Agricultural Earth Science Lab Manual

A resource for connecting STANDARDS and LABS in California Agricultural Education.

Developed by:
The Agricultural Education Curriculum Project
California State University, Fresno
Fresno, California
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Major Concepts

- Earth's place in the universe
- Dynamic earth processes
- Energy in the earth system
- Biogeochemical cycles
- Structure and composition of the atmosphere
- California Geology

Resources Referenced

Earth Sciences - Grades Nine through Twelve Science Content Standards
www.cde.ca.gov/be/st/ss/scsearth.asp

Agriculture Content Standards Grades 9-12
http://www.cde.ca.gov/ci/ct/sf/documents/ctestandards.pdf

How to use this Manual

A suggested year plan provides an outline to start planning your agricultural earth science class for the year. Online and text resources are provided to enhance your program. The agricultural earth science course has been broken into six major concepts, according to the Earth Sciences standards. Under each concept you will find the standards as well as several labs which can be used to help students master the standards. It is the intent of this manual to provide labs that require minimal resources and practical set up time, which support the goals of the agricultural education program.

Contributing Teachers

This compilation of labs has been produced under a special grant through California State University, Fresno Agricultural Education under the direction of Dr. Rosco Vaughn. Labs were submitted by agriculture teachers throughout California. The sacrifice made by teachers who took the time to share labs they have acquired and/or developed is greatly appreciated and integral in continuing to improve agricultural education in California. Thank you to the following individuals for contributions to this project:

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Ag Earth Science Year Plan

(37 weeks) * Earth Sciences Standards denoted (ES). Agriculture Content Standards denoted (AG). Foundation Content Standards denoted (FDN)

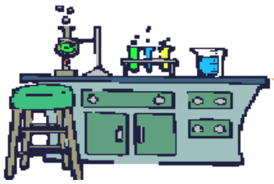
Use this as a template for planning your year. Take the opportunity to write in YOUR CHAPTERS from your selected text book, and make a note of labs you would like to use from the selections provided.

Weeks	Unit	My Chapters	Topic	Standards	Labs
2	Introduction to Earth Science & Class Overview		Establish Procedures FFA Involvement Agriculture and Earth Science Overview	(FDN) 1.2, (AG) C 1.0, 2.0, 13.0	
3	Intro to FFA		FFA, SAE & Classroom Career Development Events Leadership Opportunities	(AG)	
3	California Geology & CA Agriculture		CA Geology & Natural Resources	(ES) 9 a-d (FDN) (AG) C 1.0, 2.0, 3.0, 10.0	
4	Earth's Place in the Universe		Solar System Structure Stars, Galaxies & Universe	(ES) 1 a-g, 2 a-g (FDN) 1.1, 1.2, 2.1, 2.3, (AG) C 2.1-2.3, 6.2, 10.2, 11.2, 13.3; D 4.1	
3	Dynamic Earth Processes		Plate Tectonics	(ES) 3 a-f (FDN) 1.1, 1.2, 2.1 (AG) C 1.4, 1.5, 2.1, 2.2, 2.3, 4.2, 10.1, 10.2, 13.3; E 3.1	
3	Structure and Composition of the Atmosphere		Atmosphere Structure	(ES) 8 a-c (FDN) 1.1, 2.2, 5.3, (AG) C 2.1, 9.2, 11.5, 13.3	

Second Semester

4	FFA Ag Leadership	Record books Spring CDE Opportunities SAE Development	(FDN) 1.0, (AG) A 4.0, A 6.0,	
5	Energy in the Earth System	Solar Radiation &Heat Wind & Ocean Currents Climate & Weather	(ES) 4 a-d, 5 a-g, 6 a-d (FDN) 1.1, 1.2, 2.2 (AG) C 1.2, 1.4, 2.1,2.2, 2.3, 3.3, 6.4, 6.5, 9.2, 10.1, 11.2, 13.3; D 11.2, 11.3; E 1.0, 2.0, 3.0, 4.0, 7.1, 11.0; G 3.4	
3	Biogeochemical Cycles	Carbon Cycle & Movement of matter	(ES) 7 a-d (FDN) 1.2, 2.1, 2.2, 2.3, 5.3 (AG) C 1.5,2.1, 2.3, 10.1 10.2, 11.2, 13.3; E 1.1, 1.4, 1.5, 2.3, 3.2; G 6.4, 7.1	
2	Review for Standardized Testing	Review 6 Major Concepts	All	Gallery Learn Book Be the Teacher
1	Standardized Testing			
4	Record Keeping & Management	Record Book s Updated and Proficiency Award Applications Completed	(AG) A 4.0	

Online Resources



MUST SEE!!! Biology Junction: Fabulous teacher friendly site! Created by a teacher for teachers, the site has quick links to biology activities, openers, puzzles and handouts correlated with the national science standards. There is even an interactive pacing calendar posted to plan your year. Here is the link: http://www.biologyjunction.com/curriculm_map.htm. (*Note that curriculum is spelled curriculm). Check the main site (www.biologyjunction.com) as well for additional information.

The Science Inquirer newsletter has several links to free resources for science teachers. To access the list, visit *http://scienceinquirer.wikispaces.com/freestuff*.

Reeko's Mad Scientist Lab Welcome to Reeko's Mad Scientist Lab! Your source for free science experiments for parents, teachers, and children of all ages. Be sure to check out the "Real Time World Stats" http://www.spartechsoftware.com/reeko/

Learner.org is a great resource of information and interactive labs. www.learner.org

Marketplace for the Mind is a unique, educational resource created by The Pennsylvania Department of Agriculture in cooperation with The Pennsylvania Department of Education. Here you'll find a bounty of current agricultural educational materials aligned to Pennsylvania's Academic Standards, as well as, a wide variety of useful information on Agriculture and Agribusiness! www.marketplaceforthemind.com

Mineral Information Institute provides free materials, including rock and mineral posters and class activity ideas great for Earth Science. www.mii.org

This link from San Benito High School supports agricultural biology with labs and worksheets. It was made for the CATA skills conference in 2008.
http://www.sbhsd.k12.ca.us/~gbecerra/CATA/onlinehandouts.html

Agripedia.com
What you need, when you need it

This is a great website for agriculture searches, games, livestock breeds, and judging practice.

CELLS alive! www.cellsalive.com A great site illustrating the parts of the cell, mitosis, and meiosis. This site can be an interactive opportunity for students to learn and/or review concepts.

Insect Lore www.insectlore.com This site is managed by a local company out of Shafter and provides interactive activities, books, and live kits including ants, butterflies, ladybugs and silkworms.

Welcome to The Science Spot www.thesciencespot.net Check out the "Science Classroom" for activities and lessons. The site also includes daily trivia, puzzles and an "Idea Factory". This is also a great resource for useful worksheets.

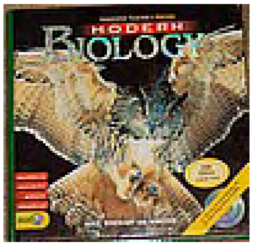
McDougal Littell CLASSZONE www.classzone.com This site is intended for use with the McDougal Little Biology text, however access to online resources is not restricted. Follow the prompts to select the biology text for California, and then select from Activities, Animated Biology, Labs or any of the other great resources.

Microbe WORLD BETA www.microbeworld.com This site is a great resource for biology teachers looking for current news related to biology, career profiles, experiments, and great resources for teachers.

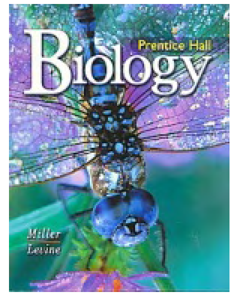
Brain POP www.brainpop.com This is a fun site with short animated clips (3-5 minutes) on nearly every subject you could think of! Great to use for class warm-ups or reviews. Each cartoon clip is followed by an interactive quiz. There is a subscription fee, but your district might want to do this for all teachers. It is worth checking into!

Text Resources

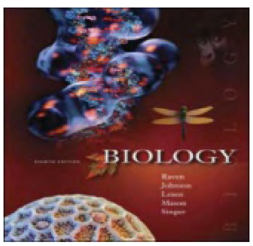
Agricultural Biology:



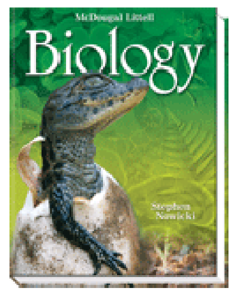
Modern Biology
Holt, Rinehart and Winston



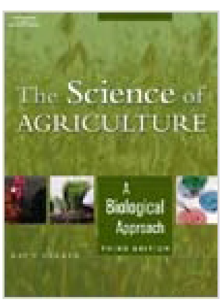
Biology
Prentice Hall



Biology
McGraw-Hill

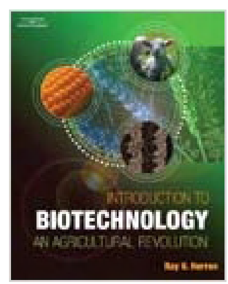


Biology
McDougal Littell

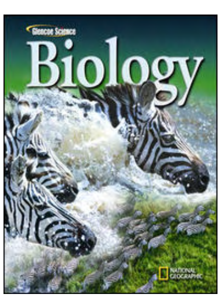


The Science of Agriculture, A Biological Approach

Thomson Delmar Learning

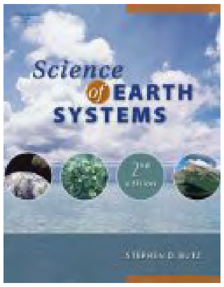


Introduction to Biotechnology,
An Agricultural Revolution
Thomson Delmar Learning



Biology
Glencoe Science

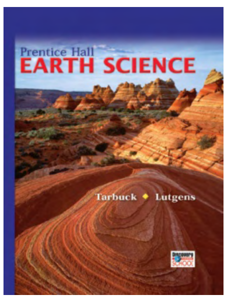
Agricultural Earth Science:



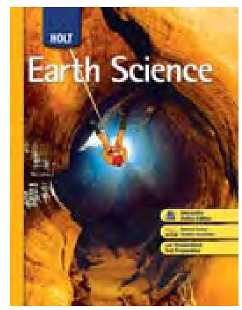
Science of Earth Systems

Delmar

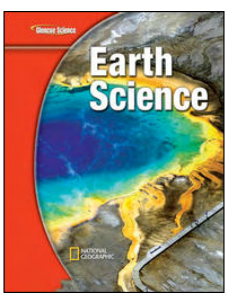
Earth Science: Geology, the Environment, and the Universe Student Edition©2008
McGraw-Hill



Earth Science
Prentice Hall



Earth Science
Holt, Rinehart, Winston



Earth Science
Glencoe Science

Earth Sciences Standards

1. Astronomy and planetary exploration reveal the solar system's structure, scale, and change over time. As a basis for understanding this concept:
    a. Students know how the differences and similarities among the sun, the terrestrial planets, and the gas planets may have been established during the formation of the solar system.
    b. Students know the evidence from Earth and moon rocks indicates that the solar system was formed from a nebular cloud of dust and gas approximately 4.6 billion years ago.
    c. Students know the evidence from geological studies of Earth and other planets suggest that the early Earth was very different from Earth today.
    d. Students know the evidence indicating that the planets are much closer to Earth than the stars are.
    e. Students know the Sun is a typical star and is powered by nuclear reactions, primarily the fusion of hydrogen to form helium.
    f. Students know the evidence for the dramatic effects that asteroid impacts have had in shaping the surface of planets and their moons and in mass extinctions of life on Earth.
    g. * Students know the evidence for the existence of planets orbiting other stars.

2. Earth-based and space-based astronomy reveal the structure, scale, and changes in stars, galaxies, and the universe over time. As a basis for understanding this concept:
    a. Students know the solar system is located in an outer edge of the disc-shaped Milky Way galaxy, which spans 100,000 light years.
    b. Students know galaxies are made of billions of stars and comprise most of the visible mass of the universe.
    c. Students know the evidence indicating that all elements with an atomic number greater than that of lithium have been formed by nuclear fusion in stars.
    d. Students know that stars differ in their life cycles and that visual, radio, and X-ray telescopes may be used to collect data that reveal those differences.
    e. * Students know accelerators boost subatomic particles to energy levels that simulate conditions in the stars and in the early history of the universe before stars formed.
    f. * Students know the evidence indicating that the color, brightness, and evolution of a star are determined by a balance between gravitational collapse and nuclear fusion.
    g. * Students know how the red-shift from distant galaxies and the cosmic background radiation provide evidence for the "big bang" model that suggests that the universe has been expanding for 10 to 20 billion years.

Lab Reference: Earth's Place in the Universe

Standards: 1a-g, 2a-g

STANDARD CONCEPT	LAB NAME	LAB NUMBER
Astronomy	Astronomy Book	A-1
Astronomy	The Big Bang Balloon	A-2
Astronomy	The Life Cycle of Stars: Webquest	A-3
Elements/Minerals	Effects of Minerals on Plant Growth	A-4
Elements/Minerals	Element Project: Class Periodic Table	A-5

Earth Science Standards

- (ES) 2.a, 2.b, and 2.c.

Agriculture Standards

- (AG) C 2.3, C 6.2, and D 4.1.
- (Foundation) 2.2 Writing, Specific Applications of Writing Strategies and Applications--Grades 9-10: (2.6a), (2.6b), and (2.6c).
- (Foundation) 2.3 Specific Applications of English Language Conventions: (1.1), (1.2), and (1.3).

Name____________________
Date_____________________

Astronomy Book

Purpose
The purpose of this lab is to create a book showing how all of the parts of the universe are connected. Your book may be any shape or size that you want (between 6"x6" and 12"x12"). Be creative and thorough![i]

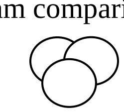
Procedure

Materials

1. Notes, science book and previous class assignments
2. Construction paper
3. Colored pens/pencils
4. Additional artistic supplies you choose!

Sequence of Steps
In order to receive full credit, astronomy books should include the following:

1. Front cover
    a. Appropriate title
    b. Picture(s)
    c. Author's name
2. Table of contents
    a. List all of the main concepts below and give the page number where it can be found in your astronomy book.
3. Main Concepts
    a. For each main concept listed below, clearly address each of the "Components to Include in your Book".
4. Back Cover
    a. Should match front cover in shape, color and size.

Main Concept	Components to Include in your Book
Universe	Definition Picture
Galaxies	Definition Table or Venn diagram comparing and contrasting the 3 types of galaxies.  Milky Way (Size, number of stars, picture with location of our solar system)

Solar System	Definition Steps of solar system formation (Pictures, explanations of pictures).
Planets	Table comparing and contrasting the inner and outer planets, including the following information: Location Types of elements that make up the planets and why Large or small gravity and why Many moons, few, or no moons and why Rings or no rings and why General pictures
Asteroid Belt	Explanation of why the asteroid belt is located where it is. Explanation of what type of planet the asteroid belt would be if it ever came together. Picture
Earth	Explanation of why the early earth was hit with so many more meteors than the current earth. Explanation of why the earth is the only planet in the solar system that supports life. Picture
Life Cycle of Stars	Picture and explanation of the stages a star goes through in its life cycle. Picture of the H-R Diagram. Label the three axes and location of each type of star.
Parallax	Definition Picture illustrating how the Parallax works.
Agricultural Implication	Identify major natural resources used in agriculture. Explanation of why the earth is the only planet currently suitable for agriculture production. Explanation of how animal breeding cycles (when animals reproduce) are impacted by the rotation of the earth.

Astronomy Book Due: _______________________ **Total Points Possible: _______________**

Notes: **Points I received: ________/__________**

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[i] Looper, Jim (2008). *Astronomy Book, Lab*. Sheldon High School.

Earth Science Standards	• (ES) 1.a and 1.d.
Agriculture Standards	• (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d).

Name____________________
Date_____________________

The Big Bang Balloon

Purpose

According to the big bang theory, almost all galaxies are moving outward from other galaxies. The purpose of this lab is to demonstrate the principles of this expansion using a simple model.[i]

Procedure

Materials

1. Large deflated round balloon
2. Felt-tip permanent pen
3. String
4. 30cm ruler

Sequence of Steps

1. Mark a pair of dots 0.5cm apart across the middle of the deflated balloon. Label these points A and B. Mark a third dot 0.5 cm away from B. Label this dot C.
2. Blow into the balloon for 2-3 seconds. Record your actual elapsed time below. Pinch the end of the balloon between your fingers to **keep it inflated**, but do not tie the neck.

   Elapsed time: ________ seconds.

3. Use the string to measure the distance across the balloon between A and B, and between B and C. Mark on the string your measurements with a pen. **Keep balloon inflated!** Once you have measured using the string, use the ruler to accurately measure the distance on the string in centimeters.

   Distance between A and B: __________ cm

   Distance between B and C: __________ cm

4. Calculate the rate of change in the distance between A and B and between B and C. To calculate the rate, subtract the original starting distance between the dots from the distance measured after inflation. Divide the number by the number of seconds you blew into the balloon. **Keep your balloon inflated!**

Formula: (inflation distance) – (start distance) = rate of change (Elapsed time)

Rate of change for A to B: _____________cm/sec

Rate of change for B to C: _____________cm/sec

5. With the balloon still inflated, blow into the balloon for an additional 2-3 seconds.

   Elapsed time: _________ seconds.

6. Measure and calculate the rate of change in the distance between A and B and B and C. To calculate the rate, use the distance measured in step 3 as the "original" distance.

   Distance between A and B: __________ cm

   Distance between B and C: __________ cm

Formula: $$\frac{(\text{inflation distance}) - (\text{start distance})}{(\text{Total elapsed time})} = \text{rate of change}$$

Rate of change for A to B: _____________cm/sec

Rate of change for B to C: _____________cm/sec

Observations

1. Did the distance from A to B or from B to C show the greatest rate of change?

2. Did the rate of change for either set of dots differ in steps 4 and 6?

3. Suppose dots C and A represent galaxies, and dot B represents the earth. How does the distance between galaxies and the earth relate to the rate at which they are moving apart?

4. Describe the location of the planets in relation to earth, when compared to the location of stars in relation to earth.

5. Compare the inflation of this balloon to “The Big Bang Theory”. How are they similar? How are they different?

[i] Prescott, Diane (2008). *The Big Bang Theory; Lab*. Atwater High School.

Earth Science Standards	•(ES) 1.e.
Agriculture Standards	•(Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d). •(Foundation) 2.1 Reading, Specific Applications of Reading Comprehension--Grades 9-10: (2.1) and (2.6).

Name____________________
Date_____________________

The Lifecycle of Stars: Webquest[i]

Purpose

The purpose of this lab is to investigate the process of nuclear fusion explained by Einstein's famous equation $E = MC^2$ and learn how mass in the form of hydrogen atoms is converted to helium and causes a release of energy that makes stars shine. We will also begin to understand the forces involved in stars that maintain this nuclear reaction and how these forces change as the star ages. We will explore the stages stars progress through from birth to death and how the death of a star depends on its initial mass. We will interpret Hertzsprung Russell diagrams and learn how they can be used to classify the life cycle stage of a star by its luminosity, temperature, magnitude, and spectral class. Finally, we will discover how infrared, x-ray, and gamma ray telescopes are being used to detect the life cycle stages of stars.[ii]

Procedure

Materials

1. Blank paper (2 sheets/student)
2. Internet Access
3. Craft supplies for Task #2

Sequence of Steps

To access this webquest, go to http://www.can-do.com/uci/ssi2003/starlife.html

Task #1

1. You will begin your webquest by learning how to identify stars by their magnitude, color, and temperature, and spectral class.
2. Click Stars: Lights in the Sky and write out the answers to the following questions on a sheet of blank paper to be turned in.
    a. Name the brightest star in the known universe.
    b. What is its magnitude?
       Are the brightest stars low magnitude or high?
    c. How much does the brightness of a star change with each change in magnitude of one?
3. Do a search on the internet for "brightest stars" and make a top **10** list on your paper of the names of the 10 brightest stars in the known universe and their magnitude.
4. Finally, design a colored diagram (HR diagram) on the back of your paper that displays the colors of the hottest stars on the left to the coolest stars on the right.
5. Stars are grouped into spectral classes based on a range of temperatures they fall into. Label the spectral classes (*O, B, A, F, G, K, M*) appropriately under each star color in your diagram.

6. To complete Task #1, Come up with a clever sentence or phrase (the first letter of each word in your phrase is one spectral class letter) to help you remember the order of the spectral classes and write it under your diagram on your construction paper.
   For example: Over Banks And Foggy Greens Kittens Meow.
7. Answer the following few more questions on the front of your paper.
   a. What color is the brightest star?
   b. What color is the coolest star?
   c. What color is our sun?
   d. What spectral class of stars is the hottest?
   e. What spectral class of stars is the coolest?
   f. What spectral class is our sun?

Task #2

Continue to read on to the section: A Nuclear Furnace on the same webpage. The animation shows how stars fuse the deuterium and tritium forms of hydrogen to form helium. Your task is to design a 3-D model of this nuclear reaction. You might want to locate some red and blue styrofoam balls at an art supply store or utilize some type of spherical object to represent the different atoms in the reaction. Glue these on a piece of cardboard and label the names of the atoms and draw arrows showing the progression of the reaction.

This 3-D model is due _______________________.

Task #3

Go to The Life and Death of Stars. Read the short section on "Where are stars born" and see pictures of the protostars of M16: The Eagle nebula and other nebulae (stars in formation) on this page. Continue by reading up on Main Sequence Stars and find out how our sun compares in mass to other stars like Sirius, and Proxima Centauri. Answer the following questions on your sheet of paper:

1. Based on its mass, will our sun be around for a while?
2. Approximately how long before our sun consumes the inner planets of our solar system?

Realize that once our Sun starts to run out of hydrogen fuel and has exhausted its ability to fuse other elements like carbon and oxygen, it will become a red giant and expand in size to envelope the Earth. And surprisingly, the larger the mass of the star, the quicker it burns its fuel sources and the shorter its lifespan. Also see and read about Hubble Space Telescope pictures of a developing galactic nebula in our Milky Way galaxy called NGC 3603

Task #4

Being that stars are quite more massive than most planet sized objects, the gravitational pull on objects close to stars is astronomically large. Find out Your Weight on Other Worlds. Record your weight on earth, the other planets, and the moon.

Task #5: Now check out the All Star Line Up and profile one of the 34 stars on this page. Organize the information provided about your chosen or assigned star into a one-page report, a poster, or maybe a short PowerPoint slide show. The life cycle of stars continues... All stars eventually become red giants or supergiants. As the main sequence star glows, hydrogen in its core is converted into helium by nuclear fusion.

This portion of your project is due: ________________________

FYI: *When the hydrogen supply in the core begins to run out, and the star is no longer generating heat by nuclear fusion, the core becomes unstable and contracts. The outer shell of the star, which is still mostly hydrogen, starts to expand. As it expands, it cools and glows red. The star has now reached the red giant phase. It is red because it is cooler than it was in the main sequence star stage and it is a giant because the outer shell has expanded outward.*
In the core of the red giant, helium fuses into carbon. All stars evolve the same way up to the red giant phase. The amount of mass a star has determines which life cycle path it will take Read more about red giants.

Task #7 See animation of a supernova explosion and photographs of actual supernova detected by emitted X-rays. At this point, stars at least 5X more massive than our Sun that have gone supernova will either die as a neutron star or a black hole.

Make a poster display of the "Life Cycle of Massive Stars" on a small poster board. Label and color the star types and progression correctly for full credit.

This portion of your project it due: ________________________

Task #8: Time for some fun as a reward. Play the Falling Stars Applet Game and destroy those falling stars. What score did you earn on it? Record it! Highest score gets a reward.

[i] Cosmic Wonders, Stars. Retrieved May 18, 2009, from Sea and Sky Web site: http://www.seasky.org/celestial-objects/stars.html
[ii] (2008). *The Lifecycle of Stars Lab*. Atwater High School.

Earth Science Standards	• (ES) 2.c.
Agriculture Standards	• (AG) C 10.2, C 11.2, and C 13.3. • (Foundation) 1.1 Mathematics, Specific Applications of Algebra I: (10.0), (12.0), and (15.0). • (Foundation) 1.1 Mathematics, Specific Applications of Probability and Statistics: (8.0). • (Foundation) 1.2 Science, Specific Application of Investigation and Experimenation: (1.a) and (1.d).

Name____________________

Date_____________________

Effects of Minerals on Plant Growth

Purpose

Minerals in the soil affect plant growth. Some minerals affect height while others affect tissue development. The purpose of this exercise is to observe the effects of minerals on plant growth.[i]

Procedure

Materials

1. Seedlings (approx. 5cm height)
2. 15 flowerpots, 8cm diameter
3. Nitrogen compound (ex. sodium nitrate)
4. Phosphorus compound (ex. sodium phosphate)
5. Potassium compound (ex. potassium sulfate)
6. Soil sample
7. Balance
8. Evaporating dishes
9. Drying oven
10. Commercial plant nutrient mixture

Sequence of Steps

1. Fill each of the flowerpots to 2cm from the top with the soil sample.
2. Add 1g of sodium nitrate to each of 3 flowerpots. Mix into soil well. Label pots (A1-3).
3. Add 1g of sodium phosphate to each of 3 other flowerpots. Mix well and label (B1-3).
4. Add 1g of potassium sulfate to each of 3 other pots. Mix well and label (C1-3).
5. Add 2g of commercial plant nutrient mixture to each of 3 more pots. Mix well and label (D1-3).
6. Label the remaining 3 control pots as (E1-3).
7. Transplant 1 seedling into each of the 15 flowerpots.
8. Water the plants regularly. Observe and record their height each day for at least 3 weeks.
9. At the end of this time, open the flowerpots. Gently remove the soil from around the roots. Record observations of the root growth for each treatment group. Also note any apparent deficiencies in stem and leaf structure.

Observations

1. Using a periodic table, locate the three elements used in this study (nitrogen, phosphorus, potassium). Record the atomic number for each mineral below.

2. Studies show that all elements with an atomic number greater than lithium have been formed by nuclear fusion in stars. Define “nuclear fusion” and determine if the 3 elements used in this lab were formed by nuclear fusion in stars.

Table 1. Daily record of plant heights (cm) for treatment groups: (A) Sodium Nitrate, (B) Sodium Phosphate, (C) Potassium Sulfate, (D) Commercial Mix and for the control group (E).

	Treatment Groups												**Control Group**		
	A1	A2	A3	B1	B2	B3	C1	C2	C3	D1	D2	D3	E1	E2	E3
Day 1															
Day 2															
Day 3															
Day 4															
Day 5															
Day 6															
Day 7															
Day 8															
Day 9															
Day 10															
Day 11															
Day 12															
Day 13															
Day 14															
Day 15															
Total Growth															

3. For each plant, write down the height at day 15, and subtract the height at day 1. This is your total growth for each plant. Put this number in the bottom line of the table above.

4. Calculate the average growth for each treatment group and for the control group. For each letter group, add the total growth numbers together and divide by the number of plants used in that group. For example, to find the average growth for plants treated with sodium nitrate (A), add the total growth for A1+A2+A3, and divide by 3. Write the averages below.

5. Root growth observations. After removing the soil from your samples, record your observations for each treatment group and for the control group below. Be specific about details such as length, thickness, and amount of roots.

Table 2. Observations of root growth by treatment group and control group.

(A) Sodium Nitrate	(B) Sodium Phosphate	(C) Potassium Sulfate	(D) Commercial Mix	(E) Control

6. Based on your observations, describe your results and how this information could help plant producers.

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[i] *Ecology Investigation: Effects of Minerals on Plant Growth*. Boston, Massachusetts: Prentice Hall, Inc.

Earth Science Standards	• (ES) 2.c and 9.a.
Agriculture Standards	• (AG) C 2.1, C 2.2, and C 2.3. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and 1.d).

