to their future, compared to the control students. While carrying out the learning assignments and participating in class discussions, the students were engaged in organizing the newly introduced scientific concepts and integrating them into a coherent structure of knowledge. In the study by Barak et al.(2011) the experimental group students showed significantly higher motivation in all categories, compared to the control group students. The authors suggested that the use of BrainPop animated movies enhances students' motivation to learn science, compared to just using textbooks and still-pictures.

Extensive research has also shown a correlation between positive student perceptions and achievement. Rigby, Deci, Patrick, and Ryan (1992) reported that many studies of the relationship between motivation and learning achievement confirm that when students are more engaged in learning, they will more fully understand new knowledge and be more flexible in their use of it. By promoting intrinsic motivation, task involvement will increase and consequently, so will learning achievement.

**Animations Effect on Student Achievement/Understanding.**

This section will examine the extensive research that was been completed on the effect of animations on student content knowledge. Rosen (2009) sought to investigate the effect of an animation-based environment on student understanding and comprehension of content. This study examined 418 fifth and seventh grade students across Israel for a period of two to three months. Students in the experimental group participated at least once a week in science and technology lessons that integrated BrainPop animation videos. Students in the control group were of the same grade level as the experimental group, but received science and technology instruction using traditional methods. Traditional methods defined as teacher-centered, lecture based instruction. “The findings showed that integrating BrainPop animations into the learning process significantly increased the ability to transfer scientific and technological knowledge of elementary-school and secondary-school students. During the same time period, the findings showed only a low increase in the same ability of the control group” (Rosen, 2009, p. 458).

Höffler and Leutner (2007) also demonstrated the positive impact of animations on instruction and achievement. This study was a meta-analysis on the effect of instruction animations compared to static pictures from text. The authors found an overall advantage of animations over static pictures. The advantage also became particularly evident under specific combinations of instructional circumstances. Obviously, animations were more successful than static pictures when instructing on content with moving parts. For example, an animation showing the movement of molecules in a heated piece of metal

was much more effective than a static picture of the speed of the molecules when heated. The meta-analysis by Höffler and Leutner (2007) suggested that instructional animations are, in general, superior to static pictures with respect to learning outcome.

Serİn (2011) investigated the effects of computer-based instruction on Turkish student achievement and understanding, by measuring pre and post-test scores. The study collected data on fifty two 5th grade students in Turkey. The students were divided into two gender representative groups and subjected to traditional versus computer-based instructional styles. The 26 students in the experimental group received the interactive computer-based science and technology instruction three hours a week, for a duration of three weeks. The 26 students in the control group received only traditional teaching methods. Traditional teaching methods included lecture based, teacher-centered, textbook driven instruction.

In the study both the experimental and control groups showed an increase in student content knowledge. However, the experimental group showed a statistically significant increase over the control group. Based on the significant difference in achievement between pre and post-test scores between groups, Serİn concluded that the use of computer-based instruction and animations increased the achievement of students.

Personally, I believe that when a student can visualize a concept or process occurring, the student is more likely to retain the knowledge. Like the authors of these studies, I perceive that technology creates a more flexible, wider array of tasks, where students can maximize learning. The studies also all concluded that students show an increase in achievement with the use of this technology, but why?

**How Animations Promote Increases in Content Knowledge.**

According to Barak, Ashkar, and Dori (2011), “Animation can contribute to a better understanding of the learning material in two ways. First, it enables the creation of mental representations of concepts, phenomenon, and processes. Second, it can be used to support challenging cognitive processes such as abstraction, imagination, or creativity, which some learners are short of”(p. 841).

The differences in learning with retention or problem-solving tasks comparing dynamic vs. non-dynamic pictures, has been researched extensively. In particular, deeper understanding and thus, the ability to solve advanced problems should profit from learning with animations. According to the supplantation framework of Salomon (1979), animations dynamically display a process or a procedure, which should be able to compensate for a student's insufficient aptitude or skill to imagine motions. Thus, the animation provides an external model for a mental representation.

Barak, Ashkar, and Dori (2011) also stated that the success of the experimental group students in answering questions and providing correct explanations can be explained by their engagement in three important cognitive processes: selecting, organizing, and integrating.” I agree with the findings of these studies that the use of animations can help with student achievement. Many scientific processes are abstract ideas that happen on a microscopic level. Until a computerized modeling animation is used, students can try to imagine concepts, but may not grasp the true understanding. It is my personal belief that a picture is worth a thousand words. For example, I can sit in class and try to explain to my students how the molecules move in a liquid or gas, but until they can actually visualize the concept it is hard for them to truly understand. The

current development of Java, Flash, and other web-based applications allows teachers to now present these complex processes and animations.

## **Simulations**

### **Computer Simulations in Support of Instruction.**

Computer simulations allow students to interact with the computer, identify problems, write hypotheses, manipulate variables in simulated experiments, and to collect data. The use of simulations in the science classroom has the potential to generate higher learning outcomes in ways not previously possible (Akpan, 2001). In comparison with textbooks and lectures, a learning environment with a computer simulation has the advantages that students can systematically explore hypothetical situations, interact with a simplified version of a process or system, change the time-scale of events, and practice tasks and solve problems in a realistic environment without stress (van Berkum & de Jong, 1991).

“By placing emphasis on the learner as an active agent in the process of knowledge acquisition, computer simulations can support authentic inquiry practices that include formulating questions, hypothesis development, data collection, and theory revision. Proceeding through a simulation can gradually lead learners to infer the features of the simulation’s conceptual model, which may lead to changes in the learners’ original concepts” (Rutten et al., 2011, p.136). By actively involving learners in exploring and discovering, computer simulations can be powerful learning tools, as learning involving doing is retained longer than learning via listening, reading, or seeing (Akpan, 2001).

Computer simulations incorporate many other factors of instruction to accommodate the different learning styles of the students. Computer simulation is a teaching technique that reproduces actual events and processes under test conditions. This is of particular importance when the area of topic being studied is too large for classroom study. An example is when students attempt to understand processes of the solar system; which cannot be done to scale for obvious reasons. Students must use simulations and interactive media to understand processes such as eclipses or moon phases. Simulations enable students to understand complex interactions of physical or social environment factors.

Simulations are also advantageous when investigating dangerous concepts. Dangerous concepts defined as outcomes that could result in harm to person, property or animal. As a technique for instruction, simulation allows students to deal in a realistic way with matters of vital concern, but without dire consequences should they make wrong choices. According to Udo & Etiubon (2011) time compression is another cost-saving feature of simulation technology. Events that can take anywhere from hours to eons in real time can be simulated in a few minutes.

### **Simulations and Achievement.**

Extensive research has also taken place on how computer simulations affect student content knowledge and achievement. Udo & Etiubon (2011) investigated the relative effectiveness of computer-based science simulations on students' achievement at the secondary school level when compared with traditional expository teaching methods.

“The results of data analysis using Analysis of Covariance (ANCOVA) of pre and post test scores showed that students taught by computer-based science simulations performed significantly better than those taught using the traditional expository method, (mean diff. = 4.34; sig. = .032)” (Udo & Etiubon, 2011, p.212)

Wang & Reeves (2007) stated that realistic graphic simulation with high quality video enables students to observe scientific, industrial, role-playing and decision-making processes; and brings reality into the classroom where conventional practice is out of reach. Computer-based simulations, allow learners to work in a dynamic interactive environment which facilitate their knowledge reformulation and concept attainment besides evoking and sustaining interest, concretizing learning and making learning less stressful.

Huppert, Lomask, & Lazarowitz, (2002) found that simulated experiments, have great potential to address the problem solving process which is a complex activity. Their research investigated the computer simulation’s impact on students’ academic achievement and on their mastery of science process skills in relation to their cognitive stages. “The results indicate that the concrete and transition operational students in the experimental group achieved significantly higher academic achievement than their counterparts in the control group. Students’ academic achievement may indicate the potential impact a computer simulation program can have, enabling students with low reasoning abilities to cope successfully with learning concepts and principles in science which require high cognitive skills” (Huppert, Lomask & Lazarowitz, 2002, p.803).

Jimoyiannis and Komis (2001) also found similar results, stating that computer simulations led to an increase in student content knowledge. Jimoyiannis and Komis

compared a group of students who received traditional classroom instruction with a group who were exposed to both traditional instruction and computer simulations. They investigated the effect of this intervention on students' understanding of basic kinematics concepts concerning simple motions through the Earth's gravitational field. The students who used the computer simulation in addition to traditional instruction achieved significantly higher results on the research tasks. Therefore, the researchers suggest that computer simulations can be used as a complement to other forms of instruction in order to facilitate students' understanding.

Rivers and Vockell (1987) stated that computer simulations have been found to enhance students' active involvement in the learning process, enabling them to apply principles more often, and helped students to meet the learning unit goals. Students who used the guided version of the simulation performed better in the tests of scientific and critical thinking than the students in the control group.

Becker (1986) found that the use of computer-assisted learning improved the academic performance of below-average and average students in the middle school. The and Fraser (1995) compared the experimental group, which learned with computer simulations, with the control group which studied in an expository mode, and reported that the differences on achievement and attitudes were significantly higher.

Huppert, Lomask, & Lazarowitz, (2002) stated that a computer simulated experiment addresses the problem solving process by controlling the input values of a model, describing its changes through time, and examining the changes in the outcomes. Based upon what students know about the problem, they can engage in an alternative path of effective learning at their own pace. The integration of short simulations into the



existing curriculum of heterogeneous classes, in which learners are at different cognitive stages, holds a promise to improve their academic achievement.

### **Simulations and Perception/Motivation.**

Extensive studies have shown that through the use of simulations students are more actively engaged and motivated in the learning process by interacting with the computer software in an ongoing dialogue. Geban, Askar & Ozkan (1992) investigated the effects of a computer-simulated lab experiment on the process skills and attitudes towards science at the high school level. An experimental group was compared against a control group of 200 students using a conventional approach. Their results indicated that the computer-simulated experiment approach produced significantly greater science process skills and more positive attitudes towards science than the conventional approach. The authors also stated that the primary goal of science education is to promote positive attitudes towards science courses and that computer based simulations promote these attitudes.

Computer based models and simulations can have a significant impact on student motivation and was indicated by a rise in student interest in the study by Wang & Reeves (2007). A good strategy for the enhancement of a student's motivation toward a task hinges on an enhancement of that task's capacity to spark the student's interest. The study by Wang & Reeves (2007) revealed multiple forms of evidence that the computer based simulation and the associated learning activity improved students' motivation. Wang & Reeves believe that what educators do to help students actively engage in

learning may be more important to academic success than how much information is presented to them through instructional materials or other forms of instruction.

To enhance the active engagement of students as they learn science, the computer-based simulations developed during their study employed four intrinsic motivational strategies suggested by Malone and Lepper (1987): challenge, curiosity, control, and fantasy. Challenge is defined as engaging in activities that challenge the learners' abilities may enhance intrinsic motivation. Curiosity is a response to any novel and extraordinary idea that drives students to discover. Curiosity can be stimulated by using technical events to attract the learner's attention. Control suggests that learners' intrinsic motivation may be enhanced if activities can provide a sense of control and allow learners to direct their own learning performance. Last is fantasy, an environment that evokes mental images of physical or social situations not actually present or in some cases not possible. These four factors are believed to enhance intrinsic motivation if incorporated in a computer-based simulation lesson. Huppert, Lomask & Lazarowitz (2002) affirmed that computer simulations can positively influence students' satisfaction, participation and initiative, and improve their perception of the classroom environment. To summarize, Olsen and Clough (2001) simply state that simulations fascinate students and have the potential to grab and maintain their attention in ways that interacting with a teacher, reading a book, seriously discussing ideas with other students, and thinking about their own learning cannot.

### **Barriers and Considerations for implementation**

Although animations and computer simulations can serve as powerful tools in an educator's arsenal, one must also be aware of some possible pitfalls. Some of the pitfalls of learning using animations and simulations are that misconceptions can arise as a direct consequence of misdirection or misuse of simulations. Educators should become aware of the common misconceptions associated with the topic of study and address those misconceptions before student use of the simulation. Gazit et al. (2005) state that simulation learning should be accompanied by suitable scaffolding and guided reflection. The authors believe that the emergence of new misconceptions is a consequence of the lack of monitoring student use. It is suggested that teachers guide their students through the use of simulations and gradually lead the students, through observe–deduce questions, to higher and more complex tasks in planetary science. Such activities could reduce the danger of self-constructed misconceptions that may emanate from the powerful representations within the simulation.

Another consideration before implementing animations and simulations into the classroom is that technology is not perfect. The possibility exists that computers and technology break down and are not always reliable resources. When computer malfunctions occur during lessons that solely rely on the use of computer technology, serious negative outcomes to the learning process can occur. Teachers must also become comfortable with the use of a certain technology to maximize the effect that it has on learning. Teachers must be confident with their own abilities in order to convey those beliefs and attitudes upon their students.

One must also consider their rationale and main goal for using technology, such as simulations in the classroom. Just because a teacher has a simulation that they like,

that should not determine the content that is being taught. Teachers must consider their purpose for using the technology and if it is developmentally appropriate for the age group of the students. The availability of technology and simulations does not justify its inclusion in the classroom. According to Olson and Clough (2001) as technology becomes more widely available at lower cost, unfortunately teachers are increasingly including activities in their curricula that are neither developmentally appropriate nor coherent with other topics. “Introductory high school biology and even middle school life science students are now performing gel electrophoresis and polymerase chain reactions simply because the technology has recently become available at reasonable expense. Never mind that most students have little or no prior chemistry experience and have significant difficulty conceptually understanding the molecular structure and function of DNA and proteins” (Olson and Clough, 2001, p.11).

### **Chapter 3: Application**

This project consists of twenty lesson plans centered on student use of animations and simulations. Students who are struggling to understand concepts after traditional instruction will benefit from these visual aides. These lesson plans are a compilation of animations and simulations that are useful for dispelling common misconceptions and providing students with activities that might not otherwise be feasible due to money, ethical issues, safety concerns, scale of the study, or duration of the study.

The project includes twenty lesson plans with multiple animations or simulations in each lesson that enhance the Regents Earth Science curriculum. The lesson plans

include all aspects of the Earth Science curriculum including geology, meteorology and astronomy. Topics explored in the lesson plans include, but are not limited to rocks, plate tectonics, earthquakes, fronts, moon phases and seasons. These interactive lessons visually engage students and incorporate various learning styles. Students therefore can take control over their own learning and have a choice on what to manipulate, and how to manipulate the simulations. Each lesson plan includes links to animations/simulations, along with the lesson procedure and associated worksheets and assessments. Research shows that student achievement and motivation will be enhanced by the animated, interactive lessons in this project.

Each lesson in the compilation will include the following, as applicable:

- Title of lesson
- Course(s) for lesson
- NYS standards that fit the lesson
- Narrative Summary of the lesson and how animation/simulation enhanced instruction
- Rationale for choosing this particular animation/simulation (concept is too small/too large, concept would normally require much longer time, etc.
- Possible misconceptions of the given topic of study.
- Recommendations for implementing in the classroom (i.e. if students can work in groups, if worksheet needs to be incorporated etc.)

Where the above points are not addressed by research in the attached literature review, the information provided will be either based on the thesis author's own experience or projected implementation in the classroom. This knowledge will come from having taught Regents Earth Science and Physical Science (Sept. 2008-present)

<b>Title:</b>	Groundwater (Porosity and Permeability) #1
<b>Source/website:</b>	<a href="http://www.eram.k12.ny.us/education/page/download.php?fileinfo=cGVybS5wb3Jvcy5zd2Y6Ojovd3d3L3NjaG9vbHMvc2MvcmVtb3RlL2ltYWdlcy9kb2NtZ3IvNDQ3ZmlsZTE3NDcuc3dm&amp;sectiondetailid=17500">http://www.eram.k12.ny.us/education/page/download.php?fileinfo=cGVybS5wb3Jvcy5zd2Y6Ojovd3d3L3NjaG9vbHMvc2MvcmVtb3RlL2ltYWdlcy9kb2NtZ3IvNDQ3ZmlsZTE3NDcuc3dm&amp;sectiondetailid=17500</a> (4 columns)  <a href="http://techalive.mtu.edu/meec/module06/Permeability.htm">http://techalive.mtu.edu/meec/module06/Permeability.htm</a> (actual sediment: gravel, sand etc.)  <a href="http://earthguide.ucsd.edu/earthguide/diagrams/groundwater/index.html">http://earthguide.ucsd.edu/earthguide/diagrams/groundwater/index.html</a> (Groundwater and wells)  Groundhog video (pollution etc.)
<b>Course:</b>	Regents Earth Science
<b>NYS Standard:</b>	1.2g- Earth has continuously been recycling water since the outgassing of water early in its history. This constant recirculation of water at and near Earth's surface is described by the hydrologic (water) cycle. ¥ A portion of the precipitation becomes runoff over the land or infiltrates into the ground to become stored in the soil or groundwater below the water table. Soil capillarity influences these processes. ¥ The amount of precipitation that seeps into the ground or runs off is influenced by climate, slope of the land, soil, rock type, vegetation, land use, and degree of saturation. ¥ Porosity, permeability, and water retention affect runoff and infiltration.

<b>Summary:</b>	The bead columns animation allows students to visualize how particle size affects the permeability of groundwater through sediment. Students can see how larger particles allow water to infiltrate more quickly. Students can also see how particle size affects the porosity (pore space) of a sample. A mixture of particle size in the fourth column allows students to see how arrangement of particles affects infiltration rate and porosity. Many students don't have any prior knowledge on groundwater or even where their drinking water comes from.
<b>Rationale:</b>	Porosity, infiltration rate and permeability are an important part of the Earth Science curriculum. It is a very tough concept for most students to understand because students rarely visualize how water seeps through the ground after rainstorms. Students have very little to no prior knowledge on groundwater. This simulation helps students by: <ul style="list-style-type: none"> <li>- Providing them with a visual representation of groundwater movement, which they cannot otherwise see in real life. Students rarely think about processes going on beneath their feet.</li> <li>- Helping them connect to a concept that affects their daily drinking water.</li> </ul>
<b>Possible Misconceptions:</b>	This animation helps to dispel common misconceptions on porosity. The majority of students believe that larger particles have more porosity than smaller particles. The amount of water in the beakers will show students that particle size does not affect porosity.
<b>Recommendations:</b>	Students should follow along on worksheet during animation and discussion.

#### Lesson Procedure:

- 1) Brief discussion on where water goes when it rains. The water out of your faucet comes from where? Get students beliefs on these concepts.
- 2) PowerPoint notes on vocabulary terms- infiltration, porosity, permeability.
- 3) 1<sup>st</sup> animation: raise of hands on which column will drain the fastest. Will each have the same amount of water? Discussion after playing animation several times.
- 4) Explain the challenging concept of porosity. Imagine a column full of baskets and a column full of marbles. Although the basketballs would have larger pore spaces, there would only be a small number of those spaces. The column of marbles would

have smaller pore spaces, but a much greater number of those spaces. Mathematically the percentage of pore space would be the same. Only in the 4<sup>th</sup> column with mixed particle size would those pore spaces be filled by smaller particles falling into the gaps.

- 5) Show 2<sup>nd</sup> animation on actual sediment (gravel, sand, silt and clay) and have students now predict infiltration rates. From last animation students should be able accurately predict. Also have a discussion on garbage dumps and how they can prevent chemical from leaking into groundwater supply (clay).
- 6) Now that students have a basic understanding have volunteers come up to smartboard and demonstrate knowledge on the water table with 3<sup>rd</sup> animation. Explain how wells work for drinking water by intersecting the water table.
- 7) Cartoon groundhog video to summarize groundwater and explain groundwater contamination.
- 8) Summative worksheet assessing student knowledge on infiltration, porosity, permeability.



Name \_\_\_\_\_

Groundwater

1) Which of the following surface soil types has the *slowest* permeability rate and is most likely to produce flooding?

- A) pebbles
- B) silt
- C) sand
- D) clay

2) Which is most important in determining the amount of ground water that can be stored within a rock?

- A) the rock's geologic age
- B) the rock's hardness
- C) the rock's porosity
- D) the rock's color

3) The water table usually rises when there is

- A) an increase in the amount of precipitation
- B) an increase in the slope of the land
- C) a decrease in the amount of infiltration
- D) a decrease in the amount of surface area covered by vegetation

4) The diagram below shows two identical containers filled with uniform particles that were sorted by size. What characteristic is most likely the same for these particle-filled containers?

- A) water retention
- B) capillarity
- C) porosity
- D) infiltration rate

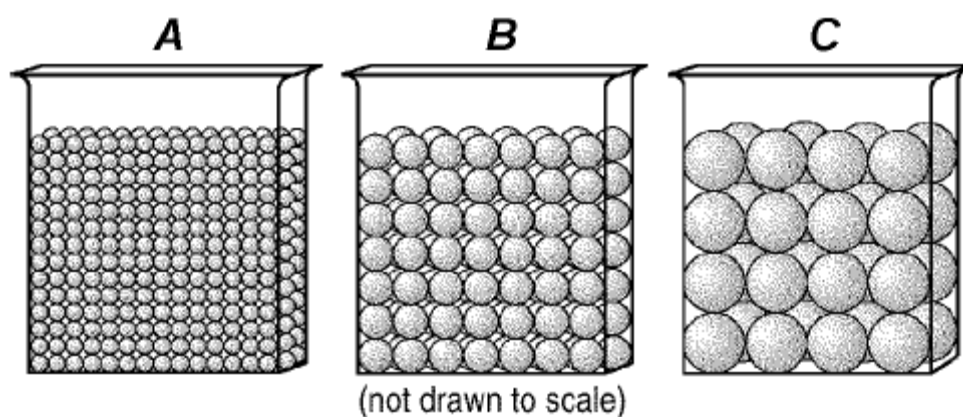
5) Which sediment size would allow water to flow through at the *fastest* rate?

- A) silt
- B) sand
- C) clay
- D) pebbles

6) Why does water move very slowly downward through clay soil?

- A) Clay soil is composed of low-density minerals.
- B) Clay soil is composed of very hard particles.
- C) Clay soil has large pore spaces.
- D) Clay soil has very small particles.

The diagrams below represent three containers, *A*, *B*, and *C*, which were filled with equal volumes of uniformly sorted plastic beads. Water was poured into each container to determine porosity and infiltration time.



7) Which data table *best* represents the porosity and infiltration time of the beads in the three containers?

