Laboratory Workbook
and
Weekly Assignment Schedule

by

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D.I.V.E. Earth Science Laboratory Workbook

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You are allowed to make 1 copy of this workbook per family member completing this course.

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</table>
Using DIVE Earth Science

The goal of DIVE Earth Science is to teach you about God's creation through
definitions, lectures, facts practice, laboratory activities and review. We recommend the following weekly schedule,
which should take about 1 hour per day to complete:

Day 1: Watch the “Rules and Definitions” at the beginning of the assigned “A” lecture. Write down all assigned
Day 2: Watch lecture A and take notes, complete Review Questions, work on Facts Practice.
Day 3: Watch lecture B and take notes, complete Review Questions, work on Facts Practice.
Day 4: Complete Lab Activity.

DIVE Earth Science is designed to get you ready for DIVE's High School science courses, where note-taking is an
important skill. You will take notes on each DIVE lecture, then complete review questions based on the lecture. If
you completed your definitions, and took good notes on the lecture, you should be able to do well on the review
questions. Then, every 8 weeks you will have a review of topics covered over the previous 7 weeks. Treat this quar-
terly review as a regular homework assignment, where you are allowed to use your lecture notes and definitions to
answer the questions. You can add an extra challenge by not allowing the use of any notes or definitions, and limiting
your time to 30 minutes.

Supplies required: A computer with Internet, a 1 inch, 3-ring binder with dividers, college rule notebook paper,
3-hole punch (or 3-hole printer paper), scientific calculator. I recommend that you print the DIVE Earth Science
Workbook and place it in a 3-ring binder, and then add 100 pages of college rule paper (or 3-hole copy paper) for
taking notes and writing definitions. Because the lectures, review questions, and facts practice use Adobe Flash
technology, DIVE Earth Science will not currently work on an iPad or iPhone.

Laboratory Supplies: All lab supplies can be purchased at local stores and/or Internet sites. A pdf
document is included on the DIVE CD that lists all supplies and costs. Read it carefully. Many supplies you
will already have. DO AS MANY HANDS-ON LABS AS YOU CAN AFFORD. Total cost is around $200.

Google Earth: We will use Google Earth for several activities. Download it now for free at
[earth.google.com] You do not need the “Pro” version.

Special Note on Facts Practice: DIVE Earth Science Facts Practice is basically a computerized “flashcard” tool
designed to help you memorize important Earth Science facts. God knew what he was doing when he assigned
animal-naming duties as one of mankind’s first jobs (Genesis 2:19-20). Knowing something’s name is the first step
in understanding it better and enjoying it more, and if you know the names of all kinds of rocks, clouds, lakes,
canyons, etc., it is more likely that you will investigate these things further. Each Facts Practice IS NOT A TEST, it
is a memory tool that you are supposed to do multiple times until you achieve a perfect score.

Scheduling your year: The Table of Contents is set up as a weekly schedule consisting of weekly Assignments, Facts Practice, and Laboratory activities. It is designed to be broken up into two, 16-week semesters. I recommend beginning around mid-August, allowing for a break at Thanksgiving, and concluding one to two weeks before Christmas. Continue after New Year’s, taking another break after completing Week 24. When you begin a week, first read your table of contents and determine what will be covered.

Be flexible! If your child needs an extra week or two in a semester, don’t be afraid to give it to them.
Using DIVE Earth Science, continued

**Grading:** A grading calculator is provided. Watch the Getting Started lesson to familiarize yourself with it.

*Notes and definitions (Worth 25%):* Grade these based on completion. If your child completed all definitions and took a thorough set of notes, give them a 100%. Deciding what “thorough” means is sometimes difficult. At the very least, briefly review the DIVE Video Lectures assigned for that week, which will give you a good indication of whether your child has a thorough set of notes. Some things your child should take notes on include titles and subtitles, definitions and important concepts, diagrams and tables with notes explaining them, and ALL practice problems. If you have more than one child working on the same DIVE Science course, give the better grade to the one with the more thoroughly completed set of notes.

*Review questions (25%):* Review questions are computer-generated, and correct answers are given upon completion. Watch the Getting Started lesson to learn how to work with the computer-generated review questions. If you need a more detailed answer, Video Solutions to review questions are provided at the end of each DIVE Lecture.

*Laboratory Assignments (20%):* Grade these based on completion. If your child completes all topics covered on the DIVE Video Lab, then give them a 100%. I do not recommend basing the grade on whether or not the student performed a flawless execution of the lab activity, but instead on completion, effort, and attitude. Give lower scores for incomplete, sloppy or lazy work. For most students, lab is their favorite part of science, and lab should be an “easy A” for them.

*Facts Practice (10%):* As mentioned on p. ii, the goal of the facts practice is to complete each set as many times as necessary until you get a perfect score (100%). If one of the facts practice sets is particularly challenging to you, then just record your best score. Note: some weeks do not have a scheduled Facts Practice. Use those weeks to review any of the Facts, especially the ones that are more challenging for you.

*Quarterly review (20%).* Students who took good notes and studied their definitions and review questions will do the best on the quarterly reviews. Most questions will be similar to the weekly DIVE review questions. If your child can correctly answer all the weekly review questions, then they should do fine on the quarterly review. Remember, you can treat the quarterly review like a test by not allowing the use of notes or definitions. If you do this, give your child time to study their notes, definitions and weekly review questions beforehand.

**Did I pass?** Here is my recommended grading system for DIVE Earth Science:

90-100 = A  
85-90 = B  
80-85 = C  
75-80 = D  
Below 75 = F
Laboratory Activity 1.1

The Scientific Method

Introduction
Welcome to Earth Science Laboratory! In today’s lab, you will become familiar with the Scientific Method, and how you can use it to answer questions you have about God’s creation.

How to Complete a DIVE Earth Science Laboratory Activity

1. Open your workbook to the appropriate page. Have a pencil and calculator ready.
2. Turn on your DIVE Video Lab and begin watching.
3. Watch the activity, pausing and rewinding as necessary. Fill in the activity book as you go.
4. Optional: Use your own equipment to complete the activity! You don’t have to do this for every lab, but it is recommended that you try at least a few.

Steps of the Scientific Method

Describe each of the five parts of the scientific method:

Introduction

Hypothesis

Methods

Results

Discussion
Laboratory Equipment

Equipment used for containing substances______________________________________________________
___________________________________________________________________________________

Equipment used for measuring____________________________________________________________
___________________________________________________________________________________
___________________________________________________________________________________

Miscellaneous equipment_______________________________________________________________
___________________________________________________________________________________
___________________________________________________________________________________

Laboratory Safety

What is the most dangerous chemical you will use?__________________________________________
___________________________________________________________________________________

Where can you purchase / borrow it?_____________________________________________________
___________________________________________________________________________________

How do you mix acid and water?___________________________________________________
___________________________________________________________________________________

What do you do if you get acid on you?_______________________________________________
___________________________________________________________________________________

How can you protect yourself from acid spills during lab?______________________________________
___________________________________________________________________________________

A very effective method for preventing accidents during lab is to ____________ the experiment before performing it.

Doing a science experiment.