Name____________________
Date_____________________

Element Project: Class Periodic Table

Purpose

An element is a substance that cannot be broken down into simpler; stable substances by chemical means. [i] California is rich in many elements, and it is important to understand how elements are categorized using the periodic table. The purpose of this lab is to create a class Periodic Table of the elements, with each student generating one element. [ii]

Procedure

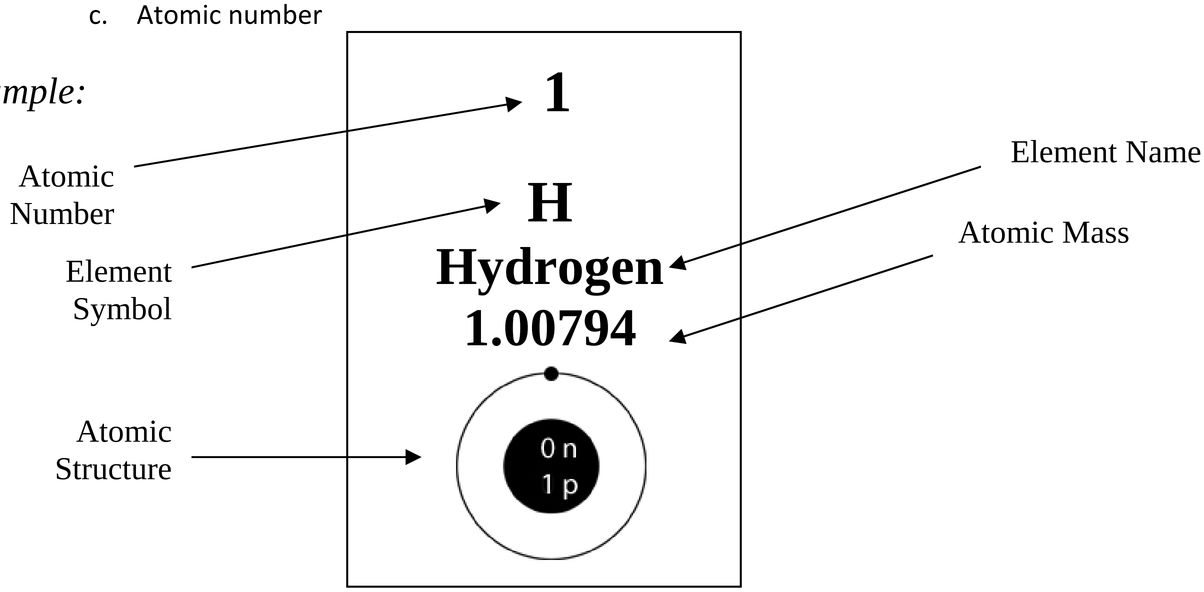
Materials

1. 8 ½ x 11" piece of blank white paper
2. Colored writing pens or pencils
3. Periodic Table for reference in text book or poster

Sequence of Steps

1. Work with your instructor to select an element from the periodic table.
2. On a blank piece of white paper, create your portion of the periodic table for your element including:
   a. Element symbol
   b. Element name
   c. Atomic number
   d. Atomic mass
   e. Diagram of atomic structure

Example:



Observations and Conclusion

1. What evidence do scientists have, which indicates that all elements with an atomic number greater than that of lithium have been formed by nuclear fusion in stars?

2. Identify three elements and indicate their major economic importance to California.

   Element 1:

   Element 2:

   Element 3:

3. Looking at the completed periodic table, make three observations relating to the organization and information included in the periodic table.

4. N, P and K are three common elements included in plant fertilizer. Identify these elements and in the space below write their name, atomic number, and atomic mass.

[i] (2007). *Earth Science*. Holt, Rinehart and Winston: Harcourt Education.
[ii] Galan, Daniel (2008). *Element Project, Lab*. Calexico High School.

Earth Sciences Standards

3. Plate tectonics operating over geologic time has changed the patterns of land, sea, and mountains on Earth's surface. As the basis for understanding this concept:
   a. Students know features of the ocean floor (magnetic patterns, age, and sea-floor topography) provide evidence of plate tectonics.
   b. Students know the principal structures that form at the three different kinds of plate boundaries.
   c. Students know how to explain the properties of rocks based on the physical and chemical conditions in which they formed, including plate tectonic processes.
   d. Students know why and how earthquakes occur and the scales used to measure their intensity and magnitude.
   e. Students know there are two kinds of volcanoes: one kind with violent eruptions producing steep slopes and the other kind with voluminous lava flows producing gentle slopes.
   f. * Students know the explanation for the location and properties of volcanoes that are due to hot spots and the explanation for those that are due to subduction.

Lab Reference: Dynamic Earth Processes

Standards: 3a-f

STANDARD CONCEPT	LAB NAME	LAB NUMBER
Earthquakes	Virtual Earthquake Webquest	B-1
Ocean Floor	Sea Floor Spread	B-2
Ocean Floor	The Ocean Floor and Particle Size	B-3
Plate Tectonics	Plate Boundaries	B-4
Plate Tectonics	Plate Tectonics Webquest	B-5
Plate Tectonics	Snack Tectonics	B-6
Properties of Rock	Classifying Rocks	B-7
Properties of Rock	Density of Solids—How Sweet it is!	B-8
Properties of Rock	Density: Solids vs. Liquids	B-9
Volcanoes	Creating a Simulation Volcano	B-10
Volcanoes	Effects of Magma on Surrounding Rock	B-11
Volcanoes	Volcanoes—Problem Based Learning	B-12

Earth Science Standards	•(ES) 3.d.
Agriculture Standards	•(AG) C 2.2. •(Foundation) 1.1 Mathematics, Specific Applications of Algebra I: (10.0), (12.0), and (15.0). •(Foundation) 2.1 Reading, Specific Applications of Reading Comprehension--Grades 9-10: (2.1) and (2.6).

Name___________________

Date____________________

Virtual Earthquake Webquest

Purpose

The purpose of this lab is to investigate earthquakes using the internet. [i]

Procedure

Materials

1. Internet Access

Sequence of Steps

1. Go to Internet Explorer and type in the following web address: http://www.sciencecourseware.com
2. Click on "Virtual Courseware for Earth & Environmental Sciences" (above the earth picture!)
3. Now click on the word "Earthquake" (There is a red dot next to it.)
4. Under "tutorials" click on "SP Lag Time": Click "Start" to review how S and P waves differ in their travel times. When it is finished, close the website, and go on to the next assignment below.
5. Next go to the website: http://www.sciencecourseware.com/VirtualEarthquake/VQuakeExecute.html
6. Read all of the information on the page about earthquakes and epicenters. Then choose one of the four areas at the bottom for the seismogram and click "Submit Choice"
7. Look at the map and then read the paragraph about how to measure the S-P interval. (DON'T SKIP THIS… You will need to know how!!)
8. Click on "View Seismograms" when you are finished reading
9. For each Seismogram (graph) figure out the S-P interval and type your answer in the box below the seismogram
10. When you finish typing all three S-P measurements, click "Convert S-P Interval"
11. Read about determining earthquake distance, and then fill in the chart with the distances (use the graph to find the seconds that they give you and then figure out what the distance would be for those seconds)
12. When you fill in the chart, click on "Find Epicenter"
13. If yours is not exactly right, click on "View True Epicenter" to see what it should have looked like (it compares yours with the real one!) ***Print this page (Click on "File" and then "Print") and write your name on it. (You will turn it in for a grade!)***
14. After you have printed the page, click on "Compute Richter Magnitude"
15. READ the page and learn how to calculate the magnitude of an earthquake (You need to understand how to find the maximum amplitude of the S wave)
16. Click "Go to Next Page" and learn how to read the Richter Scale on a Nomogram

17. Click "Go to Next Page" and enter the Richter Magnitude (the S wave Amplitude) for each of the three seismograms that you had found
18. When you enter all three, click "Submit to Nomogram"
19. Use the three lines to find what your Richter Magnitude of the earthquake would be (see where the lines connect) and enter it in the box
20. After your magnitude guess is entered, click "Confirm Magnitude"
21. See if your magnitude was close to the magnitude found by scientists!
22. Complete the boxes on that page and then click "Get Certificate" to become an official virtual seismologist
23. ***Print your certificate!!*** (Put the arrow cursor over your certificate until the gray box comes up in the top left corner. Then click on the picture of the printer. Click on the word "print")
24. Turn in your certificate and your Epicenter pages stapled together.

Congratulations! You are now a Certified Virtual Seismologist!

[i] (2008). Virtual Earthquake Webquest. *Atwater High School Agriculture Department.*

Earth Science Standards	• (ES) 3.a and 3.c.
Agriculture Standards	• (AG) C 1.4, C 1.5, C 2.3, C 4.2, and C 13.3. • (Foundation) 1.1 Mathematics, Specific Applications of Algebra I: (10.0), (12.0), and (15.0).

Name____________________

Date_____________________

Sea Floor Spread

Purpose

The purpose of this lab is to utilize the age and position of rock formations associated with the Mid Atlantic Ridge to evaluate the hypothesis of sea floor spreading. The sea floor spreading hypothesis presents the idea that new crust is continually being formed at the center of a mid-ocean ridge, which is causing the sea floor to spread apart. This may have caused the tectonic plates to move. [1]

Procedure

Materials

1. Metric ruler
2. Six different colored pencils

Sequence of Steps

1. Using the map Figure 1. Sea Floor Spread, color the various rock formations associated with both the Mid Atlantic Ridge and East Pacific Ridge systems. Create a color key indicating the color associated with each specific rock age.
    a. For more information on the Mid Atlantic Ridge, and a map of the location, visit: http://www.platetectonics.com/oceanfloors/africa.asp
    b. For more information on the East Pacific Ridge, and a map of the location, visit: http://www.platetectonics.com/oceanfloors/andreas.asp
2. Calculate the average spreading rate associated with each ridge. Show all work for full credit! To calculate the average spreading rate for the Mid Atlantic Ridge, use the following procedure:
    a. Measure the distance in centimeters (cm) from the Mid Atlantic Ridge to the interface between rock sequence 4 and 5 (where they meet) in three different places on your map. Record your answers below.

        Measurement 1: _________cm
        Measurement 2: _________cm
        Measurement 3: _________cm

    b. Determine the average distance of the three measurements to the nearest 10^{th} of a centimeter. Show your work and record your answer below.

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1 Prescott, Diane (2008). *Sea Floor Spread*, *Lab*. Atwater High School.

Average distance for 4 & 5 ridge: __________cm

c. Convert your average measurement in centimeters to kilometers by using the map scale (1cm = 500km). This is done by multiplying the average distance in cm by 500km. Record your answer to the nearest 10^{th} of a kilometer.

   Average distance: __________km

d. Knowing that the age of the interface between rock sequences 4 and 5 is approximately 118 million years old, calculate how far the rocks have moved in kilometers per year. This is done by dividing your average distance in kilometers by 118 million years. Record your answer below.

   Distance rock moved per year: __________km/year

e. Now, determine the distance the rock moved in centimeters. This can be done by multiplying the distance the rock moved in km/year (Step d) by 1000,000. Record your answer below.

   Distance rock moved per year on map scale: __________cm/year

f. Finally, determine the rate of sea floor spread associated with the Mid Atlantic Ridge by multiplying the distance moved in centimeters per year by 2. This determines the rate of sea floor spread because new rock is created on **both** sides of the ridge and is pushed outward. Record your answer below.

   Rate of sea floor spread for the Mid Atlantic Ridge per year: __________ cm/year

3. To calculate the average spread rate for the East Pacific Ridge, use the following procedure. Show all work for full credit!
   a. Measure the distance in centimeters from the East Pacific Ridge to the interface between rock sequence 3 and 4 in three different places on your map. Record your answers below.

      Measurement 1: __________cm
      Measurement 2: __________cm
      Measurement 3: __________cm

   b. Determine the average distance of the three measurements to the nearest tenth of a centimeter. Show your work and record your answer below.

Average distance for 3 & 4 ridge: __________cm

c. Convert your average measurement in centimeters to kilometers by using the map scale (1cm = 500km). This is done by multiplying the average distance in centimeters by 500km. Record your answer to the nearest tenth of a kilometer.

Average distance: __________ km

d. Knowing that the age of the interface between rock sequence 3 and 4 are approximately 56 million years old, calculate how far the rocks have moved in kilometers per year. This is done by dividing your average distance in kilometers by 56 million years. Record your answers below.

Distance rock moved per year: __________ km/year

e. Now, determine the distance the rock moved in centimeters. This can be done by multiplying the distance the rock moved in kilometers per year (Step d) by 100,000. Record your answer below.

Distance rock moved per year on map scale: __________ cm/year

f. Finally, determine the rate of sea floor spread associated with the East Pacific Ridge by multiplying the distance moved in centimeters per year by 2. This determines the rate of sea floor spread because new rock is created on **both** sides of the ridge and is pushed outward. Record your answer below.

Rate of sea floor spread for the East Pacific Ridge per year: __________ cm

Observations

1. Describe how the mapping of rocks ages on the ocean floor helps to support the theory of continental drift and sea floor spreading.

2. Briefly explain how the rate of sea floor spreading can be determined in both the Atlantic and Pacific Oceans.

3. Is the average rate of sea floor spreading the same in both Atlantic and Pacific Oceans? If not, how do the compare?

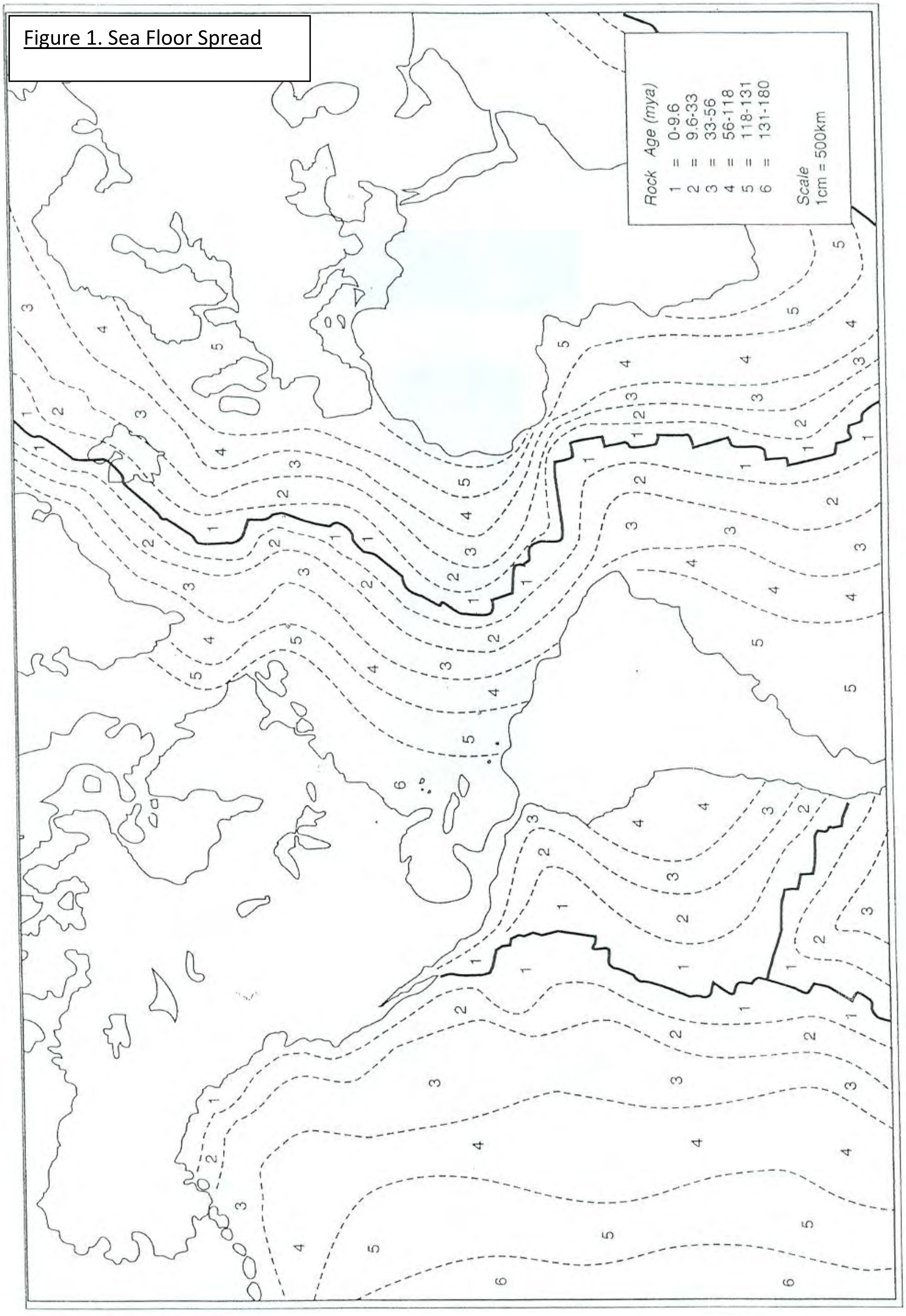
4. Explain how the discovery of sea floor spreading has helped the theory of continental drift.

5. Using your textbook, internet, or other available resources, investigate 5 agricultural commodities produced/harvested off the coast of California in the Pacific Ocean and list them below.

6. Determine if any animals you listed in answer 5 are domesticated or non-domesticated. Hint: Domesticated animals are primarily raised in confinement and bred or produced for a specific purpose.

7. Identify 3 agricultural jobs connected to the ocean and production of ocean commodities. List the jobs below.

Figure 1. Sea Floor Spread



Earth Science Standards	• (ES) 3.c.
Agriculture Standards	• (AG) C 2.1, C 2.2, C 10.1, and C 13.3. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d).

Name____________________
Date_____________________

The Ocean Floor and Particle Size

Purpose

The purpose of this lab is to evaluate how particle size in soil and rock affects the rate at which the particles settle.[i]

Procedure

Materials

1. Large transparent containers (2)
2. Clay sample
3. Sand sample
4. White paper (2)
5. Tablespoon
6. Water
7. Stopwatch
8. Hand lens

Sequence of Steps

1. Fill two large transparent containers with water.
2. Place two samples of sediment, the clay sample and sand sample, on separate sheets of white paper.
3. Study the samples with a hand lens. Determine which sediment sample has larger-sized particles and record your observations.
4. Measure 1 tbsp of the clay sample.
5. With your stopwatch ready, hold the spoon of clay directly above the first container and pour the clay into the water. Time how long it takes for the entire sample to reach the bottom of the container and settle. Record your observations.
6. Repeat the process using the second container and the sand sample. Make sure to keep variables consistent by holding the spoon the same distance from the container as you did in the clay sample. Record your observations.

Observations

1. After observing your samples with the hand lens, which sample had the smaller particles? Make at least three other observations about your samples.

2. Record your settling times below:

   Clay: __________ seconds   Sand: __________ seconds

3. Which sample took longer to settle in the water?

4. Explain the general relationship between sediment size and settling rates.

5. Both of these sediments enter the ocean water from rivers. Predict which type of sediment would be found closest to the coast. Explain.

6. Which will be found farther away? Explain.

7. How does this principle impact agricultural production **<u>land</u>** in the following areas:
   a. Delta (Freshwater area where rivers feed into the ocean)

   b. Floodplains (Areas that regularly flood when rivers/lakes are full)

   c. Dried up river beds or lakes

8. How does this principle impact irrigation practices by agriculturists?

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[i] Tarbuck, E., & Lutgens, F. (2009). *Earth Science*.Boston: Prentice Hall.

Earth Science Standards	• (ES) 3.a and 3.b.
Agriculture Standards	• (AG) C 2.1, C 2.2, C 10.1, and C 13.3. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d).

Name____________________

Date_____________________

Plate Boundaries

Purpose

The movement of lithospheric plates has created many of earth's topographical features. The purpose of this lab is to demonstrate the results of plate movement by using models of plates. [i]

Procedure

Materials

1. Ruler
2. Paper
3. Scissors
4. Two colors of clay
5. Plastic knife

Sequence of Steps

1. Draw two 10 x 20 cm rectangles on your paper, and cut them out.
2. Using your hands, flatten out the two pieces of clay to about 1 cm of thickness.
3. Cut each piece of clay into a 10 x 20 cm rectangle.
4. Place a paper rectangle on each piece of clay.
5. Place the two clay models side by side on a flat surface, paper side down. Place your hands directly on the top of the each piece.
6. Slowly push the models together until the edges begin to buckle and rise off the surface of the table.
7. Turn the clay models around so that the unbuckled edges are touching. If the edges have been slightly deformed, smooth them out.
8. Again, place hands on clay models. Apply only slight pressure toward the seam. Slide one clay model forward and the other model backward about 7 cm.
9. Repeat Step 8 three more times.

Observations

1. Draw a picture of your pieces of clay after you have applied pressure 4 times.

2. What type of boundary are you demonstrating with the model in Step 6?

3. What type of boundary are you demonstrating with the model in Steps 8 & 9?

4. How does the appearance of the facing edges of the models in the two processes compare?

5. What are the principal structures that form at the three different kinds of plate boundaries?

6. How does topography of the land, which has been affected by plate movement, determine areas viable for agriculture production?

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[i] Prescott, Diane (2008). *Plate Boundaries, Lab*. Atwater High School.

Earth Science Standards	• (ES) 3.a and 3.b.
Agriculture Standards	• (AG) C 2.1, C 2.2, and C 10.1. • (Foundation) 2.1 Reading, Specific Applications of Reading Comprehension--Grades 9-10: (2.1) and (2.6).

Name____________________

Date_____________________

Plate Tectonics Webquest

Purpose

The purpose of this lab is to investigate plate tectonics. [i]

Procedure

Materials

1. Internet Access

Sequence of Steps

1. Go to the following website:
   http://volcano.und.nodak.edu/vwdocs/vwlessons/plate_tectonics/introduction.html

2. Use the website to complete the webquest questions listed below.

Webquest Questions

1. List the three key points of the theory of plate tectonics:
   a.

   b.

   c.

2. List the three chemical layers of Earth's crust and what each layer is made of:

   a.

   b.

   c.

3. What is the lithosphere?

4. What is the aesthenosphere?

5. What was Wegener's evidence that Pangea once existed?

    a.

    b.

    c.

    d.

6. Who actually accepted Wegener's ideas? Why?

7. How tall is the Mid-Atlantic Ridge?

8. At what ocean depth does the Mid-Atlantic Ridge begin?

9. What was Harry Hess' explanation of the "global rift system"?

10. What was studied as one test of the sea-floor spreading hypothesis?

11. What are the three types of plate boundaries?

    a.

    b.

    c.

[i] (2008).Plate Tectonics Webquest. *Atwater High School Agriculture Department.*

Earth Science Standards

- (ES) 3.a and 3.b.

Agriculture Standards

- (AG) C 2.3 and C 13.3.
- (Foundation) 2.1 Reading, Specific Applications of Reading Comprehension--Grades 9-10: (2.1) and (2.6).

Name____________________

Date_____________________

Snack Tectonics

Purpose

The purpose of this lab is to visualize the interactions at plate boundaries. [i]

Procedure

Materials

1. Fruit by the Foot candy
2. Graham crackers
3. Frosting
4. Water
5. Plastic knife
6. Wax Paper
7. Plastic cup

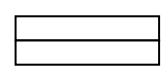
Sequence of Steps

Before jumping into Part I below, read ***Background Information*** *provided. Highlight key concepts and important points to remember.*

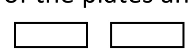
*ALL MEMBERS OF THE LAB GROUP, THOROUGHLY WASH AND DRY HANDS!
*MAKE SURE YOUR LAB STATION IS CLEAN AND DRY!
*DO NOT EAT ANY MATERIALS UNTIL YOU ARE COMPLETELY FINISHED WITH THE LAB!

Part I: Divergent Plate Boundary

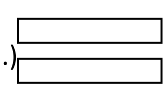
1. Place a large dollop of frosting on the wax paper. This will represent the fluid, middle mantle or asthenosphere. Notice that it is not fluid like water, but is thick and sticky. However, the asthenosphere can still move or flow.
2. Spread the frosting to an approximate thickness of 0.5 cm with the plastic knife.
3. Place the two oceanic plates (fruit by the foot) on the frosting so that the long edges are touching.



4. Gently press down along the entire edges that are touching (to simulate the density of the plates) and spread the plates about 0.5 cm apart. (Continue pushing down slightly as you spread the plates apart.)
5. In "observations" draw a side view of what you see happening (oceanic plates and asthenosphere.)
(This is what it would look like if you brought your eyes down to the level of the plates and looked at the ends of both plates.)



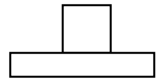
6. In "observations" draw a top view of what you see happening.
(This is what it would look like if you were in an airplane flying over the top and looking down.)



7. Remove one of the oceanic plates and set it aside to use later. **DO NOT EAT IT!**

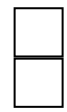
Part II: Convergent Plate Boundaries

Continental-Oceanic Plate Boundary



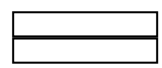
8. Smooth out the asthenosphere (frosting.)
9. Gently place one of the continental plates (graham cracker) on the asthenosphere so that it is touching the long edge of the oceanic plate.
10. Push the two plates together.
    a. Push the continental plate from the back and do not push down (to simulate that continental plates are not very dense.)
    b. Push down on the entire length of the oceanic plate that is touching the continental plate.
11. Draw a side view of what you see happening.
12. Draw a top view of what you see happening.
13. Remove the oceanic plate and set it aside to use later. **DO NOT EAT IT!**

Continental-Continental Convergent Plate Boundary



14. Smooth out the asthenosphere (frosting.)
15. Fill the plastic cup with water. Submerge 1 cm of each of the continental plates (graham crackers) for 1-2 seconds. BE CAREFUL, if you leave the plates in the water too long, this part will not work.
16. Gently place the continental plates on the asthenosphere so that the entire **wet edges are touching**.
17. Without pushing down, slowly push the plates together from the back.
18. Draw a side view of what you see happening.
19. Draw a top view of what you see happening.
20. Remove the continental plates and set aside for later on a paper towel. **DO NOT EAT THEM!** Make sure that the edges opposite the wet edges stay dry!

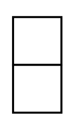
Oceanic-Oceanic Convergent Plate Boundary



21. Smooth out the asthenosphere (frosting.)
22. Place both pieces of oceanic crust on the asthenosphere so that the long edges are touching.
23. Gently press down along the entire edges that are touching and push the plates together. Continue pushing down slightly as you push the plates together.
24. . (Remember, you are trying to show how both plates will sink into the mantle.)
25. Draw a side view of what you see happening.
26. Draw a top view of what you see happening.
27. Set the two oceanic plates aside for later. **DO NOT EAT THEM!**

Part III: Transform Plate Boundary

28. Smooth out the asthenosphere (frosting.)
29. Gently place the two pieces of continental crust on the asthenosphere so that the **dry edges are touching**.
30. Hold the two continental plates from the back and very gently push them together as you slide one plate towards you and one plate away from you.
31. Draw a side view of what you see happening.
32. Draw a top view of what you see happening.



33. **You are now done with the activity and may eat any of the food you wish.**
34. Clean up your lab station according to your teacher's instructions.

Observations

Complete a drawing as described in the Sequence of Steps for each plate boundary. Include arrows to show the direction the plates are moving.

PART I – DIVERGENT PLATE BOUNDARY

SIDE VIEW	TOP VIEW

PART II – CONVERGNET PLATE BOUNDARY

1 – continental-oceanic convergent plate boundary

SIDE VIEW	TOP VIEW

2 – continental-continental convergent plate boundary

SIDE VIEW	TOP VIEW

3 – oceanic-oceanic convergent plate boundary

SIDE VIEW	TOP VIEW

PART III – TRANSFORM PLATE BOUNDARY

SIDE VIEW	TOP VIEW

ANALYSIS: **(Answer with complete sentences, using actual data.)**

1. When plates move, which type will float higher on the asthenosphere? Explain.

2. Why is it important to know what types of plates are interacting at convergent plate boundaries, but not at divergent or transform? Explain.