A)

Beaker	Porosity (%)	Infiltration Time (sec)
<i>A</i>	40	0.4
<i>B</i>	40	2.8
<i>C</i>	40	5.2

C)

Beaker	Porosity (%)	Infiltration Time (sec)
<i>A</i>	20	0.4
<i>B</i>	30	2.8
<i>C</i>	40	5.2

B)

Beaker	Porosity (%)	Infiltration Time (sec)
<i>A</i>	40	5.2
<i>B</i>	40	2.8
<i>C</i>	40	0.4

D)

Beaker	Porosity (%)	Infiltration Time (sec)
<i>A</i>	20	5.2
<i>B</i>	30	2.8
<i>C</i>	40	0.4

<b>Title:</b>	Igneous Rock Formation #2
<b>Source/website:</b>	<p>BrainPop- rocks</p> <p><a href="http://www.classzone.com/books/earth_science/terc/content/investigations/es0603/es0603page01.cfm">http://www.classzone.com/books/earth_science/terc/content/investigations/es0603/es0603page01.cfm</a> (igneous rocks)</p> <p><a href="http://www.eram.k12.ny.us/education/page/download.php?fileinfo=aWduZW91cy5zd2Y6Ojovd3d3L3NjaG9vbHMvc2MvcmVtb3RIL2ltYWdlcy9kb2NtZ3IvMzMzMzZmlsZTYxNC5zd2Y=&amp;sectiondetailid=17500">http://www.eram.k12.ny.us/education/page/download.php?fileinfo=aWduZW91cy5zd2Y6Ojovd3d3L3NjaG9vbHMvc2MvcmVtb3RIL2ltYWdlcy9kb2NtZ3IvMzMzMzZmlsZTYxNC5zd2Y=&amp;sectiondetailid=17500</a> (Practice with Earth Science Reference Table Chart)</p>
<b>Course:</b>	Regents Earth Science
<b>NYS Standard:</b>	<p>3.1c- Rocks are usually composed of one or more minerals.</p> <p>¥ Rocks are classified by their origin, mineral content, and texture.</p> <p>¥ Conditions that existed when a rock formed can be inferred from the rock's mineral content and texture.</p>
<b>Summary:</b>	<p>The igneous rocks animations allow students to visualize different types of igneous rocks form. Students can see how cooling rates of magma or lava affect the crystal size of igneous rocks. Students will become familiar with the various types of igneous rocks such as intrusive, extrusive, felsic, mafic and vesicular texture. Particular types of igneous rocks such as granite, pumice, scoria, obsidian and pegmatite will be identified. Through the animations students will learn that the more quickly lava is forced to cool, the smaller the crystals. The longer the magma has to cool, the larger the crystals.</p>
<b>Rationale:</b>	<p>Igneous rocks and the rock unit in general, is one of the most important units in all of geology. Many of the future units will be based on student understanding of the rock unit, such as weathering, erosion and plate tectonics. Students have difficulty understanding how igneous rocks are created due to the fact that in Rochester, we have no natural igneous rocks. The animations help students to visualize these processes because most of my students have never seen any type of volcanic activity. The animations help students to visualize the volcanic activity occurring and the solidification of molten material. Students rarely think about the processes going on underneath the surface of the earth such as the cooling of magma chambers. This</p>

	<p>simulation helps students by:</p> <ul style="list-style-type: none"> <li>- Providing students with a visual representation of magma solidification and crystal growth. These processes cannot be seen in a classroom setting due to our geographic location and also the fact that many igneous processes occur deep underground.</li> <li>- Helping students to understand how pumice forms during dangerous volcanic eruptions.</li> </ul>
<b>Possible Misconceptions:</b>	Students believe that all igneous rocks form from cooling lava that seeps out of volcanoes. (The truth is only small portion of igneous rocks form that way).
<b>Recommendations:</b>	Students carefully answer questions while using the animations.

#### Lesson Procedure:

- 1) KWL chart about what students know, what they want to know and later what they learned.
- 2) BrainPop video on rocks and associated worksheet
- 3) PowerPoint notes on key terms: intrusive, extrusive, felsic, mafic, texture, crystals size, vesicular etc.
- 4) Students use laptops to investigate 1<sup>st</sup> website. Students follow directions and click on various rocks to examine them. Students answer questions on the website while investigating.
- 5) Students use animated earth science reference table website to answer questions based on the igneous rock chart.
- 6) Students complete hands-on igneous rock lab with actual rock samples.
- 7) Ticket out the door.

Name \_\_\_\_\_ Reference Table Chart Worksheet

- 1) According to the *Earth Science Reference Tables*, which is a fine-grained igneous rock made up primarily of pyroxene and plagioclase feldspar?  
A) granite  
B) gabbro  
C) basalt  
D) rhyolite
- 2) According to the "Scheme for Igneous Rock Identification" in the *Earth Science Reference Tables*, basalt contains the *greatest* quantity of which mineral?  
A) mica  
B) quartz  
C) pyroxene  
D) potassium feldspar
- 3) According to the "Scheme for Igneous Rock Identification" in the *Earth Science Reference Tables*, which statement best describes the percentage of plagioclase feldspars in a sample of gabbro?  
A) Gabbro always contains less plagioclase than pyroxene.  
B) Gabbro contains no plagioclase feldspars.  
C) Plagioclase feldspars always make up 25% of a gabbro sample.  
D) The percentage of plagioclase feldspar in gabbro can vary.
- 4) A fine-grained igneous rock contains 11% plagioclase, 72% pyroxene, 15% olivine, and 2% amphibole. According to the *Earth Science Reference Tables*, this rock would most likely be classified as  
A) rhyolite  
B) gabbro  
C) basalt  
D) granite
- 5) According to the *Earth Science Reference Tables*, rhyolite and granite are alike in that they *both* are  
A) felsic  
B) fine-grained  
C) dark-colored  
D) mafic

- 6) An igneous rock which has crystallized deep below the Earth's surface has the following approximate composition: 70% pyroxene, 15% plagioclase, and 15% olivine. According to the *Earth Science Reference Tables*, what is the name of this igneous rock?
- A) gabbro  
B) rhyolite  
C) basalt  
D) granite
- 7) According to the *Earth Science Reference Tables*, which is the best description of the properties of basalt?
- A) fine-grained and felsic  
B) coarse-grained and mafic  
C) coarse-grained and felsic  
D) fine-grained and mafic

Name \_\_\_\_\_ Igneous Ticket out the Door

- 1) The best evidence for determining the cooling rate of an igneous rock during its solidification is provided by
  - A) the disintegration of radioactive substances
  - B) the crystal size of its minerals
  - C) index fossils
  - D) faults in the rock
- 2) Extremely small crystal grains in an igneous rock are an indication that the crystals formed
  - A) from an iron rich magma
  - B) under high pressure
  - C) deep below the surface of the earth
  - D) over a short period of time
- 3) Large crystal grain in an igneous rock indicate that the rock was formed
  - A) under low pressure
  - B) by cooling slowly
  - C) by cooling quickly
  - D) at a low temperature
- 1) Sand collected at a beach contains a mixture of pyroxene, olivine, hornblende, and plagioclase feldspar. According to the Earth Science Reference Tables, the rock from which this mixture of sand is best described as
  - A) light colored with a felsic composition
  - B) light colored with a mafic composition
  - C) dark colored with a mafic composition
  - D) dark colored with a felsic composition
- 5) If an igneous rock has a vesicular texture, such as pumice, the rock cooled.
  - A) quickly
  - B) slowly

<b>Title:</b>	Rock Cycle Processes #3
<b>Source/website:</b>	<p>BrainPop- rock cycle</p> <p><a href="http://www.classzone.com/books/earth_science/terc/content/investigations/es0602/es0602page01.cfm">http://www.classzone.com/books/earth_science/terc/content/investigations/es0602/es0602page01.cfm</a> (rock cycle and visual processes)</p> <p><a href="http://www.phschool.com/atschool/phsciexp/active_art/rock_cycle/index.html">http://www.phschool.com/atschool/phsciexp/active_art/rock_cycle/index.html</a></p> <p>(visualizing rock cycle, actually showing erosion, melting etc.)</p>
<b>Course:</b>	Regents Earth Science
<b>NYS Standard:</b>	<p>2.1m- Many processes of the rock cycle are consequences of plate dynamics.</p> <p>2.1w- Sediments of inorganic and organic origin often accumulate in depositional environments. Sedimentary rocks form when sediments are compacted and/or cemented after burial or as the result of chemical precipitation from seawater.</p>
<b>Summary:</b>	<p>The rock cycle animations allow students to visualize how igneous, sedimentary and metamorphic rocks form. Students can see how each rock can also turn into a different type of rock o many years. Students will become familiar with terms such as weathering, erosion, compaction, cementation, solidification and pressure. Through the animations students will learn that not only can an igneous rock become a sedimentary or metamorphic rock, but it can also melt to become a new igneous rock.</p>
<b>Rationale:</b>	<p>The rock unit is the main staple of the entire geology curriculum. This lesson will help students to solidify their understanding of rocks as they explore the rock cycle. The animations help students to visualize the complex processes a rock can undergo during its lifetime. These animations help students to understand that the rock cycle has no end and that a rock can change forms over and over again. Students typically do not think about how rocks have and will change over the years. It is difficult without the animations to imagine how a rock in their front yard may change over millions and millions of years. This simulation helps students by:</p> <ul style="list-style-type: none"> <li>- Providing students with a visual representation of</li> </ul>



	<p>all of the rock cycle processes. Students in one class period can actually see the processes occurring as the rock changes forms.</p> <ul style="list-style-type: none"><li>- - Allowing students to take a journey on the rock cycle with is impossible in real life due to the massive amount of time the processes take.</li></ul>
<b>Possible Misconceptions:</b>	Many students believe that rocks are permanent fixed objects. For example, a piece of granite will remain a piece of granite indefinitely.
<b>Recommendations:</b>	Students explore the rock cycle individually on their laptops.

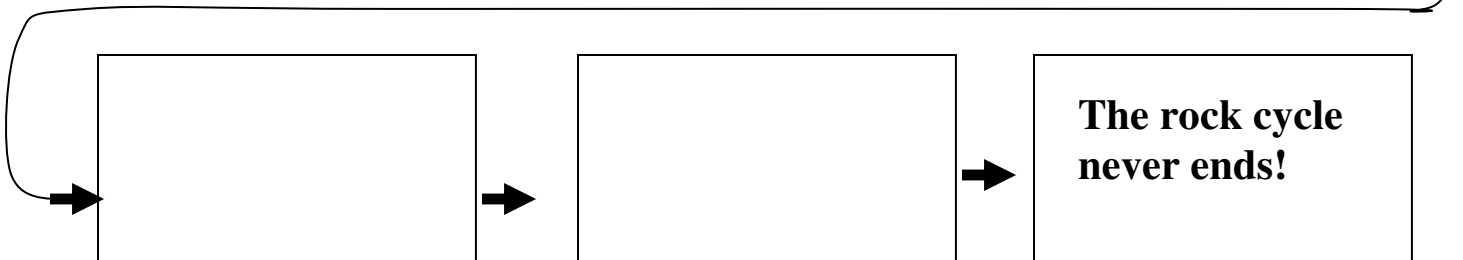
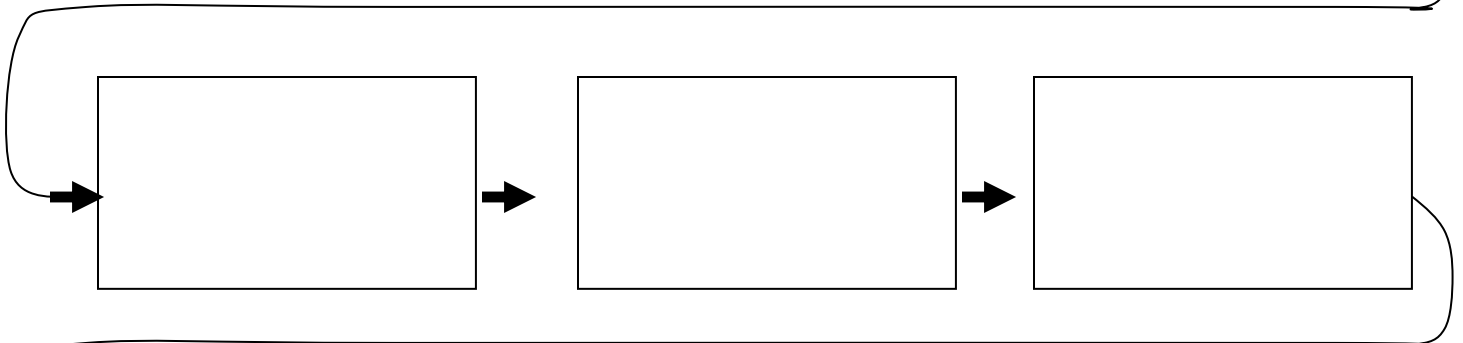
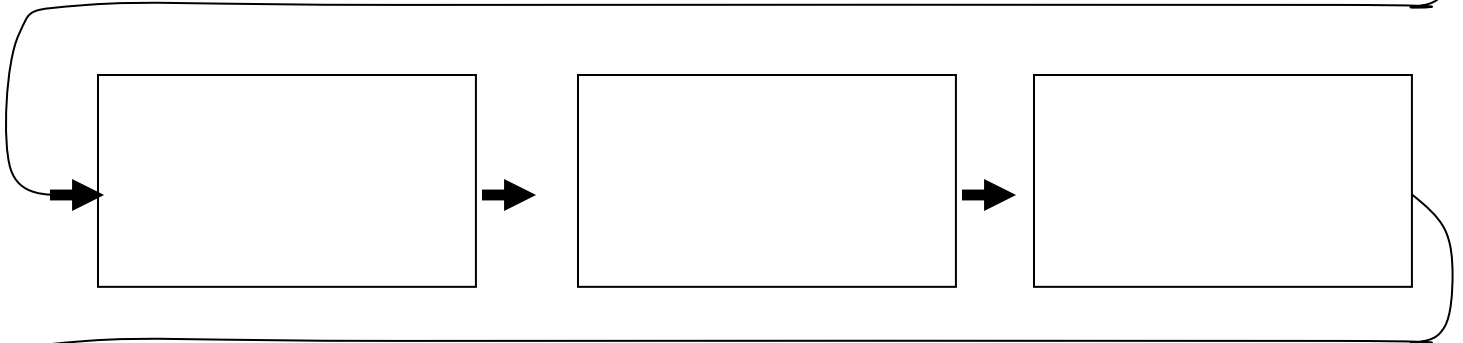
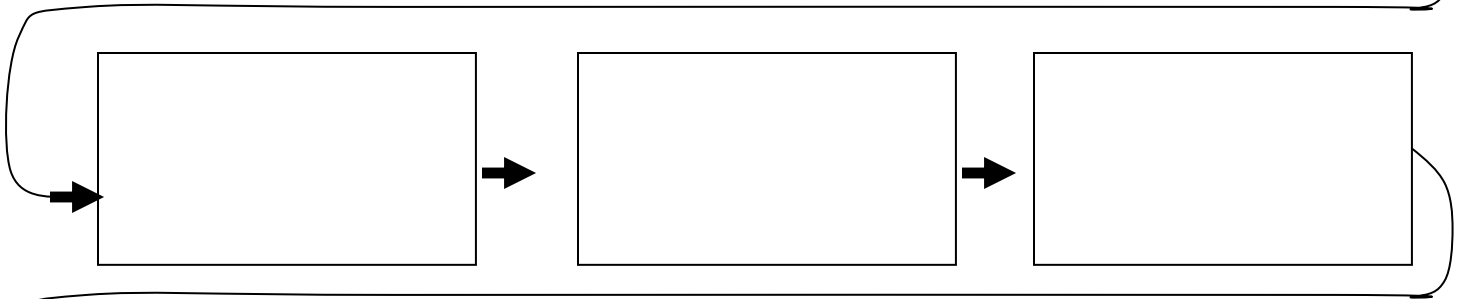
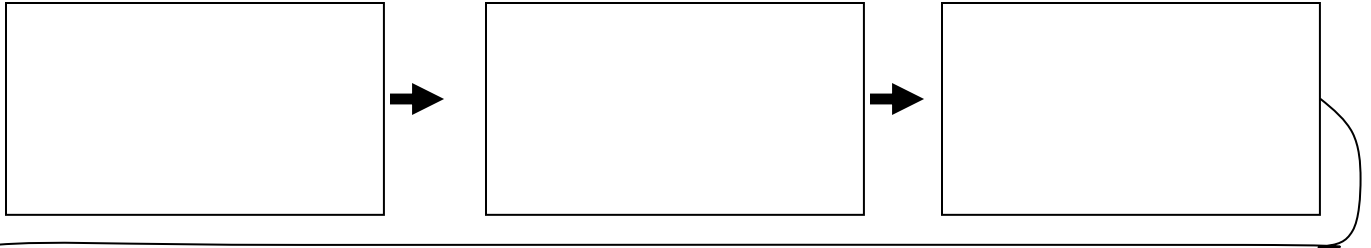
#### Lesson Procedure:

- 1) BrainPop video on the rock cycle and associated worksheet.
- 2) Students use laptops to investigate 1<sup>st</sup> website. Students follow directions and click on various rocks to examine them. Students answer questions on the website while investigating.
- 3) Students investigate 2<sup>nd</sup> website on their laptop. Students have the option to travel any path they choose on the website. Website show rocks actually breaking down, being cemented etc.
- 4) Class discussion on rock cycle chart from Reference Tables to clarify any confusion.
- 5) Students complete journey on the rock cycle lab with illustrations.

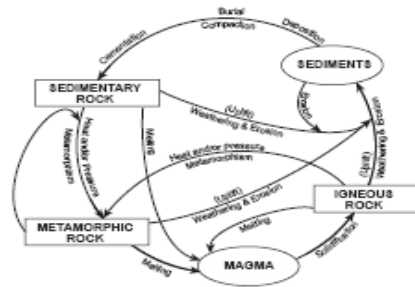
Name \_\_\_\_\_

Rock Cycle Movie

**Pretend you are making a movie on the life of a rock. You are going to show the audience how a rock can change from one type to another type over many years. In each box you are drawing a picture showing how the rock has changed. The first scene of the movie is starting as magma (melted rock).**



# Rock Brochure




**You have been hired by the Rochester Museum and Science Center to make a brochure explaining rocks to elementary school students visiting on class field trips.**

The front page will explain only igneous rocks:

- 1) **Draw a picture showing the general grain size of intrusive igneous rocks vs. extrusive igneous rocks.**
- 2) Fill in the blanks: ***Extrusive* igneous rocks form \_\_\_\_\_ (above or below) the Earth's surface, cool \_\_\_\_\_ (quickly or slowly) and have a \_\_\_\_\_ (larger or smaller) grain size than intrusive rocks.**
- 3) Fill in the blanks: ***Intrusive* igneous rocks form \_\_\_\_\_ (above or below) the Earth's surface, cool \_\_\_\_\_ (quickly or slowly) and have a \_\_\_\_\_ (larger or smaller) grain size than extrusive rocks.**
- 4) **Explain in one sentence how igneous rocks form.**

Inside flap of the brochure will explain only sedimentary rocks:

- 5) **List the 3 textures of sedimentary rocks, give an example of each, and draw the *map symbol* (ex: clastic; conglomerate;  )**

6) **Explain in one sentence how clastic sedimentary rocks are classified.**

7) **Draw a conglomerate rock vs. a breccia rock**

The inside flap of the back page will explain only metamorphic rocks:

8) **List the two types of metamorphism and which type is more common, “affects more rock”.**

9) **Explain in one sentence what “foliated” means and list the rock which forms from low metamorphism of shale.**

10) **Draw and label a picture of the metamorphic rock which exhibits banding and high grade metamorphism.**

Back Cover of the brochure will explain the rock cycle:

11) Fill in the blank: **Sedimentary rocks and igneous rocks undergo \_\_\_\_\_ and/or \_\_\_\_\_ to become metamorphic rocks**

12) Fill in the blank: **Metamorphic rocks can undergo \_\_\_\_\_ & \_\_\_\_\_ to become sediments and/or \_\_\_\_\_ to become magma.**

13) True or false? **An igneous rock will always weather and erode to become a sedimentary rock?**

14) **Fallbrook in Geneseo, NY is famous for fossil rich shale layers, which is a \_\_\_\_\_ rock. (igneous, sedimentary, metamorphic)**

<b>Title:</b>	Weathering and mass movement #4
<b>Source/website:</b>	<p><a href="http://ees.as.uky.edu/sites/default/files/elearning/module07swf.swf">http://ees.as.uky.edu/sites/default/files/elearning/module07swf.swf</a></p> <p>(weathering)</p> <p><a href="http://ees.as.uky.edu/sites/default/files/elearning/module11swf.swf">http://ees.as.uky.edu/sites/default/files/elearning/module11swf.swf</a></p> <p>(forms of mass movement interactive)</p> <p><a href="http://www.youtube.com/watch?v=ZVYGJYnJTio">http://www.youtube.com/watch?v=ZVYGJYnJTio</a>  <a href="http://www.youtube.com/watch?v=23NZTzpw6cY">http://www.youtube.com/watch?v=23NZTzpw6cY</a>  <a href="http://www.youtube.com/watch?v=-nx-gYYRu5I">http://www.youtube.com/watch?v=-nx-gYYRu5I</a></p> <p>rockslide, landslide, mass movement videos</p>
<b>Course:</b>	Regents Earth Science
<b>NYS Standard:</b>	<p>2.1s Weathering is the physical and chemical breakdown of rocks at or near Earth's surface. Soils are the result of weathering and biological activity over long periods of time.</p> <p>2.1t Natural agents of erosion, generally driven by gravity, remove, transport, and deposit weathered rock particles.</p>
<b>Summary:</b>	The weathering animation website allows students to visualize how the various types of weathering breaks down rock. Students can see how ice wedging makes cracks in rock larger, how tree roots can split rocks and how thermal expansion of minerals loosens rock particles. The websites will also introduce students to terms such as abrasion, mass movement, creep, and liquefaction. Through the models students will also learn ways to prevent mass movement of rock and sediment.
<b>Rationale:</b>	<p>This lesson will help students to understand the relationship between weathering and mass movement. The animations help students to recognize that human interactions can negatively effect the environment and cause landslides, rockslides etc. These animations help students to understand that the rock breakdown over time for various reasons and those weathered particles can easily be influenced by gravity. It is difficult without the animations and models to visualize slow processes such as creep taking place because of its extremely slow nature. This simulation helps students by:</p> <ul style="list-style-type: none"> <li>- Providing students with a visual representation of various forms of weathering.</li> </ul>

	- - Allowing students to manipulate erosion control variables which would otherwise be too dangerous and too expensive in real life.
<b>Possible Misconceptions:</b>	Many students believe that rocks are weathered or broken down by the actual weather (rain, wind, snow etc.). There are many other forms of weathering that students do not know exist.
<b>Recommendations:</b>	Students explore the model individually.

#### Lesson Procedure:

- 1) As a class students observe 1<sup>st</sup> website on the smartboard. Students observe various forms of weathering and participate in class discussion.
- 2) Students observe heating of granite demo throughout remainder of class, while working on next parts of the lesson. (Heat granite with torch, place in cold water. Teacher repeats this several times throughout the lesson).
- 3) Students investigate 2<sup>nd</sup> website on their laptops. Students complete website readings and investigate various animations.
- 4) Students summarize the lesson by completing the model of landslide prevention. Simulation should show student understanding of content.
- 5) Students watch 3 youtube clips on Tennessee rockslide, Japan landslide and Italian liquefaction, and participate in discussion.
- 6) Summative ticket out the door to assess understanding.

Name \_\_\_\_\_

Ticket out the door

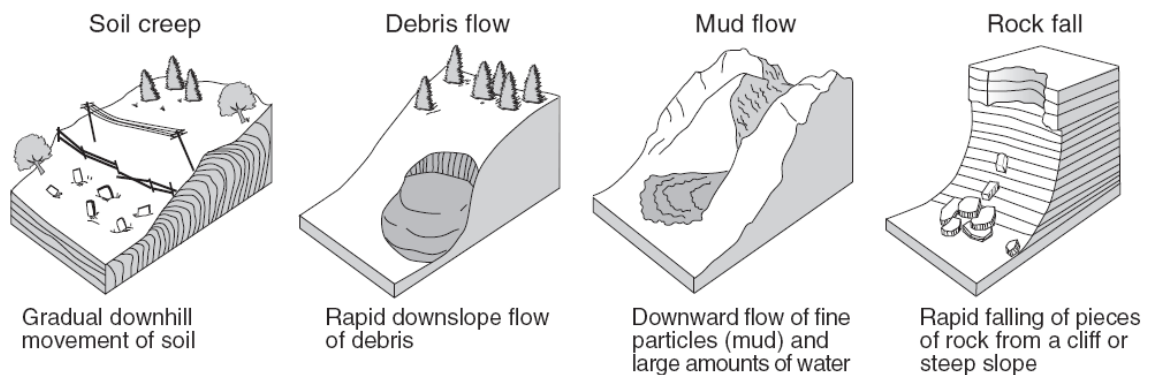
1) Which erosional force acts alone to produce rockslides and landslides?

- A) sea waves
- B) winds
- C) running water
- D) gravity

2) At high elevations in New York State, which is the most common form of physical weathering?

- A) abrasion of rocks by wind
- B) dissolving of minerals into solution
- C) oxidation by oxygen in the atmosphere
- D) alternate freezing and melting of water

3)



Which process is shown in these diagrams?

- A) chemical weathering
- B) wind action
- C) mass movement
- D) rock abrasion

4) Explain how plants might contribute to weathering of rocks.