Introduction

Anything that takes up space and has mass is called matter. We can weigh an object to get an idea of how much mass it has. We can measure its volume to get an idea of how much space it takes up. Scientists measure masses and volumes of materials to determine their densities. The density, or mass per unit volume, of a material is helpful way for scientists to distinguish between two materials. It is one of the main measurements used to describe a material. For example, pure water (H$_2$O) at room temperature has a density of about 1.0 g/mL. This is very different from pure lead (Pb), which has a density of about 11.3 g/mL. If you had 1 mL of each substance, the water would weight 1.0 g, and the lead would weight 11.3 g. Lead is probably the most dense substance in your rock collection.
In Laboratory Activity 1 you will attempt to answer the following question about rocks in your collection:

**Which ore is the most dense?**

**Hypothesis:** Determine the ores in your rock and mineral set. You should have a list that tells you which numbered specimens are ores. Based on what you learned in the introduction, together with any experience you have with ores, make an educated guess:_________________________________________________________.

**Methods**

Materials

**Equipment:** Ores from your rock and mineral kit (#30-45 if you have the same kit used in the video lab), digital balance, 100 mL graduated cylinder, cup, tweezers or pliers, calculator.

**Chemicals:** Tap water

Procedure

For detailed explanation of procedure, please watch video lab. Record all measurements in the following table, or make a spreadsheet on your computer to automatically calculate density.

FIND MASS FIRST, THEN VOLUME

<table>
<thead>
<tr>
<th>Ore</th>
<th>Mass (g)</th>
<th>Volume (mL)</th>
<th>Density (g/mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>
Week 1

**Results:** Calculate the density and record in the table on page 4. Round each answer to 2 decimal places.

**Discussion:**

1. Was your hypothesis correct? Why or why not?

2. Which ore had the second-highest density?

3. List at least three sources of error.

4. Considering the question answered in this experiment, list some similar questions that could be answered about density by doing a science experiment.

5. Why would a geologist be interested in knowing a rock’s density?
Laboratory Activity 1.2

Using a Compass and Map

Introduction
In this lab activity you will learn to use a magnetic compass to determine the orientation of your home or school. You will then learn about maps and map scale, and combine your knowledge of compasses and maps to plot courses. You will check your work using Google Earth.

Methods

Materials

Equipment: Brunton Classic magnetic compass, drawing compass, ruler, computer with Google Earth, calculator

Procedure
For detailed explanation of procedure, please watch video lab. Record all measurements in the workbook.

Part 1: Using a compass

<table>
<thead>
<tr>
<th>Direction Name</th>
<th>Angle</th>
</tr>
</thead>
<tbody>
<tr>
<td>North</td>
<td>0°</td>
</tr>
<tr>
<td>Northeast</td>
<td>45°</td>
</tr>
<tr>
<td>East</td>
<td>90°</td>
</tr>
<tr>
<td>Southeast</td>
<td>135°</td>
</tr>
<tr>
<td>South</td>
<td>180°</td>
</tr>
<tr>
<td>Southwest</td>
<td>225°</td>
</tr>
<tr>
<td>West</td>
<td>270°</td>
</tr>
<tr>
<td>Northwest</td>
<td>315°</td>
</tr>
</tbody>
</table>

Record a direction name and angle for questions 1-4.
1. The front of my home faces ________________________________.
2. The back of my home faces ________________________________.
3. If I am facing my home, and I turn left (90°) and start walking, I will head ________________________________.
4. If I am facing my home, and I turn right (90°) and start walking, I will head ________________________________.
**Part 2: Map scale**

1. What are some of the common map scales?

2. How many cm are in 1 km?

3. Why do you think there is a 1:100,000 map scale?

4. How many inches are in a mile?

5. Why do you think there is a 1:63,360 map scale?

---

**Part 3: Compass and Map**

To the right is a section of the USGS 1:63,360 Katmai A-3 Quadrangle Map, published with revisions in 1977. The red square is where a hot spring was discovered by Dr. Robert F. Griggs, who explored the area after the eruption of Novarupta volcano in 1912. Estimate the distance between the red dot and the red square.

__________________ mi

If a group started at the red dot and walked in a straight line to the red square, what would their heading need to be?

__________________°

Assuming a declination of 21.5° East, recalculate their heading to get a magnetic bearing.

__________________°
Part 4: Using Google Earth

1. If you have not downloaded Google Earth, click here and download it now.

2. Type your home address into the Google Earth toolbar and press Enter. Record the latitude, longitude, and elevation of your home.

   Latitude: _______________________________
   Longitude: ______________________________
   Elevation: _______________________________

3. Type in “Dakavak Lake” and press Enter. Watch video lab to learn how to find distances using Google Earth.

   distance = _____________ mi
   heading = ____________°

   Compare your distance measured using Google Earth with your distance in Part 3. Calculate a percent difference.

   % Difference = ((larger - smaller) / larger) x 100% = ________________%

   Subtract the declination from the Google Earth heading to get the magnetic bearing:_____________°

   How does this bearing compare to the magnetic bearing calculated on p. 8?

Part 5 (Optional): TerraGo plugin for Acrobat Reader and GEOpdf files

Find store.usgs.gov on the Internet. Select “Map Locator” and download the free TerraGo plugin. This allows you to use GEOpdf files.

Go back to “Map Locator” and under “SEARCH,” type in Katmai A-3, then under “Search Type” select “USGS Map Name” and click “Go.”

Click on the red balloon on the map, and download the smaller of the two files. Watch video lab and measure the distance you estimated in Parts 3 and 4 above.

   TerraGo distance = __________________________ mi.

   % difference between Parts 4 and 5______________________________________%

   % difference between Parts 3 and 5________________________________________%

   Is the GEOpdf declination different than in Part 3?_______________________________________
Laboratory Activity 1.3

Contour Lines

Introduction
As you learn more about topographic maps, you are probably wondering what all those curvy lines are! Those are contour lines, and they are very helpful because they give you an idea of how steep the terrain is. The closer contour lines are together, the steeper the terrain. Contour lines are isopleths, or lines of equal measure. On topographic maps, isopleths are measuring lines of equal altitude above sea level. On bathymetric (nautical) charts, isopleths are lines of equal depth. In this lab activity, you will use a plastic model to learn how to make contour lines and draw a profile. Then you will use an actual topographic map section to make a profile. You will learn to make a profile using Google Earth.

Methods

Materials

Equipment: Contour line kit, ruler, water, cup or pitcher, dark-colored crayon, cookie sheet to set experiment in and prevent spills (optional), computer with Google Earth

Procedure

For detailed explanation of procedure, please watch video lab. Record all measurements in the workbook.

Part 1: Making contour lines

Fill container in 0.5 cm increments

Each new water line is marking an isopleth. Mark its location with a crayon.

Measure highest point (last point submerged) and mark it with an “X”

DO NOT THROW AWAY THE CONTAINER! You need it for several other laboratory activities.
To the best of your ability, redraw a top view of your contour lines below. Then, make a profile through the highest point on your image. Use the grids as guides for placing your contour lines.

Part 2: Making a profile from a real 1983 USGS topographic map. Draw the 200 ft. intervals only.
**Week 3**

**Part 3:** Use Google Earth to make a profile

1. Fly to “Mount Saint Helens.” Watch video lab to learn how to make a profile. Sketch your profile below.

2. In what ways is your Google Earth profile similar to your profile drawn in Part 2?

3. In what ways is your Google Earth profile different than your profile drawn in Part 2?

4. What might be some reasons for the similarities/differences in profiles between Part 2 and 3?
Laboratory Activity 1.4

Study of Minerals

Introduction

You have learned that minerals are the building blocks of rocks, and that minerals are composed of elements arranged as individual atoms, or as compounds. One challenging task of a geologist is identifying different kinds of minerals found in nature. Fortunately, some tests are rather simple and require relatively inexpensive equipment, but can still help a geologist to identify certain minerals. In this lab activity, you will use some common tests to see how minerals vary in their physical properties. You will also make some hypotheses regarding mineral hardness and density, and then test those hypotheses with your own tests.