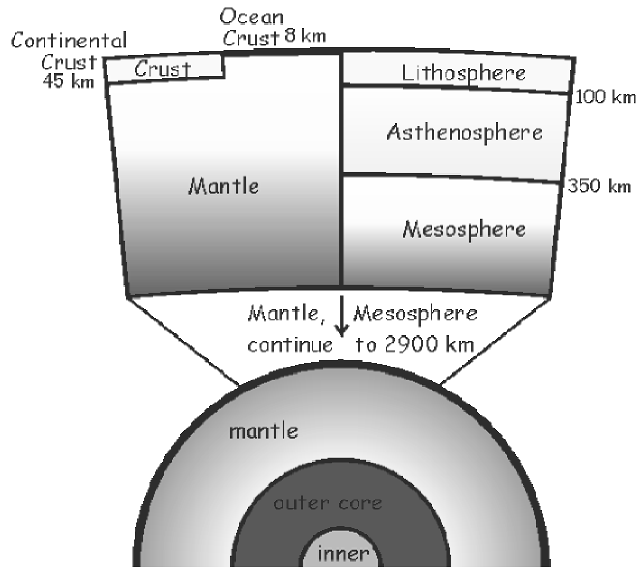
3. Draw a picture showing the direction of plate movement and convection in the asthenosphere for a divergent plate boundary. Next to the drawing explain with words, why plates diverge.

4. Draw a picture showing the direction of plate movement and convection in the asthenosphere for a convergent plate boundary. (This can be a simple picture and does not need to represent a specific type of convergent plate boundary.) Next to the drawing explain with words, why plates converge.

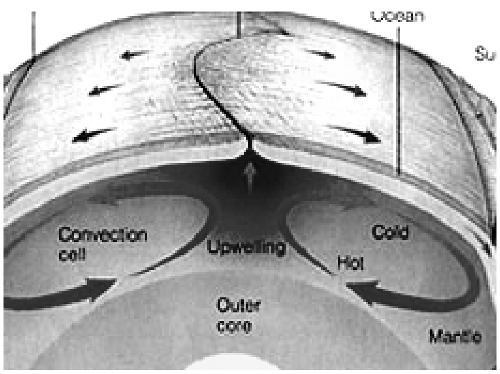
5. Draw a picture showing the direction of plate movement at a transform plate boundary. (Do not show convection in the asthenosphere.)

6. How has plate movement throughout history created natural resources which help agricultural production, as well as natural resources which hinder agricultural production? Provide at least two examples for each.

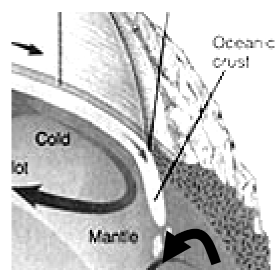
Background Information: Snack Tectonics



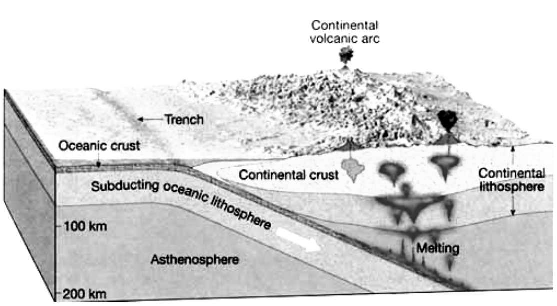
The crust and upper mantle taken together are called the lithosphere. The lithosphere is broken into sections called plates. These plates are rigid (hard and easily breakable) and float around on the middle of the mantle, called the asthenosphere. Just like a boat or raft adrift on the ocean moves in whatever direction the water under it moves, a plate will move in whatever direction the asthenosphere below it moves. When the edges of two plates interact (touch), a plate boundary is created. Depending on the way the two plates move relative to each other, different types of plate boundaries are created. There are three main types of plate boundaries: divergent, convergent, and transform.



1 – **Divergent Plate Boundary** – The word "diverge" means to spread apart or go in opposite directions. What ***causes*** plates to diverge is material in the asthenosphere rising to the surface. As the material rises to the surface, it cools, and turns. When the asthenosphere turns, it drags the plates with it, thus pulling them apart. The gap left is filled with rising lava, which ultimately cools, and forms new rock.

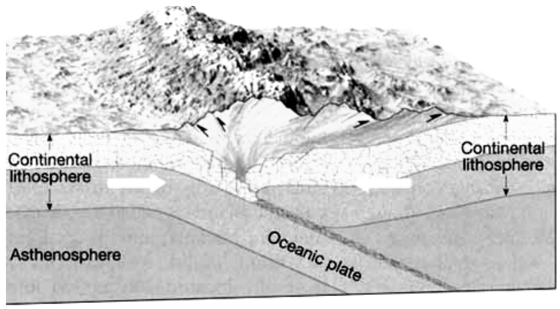


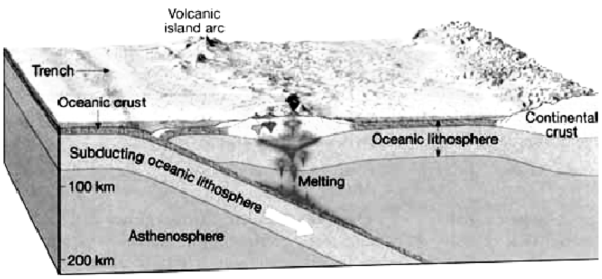
2 – Convergent Plate Boundary – The word "converge" means to come together. This situation is created when molten material in the asthenosphere sinks below the boundary. The material that is sinking pulls the plates together as it sinks. Since oceanic plates are different than continental plates, the result of the plates coming together differs depending on which types of plates are converging.



A – **Continental-Oceanic Convergent Plate Boundary** – Continental plates are very thick (that is why they stick up out of the ocean) and are not very dense. Therefore, continental plates float very high on the asthenosphere. Oceanic plates, however, are very thin (that is why we have oceans) and are very dense. Oceanic plates float lower in the asthenosphere. When a thick, not dense continental plate collides with a thin, dense oceanic plate, the oceanic plate sinks under the continental plate and is forced lower in the mantle. This creates a subduction zone and we can say that the oceanic plate subducts below the continental plate.

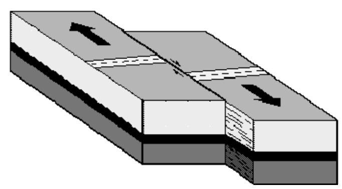
B – Continental-Continental Convergent Plate Boundary – When two thick, not dense continental plates come together, neither will sink into the mantle. Instead, both will crumble and push upwards.





C - Oceanic-Oceanic Convergent Plate Boundary – When two thin, dense oceanic plates come together, both will sink into the mantle. This creates an ocean trench as the plates are pulled lower into the mantle.

3 – Transform Plate Boundary – Very complex interactions of convection currents in the mantle create a transform plate boundary. Therefore, we will not discuss exactly how transform plate boundaries are created, only that a transform plate boundary is a location where two plates are sliding horizontally past each other.



HYPOTHESIS: If plate interaction is modeled, then the types of plate boundaries can be visualized.

i Looper, Jim (2008).Snack Tectonics, Lab. *Sheldon High School Science Dept.*

Earth Science Standards	• (ES) 3.c.
Agriculture Standards	• (AG) C 10.1, C 10.2, and C 13.3. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d).

Name____________________
Date_____________________

Classifying Rocks

Purpose

The purpose of this lab is to explore the processes that form igneous, sedimentary, and metamorphic rocks. Using the charts, students will be able to identify rocks by their physical characteristics.[i]

Procedure

Materials

1. Rock samples
2. Magnifying lens
3. Student worksheet and guide

Sequence of Steps

1. Study Table 1: *Characteristics of Rock Types* to review identifying characteristics.
2. Working with a partner and using the magnifying lens, examine rock samples and fill in the *Rock Data Sheet* (Table 2).
3. Compare the rock to the identifying characteristics shown in Table 1 below.

Table 1: Characteristics of Rock Types

Rock Type	Formed by	Some Identifying Characteristics
Igneous	Cooling of magma	Surface can be sooth as glass <u>or</u> individual crystals can be large enough to be seen by the human eye. If crystals are visible, they often appear to interlock, like pieces of a puzzle.
Sedimentary	Tiny rock pieces cementing together	Can contain fossils. Can sometimes see of feel individual sediments such as sand or pebbles. Can be more crumbly than other rock types. Can sometimes feel lighter than other rock types.
Metamorphic	High heat and/or high pressure of the earth	Often see different bands of color sandwiched together. Crystals can be very small and hard to see.

Observations

Table 2. Rock Data Sheet

Name of Rock	Observations of Identifying Characteristics	Igneous, Metamorphic, or Sedimentary?

1. Do all rocks of the same type, such as all igneous rocks, look the same? Support your answer with evidence from your observations.

2. What characteristic was most useful in identifying each type of rock listed below? Explain.

   Igneous: ____

   Metamorphic: ____

   Sedimentary: ____

3. Your cousin called to tell you she found the coolest rock while she was at camp. She knows you have been studying rocks at school, and she asks you what type of rock she has. Which of the following facts would be the most helpful to you to begin to identify the type of rock and which does not help at all? Explain your reasoning.

   Characteristics:
   - The rock is light in color.
   - The rock is shiny.
   - The rock was found high in the slopes of an extinct volcano.
   - The rock is small enough to fit in her hand.

4. Analyze the information you have been given. Based on your interpretation, how would the presence of each type of rock in the soil affect agriculture production?

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[i] Prescott, Diane (2008). *Classifying Rocks, Lab*. Atwater High School.

Earth Science Standards	• (ES) 3.c.
Agriculture Standards	• (AG) C 10.1, C 10.2, C 13.3, and E 3.1 • (Foundation) 1.1 Mathematics, Specific Applications of Algebra I: (10.0), (12.0), and (15.0). • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d).

Name____________________

Date_____________________

Density of Solids – How Sweet it is!

Purpose

The purpose of this lab is to investigate density by determining which is more dense, a Snickers or a Three Musketeers bar.[i]

Procedure

Materials

1. Snickers
2. Three Musketeers
3. Ruler
4. Triple beam balance
5. Cup
6. Water
7. Knife
8. Paper towel

Sequence of Steps

1. Read the "Background" section for this lab. Highlight significant information and use this as a resource when completing the lab.
2. Unwrap, but DO NOT EAT YOUR CANDY!!!
3. Measure the length, width, and height of the snickers bar in centimeters. Record your findings in "observations".
4. Determine the volume of the snickers bar by multiplying the length by the width, then by the height. Because you are multiplying the units and well as the numbers, this will give you an answer in cm^3. Record below your findings in "observations".
5. Determine the mass of the snickers bar on the triple beam balance. Record in "observations".
6. Repeat steps 2-5 for the Three Musketeers Bar.
7. Determine the density of each bar by dividing the mass by the volume. Show your work and record in "observations".
8. Knowing that the density of water is 1 g/cm^3, predict whether each bar will float or sink in water. Record your prediction.
9. Drop each bar into the water, observe, IMMEDIATELY REMOVE, and record below.
10. Cut each bar in half vertically. Draw and label what you see.
11. Bring your work to your teacher to view your results.

BACKGROUND

Density is a measure of how tightly packed the particles are in a substance. It is often easiest to think of density in terms of how heavy something is, but this does not always give us the best picture. For example a kilogram of feathers has the same mass as a kilogram of gold. They do not, however, have the same density. That is the particles (atoms) of gold are much closer together than are the feathers. Therefore, a kilogram of feathers would take up significantly more space than a kilogram of gold. Conversely, if you had two identical bags, one full of gold and one full of feathers, the bag full of gold would have a much greater mass. Since it is not easy to picture what density really is, we need a better way to talk about and find the density of a substance. We can use two important pieces of information from the above example, mass and volume to calculate the density. Mass is a measure of the amount of "stuff" that makes up a substance. The "stuff" is more accurately called matter. Matter can be an atom, a molecule, or an entire object. Basically, anything you can think of is matter. In general, the more massive an object is, the heavier it is. Volume is the amount of space something takes up. The more space a substance takes up, the greater the volume.

The technical definition of density is the amount of matter in a given volume. That is, how much "stuff" is packed into a certain amount of space? Therefore, if you know the mass and volume of a substance, you can very easily calculate the density. The formula used to calculate density is:

$$\text{Density} = \frac{\text{mass}}{\text{volume}}$$

There are many units that can be used to express density. Here are a few common examples: g/ml (grams per milliliter), g/L (grams/liter), g/cm^3 (grams per cubic centimeter), g/cc (grams per cubic centimeter.) For example, if it was determined that a box had a mass of 150 g and a volume of 15 cm^3, then the density would be equal to 10 g/cm^3. Water has a density of 1 g/ml or 1 g/cm3. That means that every ml of water will have a mass of 1 g.

HYPOTHESIS: If a ________________________ has particles that are packed more tightly than a ____________________________, then a __________________________ is more dense than a

Observations

VOLUME

CANDY	LENGTH (cm)	WIDTH (cm)	HEIGHT (cm)	VOLUME (cm^3) – show work

DENSITY

CANDY	MASS (g)	VOLUME (cm^3)	DENSITY (g/cm3) – show work

WATER TEST

CANDY	PREDICTION (sink or float)	OBSERVATIONS (sink or float)

WHAT'S INSIDE **Snickers** **Three Musketeers**

ANALYSIS: (Answer using complete sentences and actual data.)

1. Which candy bar is more dense? Explain how you know using actual data and by comparing the two.

2. What do you predict is the cause of the difference in densities between the two candy bars? Explain.

3. Draw and label a subatomic picture of the two pieces of candy. You can use dots to represent the molecules.

Snickers **Three Musketeers**

i Looper, Jim (2008).How Sweet it Is, Lab. *Sheldon High School Science Dept.*

Earth Science Standards

- (ES) 3.c.

Agriculture Standards

- (AG) C 10.1, C 10.2, C 13.3, and E 3.1.
- (Foundation) 1.1 Mathematics, Specific Applications of Algebra I: (10.0), (12.0), and (15.0).
- (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d).

Name____________________

Date_____________________

Density: Solids vs. Liquids

Purpose

The purpose of this lab is to explore the fundamental concept of density.[i]

Procedure

Materials

1. Containers with different Volumes and shapes (5)
2. Balance
3. Graduated cylinder
4. Funnel
5. Paper towels
6. Calculator

7. Wood chips (3)
8. Granite rocks (3)
9. Pieces of coal (3)
10. Pieces of quartz (3)
11. Pieces of tape (5)
12. Pen
11. Ruler

Sequence of Steps

*Which is denser: solid matter or liquid matter? Is there a difference? Consider these questions and form your hypothesis. Write your hypothesis under “observations” on page 3.

Part 1: Density of Water

1. Evaluate the 5 containers you have. Predict which will hold the largest volume of water, from greatest volume to least volume.
2. Using the tape and a pen, label all five containers A-E. (A should indicate the container with the greatest volume, and E should be the lowest volume.)
3. Using the scale, determine the mass of the empty containers and record your data in <u>Table 1. Determining the Density of a Liquid Substance</u>.
4. Fill each cup with water and determine the mass of the filled container to the nearest gram. Record your data in Table 1.
5. Subtract the mass of the empty container from the mass of the filled container. This will give you the mass of the water. Record the mass of the water in Table 1.
6. Using the graduated cylinder, determine the volume of water for each container. Record your data in Table 1.
7. Determine the density of water by using the density formula, and record your data in Table 1.

Density = mass/volume

Part 2: Density of Solid Objects

1. Estimate the volume of each sample by using the "*formula method*" for regular shaped objects and record data in Table 2. Determining the density of solid objects.

   Example: *To find the volume of a rectangular object, the formula is: Volume= (base) x (height) x (width)*

2. Fill the graduated cylinder with water to 50mL.

3. Find the volume of an object using the "*water displacement method*" and record your data on Table 2.
   a. Note that the water is at 50mL
   b. Carefully drop the solid object into the graduated cylinder of water. Determine the new level of the water.
   c. Subtract from this number the original level (50mL). This will indicate how much water was displaced by the solid object.
   d. The amount of water displaced = the volume of the object.

4. Using the same formula you used in Part 1 of this lab, calculate the density for each piece of solid matter. Record data in Table 2.

Observations

***Hypothesis:**

____

Table 1. Determining the density of a liquid substance.

Container	Mass of Empty Container (g)	Mass of Container & Water (g)	Mass of Water (g)	Volume of Water (mL)	Density of Water (g/mL)
A					
B					
C					
D					
E					

Table 2. Determining the Density of solid objects.

Name of Solid Object	Mass (g)	Volume using Formula (cm3)	Volume using Water Displacement (cm3)	Density using Formula	Density using Water Displacement
Wood Chip 1					
Wood Chip 2					
Wood Chip 3					
Granite 1					
Granite 2					
Granite 3					
Coal 1					
Coal 2					
Coal 3					
Quartz 1					
Quartz 2					
Quartz 3					

1. Based on your experiment, what was the average density of the water?

2. Which solid object was the densest?

3. What are some factors that lead to coming up with varying densities of water each time?

4. What are some things you could do next time to acquire more accurate data?

5. Were your predictions correct on the volume of water the container would hold? What are some things that might have thrown you off?

6. What are the two methods we used to determine the volume of a solid object?

    a. ____________________ b. ____________________

7. In your opinion, which method do you think is the most accurate way for determining the volume of a solid object? Explain.

8. Why did some objects float when you placed them in water and others sink?

9. What did you discover about the density of solids vs. liquids?

10. Based on this information, do you accept or reject your hypothesis?
    (accept = your hypothesis was right, reject = your hypothesis was wrong)

11. How is density used in agriculture? Think creatively and develop two examples where density could be important to agriculturists.

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[i] Prescott, Diane (2008).Density, Lab. *Atwater High School*.

Earth Science Standards	• (ES) 3.e.
Agriculture Standards	• (AG) C 2.1, C 10.1, and C 13.3. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d)

Name____________________

Date_____________________

Creating a Simulation Volcano

Purpose

The purpose of this experiment is to build a real working volcano. After mixing just the right amount of ingredients together, adding the final item will make the volcano 'blow its top' spewing red lava down the sides. [i]

Procedure

Materials

Flour (6 cups)
Salt (2 cups)
Cooking oil (4 tbs)
Water (2 cups)
Large bowl
Empty soda bottle
Baking pan or tray
Red food coloring
Liquid detergent (6 drops)
Baking Soda (2 tbs)
Vinegar
Measuring cup
Tablespoon
Safety goggles

Sequence of Steps

1. First we need to create the 'salt dough'. Mix 6 cups flour, 2 cups salt, 4 tablespoons cooking oil, and 2 cups of water in a large bowl. Work the ingredients with your hands until smooth and firm. Add more water to the mixture if needed.
2. Stand the soda bottle in the baking pan. Mold the salt dough around the bottle making sure you don't cover up the bottle mouth or drop any dough into the bottle. Take your time on this step and build your volcano with as much detail as you like.
3. Fill the bottle most of the way with warm water mixed with a little of the red food coloring.
4. Put 6 drops of the liquid detergent into the bottle.
5. Add 2 tablespoons of baking soda.
6. Stand back and slowly pour vinegar into the bottle.
7. Notice the red 'lava' that flows out of your volcano. This happens because of the baking soda and vinegar mixture. Mixing baking soda and vinegar produces a chemical reaction in which carbon dioxide gas is created - the same gas that bubbles in a real volcano. The gas bubbles build in the bottle, forcing the liquid 'lava' mixture of the bottle and down the sides of your volcano.

Observations

1. In your own words, summarize the reaction you created inside the volcano. Compare what you did to the process that occurs in a real volcano.

2. Identify the main kinds of volcanoes. Compare and contrast their eruptions and the products of their eruptions.

3. Assume you are an agriculturist farming in an area that is frequently affected by volcanic ash. The United States Geological Survey has given you this information[ii]:

> Explosive eruptions that destroy vegetation and deposit volcanic rocks and ash over wide areas create conditions that (1) promote increased rates of surface runoff during rainstorms; (2) dramatically increase the availability of loose debris that can be eroded and transported into river valleys; and (3) typically result in persistent airborne "ashy" conditions due to wind and human activities. The destruction of vegetation combined with deposition of ash on hill slopes reduces the amount of water that normally soaks into the ground or is transpired by plants.

What are three things you must consider if you are farming in this area?

[i] Look out, she's gonna blow! Retrieved November 24, 2008, from Reeko's Mad Scientist Lab Web site: http://www.reekoscience.com/Experiments/volcano.aspx
[ii] Ash Properties & Dispersal by Wind. Retrieved November 24, 2008, from Volcanic Ash: Effects & Mitigation Strategies Web site: http://volcanoes.usgs.gov/ash/properties.html

Earth Science Standards	• (ES) 3.c.
Agriculture Standards	• (AG) C 10.1. C 10.2, and C 13.3. • (Foundation) 1.1 Mathematics, Specific Applications of Geometry: (8.0). • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d).

Name____________________

Date_____________________

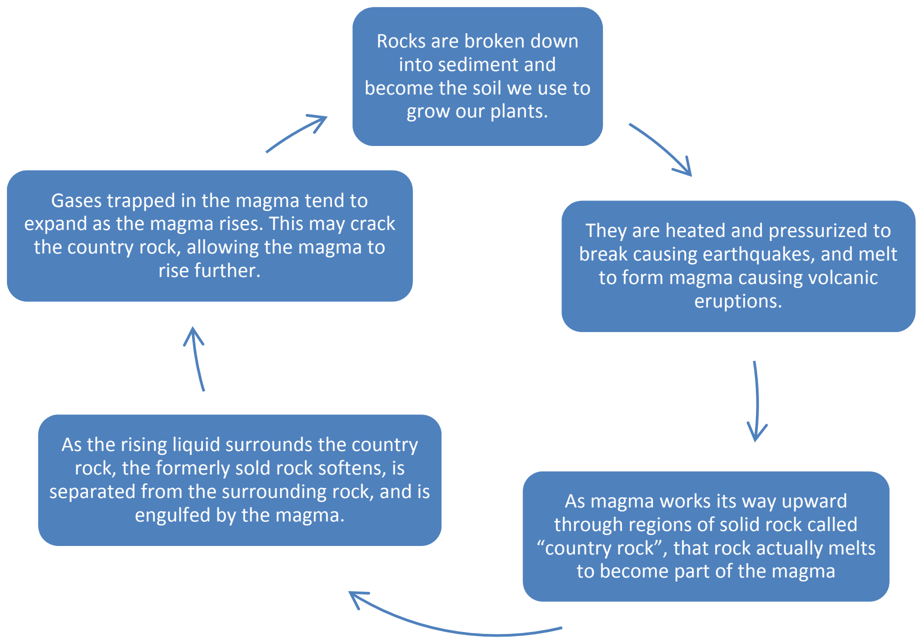
Effect of Magma on Surrounding Rock

Purpose

The purpose of this lab is to demonstrate the process of the invasion of solid rock by magma, by using acid (vinegar) to penetrate the shell of an egg without breaking it. [i]

Background

All 3 types of rocks go through the rock cycle. There is not one type of rock that stays the same.



Procedure

Materials

1. Balance/scale
2. Beaker (500ml)
3. Egg
4. Meter stick
5. String (30cm)
6. Vinegar (white)
7. Water
8. Pen/pencil

Sequence of Steps

1. Determine the mass and circumference of the egg. Record in <u>Table 1. Characteristics of egg before and after acid treatment.</u>
   a. Mass is the weight of an object. Carefully take the egg and place on the balance/scale. Record the weight in grams.

b. Circumference refers to the distance around the center of the egg. Take a piece of string and wrap it once around the center of your egg. Make a mark on the string where it reaches fully around the egg. Carefully set your egg aside. Lay the string flat on your desk and measure the distance you marked with your ruler. Record the circumference in centimeters.

2. Record the characteristics such as color, hardness of shell and smoothness of shell. To make your data quantitative, use a number scale of 1-10 for the evaluation of hardness and smoothness of shell.
   1=extremely soft, 10=extremely hard   1=extremely rough, 10=extremely smooth
3. Place the egg in the beaker and cover with vinegar.
4. Allow the beaker to stand undisturbed overnight.
5. Pour off the vinegar and replace with water.
6. Allow the beaker to stand undisturbed for 3 days.
7. Pour off the water and examine the egg. Record its mass and circumference and any other changes.

Observations

Table 1. Characteristics of egg before and after acid treatment.

Properties	Egg (before)	Egg (after)
Quantitative Data		
Mass (g)		
Circumference (cm)		
Hardness of Shell (1-10)		
Smoothness of Shell (1-10)		
Qualitative Data		
Color		
Other		

1. Using complete sentences compare the egg before and after soaking it in vinegar.

2. Why did you soak the egg in vinegar? What was the purpose of this lab?

3. Explain, in order, the process that caused the changes in the egg.

4. Use the processes you listed above and explain how magma changes the country rock it invades.

5. As molten magma moves from the subduction zone through the continental crust, it forms chambers which cool slowly. In the process, elements separate out in zones. Heavy elements sink to the bottom while lighter elements float to the top. These elements combine to form minerals.[ii] Predict how the movement of magma can negatively or positively affect soil for agriculture production. Explain using complete sentences.

6. As magma moves through and over land it can cause erosion. Define erosion and the effect erosion has on agriculture production.

---

[i] Goehring, JessaLee (2008).Effect of Magma on Surrounding Rock, Lab. *Lodi High School*.
[ii] Floor Anthoni, Dr. J (2000). Soil Geology. Retrieved November 21, 2008, from Seafriends Web site: http://www.seafriends.org.nz/enviro/Soil/geosoil.htm

Earth Science Standards	• (ES) 3.e.
Agriculture Standards	• (AG) C 2.1, C 2.2, C 10.1, and C 13.3. • (Foundation) 2.1 Reading, Specific Applications of Reading Comprehension--Grades 9-10: (2.1) and (2.6). • (Foundation) 2.2 Writing, Specific Applications of Writing Strategies and Applications--Grades 9-10: (1.2), (1.3), (2.3b), and (2.3f).

Name____________________

Date_____________________

Volcanoes - Problem Based Learning

Purpose

The purpose of this lab is to investigate volcanoes and develop a research paper analyzing real-life situations. [i]

Procedure

Materials

1. Internet Access

Sequence of Steps

1. Your teacher will divide the class into working groups for this lab.
2. Read the background information entitled "Problem Based Learning Model" to familiarize yourself with the PBL process.
3. Go to the following website: http://www.cotf.edu/ete/modules/volcanoes/volcano.html
4. Using the pieces to the puzzle shown as your guide, please click on the various pieces to learn about volcanoes and certain problems at hand! (Leave the big white piece entitled "Situations" for last.)
    a. Volcanology
    b. Volcanoes & Earth
    c. Analyzing Volcanoes
5. When you have finished reviewing information about these volcanoes, click on the puzzle piece entitled "Situations". Read each situation presented. Then using the following Questions below, choose a situation that you will use for your project. One of the following volcanoes will be the base for your problem!
    a. Yellowstone Information
    b. Kilauea Information
    c. Mt. Hood Information
    d. Orting Information (Mt. Rainier)
6. When you have made your choice, use the information you have researched to write a persuasive paper with the solution to your problem. Read ***"Research Paper Assignment Details"*** below before starting.

Problem Based Learning Model

1. **Read and analyze the problem scenario**. Check your understanding of the scenario by discussing it within your group. A group effort will probably be more effective in deciding what the key factors are in this situation. Because this is a real problem solving situation, your group will need to actively search for the information necessary to solve the problem.

2. **List what is known**. Start a list in which you write down everything you know about this situation. Begin with the information contained in the scenario. Add knowledge that group members bring. (You may want a column of things people think they know, but are not sure!)

3. **Develop a problem statement**. A problem statement should come from your analysis of what you know. In one or two sentences you should be able to describe what it is that your group is trying to solve, produce, respond to, or find out. The problem statement may have to be revised as new information is discovered and brought to bear on the situation.

4. **List what is needed**. Prepare a list of questions you think need to be answered to solve the problem. Record them under a second list titled: "What do we need to know?" Several types of questions may be appropriate. Some may address concepts or principles that need to be learned in order to address the situation. Other questions may be in the form of requests for more information. These questions will guide searches that may take place on-line, in the library, or in other out-of-class searches.

5. **List possible actions**. List recommendations, solutions, or hypotheses under the heading: "What should we do?" List actions to be taken, e.g., question an expert, get on-line data, visit library.

6. **Analyze information**. Analyze information you have gathered. You may need to revise the problem statement. You may identify more problem statements. At this point, your group will likely formulate and test hypotheses to explain the problem. Some problems may not require hypotheses; instead a recommended solution or opinion (based on your research data) may be appropriate.