---



---



---

5) Explain what caused the slow moving landslide in Italy.

---



---



---

<b>Title:</b>	Stream Erosion and oxbow lakes #5
<b>Source/website:</b>	<a href="http://www.wiley.com/college/strahler/0471480533/animations/ch17_animations/animation1.html">http://www.wiley.com/college/strahler/0471480533/animations/ch17_animations/animation1.html</a> (erosion on outside of bend)  <a href="http://www.cleo.net.uk/resources/displayframe.php?src=309/consultants_resources/_files/meander4.swf">http://www.cleo.net.uk/resources/displayframe.php?src=309/consultants_resources/_files/meander4.swf</a> (meandering stream/oxbow)  <a href="http://www.wwnorton.com/college/geo/egeo2/content/animations/14_1.htm">http://www.wwnorton.com/college/geo/egeo2/content/animations/14_1.htm</a> (summary with terms)
<b>Course:</b>	Regents Earth Science
<b>NYS Standard:</b>	2.1u The natural agents of erosion include: ¥ <i>Streams (running water)</i> : Gradient, discharge, and channel shape influence a stream's velocity and the erosion and deposition of sediments. Sediments transported by streams tend to become rounded as a result of abrasion. Stream features include V-shaped valleys, deltas, flood plains, and meanders. A watershed is the area drained by a stream and its tributaries.
<b>Summary:</b>	The stream erosion animations allow students to visualize how stream banks can be eroded over time. Students can see how water velocity is greatest on the outside of the curve, therefore leading to erosion. Stream velocity is slower on the inside of the curve, thus creating deposition. The slower stream velocity can longer carry heavier sediment. This causes the stream to be deeper on the outside of a curve and shallower on the inside of the curve. These animations also allow students to visualize stream meanders are created. Te stream becomes more and more S-shaped until eventually two curves erode together, creating an oxbow lake.
<b>Rationale:</b>	In the Earth Science curriculum, stream processes are the most important of all the agents of erosion. Students rarely think about water is going on inside of a river or stream when they see one. The animations help students to visualize how erosion and deposition affect the depth and shape of a stream. These processes are constantly shaping the landscape around them. This simulation helps students by: <ul style="list-style-type: none"> <li>- Providing them with a visual representation of</li> </ul>



	stream erosion and deposition leading to oxbow lakes. This is difficult to see at full scale inside a classroom setting. Although the stream table lab helps with the processing of this content, the animations allow students to visualize all of the processes occurring.
<b>Possible Misconceptions:</b>	Students believe that all parts of a stream are traveling at the same speed. Oxbow lakes have only just been natural ponds.
<b>Recommendations:</b>	Students should follow along on note packet during animations and discussion.

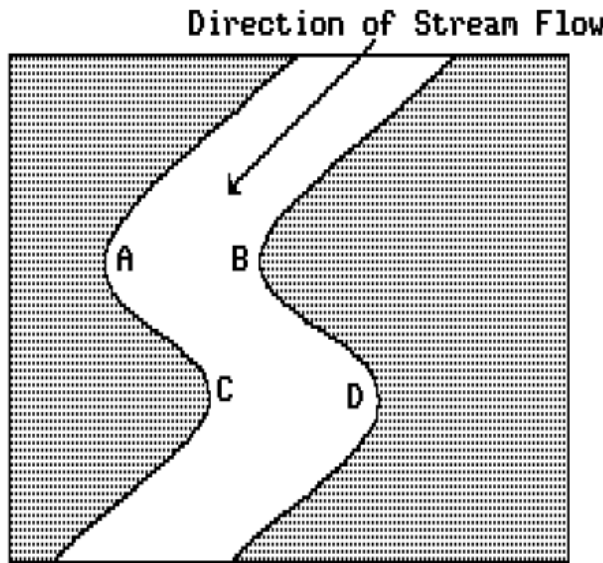
### Lesson Procedure:

- 1) PowerPoint notes on erosion, where streams move the fastest
- 2) Car example on smartboard. (Forget to turn the wheel going around a curve. Where would you crash into).
- 3) Revisit how large particles can no longer be carried by slow moving streams and they become deposited.
- 4) Show 1<sup>st</sup> animation and have class discussion. How students draw the shape of the bottom of a stream bed around a curve.
- 5) Show pictures of oxbow lakes and ask students how these formed. (get an idea about misconceptions). Show 2<sup>nd</sup> animation and explain how water eventually wants to take a straight path, path of least resistance.
- 6) Show 3rd animation and discuss important vocabulary during meander formation such as cut off and meander neck.
- 7) Have students finish class with the stream table lab. Students have trays of sand connected to water tubes and experiment with meanders. Students create small stream channels in sand and watch as over a few minutes streams naturally start to meander.
- 8) Summative worksheet assessing student knowledge on stream erosion and meanders.

Name \_\_\_\_\_

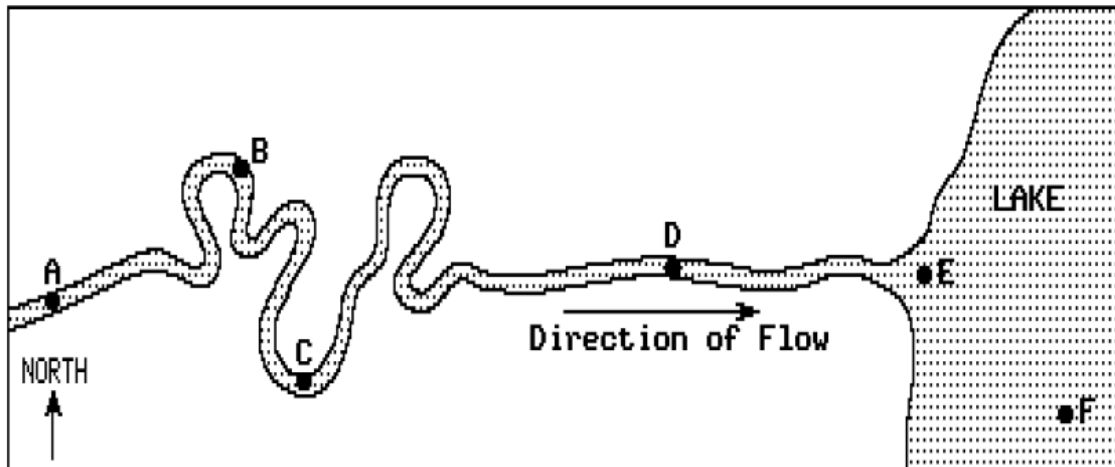
Stream Processes

The map below represents a view of a flowing stream. The letters identify locations in the stream near the interface between land and water. At which two locations is erosion due to flowing water likely to be greatest?



- 1) A) A and D      C) B and D  
     B) A and B      D) B and C

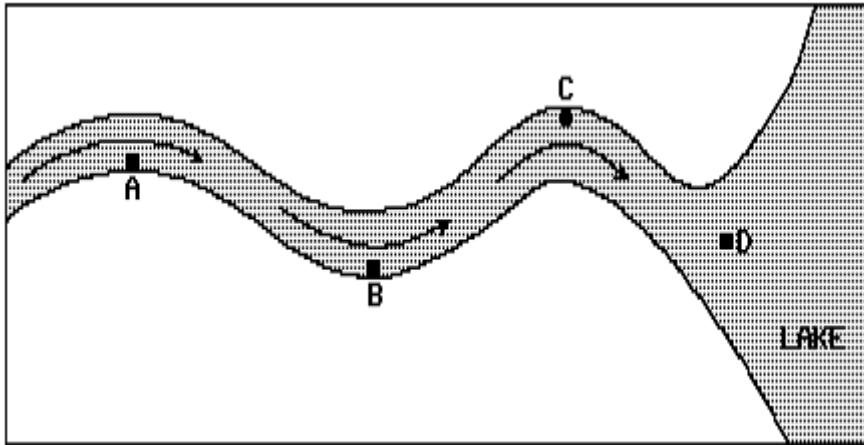
The map below shows a stream flowing into a lake. Letters A through F represent locations in the stream and lake.



2) Where would the greatest amount of sediment most likely be deposited?

- A) B      B) F      C) D      D) E

The map below shows the top view of a meandering stream as it enters a lake.



3) Which of the following has the streams velocity labeled correctly?

- A) Velocity is fastest at A and B, slowest at C.
- B) Velocity is fastest at B and C, slowest at A .
- C) Velocity is fastest at B, slowest at A and C.

<b>Title:</b>	Deposition (vertical and horizontal sorting) #6
<b>Source/website:</b>	<a href="http://www.eram.k12.ny.us/education/components/doc_mgr/default.php?sectiondetailid=17500&amp;fileitem=827&amp;catfilter=447">http://www.eram.k12.ny.us/education/components/doc_mgr/default.php?sectiondetailid=17500&amp;fileitem=827&amp;catfilter=447</a> (vertical sorting)  <a href="http://www.eram.k12.ny.us/education/components/doc_mgr/default.php?sectiondetailid=17500&amp;fileitem=829&amp;catfilter=447">http://www.eram.k12.ny.us/education/components/doc_mgr/default.php?sectiondetailid=17500&amp;fileitem=829&amp;catfilter=447</a> (graded bedding)  <a href="http://www.eram.k12.ny.us/education/components/doc_mgr/default.php?sectiondetailid=17500&amp;fileitem=828&amp;catfilter=447">http://www.eram.k12.ny.us/education/components/doc_mgr/default.php?sectiondetailid=17500&amp;fileitem=828&amp;catfilter=447</a> (horizontal in a stream)  <a href="http://www.classzone.com/books/earth_science/terc/content/visualizations/es0604/es0604page01.cfm?chapter_n_o=visualization">http://www.classzone.com/books/earth_science/terc/content/visualizations/es0604/es0604page01.cfm?chapter_n_o=visualization</a> (horizontal sorting into large body of water)
<b>Course:</b>	Regents Earth Science
<b>NYS Standard:</b>	<p>2.1u The natural agents of erosion include:            ¥ <i>Streams (running water)</i>: Gradient, discharge, and channel shape influence a stream's velocity and the erosion and deposition of sediments. Sediments transported by streams tend to become rounded as a result of abrasion. Stream features include V-shaped valleys, deltas, flood plains, and meanders. A watershed is the area drained by a stream and its tributaries.</p> <p>2.1v Patterns of deposition result from a loss of energy within the transporting system and are influenced by the size, shape, and density of the transported particles. Sediment deposits may be sorted or unsorted.</p>
<b>Summary:</b>	<p>The water columns animation allows students to visualize how particle size, shape and density affect the settling rate of sediment in bodies of water. Students can see how larger, rounder, denser particles settle faster to the bottom than small, flat, less dense particles. Students can also visualize how a decrease in stream velocity results in horizontal sorting of sediment. As stream velocity decreases, the largest, roundest, most dense particles settle closest to shore and smaller particles are carried further outward.</p>
<b>Rationale:</b>	In the Earth Science curriculum, stream processes are the most important of all the agents of erosion. Students

	<p>rarely think about water is going on inside of a river or stream when they see one. The animations help students to visualize how particles settle when a stream empties into a lake or ocean. This simulation helps students by:</p> <ul style="list-style-type: none"> <li>- Providing them with a visual representation of sediment transport and deposition, which is difficult to see when stuck inside a classroom setting. Students rarely think about processes going on underneath the surface of the water.</li> </ul>
<b>Possible Misconceptions:</b>	Many students don't realize that streams and river carry sediment. Many students believe that rivers are just running water.
<b>Recommendations:</b>	Students should follow along on note packet during animations and discussion.

#### Lesson Procedure:

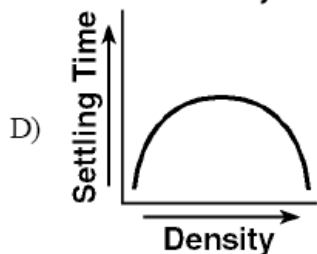
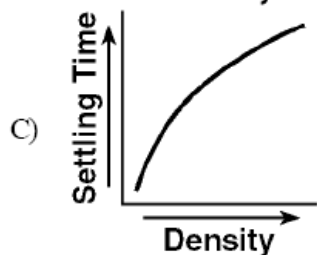
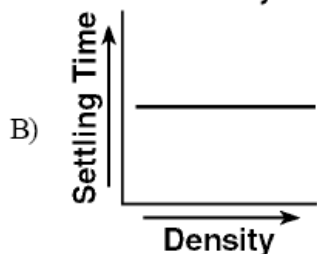
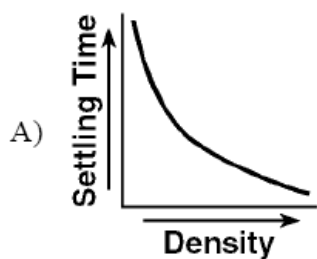
- 1) PowerPoint notes on vocabulary terms
- 2) 1<sup>st</sup> animation: raise of hands on which will hit the bottom first? Large? Small? Flat? Round? Etc. Explain vertical sorting and when it occurs.
- 3) Explain graded bedding. Show 2<sup>nd</sup> animation and discuss vertical sorting on top of vertical sorting.
- 4) Discuss stream velocity and how faster speeds can carry larger sediment. Slower velocity can only carry smaller sediment. Now what happens to the sediment when the stream slows down? Show 3<sup>rd</sup> animation and discuss how largest particles are deposited first.
- 5) Give examples of Darien Lake or Seabreeze waterslides. Ask students what happens to your speed when your raft hits the large pool at the bottom? (velocity decreases)
- 6) Show 4<sup>th</sup> animation. Discuss how just like at Darien Lake the velocity decreases as the stream enters the large body of water. Due to this the largest, rounded, most dense particles are deposited first and the smaller particles are carried further out.
- 7) Summative worksheet assessing student knowledge on deposition and sorting.

Name \_\_\_\_\_ Running Water Deposition

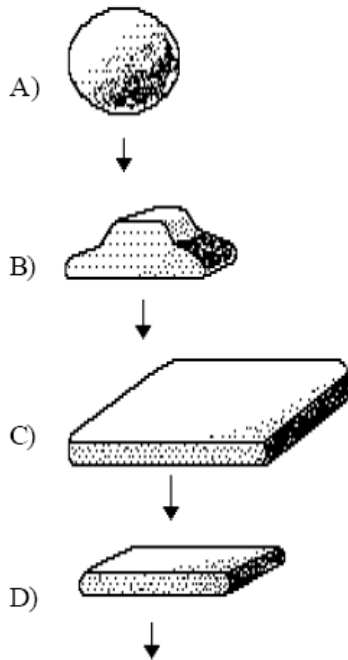
1) A glass sphere and a lead sphere have the same volume. Each sphere is dropped into a container of water. Which statement best explains why the lead sphere settles faster?

- A) The lead sphere has a higher density.
- B) The lead sphere takes up less space.
- C) The glass sphere has more surface area.
- D) The glass sphere has a smoother surface.

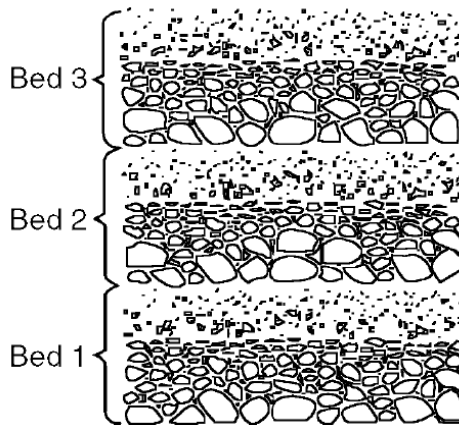
2) Which graph shows the relationship between the density of particles and their settling time in still water? (Assume that the particles have the same size and shape.)



3) If all the particles below have the same mass and density, which particle will settle the fastest in quiet water?



The diagram below shows three beds of sediment deposited at different times in a quiet body of water.



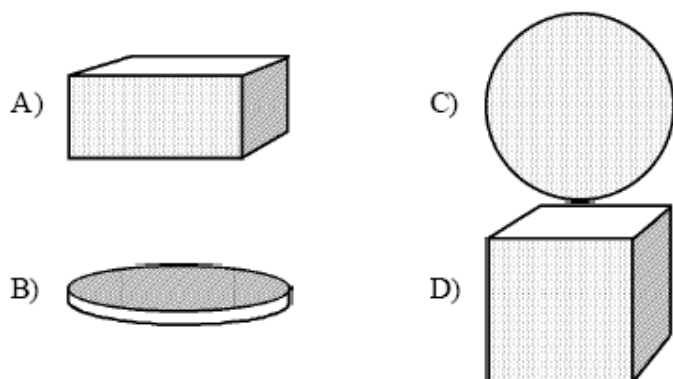
4) The sediment deposited in each bed is best described as

- A) sorted mainly according to particle shape
- B) a mixture of sorted and unsorted particles
- C) sorted mainly according to particle size
- D) showing no evidence of sorting

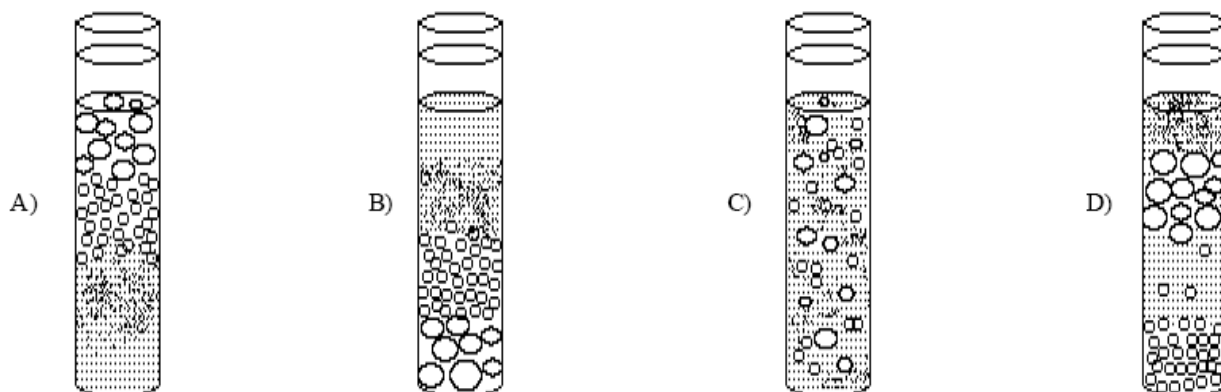
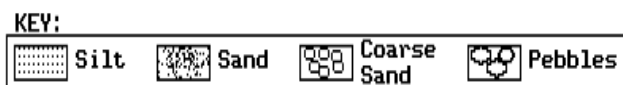
Four samples of aluminum, A,B,C, and D have identical volumes and densities, but different shapes. Each piece is dropped into a long tube filled with water. The time each sample takes to settle to the bottom of the tube is shown in the table below.

Sample	Time to Settle (sec)
A	2.5
B	3.7
C	4.0
D	5.2

5) Which diagram most likely represents the shape of sample A?

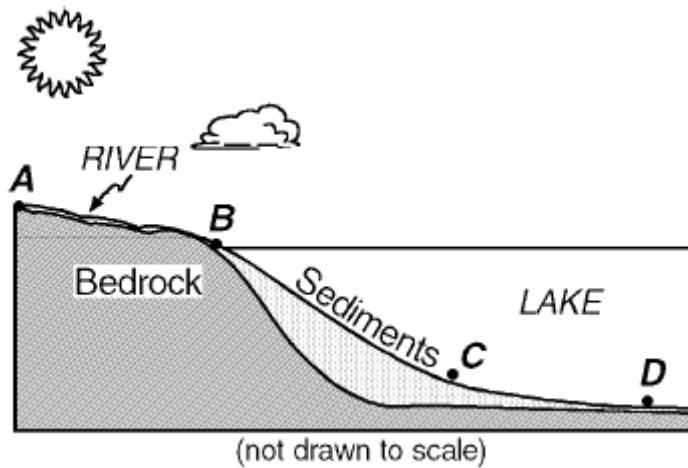


6) A large glass cylinder containing a mixture of sediments of the same density and water is shaken. Which drawing below best represents the result after settling?





The diagram below represents a river flowing into a large lake. The river is carrying particles ranging in size from cobbles to clay.



- 7) When water from the river enters the lake, particles of which size will settle first, closest to shore?
- A) silt    B) pebbles    C) clay    D) cobbles
- 8) Clay particles would most likely settle at which location?
- A) A    B) B    C) C    D) D
- 9) Which statement best explains the horizontal sorting of the sediments pictured in the diagram?
- A) Increased stream velocity carries larger particles farther into the ocean than it carries the smaller ones.
- B) Larger particles settle more quickly than smaller ones.
- C) Rainfall increases the accumulation of limestone in deeper ocean areas.
- D) Suspended material and dissolved chemicals settle immediately.

<b>Title:</b>	Wave erosion, wave processes #7
<b>Source/website:</b>	<p><a href="http://oceanica.cofc.edu/an%20educator%27sl%20guide%20to%20folly%20beach/guide/driftanimation.htm">http://oceanica.cofc.edu/an%20educator%27sl%20guide%20to%20folly%20beach/guide/driftanimation.htm</a></p> <p>(longshore drift animation)</p> <p><a href="http://highered.mcgraw-hill.com/sites/0072402466/student_view0/chapter14/animations_and_movies.html#">http://highered.mcgraw-hill.com/sites/0072402466/student_view0/chapter14/animations_and_movies.html#</a></p> <p>(spits, bars animations)</p> <p><a href="http://ees.as.uky.edu/sites/default/files/elearning/module14swf.swf">http://ees.as.uky.edu/sites/default/files/elearning/module14swf.swf</a></p> <p>(wave processes interactive model)</p>
<b>Course:</b>	Regents Earth Science
<b>NYS Standard:</b>	<p>2.1t Natural agents of erosion, generally driven by gravity, remove, transport, and deposit weathered rock particles. In certain erosional situations, loss of property, personal injury, and loss of life can be reduced by effective emergency preparedness.</p> <p>2.1u The natural agents of erosion include:  <i>Wave Action:</i> Erosion and deposition cause changes in shoreline features, including beaches, sandbars, and barrier islands. Wave action rounds sediments as a result of abrasion. Waves approaching a shoreline move sand parallel to the shore within the zone of breaking waves.</p>
<b>Summary:</b>	The longshore drift animation allows students to visualize objects such as sand, are slowly moved down the beach by breaking waves. Waves rarely crash straight onto shore so the angle that the waves break will push sediment parallel to the shoreline. The 2 <sup>nd</sup> website allows students to see how wave erosion and wave deposition interact. The formation of spits and bars is visually accessible to students. Through the modeling students will also learn ways to prevent erosion of the shoreline such as seawalls and groins.
<b>Rationale:</b>	This lesson will help students to understand the relationship between wave erosion and deposition. These animations are helpful to students because many of my students have never been to the ocean or a beach for that matter. These animations help students to

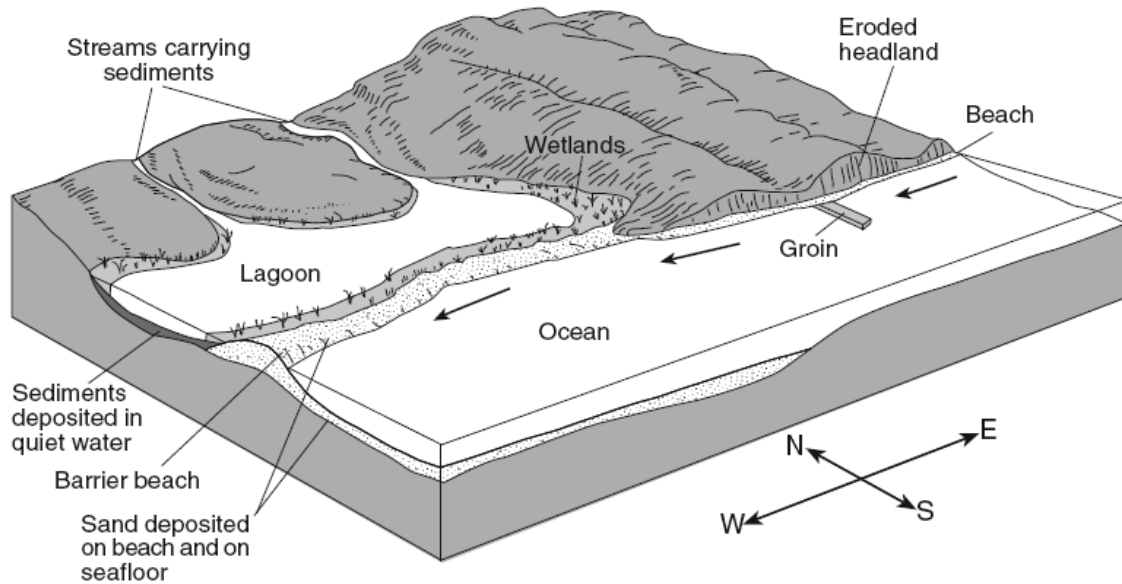
	<p>understand that waves can be destructive forces of nature and erode land and beachfront properties. However, the animations also allow students to view the depositional features of waves such as the creation of bars and spits. The animations helps students by:</p> <ul style="list-style-type: none"> <li>- Providing students with a visual representation of various forms of wave action. Creation of bars and spits.</li> <li>- - Allowing students to manipulate erosion control variables which would otherwise be too time consuming and too expensive in real life.</li> </ul>
<b>Possible Misconceptions:</b>	Many students believe that waves only wash sand away.
<b>Recommendations:</b>	Students explore the last website individually on their laptops.