Methods

Materials

Equipment: Rock and mineral kit, rock and mineral test kit, digital balance, 100 mL graduated cylinder, cup, tweezers or pliers, calculator.

Chemicals: Tap water, hydrochloric acid (optional)

Procedure

For a detailed explanation of procedure, please watch the video lab. Some general reminders are given below. Record all measurements and observations on the following pages.

Hardness - Mineral A is harder than mineral B if A can scratch B, but B cannot scratch A.

<table>
<thead>
<tr>
<th>Scratch With</th>
<th>Hardness</th>
</tr>
</thead>
<tbody>
<tr>
<td>fingernail</td>
<td>2</td>
</tr>
<tr>
<td>copper coin</td>
<td>3</td>
</tr>
<tr>
<td>iron knife or nail</td>
<td>5 - 5.5</td>
</tr>
<tr>
<td>glass plate</td>
<td>6</td>
</tr>
</tbody>
</table>

Density (specific gravity) - See Lab 1.1 for procedure (mass/volume).

Cleavage - Review Lecture 1.3A; basal, prismatic, cubic.

Color - general color, or list more than one color if distinct bands are visible

Streak - one color

Luster - metallic or non-metallic
Part 1: Moh’s Mineral Hardness Scale

<table>
<thead>
<tr>
<th>Mineral (kit #)</th>
<th>Theoretical Hardness</th>
<th>Experimental Hardness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Talc (Schist) (19)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Gypsum (44)</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Calcite (6)</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Fluorite (43)</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Apatite (45)</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Microcline (1)</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Quartz (7)</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Beryl (42)</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Corundum (50)</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Diamond (-)</td>
<td>10</td>
<td>-</td>
</tr>
</tbody>
</table>

1. After doing the hardness tests yourself, would you agree with most of the theoretical values?

2. If your experimental hardness values differed from theoretical values, list some reasons why you think that might have happened.

3. Pick 5 other rocks or minerals from your set and estimate a value for their hardness.

Sample 1_________________

Sample 2_________________

Sample 3_________________

Sample 4_________________

Sample 5_________________
### Part 2: Mineral Comparison Chart

<table>
<thead>
<tr>
<th>Mineral (kit #)</th>
<th>Cleavage</th>
<th>Color</th>
<th>Streak</th>
<th>Luster</th>
<th>React with HCl? Yes/No</th>
<th>Mass (grams)</th>
<th>Volume (mL)</th>
<th>Density (g/mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gypsum (44)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dolomite (30)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corundum (50)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Microcline (1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plagioclase (2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hornblende (3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Muscovite (4)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biotite (5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calcite (6)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quartz (7)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1) Compare minerals that you measured both density and hardness (Part 1). Do you see a relationship between density and hardness? Describe it.

2) What does it usually mean when a mineral reacts with HCl (fizzes?).

3) What are some other patterns you see in your data?
Laboratory Activity 1.5

Study of Rocks

Introduction

You have learned that rocks are composed of minerals. You also know that “every rock has a story,” and part of that story is determining what it is made of and how it compares with similar rock types. In this activity, you will answer questions about the three major rock types while building your skills at identifying rocks.

Methods

Materials

Equipment: Rock and mineral kit, rock and mineral test kit, digital balance, 100 mL graduated cylinder, cup, tweezers or pliers, water, calculator.

Procedure

For a detailed explanation of procedure, please watch the video lab. Record all measurements and observations on the following pages.

Part 1: Rock types

Classify rocks on the following page. Use the space below for notes and calculations.
<table>
<thead>
<tr>
<th>Rock (kit #)</th>
<th>Color</th>
<th>Streak</th>
<th>Mass (grams)</th>
<th>Volume (mL)</th>
<th>Density (g/mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pumice (8)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Obsidian (9)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scoria (10)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basalt (11)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Andesite (12)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Granite (13)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rhyolite (14)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Olivine (48)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amphibolite (15)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slate (16)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quartzite (17)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gneiss (18)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Talc Schist (19)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Garnet Schist (20)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marble (21)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anthracite Coal (22)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Graphite (36)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conglomerate (23)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sandstone (24)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arkose (25)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shale (26)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oil Shale (27)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calcareous Tufa (28)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Limestone (29)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Part 2: Comparing igneous rock types

Question: Are more mafic igneous rocks darker in color?

Hypothesis: Write your educated guess here:

Methods

Materials
See Introduction

Procedure
Organize rocks into mafic and felsic groups. Compare colors.

Results

Felsic (granite, rhyolite, quartz (lab 1.4))
Mafic (basalt, andesite, olivine)

Discussion:

1. Was your hypothesis correct? Why or why not?

2. List at least three sources of error.

3. Considering the question answered in this experiment, list some similar questions that could be answered about igneous rocks by conducting a science experiment.

You know that metamorphic rocks are formed by the alteration of existing rock by high heat, pressure, and/or chemically active fluids. These alterations can lead to a change in density.

**Question:** Are metamorphic rocks normally (more than 50% of the time) more dense than their non-metamorphic counterparts?

**Hypothesis:** Write your educated guess here:

**Methods**

**Materials**
See Introduction

**Procedure**
Organize rock data as shown below

**Results**

<table>
<thead>
<tr>
<th>Metam. type</th>
<th>Metamorphic density</th>
<th>Non-Metam. type</th>
<th>Non-Metamorphic density</th>
<th>Metam. more dense?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marble</td>
<td></td>
<td>Limestone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slate</td>
<td></td>
<td>Shale</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quartzite</td>
<td></td>
<td>Sandstone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gneiss</td>
<td></td>
<td>Granite</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Discussion:**

1. Was your hypothesis correct (more than 50% of metamorphic samples more dense)? Why or why not?

2. List at least three sources of error.

3. Considering the question answered in this experiment, list some similar questions that could be answered about metamorphic rocks by conducting a science experiment.
Laboratory Activity 1.6

Study of Mud and Clay

Introduction

Mud and Clay are not really liquids and not really rocks, although they can flow like liquids and harden into rocks. Clay specifically refers to particles 0.002 mm in diameter and smaller, while mud can be a mixture of clay and silt particles. Clays are less fluid than muds, and can be molded into shapes and air-dried or heat-dried in a kiln. Clays are primarily formed from minerals high in aluminum and silica, such as kaolinite. As sedimentary rocks, clays typically form sedimentary shales and metamorphosed slates and schists, while muds form mudstones and schists.

In this activity, you will compare and contrast some of your rocks made from clay. You will also use some air-dry clay to make a gold-panning dish, which you will use in Laboratory Activity 1.7.

Methods

 Materials
 Equipment: Rock and mineral kit, rock and mineral test kit, air-dry clay, blunt knife or similar tool for shaping clay, acrylic paint (optional), calculator.

 Procedure: Refer to the video lab for further instructions.

Part 1. Comparing rocks made of mud and clay. Use data from Lab 1.5 for color and streak.

<table>
<thead>
<tr>
<th>Rock Type (Kit #)</th>
<th>Color</th>
<th>Streak</th>
<th>Hardness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slate (16)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Talc Schist (19)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Garnet Schist (20)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shale (26)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oil Shale (27)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Were most of the rocks light or dark in color? In streak?

2. What was the average hardness? Were the metamorphosed muds and clays (slate, schists) harder than the sedimentary muds and clays (shale, oil shale)?
Week 6
Part 2. Make a gold pan out of clay

Follow procedure on video lab.
Try to match the pattern below.
Laboratory Activity 1.7

How to Find Gold

Now a river went out of Eden to water the garden, and from there it parted and became four riverheads. The name of the first is Pishon; it is the one which skirts the whole land of Havilah, where there is gold. And the gold of that land is good.