7. **Present findings**. Prepare a report in which you make recommendations, predictions, inferences, or other appropriate resolution of the problem based on your data and background. Be prepared to support your recommendation.

Note: The steps in this model may have to be visited several times. Steps two through five may be conducted concurrently as new information becomes available. As more information is gathered, the problem statement may be refined or altered.

Research Paper Assignment Details

1. It should be approximately 2 pages long, double spaced, and must be written in 12 point font (either Arial or Times New Roman **only**).
2. Please include a title page that has "Volcano Project", the name of your situation, your name, and the date. You may use any font for your title page and can include a picture if you choose.
3. Your paper needs to include and answer the following situation:
   a. Decide…
      - Whether to build a new high school in the shadow of Mt. Rainier.
      - What are the prospects for the population near Kilauea?
      - What should be done in the Portland area when Mt. Hood starts acting like Mt. St. Helens?
      - What should be done if we are facing an eruption in Yellowstone as devastating as a nuclear attack?
4. Answer the situation and problem presented above. Make a suggestion that they can follow. (Use the various puzzle pieces for the places.)
5. Assess the type of volcano at hand and the damage that could be caused. (Use the Volcanology puzzle piece.)
6. Determine the risk analysis for the volcano problem in your situation. (Use the Analyzing Volcanoes puzzle piece.)

Paper Due Date: ___________________________________

[i] (2008). Volcanoes PBL. *Atwater High School Agriculture Department.*

Earth Sciences Standards

4. Energy enters the Earth system primarily as solar radiation and eventually escapes as heat. As a basis for understanding this concept:
    a. Students know the relative amount of incoming solar energy compared with Earth's internal energy and the energy used by society.
    b. Students know the fate of incoming solar radiation in terms of reflection, absorption, and photosynthesis.
    c. Students know the different atmospheric gases that absorb the Earth's thermal radiation and the mechanism and significance of the greenhouse effect.
    d. * Students know the differing greenhouse conditions on Earth, Mars, and Venus; the origins of those conditions; and the climatic consequences of each.

5. Heating of Earth's surface and atmosphere by the sun drives convection within the atmosphere and oceans, producing winds and ocean currents. As a basis for understanding this concept:
    a. Students know how differential heating of Earth results in circulation patterns in the atmosphere and oceans that globally distribute the heat.
    b. Students know the relationship between the rotation of Earth and the circular motions of ocean currents and air in pressure centers.
    c. Students know the origin and effects of temperature inversions.
    d. Students know properties of ocean water, such as temperature and salinity, can be used to explain the layered structure of the oceans, the generation of horizontal and vertical ocean currents, and the geographic distribution of marine organisms.
    e. Students know rain forests and deserts on Earth are distributed in bands at specific latitudes.
    f. * Students know the interaction of wind patterns, ocean currents, and mountain ranges results in the global pattern of latitudinal bands of rain forests and deserts.
    g. * Students know features of the ENSO (El Niño southern oscillation) cycle in terms of sea-surface and air temperature variations across the Pacific and some climatic results of this cycle.

6. Climate is the long-term average of a region's weather and depends on many factors. As a basis for understanding this concept:
    a. Students know weather (in the short run) and climate (in the long run) involve the transfer of energy into and out of the atmosphere.
    b. Students know the effects on climate of latitude, elevation, topography, and proximity to large bodies of water and cold or warm ocean currents.
    c. Students know how Earth's climate has changed over time, corresponding to changes in Earth's geography, atmospheric composition, and other factors, such as solar radiation and plate movement.
    d. * Students know how computer models are used to predict the effects of the increase in greenhouse gases on climate for the planet as a whole and for specific regions.

Lab Reference: Energy in the Earth System

Standards: 4a-d, 5a-g, 6a-d

STANDARD CONCEPT	LAB NAME	LAB NUMBER
Climate and Weather	Caleb Weatherbee: Farmer's Almanac	C-1
Climate and Weather	Creating a Climatogram	C-2
Climate and Weather	Jack Frost and The Crops: Farmer's Almanac	C-3
Earth	Half Earth Model: Winds, Currents and Climate	C-4
Greenhouse Effect	Modeling The Greenhouse Effect	C-5
Ocean Currents	Graphing Tidal Cycles	C-6
Ocean Currents	Ocean Circulation Webquest	C-7
Ocean Currents	Ocean Currents and Climate	C-8
Salinity	Salinity	C-9
Solar Energy	Insulation: Preventing Conduction	C-10
Wind Patterns	Wave Motion	C-11

Earth Science Standards

- (ES) 6.a and 6.b.

Agriculture Standards

- (AG) C 2.1.
- (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d)
- (Foundation) 2.2 Writing, Specific Applications of Writing Strategies and Applications--Grades 9-10: (2.1) and (2.6a).

Name____________________

Date_____________________

Caleb Weatherbee: Farmer's Almanac

Purpose

The purpose of this lab is to explore the accuracy of the Farmer's Almanac in predicting weather forecasts. [i]

Background

Caleb Weatherbee is the name given to all Farmer's Almanac forecasters. "Caleb Weatherbee" prepares forecasts two years in advance using a "secret" formula based on sunspots, the planets and the moon. The Farmer's Almanac claims 80% to 85% accuracy for the forecasts. These predictions are important for farmers as they develop planting and harvesting schedules. Many farmers plant crops in the spring between the months of March and May, but rain and cool weather often delay planting.

Procedure

Materials

1. Farmer's Almanac (class set or 1 per 2 students)
2. Computer access to www.weather.com
3. Local planting/harvesting schedule (optional)

Sequence of Steps

1. Select 3 or 4 past calendar days for the current year and write them in "observations".
2. Divide into groups of 3-4
3. Your teacher will assign each group a zone from the United States Zoned Weather Map in the Farmer's Almanac. Record this zone in "observations".
4. Select 2 states within your assigned zone and record.
5. Research the recorded weather conditions for the dates selected above for each of the state capitals you selected. Make a note of any other important state information such as climate and crops.
6. Compare the recorded weather conditions with the predictions in the Farmer's Almanac. Assign points to each comparison and total scores based on the following scale.

1 point: Prediction **MOSTLY** matches Recorded Weather Condition
0.5 point: Prediction **SOMEWHAT** matches Recorded Weather Condition
0 points: Prediction **DOES NOT** match Recorded Weather Condition

Example:

Date	Recorded Weather Conditions	Predicted Weather from Almanac	Rating
Jan 1 2007	High: 39 degrees Low:30 degrees No precipitation	Light Snow	0
Jan 6 2007	High: 45 degrees Low: 34 degrees No precipitation	Light snow continues then clearing	0
Jan 15, 2007	High: 35 degrees Low: 18 degrees Precipitation 0.06 in	Clearing, cold	0.5

7. Report your findings to the class and record on a class chart to determine an overall accuracy percentage for the Farmer's Almanac. To calculate the percentage, add up all the ratings and divide by the total number of recorded weather conditions.

Observations

1. Calendar days we selected in the past year:

   ______________________ ______________________ ______________________

2. The zone we were assigned from the United States Zoned Weather Map:

   ____

3. The 2 states we selected within our zone:

   ______________________ ______________________

State:			
Date	Recorded Weather Conditions & Notes	Predicted Weather from Almanac	Rating

State:			
Date	Recorded Weather Conditions & Notes	Predicted Weather from Almanac	Rating

Agriculture Application:

Get a copy of your local planting and harvesting schedule, or find one online. Select 5 agriculture commodities and determine when they should be planted and when they should be harvested. Explain your findings.

[i] Goehring, Jessalee (2008).Caleb Weatherbee, Lab. *Lodi High School Ag Dept.*

Earth Science Standards	• (ES) 6.a and 6.b.
Agriculture Standards	• (AG) C 2.2 C 11.2, and E 7.1. • (Foundation) 1.1 Mathematics, Specific Applications of Probability and Statistics: (8.0).

Name____________________

Date_____________________

Creating a Climatogram

Purpose

The purpose of this lab is to determine which cities are best for specific recreational facilities based on climate data.[i]

Procedure

Materials

1. Graph paper
2. Colored pencils

Sequence of Steps

1. Read the background information and hypothesis in "observations".
2. Work in groups of three. Each person should graph the data for one of the cities: A, B or C. (All are at the same latitude)
3. Construct a graph placing months on the x-axis, precipitation on the left y-axis and temperature on the right y-axis. (Use the example in background information as a guide.)
    a. Write a title on your graph.
    b. Construct a key.
4. Using the data for precipitation, construct a bar graph of average monthly precipitation.
    a. Color all bars green.
    b. Add precipitation to the key.
5. Using the same green colored pencil, draw a snowflake under the names of the months where at least some of the precipitation is snow.
6. Using the data for average high temperature, construct a line graph and connect all points with a smooth curve (do not just connect the dots.)
    a. Use red colored pencil for average high temperature.
    b. Add average high temperature to your key.
7. Using the data for average low temperature, construct a line graph and connect all points with a smooth curve (do not just connect the dots.)
    a. Use a blue colored pencil for average low temperature.
    b. Add average low temperature to your key.
8. Complete review questions in "observations".

Data

CITY A	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Avg. High (˚C)	6	8	14	19	24	29	32	31	27	21	14	8

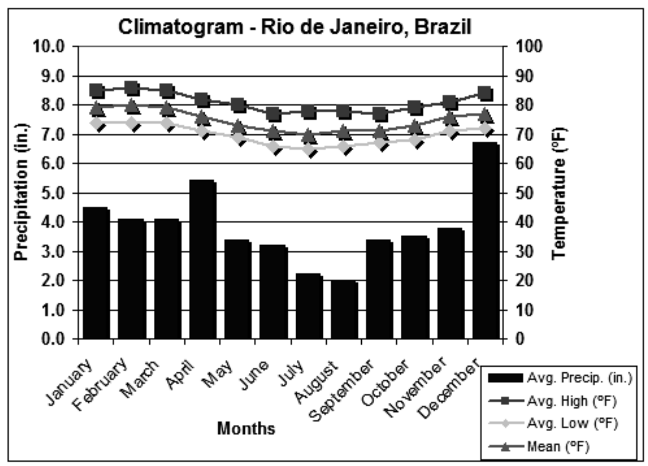
Avg. Low (˚C)	-3	-2	3	8	14	19	22	21	17	10	5	0
Avg. Precip.	6.9	6.9	8.1	6.9	9.4	8.6	9.7	9.9	8.4	7.6	7.9	7.9
Snow	Snow	Snow	Snow	Trace	None	None	None	None	None	Trace	Snow	Snow

CITY B	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Avg. High (˚C)	13	16	16	17	17	18	18	19	21	21	17	13
Avg. Low (˚C)	8	9	9	10	11	12	12	13	13	13	11	8
Avg. Precip.	10.4	7.6	7.9	3.5	0.8	0.5	0.3	0.3	0.8	3.3	8.1	7.9
Snow	Trace	Trace	Trace	None	None	None	None	None	None	None	None	Trace

CITY C	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Avg. High (˚C)	7	11	13	18	21	28	33	32	27	21	12	8
Avg. Low (˚C)	-6	-4	-2	1	4	8	11	10	6	1	-3	-7
Avg. Precip.	2.5	2.3	1.8	1.3	1.8	1	0.8	0.5	0.8	1	2	2.5
Snow	Snow	Snow	Snow	Snow	Snow	Trace	None	None	Trace	Trace	Snow	Snow

Observations

BACKGROUND: Climate is the long term conditions of temperature and precipitation in an area. This information can be used not only for scientific research, but to determine where the best locations are for recreational facilities such as water parks, ski parks, mountain climbing parks, etc. This is mostly common sense. For example, you would probably not spend the money to build a snow board and snow ski park in Mexico. By the same token, you would probably not build a water park in Alaska. In determining the best locations for various facilities, climatograms are very helpful because the information you need is all together in one place for you to look at all at one time.



HYPOTHESIS: If average high monthly temperature, average low monthly temperature, average precipitation and whether or not there was snowfall are plotted on a graph, then it can be determined which recreational facilities are best for each area.

<u>ANALYSIS</u>: (Answer the following with complete sentences using actual data. When asked to calculate write the formula, show the complete set up and express your answer with appropriate units.)

1. Calculate the average precipitation for each city. To do this: add precipitation for all months, and then divide by 12.

City A

City B

City C

2. Which city has most constant temperature over the course of the year? Explain.

3. Which city has the greatest change in temperature over the course of the year? Explain.

4. The three cities are at the same latitude, but which city is probably closest to an ocean? Explain.

5. The three cities are at the same latitude, but which city is probably in the middle of the continent? Explain.

6. Which city would be the best choice for a water park? Explain

7. Which city would be the best choice for a cross-country ski center? Explain.

8. What other factors would you need to take into consideration in determining the ideal facility for each city? Explain.

9. Which city would be the best choice for producing crops? What additional information would you need?

10. Investigation: Using the internet, or other classroom resources, determine 2 agricultural commodities which could be produced in each city based on the climate knowledge you now have.

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[i] Looper, Jim (2008). Creating a Climatogram, Lab. *Sheldon High School Science Dept.*

Earth Science Standards	• (ES) 6.a and 6.b.
Agriculture Standards	• (AG) C 11.2, C 13.3, and G 3.4. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.m)

Name____________________

Date_____________________

Jack Frost and the Crops: Farmer's Almanac

Purpose

By using the Farmer's Almanac, students will explore frost as well as the impact it can have on a farmer's crop and their food supply. [i]

Background

Farming is governed by the season. For example, corn's growing season begins at the last frost in the spring and ends when the first fall frost occurs. The last frost gives farmers an indication as to when they can plant in early spring. The first frost means the end of the growing season. Because of frost, many farmers must time planting and harvesting carefully. A late spring frost means having to replant crops; while an early fall frost may damage crops and reduce the amount produced for the year. Farmers use the Farmer's Almanac to help predict the first and last frost and make decisions about planting and harvesting.

Procedure

Materials

1. 2 tin cans without a lid (condensed soup cans)
2. Rock salt or table salt
3. Crushed ice

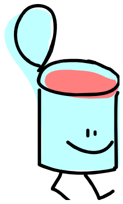
Sequence of Steps

1. In a moment you will carefully fill 1 can with a salt/ice mixture and the other can with a water/ice mixture. Formulate a hypothesis of which can will form frost and record in "observations".
2. Fill one tin can half full of crushed ice. Add 4 tablespoons of salt.
3. Mix this can well for about 30 seconds and then let sit.
4. In the second can, put only crushed ice and tap water. Fill the can about half way full of ice and then put just enough tap water in the can to cover the ice.
5. Observe if frost is forming on the outside of the cans.
6. Compare both cans and note the characteristics of matter on the outside of the cans. Record your observations.

Observations

1. Hypothesis:

2. Compare both cans and note the characteristics of matter on the outside of the cans.



Can #1: Salt/Ice

Can #2: Water/Ice

3. Which can had frost form on it? Which can had dew form on it?

4. When and where have you observed frost form?

5. Critical Thinking: Why do you suppose you got the results you did in this lab?

6. Brainstorm: What might frost do to a farmer's crop?

7. Investigate: What can farmers do to prevent frost damage?

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[i] Goehring, Jessalee (2008).Jack Frost, Lab. *Lodi High School Ag Dept.*

Earth Science Standards

- (ES) 5.e, 5.f, 6.a, and 6.b.

Agriculture Standards

- (AG) E 11.0.
- (Foundation) 1.1 Mathematics, Specific Applications for Algebra I Standards: (15.0).

Name____________________

Date_____________________

Half Earth Model: Winds, Currents and Climate

Purpose

The purpose of this lab is to create a three dimensional model of half of the earth, applying what you know about winds, currents and climate. [i]

Procedure

Materials

1. Paper mache, foam, cardboard, or any other material that is not food or perishable. (In other words, it won't spoil, grow mold or get stinky!)
2. A piece of cardboard or other flat surface upon which you can attach your model.

Sequence of Steps

1. Construct a 3-D model of half of the earth, and attach your model to cardboard or a flat surface that you can easily carry.

2. At the top of the cardboard (or other backing) write an appropriate title for your project.

3. Paint or color your model showing the land and water.
    a. You may show either Eastern or Western Hemisphere.
    b. Make sure the land sticks up higher than the water.

4. Add a line, straw, skewer, etc. at a 23˚ angle to show the angle of the tilt of the earth.
    a. Make sure you lean the ½ earth one way of the other on the 23˚ angle away from vertical.

5. Add lines, yarn, string etc. to represent and label:
    a. The equator
    b. 30˚ North and 30˚ South Latitude
    c. 60˚ North and 60˚ South Latitude

6. Label 90˚ North Latitude and 90˚ South Latitude

7. On the cardboard (backing) to the left of the ½ earth,
    a. Add lines, yarn, string, skewers, etc. to show the rays from the sun striking the earth at:
        i. The equator, 30˚ North and 30˚ South Latitude, 60˚ North and 60˚ South Latitude, and 90˚ North and 90˚ South Latitude.
        ii. Remember, because the sun is so far away, all rays strike the earth parallel to each other.

8. At the bottom of the cardboard (backing),
    a. Write whether it will be "summer" or "winter" in the Northern hemisphere
    b. Underneath where you have labeled the season, explain why it will be that season due to the angle of incoming solar radiation.

9. To the right of the ½ earth,
    a. Draw or construct red arrows showing where there will be warm, rising air.
    b. Draw or construct blue arrows showing where there will be cool, sinking air.

10. On the top of the latitude lines where there will be a lot of precipitation, add cotton (or some other material) to represent clouds and precipitation.

11. Between the latitude lines, label where appropriate:
    a. Tropical Rain Forest
    b. Subtropical Desert
    c. Temperate Rain Forest
    d. Polar Desert
    e. Hint: the climate zones are the same above and below the equator!

12. Between the latitude lines, label where appropriate:
    a. Warm
    b. Cold
    c. Dry
    d. Wet
    e. Hint: the climate zones are the same above and below the equator!

13. On the ½ earth, in the oceans,
    a. Draw or construct red arrows showing the movement of warm surface currents.
    b. Draw or construct blue arrows showing the movement of cold surface currents.

14. Place an "X" somewhere on the ½ earth model
    a. To the left of the ½ earth on the cardboard (backing):
        i. Explain in detail the climate in this area marked by an "X", including latitude, angle of incoming solar radiation, movement of air, movement of ocean

water, the name of the climate zones, temperature and precipitation of the area, and at least 3 plants and 3 animals you might find living in this area.

[i] Looper, Jim (2008).Unit 3 Project: ½ Earth, Winds, Currents and Climate. *Sheldon High School Science Dept.*

Earth Science Standards	•(ES) 6.c and 6.d.
Agriculture Standards	•(AG) C 1.2, C 3.3, and C 9.2. •(Foundation) 1.1 Mathematics, Specific Applications of Probability and Statistics: (8.0).

Name____________________

Date_____________________

Modeling the Greenhouse Effect

Purpose

The purpose of this lab is to model the greenhouse effect and compare your results to the greenhouse effect caused by Earth's atmosphere.[i ii]

Background

A greenhouse is a structure whose glass or plastic panes allow light from the sun to enter the structure but also prevent heat from escaping. In a similar way, Earth's atmosphere allows solar radiation to pass through it. Some of this radiation is absorbed by Earth's surface. Gases in the atmosphere, including carbon dioxide and water vapor, also absorb some of this energy and reflect it back to Earth's surface as heat. This greenhouse effect makes our planet's surface and atmosphere warmer than they would be otherwise.

Procedure

Materials

1. Clean, dry, transparent 2-L plastic soda bottles with caps (2)
2. Lab burner
3. Heat-resistant gloves
4. Safety matches
5. Large, metal knitting needle
6. Celsius thermometers (2)
7. Modeling clay
8. Direct sunlight or a lamp with 100W bulb
9. Clock or watch
10. Colored pencils
11. Safety Goggles

**If lab burners are not available, other instruments may be provided by the teacher to make holes in the plastic bottles.*

Sequence of Steps

1. Put on safety goggles.
2. Connect the lab burner to the gas valve.
3. Put on heat resistant gloves and open the valve. Carefully light the burner and properly dispose of the match.
4. CAUTION: Carefully warm the knitting needle in the flame and use it to make 30 holes in one of the 2-L bottles. Distribute the holes evenly around the bottle, but do not make holes around the bottom 6cm of the bottle. Turn off the burner and put it away.

5. Lower one thermometer into the mouth of each bottle so that the bulbs of the thermometers are at the bottoms of the bottles. Screw the caps tightly onto the bottles.
6. Use the modeling clay to secure the bottles – upside down – in an area that gets direct sunlight or under the lamp. The bottles should be about 15cm apart. If you are using a lamp, adjust the lamp so that each bottle is the same distance – about 10cm – from the bulb.
7. Adjust the bottles so that the thermometers are set up the same way with respect to the light source.
8. If you are using a lamp as your light source, turn it on. CAUTION: Lamps can get very hot. Do not move too close to the lamps when they are in use. Measure the initial temperature shown on each thermometer and record these values in the data table.
9. Measure and record the temperature in each bottle every 5 minutes for 30 minutes.

Observations

Data Table

Time (minutes)	Temperature (˚C)	
	Bottle Without Holes	Perforated Bottle
0		
5		
10		
15		
20		
25		
30		

Graph

Construct a line graph of your data on the grid. Plot time, in minutes, on the horizontal axis, and temperature, in degrees Celsius, on the vertical axis. Use a different colored pencil to connect each set of data points. Include a key that indicates which set of data is which. Give your graph an appropriate title.

KEY:

1. In which of the two bottles did the temperature of the air rise at a faster rate? Explain why this happened.

2. In which of the bottles did the air reach the higher temperature? Why?

3. Which processes of heat transfer – conduction, radiation, convection – are involved in this activity?

4. Which bottle simulates the greenhouse effect caused by Earth's atmosphere? Why?

5. What are some of the limitations of this model of Earth's greenhouse effect?

6. How is the greenhouse effect related to global warming?

7. How is agriculture production potentially impacted by the greenhouse effect?

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[i] Pearson Prentice Hall, Modeling the Greenhouse Effect. *Pearson Education, Inc.*
[ii] Goehring, Jessalee (2008). Greenhouse Effect Lab. *Lodi High School Ag Dept.*

Earth Science Standards	•(ES) 5.b and 5.d.
Agriculture Standards	•(AG) D 11.2 and D 11.3. •(Foundation) 1.1 Mathematics, Specific Applications of Probability and Statistics: (8.0).

Name____________________

Date_____________________

Graphing Tidal Cycles

Purpose

The purpose of this lab is to determine the tidal pattern an area experiences.[i]

Procedure

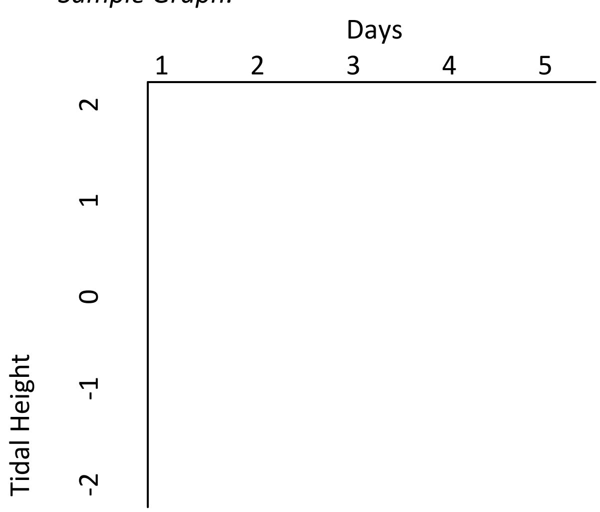
Materials

1. Graph paper
2. Pencil

Sequence of Steps

1. Read background information in “observations”.
2. Label the graph paper to make a graph of the tidal cycle. The x-axis should be in days, and the y axis should be in feet. For this graph, place the x axis at the top of the graph, rather than at the bottom. See the sample graph for how to set up your graph.

Sample Graph:



3. Use the data in Table 1 to make a graph of the tidal cycle.

Table 1. Tidal Data for Long Beach, New York, January 2003
All times are listed in Local Standard Time (LST). All heights are in feet.

Day	Time	Height	Time	Height	Time	Height	Time	Height
1	5:45am	5.5	12:16pm	-0.7	6:12pm	4.4	--------	----------
2	12:18am	-0.5	6:35am	5.6	1:07pm	-0.8	7:03pm	4.4
3	1:10am	-0.5	7:23am	5.5	1:56pm	-0.8	7:53pm	4.4
4	1:59am	-0.4	8:11am	5.4	2:42pm	-0.7	8:42pm	4.3
5	2:45am	-0.2	8:59am	5.1	3:25pm	-0.5	9:32pm	4.2
6	3:30am	0.0	9:47am	4.8	4:07pm	-0.3	10:23pm	4.0
7	4:14am	0.3	10:35am	4.6	4:49pm	-0.1	11:12pm	3.9
8	5:01am	0.6	11:22am	4.3	5:32pm	0.2	11:59pm	3.9
9	5:54am	0.8	12:09pm	4.0	6:18pm	0.4	---------	---------
10	12:45am	3.9	6:56am	0.9	12:57pm	3.7	7:10pm	0.5
11	1:31am	3.9	7:59am	0.9	1:47pm	3.5	8:02pm	0.5
12	2:19am	4.0	8:57am	0.8	2:41pm	3.4	8:53pm	0.5
13	3:10am	4.1	9:50am	0.6	3:39pm	3.5	9:41pm	0.4
14	4:02am	4.3	10:38am	0.3	4:34pm	3.6	10:28pm	0.2
15	4:51am	4.6	11:26am	0.1	5:23pm	3.7	11:15pm	0.1
16	5:36am	4.8	12:12pm	-0.1	6:08pm	3.9	--------	--------
17	12:02am	-0.1	6:17am	5.0	12:57pm	-0.3	6:51pm	4.1
18	12:49am	-0.2	6:58am	5.1	1:40pm	-0.5	7:32pm	4.2
19	1:35am	-0.4	7:38am	5.2	2:22pm	-0.6	8:15pm	4.3
20	2:20am	-0.4	8:21am	5.2	3:30pm	-0.7	9:01pm	4.4
21	3:05am	-0.4	9:07am	5.1	3:44pm	-0.7	9:51pm	4.5
22	3:52am	-0.3	9:58am	4.9	4:27pm	-0.6	10:44pm	4.6
23	4:43am	-0.1	10:52am	4.7	5:13pm	-0.4	11:37pm	4.7
24	5:43am	0.1	11:48am	4.4	6:08pm	-0.2	--------	--------
25	12:32am	4.7	6:53am	0.2	12:47pm	4.2	7:11pm	-0.1
26	1:30am	4.8	8:06am	0.2	1:50pm	3.9	8:17pm	0.0
27	2:31am	4.8	9:12am	0.1	2:57pm	3.8	9:19pm	0.0
28	3:35am	4.8	10:13am	-0.1	4:05pm	3.9	10:17pm	-0.1
29	4:37am	5.0	11:09am	-0.3	5:07pm	4.0	11:13pm	-0.2
30	5:33am	5.1	12:01pm	-0.5	6:01pm	4.2	--------	--------
31	12:06am	-0.3	6:22am	5.2	12:51pm	-0.6	6:50pm	4.3

Source: Center for Operational Oceanographic Products and Services, National Oceanographic and Atmospheric Association, National Ocean Service.

Observations

Background: Tides are the cyclical rise and fall of sea level caused by the gravitational attraction of Earth to the moon and, to a lesser extent, to the sun. Gravitational pull creates a bulge in the ocean on the side of Earth nearest the moon. A similar bulge forms on the opposite side of Earth from the moon because the moon's pull is weaker on that side. Tides develop as the rotating Earth moves through these bulges, causing periods of high and low water. In this lab, you will make a graph of tidal data to determine whether an area has diurnal, semidiurnal, or mixed tides.

1. What tidal pattern does this area experience? Explain how you determined this.

2. What is the greatest tidal range for the data you graphed? What is the least tidal range? What types of tides correspond to each of these tidal ranges?

3. Based on your graph, identify the days when each moon phase could have occurred: new moon, first quarter moon, full moon, last quarter moon. How do you know this?