#### Lesson Procedure:

- 1) Ask how many students have been to the ocean. If they have ask what happens to their position to their beach towel if they are in the ocean. They end up being carries down shore by longshore drift.
- 2) As a class students observe 1<sup>st</sup> website on the smartboard. Watch as longshore drift is explained with a single sand grain.
- 3) Show picture of Massachusetts and ask why it has a hook. Students observe 2<sup>nd</sup> website of smartboard. Processes such as deposition of spits and sandbars are demonstrated.
- 4) Students investigate 3rd website on their laptops. Students complete website readings and investigate various animations.
- 5) Students summarize the lesson by completing the model of wave erosion prevention. Simulation should show student understanding of content.
- 6) Students complete worksheet to be collected.

Name \_\_\_\_\_

Wave Worksheet



1) The groin structure will change the pattern of deposition along the shoreline, initially causing the beach to become

- A) wider on the western side of the groin
- B) wider on the eastern side of the groin
- C) narrower on both sides of the groin
- D) wider on both sides of the groin

2) Explain in your own words, what causes the longshore drift in the diagram above?

---



---



---



---

3) Explain what could be done to prevent this home from being destroyed.

---



---



---



---



---



---

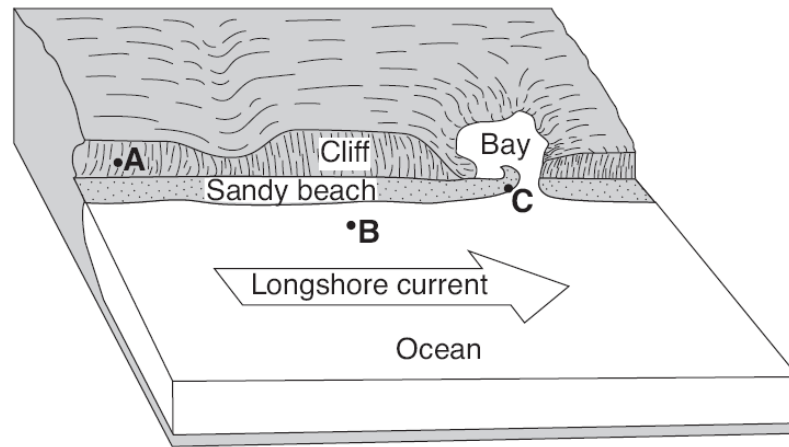


---



---

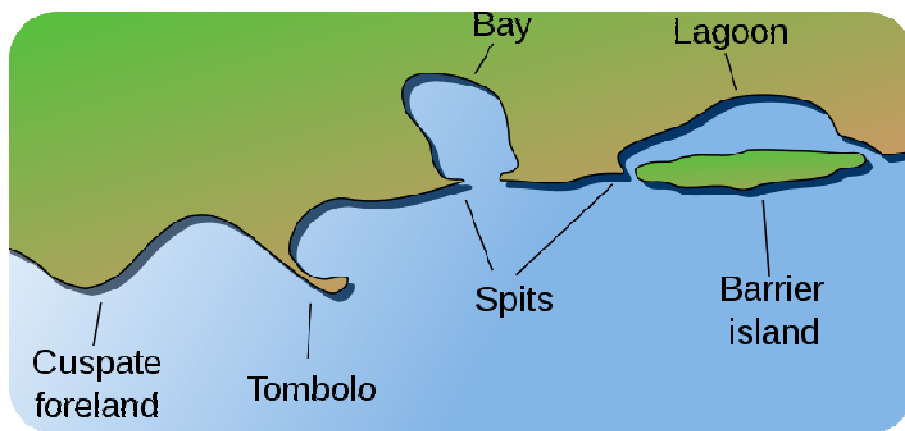




4) Which list best represents the primary processes occurring along the coastline at points A,B and C?

- 1) A- folding; B- subduction; C- crosscutting
- 2) A- weathering; B- erosion; C- deposition
- 3) A- faulting; B- conduction; C- mass movement
- 4) A- precipitation; B- infiltration; C- evaporation

5) In the picture below what direction must the longshore drift be going?




---

<b>Title:</b>	Glacial formation, processes and landforms #8
<b>Source/website:</b>	<a href="http://www.wwnorton.com/college/geo/animations/glacial_advance_retreat.htm">http://www.wwnorton.com/college/geo/animations/glacial_advance_retreat.htm</a> (glacial movement)  <a href="http://ees.as.uky.edu/sites/default/files/elearning/module13swf.swf">http://ees.as.uky.edu/sites/default/files/elearning/module13swf.swf</a> (module on glacial movement and landforms)  <a href="http://highered.mcgraw-hill.com/olcweb/cgi/pluginpop.cgi?it=swf::640::480::/sites/dl/free/0073369365/274928/GlacialLandforms_Final.swf::">http://highered.mcgraw-hill.com/olcweb/cgi/pluginpop.cgi?it=swf::640::480::/sites/dl/free/0073369365/274928/GlacialLandforms_Final.swf::</a> (esker, drumlins, moraines etc.)  <a href="http://phet.colorado.edu/en/simulation/glaciers">http://phet.colorado.edu/en/simulation/glaciers</a> (glacier simulation)
<b>Course:</b>	Regents Earth Science
<b>NYS Standard:</b>	2.1u The natural agents of erosion include: ¥ <i>Glaciers (moving ice)</i> : Glacial erosional processes include the formation of U-shaped valleys, parallel scratches, and grooves in bedrock. Glacial features include moraines, drumlins, kettle lakes, finger lakes, and outwash plains.
<b>Summary:</b>	The lesson on glacier formation and glacial erosion is enhanced by animations and simulations. Students have very little background knowledge on glaciers because of where we live. I have yet to have a student that has seen a glacier in real life. Students need to know not only how glaciers form, but also how they erode landscapes and create features such as drumlins and moraines.
<b>Rationale:</b>	This lesson will help students to visualize glaciers are created and how they affect landscapes. The animations and simulation allow students to visualize how a moving glacier carves out the landscape and creates features such as striations and kettle hole lakes. Our region is littered with glacial features, yet my students have very little knowledge that these features came from glaciers. The animations allow students to visualize how glaciers shape mountains in location not accessible to my students. The simulation allows students to manipulate the temperature and snowfall conditions and view how that effects glacier formation. These animations helps students by: <ul style="list-style-type: none"> <li>- Providing students with a visual representation of the creation of glaciers and their features.</li> <li>- - Allowing students view changes in landscapes that cannot be viewed inside of a classroom.</li> </ul>
<b>Possible</b>	Glaciers are frozen rivers. Glaciers only occur at the

<b>Misconceptions:</b>	north pole.
<b>Recommendations:</b>	Complete simulation on personal laptops

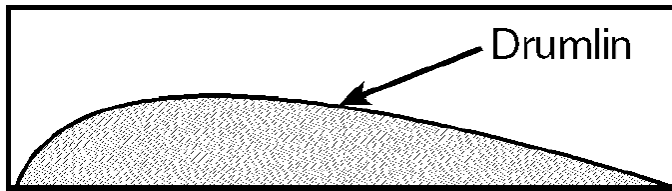
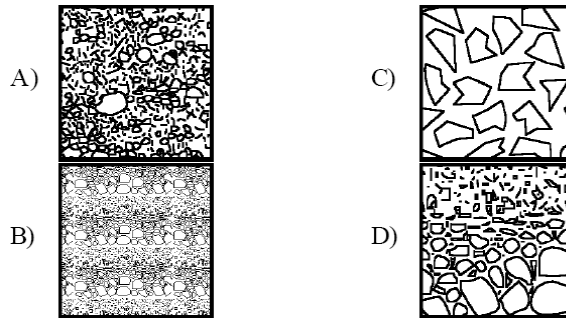
Lesson Procedure:

- 1) View first website on smartboard and discuss how glaciers form. Discuss how glaciers slowly move downhill due to gravity.
- 2) Students investigate 2<sup>nd</sup> website on laptops and complete readings on the side of the animation. Animations investigate erosional features such as horns and arêtes, while also describing glacial plucking.
- 3) On smartboard show pictures of landforms around the Rochester area. Ask students what may have caused them. As a class view 3<sup>rd</sup> website showing continental glacier features such as kettle hole lakes and drumlins. Discuss as a class individual features and how they formed.
- 4) View 4th website simulation on laptops. Students will manipulate variables and investigate how they effects glacial movement.
- 5) Students will complete post-assessment to assess understanding.

Name \_\_\_\_\_

Glacier Post-Assessment

1) Which diagram best represents sediment transported by a glacier?

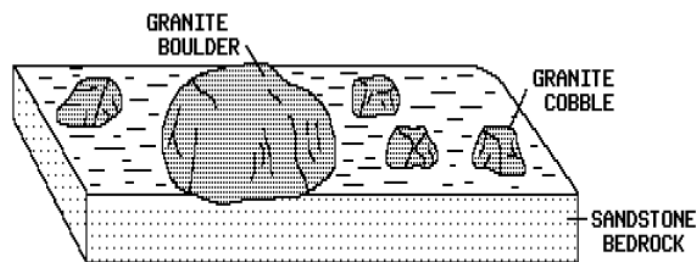


2) The pictures of the drumlin above is most likely composed of

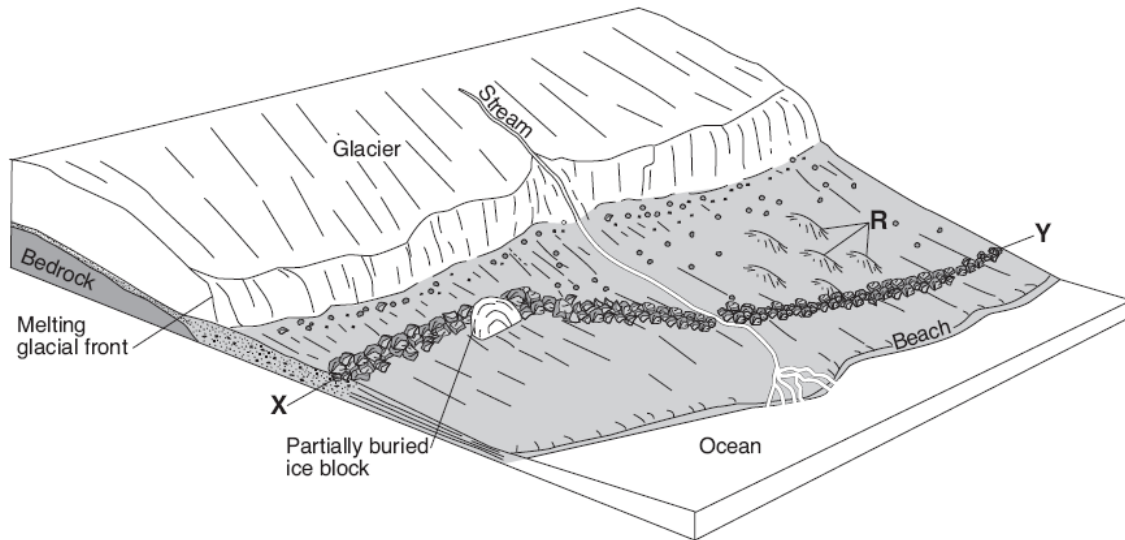
- A) cemented sediments
- B) unsorted sediments
- C) horizontally layered sediments
- D) vertically layered sediments

3) What is this isolated granite boulder on top of sandstone bedrock called?

- A) erratic
- B) kettle lake
- C) esker
- D) moraine







4) The elongated hills labeled R are most useful in determining the

- A) age of the glacier
- B) direction the glacier has moved
- C) thickness of the glacier
- D) rate at which the glacier is melting

5) Which feature will most likely form when the partially buried ice block melts?

- A) drumlin    B) moraine    C) kettle lake    4) finger lake

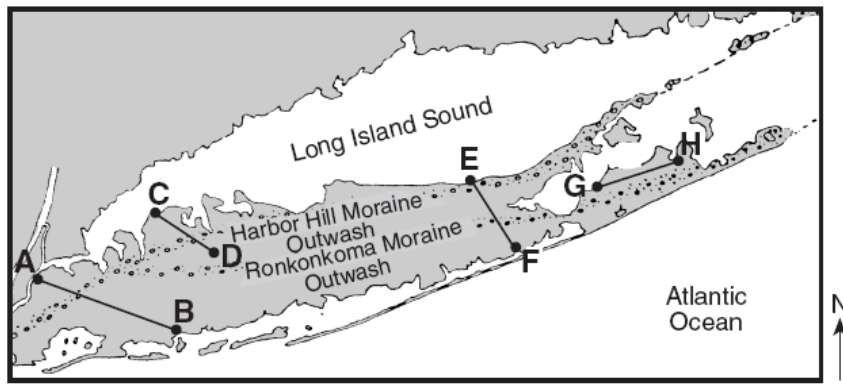
6) The ridge of sediments from X to Y can best be described as

- A) sorted and deposited by ice
- B) sorted and deposited by meltwater
- C) unsorted and deposited by ice
- D) unsorted and deposited by meltwater

7) Which agent of erosion produced this valley?

- A) wave action
- B) moving ice
- C) blowing wind
- D) flowing water





8) Which agent of erosion transported the sediments that formed the moraines shown on the map?

- A) water    B) wind    C) ice    D) mass movement

9) Along which reference line was the cross section taken?



- A) AB    B) CD    C) EF    D) GH

10) A major difference between sediments in the outwash and sediments in the moraines is that the sediments deposited in the outwash are

- A) larger    B) sorted    C) more angular    D) older

<b>Title:</b>	Plate tectonics, Pangaea, Boundaries #9
<b>Source/website:</b>	<p><a href="http://www.classzone.com/books/earth_science/terc/content/visualizations/es0806/es0806page01.cfm?chapter_no=visualization">http://www.classzone.com/books/earth_science/terc/content/visualizations/es0806/es0806page01.cfm?chapter_no=visualization</a> (Pangaea break-up)</p> <p><a href="http://www.classzone.com/books/earth_science/terc/content/visualizations/es0804/es0804page01.cfm?chapter_no=visualization">http://www.classzone.com/books/earth_science/terc/content/visualizations/es0804/es0804page01.cfm?chapter_no=visualization</a> (boundary animations)</p> <p><a href="http://www.geo.cornell.edu/eas/education/course/descr/EAS20/2008%20Lectures/Lecture%207%20web/PlateMotionppt.html">http://www.geo.cornell.edu/eas/education/course/descr/EAS20/2008%20Lectures/Lecture%207%20web/PlateMotionppt.html</a> (boundaries on a global scale)</p> <p><a href="http://sepuplhs.org/middle/iaes/students/simulations/SEPUP_Plate_simulation.swf">http://sepuplhs.org/middle/iaes/students/simulations/SEPUP_Plate_simulation.swf</a> (boundary simulation)</p>
<b>Course:</b>	Regents Earth Science
<b>NYS Standard:</b>	<p>2.1l The lithosphere consists of separate plates that ride on the more fluid asthenosphere and move slowly in relationship to one another, creating convergent, divergent, and transform plate boundaries. These motions indicate Earth is a dynamic geologic system. ¥ These plate boundaries are the sites of most earthquakes, volcanoes, and young mountain ranges.</p> <p>2.1m Many processes of the rock cycle are consequences of plate dynamics. These include the production of magma (and subsequent igneous rock formation and contact metamorphism) at both subduction and rifting regions, regional metamorphism within subduction zones, and the creation of major depositional basins through down-warping of the crust.</p> <p>2.1n Many of Earth's surface features such as mid-ocean ridges/rifts, trenches/subduction zones/island arcs, mountain ranges (folded, faulted, and volcanic), hot spots, and the magnetic and age patterns in surface bedrock are a consequence of forces associated with plate motion and interaction.</p>
<b>Summary:</b>	The plate tectonics animations allow students to visualize the dynamic processes of plate movement. Students can see how the super continent of Pangaea once existed and how it has since broken apart. Students will also become familiar with terms such as convergent, divergent and transform boundaries. Through the animations students will learn the

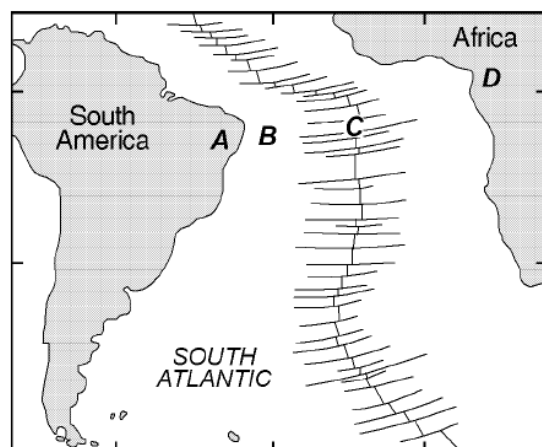
	complex processes that occur at the three types of plate boundaries.
<b>Rationale:</b>	<p>The plate tectonics unit is the building block for both the volcanoes and earthquakes units. This lesson will help students to understand that the earth is composed of plates that move very slowly. The animations help students to visualize the complex processes that occur when plates collide, move away from one another and slide past each other. These animations help students to understand that previously unexplained events such as volcanoes and earthquakes occur due to these plate boundaries. It is difficult without the animations for students to truly visualize lithospheric plates sliding past and being subducted under one another. This simulation helps students by:</p> <ul style="list-style-type: none"> <li>- Providing students with a visual representation of all of the types of plate boundaries.</li> <li>- - Allowing students to take a view the earth on a global scale and how lithospheric plates interact with one another. It also allows students to see the consequences of crustal collisions.</li> </ul>
<b>Possible Misconceptions:</b>	Students believe that the plates float around on top of the earth. Students believe continents are on one plate and oceans are on another plate.
<b>Recommendations:</b>	Students explore the last two websites on their laptops.

#### Lesson Procedure:

- 1) BrainPop video on plate tectonics
- 2) Students follow along and copy notes from PowerPoint. Animations are embedded throughout.
- 3) Students complete Pangaea evidence cutting activity (cut out Africa and South America and glue together on construction paper)
- 4) Students investigate 3<sup>rd</sup> website on their laptops. Students explore various types of plate boundaries
- 5) Students explore 4<sup>th</sup> website and can adjust time scale to see the extremely slow speed that the plates move.
- 6) Students complete plate tectonics assessment.

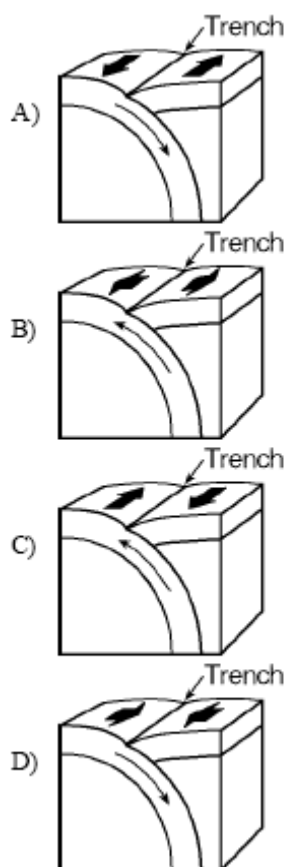
Name \_\_\_\_\_

Plate Tectonics assessment



1) In the diagram above, which location has the youngest crust? \_\_\_\_\_

2) Which picture shows the correct plate motion at the Peru-Chile Trench?



3) The Peru-Chile Trench marks the boundary between the

- A) Caribbean Plate and the Scotia Plate
- B) North American Plate and the Cocos Plate
- C) Pacific Plate and the Antarctic Plate
- D) Nazca Plate and South American Plate

4) Mid-ocean ridges normally form where tectonic plates are

- A) stationary
- B) sliding past each other
- C) converging
- D) diverging

5) What type of boundary is the San Andreas Fault in California?

---

6) The motion of the convection currents in the mantle beneath the Atlantic Ocean appears to be mainly making this ocean basin

- A) narrower
- B) wider
- C) deeper
- D) shallower

7) List two pieces of evidence that support the existence of Pangaea.

---

---

<b>Title:</b>	Hot Spots and introduction to earthquakes #10
<b>Source/website:</b>	<p><a href="http://www.wwnorton.com/college/geo/egeo2/content/animations/2_6.htm">http://www.wwnorton.com/college/geo/egeo2/content/animations/2_6.htm</a> (mantle plume)</p> <p><a href="http://www.wiley.com/college/strahler/0471480533/animations/ch14_animations/hot_spot.html">http://www.wiley.com/college/strahler/0471480533/animations/ch14_animations/hot_spot.html</a> (narrated animation)</p> <p><a href="http://www.classzone.com/books/earth_science/terc/content/investigations/es0810/es0810page01.cfm">http://www.classzone.com/books/earth_science/terc/content/investigations/es0810/es0810page01.cfm</a> (investigating hot spots, Hawaii) questions associated</p> <p><a href="http://www.classzone.com/books/earth_science/terc/content/visualizations/es1002/es1002page01.cfm">http://www.classzone.com/books/earth_science/terc/content/visualizations/es1002/es1002page01.cfm</a> (intro to P and S waves)</p> <p><a href="http://highered.mcgraw-hill.com/sites/0072402466/student_view0/chapter16/animations_and_movies.html#">http://highered.mcgraw-hill.com/sites/0072402466/student_view0/chapter16/animations_and_movies.html#</a> (series of earthquake animations)</p>
<b>Course:</b>	Regents Earth Science
<b>NYS Standard:</b>	<p>2.11 The lithosphere consists of separate plates that ride on the more fluid asthenosphere and move slowly in relationship to one another, creating convergent, divergent, and transform plate boundaries. These motions indicate Earth is a dynamic geologic system.  ¥ These plate boundaries are the sites of most earthquakes, volcanoes, and young mountain ranges.</p> <p>2.1n Many of Earth's surface features such as mid-ocean ridges/rifts, trenches/subduction zones/island arcs, mountain ranges (folded, faulted, and volcanic), <u>hot spots</u>.</p>
<b>Summary:</b>	The hot spots animations allow students to visualize a concept that is typically very difficult for them to comprehend. The hot spot plume stays in the same location; while the plate is what is moving above it. Students can how the Hawaiian Islands formed and also their ages. Students will calculate the speed that the plate is moving and also realize the oldest of the Hawaiian Islands is to the Northwest. Through the earthquake animations students will also be introduced to what generates earthquakes and the various types of earthquake waves.
<b>Rationale:</b>	This lesson will help students to understand how hot spot volcanoes such as the Hawaiian Islands were

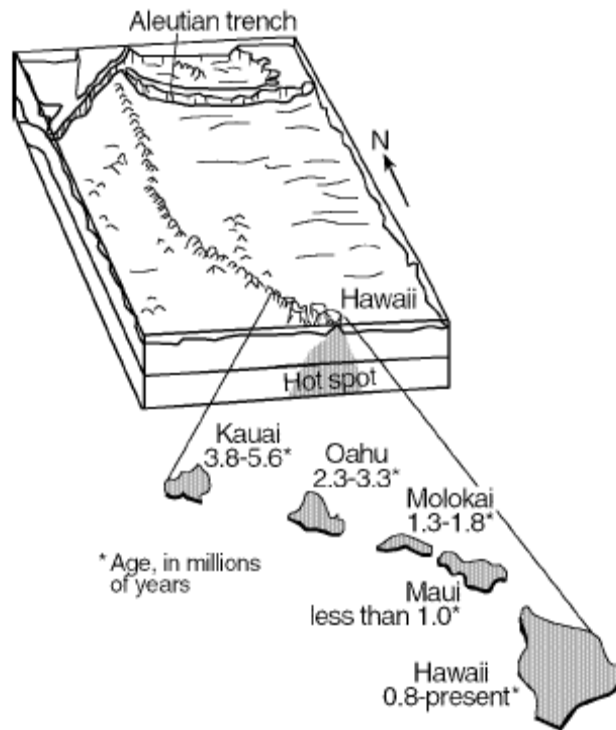
	<p>formed. The animations help students to visualize the how Hawaii formed and also the age of the islands and why the islands are progressively old to the Northwest. These animations help students to understand processes that they cannot observe in real life. It is difficult without the animations for students to truly visualize the magma plume punching a hole through the lithospheric plate while, the plate slides over top. The introduction to earthquake waves animations also help students to visualize waves that cannot be seen with the human eye. These animations helps students by:</p> <ul style="list-style-type: none"> <li>- Providing students with a visual representation of hot spots and Hawaiian Island formation</li> <li>- - Allowing students investigating the movement and traveling time of earthquake P and S waves.</li> </ul>
<b>Possible Misconceptions:</b>	<p>The Hawaiian Islands are all active volcanoes. Earthquakes can be felt only at the location of plate movement (confusion of how waves travel)</p>
<b>Recommendations:</b>	<p>Students explore the last two websites on their laptops.</p>

#### Lesson Procedure:

- 1) Students follow along on PowerPoint and view 1<sup>st</sup> two website animations.
- 2) Students investigate 3<sup>rd</sup> website on Hawaiian Islands, age and plate movement speed. Students answer questions while completing readings and watching animations.
- 3) Class discussion on introduction to earthquakes, where most occur etc. Get an idea of misconceptions
- 4) Students view 4<sup>th</sup> and 5<sup>th</sup> website animations on smartboard. Students become familiar with terms such as p wave, S wave, focus, seismograph etc.
- 5) Students complete ticket out the door.