*Genesis 2:11-12, NKJV*

**Introduction**

Almost since the beginning of creation, good locations to find gold have been known. God gave the earth to humans to take care of and to use. The prosperity of any nation is directly related to their ability to take the Earth’s materials and turn them into something that other people would want to buy. Christians should know they were created in God’s image (Genesis 1:27). He is the best Creator of all, but since He made us in His image, we are able to create things, too. We should want to take things out of the Earth that look like they are messy and worthless, and turn them into something useful. A nation that teaches its children to honor God by making wise use of the Earth’s materials to serve Him and mankind will be prosperous. A nation whose people would rather fight amongst themselves and with other nations will have a more difficult time being prosperous.

Throughout history, the prosperity of many nations has been tied not only to their relative abundance of gold, but also to their ability to extract it from the earth. Gold is almost always associated with mountainous regions, and mountainous regions are always associated with volcanic activity, so it is self-evident that if you want to find gold, head to the mountains! Once you get to the mountains though, where should you go next? There are many places to find gold, but one in particular is called an epithermal deposit. As shown in the diagram on the next page, igneous rocks undergo hydrothermal alteration, releasing clay minerals. The process is called argillic alteration. Compared to magma, the alteration occurs at fairly cool temperatures, but warm enough to make gold (Au) more soluble. As the hydrothermal fluid exits in a hot spring, it cools, causing gold to precipitate out. This is called an epithermal gold deposit. Over time, runoff carries this gold to a stream, forming a placer deposit.

In this lab activity, you will use the gold pan you made in Activity 1.6 to pan for “fool’s gold” (iron pyrite). You will also identify good places to look for gold on a topographic map.

**Methods**

**Equipment:** Clay gold pan from Activity 1.6, sand, iron pyrite (sample #40 in rock collection), hammer

**Chemicals:** water

**Procedure:** Refer to video lab. Record data on following page.
Part 1: Identifying gold deposits

The map on the right was drawn in the early 1900s.

1) Circle the location(s) you think might have epithermal gold deposits.

2) Using a different-colored pen or pencil, circle the location(s) you think might have placer gold deposits.

Part 2. Gold panning

Follow instructions on video lab.

1. What is liquefaction?

2. Why does the gold settle to the bottom of the pan?

3. What is the density of pure gold? How many times more dense is gold than quartz (\( \rho = 2.7 \text{ g/mL} \))?
Week 8

End of Section 1

No Lab Activity This Week
Laboratory Activity 2.1

Using GPS

Introduction

In Lesson 1.7 you defined and studied Global Positioning Systems (GPS). If you really want to get out and explore and investigate the Earth, then a GPS is a great tool to have along. In this lab activity you will learn how GPS works, you will become familiar with different types of GPS receivers and transmitters and their uses, and you will use GPS to study changes in Earth’s surface features. You will also learn about geocaching, a high-tech game of hide-and-seek.

Methods

Equipment: Google Earth, ruler, calculator, GPS unit (optional)
Chemicals: none

Procedure: Refer to video lab. Record data on following page.

Part 1: How GPS Works

The Global Positioning System is a system of 24 solar-powered satellites, also known as NAVSTAR satellites, each of which orbit the Earth twice a day at an altitude of about 12,000 miles and speeds around 7,000 miles per hour! So you don’t have a GPS in your car, phone, boat, etc., you have a GPS receiver. Better receivers are more costly, but they are designed to receive the GPS signals even when blocked by trees, clouds, windows, etc. GPS signals are electromagnetic waves, which are the same type of wave as sunlight, x-rays, and radio waves. In fact, civilian GPS signals are a low-power radio wave. So just like a building or a mountain can block sunlight, the same types of obstacles can block GPS signals.

1. Compare the two photos on the right of satellite signal strength received by a Garmin 60CSx GPS receiver. Circle the photo that you think was taken when the GPS was outside. List two reasons for your choice.
Part 2: Using GPS Receivers and Transmitters

GPS Receivers are used to navigate on and above the Earth’s surface. GPS transmitters are a bit more complex, as they not only receive a GPS signal, but they also transmit a signal back to commercial satellites, which in turn transmit the signal to a variety of sources including phones, Internet, and even GEOS International Emergency Response Coordination Center (www.geosalliance.com). While some GPS receivers simply provide a digital display of latitude and longitude, the most common types behave more like a GIS, allowing you to interact with a map layer.

If you own a GPS now or in the future, you will most likely use it mainly for navigating on streets. There is plenty of information available on how to use GPS for street navigation, so instead of spending time on that, you will instead learn how to use GPS to investigate and explore the Earth in other ways. Watch the video lab and answer the following questions. Have Google Earth opened and ready for use.

1. Identifying roadside features.
   Write a sentence or two on how you can use a GPS receiver with a street map layer along with a digital camera to investigate Earth’s features.

   Use Google Earth to determine the approximate latitude and longitude where the photo was taken. What state was the photo taken in?

   Latitude: ____________________   Longitude:_____________________   State: ________________

   This area receives very little annual rainfall, so how do you think the soft, red sedimentary rock cliffs were eroded?

2. Identifying features from the air.
   Using Google Earth, enter the GPS coordinates recorded during an airline flight across British Columbia, Canada. Rotate Google Earth and try to get it to look like the photo in the video lab. What is the name of the mountain peak next to the glacier?
Part 2 continued:

3. Using GPS with a nautical chart layer.
   What are two causes for the reduction of land surface in the Mississippi River Delta near Port Fourchon, Louisiana?

   How was GPS used by students to conduct research in the Brazos River Delta near Freeport, Texas?

4. Using a GPS with a topographic map layer.

   Use the photograph and a ruler to estimate Princess Glacier’s average recession rate from the time the topographic map was made in 1951 to the time the photograph was taken in 2011.

5. Using a SPOT Satellite Messenger

   How does a SPOT Satellite Messenger differ from a GPS receiver?

   What are some reasons a SPOT may not be able to send a signal?
Week 9

Part 3: Geocaching

What is geocaching?

What year was geocaching invented?

Is there a certain size of container to use for a geocache?

What are some good items to put in a geocache?

What is the most important rule of geocaching?

What one item should all geocaches contain?

Go to www.opencaching.com or www.geocaching.com, type in your zip code, and find some geocaches near you. What are some items they contain?

Optional: Make your own geocache!
Laboratory Activity 2.2

The Earth Under Your House

Introduction

In this laboratory activity you will use Google Earth and other resources to determine the composition of Earth materials under your house!

Methods

Equipment: Google Earth and other Internet sites.

Chemicals: none

Procedure: Refer to video lab. Record your data on the following pages. You will need to go to the following website. If you have the pdf file of this workbook open, you can just click on it and it should take you to the site. Otherwise, type it in to your Internet search engine (Google, Firefox, etc.) exactly as shown:

http://tin.er.usgs.gov/geology/state/

Part 1: What is under your house?

My house is at: Latitude:_________________________ Longitude:_________________________

Name of Formation

Relative Geologic Time Scale Age:

Original map label:

Comments:
Part 1 Continued:

Primary rock type:

Secondary rock type:

Other rock types:

Coverage in your state (square miles):

Part 2: What are some other formations within a 20-mile radius of your house?