4. On January 4th (Day 5 on the table) at 9:00am, Jarred anchored his boat in about 4 feet of water at the beach. When he returned to his boat at 3:30 that afternoon, the boat was completely in the sand. What had happened? How long did Jarred have to wait to leave the area in his boat?

5. Speculate why a strong understanding of tidal cycles is important for commercial fishermen, who make up an important part of the agriculture industry.

---

[i] Tarbuck, E, & Lutgens, F (2009). *Earth Science*. Boston: Prentice Hall.

Earth Science Standards

- (ES) 5.b and 5d.

Agriculture Standards

- (AG) C 2.3, D 11.2, and D 11.3.
- (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.d).
- (Foundation) 2.1 Reading, Specific Applications of Reading Comprehension--Grades 9-10: (2.6).

Name____________________

Date_____________________

Ocean Circulation Webquest

Purpose

The purpose of this lab is to investigate deep ocean circulation using internet resources.[i]

Procedure

Materials

1. Internet access

Sequence of Steps

1. Go to the website below and read about each of the following topics. (You will have to click on the link name for each topic to learn about the ocean currents and heat distribution.) http://www.divediscover.whoi.edu/circulation/index.html
2. Click on, "Begin the Interactive".
   a. Differential Heating
   b. Clickable Tank (Temperature zones)
   c. North Atlantic Circulation
   d. World Circulation
3. When you have learned about how ocean circulation patterns work, please answer the questions below.

Webquest Questions

1. The curve of the earth, causes the sun's rays to strike where?

2. The world's surface ocean currents are driven by what force?

3. The density of seawater, which affects deep ocean circulation, depends on what?

4. If you traveled from the surface of the ocean to the bottom, what would you find out about density?

5. What would you find out about temperature and salinity traveling from the surface to the bottom?

6. Why does surface water sink in the North Atlantic?

7. What is the name of the world's system of ocean currents that distribute heat around the world?

If you finish early, click on the Hot Topic link on the first page entitled,
"Going Vertical: Gauging Ocean Overturn Rates"

Or, enter the website: http://www.divediscover.whoi.edu/hottopics/waterage.html
Read about the ocean climates and how temperature and salinity relate

[i] (2008). *Ocean Circulation Computer Lab*. Atwater High School Agriculture Department.

Earth Science Standards

- (ES) 5.d.

Agriculture Standards

- (AG) C 2.3, C 10.1, C 13.3, D 11.2, and D 11.3
- (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.d).
- (Foundation) 2.1 Reading, Specific Applications of Reading Comprehension--Grades 9-10: (2.3).

Name____________________

Date_____________________

Ocean Currents and Climate

Purpose

The purpose of this lab is to visualize ocean current movement based on temperature, salinity and wind.[i]

Procedure

Materials

1. Baby food jars (4)
2. Index card
3. Salt
4. Food Coloring
5. Stirring Rod
6. Tray
7. Triple beam balance

Sequence of Steps

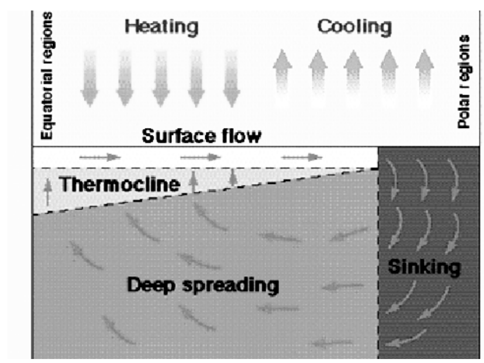
1. Read background information in "observations".
2. Develop your hypothesis and record in "observations".
3. Fill two baby food jars completely full with water. (The water should be "bubbled up" over the top.)
    a. Add a drop of red food coloring.
    b. These jars will represent fresh water.
4. Fill two baby food jars ¾ full with water.
    a. Dissolve 10 g of salt in two of the jars.
    b. Add a drop of blue food coloring.
    c. These jars will represent salt water.
    d. Add water to make certain all jars are completely full. (The water should be "bubbled up" over the top.)
5. Predict what will happen when you invert the salt water over the fresh water. Record in "observations" by coloring what you think the result will be.
6. DO THE NEXT PART OVER THE TRAY.
    a. Place an index card on top of the salt water.
    b. Holding the card against the top of the jar, turn the jar over and place it on top of the fresh water.
    c. Have a lab partner carefully remove the card. Record results by coloring what you see.
    d. If the layers mixed or inverted, indicate that in your observations.
    e. LEAVE THESE JARS STACKED IN THE TRAY FOR LATER.
    f. BE CAREFUL NOT TO KNOCK THEM OVER.
7. Predict what will happen when you invert the fresh water over the salt water. Record by coloring what you think the result will be.
8. DO THE NEXT PART OVER THE TRAY.

a. Place an index card on top of the fresh water.
b. Holding the card against the top of the jar, turn the jar over and place it on top of the salt water.
c. Have a lab partner carefully remove the index card. Record results by coloring what you see.
d. If the layers mixed or inverted, indicate that in your observations.
e. LEAVE THESE JARS STACKED IN THE TRAY FOR THE NEXT PART OF THIS ACTIVITY.
f. BE CAREFUL NOT TO KNOCK THEM OVER.

9. Predict what will happen if you turn both sets of jars horizontal (sideways.) Record by coloring what you thing the result will be.
10. Carefully and slowly turn both sets of jars so that they are horizontal.
    a. DO NOT ALLOW THE JARS TO SEPARATE. (You will need to hold the jars the entire time.)
    b. Record your observations by coloring what you see. If the layers mixed or inverted, be sure to indicate that in your observations.
11. Clean up by pouring all water down the drain and thoroughly rinsing out all jars, so that all salt has been washed away.
12. Dry all materials and clean up according to your teacher's instructions.

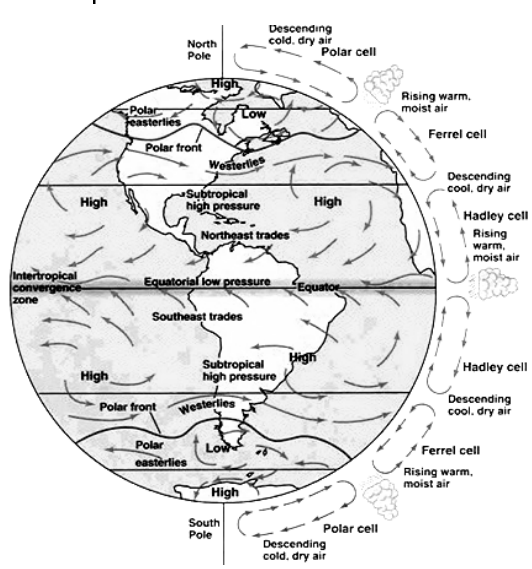
Observations

Background Information: Due to the nature of water, warm water carries with it a lot of energy. Warm water will release some of its thermal energy and warm the air above it. Therefore, where there is warm water, there is warm air. The movement of warm water and warm air help to distribute heat around the earth. Ocean currents are the second major factor affecting climate, after latitude. Water in the upper part of the ocean (at the surface) moves somewhat independently from the water in the deeper part of the ocean. However, both have some affect on climate.



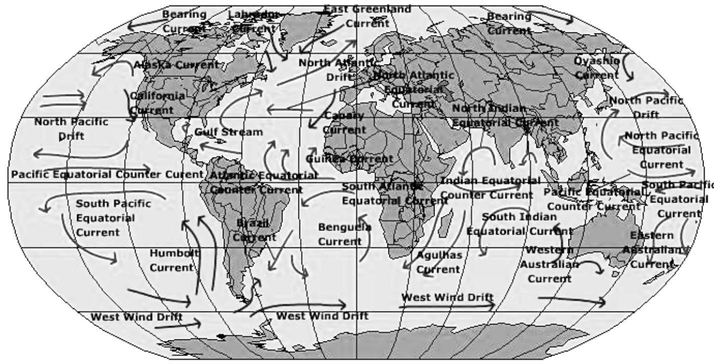
SURFACE CURRENTS – Surface ocean currents are generated when global winds blowing over the water for a long period of time, causes the water to move in the same direction. Observe the two pictures below: one of global wind patterns and the other of surface ocean currents. Notice how the two are similar.

Global Winds



Notice that the global wind patterns and currents on the surface of the ocean are very similar, but not exactly alike. The differences are caused by the continents. Wind in the atmosphere can continue to blow right over the land, but the water in the oceans has to turn when it hits the land.

Ocean Surface Currents



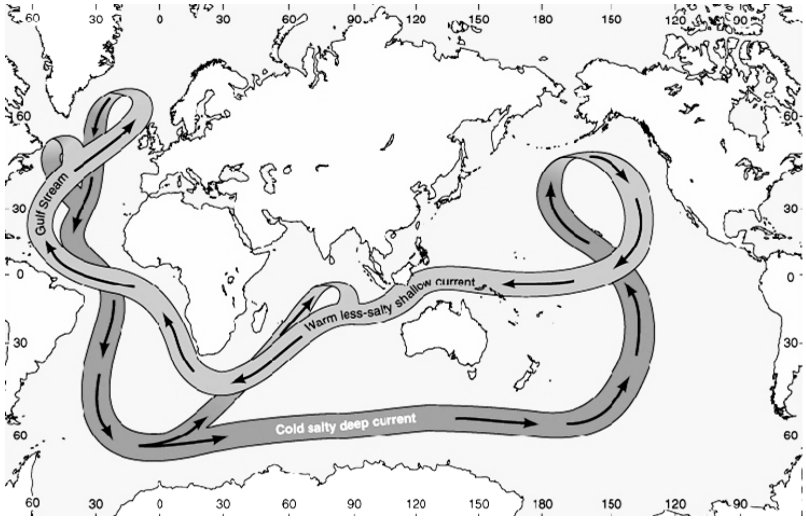
Surface ocean currents adjust the climate of an area only slightly. For example, if you look at the western coast of North America (near California), you will see that the California Current is brining water from the nearer the pole towards the equator. This means that cold water and cold air are moving by the California coast. This will adjust the climate and make it a little more cool and a little more dry than it otherwise would be based on latitude alone. Conversely, on the eastern coast of North America (near Florida, etc.), the Gulf Stream is brining water from nearer to the equator towards the pole. This means that warm water and warm air are moving by the east coast of the United States. This will adjust the climate and make it a little more warm and a little more wet (humid) than it otherwise would be based on latitude alone. Therefore, even though Sacramento, California and Washington, D.C are at approximately the same latitude (38^{o} North latitude), the two cities have slightly different climates. Sacramento will be a little cooler and drier, while Washington, D.C. will be a little warmer and wetter.

DEEP OCEAN CURRENTS – The Global Conveyer Belt

Deep ocean circulation based on density is called thermohaline circulation. *Thermo* meaning heat and *haline* meaning salinity (saltiness.) It is easy to presume that all ocean water has the same salinity. That is, the same amount of salt is dissolved in all ocean water. However, this is not true.

Water near the equator is warmed by the sun. As this water is warmed, some of it evaporates. The salt does not evaporate and so stays in the water. This causes the warm water near the equator to increase in salinity (become more salty.) Although the density increases due to the increase in salinity, the water is still has a very low density because it is so warm. The warm water will then move away from the equator towards the poles.

Water near the poles is very cold and some of it even freezes. However, when the water freezes, the salt does not, and so stays in the water. Now, the water near the poles is very cold and very salty, making it very dense. This water will sink and move back towards the equator.



This whole cycle is called the global conveyer belt and is very important both in the cycling of nutrients and in regulating global temperatures. This cycle, although in constant motion, can take a thousand years to complete.

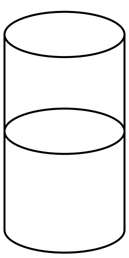
HYPOTHESIS: If ocean water is cool and salty, then it will have a ____________ density and will _____________.

RESULTS:

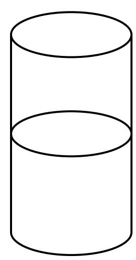
SALINITY AND DEEP OCEAN CURRENTS

Salt water over fresh water.

Prediction (color what you think the result will be):

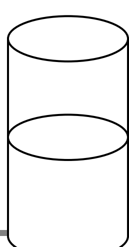


Observations (color what you see and describe):

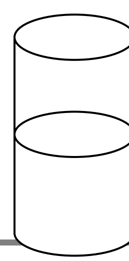


Fresh water over salt water.

Prediction (color what you think the result will be):

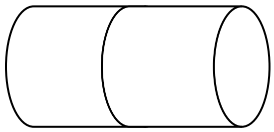


Observations (color what you see and describe):

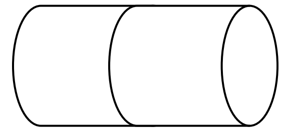


Salt water over fresh water turned horizontal.

Prediction (color what you think the result will be):

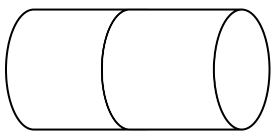


Observations (color what you see and describe):

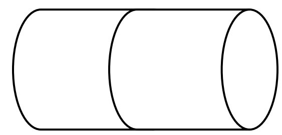


Fresh water over salt water turned horizontal.

Prediction (color what you think the result will be):



Observations (color what you see and describe):



<u>ANALYSIS</u>: (Answer using complete sentences and actual data.)

1. Is salt water or fresh water more dense? Explain how you know and why you think this is.

2. Taking into account, only salinity, where would you expect the most dense water to be? Explain.

3. Taking into account only temperature, where would you expect the most dense water to be? Explain.

4. Taking into account both salinity and temperature, where would you expect the most dense water to be? Explain.

5. Do you think it is possible for the direction of deep ocean currents to be reversed? Explain.

Application to Agriculture

"An estuary is a partially enclosed body of water along the coast where freshwater from rivers and streams meet and mix with salt water from the ocean. Estuaries are protected from the full force of ocean waves, winds, and storms by barrier islands or peninsulas.

Estuaries are very productive environments! They create more organic matter each year than comparably sized areas of forest, grassland, or agricultural land. They support unique communities of plants and animals, specially adapted for life at the margin of the sea."[ii]

Using this information and your own knowledge, describe the advantages and challenges of using an estuary for production agriculture.

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[i] Looper, Jim (2008). *Ocean Currents and Climate, Lab*. Sheldon High School.

[ii] National Estuary Program; About Estuaries. Retrieved December 4, 2008, from United States Environmental Protection Agency Web site: http://www.epa.gov/nep/about1.htm

Earth Science Standards	• (ES) 5.d.
Agriculture Standards	• (AG) C 2.3, C 6.4, C 6.5, C 13.3, D 11.2, and D 11.3. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.c)

Name____________________

Date_____________________

Salinity

Purpose

The purpose of this lab is to explore the effect of salinity on objects in water.[i]

Procedure

Materials

1. Two clear cups
2. Water
3. Salt
4. Potato piece
5. Carrot piece
6. Spoon

Sequence of Steps

1. Read through the sequence of steps and then develop a hypothesis reflecting how much salt you think will be needed to make the carrot and potato float.
2. Obtain two clear plastic cups. Fill each cup half-full with water.
3. Place a piece of carrot into the first cup. Does it float or sink?
4. Using a plastic spoon, add salt, one spoonful at a time, to the cup of water with the carrot in it. Stir the solution and record the number of spoonfuls added until your observation changes.
5. Place a piece of potato into the second cup of water.
6. Repeat step 3 for the potato and record your information.
7. Complete review questions.

Hypotheses

(Carrot) If ____

____________________________________, Then _______________________________________

____.

(Potato) If ____

____________________________________, Then _______________________________________

____.

Observations:

	Sink or Float?	1 tbsp salt	2 tbsp salt	3 tbsp salt	4 tbsp salt	5 tbsp salt	6 tbsp salt
Carrot							
Potato							

Conclusion:

1. Which object, the carrot or the potato, required the greatest amount of salt?

2. Compare your data with classmates. What are some possible reasons for inconsistent results?

3. What happens to the salinity (salt concentration) as salt is added to the water?

4. If you were swimming, would it be easier to stay afloat in an ocean or a freshwater lake? Why?

5. How does the salinity in an aquatic habitat affect species for commercial production/harvesting, sport fishing and other purposes?

Bonus Question

If you put one hand in salt water and the other in fresh water for a long period of time, what effect would each type of water have on your skin?

[i] Machado, Kristen (2008). Salinity. *East Union High School Ag Dept., Manteca.*

Earth Science Standards	•(ES) 4.a and 4.b.
Agriculture Standards	•(Foundation) 1.1 Mathematics, Specific Applications of Probability and Statistics: (8.0). •(Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a).

Name____________________

Date_____________________

Insulation: Preventing Conduction

Purpose

The purpose of this lab is to determine which material will provide the best insulation and therefore slow conduction. [i]

Procedure

Materials

1. Can with lid
2. 200 ml of boiling water
3. Thermometer
4. Insulating materials (Be creative! Each group is to provide their own insulating materials. List the materials your group will use below.)
   Additional materials my group will use:

Sequence of Steps

1. Read the background information provided in "observations".
2. Determine what your group will use as insulating materials and write down your hypothesis in "observations".
3. List all materials in the "materials" section.
4. Insulate your can with the materials your group provided.
5. Draw a cross-section (as if you cut your can in half) showing the insulation. Label the parts of your apparatus.
6. Make an opening in the lid of your can, just large enough for a thermometer to fit through.
7. Obtain 200 ml of boiling water from your teacher. (Be very careful!)
8. Immediately put the lid on. Read and record the initial temperature (Time = 0) in Table 1.
9. Read and record the temperature every 20 minutes.
10. Share your data with the class and gather all other data.
11. Clean up according to your teacher's instructions.

Observations

Background Information: Energy always flows from areas of higher energy to areas of lower energy. In terms of heat, this means that energy will flow from hotter areas to cooler areas. This occurs any time there is a temperature difference. The greater the temperature difference, the faster conduction will occur to equalize temperatures.

Some materials allow thermal energy to flow freely from hot to cold. These materials are called conductors. Metals are generally very good **conductors**, which is why we use metals for pots and pans. Materials that slow conduction are called **insulators.** In general, the less dense something is (the more air spaces there are), the better insulator it is because trapped air (where there is no air exchange) is one of the best insulators around. Plastic, foam, and air trapped between two panes of glass (dual pane windows) are some of the best insulators.

1. **Hypothesis:** If an insulator is made using ____, then the flow of thermal energy will be minimized.

2. Draw a cross section of your can showing the insulation. Label all components.

Table 1. Water temperatures over time in a comparison of insulating materials.

	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8
Primary Insulating Material								
Time (min)	Temperature (^{o}C)							
0								
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Construct a line graph showing the temperature change for each set up. Write a tile on your graph. Place Time (min) on the x-axis and Temperature (^{o}C) on the y-axis. Use a different color for each line and make a key indicating which line corresponds to which group. Draw all lines using a ruler. Make your graph neat and complete.

ANALYSIS: (Answer using complete sentences and actual data.)

1. Calculate the temperature change for each group. Show your work.
(Temperature Change = final temperature – initial temperature --- $\Delta T = T_f - T_i$)

Group 1	
Group 2	
Group 3	
Group 4	
Group 5	
Group 6	
Group 7	
Group 8	

2. Which group's set up had the least temperature change? Explain how you determined this (compare insulation to that of the other groups).

3. If you were going to build a home, explain the characteristics of the insulation you would you use to make sure it was as energy efficient as possible? Explain why.

4. Brainstorm at least 3 aspects of production agriculture which rely on insulation for the quality of their product.

5. What agricultural products and/or byproducts could be used for insulation?

[i] Looper, Jim (2008). Insulation: Preventing Conduction, Lab. *Sheldon High School Science Dept.*

Earth Science Standards	• (ES) 5.a.
Agriculture Standards	• (AG) C 1.4 and C 2.3. • (Foundation) 1.1 Mathematics, Specific Applications of Algebra I: (10.0), (12.0), and (15.0).

Name____________________

Date_____________________

Wave Motion

Purpose

In this investigation you will simulate wave motion to observe how energy generates wave motion in water. You will also observe the properties of waves. [i]

Procedure

Materials

1. Graph paper
2. Large sheet of paper
3. 3 colored pencils
4. Marker
5. Meter stick
6. Slinky

Sequence of Steps

1. In "observations" read background information and complete pre-lab questions.
2. On the large sheet of paper, use the meter stick to draw a grid that is 2 meters long and 1 meter wide. Mark the grid in increments of 6 inches (½ a foot).
3. Place the sheet of paper on the floor and line up the slinky at one end of the 2 meter line on your grid. Have one person hold the slinky at each end of the paper and do not let go.
4. Quickly move the slinky causing it to make waves along the line of the grid.
5. Two people will be on either end of the paper, controlling the slinky movement. One person will mark on the paper, where the **crest** of a wave hits. Another person will mark on the paper, where a **trough** of a wave hits.
6. On the graph paper, make a line graph with wavelengths on the horizontal axis and wave height on the vertical axis. Plot a wave, labeled A, which represents the wave that you observed in Step 5. Begin at 0 in the middle of the graph, and plot the height and length. Indicate the direction of the wave's motion.
7. Continue the investigation by changing the speed of your slinky toss. Repeat steps 5 and 6, using a different colored pencil to draw your plot. Try to generate small waves and large waves labeling them B and C.
8. On your graph, you should have the plots of three waves. Label a crest and trough on each of the waves that you plotted.

   What are the wavelengths of the three waves that you plotted?

   A.________ B.________ C.________

   What are their wave heights? A.________ B.________ C.________

9. Using the formula in the prelab preparation, calculate the wave speeds of the three waves represented on the graph if each wave period is six seconds.

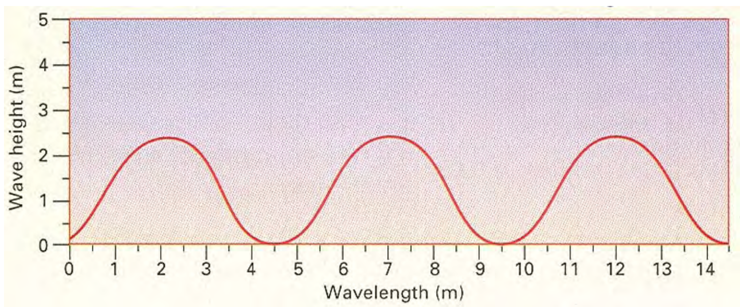
A.______________ B.______________ C.______________

Observations

Background Information: The source of wave movement in water is energy, which is generated primarily from wind. To a person standing on a beach and watching the waves come in to the shore, it may not be easy to understand that wind is the primary energy source of waves. Waves appear to move forward because of the actual movement of the water. However, only the energy of the waves moves forward; the water moves very little.

Pre-Lab Questions:

1. Study the graph on the right. Identify the wave crests and wave troughs. The wavelength is the distance between two successive crests or troughs.



What is the wavelength? __________

What is the wave height? __________

2. The wave period is the time required for two successive crests or troughs to pass a certain point. Wave speed can be calculated using the following formula:

$$\text{Wave Speed} = \frac{\text{Wavelength}}{\text{Wave Period}}$$

What is the speed of waves shown in the graph if the wave period is five seconds? __________

Post-Lab Questions:

1. How do the wave motions differ on your graph?

2. If these were real water waves, what might be the cause(s) of the different motions?

3. How is the action of the slinky similar to wave movement in water?

4. The commercial fishing industry is an important part of the California Agriculture industry and contributes to California's economy. Why is an understanding of wave motion important to fishermen?

5. Application: Using the internet or other available resources, investigate how much the commercial fishing industry contributes to the state economy.

[i] Prescott, Diane (2008).Wave Motion, Lab. *Atwater High School*.

Earth Sciences Standards

7. Each element on Earth moves among reservoirs, which exist in the solid earth, in oceans, in the atmosphere, and within and among organisms as part of biogeochemical cycles. As a basis for understanding this concept
    a. Students know the carbon cycle of photosynthesis and respiration and the nitrogen cycle.
    b. Students know the global carbon cycle: the different physical and chemical forms of carbon in the atmosphere, oceans, biomass, fossil fuels, and the movement of carbon among these reservoirs.
    c. Students know the movement of matter among reservoirs is driven by Earth's internal and external sources of energy.
    d. * Students know the relative residence times and flow characteristics of carbon in and out of its different reservoirs.

Lab Reference: Biogeochemical Cycles

Standards: 7a-d

STANDARD CONCEPT	LAB NAME	LAB NUMBER
Carbon Cycle	Dinosaur Breath	D-1
Element Cycles	Hyperlink Habitats	D-2
Nitrogen Cycle	Farming Nitrogen	D-3
Rock Cycle	Modeling the Rock Cycle	D-4
Soils	Elementary Study of Soils	D-5
Soils	Soil Permeability	D-6
Water	Water Conservation	D-7
Water Cycle	The Water Cycle and The Environment	D-8
Weathering	Causes of Weathering	D-9
Weathering	Effect of Temperature on Chemical Weathering	D-10
Weathering	Weathering and Erosion Picture	D-11

Earth Science Standards

- (ES) 7.b and 7.c.

Agriculture Standards

- (AG) C 1.5, C 2.3, C 13.3, E 1.1, and E 12.3.
- (Foundation) 2.1 Reading, Specific Applications of Reading Comprehension--Grades 9-10: (2.1) and (2.6).
- (Foundation) 5.3 Critical Thinking Skills.

Name____________________

Date_____________________

Dinosaur Breath

Purpose

The purpose of this lab is to study the effects of the carbon cycle. To do this, we will learn about the role of dinosaurs in the carbon cycle, the eventual storage of excess carbon in the form of chalk, and why the carbon cycle is important.[i]

Procedure

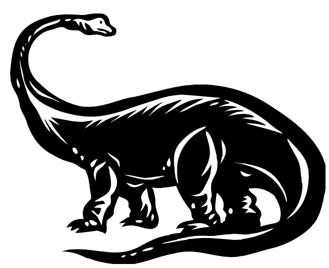
Materials

1. Crushed chalk (do not use dustless chalk)
2. Vinegar
3. Beaker or glass jar
4. Diagram of Carbon Cycle

Sequence of Steps

1. Read the background information and highlight important information.
2. Refer to your Carbon Cycle diagram and determine where the dinosaurs may have stored carbon within their bodies. Record your predictions in “observations”.
3. Crush a piece of chalk so that it is in “dust” form and place in your beaker.
4. Pour 20mL of vinegar over the chalk. Record your observations.

Background Information



All animals, including dinosaurs of Jurassic times and humans, are part of the carbon cycle. By eating food, animals gain carbon in the form of carbohydrates and proteins. In each of our cells, oxygen combines with food to give energy for daily activity. Carbon dioxide, a waste product of this cellular metabolism, is released back into the atmosphere when we exhale or breathe.

Some of the carbon dioxide in the atmosphere dissolves and is stored in ocean waters. The oceans act as a storage place or “sink” for carbon.

Many organisms living in the ocean use the dissolved carbon dioxide to make calcium carbonate ($CaCO_3$) shells. Some of these organisms are large and easy to see (for example, clams and snails), but most of the carbonate shells are produced by the microscopic creatures called plankton.

Floating in all the oceans of the world, plankton absorb vast quantities of carbon in their shell-building activities. They do not live long though! In some places, when they die, their shells fall to the bottom of the ocean floor to form sediments of limestone and chalk.

Raised above sea level by tectonic activity, the sediment often forms large rock formations. The white cliffs of Dover are gigantic chalk cliffs originally formed from these types of sediment. Natural chalk is mined from such formations. Much of the chalk sold today is 'dustless' chalk, which is synthetic and NOT composed of natural carbonate. Dustless chalk will not work in this demonstration.

Observations

1. Based on your observations, where do you think the dinosaurs may have stored carbon within their bodies? What form is the stored carbon?