Name \_\_\_\_\_ Hot Spots and Intro to Earthquakes

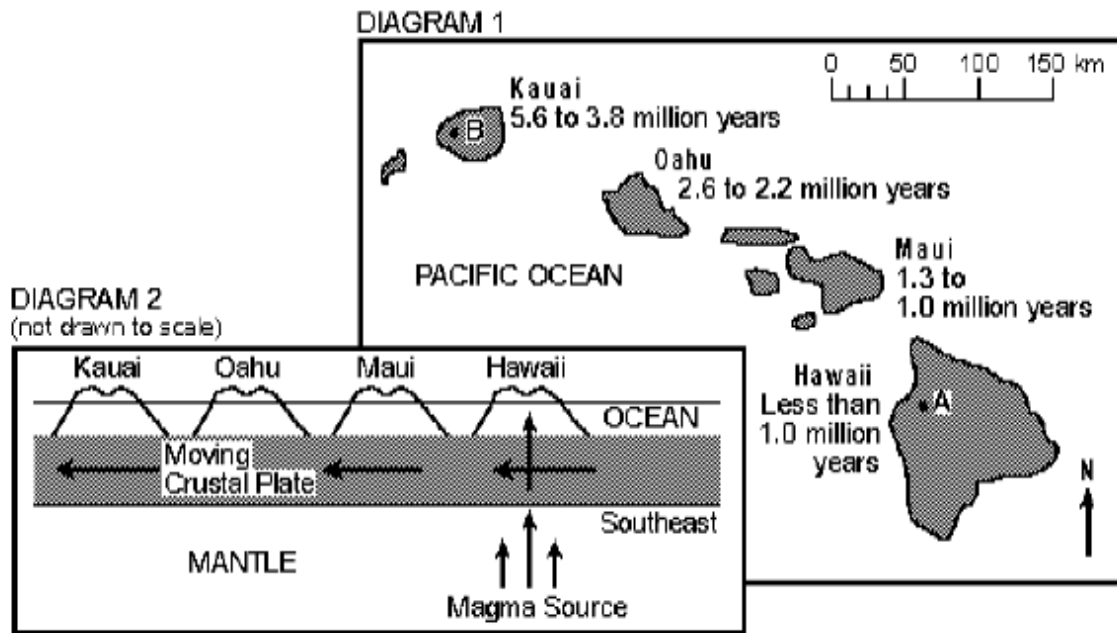


1) The diagram above provides evidence that the Pacific crustal plate is moving toward the

- A) east    B) southwest    C) south    D) northwest

2) Volcanic activity like that which produced the Hawaiian Islands is usually closely associated with

- A) frequent earthquake activity  
 B) nearness to the center of the ocean  
 C) sudden reversals in earth's magnetic field  
 D) frequent major changes in climate.



- 3) Which of the Hawaiian Islands has the greatest probability of having a volcanic eruption?
- A) Oahu    B) Hawaii    C) Kauai    D) Maui
- 4) If each island formed as the crustal plate moved over the magma source in the mantle as shown in diagram II, where would the next volcanic island most likely form?
- A) southeast of Hawaii  
B) northwest of Kauai  
C) northeast of Hawaii  
D) between Hawaii and Maui
- 5) Earthquakes generate compressional waves (P-waves) and shear waves (S-waves). Compared to the speed of shear waves in a given earth material, the speed of compressional waves is
- A) always faster  
B) always slower  
C) always the same  
D) sometimes faster and sometimes slower
- 6) Where are earthquakes most likely to take place?
- A) along the core-mantle interface  
B) where the composition of the earth is uniform  
C) near the equator  
D) near plate boundaries

- 7) The time that an earthquake occurs can be inferred by knowing the
- A) Distances between seismograph stations
  - B) Epicenter distance and arrival time of the P-waves
  - C) Travel time of the S-waves
  - D) Arrival time of the P-waves
- 8) It is suggested that the outer core of the Earth is liquid. Which is the strongest evidence for this?
- A) P-waves disappear as they move through the outer core
  - B) S-waves disappear as they move through the outer core
  - C) S-waves speed up as they move through the outer core
  - D) P-waves are transmitted through the outer core

<b>Title:</b>	Tsunamis #11
<b>Source/website:</b>	<p><a href="http://www.pep.bc.ca/tsunamis/causes_1.htm">http://www.pep.bc.ca/tsunamis/causes_1.htm</a> (animation, preparedness plan, quiz)</p> <p><a href="http://www.nytimes.com/interactive/2011/03/11/world/asia/20110311EARTHQUAKE_zoomer.html?ref=asia">http://www.nytimes.com/interactive/2011/03/11/world/asia/20110311EARTHQUAKE_zoomer.html?ref=asia</a> (zoom in on Japan destruction)</p> <p><a href="http://www.cnn.com/video/#/video/world/2011/03/11/sot.tsunami.hit.japan.cnn">http://www.cnn.com/video/#/video/world/2011/03/11/sot.tsunami.hit.japan.cnn</a> (CNN video- Japan tsunami)</p>
<b>Course:</b>	Regents Earth Science
<b>NYS Standard:</b>	<p>2.11 The lithosphere consists of separate plates that ride on the more fluid asthenosphere and move slowly in relationship to one another, creating convergent, divergent, and transform plate boundaries. These motions indicate Earth is a dynamic geologic system.</p> <p>¥ These plate boundaries are the sites of most earthquakes, volcanoes, and young mountain ranges.</p> <p>¥ Earthquakes, volcanoes and tsunamis present geologic hazards to humans. Loss of property, personal injury, and loss of life can be reduced by effective emergency preparedness.</p>
<b>Summary:</b>	<p>The tsunami animations allow students to visualize a concept that they have never had any first hand experience with. Students can visualize how the movement of lithospheric plates causes the movement of the ocean water above them, thus generating a tsunami. Through the tsunami website students will also be introduced to preparedness plans and actions to take in the event of a tsunami. In this lesson students will understand the vast destruction that can occur when they examine the 2011 Japan tsunami.</p>
<b>Rationale:</b>	<p>This lesson will help students to understand how Tsunamis form. The animations help students to visualize the how tectonic movement at plate boundaries can lead to a massive tsunami. These animations help students to understand processes that they cannot observe in real life. It is difficult without the animations for students to visualize how the wave is hardly noticeable in deep water, but builds up as it reaches shallow water. The student will also learn about warning signs of tsunamis, action plans and study past tsunamis, such as the 2011 Japan tsunami. These animations helps students by:</p> <ul style="list-style-type: none"> <li>- Providing students with a visual representation</li> </ul>

	plate movement which generates tsunamis - - Allowing students to explore past tsunami footage and action plans.
<b>Possible Misconceptions:</b>	Many students believe that a tsunami is one giant 100 foot tall wave that crashes and knocks over buildings.
<b>Recommendations:</b>	Students explore the first websites on their laptops.

**Lesson Procedure:**

- 1) Create KWL chart, find out student misconceptions. Many misconceptions come from movies that students have seen.
- 2) Students investigate 1<sup>st</sup> website on their laptops. Students must click on all tabs and eventually complete online quiz at the end.
- 3) Students explore action plans and preparedness plans on website.
- 4) Class discussion on past tsunamis, especially 2011 Japan tsunami.
- 5) As a class view footage of 2011 tsunami (website above), also zoom in on website photos of destruction.
- 6) Students complete ticket out the door.

Name \_\_\_\_\_

Tsunamis

1) Explain what causes a tsunami.

---



---



---

2) Describe a warning sign that a tsunami may be approaching.

---

3) Imagine that you are on the beach in California and an announcement is made that a tsunami is approaching. Describe what you should do to avoid danger.

---

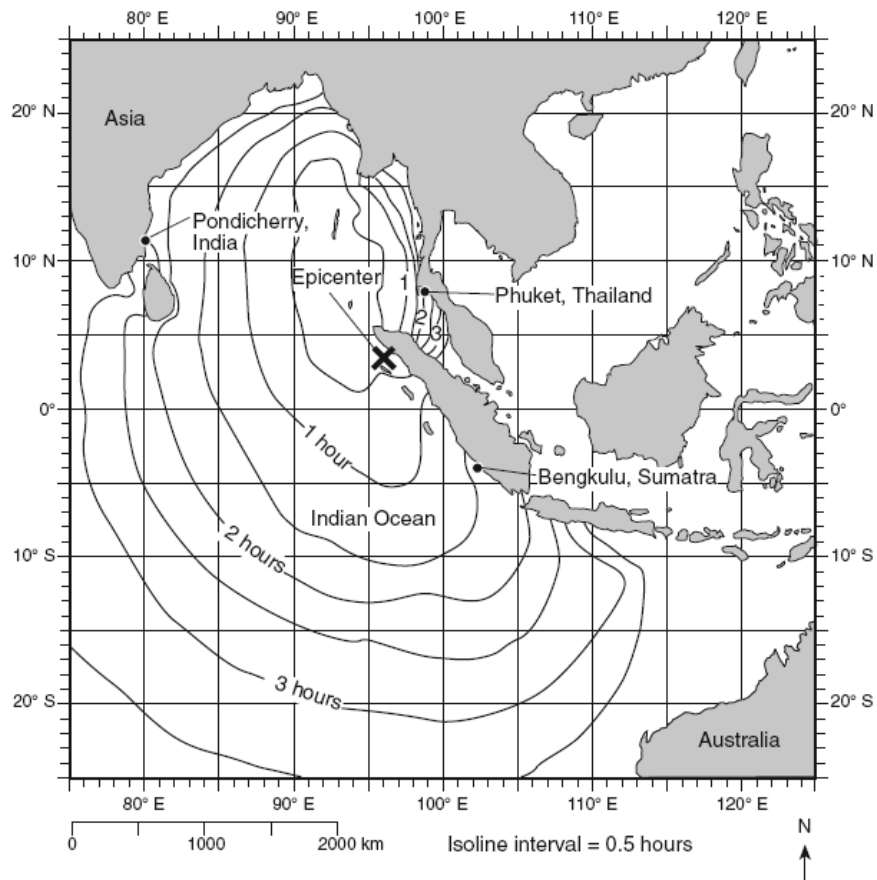


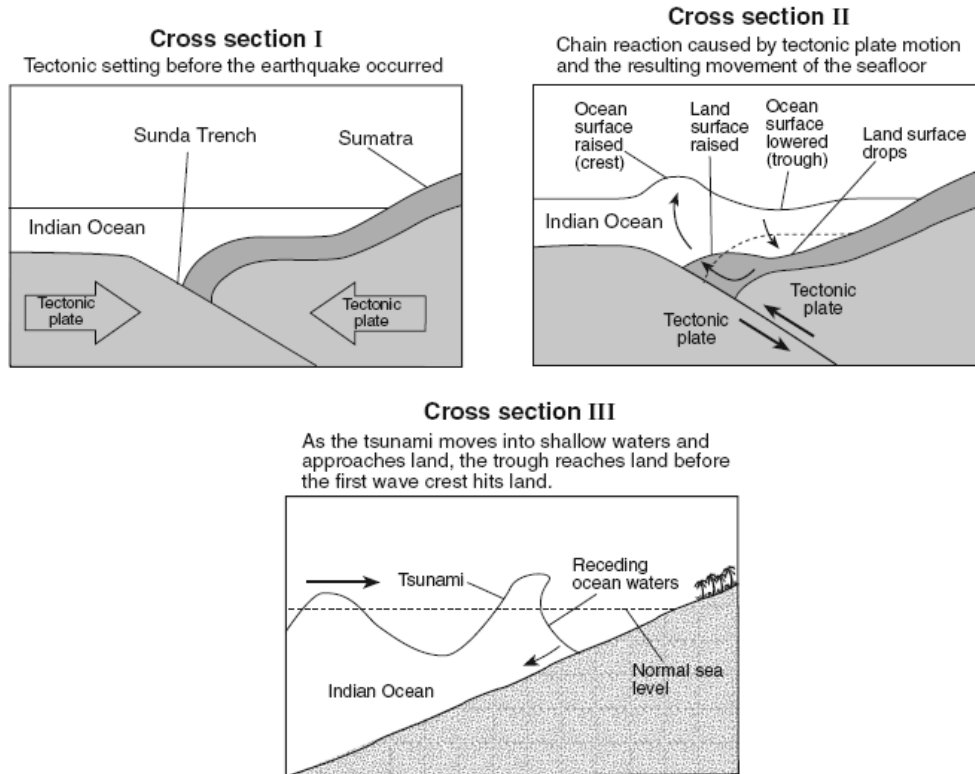
---



---

The X on the map below represents the epicenter of an earthquake that occurred on December 26<sup>th</sup>, 2004.





4) According to the map, how long after this earthquake did the first tsunami wave arrive at Bengkulu, Sumatra?

---

5) Identify the overriding tectonic plate at the convergent plate boundary where this earthquake occurred.

---

6) Based on cross section III, describe the ocean water-level change at the shoreline that people observed just before the first tsunami wave approached the shore.

---



---

<b>Title:</b>	Heat transfer #12
<b>Source/website:</b>	<p><a href="http://www.harcourtschool.com/activity/states_of_matter/">http://www.harcourtschool.com/activity/states_of_matter/</a> (phase changes animation)</p> <p><a href="http://www.bgfl.org/bgfl/custom/resources_frp/client_frp/ks3/science/changing_matter/index.htm">http://www.bgfl.org/bgfl/custom/resources_frp/client_frp/ks3/science/changing_matter/index.htm</a> (phase changes, molecule movement)</p> <p><a href="http://www.footprints-science.co.uk/states.htm">http://www.footprints-science.co.uk/states.htm</a> (Phase changes, condensation etc.) complete questions</p> <p><a href="http://www.wisc-online.com/Objects/ViewObject.aspx?ID=sce304">http://www.wisc-online.com/Objects/ViewObject.aspx?ID=sce304</a> (conduction, convection, radiation animation)</p>
<b>Course:</b>	Regents Earth Science
<b>NYS Standard:</b>	<p>2.1a- Earth systems have internal and external sources of energy, both of which create heat.</p> <p>2.2b- The transfer of heat energy within the atmosphere, the hydrosphere, and Earth's surface occurs as the result of radiation, convection, and conduction.</p> <p>¥ Heating of Earth's surface and atmosphere by the Sun drives convection within the atmosphere and oceans, producing winds and ocean currents.</p>
<b>Summary:</b>	The phase change animations allow students to visualize the phases of matter occurring in substances. It is important for students to visualize and understand the molecular motion in each phase. For example, the molecules are moving fastest and are farthest apart in the gas phase. Student must also know vocabulary terms such as condensation and evaporation. In this lesson students will also explore heat transfer (conduction, convection, and radiation)
<b>Rationale:</b>	<p>This lesson will help students to understand the phases of matter. The animations help students to visualize not only each phase of matter but also the molecular motion. These animations allow students to manipulate the temperature of a substance and observe how it affects the phase of matter. Students can visualize the molecular motion, which cannot be observed in real life classroom situations. Students will then apply their knowledge of molecular motion to the three types of heat transfer. These animations helps students by:</p> <ul style="list-style-type: none"> <li>- Providing students with a visual representation of</li> </ul>



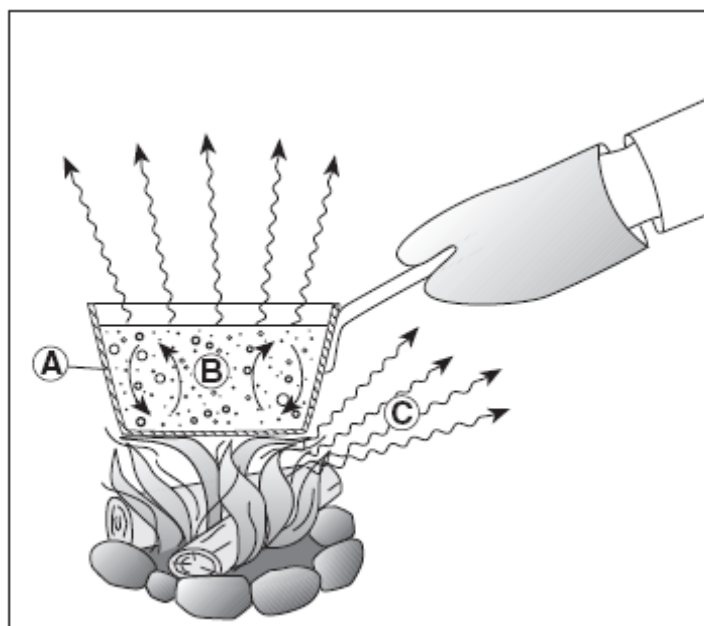
	molecular motion that cannot be observed in the classroom. - - Allowing students to connect molecular motion of phases of matter and the relationship with types of heat transfer (conduction etc.)
<b>Possible Misconceptions:</b>	Many students believe that during vaporization the water molecules disappear.
<b>Recommendations:</b>	Complete together as a class

## Lesson Procedure:

- 1) Watch BrainPop video on heat.
- 2) As a class, complete the first 3 websites and have discussions. Discuss terms such as condensation, vaporization, sublimation. On 3<sup>rd</sup> website discuss temperature graph and how temperature does not increase during melting, boiling.
- 3) Show dry ice experiments (sublimation)
- 4) BrainPop video on matter changing states and complete associated “quiz” worksheet.
- 5) Show lava lamp in classroom and ask students why the movement is occurring.
- 6) Show and discuss 4<sup>th</sup> website animation on the types of heat transfers. Give real life examples show as a metal spoon in hot soup.
- 7) Students complete post assessment.

Name \_\_\_\_\_

### Phases and Heat Transfer Post Assessment



1) Which table correctly identifies the types of heat transfer at A,B and C?

Letter	Type of Heat Transfer
A	conduction
B	radiation
C	convection

( 1 )

Letter	Type of Heat Transfer
A	radiation
B	conduction
C	convection

( 3 )

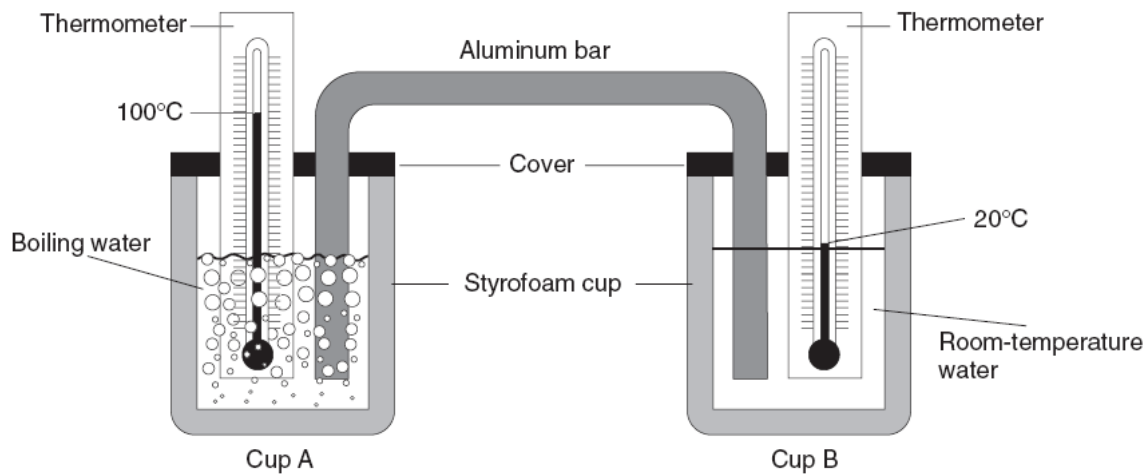
Letter	Type of Heat Transfer
A	conduction
B	convection
C	radiation

( 2 )

Letter	Type of Heat Transfer
A	radiation
B	convection
C	conduction

( 4 )

2) Over the next 15 minutes, which changes would most likely occur?



- A) The temperature in cup A will decrease and the temperature in cup B will increase.
- B) The temperature in cup A will decrease and the temperature in cup B will decrease.
- C) The temperature in cup A will increase and the temperature in cup B will increase.
- D) The temperature in cup A will increase and the temperature in cup B will decrease.

3) Which process is most responsible for the temperature changes that will take place?

- A) radiation of heat from the water in the cups to the thermometers
- B) conduction of heat through the aluminum bar
- C) radiation of heat from the water in the cups into the air
- D) conduction of heat through the air to the water in the cups

4) During which process does heat transfer occur because of density differences?

- A) conduction
- B) convection
- C) radiation
- D) reflection

5) The sun heats the earth by which type of heat transfer?

- A) conduction
- B) convection
- C) radiation

6) A pan sitting on a stove is which type of heat transfer?

- A) conduction
- B) convection
- C) radiation

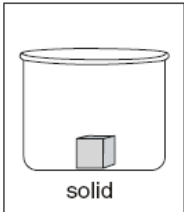
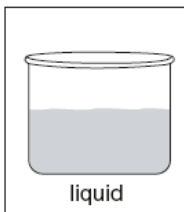
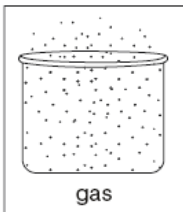
7) Water vapor changes to liquid water during which process?

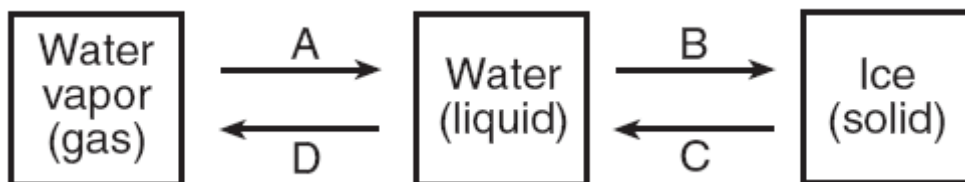
- A) dissolving
- B) melting
- C) evaporation
- D) condensation

8) In what phase of matter are the molecules the farthest apart?