Formation 1
   Name of formation:
      Primary rock type:
      Secondary rock type:
      Other rock types:

Formation 2
   Name of formation:
      Primary rock type:
      Secondary rock type:
      Other rock types:

Formation 3
   Name of formation:
      Primary rock type:
      Secondary rock type:
      Other rock types:
Laboratory Activity 2.3

Liquefaction and Fossil Sorting

Introduction

Almost all fossils are found in water-deposited sedimentary strata. But are the fossils in their original positions, and if not, would their density relative to surrounding sediments affect their movement? You learned about liquefaction in your lectures this week, now you will see them work in real situations. You will also see why these wet, sedimentary materials are referred to as non-Newtonian fluids. As you do this activity, imagine the same processes you are investigating happening during and after the Flood on a much, much larger scale.

Equipment: 5 plastic beads 1/4 in. diameter., 5 metal beads or lead “split shot” 1/4 in. diameter, 2 clear plastic tapered “Solo” 9 oz cups, plastic container from Lab Activity 1.3 on contour lines, toothpick or small twig, electric drill (optional).

Chemicals: corn starch (12 oz. box), sand, water

Procedure: Refer to video lab. Record your data on the following pages.

Part 1: Making a mess with non-Newtonian fluids

1. Describe what happened when you pushed your hand into the corn starch mixture.

2. Describe what happened when you hit the corn starch mixture with your fist.

3. Describe what happened to the toothpick when you shook the corn starch mixture.

4. Optional: Describe what happened when you vigorously vibrated the corn starch mixture with the drill.
Part 2: Liquefaction experiment

Question: Can liquefaction sort objects by their density?

Hypothesis: Yes or No. Answer in a complete sentence, and apply what you know regarding density, liquefaction, and the results from Part 1.

Methods:

Procedure: Refer to video lab. Record results in the table below.

Results: Record whether beads moved higher (H), sank deeper (D), or remained in the same place (S).

<table>
<thead>
<tr>
<th></th>
<th>Starch</th>
<th>Sand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plastic Beads</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metal Beads</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

What fraction of plastic beads moved higher?

What fraction of metal beads (split shot) sank deeper?

Discussion:

1. Was your hypothesis correct? Why or why not?

2. How might liquefaction affect fossil sorting of a clam shell and seabird that died and were buried on a pre-Flood beach?

3. List at least three sources of error.

4. Considering the question answered in this experiment, what are two other questions about liquefaction that could be answered by doing a science experiment?
Laboratory Activity 2.4

Canyon Formation
Note: Part 3 must be set up today and completed tomorrow.

Introduction

Present day processes can help us understand past events, but really, the past is the key to understanding many of Earth’s major surface features, including canyons. When we trust God’s word over man’s, we learn that His word speaks of a major global cataclysm, where “fountains of the deep” burst open, rains fell, and Earth was completely covered with water. Even today, Earth is still almost completely covered with water, and evidence of massive historic water-erosion events are everywhere. It is also evident that mountains rose and valleys sank, which could be why the floodwaters began to recede after 150 days.

Science alone cannot answer questions about Earth history. Questions about natural history are “mixed questions” and require inputs from other sources, such Scripture and other documents that are historically accurate. Even then, we cannot verify claims made about how canyons and other features like salt diapirs formed in the past. In Laboratory Activity 2.4, you will experiment with sheet flow and channelized flow to understand more about how water interacts with unlithified and water-saturated sediments to form canyons. You will also study salt diapirism and see how these structures might be responsible for forming giant sinkholes like Hebes Chasma on Mars and Palo Duro Canyon on Earth.

**Equipment:** 2 clear plastic tapered “Solo” 9 oz cups, plastic container from Lab Activity 1.3 on contour lines, 5 ft of 3/16 or 1/4 inch diameter plastic tubing, bucket or pitcher, piece of cardboard

**Optional equipment:** Video camera or digital still camera, “chip” clip or clothespin.

**Chemicals:** sand, salt, water

**Procedure:** Refer to video lab. Record your data on the following pages.

**Part 1: Sheet flow**

Flat surface:

  Trial 1

  Trial 2
Part 1 continued

Sloped surface:

Trial 1

Trial 2

Part 2: Channelized flow

Above-ground:

Trial 1

Trial 2

Below-ground:

Trial 1

Trial 2
Part 3: Salt Diapirism

Question: Can salt rise through sedimentary layers via liquefaction?

Hypothesis: Yes or No. Answer in a complete sentence, and apply what you know regarding density, liquefaction, and the results from Laboratory Activity 2.3.

Methods:

Procedure: Refer to video lab. Record results in the table below.

Results: Record “yes” or “no” as to whether salt moved up and whether a sinkhole formed.

<table>
<thead>
<tr>
<th>Surface submerged</th>
<th>Surface dry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salt moved up?</td>
<td></td>
</tr>
<tr>
<td>Sinkhole formed?</td>
<td></td>
</tr>
</tbody>
</table>

Other observations

Discussion:

1. Was your hypothesis correct? Why or why not?

2. Do you think it is possible that Hebes Chasma or Palo Duro Canyon are really just giant sinkholes? Explain.

3. List at least three sources of error.

4. Considering the question answered in this experiment, what are two other questions about diapirism that could be answered by doing a science experiment?

****** Rinse one of your 9 oz. Solo cups, fill it with water, and put it in the freezer. You will use the ice next week.
Laboratory Activity 2.5

Glacial Landscapes

Note: Part 2 must be set up today and may not finish until tomorrow.

Introduction

Both flood geologists and uniformitarian geologists agree that ice sheets and glaciers have covered large parts of the Earth’s surface. The disagreements are about timing and rates. Flood geologists hypothesize that Earth has just had one major Ice Age that occurred in stages, and that it was brought on as a result of Flood-related atmospheric cooling. We also know that science cannot answer questions about the past, but that should not stop us from trying to find the most reasonable interpretations from the evidence left behind. Questions about historic events like the Ice Age are “mixed questions”, and rely on inputs from other areas like Scripture, history, and philosophy to come up with the best interpretation of what we observe.

In Laboratory Activity 2.5, you will observe glacial movement and melting and their effects on the landscape.

**Equipment:** Plastic container from Lab Activity 1.3 on contour lines, 1 clear plastic tapered “Solo” 9 oz cup, small rocks and sticks or other objects.

**Optional equipment:** Video camera or digital still camera.

**Chemicals:** sand, corn starch, water, ice you put in freezer at end of Lab 2.4

**Procedure:** Refer to video lab. Record your data on the following pages.

**Part 1: Rivers of Ice**

Make a sketch of your glacier in the space provided.

Did the glacier flow downhill?

Did the glacier transport any rocks?
Part 2: Glacial meltwaters

Make a sketch of your glacial landscape before melting.

Make a sketch of your glacial landscape after melting.

Describe some similarities in your pre and post-melt landscapes.

Describe some differences in your pre and post-melt landscapes.

What are some other tests you could run to observe the effects of glacial meltwaters on landscapes?
Laboratory Activity 2.6

Tephra Formation

Introduction

The Flood started when the “fountains of the deep” burst (Genesis 7:11). A reasonable assumption is that these fountains behaved like giant volcanic cracks, spewing not only water, but all the other products volcanoes spew, including lava, mud, ash, asphalt, salts, and more. Volcanoes also release lots of fragmented rock material, and you learned in Lesson 2.6 that this is called tephra. You also know that magma comes from various depths underground, where it is subjected to extremely high pressures. When it reaches the surface, it may expand, and if it cools rapidly like pumice does, it will “freeze” in an expanded state.

In Laboratory Activity 2.6, you will use popcorn to study tephra and answer the following question:

Can the density of magma change once it becomes lava?

Hypothesis: Circle one:

Yes, if % difference is greater than or equal to 5%

No, if % difference is less than 5%

Methods

Equipment: air popcorn popper, 100 mL graduated cylinder, digital balance, bowl to catch popcorn
Chemicals: popcorn

Procedure: Refer to video lab. Record your data below.