2. Where did the carbon go after it was exhaled?

3. What happened when you poured the vinegar over the chalk? What was released?

4. How is the carbon dioxide released compared to dinosaur breath?

5. Explain, in your own words, the process of the carbon cycle.

6. Why is it conceivable that dinosaur breath was released when vinegar was added to chalk?

7. Why does carbon combine with so many different molecules in the carbon cycle?

8. Describe or draw the carbon pathway using your favorite dinosaur (herbivore or carnivore). Start from the dinosaur to the shell of a marine organism (label it) and then move to chalk. **Show at least 6 steps that carbon must travel through.**

9. Agricultural Application: Did you know that diamonds and graphite are made from carbon? Mining natural resources is an important sector of the agriculture industry. Brainstorm below products which can be made from these 2 carbon containing minerals:

Diamonds

Graphite

[i] Prescott, Diane (2008).Dinosaur Breath. *Atwater High School Ag Dept.*

Earth Science Standards	•(ES) 7.a, 7.b, and 7.c.
Agriculture Standards	•(AG) C 2.1, C 2.3, E 1.1, E 1.4, and E 1.5. •(Foundation) 2.1 Reading, Specific Applications of Reading Comprehension--Grades 9-10: (2.1) and (2.6). •(Foundation) 2.2 Writing, Specific Applications of Writing Strategies and Applications--Grades 9-10: (1.2), (1.3), (2.3b), and (2.3f). •(Foundation) 5.3 Critical Thinking Skills.

Name____________________

Date_____________________

Hyperlink Habitats

Purpose

The purpose of this lab is to explore the interconnectedness of a tropical rainforest ecosystem. You will understand a variety of concepts related to ecosystems and the relationships between the water, carbon & nitrogen cycles. You will also create a map of the Hyperlink Habitat illustrating the relationships among various elements in the nutrient cycles.[i]

Procedure

Materials

1. Internet Connection
2. Blank paper

Sequence of Steps

1. Complete pre-lab questions.
2. Type in the website: http://school.discovery.com/lessonplans/activities/hyperlinkhabitat/#
3. You need to now click on the underlined link in the first procedure paragraph: Hyperlink Habitat
4. A small information box will come up and give you information about a tropical rainforest. You need to read all this information and click on every link until no links are "blue" any longer.
5. When you have finished researching, you will need to create a map illustrating how the 10 tropical rainforest elements you researched are interconnected. Use a two-way arrow for mutualism relationships. Use a one-way arrow for other relationships with the arrow pointed at the organism that is either not affected or negatively affected.
6. Your map needs to include the following 10 elements:
   - ✓ Soil & Nutrient Cycle
   - ✓ Ants
   - ✓ Photosynthesis
   - ✓ Canopy Trees
   - ✓ Water Cycle
   - ✓ Indians
   - ✓ Frogs
   - ✓ Bromeliads
   - ✓ Monkeys
   - ✓ Deforestation

7. Please title your map “The Tropical Rainforest”.
    - ✓ Put a star next to each element that is involved in the **carbon cycle**.☆
    - ✓ <u>Underline</u> the elements that are involved with the **water cycle**.
    - ✓ Circle the elements that are involved in the **Nitrogen** cycle. ○
    - ✓ (Some elements may be involved in more than one cycle, or all three!)
8. When you finish drawing your Habitat map, please show your instructor and then get the “official” copy of the map.
9. Compare your map to the actual Habitat map for the Tropical Rainforest. Note any differences between the two and why they may be different.
10. Next you will create a new Habitat map using the same techniques for the Ecosystem in which you live! (Think of your environment and the interconnectedness that you see or experience each day.) You may create your map either on the computer or by hand.
11. List 10 different elements for your ecosystem. Remember that you need to include elements that are part of the carbon, water, or nitrogen cycles!! You may use the computer to research these elements if you need more information for your ecosystem.
12. Using your 10 elements, create your own Habitat map on a separate sheet of paper, including the arrows and identifying characters for the various biogeochemical cycles (star, circle, or underline). Be sure to include a title of your ecosystem on your Habitat map.

13. Complete the Analysis & Conclusions section.

Pre-lab Questions

1. What nutrient cycles will you find in a tropical rainforest?

2. How would plant and animal species in a rainforest be interconnected?

3. What effects would different species have on one another, if any?

4. Define the following terms:
    a. Parasitism

    b. Mutualism

    c. Commensalism

Analysis and Conclusions

After your map is complete, write a three-paragraph description of your Habitat map and an explanation of the elements you chose. (Your paper needs to be similar to the explanation you read on the internet for the tropical rainforest.)

Written Paper Requirements:

- ✓ Please bold or underline the elements in your paper that can be found in your Habitat map and include a heading and title.
- ✓ Each paragraph needs to be at least 5 sentences long. (You will be graded on your content and that it explains your Habitat map!)
- ✓ Only use Arial or Times New Roman size 12 point font.
- ✓ Double space your paper.
- ✓ At the end of this lab, you need to turn in your written paper for the Ecosystem you chose, with the Habitat map for that ecosystem stapled to the back.

Written Paper is due: ________________________________

[i] (2008).Hyperlink Habitats. *Atwater High School Ag Dept.*

Earth Science Standards	• (ES) 7.a.
Agriculture Standards	• (AG) C 11.2, C 13.3, and E 1.1. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.d). • (Foundation) 5.3 Critical Thinking Skills.

Name____________________

Date_____________________

Farming Nitrogen

Purpose

The purpose of this lab is to explore the nitrogen cycle by evaluating a farming case study.[i]

Procedure

Materials

1. Case study

Sequence of Steps

1. Read the following background information and highlight important facts.

   Background Information

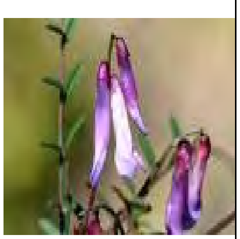
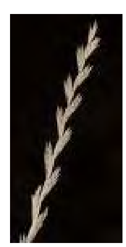
   Sometimes farmers grow crops of rye and other grasses and then plow them under the soil to decay. This farming practice helps to increase crop yields of other plants. Farmers may also plow under legumes such as peas, vetch, and lentils. Legumes are plants that have colonies of nitrogen- fixing bacteria living in nodules on the plant roots.

2. Read the case study and develop your hypothesis:

   Case Study

   In an effort to determine which practice produces the best crop yields, scientists performed an experiment. They grew corn on land that had previously received one of five treatments. Three fields had previously been planted with different legumes. A fourth field had been planted with rye. The fifth field was left bare. All of the fields were then plowed under and corn was planted. None of the fields received a fertilizer treatment while the corn was growing.

Arial View of Fields

Monantha Vetch (Legume)	**Hairy Vetch (legume)**	**Austrian Peas (legume)**	**Rye (grass)**	**No Cover**
				

Hypothesis: Which treatment group will help the main crop grow?

Results: *Below is a table with the results from the experiment. Evaluate the table and answer the questions below.*

Corn Production	
Previous Crop	**Average Yield of Corn (kg/ha)**
Monantha Vetch (legume)	2876
Hairy Vetch (legume)	2870
Austrian Peas (legume)	3159
Rye (grass)	1922
None	1959

1. Compare the effect of growing legumes to that of growing grass on the yield of corn. How do those yields differ from the yield on the field that had received no prior treatment?

2. Which treatment produced the best yield of corn? The worst yield of corn?

3. Based on your knowledge of the nitrogen cycle, how can you explain these results?

[i] Knapp, Beth (2008).Farming Nitrogen, Lab.*Atwater High School Ag Dept*.

Earth Science Standards	•(ES) 7.c.
Agriculture Standards	•(AG) C 10.1, C 13.3, and E 1.1. •(Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a)) and (1.d).

Name____________________

Date_____________________

Modeling the Rock Cycle

Purpose

The purpose of this lab is to model the changes which occur during the rock cycle.[i]

Background Information

The term 'rock cycle' refers to the constant recycling of material in the earth's crust.

- Mountains are worn down by **weathering** and **erosion**, and the pieces of eroded rock may eventually be deposited and form **sedimentary** rocks.
- Sedimentary rocks may become buried and compressed; if they are subjected to heat and pressure, they may be transformed into **metamorphic** rocks.
- Sedimentary rocks may be **uplifted** by movements of the Earth's crust.
- Metamorphic rocks may continue to be uplifted to form mountain ranges, which may be weathered and eroded.
- Metamorphic rocks may sink deeper into the hot mantle, and melt to form **magma**.
- Magma is pushed up towards the crust by pressure and **convection**, eventually cooling and hardening to form **igneous** rock.
- If the magma is pushed out from the crust by volcanic activity it will form **extrusive igneous rock** on the surface.
- If magma cools below the surface it will crystallize into **intrusive igneous rock**.
- Any type of rock may eventually reach the surface as a result of mantle or crust movements, and be weathered and eroded – and the cycle begins again.

Procedure

Materials

1. Sugar cubes
2. Foil
3. Candles
4. Hand lens
5. Goggles
6. Test tube clamps

Sequence of Steps

1. Examine the sugar cube with the hand lens. How is the sugar cube like a sedimentary rock?

2. Crush the sugar cube into a powder. What part of the rock cycle does this represent?

3. Make a boat with your foil. Pour the crushed sugar into the foil boat. What part of the rock cycle does this represent?

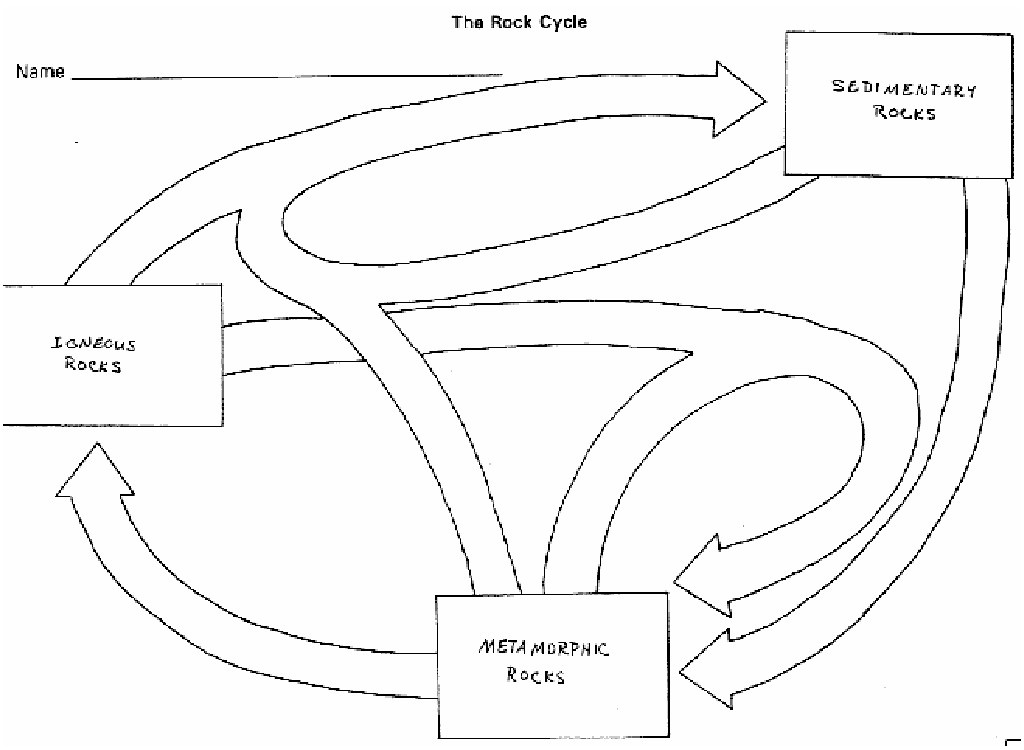
4. Using the test tube clamps to hold the foil boat over the candle flame. Observe as the sugar melts. What part of the rock cycle does this represent?

5. Break the cooled harden sugar into pieces. What part of the rock cycle does this represent?

6. Break the cooled and hardened sugar into pieces. What part of the rock cycle does this represent?

7. What are some observations you made when the sugar was put under a flame?

8. Complete the rock cycle below by labeling and coloring the different arrows.



[i] Prescott, Diane (2008). Modeling the Rock Cycle, Lab. *Atwater High School Ag Dept.*

Earth Science Standards

- (ES) 7.c.

Agriculture Standards

- (AG) C 10.1 and C 13.3.
- (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a), (1.c), and (1.d).

Name____________________

Date_____________________

Elementary Study of Soils

Purpose

The purpose of this lab is to determine soil textural class by feel. [i]

Procedure

Materials

1. Spray bottle filled with water
2. Sink (to wash hands)
3. Paper towels
4. A variety of soil samples

Sequence of Steps

1. Review soil textural class characteristics under “background information”.
2. Complete the following steps, recording observations.
3. Examine the dry soil sample

   (Note: Look for clods and ease of crumbling them between your fingers. Remember soils high in sand are seldom cloddy. Soils high in silt may be cloddy but usually break easily. Clay soils are usually cloddy and are often hard to break.)
4. Take a quantity of soil about the size of a golf ball. Moisten it with water from the spray bottle to the consistency of putty
5. Try to form a ball with the moistened soil sample; then try to form a "ribbon" by working the soil between the thumb and forefinger

   (Note: Soils high in sand feel gritty and ribbon poorly unless also high in clay. Soils high in silt feel smooth or floury. They may also form a short ribbon in varying length depending on the clay content. Soils high in clay can be rolled out into very thin ribbons.)
6. Saturate the soil sample and note staining on the fingers

   (Note: Clay or loam soil is indicated if the moist soil ball stains your fingers.)
7. Compare several soil samples of different textures

   (Note: Compare the amount of grittiness of sand to the smoothness of silt and the stickiness of clay. Sand gives a grinding sound when held close to the ear. Grittiness indicates a sandy soil. Silt is smooth and velvety. Clay is sticky.)

Background Information: Soil Textural Class Characteristics

Sand or loamy sand: Dry--loose, single grained; gritty; no or very weak clods; Moist--gritty; forms easily crumbled ball; does not ribbon; Wet--lacks stickiness, but may show faint clay staining (loamy sand especially); Individual grains can be both seen and felt under all moisture conditions

Sandy loam: Dry--clods break easily; Moist--moderately gritty to gritty; forms balls that withstand careful handling; ribbons very poorly; Wet--definitely stains fingers; may have faint smoothness or stickiness, but grittiness dominates; Individual grains can be seen and felt under nearly all conditions

Loam: This is the most difficult texture to place since characteristics of sand, silt and clay are all present but none predominates; Suggests other textures; Dry--clods slightly difficult to break; somewhat gritty; Moist--forms firm ball; ribbons poorly; may show poor fingerprint; Wet--gritty, smooth and sticky all at same time; Stains fingers

Silt or silt loam: Dry--clods moderately difficult to break and rupture suddenly to a floury powder that clings to fingers; shows fingerprint; Moist--has smooth, slick, velvety or buttery feel; forms firm ball; may ribbon slightly before breaking; shows good fingerprint; Wet--smooth with some stickiness from clay; stains fingers; Grittiness of sand is well masked by other separates; (Texture most like silt loam; there are few silt soils)

Sandy clay loam: Dry--clods break with some difficulty; Moist--forms firm ball that dries moderately hard; forms 1/2" ribbons that hardly sustain own weight; may show poor to good fingerprint; Wet--grittiness of sand and stickiness of clay about equal, masking smoothness of silt; stains fingers

Clay loam: Dry--clods break with difficulty; Moist--forms firm ball that dries moderately hard; ribbons fairly well, but ribbons barely support own weight; shows fair to good fingerprint; Wet--moderately sticky with stickiness dominating over grittiness and smoothness; stains finger

Silty clay loam: Resembles silt loam but with more stickiness of clay; Dry--clods break with difficulty; Moist--shows a good fingerprint; forms a firm ball drying moderately hard; ribbons 1/2" that can be fairly thin; Wet--stains fingers; has sticky-smooth feel with little grittiness of sand

Sandy clay: Dry--often cloddy, clods broken only with extreme pressure; Moist--forms very firm ball, drying quite hard; shows fingerprint; squeezes to thin, long, somewhat gritty ribbon; Wet--stains fingers; clouds water; usually quite sticky and plastic, but has some grittiness present

Silty clay: Dry--see sandy clay; Moist--forms very firm ball becoming quite hard on drying; shows fingerprint; squeezes out to a thin, long, smooth ribbon; Wet--stains fingers; clouds water; stickiness dominates over smoothness, grittiness is virtually absent

Clay: Dry--cloddy, clods often cannot be broken even with extreme pressure; Moist--forms firm, easily molded ball drying very hard; squeezes out to a very thin ribbon 2 to 3 inches long; Wet--

stains fingers, clouds water; usually very sticky with stickiness masking both smoothness and grittiness; wets slowly

Observations

Soil Sample Letter/#	Visual Observations	Ball/Ribbon Test Observations	Staining Observations	Determined Soil Class

1. Describe your results.

2. How does soil textural class affect the movement of matter among reservoirs?

3. Give at least 3 specific reasons why this information is important to agriculturists.

4. What can agriculturists do to alter the soil class in their area?

[i] Kohntopp, John (2008). Elementary Study of Soils. *Elko High School Agriculture Department Elko, NV.*

Earth Science Standards	• (ES) 7.c.
Agriculture Standards	• (AG) C 10.1, C 10.2, and C 13.3. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d).

Name____________________

Date_____________________

Soil Permeability

Purpose

The permeability of soils affects the way groundwater moves. Some soils are highly permeable, while others are not. The purpose of this lab is to determine the permeability of various soils, and draw conclusions about their effect on the movement of water underground. [i]

Procedure

Materials

1. 100mL graduated cylinder
2. Beaker
3. Small funnel
4. 3 pieces of cotton
5. Samples of coarse sand, fine sand, and soil
6. Clock or watch with a second hand

Sequence of Steps

1. Place a small, clean piece of cotton in the neck of the funnel.
2. Fill the funnel above the cotton with coarse sand. Fill the funnel about 2/3rds of the way.
3. Pour water into the graduated cylinder until it reaches the 50mL mark.
4. In the data table, keep track of the time from the second you start to pour the water into the funnel. Measure the amount of time it takes the water to drain through the funnel filled with coarse sand. Using the graduated cylinder, measure the amount of water recovered in the beaker.
5. With the bottom of the funnel over the beaker, pour the water from the graduated cylinder slowly into the sand in the funnel.
6. Record in the data table the time it takes for the water to drain through the sand.
7. Empty and clean the measuring cylinder, funnel, and beaker.
8. Repeat steps 1-7 first using fine sand and then using soil.

Observations

Data Table

	Time Needed for Water to Drain Through Funnel	Water Collected in Beaker (mL)
Coarse Sand		
Fine Sand		
Soil		

1. Of the three materials you tested, which has the greatest permeability? The least permeability?

2. Why were different amounts of water recovered in the beaker for each material tested?

3. What effect would the differences you observed in this lab have on the movement of groundwater through different soils?

4. What factors might affect the accuracy of your results in this experiment? How would repeating each test several times affect your measurements?

[i] Tarbuck, E, & Lutgens, F (2009). *Earth Science*. Boston, MA: Prentice Hall.

Earth Science Standards	•(ES) 7.c.
Agriculture Standards	•(AG) E 1.1, E 2.3, and E 3.2. •(Foundation) 2.1 Reading, Specific Applications of Reading Comprehension--Grades 9-10: (2.1) and (2.6).

Name____________________

Date_____________________

Water Conservation

Purpose

The purpose of this exercise is to study the water cycle and factors which have created water problems. [i]

Procedure

Materials

1. Colored pencils

Sequence of Steps

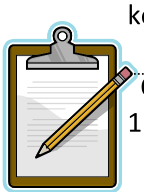
1. Read Background on "The Water Cycle"

Rain, sleet and snow are forms of precipitation. The return of water vapor to the atmosphere is **evaporation**. Together, these processes constitute the **water cycle**. Following precipitation, water may run of the ground and collect in streams, ponds and oceans. This is **surface water**. Some of the water may soak into the ground and reach the water table, enter plant roots, rise through the soil to the surface, or emerge as a spring.

2. The landscape shown in "observations" is a setting for the construction of a diagram of the water cycle. Movement of water will be indicated with arrows; the arrow indicating the direction of movement. The color of the arrow will classify the water as:

- Precipitation (red)
- Surface water (blue)
- Ground water (green)
- Water evaporating and returning to the atmosphere (yellow)

Indicate the kind of water with a letter placed on the arrow, according to the description and key below the water cycle.

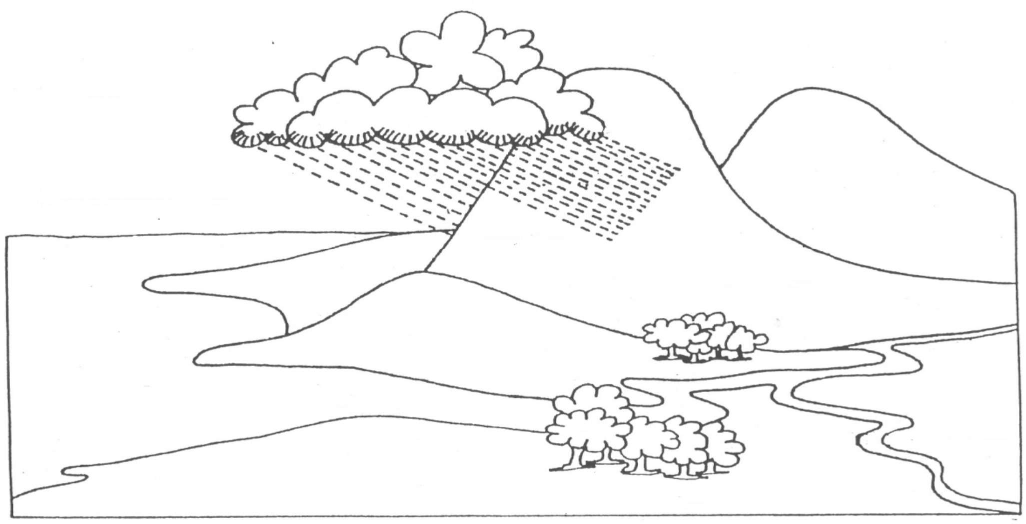


Observations

1. Use the directions above and the key provided to illustrate the diagram of the water cycle on the next page.
   a. Precipitation from cloud to earth (red)
   b. Runoff water to pond (blue)
   c. Surface water stored in pond (blue)
   d. Ground water seeping through soil to water table (green)
   e. Ground water stored at water table (green)
   f. Ground water absorbed by plant roots (green)
   g. Water transpired from leaves to atmosphere (yellow)

h. Water evaporating from soil surface into atmosphere (yellow)
i. Water evaporating from surface of pond (yellow)[ii]

THE WATER CYCLE



Conclusions:

1. What internal/external sources of energy drive the movement of water and matter on the Earth's surface?

2. Explain the problems created by each of the following practices related to water:
   a) Pumping water from deep wells for air-conditioning systems in buildings.

   b) Draining swamps and marshes.

   c) Cutting forests in watershed (hilly) regions.

   d) Cutting bottomlands and flood plains along large rivers.

   e) Losing top soil through erosion.

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[i] Agricultural Biology Curriculum Lesson Plans. Sacramento: California State Department of Education, Agriculture Education Unit, 1990.
[ii] "The Water Cycle." Mordialloc Cluster. 3 Oct 2008 <www.mordiallóccluster.vic.edu.au>.

Earth Science Standards	•(ES) 7.c.
Agriculture Standards	•(AG) C 2.1, C 10.1, C 10.2, C 13.3, and E 1.1. •(Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.d).

Name____________________

Date_____________________

The Water Cycle and the Environment

Purpose

The purpose of this lab is to simulate the water cycle and evaluate the effect of environmental changes.[i]

Background Information

All of the earth's water goes through a cycle in which the water changes its location or physical state through different processes. In accordance with the law of conservation of matter, water is not created or destroyed. It just changes form. Water can be found in all three states of matter during the cycle: solid (ice caps), liquid (lakes) and gas (water vapor).

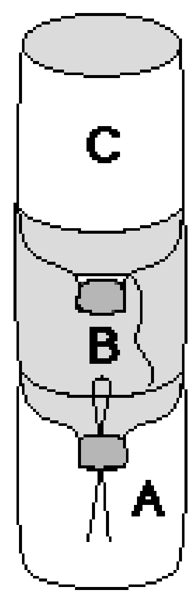
There are five processes by which water moves through the cycle. Water in oceans and lakes evaporates into the air. Cool air in the atmosphere causes this water vapor to condense into a cloud. Precipitation from the cloud falls to the ground as rain, sleet, or snow. The water on the ground percolates through the soil and some of it is absorbed by plants. As the plants go through photosynthesis (converting sunlight, water and carbon dioxide for their own food), they absorb water from the soil and release some of it back into the air through transpiration.

These patterns of change can vary, but the cycle occurs continuously. Water has been cycling by means of these processes since time began.

Procedure

Materials

1. 2-L plastic bottles (3) with caps
2. Water (Warm, room temp, ice)
3. Marker or crayon
4. Scissors
5. Push pin
6. Yarn (60cm)
7. Soil (1 cup or 225 mL)
8. Bean seeds



Sequence of Steps

Set-up

1. Remove labels from your 2 liter bottles (three total) by filling them with very warm water to warm the label's glue.
2. Draw a line with a marker or crayon just below the "shoulder" of bottle A, keeping the line at the same height on the bottle all the way around. (An easy way to do this is by laying the bottle on its side and slowly turning the bottle while you hold the marker tip against it.) Then cut the bottle along this

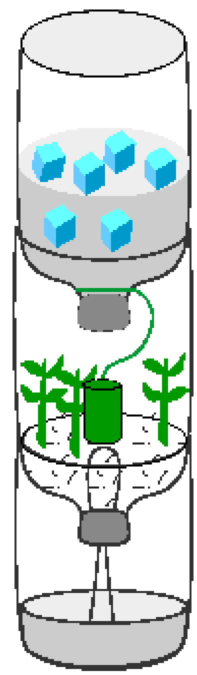
line using scissors. Using the same method, cut bottles B and C just above the "hips".

3. Poke a hole in one cap using a push pin. The hole should be just large enough to thread your string through it. Place that cap on bottle B.

4. Cut a 40 cm length of yarn. Fold the yarn in half and insert the folded end through the cap hole to make a loop inside the bottle. Leave at least 5 cm of each end of the string hanging down from the cap.

5. Place a cap with no hole in it on bottle C. Tie 20 cm of string around the bottle's neck so that one end hangs down about 7 cm.

6. Assemble the containers into a column: B inserts into A; C inserts into B. These three parts of the model will be referred to as "chambers" for the rest of the lab.



Process

1. Wet both strings thoroughly. Add 150 ml of water to chamber A. This will be the water source for your cycle.

2. Fill chamber B with enough moist soil to cover the loop of string (about 1 cup or 225 ml). The string should run up into the soil and not be pressed against the side of the column.

3. Plant several bean seeds in the soil around the sides of chamber B.

4. Leave chamber C off when you are running the water cycle to let air circulate and help the seeds grow.
5. Place the third bottle cap on top of the soil at the center of chamber B so that the end of string tied to chamber C hangs into the cap. This is your rain collector.

6. Place chamber C back on chamber B and fill C with ice water.

Observations

1. What do these three parts in your model represent in the water cycle?

   - The water & ice in chamber C =

   - The cap in chamber B =

   - The water in chamber A =

2. **E**xplain how the following processes are demonstrated in your water cycle column.
    - Evaporation =
    - Transpiration =
    - Condensation =
    - Precipitation =
    - Percolation =

3. Pretend you added acid to the water in chamber A. Does water in other parts of the cycle become acidic? Why?

4. What process would be represented in chamber B if the acid was to move through the water?

5. Name two other environmental changes, in either chamber A or C, which could affect the growth of the plants in chamber B.

[i] Prescott, Diane (2008). Water Cycles' Environment. *Atwater High School Ag Dept.*

Earth Science Standards	• (ES) 7.c.
Agriculture Standards	• (AG) C 2.1, C 2.2, C 10.1, and C 13.3. • (Foundation) 5.3 Critical Thinking Skills.

Name____________________

Date_____________________

Causes of Weathering

Purpose

The purpose of this lab is to evaluate the cause of weathering and the effect agricultural production has on weathering.[i]

Procedure

Materials

1. 1-L Plastic container with lid
2. Rocks
3. Water
4. Strainer
5. Clear glass jar
6. Hand lens

Sequence of Steps

1. Fill a 1-L plastic container about half full of rocks. Add enough water to barely cover the rocks.
2. Place a tight-fitting lid on the container and shake the container vigorously 100 times.
3. Hold a strainer over a clear glass jar. Pour the water and rocks into the strainer.
4. Use a hand lens to observe the bottom and sides of the empty container. Then use the hand lens to observe the water in the glass jar.