- A) solid
- B) liquid
- C) gas

9) Complete the chart below

	 solid	 liquid	 gas
Does this phase of matter have a definite shape? Write <b>Yes</b> or <b>No</b> in each box.			
Does this phase of matter have a definite volume? Write <b>Yes</b> or <b>No</b> in each box.			
How do these phases rank in order of the relative speed of their particles? Rank them <b>1, 2, 3</b> , with 1 having the slowest particles and 3 having the fastest particles.			



10) Which process is represented by B?

- A) condensing
- B) evaporating
- C) freezing
- D) melting

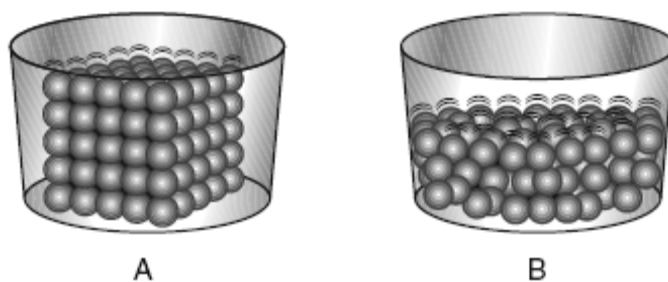
11) Which process is represented by D?

- A) condensing
- B) evaporating
- C) freezing
- D) melting

12) Which two processes decrease the motion of the molecules?

- A) A and B
- B) B and C
- C) C and D
- D) D and A

13) Which phases of matter are represented in diagram A and B?



(Not drawn to scale)

A: \_\_\_\_\_

B: \_\_\_\_\_

<b>Title:</b>	Rainshadow Effect (orographic lifting) and Coriolis Effect #13
<b>Source/website:</b>	<p><a href="http://bcs.whfreeman.com/thelifewire/content/chp56/5602001.html">http://bcs.whfreeman.com/thelifewire/content/chp56/5602001.html</a> (animation)</p> <p><a href="http://www.pbs.org/wgbh/nova/kilimanjaro/weather.html">http://www.pbs.org/wgbh/nova/kilimanjaro/weather.html</a> (orographic lifting, Mt. Kilimanjaro)</p> <p><a href="http://www.youtube.com/watch?v=hXri71sMM&amp;feature=related">http://www.youtube.com/watch?v=hXri71sMM&amp;feature=related</a> (real life example video)</p> <p><a href="http://www.classzone.com/books/earth_science/terc/content/visualizations/es1904/es1904page01.cfm">http://www.classzone.com/books/earth_science/terc/content/visualizations/es1904/es1904page01.cfm</a> (Coriolis Effect)</p> <p><a href="http://www.uwf.edu/atc/projects/coriolis/main.swf">http://www.uwf.edu/atc/projects/coriolis/main.swf</a> (wind belt deflection)</p>
<b>Course:</b>	Regents Earth Science
<b>NYS Standard:</b>	<p>1.1e The Foucault pendulum and the Coriolis effect provide evidence of Earth's rotation.</p> <p>2.1f Air temperature, dewpoint, cloud formation, and precipitation are affected by the expansion and contraction of air due to vertical atmospheric movement.</p> <p>2.2c A location's climate is influenced by latitude, proximity to large bodies of water, ocean currents, prevailing winds, vegetative cover, elevation, and mountain ranges.</p>
<b>Summary:</b>	The rainshadow effect animations allow students to visualize the expansion and cooling of air as it is forced up over a mountain. It is important for students to visualize the processes occurring on both the windward and leeward side of a mountain range. The animations allow students to understand the climate of areas such as Seattle due to this effect. Real life examples are given based on orographic lifting such as Mount Kilimanjaro. Student must also know How wind belts are deflected because of earth's rotation. (Coriolis Effect)
<b>Rationale:</b>	This lesson will help students to understand various processes that affect weather conditions. The animations

	<p>help students to visualize the expansion and contraction of air molecules causing heating and cooling of air. These animations allow students to visualize air being forced over a mountain range, thus cooling the air and causing precipitation. Students can visualize the expansion of air, which cannot be observed in real life classroom situations. Students will then apply their knowledge to areas such as Seattle and Mt. Kilimanjaro. These animations helps students by:</p> <ul style="list-style-type: none"> <li>- Providing students with a visual representation air parcels forced upward until dewpoint is reached.</li> <li>- - Allowing students to connect these processes with real word examples.</li> </ul>
<b>Possible Misconceptions:</b>	Many student believe that snow only occurs near the poles, not near the equator (Mt. Kilimanjaro)
<b>Recommendations:</b>	1 <sup>st</sup> two websites independently on laptops.

#### Lesson Procedure:

- 1) Brief discussion on why it rains often in some places and desert occurs in other places.
- 2) Students complete 1st narrated rain shadow effect animation and complete questions at the end.
- 3) Student visit 2<sup>nd</sup> website and learn about Mt. Kilimanjaro on laptops.
- 4) As a class watch youtube video on real world examples of rain shadow effect.
- 5) Have class discussion on orographic lifting.
- 6) Investigate Coriolis Effect as a class on 4<sup>th</sup> website.
- 7) Discuss the connection between wind belts on 5<sup>th</sup> website.
- 8) Complete ticket out the door.

Name \_\_\_\_\_

Ticket out the Door

1) What is the definition of a rain shadow?

---



---

2) What happens to the temperature of rising air?

---



---

3) Does rising air expand or contract?

---



---

4) Which holds more water, warm air or cool air?

---



---

5) What happens to the water vapor in the air when it cools at high altitudes?

---



---

6) What happens to the temperature of falling air?

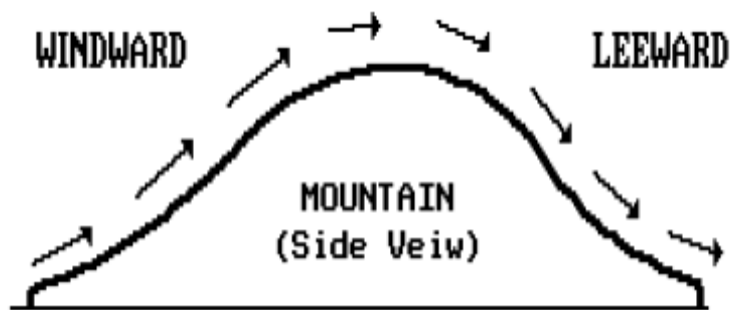
---



---

7) As the air moves down the leeward side of the mountain the air will

- A) warm due to expansion
- B) cool due to expansion
- C) warm due to compression
- D) cool due to compression





8) What is the Coriolis Effect?

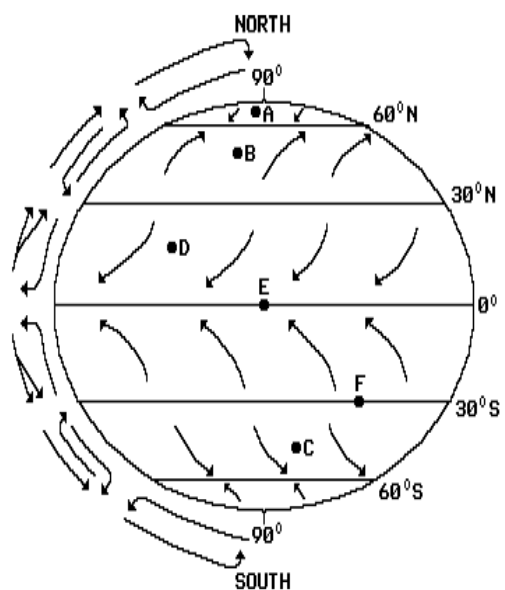
---

9) Which way does the Coriolis Effect bend the winds in the Northern Hemisphere?

---

10) Which way does the Coriolis Effect bend the winds in the Southern Hemisphere?

---

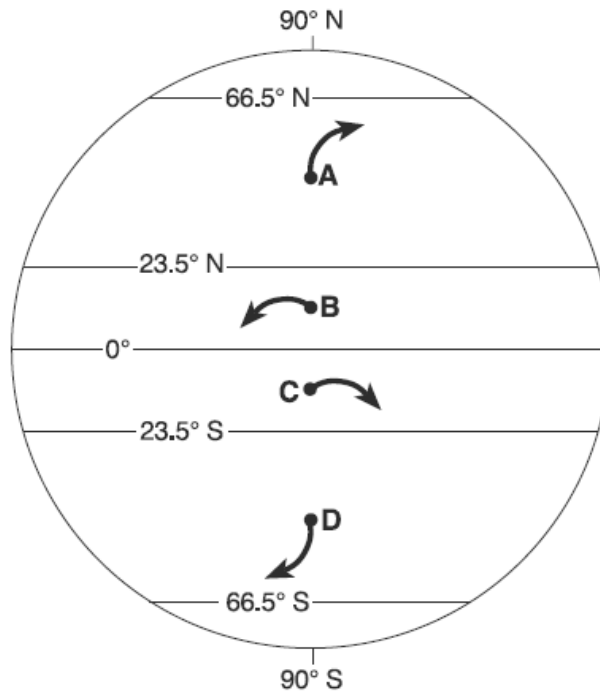


11) Which location is experiencing a southwest planetary wind? \_\_\_\_\_

12) Which location is experiencing a northeast planetary wind? \_\_\_\_\_

13) The arrow at which location correctly a deflection of wind that could be due to the Coriolis Effect?

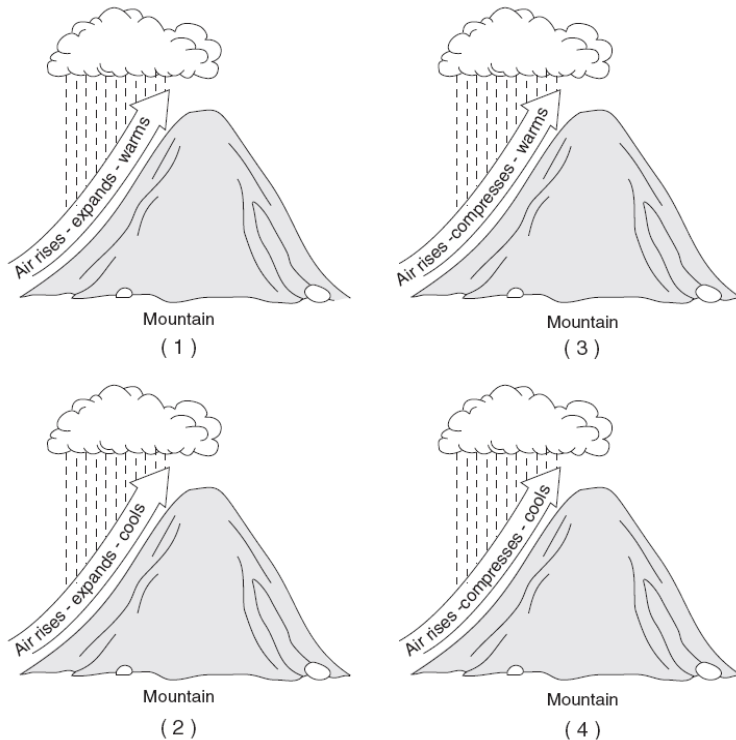
- A) A
- B) B
- C) C
- D) D



14) If you shoot a cannon from the equator pointing toward the North Pole, which way would the cannon ball appear to be deflected?

\_\_\_\_\_

15) Which is drawn correctly?



<b>Title:</b>	Air Pressure and Land/Sea breezes #14
<b>Source/website:</b>	<p><a href="http://www.juicygeography.co.uk/animations.htm">http://www.juicygeography.co.uk/animations.htm</a> (click high and low pressure animations)</p> <p><a href="http://www.eram.k12.ny.us/education/page/download.php?fileinfo=Q3ljQW50aUN5Yy5zd2Y6Ojovd3d3L3NjaG9vbHMvc2MvcmVtb3RlL2ltYWdlcy9kb2NtZ3IvNDQ0ZmlsZTgwMjluc3dm&amp;sectiondetailid=17500">http://www.eram.k12.ny.us/education/page/download.php?fileinfo=Q3ljQW50aUN5Yy5zd2Y6Ojovd3d3L3NjaG9vbHMvc2MvcmVtb3RlL2ltYWdlcy9kb2NtZ3IvNDQ0ZmlsZTgwMjluc3dm&amp;sectiondetailid=17500</a> (high vs. low animations)</p> <p><a href="http://www.mesoscale.iastate.edu/agron206/animations/12_CycAntCyc.html">http://www.mesoscale.iastate.edu/agron206/animations/12_CycAntCyc.html</a> (3D high and low)</p> <p><a href="http://www.classzone.com/books/earth_science/terc/content/visualizations/es1903/es1903page01.cfm?chapter_no=visualization">http://www.classzone.com/books/earth_science/terc/content/visualizations/es1903/es1903page01.cfm?chapter_no=visualization</a> (land breeze/sea breeze)</p>
<b>Course:</b>	Regents Earth Science
<b>NYS Standard:</b>	<p>2.1e Weather variables are interrelated. For example: ¥ temperature and humidity affect air pressure and probability of precipitation ¥ air pressure gradient controls wind velocity</p> <p>2.1h Atmospheric moisture, temperature and pressure distributions; jet streams, wind; air masses and frontal boundaries; and the movement of cyclonic systems and associated tornadoes, thunderstorms, and hurricanes occur in observable patterns. Loss of property, personal injury, and loss of life can be reduced by effective emergency preparedness.</p>
<b>Summary:</b>	<p>The air pressure unit is the main principle behind weather topics. Students must understand air pressure to understand future units on fronts. These animations allow students to visualize the cause of high and low pressure systems. High pressure is caused by sinking air (no cloud development) and low pressure is caused by rising air (cloud formation). Low pressure brings precipitation and high pressure bring clear skies (low, H<sub>2</sub>O; high, dry). It is important for students to visualize the processes occurring as air pressure from areas of high pressure to areas of low. The animations allow students to understand the movement of air across weather systems. Low pressure is counterclockwise and inward and high pressure is clockwise and outward. Students must also know how heating of air and pressure differences causes landbreezes and seabreezes.</p>

<b>Rationale:</b>	<p>This lesson will help students to understand various conditions that cause air pressure differences. The animations help students to visualize how heating and cooling of air causes high and low air pressure. These animations allow students to visualize how air flows into and out of pressure systems thus creating wind. Student knowledge on air pressure helps them to understand the interaction of weather systems, eventually leading to fronts in the next unit. Students can visualize the movement of air (wind) from high to low pressure centers. These animations helps students by:</p> <ul style="list-style-type: none"> <li>- Providing students with a visual representation of high and low pressure being created. Students can visualize movement of air.</li> <li>- - Allowing students to connect these processes with real word examples of land and sea breezes based on pressure differences.</li> </ul>
<b>Possible Misconceptions:</b>	The H on a weather map means Hot.
<b>Recommendations:</b>	Complete lesson and websites as a class.

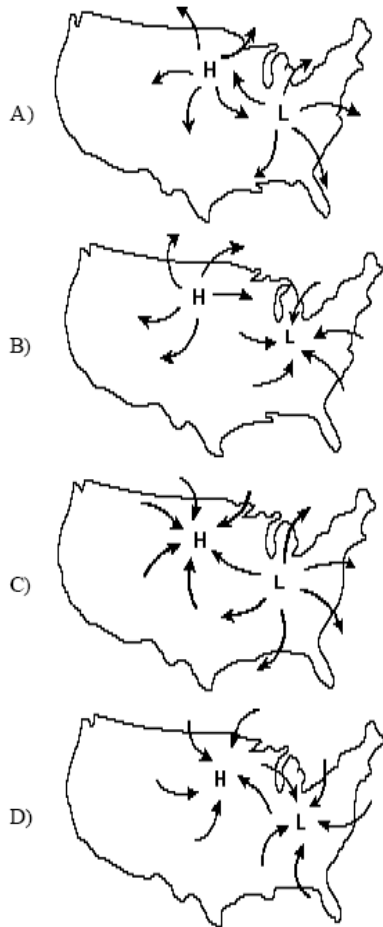
#### Lesson Procedure:

- 1) Students follow along on PowerPoint on air pressure; ask students why we have wind.
- 2) Students view 1<sup>st</sup> website on the smartboard and participate in class discussion.
- 3) Students view 2<sup>nd</sup> and 3<sup>rd</sup> website on the smartboard and discuss as a class.
- 4) Ask students if they have ever been to the beach on a hot summer day. What do they notice about the wind?
- 5) View 4<sup>th</sup> website on land and sea breezes.
- 6) Complete ticket out the door.

Name \_\_\_\_\_

Air Pressure

1) Which correctly shows a high and low pressure system in the U.S?



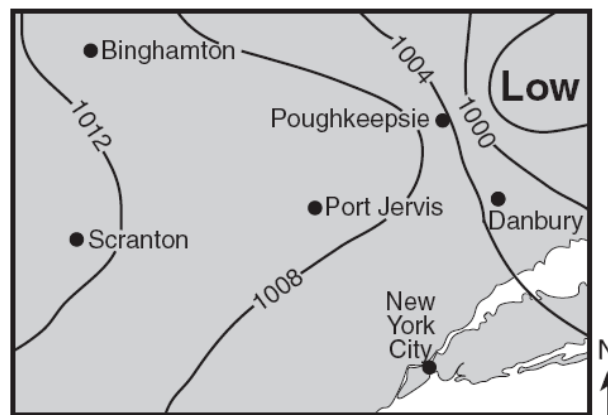
2) As warm, moist air moves into the region, the barometric pressure readings will

- A) remain the same
- B) increase
- C) decrease

3) As wind velocity decreases, the distance between isobars on a weather map will

- A) remain the same
- B) increase
- C) decrease

- 4) Which factor is most directly related to wind velocity?
- A) Relative humidity
  - B) Pressure gradient
  - C) Dewpoint
  - D) Cloud type
- 5) Two weather stations are located near each other. The air pressure at each station is changing so that the difference between the pressure is increasing. The wind speed between these two locations will probably
- A) remain the same
  - B) increase
  - C) decrease



- 6) Which city is most likely experiencing winds of the greatest velocity?
- 

- 7) Surface winds are most likely blowing from

- A) Danbury toward New York City
- B) Poughkeepsie toward Scranton
- C) Binghamton to Danbury
- D) Port Jervis toward Binghamton

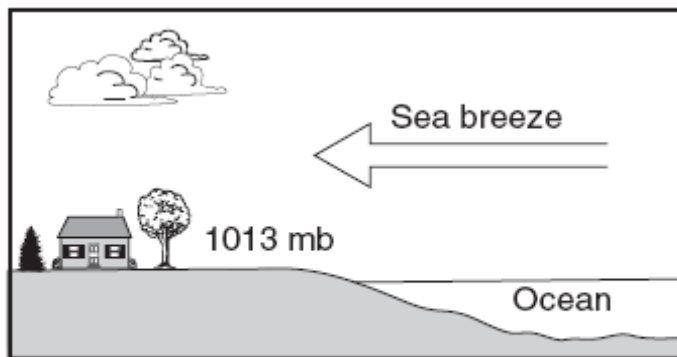
- 8) The primary cause of the winds is the

- A) uniform density of the atmosphere
- B) unequal heating of Earth's atmosphere
- C) friction between the atmosphere and lithosphere

9) Why are the beaches that are located on the southern shore of Long Island often considerably cooler than nearby inland locations on hot summer afternoons?

- A) A land breeze develops due to the lower specific heat of water and the higher specific heat of land.
- B) A sea breeze develops due to the higher specific heat of water and the lower specific heat of land.
- C) The beaches are closer to the equator than the inland locations are.
- D) The beaches are farther from the equator than the inland locations are.

10) The air pressure at the ocean surface a few miles from the shore is most likely



(Not drawn to scale)

- A) 994 mb    B) 1005 mb    C) 1013 mb    D) 1017 mb

<b>Title:</b>	Fronts #15
<b>Source/website:</b>	<p><a href="http://www.eram.k12.ny.us/education/page/download.php?fileinfo=d2VhdGhlcl9mcm9udHMuc3dmOjo6L3d3dy9zY2hvb2xzL3NjL3JlbW90ZS9pbWFnZXMvZG9jbWdyLzQ0NGZpbGU3ODA2LnN3Zg==&amp;sectiondetailid=17500">http://www.eram.k12.ny.us/education/page/download.php?fileinfo=d2VhdGhlcl9mcm9udHMuc3dmOjo6L3d3dy9zY2hvb2xzL3NjL3JlbW90ZS9pbWFnZXMvZG9jbWdyLzQ0NGZpbGU3ODA2LnN3Zg==&amp;sectiondetailid=17500</a> (4 types of fronts animation)</p> <p><a href="http://www.classzone.com/books/earth_science/terc/content/visualizations/es2002/es2002page01.cfm?chapter_no=visualization">http://www.classzone.com/books/earth_science/terc/content/visualizations/es2002/es2002page01.cfm?chapter_no=visualization</a> (cold and warm front animation with questions)</p> <p><a href="http://www.eram.k12.ny.us/education/page/download.php?fileinfo=TWlkTGFOQ3ljbG9uZS5zd2Y6Ojovd3d3L3NjaG9vbHMvc2MvcmVtb3RlL2ltYWdlcy9kb2NtZ3IvNDQ0ZmlsZTgwMjMuc3dm&amp;sectiondetailid=17500">http://www.eram.k12.ny.us/education/page/download.php?fileinfo=TWlkTGFOQ3ljbG9uZS5zd2Y6Ojovd3d3L3NjaG9vbHMvc2MvcmVtb3RlL2ltYWdlcy9kb2NtZ3IvNDQ0ZmlsZTgwMjMuc3dm&amp;sectiondetailid=17500</a> (low pressure creation of occluded front animation)</p>
<b>Course:</b>	Regents Earth Science
<b>NYS Standard:</b>	<p>2.1e Weather variables are interrelated. For example: ¥ temperature and humidity affect air pressure and probability of precipitation ¥ air pressure gradient controls wind velocity</p> <p>2.1h Atmospheric moisture, temperature and pressure distributions; jet streams, wind; air masses and frontal boundaries; and the movement of cyclonic systems and associated tornadoes, thunderstorms, and hurricanes occur in observable patterns. Loss of property, personal injury, and loss of life can be reduced by effective emergency preparedness.</p>
<b>Summary:</b>	<p>The lesson on fronts is important to the earth science curriculum and also future understanding of weather forecasts in everyday life. Without the visual aspect of fronts the movement of air is hard to comprehend as different temperature air masses approach each other. The denser cold air is forced under the less dense warm air causing that air to rise. The rising of this warm air causes it to cool and thus condense into clouds. The clouds become saturated and eventually lead to precipitation in all four types of fronts. It is important for students to visualize the processes occurring as different air masses interact with one another.</p>
<b>Rationale:</b>	<p>This lesson will help students to understand various types of fronts that occur across our country on a day to day basis. These animations allow students to visualize an extremely complex system of fronts. With the animations students can</p>



	<p>visualize how less dense is forced to rise when encountering a colder, denser air mass. These animations helps students by:</p> <ul style="list-style-type: none"> <li>- Providing students with a visual representation of different temperature and density air masses interacting.</li> <li>- - Allowing students to connect these processes with real word weather conditions and conditions they should expect when certain fronts pass through their area.</li> </ul>
<b>Possible Misconceptions:</b>	A cold front always brings very cold weather. Example, snow.
<b>Recommendations:</b>	Complete 1 <sup>st</sup> and 2 <sup>nd</sup> animation on laptops and answer questions.