1) Mass of unpopped corn: _________________g
2) Volume of unpopped corn: _________________mL
3) Mass of popped corn: _____ / _____ / ____g
4) Volume of popped corn: _____ / _____ / ____mL
Week 14

**Results:**

Density of unpopped corn: ____________________g/mL

Density of popped corn: ____________________g/mL

Percent difference: ____________________%

**Discussion:**

1. Was your hypothesis correct? Why or why not?

2. Do you think tephra is ever more dense than its magma? Explain.

3. List at least three sources of error.

4. Considering the question answered in this experiment, list some similar questions that could be answered by conducting a science experiment.
Laboratory Activity 2.7

Moving Earth’s Crust

Introduction

As you finish up Section 2 on Flood Geology, I hope that one thing you understand clearly is that natural history research is different from scientific research. We have no time machines, crystal balls, or secret codes that will provide proof of past events occurring this way or that way. What we do have though is the gift of faith God gives us (Ephesians 2:8-9) to trust His testimony about Earth history. So when God says in His word that He created in 6 days and rested on the 7th, and that there was a worldwide flood, we should take him at His word. Not everyone has eyes to see, but if you do then you have watched one lesson after another providing multiple lines of evidence confirming the Bible’s historic account. But what we see with our eyes oftentimes deceives us, and so the evidence we collect should be interpreted with great care and skepticism. God’s word is true and can stand on its own without the evidence that man collects and his favorable or unfavorable interpretations of that data.

In Laboratory Activity 2.7, you will make some models to help you understand one uniformitarian and one flood geology interpretation of Earth’s crustal movements. As you build and test your models, pay careful attention to the assumptions you have made to operate your models, and do not base all your conclusions about Earth’s crustal movements on what you observe!

**Equipment:** 1 clear plastic tapered “Solo” 9 oz cup, plastic container from Lab Activity 1.3 on contour lines, piece of cardboard about as tall and wide as the Solo cup, piece of 1+-inch thick foam that can be squeezed into bottom of the plastic container, ruler, string or fishing line

**Chemicals:** sand, water

**Procedure:** Refer to video lab. Record your data on the following pages.

**Part 1: Subduction**

1) How deep is your sand? _____________ mm

2) How far were you able to get your plate to subduct? _____________ mm

3) What evidence did your model provide that supports the idea of “slab pull”?  

4) What evidence did your model provide that rejects the idea of “slab pull”?  

5) How does your model differ from the actual Earth’s interior?
Part 2: Upward buckling

Question: Could deeper strata buckle upwards when surface material is removed?

Hypothesis: Yes or No. Answer in a complete sentence, and apply what you know regarding sedimentary strata and what you have learned in Section 2, especially Lesson 2.4A and evidence of upward buckling in Marble Canyon.

Methods:

Materials: See p. 50.
Procedure: Refer to video lab. Record results in the table below.

Results: Sketch the shape of the foam before and after sand removal.

<table>
<thead>
<tr>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Other observations:

Discussion:

1. Was your hypothesis correct? Why or why not?

2. What are some ways your model differs from real crustal layers?

3. List at least three sources of error.

4. Considering the question answered in this experiment, what are two other questions about upward buckling that could be answered by doing a science experiment?
Week 16

End of Section 2

No Lab Activity This Week
Laboratory Activity 3.1

Thermoclines

Introduction

In Lesson 1.4 you defined a thermocline as a layer of water in which there is a rapid change of temperature with depth. Thermoclines don’t just exist in water though, they exist in solid earth materials, too. At earth’s surface, solar energy is absorbed during the day, raising surface temperatures. Daily and seasonal fluctuations in sunlight effect the size and strength of thermoclines. The presence of a thermocline is also evidence that solar energy has been stored as thermal energy at the earth’s surface.

In Laboratory Activity 3.1, you will attempt to make a thermocline and estimate the amount of energy transferred from a heat lamp to the water. You will answer the following question:

Question: Can solar energy create a thermocline?

Hypothesis: Yes or No. Answer in a complete sentence.

Methods:

Equipment: Plastic container from Lab Activity 1.3 on contour lines, ruler, thermometer, 250 W heat lamp bulb, brooder reflector with clamp (clamp light), watch or stopwatch with timer.

Chemicals: Water

Procedure: Refer to video lab. Record results in the table below.

Results:

<table>
<thead>
<tr>
<th></th>
<th>0 min.</th>
<th>10 min.</th>
<th>20 min.</th>
<th>30 min.</th>
<th>ΔT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Middle</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bottom</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1) Estimate the amount of energy released by the 250 W lamp in 30 minutes: 1 Watt = 1 Joule/s
2) Estimate the amount of heat absorbed by the water: \[ Q = mC\Delta T \]

\[ m = \text{mass of water in grams} \]

\[ C = \text{specific heat of water} = 4.186 \text{ J/g/°C} \]

\[ \Delta T = \text{Temperature change for each layer.} \]

Surface

Middle

Bottom

Total

3) What % of heat was transferred from the lamp to the water in 30 minutes?

4) Graph temperature versus depth for your 30-minute data. Is this the pattern you expected?
Discussion:

1. Was your hypothesis correct? Why or why not?

2. Why don’t you think 100% of the lamp’s energy was transferred to the water?

3. List at least three sources of error.

4. Considering the question answered in this experiment, list some similar questions that could be answered by conducting a science experiment.
Laboratory Activity 3.2

Haloclines

Introduction

In Lesson 1.4 you defined a halocline as a layer of water in which there is a rapid change of salinity with depth. Like thermoclines, haloclines are caused when lower density water rests on top of higher density water. In saltwater systems, both differences in temperature and salinity combine to stratify the water.

In Laboratory Activity 3.2, you will attempt to make a halocline using two different salinities of water. You will answer the following question:

Question: Can different salinities of water stratify?

Hypothesis: Yes or No. Answer in a complete sentence.

Methods:

Equipment: Plastic container from Lab Activity 1.3 on contour lines, 100 mL graduated cylinder, digital balance, plastic tubing used in Lab Activity 2.4 on canyon formation, 2 containers for mixing salt and water
Chemicals: Table salt, water, food coloring
Procedure: Refer to video lab. Also, you will need 1000 mL of water, which you can obtain with your graduated cylinder, or the Metric/English conversion is 1000 mL ≈ 4 and 1/4 cups.

Results:

1) Observe your experiment after 1 hour. Did the halocline stay stratified?

2) Observe your experiment after 24 hours. Did the halocline stay stratified?
Discussion:

1. Was your hypothesis correct? Why or why not?

2. List at least three sources of error.

3. Considering the question answered in this experiment, list some similar questions that could be answered by conducting a science experiment.
Laboratory Activity 3.3

Currents and Waves

Introduction

In Laboratory Activity 3.3, you will do a hands-on activity, plus an experiment using a computer model to explore currents and waves.

Part 1: Downwelling

Introduction: Recall what you learned in Lecture 3.3B regarding vertical currents to come up with a hypothesis for the following question:

Question: Can cooling surface waters create downwelling?

Hypothesis: Yes or No. Answer in a complete sentence.

Methods:

Equipment: Solo cup or similar-sized clear glass or plastic container,
Chemicals: Ice, warm water, food coloring
Procedure: Refer to video lab.

Results:

1) Observe your experiment for several minutes. Did downwelling occur?