Observations

1. What did you see on the bottom or sides of the empty container during Step 4?

2. How did shaking the rock-and-water mixture change the appearance of the water?

3. How do you think your observations would change if you put the rocks and water back in the container and repeated Steps 2 through 4 several more times?

4. Suppose you found a stream where water ran over a rock ledge into a pool. What would you expect to find at the bottom of the pool?

5. In your own words, describe the process of weathering.

6. Agriculturists use water for many purposes, including irrigating fields and cleaning facilities or equipment.
    a. Could this cause weathering?

    b. What else could excess water run-off cause?

    c. How might surrounding soil, used for planting crops, be affected?

7. Agriculturists are committed to the environment. What do you suppose agriculturists currently do, and what could they do in the future, to effectively manage water use?

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[i] Tarbuck, E, & Lutgens, F (2009). *Earth Science*.Boston, MA: Prentice Hall.

Earth Science Standards	• (ES) 7.c.
Agriculture Standards	• (AG) C 2.1, C 13.3, and E 1.1. • (Foundation) 1.1 Mathematics, Specific Applications of Probability and Statistics: (8.0)

Name____________________

Date_____________________

Effect of Temperature on Chemical Weathering

Purpose

Water is the most important agent of chemical weathering. One way water promotes chemical weathering is by reacting with the minerals in rocks. The purpose of this lab is to examine the effect of temperature on chemical weathering by measuring the rate at which antacid tablets dissolve in water at different temperatures. These tablets contain calcium carbonate, the mineral found in rocks such as limestone and marble.[i]

Procedure

Materials

1. 250-ml beaker
2. Thermometer
3. Hot water
4. Ice
5. 5 antacid tablets
6. Stopwatch
7. Graph paper

Sequence of Steps

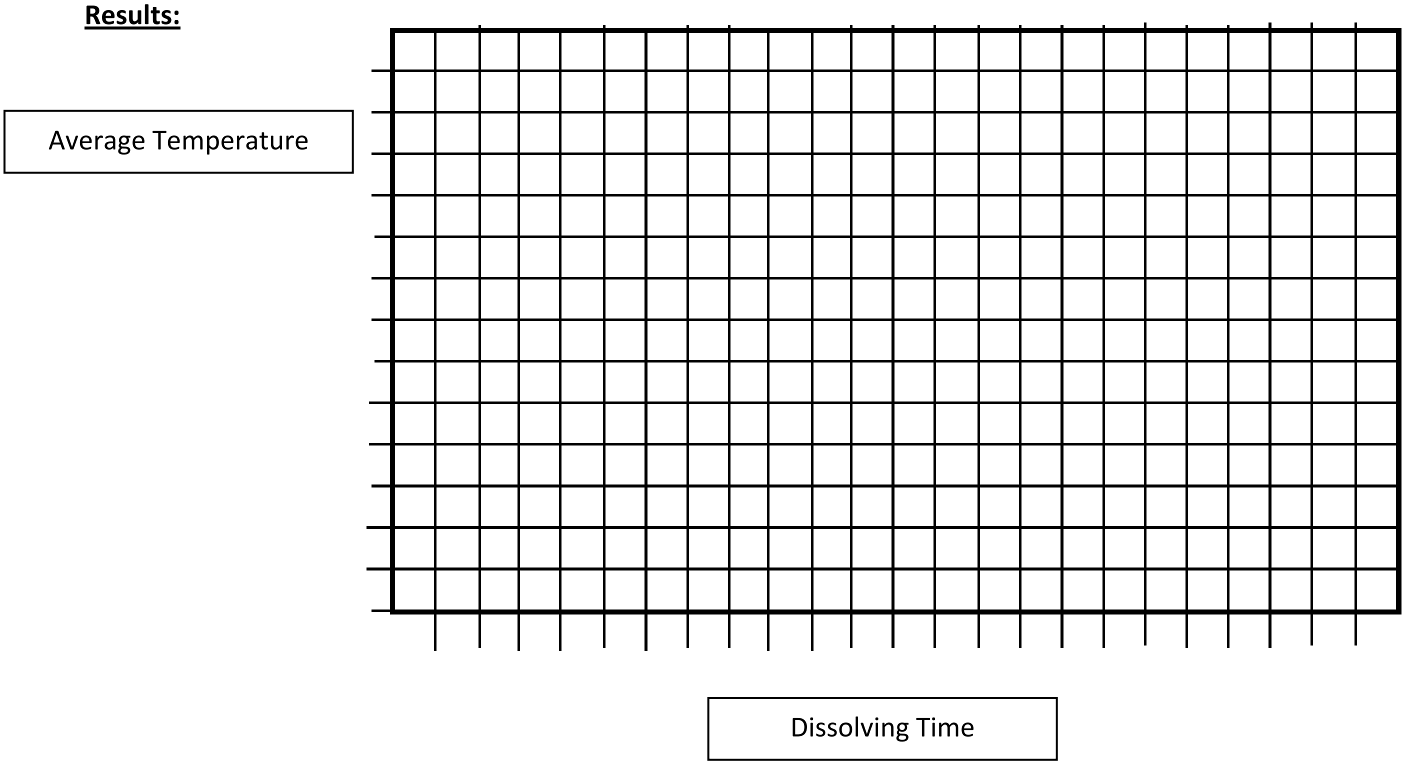
1. Add a mixture of hot water and ice to the beaker.
2. Use the thermometer to measure the temperature of the mixture and record.
3. Add either more hot water or more ice until the temperature is between 0 degrees C and 10 degrees C. The total volume of the mixture should be about 200mL.
4. When the temperature is within the correct range, remove any remaining ice from the beaker.
5. Record the starting temperature of the water in your data table.
6. Remove the thermometer from the beaker.
7. Start the stopwatch as soon as the tablet enters the water.
8. Drop an antacid tablet into the beaker.
9. Stop the stopwatch when the tablet has completely dissolved and no traces of the tablet are visible. (Don't wait for the bubbling to stop.)
10. Record the time in your data table.
11. Place the thermometer in the beaker and wait for the temperature of the water to stabilize.
12. Record the final temperature of the water in your data table.
13. Calculate the average temperature by adding the starting and final temperatures and dividing by 2.
14. Record the result in your data table.

15. Repeat Steps 2 through 6 four more times, once at each of the following temperature ranges: 10-20 degrees C, 20-30 degrees C, 30-40 degrees C, and 40-50 degrees C.
16. Adjust the relative amounts of hot water and ice to produce the correct water temperatures. The total volume of water and ice should always by about 200mL.
17. On the graph, plot your data.
18. Draw a smooth curve through the data points.

Data:

Starting Temperature (C)	*Dissolving Time*	*Final Temperature (C)*	*Average Temperature (C)*

Results:



Conclusion:

1. At which temperature did the antacid tablet dissolve most rapidly?

2. At which temperature did the antacid tablet dissolve most slowly?

3. What is the relationship between temperature and the rate at which antacid tablets react with water?

4. Would a limestone building weather more rapidly in Homer, Alaska, or in Honolulu, HI? (Both cities receive about the same amount of precipitation in an average.) Explain your reasoning.

Additional Resources:

- http://geography.sierra.cc.ca.us/Booth/Physical/chp15_gradation/denudation.htm
- http://library.thinkquest.org/20035/chemical.htm
- http://wardsci.com WARDS's Natural Science

[i] Rangel, Maria (2008). Effect of Temperature on Chemical Weathering. *Holtville High School Agriculture Department.*

Earth Science Standards

- (ES) 7.c.

Agriculture Standards

- (AG) C 2.1, G 6.4 and G 7.1.

Name____________________

Date_____________________

Weathering and Erosion Picture

Purpose

The purpose of this lab is to illustrate key terms associated with weathering and erosion.[i]

Procedure

Materials

1. Blank sheet of paper
2. Colored pens/pencils/crayons
3. Earth science notes or text

Sequence of Steps

1. On a blank piece of paper, write "Weathering and Erosion" on the top.
2. Listed below are important vocabulary words from this section. Create a poster that includes illustrations (pictures) showing each of the vocabulary words. Label each picture with the corresponding vocabulary word.
3. On the back of the page, define all vocabulary terms.

Vocabulary Terms to Illustrate:

Weathering
Erosion
Mechanical Weathering
Deposition
Physical Weathering
Rill erosion
Frost wedging
Gully erosion
Exfoliation
Chemical Weathering
Hydrolysis
Oxidation

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[i] Galan, Daniel (2008).Weathering & Erosion Picture. *Calexico High School Ag Dept.*

Earth Sciences Standards

8. Life has changed Earth's atmosphere, and changes in the atmosphere affect conditions for life. As a basis for understanding this concept:
   a. Students know the thermal structure and chemical composition of the atmosphere.
   b. Students know how the composition of Earth's atmosphere has evolved over geologic time and know the effect of outgassing, the variations of carbon dioxide concentration, and the origin of atmospheric oxygen.
   c. Students know the location of the ozone layer in the upper atmosphere, its role in absorbing ultraviolet radiation, and the way in which this layer varies both naturally and in response to human activities

Lab Reference: Structure & Composition of the Atmosphere

Standards: 8a-c

STANDARD CONCEPT	LAB NAME	LAB NUMBER
Atmosphere	Air Quality: Changing The Percentage of Oxygen	E-1
Atmosphere	The Effect of Humans on the Atmosphere	E-2
Ozone	Ozone Detection	E-3

Earth Science Standards	• (ES) 8.a.
Agriculture Standards	• (AG) C 2.1, C 9.2, and C 13.3. • (Foundation) 5.3 Critical Thinking Skills.

Name____________________

Date_____________________

Air Quality: Changing the Percentage of Oxygen

Purpose

The purpose of this lab is to observe how percentages of elements in the air can be altered. This activity is being accomplished by comparing the Mycoplasma bacterial growth in an anaerobic environment to the bacterial growth in an aerobic environment. The anaerobic environment is made by evacuating the oxygen in a closed chamber.

In this demonstration the objective is to lower the percent of oxygen to enhance the growth of the anaerobic bacteria, *Mycoplasma mastitis*. [1]

Procedure

Materials

The teacher will demonstrate this lab for you. Your responsibility is to observe and record your observations.

You need:

1. Stopwatch
2. Pen/Pencil

Your teacher needs:

1. 2 Glass jars, one with a metal or plastic lid (if using plastic, use a gallon jar)!
2. 2 Small two-inch candles
3. Matches (Long fireplace matches if you are using a gallon jar).
4. 2 fresh or frozen milk samples from a dairy
5. An incubator, oven, or a very warm room
6. 2 inoculating loops

Sequence of Steps

1. Complete Background information before lab demonstration:

Key words to know:

Anaerobic ____

[1] Dickson, Chris (2008).Lab for Unit 7; Changing the Percentage of Oxygen Found in the Air. *North High School Ag Dept*.

Aerobic ____

Key information to know:

Percent nitrogen in the air _________%

Percent oxygen in the air _________%

Examples of two bacteria that live in anaerobic environments:

a. ___________________________

b. ___________________________

Examples of food processed in anaerobic environments:

a. ___________________________

b. ___________________________

What is Mycoplasma mastitis? ____

____

____

2. Observe lab demonstrated by your teacher. Record your observations below.

Observations

1. What size jar was used in this demonstration? _________________________

2. How many seconds did it take for the flame to use the oxygen in the sealed chamber?

   __________ seconds

3. How many colonies of Mycoplasma could be observed before incubation?

   a. In the sealed chamber (anaerobic environment) ______________

   b. In the open chamber aerobic environment) _______________

4. How many colonies of Mycoplasma could be observed 24-hours after incubation?

a. In the sealed chamber (anaerobic environment) ______________

b. In the open chamber aerobic environment) _______________

5. 5. How many colonies of Mycoplasma could be observed 48-hours after incubation?

   a. In the sealed chamber (anaerobic environment) ______________

   b. In the open chamber aerobic environment) _______________

6. Did the data support the objective that more colonies would grow in the anaerobic environment? ___________

7. If the data rejected the objective that more colonies would grow in the anaerobic environment, what might be the reason? ____________________

   ____

   ____.

Teacher's Lab Guide:

Changing the Percentage of Oxygen Found in Air

SPECIAL SAFETY INSTRUCTIONS

- Latex gloves are required to set up the following demonstration. Check with your administration as to their procedures for discarding the milk samples after the completion of the demonstration.

TIME REQUIRED FOR THIS DEMONSTRATION:

- The set up time will take about 5 minutes to streak the plates (Petri dishes). If you are using frozen milk samples, allow time for them to thaw prior to streaking.
- Class time for the demonstration will take about 5 minutes. The student background questions can take up to 30 minutes prior to actually showing how oxygen is removed from the air.
- 2^{nd} and 3^{rd} day observations will take about 10 minutes.

BACKGROUND INFORMATION:

There are many ways our atmosphere is altered. Most often we think that any change in the percent of the elements that make up 'air' is a negative activity. Many organisms require an atmosphere different than the macro-atmosphere we use to breathe. Examples include certain bacteria such as botulism and tetanus.

The first human to modify the air was an Arab nomad who inadvertently made cheese when he filled his saddlebag with milk to feed himself during a journey across the desert. The movement of the horse separated the curds and whey in the milk. The desert sun provided the heat (incubation) and rennin (an enzyme) was readily available from the saddlebag (made from the stomach of a young animal). Historians believe this first processing of food occurred at the time animals began being domesticated by man (circa 9,000 B.C.).

PURPOSE OF THE DEMONSTRATION:

This lab is to demonstrate (in a relatively short time period – three 10-minute days) the altering of the percentage of oxygen in the air.

In this demonstration the objective is to lower the percent of oxygen to enhance the growth of anaerobic bacteria, *Mycoplasma mastitis*.

MATERIALS NEEDED:

- 2 Glass jars, one with a metal or plastic lid (if using plastic, use a gallon jar)!
- 2 Small two-inch candles
- Matches (Long fireplace matches if you are using a gallon jar).
- 2 fresh or frozen milk samples from a dairy (a food-animal veterinary *with whom you have a rapport*, can give you a milk samples; Petri dishes and *Mycoplasma spp* media. (*Mycoplasma* spp. will not grow on blood agar incubated aerobically).
- An incubator, oven, or a very warm room
- 2 inoculating loops

PROCEDURE

- Streak the Petri dishes (plates) using inoculating loops just prior to the beginning of class. (Students will be focused on streaking techniques instead of evacuating oxygen if you streak the plates as part of the class demonstration).
- To attain an oxygen-free (or almost oxygen-free) environment, place one of the streaked Petri dishes in one of the glass gallon jars, the second dish in the other jar.
- Place a 2 inch candle in one of the jars.
- Light the candle and seal the jar with the plastic or metal lid.
- Students should observe the lighted candle extinguish itself once the oxygen in the air in the environment of the sealed jar is used. (The question may be asked, 'what takes the place of the 21% of the air that was just burned?' *Suggested answer*: An actual vacuum was formed, although very small because of the size of the container.
- The second jar is not sealed.
- Place the two jars in an incubator at 90^{o}F for 24-48 hours (or oven, or wrap the jar in a blanket and put in a box and leave it in the sun).
- The colonies of *Mycoplasma* spp. will have a fried-egg appearance.
- Predicted outcome – The sample from the somewhat anaerobic environment should have many more and possible larger colonies than the sample from the aerobic environment.

STUDENT HANDOUT

Key words to know:

Anaerobic: <u>in the absence of oxygen</u>

Aerobic : <u>in the presence of oxygen</u>

Background information:

Percent nitrogen in the air: <u>21%</u>

Percent oxygen in the air: <u>78%</u>

Examples of two bacteria that live in anaerobic environments:

c. *Clostridium tetani* (tetanus)
d. *Clostridium botulinum* (botulism)

Examples of food processed in anaerobic environments:

a. cheese
b. sauerkraut

What is Mycoplasma mastitis? *Mycoplasma bovis* is the most common bacteria causing mastitis-like signs. It is highly contagious, and apparently harbors in the respiratory tract of the bovine.

Purpose – This lab is to observe how percentages of elements in the air can be altered.

This activity is being accomplished by comparing the Mycoplasma bacterial growth in an anaerobic environment to the bacterial growth in an aerobic environment. The anaerobic environment is made by evacuating the oxygen in a closed chamber with the use of a candle. In this demonstration the objective is to lower the percent of oxygen to enhance the growth of the aerobic bacteria, *Mycoplasma mastitis*.

Materials Needed

- (The instructor will demonstrate this lab). Your responsibility is to observe and record your observations.
- Stop watch or second hand
- Pen or pencil

Observations

1. What size jar was used in this demonstration? gallon – quart - pint
2. How many seconds did it take for the flame to use the oxygen in the sealed chamber? varies seconds
3. How many colonies of Mycoplasma could be observed before incubation?
    a. In the sealed chamber (anaerobic environment) 0
    b. In the open chamber aerobic environment) 0
4. How many colonies of Mycoplasma could be observed 24-hours after

incubation?

a. In the sealed chamber (anaerobic environment) _______________

b. In the open chamber aerobic environment) ________________

5. 5. How many colonies of Mycoplasma could be observed 48-hours after incubation?

a. In the sealed chamber (anaerobic environment) _______________

b. In the open chamber (aerobic environment) ________________

6. Did the data support the objective that more colonies would grow in the anaerobic environment? ____________

7. If the data rejected the objective that more colonies would grow in the anaerobic environment, what might be the reason? Could be that the jar was not sealed tightly enough, could be that we are seeing colonies of aerobic bacteria (some other bacteria growing).

Earth Science Standards

- (ES) 8.a and 8.b.

Agriculture Standards

- (AG) C 2.1.
- (Foundation) 1.1 Mathematics, Specific Applications of Algebra I: (10.0), (12.0), and (15.0).
- (Foundation) 2.2 Writing, Specific Applications of Writing Strategies and Applications--Grades 9-10: (1.2), (1.3), (2.3b), and (2.3f).
- (Foundation) 5.3 Critical Thinking Skills.

Name____________________

Date_____________________

The Effect of Humans on the Atmosphere

Purpose

The purpose of this lab is to increase understanding of ways to reduce the greenhouse effect.[i]

Background Information

Although you may understand the cause and effects of global warming due to the greenhouse effect, you may not establish the connection between your own behavior and its impact on the atmosphere!! By keeping a "CO_2 Journal", you will establish this connection, while at the same time, discovering what you can do to reduce global warming as part of society.

Procedure

Materials

Sequence of Steps

1. Respond to the pre-lab questions below.
2. For one week, you will determine your amounts of carbon dioxide production in daily activities.
3. Each day, you need to record your daily transportation, home energy, and waste behaviors. Write your numbers in the Carbon Dioxide Journal. Some of the information for your journal can be found in your home utility bills, cars, school bus odometers, and maps.
4. When a week is up, total your amounts, and record them on the Carbon Dioxide Calculations page. Calculate an estimate of your direct carbon dioxide emissions. Remember, this is only an estimate! Many things are assumed such as, all members of your household use energy equally and that production of electricity uses an average ratio of fossil fuels to nuclear and renewable sources.
5. On the calculations sheet, determine the lbs of carbon dioxide that you used for each source. Then add them up to determine the total weekly direct carbon dioxide emissions released by you! Write this in the "totals" section.
6. Multiply the total for your week by 52 since there are 52 weeks in a year to determine how much carbon dioxide you would emit annually.
7. Use your annual emissions value to determine the amount of indirect production of carbon dioxide you release in one year. These indirect emissions include everything from the energy needed to make your pencil, to the fuel used to go purchase your groceries! Typically, your indirect production of carbon dioxide is roughly equal to you direct production.

8. Compare your total carbon dioxide emissions with the global average! Even if you are less than the average, it still might not be low enough to stop global warming!
9. Use this information to determine ways that you can reduce your emissions of carbon dioxide and help stabilize our atmosphere!

Pre-Lab Questions

1. What is the greenhouse effect? Describe and list at least 3 facts you know about the greenhouse effect.

2. What is the chemical composition of the atmosphere?

3. How has the composition of Earth's atmosphere evolved (changed) over geologic time?

Carbon Dioxide Journal

Car Mileage

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday

Bus Mileage

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday

Train/Subway Mileage

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday

Home Energy – Check Your Family's Utility Bills!!!

Kilowatt-hours used in one month	
Hundreds of cubic feet of gas used in one month	
Gallons of heating oil used in one month	
Pounds of trash thrown away in one week	
Pounds of trash recycled in one week	

Carbon Dioxide Calculations

TRANSPORTATION

By Car

a) Miles traveled during the week: _______
b) Miles per gallon of that car: _______
c) Gallons of gasoline used (a ÷ b): _______ x 22 lbs / gal = _______ lbs CO_2

By Bus

a) Miles traveled during the week: _______ x 0.7 lbs / mile = _______ lbs CO_2

By Train or Subway

a) Miles traveled during the week: _______ x 0.6 lbs / mile = _______ lbs CO_2

HOME ENERGY

Electricity

a) Kilowatt-hours of electricity used in a month: _______

b) Kilowatt-hours used in a week (a ÷ 4): _______

c) Kilowatt-hours used per person (b ÷ # of people in household):

_______ x 1.5 lbs / kWh = _______ lbs CO_2

Natural Gas

a) Hundreds of cubic feet of gas (ccf or therms) used in a month: _______

b) Therms used in a week (a ÷ 4): _______

c) Therms used per person (b ÷ # of people in household):

_______ x 11 lbs / Thrm = _______ lbs CO_2

Heating Oil

a) Gallons of heating oil used in a month: _______

b) Gallons used in a week (a ÷ 4): _______

c) Gallons used per person (b ÷ # of people in household):

_______ x 22 lbs / gal = _______ lbs CO_2

Waste

a) Pounds of trash thrown away: _______ x 3 lbs / lb = _______ lbs CO_2

b) Pounds of trash recycled: _______ x 2 lbs / lb = _______ lbs CO_2

TOTALS

a) Total of weekly direct CO_2 emissions: _______ lbs

b) Total annual direct CO_2 emissions (a x 52): _______ lbs

c) Total annual CO_2 emissions (b x 2): _______ lbs

Global Average: 9,000 lbs CO_2 emitted annually!!

Carbon Dioxide Reduction

You are to aim for a 20% reduction in your emissions now that you know how to control them!! Figure out what steps you can take to meet that goal. Try and find ways to cut down. What would be a more efficient way to get around? How could you use less electricity? Less gas? Less oil? And what about recycling more? Write at least one paragraph (10 sentences long) explaining how you can reduce your emissions. Ask your parents, read the newspaper, or look on the Internet if you need to!

Remember… You are partially in control of what affects our atmosphere!

[i] (2008) People Changing the Atmosphere. Atwater High School Agriculture Department.

Earth Science Standards	•(ES) 8.a and 8.c.
Agriculture Standards	•(AG) C 2.1, C 11.5, and C 13.3. •(Foundation) 1.1 Mathematics, Specific Applications of Probability and Statistics: (8.0). •(Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a), (1.d), and (1.l).

Name____________________

Date_____________________

Ozone Detection

Purpose

The purpose of this lab is to determine if ground-level ozone levels can be easily monitored.[i]

Background Information

Ground level ozone, O_3 , is a secondary photochemical pollutant formed by numerous reactions involving VOCs and oxides of nitrogen. It is also produced by lightning, electrical motors, arc welders and by copiers and laser printers. It is a highly reactive oxidizing agent that strips electrons from molecules that it encounters. Obviously when living tissue comes into contact with higher than normal ozone levels serious damage can occur. Lung tissue is especially susceptible to injury. This is why asthmatics are caution to restrict outdoor activity during Ozone Action Days. Crops and trees are also damaged by higher than normal ozone concentrations. Ozone damages cell walls and chlorophyll molecules reducing the capacity of leaves to carry on photosynthesis. The productivity and health of affected crops and trees can be seriously reduced due to foliar damage. Crops most sensitive to ozone damage include soybeans, clover, alfalfa, soybeans, sweet corn, green beans, tomatoes and lettuce. A serious decline in oak and hickory tree health in eastern US has been associated with increased O_3 levels.

While it s difficult for a high school lab to generate and to measure O_3 to study its affects on living tissue; it is relatively easy for students to do a study of ozone levels in and around their homes and school. The data collected can be an excellent introduction to the study of ground-level ozone generation and the problems that it creates. Because ozone levels are highest during the summer months, plan to do this lab then. Or, do it during the summer or early fall and again during the winter to compare results

Students will produce and use Schoenbein (or Schönbein) paper to observe ozone levels. Schoenbein paper is simply a strip of paper coated with a mixture of plant starch and potassium iodide. When the strips are exposed to O_3 and water, a triiodide ion, I3-, is formed which complexes with the starch molecules to produce the reddish-blue color associated with the often used starch-iodine test. The depth of color produced on the strips is matched to a color scale which is corrected for humidity. A reasonably accurate measurement of ozone concentration in parts per million is obtained.

Procedure

Materials

1. potassium iodide
2. distilled water
3. white, unlined paper or filter paper sheets
5. corn starch
6. 250 ml Erlenmeyer flask or beaker

4. large test tubes, 16mm X 150mm (larger or smaller ones will work too)

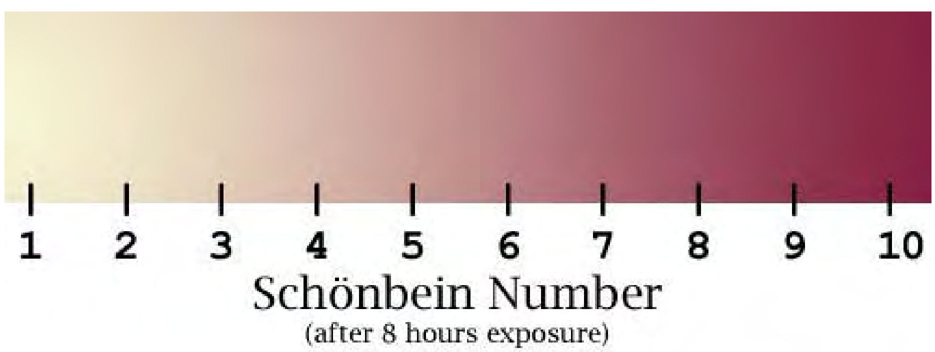
Sequence of Steps

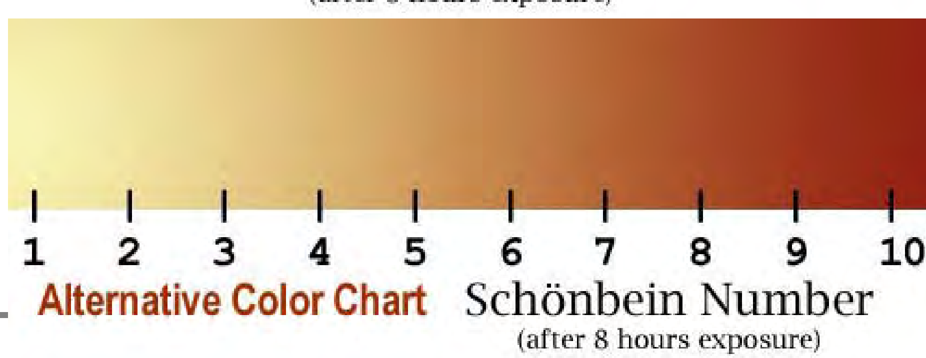
Procedure for making Schoenbein paper

1. Cut the unlined paper into strips just narrow enough to fit into the test tubes. For example, if 16 mm X 150 mm tubes are used, cut the strips 15 mm wide. The strips should be about 20cm long.
2. Make a suspension composed of 200 ml distilled water, 2 teaspoons corn starch, and ½ teaspoon potassium iodide, KI, in a flask or beaker. The starch will not dissolve but the KI will.
3. Pour the suspension into test tubes so that they are half filled.
4. Dip the paper strips into the suspension within the test tubes. Allow them to soak for 5 seconds.
5. Remove the strips and allow them to dry away from sunlight. They can be dried on toweling or hung by clothespins on a line. Students should write their names on the end of the strip that is not coated. Each student should prepare at least two strips.
6. Once the strips are dry, store them in sealed plastic bags in a dark cabinet or drawer.