#### Lesson Procedure:

- 1) Revisit last lesson on air pressure systems. Discuss how cold air is denser than warm air.
- 2) Students view 1<sup>st</sup> website on their laptops and complete readings on each website slide.
- 3) Students view 2<sup>nd</sup> website on their laptops and complete series of questions worksheet associated with animation.
- 4) View 3<sup>rd</sup> website as a class on the smartboard and have discussion on occluded fronts. Discuss how low pressure systems rotate counterclockwise along with frontal systems.
- 5) Complete ticket out the door.

Name \_\_\_\_\_ Fronts Animation Worksheet

1) When a cold front meets warm air, does the cold air move over or under the warm air that is already there?

\_\_\_\_\_

2) What happens to the warm air?

\_\_\_\_\_

\_\_\_\_\_

3) What happens to air temperature when it rises?

\_\_\_\_\_

\_\_\_\_\_

4) From the animation, what types of clouds usually form when a cold front moves through?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

5) Will the temperature change be slow or quick when a cold front moves through?

\_\_\_\_\_

6) When a warm front meets cold air, does the warm air go over the cooler air, or does it go under?

\_\_\_\_\_

7) What happens to air temperature when it rises?

\_\_\_\_\_

8) Based on the animation, what type of clouds form when a warm front moves through?

---

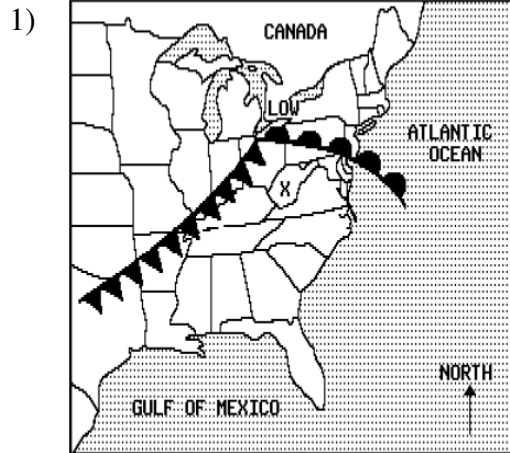
9) Which holds more water, warm air or cold air?

---

10) Do you think it usually rains more when a cold front moves through or when a warm front moves through?

---

Name \_\_\_\_\_ Fronts Ticket out the Door

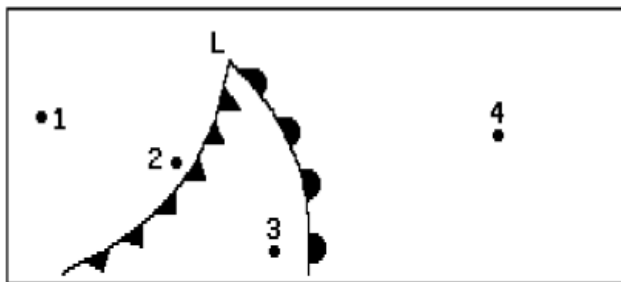


The air mass located over point X most likely originated over the

- A) Pacific Northwest
- B) Central part of Canada
- C) Northern Atlantic Ocean
- D) Gulf of Mexico

2) Why do clouds usually form at the leading edge of a cold air mass?

- A) Cold air contains more water vapor than warm air does
- B) Cold air contains more dust than warm air does
- C) Cold air flows under warm air, causing the warm air to rise and cool
- D) Cold air flows over warm air, causing the warm air to descend and cool



3) Which location in the diagram above is experiencing the heaviest precipitation?

\_\_\_\_\_

4) Compared to location 2, the temperature at location 3 is warmer or cooler?

\_\_\_\_\_

5) What usually happens to the warm air that is between the two frontal surfaces?



- A) The warm air is forced under both frontal interfaces.
- B) The warm air is forced under the cold frontal interface but over the warm frontal interface.
- C) The warm air is forced under the cold frontal interface but under the warm frontal interface.
- D) The warm air is forced over both frontal interfaces.

<b>Title:</b>	Global Warming and the Greenhouse Effect #16
<b>Source/website:</b>	<a href="http://www.brainpop.com/science/ourfragileenvironment/globalwarming/">http://www.brainpop.com/science/ourfragileenvironment/globalwarming/</a> (global warming BrainPop)  <a href="http://prof.danglais.pagesperso-orange.fr/animations/environment/greenhouse/greenhouse.htm">http://prof.danglais.pagesperso-orange.fr/animations/environment/greenhouse/greenhouse.htm</a> (greenhouse effect animation)  <a href="http://phet.colorado.edu/en/simulation/greenhouse">http://phet.colorado.edu/en/simulation/greenhouse</a> (Greenhouse Effect simulation)
<b>Course:</b>	Regents Earth Science
<b>NYS Standard:</b>	2.2d Temperature and precipitation patterns are altered by: ¥ Human influences including deforestation, urbanization, and the production of greenhouse gases such as carbon dioxide and methane.
<b>Summary:</b>	The lesson on Global warming and the greenhouse effect is an extremely important topic for this current generation of students. It is important for students to realize that the actions they take by driving cars and burning fossil fuels does have an impact on the environment. Students should know that releasing greenhouse gases into the atmosphere can have an effect on climate change. The brainpop video introduces students to the possible ramifications of global warming such as sea level change and the possibility of more severe weather.
<b>Rationale:</b>	<p>This lesson will help students to visualize how the greenhouse effect can lead to global warming. The animation and simulations allow students to visualize how infrared radiation may be trapped and re-radiated down to the earth's surface, thus heating the earth. The simulation allows students to manipulate the concentration of greenhouse gases and the affect that has on temperature. These animations helps students by:</p> <ul style="list-style-type: none"> <li>- Providing students with a visual representation of the greenhouse effect and the interaction between greenhouse gases and U.V and infrared radiation.</li> <li>- - Allowing students to connect these processes with real word applications. Students will realize that their actions play a role in climate change.</li> </ul>
<b>Possible</b>	Greenhouse gases are identical to glass in a

<b>Misconceptions:</b>	greenhouse. (Greenhouse gases “trap” heat). Many students believe carbon dioxide is the most powerful greenhouse gas.
<b>Recommendations:</b>	Complete simulation on personal laptops

Lesson Procedure:

- 1) Class discussion on prior ideas about global warming. Create KWL chart to address misconceptions.
- 2) Discussion about the temperature inside a car sitting in a parking lot on a hot sunny day.
- 3) BrainPop on Global Warming and associated worksheet
- 4) View 2<sup>nd</sup> website as a class on the smartboard and have discussion on how a greenhouse works. Use the example of the Garden Factory right next door to school.
- 5) Student complete simulation on laptops. Students can explore greenhouses and also manipulate concentration of greenhouse gases in earth’s atmosphere. Students should follow along with direction and question guide.
- 6) Complete ticket out the door.

**Greenhouse Effect Simulation Guide**  
(Adapted from Lewistonpublicschools.org)

Name \_\_\_\_\_

**Part I: A Greenhouse Simulation**

2) Select the “Glass Layers” tab.

3) What do the yellow stars represent? \_\_\_\_\_

4) What do the red stars represent? \_\_\_\_\_

5) Record the approximate temperature “inside the greenhouse” before adding glass panes.

\_\_\_\_\_

6) Add one glass pane.

7) What do the infrared photons do when they hit the glass from the bottom?

\_\_\_\_\_

8) What is the new temperature “inside the greenhouse?” \_\_\_\_\_

9) Based on the observations of the photons, why does the temperature go up so much?

\_\_\_\_\_

\_\_\_\_\_

10) What happens to the temperature as additional glass panes are added?

\_\_\_\_\_

**Part II: The Earth Simulation**

11) Select the “Greenhouse Effect” tab.

12) Which greenhouse gases are considered by the simulation?

\_\_\_\_\_

13) Which time period do the default conditions represent? \_\_\_\_\_

14) What is the average global temperature for the “today” simulation? \_\_\_\_\_



15) Reduce the greenhouse gas concentration to “None”.

16) Is the behavior of the photons more similar to the greenhouse simulation with or without glass panes?

---

17) What is the average global temperature?\_\_\_\_\_

18) Increase the greenhouse gas concentrations to “Lots.”

19) What is the average global temperature?\_\_\_\_\_

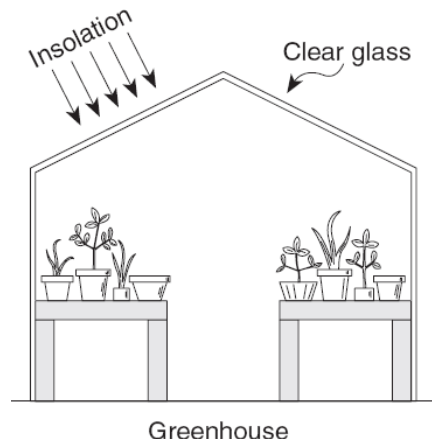
20) Considering the behavior of the photons, why does the temperature increase?

---

---

21) Experiment with other periods in earth’s history or add clouds and record interesting observations.

Name \_\_\_\_\_ Global Warming Ticket out the Door



- 1) What is the primary function of the clear glass of the greenhouse?
- A) The glass reduces the amount of insolation entering the greenhouse.
  - B) The glass allows all wavelengths of radiation to enter and all wavelengths of radiation to escape.
  - C) The glass allows short wavelengths of radiation to enter, but reduces the amount of long wavelength radiation that escapes.
  - D) The glass allows long wavelengths of radiation to enter, but reduces the amount of short wavelength radiation that escapes.

- 2) List two greenhouse gases.

\_\_\_\_\_ and \_\_\_\_\_

- 3) State one action humans could take to reduce global warming.

\_\_\_\_\_  
\_\_\_\_\_

<b>Title:</b>	Earth's Seasons #17
<b>Source/website:</b>	<a href="http://www.eram.k12.ny.us/education/components/docmgr/default.php?sectiondetailid=17500&amp;fileitem=2798&amp;catfilter=451">http://www.eram.k12.ny.us/education/components/docmgr/default.php?sectiondetailid=17500&amp;fileitem=2798&amp;catfilter=451</a>  <a href="http://esminfo.prenhall.com/science/geoanimations/animations/01_EarthSun_E2.html">http://esminfo.prenhall.com/science/geoanimations/animations/01_EarthSun_E2.html</a>  <a href="http://highered.mcgraw-hill.com/olcweb/cgi/pluginpop.cgi?it=swf::800::600::sites/dl/free/0072482621/78778/Seasons_Nav.swf::Seasons%20Interactive">http://highered.mcgraw-hill.com/olcweb/cgi/pluginpop.cgi?it=swf::800::600::sites/dl/free/0072482621/78778/Seasons_Nav.swf::Seasons%20Interactive</a>
<b>Course:</b>	Earth Science
<b>NYS Standard:</b>	<p>1.1f Earth's changing position with regard to the Sun and the moon has noticeable effects.</p> <p>¥ During Earth's one-year period of revolution, the tilt of its axis results in changes in the angle of incidence of the Sun's rays at a given latitude; these changes cause variation in the heating of the surface. This produces seasonal variation in weather.</p>
<b>Summary:</b>	The Earth's seasons computer model/simulation allows students to manipulate the tilt of earth's axis! Students can see how changing the tilt of earth affects the temperature at a given location. Students can also see how manipulating earth's tilt changes the sun's angle of insolation, therefore changing intensity and path through the sky.
<b>Rationale:</b>	<p>Seasons and the sun's angle of insolation are an important part of the Earth Science curriculum. It is a very tough concept for most students to understand because of the scale of the real objects. Students can't manipulate such variables in real life. This simulation helps students by:</p> <ul style="list-style-type: none"> <li>- providing them with models of the earth which they have the chance to manipulate</li> <li>- helping them connect to a concept that is otherwise too large to be brought into the classroom</li> </ul>
<b>Possible Misconceptions:</b>	This simulation helps to dispel the common misconception that seasons are due to the distance earth is from the sun. It is not warmer in the summer because the earth is closer to the sun then! Earth is actually

	slightly farther from the sun in the Northern hemisphere's summer.
<b>Recommendations:</b>	<p>First website is used as a class demo. Discussion on angle of insolation and the intensity of sunlight. 90 degree angle has a greater intensity than a 30 degree angle.</p> <p>Second website also used as a class demo. Discuss earth's position during Northern hemisphere's summer winter etc.</p> <p>Third website works well individually. The simulation is easy to manipulate but should incorporate a worksheet with questions to answer after specific manipulations are made. Worksheet has typed out questions from the "exercises" tab of simulation.</p>

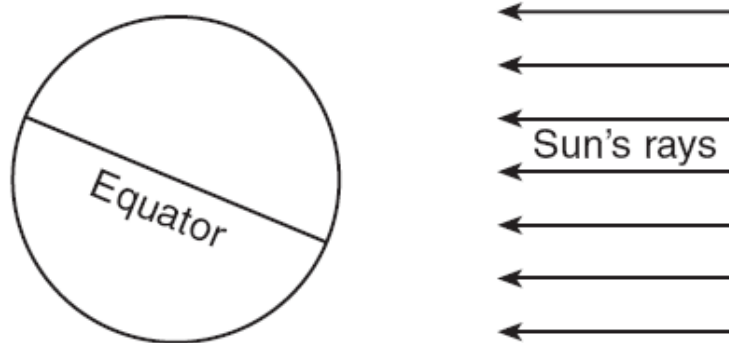
#### Lesson Procedure:

- 1) Brief discussion on misconceptions. Find out students ideas about intensity of sunlight and why we have seasons. As a class create a KWL chart about what students know, what they want to know and eventually what they learned to conclude.
- 2) 1<sup>st</sup> animation: Ask the class how will the intensity of the light will change when the flashlights angle is changed. Explain mathematically the intensity number.
- 3) Class discussion: Have students imagine they are under a large flood light. Imagine the light shining on them from a low angle, then put the flood light directly over them shooting straight down. Which would they feel hotter?
- 4) Second website: Discuss as a class earth's position during various seasons. Look at how the earth is tilted during northern hemisphere's summer and winter. Start to discuss terms such as equinox and solstice.
- 5) Students obtain laptops and view 3rd animation. Students follow along on simulation tabs, while answering the series of questions (on worksheet) that go along with simulation steps.
- 6) Complete L portion of KWL chart as a class.
- 7) Summative ticket out the door worksheet assessing student knowledge on seasons and solar intensity. (next lesson will led into more details such as what latitude sun is directly overhead on certain days, tropic of cancer and Capricorn)

Name \_\_\_\_\_

Ticket out the Door

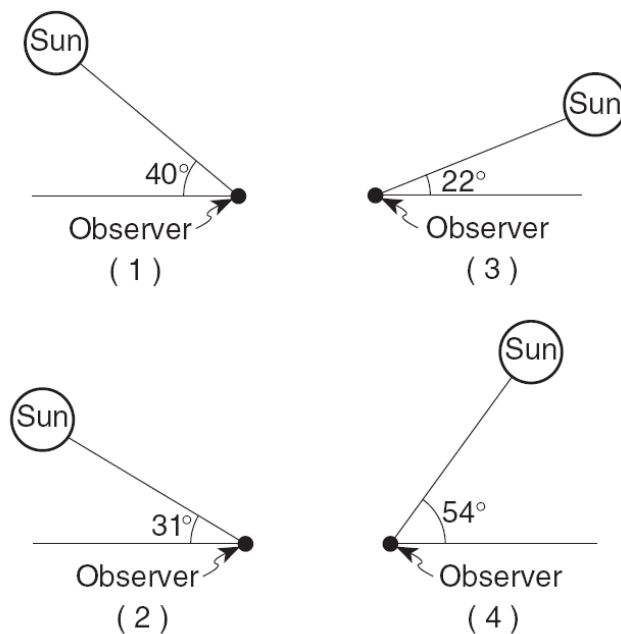
- 1) On the diagram below, shade the portion of the Earth experiencing night time.
- 2) Also, draw and label the positions of the North and South Poles on the diagram.



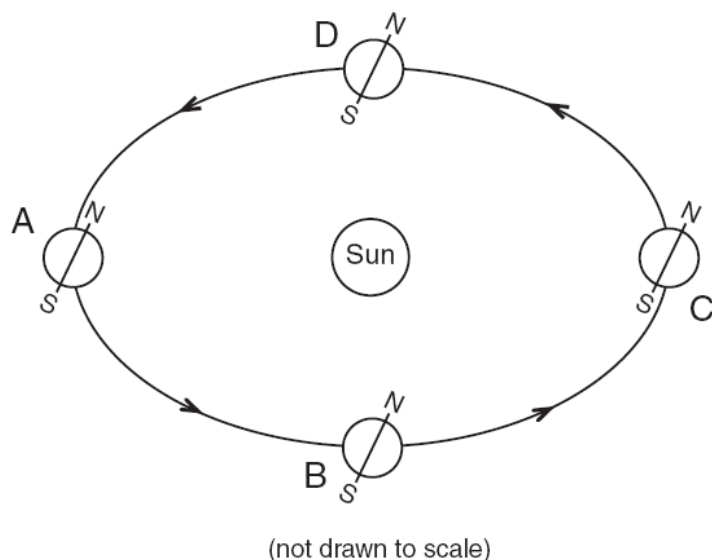
- 3) What season is it in the diagram above for the Northern Hemisphere?

\_\_\_\_\_

- 4) In which diagram below is the observer experiencing the greatest intensity of insolation?



The diagram below shows the earth moving around the sun as viewed from space. Positions A, B, C, and D represent the beginning of each season.



5) Which letter represents the earth's position at the beginning of winter for the northern hemisphere?

- A) A
- B) B
- C) C
- D) D

6) How long does it take the Earth to move from location B to location C?

- A) 1 month
- B) 3 months
- C) 6 months

<b>Title:</b>	Sun's daily path at various locations at different times of the year #18
<b>Source/website:</b>	<a href="http://www.eram.k12.ny.us/education/components/docmgr/default.php?sectiondetailid=17500&amp;fileitem=633&amp;catfilter=451">http://www.eram.k12.ny.us/education/components/docmgr/default.php?sectiondetailid=17500&amp;fileitem=633&amp;catfilter=451</a> (basic sun path)  <a href="http://www.eram.k12.ny.us/education/components/docmgr/default.php?sectiondetailid=17500&amp;fileitem=1307&amp;catfilter=451">http://www.eram.k12.ny.us/education/components/docmgr/default.php?sectiondetailid=17500&amp;fileitem=1307&amp;catfilter=451</a> (interactive sun path)  <a href="http://astro.unl.edu/naap/motion1/animations/seasons_ecliptic.swf">http://astro.unl.edu/naap/motion1/animations/seasons_ecliptic.swf</a> (interactive sun's intensity latitudes)
<b>Course:</b>	Earth Science
<b>NYS Standard:</b>	1.1h The Sun's apparent path through the sky varies with latitude and season.
<b>Summary:</b>	<p>The Sun's path animation allows students to see the Sun's path across the sky at four different earth locations during the year. This helps students to visualize the rising and setting of the sun in what I feel is the most difficult astronomy concept for students to grasp. The interactive sun's path simulation allows students to manipulate an observer's latitude while exploring the Sun's path. Finally the third simulation ties together the concepts of Sun's path, angle and effect on seasonal temperature. These animations and simulations help students to visualize concepts that are hard to see in a typical hour long class period. The simulations also clear up the commonly held misconception that the sun always rises in the east and sets in the west.</p>
<b>Rationale:</b>	<p>The Sun's path and how it affects intensity is an important part of the Earth Science curriculum. It is a very tough concept for most students to understand because of the scale of the real objects. Students can't manipulate such variables in real life. This simulation helps students by:</p> <ul style="list-style-type: none"> <li>- providing them with models of the earth and sun which they have the chance to manipulate</li> <li>- helping them connect to a concept that is otherwise too large and too time consuming (watching the sun's path throughout an entire day and various times of the year) to be brought into the classroom.</li> </ul>
<b>Possible Misconceptions:</b>	This simulation helps to dispel the common misconception that the Sun always rises in the east and

	sets in the west. Another misconception is that in Alaska the sun never sets in the summer time. It depends if the observer is above the Arctic Circle in Alaska.
<b>Recommendations:</b>	<p>First website is used as a class demo. Discussion on Sun's path at four different locations.</p> <p>Second website students manipulate through instructions on laptops.</p> <p>Third website students also complete on laptops. Ties sun's path with angle of intensity.</p>

#### Lesson Procedure:

- 1) Brief discussion on misconceptions. Find out students ideas about Sun's path. Majority of students will say the Sun always rises in the east and sets in the west.
- 2) Discuss with students terminology such as summer solstice, equinox and winter solstice.
- 3) 1<sup>st</sup> animation: discussion with students about NY location first. Does the Sun always rise in the east, set in the west or only during certain times of the year? Is the Sun ever directly overhead in NY State during anytime of the year? Ask similar questions for three other locations.
- 4) Second website: Students complete attached worksheet as they manipulate the simulation.
- 5) Students use laptops to manipulate the 3<sup>rd</sup> simulation. Students answer questions such as where is the Sun directly overhead on the summer solstice. (Tropic of cancer). Where is the Sun directly overhead during the equinoxes? (equator) Students can manipulate observer's latitude (such as 90 degrees N) and determine exactly how many days the Sun doesn't rise for in the winter.
- 6) Summative worksheet assessing student knowledge and understanding.



Name \_\_\_\_\_ Sun's Path- Changing Latitude

1) Manipulate the latitude on the website. At what latitude is the Sun directly overhead during the summer solstice?

\_\_\_\_\_

2) Change the latitude to 44 degrees N (approx. our latitude). During what time of the year does the Sun rises directly east and set directly west?

\_\_\_\_\_

3) Imagine you live at 74 degrees N latitude. What would the Sun's path in the winter be like for you?

\_\_\_\_\_

4) Change the latitude to 90 degrees N. Describe what the Sun's path would look like during the summer solstice.

\_\_\_\_\_

\_\_\_\_\_

5) At what latitude is the Sun at a 60 degree angle at solar noon?

\_\_\_\_\_

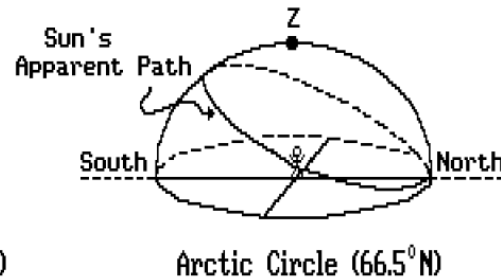
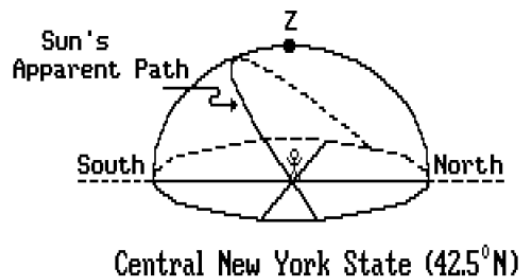
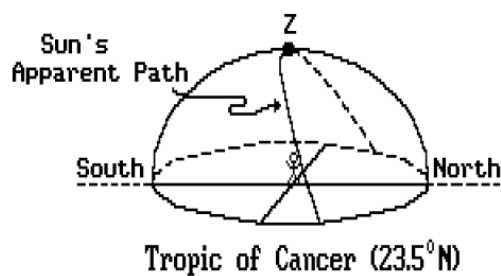
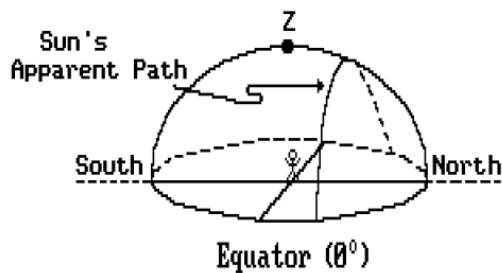
Name \_\_\_\_\_ Summative Sun's Angle

- 1) On which date does the maximum duration of insolation occur in the Northern Hemisphere?
  - A) June 21
  - B) December 21
  - C) March 21
  - D) September 23
- 2) At which latitude would the duration of insolation be *greatest* on December 21?
  - A) 23.5 degrees N.
  - B) 23.5 degrees S.
  - C) 0 degrees
  - D) 10 degrees N.
- 3) Which two factors determine the number of hours of daylight at a particular location?
  - A) longitude and the Earth's average diameter
  - B) longitude and season
  - C) latitude and the Earth's average diameter
  - D) latitude and season
- 4) The seasonal temperature changes in the climate of New York State are influenced mostly by the
  - A) changing speed at which the Earth travels in its orbit around the Sun
  - B) changing angle at which the Sun's rays strike the Earth's surface
  - C) rotation of the Earth on its axis
  - D) changing distance of the Earth from the Sun
- 5) During which month does the minimum duration of insolation occur in New York State?
  - A) February
  - B) December
  - C) September
  - D) July

6) Over a period of one year, which location would probably have the *greatest* average intensity of insolation per unit area? [Assume equal atmospheric transparency at each location.]