2) Did you notice a difference in current speed as the ice melted? Was it faster at the beginning or the end? Why?
Discussion:

1. Was your hypothesis correct? Why or why not?

2. List at least two sources of error.

3. Considering the question answered in this experiment, list some similar questions that could be answered by conducting a science experiment.

Part 2: Fetch

Introduction: Recall what you learned in Lecture 1.4 and 3.3A regarding fetch to come up with a hypothesis for the following question:

Question: Do fetch and wind speed affect wave height?

Hypothesis: Yes or No. Answer in a complete sentence.

Methods:


Procedure: Refer to video lab. If the above website does not work for you, that is okay, all the data is presented in the video lab. Record results in the table on the following page.
Results:

<table>
<thead>
<tr>
<th>Wind Speed (m s(^{-1}))</th>
<th>Fetch (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10</td>
</tr>
<tr>
<td>10</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td></td>
</tr>
</tbody>
</table>

![Graph showing wave height (meters) vs. Fetch (km)](image-url)
Discussion:

1. Was your hypothesis correct? Why or why not?

2. Multiply your wind speeds by 2.24 to convert them to miles per hour. Which wind speed(s) in the experiment exceeds that generated by a hurricane? A hurricane’s minimum sustained wind speed is 74 miles per hour.

3. Which location would you expect to have consistently better waves for surfing, Oahu, Hawaii, or Orange Beach, Alabama? Why?

4. List at least three sources of error.

5. Considering the question answered in this experiment, list some similar questions that could be answered by conducting a science experiment.
Laboratory Activity 3.4

Erosion Control

Recommended: Construct the dam for Activity 3.5 when you are finished. It takes 1-2 days to complete.

Introduction

Soil consists of layers near the Earth’s surface that, in contrast to the underlying material, have been altered by the interactions of climate, topography and living organisms over time. Soil serves as a natural medium for plant growth, so soil management is an important issue for all humans. Loss of soil from farmland can have many negative effects. Without good soil, we cannot grow plants for ourselves or for livestock, and plants will not grow naturally on bad soil either. Loss of topsoil can reduce productivity of farmland. Erosion from poorly managed farmland or construction projects can turn an otherwise clear stream into a silty, muddy mess. Pesticides, fertilizer, and animal waste attach to soil particles and wash away along with the soil, enhancing eutrophication and hypoxia in lakes, streams, estuaries, and coastal areas.

Abundant farms and farmland are a blessing from God, but all societies need to manage soil properly, minimizing its loss and maximizing its productivity. One method for achieving this is to never leave soil completely exposed as a result of livestock overgrazing and/or crop harvesting/tilling. Planting cover crops and incorporating low or no-till practices are proven methods of minimizing soil erosion while maximizing soil productivity.

The purpose of Laboratory Activity 3.4 is to answer the following question:

**Can low-till management practices reduce soil erosion?**

**Hypothesis:** Yes, if the % decrease is ≥ 5.0%, No if the % decrease is < 5.0%.

**Methods**

- **Equipment:** Plastic container from Lab Activity 1.3 on contour lines, 100 mL graduated cylinder, thick paper towel or thin cloth, ruler, containers and tools for mixing

- **Chemicals:** sand, hay (or straw, grass, or small branches), plaster of paris, water

- **Procedure:** Refer to video lab. Record your results in the table on the following page
Results:

<table>
<thead>
<tr>
<th>Trial</th>
<th>Control (mL sand)</th>
<th>+ Hay (mL sand)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Discussion:

1. Was your hypothesis correct? Why or why not? Calculate a % change: \(|\text{control-hay} + \text{control}| \times 100

2. What might be some disadvantages to having cover crops or other soil erosion control measures in place?

3. Do you think farmers should control erosion on their land? Why?

4. List at least three sources of error.

5. Considering the question answered in this experiment, list some similar questions that could be answered by conducting a science experiment.
Laboratory Activity 3.5

Building Reservoirs

Introduction

In Lecture 3.5 you learned how catastrophic failure of manmade dams can have devastating results. You also learned how reservoirs serve a number of useful purposes, with the water they store being used for consumption, irrigation, power generation, flood control, etc. Proper construction of reservoirs is essential, and engineers know much more now than they did in the early 1900's regarding what does and doesn’t work. In Laboratory Activity 3.5, you will answer the following question by building your own dam:

Which reservoir design is stronger?

A       B

Hypothesis: (Study the images of different dams shown on the video lab, and circle either A or B)

Methods

Equipment: Plastic container from Lab Activity 1.3 on contour lines, stopwatch or clock with a second hand, containers and tools for mixing

Chemicals: Silicon sealant, Plaster of Paris, water, sand

Procedure: Refer to video lab. Record your data on the following page
Results:

Record observations here:

Discussion:

1. Was your hypothesis correct? Why?

2. Where should a dam have its strongest materials, at the top or the bottom? Why?

3. List at least three sources of error.

4. Considering the question answered in this experiment, list some similar questions that could be answered by conducting a science experiment.
Laboratory Activity 3.6

Delta Formation

Introduction

In Lecture 3.4 you learned about deltas, which are places of sediment deposition. Deltas form where a stream enters a lake, estuary, sea, or other water body that has little or no current. In Laboratory Activity 3.6 you will construct a stream bed and use that to model delta formation in several different scenarios.

Methods

Equipment: Plastic container from Lab Activity 1.3 on contour lines, ruler, containers and tools for mixing, digital camera (optional)

Chemicals: Plaster of Paris, corn starch, water, sand, food coloring (optional)

Procedure: Refer to video lab. Answer the following questions as you complete each experiment.

Part 1: The “delta” shape

Sketch the shape of your delta below. Why do you think it formed this pattern?
Part 2: Sediment deposition and base level

Where did the delta start to form?

Describe the effect of base level on delta formation.

Part 3: Flood-related sediment deposition and land building.

Did you form new land?

List at least three factors that affected where the sand was deposited.

Describe 3 examples in Earth history that could have caused major sediment deposition and land-building.
Laboratory Activity 3.7

Hypoxia

Introduction

You have learned that hypoxia refers to natural waters at or below 2 ppm dissolved oxygen. You have also learned that hypoxia is natural, and tends to be more frequent in coastal areas with high productivity and/or large inputs of freshwater that enhance stratification. Human activities, especially fertilizer runoff from farmland, can enhance, but do not cause, hypoxic zones.

Hypoxic zones, also known as “dead zones”, were first documented in the 1970’s. At that time, and into the 1990’s, the primary method for measuring oxygen was a complicated and time-consuming chemical procedure known as the “Winkler method”. Today, the primary method is to use an electrode, which involves some simple calibration steps, and gives a real-time, digital readout of oxygen levels.

Since the 1970’s, the number of hypoxic zones worldwide has increased, but it is difficult to say whether the increase is from human activities alone, or if it is because of increased measurement of oxygen levels in more locations that followed from improvements in technology. It is probably a combination of both, and we would be wise to be skeptical about claims of increasing worldwide hypoxia. We should also remember that enhanced hypoxia also means enhanced productivity of natural waters, which is not necessarily harmful. Bottom waters become less-productive, but surface waters become more productive. Understanding hypoxia is an important coastal management issue, and in Laboratory Activity 3.7 you will answer the following question:

Does stratification enhance hypoxia?

Hypothesis: Yes or No. Answer in a complete sentence.

Methods

Equipment: YSI-55 digital oxygen meter, Pinpoint Salinity Monitor, 5-gallon buckets (2), ruler, Microsoft Excel or similar spreadsheet program

Chemicals: mud from a marine coastal area, seawater, fresh water (tap water)

Procedure: Refer to video lab. Record your data on the following page
Results: Record data in the table below, and on the following page graph $\Delta O_2$ vs. time for each treatment.