Ozone testing procedure

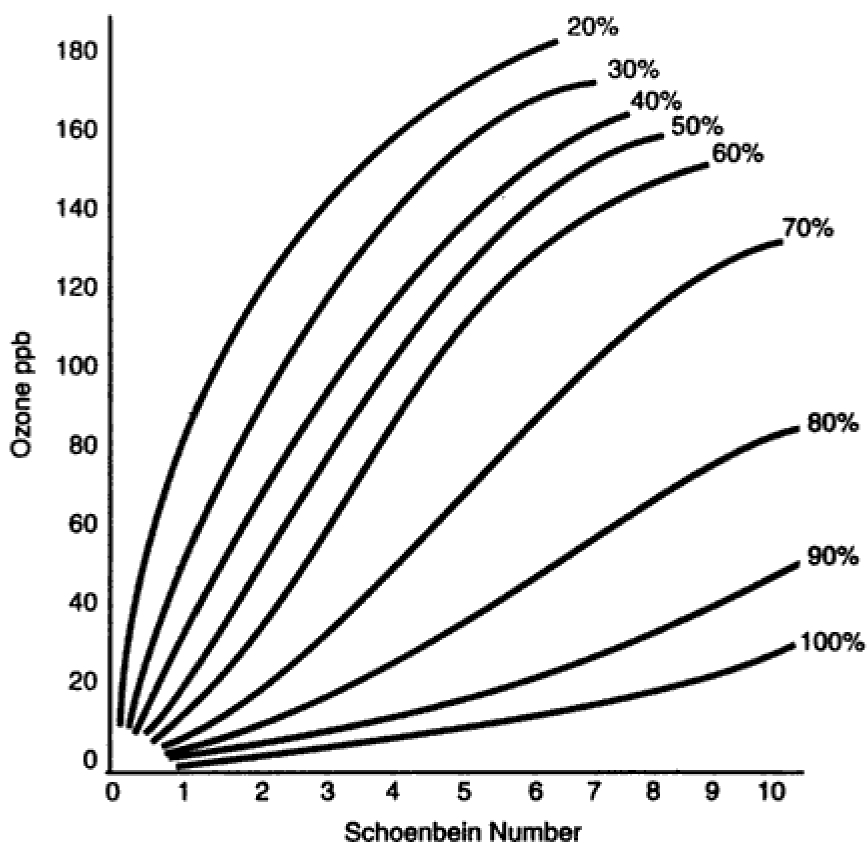
1. Spray the strip with distilled water and hang it, or tape it, or tape it at a place **out of direct sunlight** for about eight hours. Discuss with the class places that might be tested. Sites to consider would be: a corn field, a welding shop; a room where copiers or computers are being used; a parking garage; a school's mechanical room; near a heavily traveled street or highway; in a forested area, classroom, home, or yard.
2. Collect the strips after eight hours and seal them in a plastic bag until the results are read.
3. To read the strips, match their color to either one of the two scales shown below. Choose the one that best matches student results. Record the Schönbein numbers.





5. The values must be corrected for humidity because increased humidity makes the paper more sensitive to ozone and a higher Schoenbein Number would be recorded. The humidity for most localities can be found at any of the many online weather sites such as http://www.weather.com/. Once the humidity is known, use the Relative Humidity Schoenbein Number Chart below to determine the concentration of ozone in parts per million (ppm). From the Schoenbein number on the X axis draw a vertical line to the curve for the humidity of the day of testing. From that intersection, draw a line parallel to the X axis to the Y axis. The value of Y at that point is the approximate ozone concentration.

Relative Humidity Schoenbein Number Chart



Observations

1. Consult weather or news sources for your locality and find the reported ozone level. How do they compare to your numbers?

2. Compare your results with those of your classmates. Do their results differ? Discuss the differences

3. Which sites tested by your classmates yielded the highest values and lowest values? Offer an explanation for those results.

4. Why might the color change be more intense at higher relative humidity?

5. If an outdoor location shows high ozone readings, examine the leaves of plants nearby. Do they show any yellowing, spotting or damage?

6. Discuss this lab. Does it provide useful information? How might it be improved?

7. Plot the numbers collected by your class on a map. Are there any trends evident?

8. Why are ozone concentrations lower in the winter?

9. Were any of the ozone concentrations collected by your class cause for concern because they are high?

10. Ground level ozone pollution is caused by human activities. Make a list of such activities.

Extension

1. Repeat the lab with commercially available ozone test strips or badges. Compare the ozone concentration values.
2. Modify the lab using different kinds of paper and varying types of starch. Compare the results to the original lab.
3. Repeat the lab but don't spray the papers with distilled water. Does it make any difference?
4. Investigate and report on Christian Friedrich Schoenbein who discovered ozone in 1839.
5. Investigate the redox reactions involved in the color change of the strips.
6. Investigate the claim that some indoor plants can remove ozone from the air.
7. Do a survey of ozone damage to milkweed plants.

Links and sources

Schönbein color charts:
http://www.chemistryland.com/CHM107Lab/Lab4/DetectOzone/Lab4Ozone.htm
Relative Humidity Schoenbein Number Chart
http://njnie.dl.stevens-tech.edu/curriculum/norwich/schoenbeinpaper.shtml
Ozone as a pollutant http://www.dnr.state.wi.us/org/caer/ce/eek/earth/air/badozone.htm
http://www.dnr.state.wi.us/org/caer/ce/eek/earth/air/ozone.htm
http://www.eco-systems.org/roleof.htm
Ozone chemistry: http://www.fraqmd.org/OzoneChemistry.htm
http://www.chm.bris.ac.uk/motm/ozone/Low.htm

[i] Ozone Detection. Retrieved December 15, 2008, from Marketplace for the Mind Web site: http://www.marketplaceforthemind.state.pa.us/m4m/lib/m4m/documents/labs/Ozone_Lesson.pdf

Earth Sciences Standards

9. The geology of California underlies the state's wealth of natural resources as well as its natural hazards. As a basis for understanding this concept:
    a. Students know the resources of major economic importance in California and their relation to California's geology.
    b. Students know the principal natural hazards in different California regions and the geologic basis of those hazards.
    c. Students know the importance of water to society, the origins of California's fresh water, and the relationship between supply and need.
    d. * Students know how to analyze published geologic hazard maps of California and know how to use the map's information to identify evidence of geologic events of the past and predict geologic changes in the future.

Lab Reference: California Geology

Standards: 9a-d

STANDARD CONCEPT	LAB NAME	LAB NUMBER
California Geology	Element Project	F-1
California Geology	Modeling Earth's Farmland	F-2
Natural Hazards	California Agriculture Production Map	F-3
Natural Hazards	California Natural Hazards-Picture Book Project	F-4
Natural Hazards	Making Earthquake-safe Buildings	F-5
Water	Managing Water Through Slope and Velocity	F-6
Water	Raindrop Erosion	F-7
Water	What Are Their Water Needs	F-8

Earth Science Standards	• (ES) 2.c and 9.a.
Agriculture Standards	• (AG) C 2.1, 2.2, and 2.3. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d).

Name____________________
Date_____________________

Element Project

Purpose

An element is a substance that cannot be broken down into simpler; stable substances by chemical means. [i] California is rich in many elements, and it is important to understand how elements are categorized using the periodic table. The purpose of this lab is to create a class Periodic Table of the elements, with each student generating one element. [ii]

Procedure

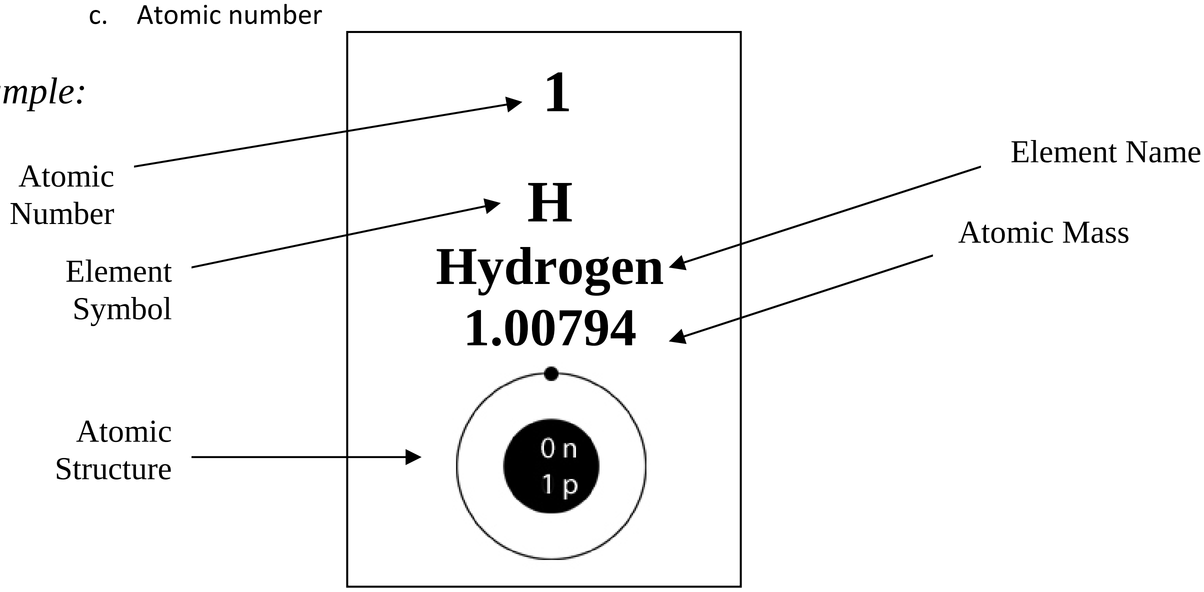
Materials

1. 8 ½ x 11" piece of blank white paper
2. Colored writing pens or pencils
3. Periodic Table for reference in text book or poster

Sequence of Steps

1. Work with your instructor to select an element from the periodic table.
2. On a blank piece of white paper, create your portion of the periodic table for your element including:
   a. Element symbol
   b. Element name
   c. Atomic number
   d. Atomic mass
   e. Diagram of atomic structure

Example:



Observations and Conclusion

1. What evidence do scientists have, which indicates that all elements with an atomic number greater than that of lithium have been formed by nuclear fusion in stars?

2. Identify three elements and indicate their major economic importance to California.

   Element:

   Element:

   Element:

3. Looking at the completed periodic table, make 3 observations relating to the organization and information included in the periodic table.

4. Agriculture Application: What are the symptoms of an excess supply or limited supply of your element in plants or animals?

[i] (2007). *Earth Science*. Holt, Rinehart and Winston: Harcourt Education.
[ii] Galan, Daniel (2008). *Element Project, Lab*. Calexico High School.

Earth Science Standards	• (ES) 9.a.
Agriculture Standards	• (AG) C 2.2. • (Foundation) 1.1 Mathematics, Specific Applications of Algebra I: (10.0), (12.0), and (15.0).

Name____________________

Date_____________________

Modeling Earth's Farmland

Purpose

The purpose of this activity is to identify the importance of farmland and how ecology affects the availability of good farm land.[i]

Procedure

Materials

1. Apple
2. Knife

Sequence of Steps

1. Cut an apple into four quarters and set aside three of the pieces.
2. One quarter of the Earth's surface is land. (This is represented by one of the apple quarters.)
3. The remaining three quarters of the Earth is covered with water. (Represented by the three pieces of apple you set aside.)
4. Slice the remaining quarter that you have in front of you into thirds (three pieces).
5. Set aside two of those three pieces because two thirds of the Earth's land is too hot, too cold, or too mountainous to farm of live on!
6. Calculate how much apple (Earth) you actually have available to farm, and record in "observations".
7. Carefully peel the remaining small piece of apple. This peel represents the usable land surface that must support the entire human population!
8. Complete the questions under "observations" and then clean your lab area.

Observations

1. How much apple (earth) is actually available to farm?

2. What is your initial observation after completing this activity?

3. What may happen if available farmland is converted to other uses?

4. Currently, what industries or other uses are taking over available farmland?

5. How does the ecosystem affect the type of land that is usable for farming? Brainstorm at least three ecological factors that affect production.

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[i] Knapp, Beth (2008).Modeling Earth's Farmland, Lab. *Atwater High School Agriculture Dept*.

Earth Science Standards	• (ES) 9.a.
Agriculture Standards	• (AG) C 1.4 and C 1.5. • (Foundation) 2.4 Specific Applications of Listening and Speaking Strategies and Applications--Grades 9-10: (1.7).

Name____________________

Date_____________________

California Agriculture Production Map

Purpose

The purpose of this exercise is to introduce the major commodities produced in the eight agricultural regions of California, as well as the top ten commodities produced in California. [1]

Procedure

Materials

1. Large CA map cut into 8 regions (1 region per group)
2. Magazines/Newspapers
3. Tape/glue
4. Notes

Sequence of Steps

1. The teacher will provide your group with an agricultural region. Complete the table below for your region only:

Our Production Region:	
Counties	**Major Commodities**

2. Create your collage. Using magazines, newspapers, and any other resources available, create a collage of pictures showing commodities produced in your assigned production region. Glue or tape these pictures to your region poster. Create an illustration for any commodity which cannot be found in the magazine.

[1] Galan, Daniel (2008).Production Regions. *Calexico Agriculture Department*.

3. Prepare for your presentation. Each group will present their information to the class. Be familiar with the commodities you have represented, and identify any of California's top 10 commodities that are produced in your region. Remember, all group member s must participate.

California Agriculture Production Regions

PRODUCTION AREA	COUNTIES	MAJOR COMMODITIES
1. Sacramento Valley	Sutter, Yolo, Butte, Sacramento, Colusa, Glenn, Tehama	Rice, Almonds, Livestock, Tomatoes, Sugar Beets
2. San Joaquin Valley	Fresno, Kern, Tulare, Merced, King, Madera, Stanislaus	Milk, grapes, cotton, almonds, oranges, stone fruit, cattle, alfalfa, poultry
3. Delta	Contra Costa, Solano, San Joaquin	Milk, Asparagus, Vegetables, Corn
4. Central Coast	Monterey, San Benito, Santa Cruz, Ventura, San Luis Obispo, Santa Barbara	Lettuce, lemon, celery, strawberries, broccoli, beef cattle, artichokes, grapes
5. South Coast	Los Angeles, Orange, San Diego, Riverside	Strawberries, oranges, tomatoes, milk, eggs, avocado, nursery
6. North Coast	Mendocino, Sonoma, Humboldt, Del Norte, Santa Clara, San Mateo, Napa`	Wine grapes, timber, nursery, milk, livestock
7. Imperial Valley	Imperial	Dates, lettuce, melons, cattle, alfalfa, cotton, wheat, sugar beets, chickens
8. Mountain	Trinity, Lassen, Modoc, Siskiyou, Mariposa, Plumas, Sierra, Nevada, Placer	Livestock, timber, hay, pasture, Christmas trees, grapes, potatoes

Teacher Reference Page:

On the following page is a map of California divided into 8 agricultural regions. You may wish to enlarge it onto butcher paper for this activity. It can also be used as a transparency or handout for your students. This map contains all of California's counties. In class you will likely have already taught California's top ten commodities. This activity can reinforce the importance of these ten commodities and the numerous other commodities grown in California. Students can gain an appreciation for California's diversity.

Earth Science Standards	• (ES) 9.b.
Agriculture Standards	• (AG) C 1.4, C 1.5, and E9.1. • (Foundation) 2.1 Reading, Specific Applications of Reading Comprehension--Grades 9-10: (2.1) and (2.6). • (Foundation) 2.2 Writing, Specific Applications of Writing Strategies and Applications--Grades 9-10: (1.2), (1.3), (2.3b), and (2.3f). • (Foundation) 5.3 Critical Thinking Skills.

Name____________________

Date_____________________

California Natural Hazards – Picture Book Project

Purpose

The purpose of this lab is to create a picture book covering your assigned California natural hazard.[i] My natural hazard is: ___________________________________

Procedure

Materials

1. Computer/printer if computer generated
2. Construction paper
3. Colored pencils/pens
4. Scissors
5. Notes and additional research information on your specific hazard

Sequence of Steps

1. Review Expectations - Your picture book will be graded on the following criteria:
   - ✓ Completeness of information. Your book address all key points listed below.
   - ✓ Accuracy of information. The information in your book is correct. There are no errors in your information.
   - ✓ Clarity of information. Your picture book is illustrated an easy to read/understand.

2. Review Points to Include – Your book must include the following information:
   - a) Cover page with title.
   - b) Index listing each page and content.
   - c) Description of the natural hazard.
   - d) What does your natural hazard look like?
   - e) What happens (technically or scientifically) when this hazard causes a natural disaster?
   - f) What areas of California are at risk for this type of natural hazard/disaster?
   - g) What conditions create a risk for this natural hazard/disaster to occur?
   - h) What are some consequences of this natural hazard/disaster? (Explain the type of damage that this natural hazard causes.)
   - i) What impact (positive/negative) does this natural hazard/disaster have on agriculture production?

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[i] Prescott, Diane (2008).California Natural Hazards. *Atwater High School Agriculture Department*.

Earth Science Standards	• (ES) 9.b.
Agriculture Standards	• (AG) B 12.0. • (Foundation) 5.3 Critical Thinking Skills.

Name____________________

Date_____________________

Making Earthquake-safe Buildings

Purpose

Evaluate strategies for making buildings earthquake-safe.[i]

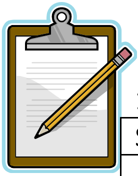
Procedure

Materials

1. Thin pieces of cardboard (7)
2. Sugar cubes
3. Peanut butter, frosting, or double sided tape
4. Small pieces of window screen (4)

Sequence of Steps

1. Construct a model of a one-story brick building using two thin pieces of cardboard as the floor and roof. Use sugar cubes as bricks and peanut butter, frosting or double sided tape to hold the bricks together.
2. Construct a second building. Make this building a two-story structure.
3. To test how well your buildings stand up to a simulated earthquake, place the one story building on a table or desk. Then either drop a large book on the table next to it, or gently shake the edge of the table. Record your observations.
4. Repeat step 3 with the two-story model building. Record your observations.
5. Construct a third building using small pieces of window screen as reinforcement. This building should be a one-story structure. Spread a thin layer of peanut butter or frosting on the inside of the walls and carefully attach pieces of screen to each of the inside walls. Use extra peanut butter or frosting to reinforce the inside corners.
6. Repeat step 3 with the reinforced building. Record your observations.



Observations

1. What happened to each building during the simulated earthquakes?

Single-story, no reinforcement	Two-story, no reinforcement	Single-story, reinforced

1. Compare the amount of earth quake damage in the three model buildings. What conclusions can you make?

2. What causes earthquakes? Explain using complete sentences.

3. Agriculture Application: Earthquakes are a natural hazard in California, and buildings, including agricultural buildings, must be earthquake safe. Agriculture Engineers study how to make structures functional for agriculture production, and safe amidst California's natural hazards. Brainstorm at least 3 agricultural structures which must be made earth-quake safe and write them below. Include the purpose, or function, of the structure as well.
   Ex. Large Greenhouse: Purpose – Protect plants and keep them warm so that they grow quickly.

   a.

   b.

   c.

[i] Tarbuck, E, & Lutgens, F (2009). *Earth Science*. Boston, MA: Prentice Hall.

Earth Science Standards	• (ES) 9.c.
Agriculture Standards	• (AG) C 2.1, C 2.3, C 10.3, C 13.3, and E 2.2. • (Foundation) 1.1 Mathematics, Specific Applications of Algebra I: (1j0.0), (12.0), and (15.0).

Name____________________

Date ____________________

Managing Water through Slope and Velocity

Purpose

The purpose of this exercise is to discover the relation between land slope and water velocity.[i]

Background Information

When water is removed by ditches, grading, or other structures the process is called "surface drainage". Excess surface drainage can lead to erosion problems. A surface drainage system that is designed with this in mind can help control and prevent erosion. Three factors that are important to consider when designing drainage systems are slope, velocity, and stabilization of the waterway.

> Terms to Remember
>
> Slope: The slope of a line is defined as the vertical change (the "rise") over the horizontal change (the "run") as one travels along the line.
>
> Velocity: Speed. Distance travelled per unit time.

Procedure

Materials

1. 4' x 8' rain gutter or equivalent
2. Tape or rule to determine percent slope
3. An apparatus to position gutter to set slopes
4. Ping pong ball
5. Stop watch or other timing device
6. Water

Sequence of Steps

1. Set a gutter to a given slope (rise/run). Calculate the percent slope and record in "observations".
2. Establish a consistent flow of water. Note: flow rate must be the same for each slope.
3. Set ping pong ball float at a given starting point, timing its travel to some predetermined end point. Measure distance between starting and ending points and record in "observations".
4. Using Unit Factor calculations determine the water velocity in feet/minute.
   Ex. ____ ft/minute = ft/sec X 60 sec/min
5. Repeat procedures for additional slopes. Set slopes from 2% to 10%.

Observations

1. Record your starting slope and calculate percent.

Rise _______ / Run__________ = _______% slope

2. Record distance between Start and End Points.

3. Determine the water velocity in ft/minute.

Seconds it took for ping pong ball: ______________

______ ft/_____ seconds ⟶ Simplify to 1 sec ⟶ ______ft/second

_______ft x 60 seconds = _________ft
Second Minute Minute

Data Table A

Slope in %	Time	Calculated Velocity
2%		
4%		
6%		
8%		
10%		

4. Summarize your observations using complete sentences. What did you discover from this experiment?

5. List at least four reasons why water is an important natural resource in California.

6. Agricultural Application: Based on this study, what do agriculturists need to know about how slope effects water velocity?

7. Agricultural Application: Why is this knowledge important to agriculturists? Brainstorm at least 3 reasons why this information is important.

[i] Osborne, Dr. E, & Moss, Dr. J (Eds.). *Physical Science Applications in Agriculture*. Illinois: (FCAE) Facilitating Coordination in Agricultural Education.

Earth Science Standards	• (ES) 9.c.
Agriculture Standards	• (AG) C 2.4, C 10.3, and E 3.2. • (Foundation) 1.1 Mathematics, Specific Applications of Algebra I: (10.0), (12.0), and (15.0). • (Foundation) 1.1 Mathematics, Specific Applications of Geometry: (8.0).

Name____________________

Date ____________________

Raindrop Erosion

Purpose

The purpose of this exercise is to evaluate erosion and factors affecting soil movement by raindrop erosion.[i]

Background Information

Erosion is a significant problem in California and around the world. Erosion causes agricultural land to be less productive, while polluting streams and rivers. When raindrops hit soil they have the potential to cause "raindrop erosion". Progressive agriculturists have implemented conservation practices such as no-till and minimum till to limit raindrop erosion, because of cover from the previous crop remaining in the field.

Procedure

Materials

1. 1" x 1" stakes, white works best (2- 8' long) (1-5' long)
2. Tape measures
3. Crop residue/mulch
4. Rain gauge
5. Sprinkler

Sequence of Steps

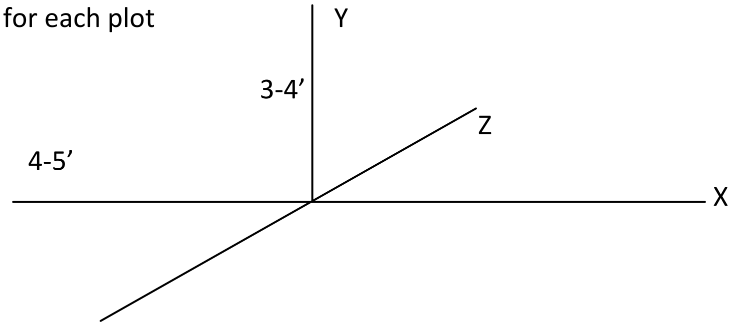
1. Locate test plots approximately 10' by 10'
2. Place the 5' stake in the ground vertically near the center of the plot (3-4' exposed).
3. Place two stakes on the ground perpendicular and adjacent to the vertical stake, forming the x, and z axis (See Figure 1). This will allow 3D measurement of maximum distances soil particles move due to raindrop impact.
4. Set-up additional stakes on other plots having different percentages of crop residue cover.
5. Simulate a rainfall event using a lawn sprinkler or similar device. Intensity may be determined by collecting simulated rainfall in a rain gauge for a given time.

   Ex. _____in/hour = in/min x 60 min/hour

6. Measure and record the maximum distance soil splashed along x, y, and z for each replication (percent residue coverage) for a given simulated rainfall event in Data Table A.
7. Plot maximum splash distance x, y, and z vs. percent residue coverage on graph paper. Interpret the findings.

8. Repeat data collection and analysis for each additional variable studied. (Ex. slope, wind, intensity and duration.)

Figure 1. Stake layout for each plot



Observations

1. What is erosion?

2. How does raindrop impact (force) affect soils and erosion of soils?

Data Table A

Replication	X	Y	Z
_____% residue			
______ % residue			
______% residue			

3. Summarize your observations using complete sentences. What did you discover from this experiment?

4. What effect does vegetative cover (or other variable) have on raindrop erosion?

5. Agricultural Application: Based on this study, what do agriculturists need to know about raindrop erosion?

7. Agricultural Application: Why is this knowledge important to agriculturists? Brainstorm at least 3 reasons why this information is important.

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[i] Osborne, Dr. E, & Moss, Dr. J (Eds.). *Physical Science Applications in Agriculture*. Illinois: (FCAE) Facilitating Coordination in Agricultural Education.

Earth Science Standards	• (ES) 9.c.
Agriculture Standards	• (AG) C 2.4 and E 2.2. • (Foundation) 2.1 Reading, Specific Applications of Reading Comprehension--Grades 9-10: (2.1) and (2.6). • (Foundation) 2.1 Reading, Specific Applications of Reading Comprehension--Grades 11-12: (2.3). • (Foundation) 2.4 Specific Applications of Listening and Speaking Strategies and Applications--Grades 9-10: (1.1), (1.7), (2.2a), (2.2b), (2.2d), and 2.2f). • (Foundation) 5.3 Critical Thinking Skills.

Name____________________

Date ____________________

What are their water needs?

Purpose

The purpose of this exercise is to evaluate the water needs of groups of individuals and how they are affected by delta regulations. [i]

Procedure

Materials

1. Access to information such as internet research, current agricultural publications, newspapers, and magazines.

Sequence of Steps

1. Gather information, including facts and specific examples, and complete Table 1.
2. After Table 1 is complete, your instructor will assign you a specific group to represent such as Central Valley Farmers Association or Save the Delta Association. As a group, your challenge is to prepare for a class debate using the following criteria:

- All members of the group present information.
- Facts, examples, and statistics are shared.
- The presentation is convincing, working to educate other groups about why YOUR GROUP needs water.
- Includes at least 1 visual aid.
- Presentation/debate is between 3-5 minutes in length.

Table 1. Fill in the following information as it relates to each agency listed. Be as specific and thorough as you can. Discuss this information with others in your class and fill in any additional information they were able to come up with that you were not.

AGENCY	Central Valley Farmers Association	Save the Delta Association
WATER NEEDS		
HOW AGENCY BENEFITS OR IS HELPED BY AQUEDUCTS DIVERTING WATER AWAY FROM THE DELTA		
HOW AGENCY IS AFFECTED BY INCREASING WATER FLOW OUT OF THE DELTA		
IS AGENCY IN SUPPORT OF OR IN OPPOSITION TO INCREASING FLOW OF WATER AWAY FROM DELTA – EXPLAIN WHY OR WHY NOT		
OTHER IMPORTANT INFORMATION TO CONSIDER (ethical/environmental)		

AGENCY	Delta Fishermen and Recreation Association	Los Angeles County Water Board	Northern California Rice Farmers Association
WATER NEEDS			
HOW AGENCY BENEFITS OR IS HELPED BY AQUEDUCTS DIVERTING WATER AWAY FROM THE DELTA			
HOW AGENCY IS AFFECTED BY INCREASING WATER FLOW OUT OF THE DELTA			
IS AGENCY IN SUPPORT OF OR IN OPPOSITION TO INCREASING FLOW OF WATER AWAY FROM DELTA – EXPLAIN WHY OR WHY NOT			
OTHER IMPORTANT INFORMATION TO CONSIDER (ethical/environmental)			

[i] Looper, Jim (2008).What are their needs? Lab. *Sheldon High School Science Dept.*