- A) New York City
- B) Tropic of Cancer
- C) the North Pole
- D) the Arctic Circle

\*The diagrams below represent plastic hemisphere models. Lines have been drawn to show the apparent path of the Sun across the sky on June 21 for observers at four different Earth locations. The zenith (Z) is the point in the sky directly over the observer\*



7) The Arctic Circle has the coolest climate of these four locations because the Arctic Circle

- A) receives the fewest hours of daylight
- B) is usually farthest from the Sun
- C) receives mostly low-angle, slanting insolation rays
- D) reflects the least amount of insolation

8) Which location will experience the shortest duration of insolation?

- A) Arctic Circle
- B) Equator
- C) Tropic of Cancer
- D) central New York State

<b>Title:</b>	Moon Phases and revolution #19
<b>Source/website:</b>	<a href="http://www.sumanasinc.com/webcontent/animations/content/moonphase.html">http://www.sumanasinc.com/webcontent/animations/content/moonphase.html</a> (moon phase animation)  <a href="http://www.eram.k12.ny.us/education/components/docmgr/default.php?sectiondetailid=17500&amp;fileitem=2344&amp;catfilter=452">http://www.eram.k12.ny.us/education/components/docmgr/default.php?sectiondetailid=17500&amp;fileitem=2344&amp;catfilter=452</a> (interactive moon phases simulation)
<b>Course:</b>	Earth Science
<b>NYS Standard:</b>	<p>1.1a Most objects in the solar system are in regular and predictable motion.</p> <p>¥ These motions explain such phenomena as the day, the year, seasons, phases of the moon, eclipses, and tides.</p>
<b>Summary:</b>	The moon phases computer model/simulation allows students to view the positions of the Sun, Earth and moon while also viewing how the moon would appear to an observer standing on Earth. Students can also move the moon to a different position in its revolution and see the corresponding moon phase.
<b>Rationale:</b>	<p>Moon phases are an important part of the Earth Science curriculum and are a staple of the Regents Exam. Students typically struggle with moon phases because of the scale of the real objects. It is hard for students in real life to visualize the positions of the Sun, Earth and moon that create each moon phase. This simulation helps students by:</p> <ul style="list-style-type: none"> <li>- providing them with models of the Sun, Earth and moon which they have the chance to manipulate the moon's position.</li> <li>- helping them connect to a concept that is otherwise too large to be brought into the classroom</li> </ul>
<b>Possible Misconceptions:</b>	This simulation helps to dispel the common misconception that during a full moon the entire moon is lit up (actually just the side that is facing you).
<b>Recommendations:</b>	<p>First website teacher explains to class (imagine yourself standing on earth looking at the moon). Students will answer a series of questions after.</p> <p>Second website students explore on their laptops.</p> <p>Students will answer questions on the exercises tab.</p>

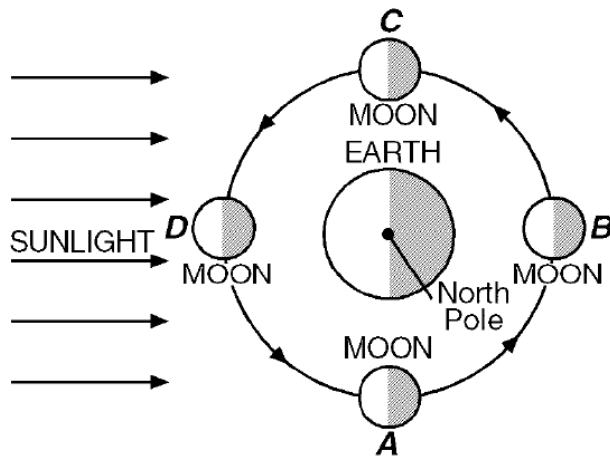
**Lesson Procedure:**

- 1) 1<sup>st</sup> animation: Students will participate in class discussion as the animation is continuously being played.
- 2) Students will volunteer answers to questioning on the animation by the teacher.
- 3) Students will use laptops to independently explore second website.
- 4) Students will answer questions on the exercises tab.
- 5) Students will complete exit slip showing their understanding of the lesson's content.

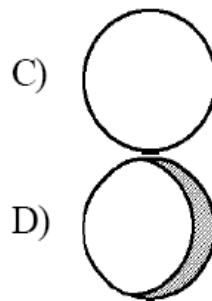
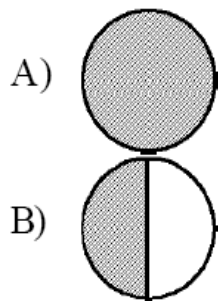
Name \_\_\_\_\_

Moon Phases Exit Slip

The diagram below shows the Moon in four different positions, A, B, C and D, as it orbits Earth.



1) How does the Moon appear to an observer in New York State when the Moon is located at position A?



2) What is the approximate length of time the Moon takes to travel from position A to position C?

- A) 1 day
- B) 365 days
- C) 15 days
- D) 30 days

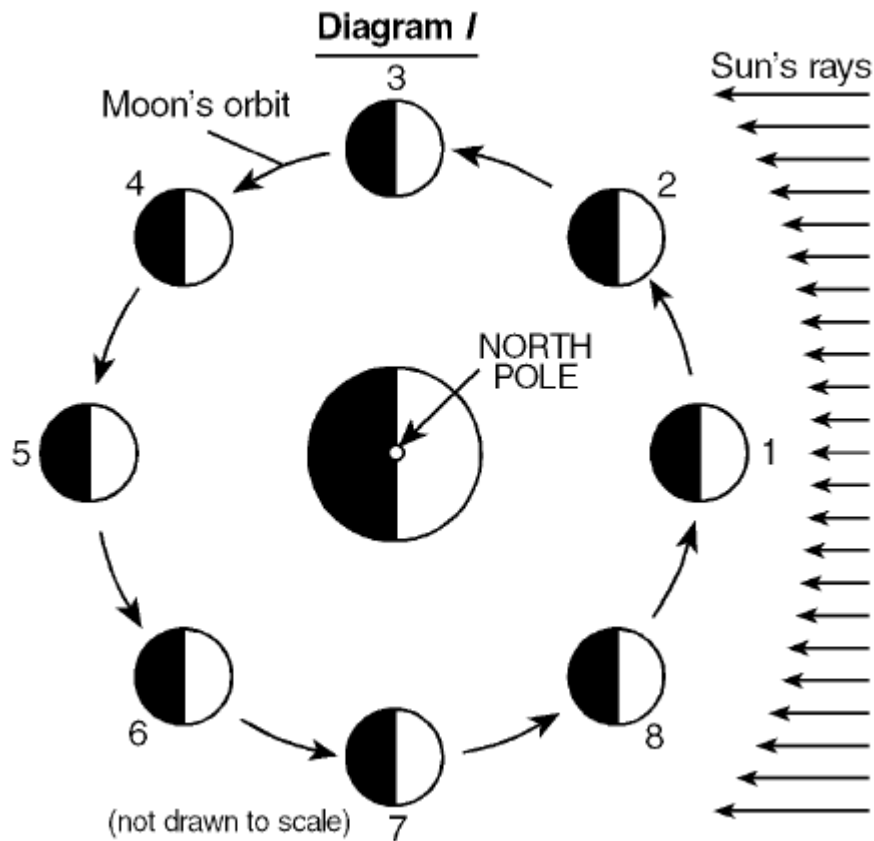
3) What is the name of the Moon phase that occurs when the Moon is in position B?

- A) new moon
- B) full moon
- C) first quarter
- D) waning crescent
- E)

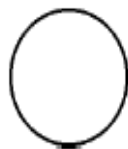
4) Which motion causes the Moon to show phases when viewed from the Earth?

- A) the rotation of the Earth on its axis
- B) the revolution of the Moon around the Earth
- C) the rotation of the Sun on its axis
- D) the rotation of the Sun on its axis

Use the diagram below for question #5.



5) Shade the circle below to illustrate the Moon's phase as seen from the Earth when the moon is in position 4.



<b>Title:</b>	Eclipses #20
<b>Source/website:</b>	<a href="http://csep10.phys.utk.edu/astr161/lect/time/eclipses.html">http://csep10.phys.utk.edu/astr161/lect/time/eclipses.html</a> (website reading/definitions)  <a href="http://www.eram.k12.ny.us/education/components/docmgr/default.php?sectiondetailid=17500&amp;fileitem=2345&amp;catfilter=452">http://www.eram.k12.ny.us/education/components/docmgr/default.php?sectiondetailid=17500&amp;fileitem=2345&amp;catfilter=452</a> (interactive eclipse)
<b>Course:</b>	Earth Science
<b>NYS Standard:</b>	1.1a Most objects in the solar system are in regular and predictable motion. ¥ These motions explain such phenomena as the day, the year, seasons, phases of the moon, eclipses, and tides.
<b>Summary:</b>	The Eclipse animation allows students to see the shadows created when the moon passes between the sun and earth and also the earth's shadow as it falls across the moon. This helps students to visualize both the solar and lunar eclipse. The interactive animation allows students to manipulate the moon's position as well as its distance to earth, tilt and actual size. This will help students to understand that the moon is just the right distance and size from earth to create a perfect solar eclipse. This simulation helps students to visualize concepts that are rare to see due to the fact they occur every few years. In the simulation variables such as moon size can be manipulated that couldn't be in real life.
<b>Rationale:</b>	Solar and Lunar eclipses are an important part of the Earth Science curriculum. Students typically comprehend the idea of eclipses quickly, but think that they should occur every new moon and full moon. This simulation helps students by: <ul style="list-style-type: none"> <li>- providing them with models of the earth, moon and sun which they have the chance to manipulate</li> <li>- helping them connect to a concept that is otherwise too large and too rare to be brought into the classroom.</li> </ul>
<b>Possible Misconceptions:</b>	This simulation helps to dispel the common misconception that solar and lunar eclipses should occur every month. Students often believe that solar eclipses should occur every new moon phases and



	lunar eclipses every full moon phase. The manipulation of the moon's orbital tilt in the simulation helps to dispel this misconception.
<b>Recommendations:</b>	Laptop use for personal exploration of the simulation website and tabs.

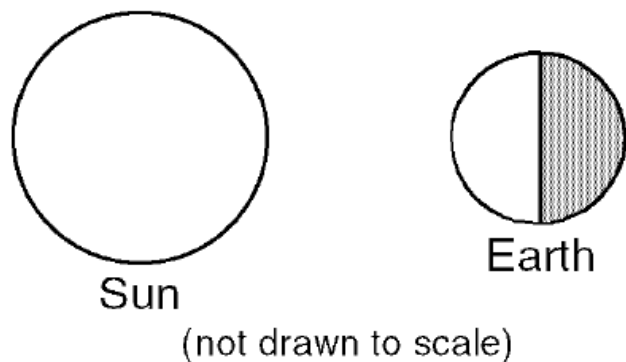
Lesson Procedure:

- 1) Brief description of terminology in PowerPoint notes.
- 2) Students investigate vocabulary terms and eclipse information from website.  
Students can click on links to view pictures of eclipses.
- 3) Students investigate 2<sup>nd</sup> website with their laptops. Students will explore and answer questions on the exercises tab.
- 4) Student complete eclipse worksheet to assess understanding.

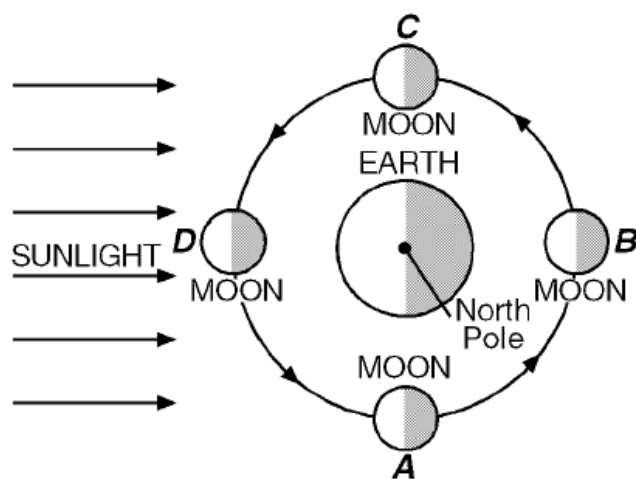
Name \_\_\_\_\_

Eclipses!

1) Draw the Moon (as a small circle), showing its position at the time of a lunar eclipse.



Use the diagram and the cartoon below to answer question #2.



2) The type of eclipse represented in the cartoon might occur when the moon is located at position

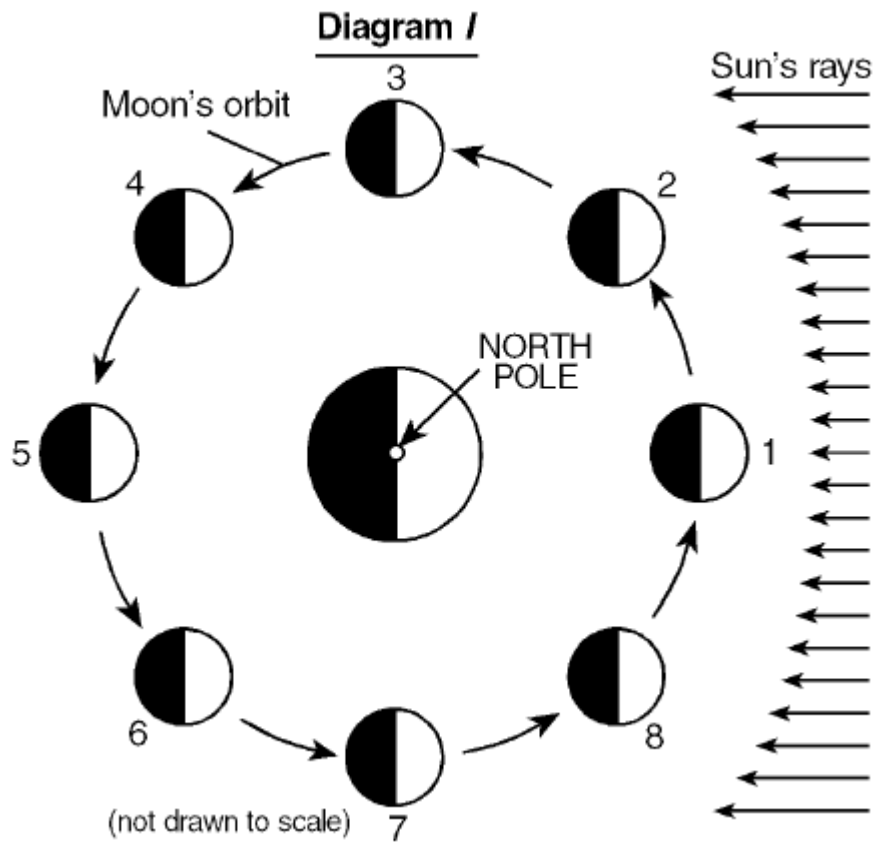
- A) A    B) B    C) C    D) D

3) The new-moon phase occurs when the moon is positioned between the earth and the sun. However, these positions do not always cause an eclipse of the sun because the

- A) Moon's orbit is tilted relative to the Earth's orbit
- B) Night side of the moon faces towards the Earth
- C) Apparent diameter of the Moon is greatest during the new-moon phases
- D) New-moon phase is visible only at night

4) In diagram I below, which two moon positions create eclipses?

\_\_\_\_\_ and \_\_\_\_\_



## **Chapter 4: Conclusion**

Technology integration has had a long history in the American educational system. Federal, state and local legislation push for an emphasis on technology integration into all classrooms. Studies have shown that students have difficulty in learning abstract phenomenon and processes that can't be seen or felt. Computer simulations are an important teaching technique that can be used to demonstrate a topic or process too large or too long for classroom study. Simulations enable students to understand complex interactions of physical or social environment factors. Students have many deep rooted earth science misconceptions that they bring with them into the science classroom. According to Bakas and Mikropoulos (2003) children enter the classroom with a wide range of misconceptions that conventional teaching methods usually cannot overcome, in part because of the lack of appropriate teaching aids. Students need an educational virtual environment for support of the teaching of abstract processes.

Extensive studies have indicated that computer animations and simulations have a positive impact on the classroom environment and have been shown to address student issues with abstract phenomena. Although there are downfalls that educators must consider before implementing computer technology in their lessons, there are many advantages associated with animations and simulations. Yang and Heh (2007) found that the use of computer simulations cause an increase in academic achievement and science process skills versus students who learn through traditional methods. Computer animations have also been shown to increase not only student understanding of content knowledge, but also student motivation. In conclusion, Huppert, Lomask & Lazarowitz (2002) established that computer simulations can positively influence students'

satisfaction, participation and initiative, and improve their perception of the classroom environment.

### **References**

- AAAS. (1993). *Benchmarks for Science Literacy: Project 2061*. New York: Oxford University Press.
- Akpan, J. P. (2001). Issues Associated With Inserting Computer Simulations Into Biology Instruction: a Review of the Literature. *Electronic Journal of Science Education*, 5(3).
- Bakas, C., & Mikropoulos, T. (2003). Design of Virtual Environments for the Comprehension of Planetary Phenomena Based on Students' Ideas. *International Journal Of Science Education*, 25(8), 949-967.
- Barak, M., Ashkar, T., & Dori, Y. J. (2011). Learning Science via Animated Movies: Its Effect on Students' Thinking and Motivation. *Computers & Education*, 56(3), 839-846.
- Becker, H. J. (1986) Instructional Uses of Computers. Reports from the 1985 National Survey, Centre for Social Organization of Schools. The John Hopkins University.
- Davies, R. (2011). Understanding Technology Literacy: A Framework for Evaluating Educational Technology Integration. *Techtrends: Linking Research & Practice to Improve Learning*, 55(5), 45-52.

- de Jong, T., & van Joolingen, W. R. (1998). Scientific Discovery Learning with Computer Simulations of Conceptual Domains. *Review of Educational Research*, 68(2), 179–201.
- Furness, T. A., Winn, W., and Yu, R. (1997). Global Change, VR and Learning. In a Report for the NSF of Workshops, *The Impact of Three Dimensional Immersive VE on Modern Pedagogy*.
- Gazit, E., Yair, Y., & Chen, D. (2005). Emerging Conceptual Understanding of Complex Astronomical Phenomena by Using a Virtual Solar System. *Journal Of Science Education & Technology*, 14(5/6), 459-470.
- Geban, O., Askar, P., & Ozkan, I. (1992). Effects of Computer Simulations and Problem-Solving Approaches on High School Students. *Journal Of Educational Research*, 86(1), 5-11.
- Henriques, L. (2002). Children's Ideas About Weather: A Review of the Literature. *School Science and Mathematics*, 102(5), 202-215.
- Höffler, T. N., & Leutner, D. (2007). Instructional Animation Versus Static Pictures: A Meta-Analysis. *Learning & Instruction*, 17(6), 722-738.

- Huppert, J. J., Lomask, S., & Lazarowitz, R. R. (2002). Computer Simulations in the High School: Students' Cognitive Stages, Science Process Skills and Academic Achievement in Microbiology. *International Journal Of Science Education*, 24(8), 803-821.
- Johanningmeier, E.V. (2010) A Nation at Risk and Sputnik. *American Educational History Journal*, 37(1/2), 347-365.
- King, C. (2010). An Analysis of Misconceptions in Science Textbooks: Earth Science in England and Wales. *International Journal Of Science Education*, 32(5), 565-601.
- Koretz, D. (2009). How Do American Students Measure Up? Making Sense of International Comparisons. *Future Of Children*, 19(1), 37-51
- Malone, M. R., & Lepper, M. R. (1987). Making Learning Fun. In R. E. Snow & M. J. Farr (Series Eds.), R. E. Snow & J. F. Marshall (Vol. Eds.), *Aptitude, learning, and instruction*, vol. 4: Cognitive and affective process analyses (pp. 223–253). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Meyer, R. E. (2002). Cognitive Theory and the Design of Multimedia Instruction: An Example of the Two-Way Street Between Cognition and Instruction. *New Directions for Teaching & Learning*, (89), 55-71.



- Miller, B. W., & Brewer, W. F. (2010). Misconceptions of Astronomical Distances. *International Journal Of Science Education*, 32(12), 1549-1560.
- Najjar, L. J. (1998). Principles of Educational Multimedia User Interface Design. *Human Factors*, 41(2), 311–323.
- Olson, J. K., & Clough, M. P. (2001). Technology's Tendency to Undermine Serious Study: A Cautionary Note. *Clearing House*, 75(1), 8-13.
- Osborne, J., Simon, S., Collins, S. (2003) Attitudes Towards Science: A Review of the Literature and its Implications. *International Journal of Science Education* 25(9),1049–1079.
- Ramsden, J.M. (1998) Mission Impossible? Can Anything be Done About Attitudes to Science? *International Journal of Science Education*, 20(2),125–137.
- Rigby, C. S., Deci, E. L., Patrick, B. C., & Ryan, R. M. (1992). Beyond the Intrinsic-extrinsic Dichotomy: Self-determination in Motivation and Learning. *Motivation and Emotion*, 16(3), 165–185.
- Rivers, R. H. and Vockelle, E. (1987) Computer Simulations to Stimulate Scientific Problem Solving. *Journal of Research in Science Teaching*, 24 (5), 403–415.

- Rosen, Y. (2009). The Effects of an Animation-Based On-Line Learning Environment on Transfer of Knowledge and on Motivation for Science and Technology Learning. *Journal of Educational Computing Research*, 40(4), 451-467.
- Rutten, N., van Joolingen, W. R., & van der Veen, J. T. (2012). The Learning Effects of Computer Simulations in Science Education. *Computers & Education*, 58(1), 136-153.
- SerİN, O. (2011). The Effects of the Computer-Based Instruction on the Achievement and Problem Solving Skills of the Science and Technology Students. *Turkish Online Journal of Educational Technology*, 10(1), 183-201.
- Shu-Nu, C., Yau-Yuen, Y., & May, C. (2009). Ninth Graders' Learning Interests, Life Experiences and Attitudes Towards Science & Technology. *Journal Of Science Education & Technology*, 18(5), 447-457.
- Sulaiman, T. (2011). An Analysis of Teaching Styles in Primary and Secondary School Teachers based on the Theory of Multiple Intelligences. *Journal of Social Sciences*, 7(3), 428-435.
- The, G. P. L. and Fraser, J. B. (1995) Gender Differences in Achievement and Attitudes Among Students Using Computer-assisted Instruction. *International Journal of Instructional Media*, 22 (2), 111–120.

- Udo, M., & Etiubon, R. (2011). Computer-Based Science Simulations, Guided-Discovery and Students' Performance in Chemistry. *Modern Applied Science*, 5(6), 211-217.
- van Berkum, J. J. A., & de Jong, T. (1991). Instructional Environments for Simulations. *Education & Computing*, 6, 305–358.
- Wang, S., & Reeves, T. (2007). The Effects of a Web-based Learning Environment on Student Motivation in a High School Earth Science Course. *Educational Technology Research & Development*, 55(2), 169-192.
- Winn, W. (1997). *The Impact of Three-Dimensional Immersive Virtual Environments on Modern Pedagogy*, (HITL Technical Report R-97-15), University of Washington, Human Interface Technology Laboratory, Seattle, WA.
- Yang, K., & Heh, J. (2007). The Impact of Internet Virtual Physics Laboratory Instruction on the Achievement in Physics, Science Process Skills and Computer Attitudes of 10th-Grade Students. *Journal Of Science Education & Technology*, 16(5), 451-461.