1) What was the initial bottom salinity (average)?

2) Was the salt+fresh treatment still stratified at the end of the experiment?

<table>
<thead>
<tr>
<th>Time</th>
<th>position</th>
<th>Salt (ppm)</th>
<th>Salt + Fresh (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 pm</td>
<td>top</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>bottom</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$\Delta O_2$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Midnight</td>
<td>top</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>bottom</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$\Delta O_2$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 am</td>
<td>top</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>bottom</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$\Delta O_2$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Noon</td>
<td>top</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>bottom</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$\Delta O_2$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 pm</td>
<td>top</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>bottom</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$\Delta O_2$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Discussion:

1. Was your hypothesis correct? Why or why not?

2. Which treatment had the lowest final bottom oxygen concentration? Is this what you expected?

3. If stratification is required for hypoxia to occur, then do we really need to be concerned about anthropogenic nutrient increases? Why?

4. List at least three sources of error.

5. Considering the question answered in this experiment, list some similar questions that could be answered by conducting a science experiment.
Week 24
End of Section 3

No Lab Activity This Week
Laboratory Activity 4.1

Atmospheric Heating & Cooling

Introduction

In Laboratory Activity 3.1, you learned how the presence of a thermocline is evidence that solar energy has been stored as thermal energy in a water body. In Lesson 4.1B, you learned that atmospheric temperature changes are influenced by the heat capacity of materials at the Earth’s surface, with water having a heat capacity about 5 times greater than land. In laboratory activity 4.1, you will answer the following question:

Where would you expect the greatest atmospheric temperature changes, an inland city, or a coastal (or island) city?

Hypothesis: If necessary, watch the video lecture again to review the topic, then make a choice. Answer in a complete sentence.

Methods

Equipment: 2 plastic Solo cups (or glass beakers), 2 thermometers, 250 W heat lamp bulb, brooder reflector with clamp (clamp light), watch or stopwatch with timer, tape, ruler.

Chemicals: water, sand

Procedure: Refer to video lab. Record your data on the following page.
### Results

<table>
<thead>
<tr>
<th>Time (minutes)</th>
<th>Water °C</th>
<th>Sand °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>45</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Other observations

![Temperature vs. Time Graph](image-url)
Discussion:

1. Was your hypothesis correct? Why or why not?

2. Do you think the atmosphere of inland areas typically have larger or smaller daily temperature fluctuations than islands found at similar latitudes?

3. List at least three sources of error.

4. Considering the question answered in this experiment, what are two other questions that could be answered by doing a science experiment?
Laboratory Activity 4.2

Measuring Humidity

Introduction

A psychrometer is a device used to measure humidity. It consists of two thermometers called the “wet bulb” and “dry bulb”. The thermometers are swung through the air, and then the temperatures read immediately and recorded. The bigger the temperature difference, the higher the humidity. A reasonable estimate of the relative humidity is obtained using a chart like the one on the following page. It is rather complex, but all you need to do is find your wet bulb temp. (blue), green bulb temp. (green), and find where they intersect. Then, determine where that intersection lies relative to the humidity curves (red). Notice that the wet and dry bulb temperatures are equal at 100% humidity. This is also the dew point, the temperature at which dew forms. In Laboratory Activity 4.2, you will make a psychrometer and test it while answering the following question:

Is it more humid indoors or outdoors?

Hypothesis: The answer depends a lot on where you live, as well as current weather conditions. Make your best guess, and write the answer as a complete sentence.

Methods

Equipment: 2 thermometers, string, paper towel, rubber band or twist-tie, digital camera (optional)
Chemicals: water

Procedure: Refer to video lab. Record your data below.
## Results

<table>
<thead>
<tr>
<th></th>
<th>Wet Bulb (°C)</th>
<th>Dry Bulb (°C)</th>
<th>% Relative Humidity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>indoors</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>average</td>
<td></td>
<td>average</td>
<td>average</td>
</tr>
<tr>
<td><strong>outdoors</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>average</td>
<td>average</td>
<td>average</td>
<td></td>
</tr>
</tbody>
</table>

Time of day: _______________

Relative humidity recorded from a local weather station: ____________%

## Discussion:

1. Was your hypothesis correct? Why or why not?

2. How did your outdoor humidity calculation compare to the weather station’s value? Calculate the % difference, \(((\text{larger} - \text{smaller}) / \text{larger}) \times 100\%\).

3. What do you think the relative humidity percentage usually is on a foggy day?

4. List at least three sources of error.

5. Considering the question answered in this experiment, what are two other questions that could be answered by doing a science experiment?
Laboratory Activity 4.3

Tracking Hurricanes

Introduction

In Lesson 1.5, you were introduced to hurricanes and the typical paths they take. You will learn more about hurricanes in Lesson 4.4. In Laboratory Activity 4.3, you will learn how to track hurricanes. In the Atlantic/Caribbean region, hurricane season officially runs from June 1 to November 30. Throughout recorded history, hurricanes and smaller tropical systems have been known to bring strong winds and heavy rains not just to coastal areas, but far inland as well. You can be a big help to friends and family by being aware of the hurricane season and understanding their paths.

Methods

Equipment: colored pens or pencils (optional)
Procedure: Refer to video lab. Plot the data below on the hurricane tracking chart.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>23.1 N 75.1 W TD</td>
<td>15.0 N 42.1 W TS</td>
<td>15.0 N 59.0 W TS</td>
</tr>
<tr>
<td>2</td>
<td>24.5 N 76.5 W TS</td>
<td>17.0 N 59.3 W TS</td>
<td>17.9 N 65.0 W TS</td>
</tr>
<tr>
<td>3</td>
<td>25.9 N 80.3 W H-1</td>
<td>20.6 N 77.2 W TS</td>
<td>19.7 N 68.8 W H-1</td>
</tr>
<tr>
<td>4</td>
<td>24.9 N 82.6 W H-2</td>
<td>24.8 N 83.2 W H-1</td>
<td>21.9 N 73.3 W H-3</td>
</tr>
<tr>
<td>5</td>
<td>24.4 N 84.7 W H-3</td>
<td>26.5 N 86.2 W H-2</td>
<td>26.5 N 77.2 W H-2</td>
</tr>
<tr>
<td>6</td>
<td>25.2 N 86.7 W H-4</td>
<td>27.4 N 90.6 W H-4</td>
<td>30.0 N 77.4 W H-1</td>
</tr>
<tr>
<td>7</td>
<td>27.2 N 89.2 W H-5</td>
<td>28.9 N 94.7 W H-4</td>
<td>35.5 N 76.3 W H-1</td>
</tr>
<tr>
<td>8</td>
<td>31.1 N 89.6 W H-1</td>
<td>40.2 N 94.1 W TD</td>
<td>40.3 N 74.1 W TS</td>
</tr>
<tr>
<td>9</td>
<td>35.6 N 88.0 W TD</td>
<td>49.7 N 53.9 W ES</td>
<td>44.2 N 72.1 W ES</td>
</tr>
<tr>
<td>10</td>
<td>40.1 N 82.9 W ES</td>
<td>60.0 N 28.0 W ES</td>
<td>53.0 N 60.0 W ES</td>
</tr>
</tbody>
</table>

TD = Tropical Depression
TS = Tropical Storm
H-1 to H-5 = Category 1-5 Hurricane
ES = Extratropical Storm
Week 27

**Discussion:**

1. What are some similarities in the tracks of the three hurricanes you plotted?

2. What are some differences in the tracks of the three hurricanes you plotted?

3. Which tropical cyclone traveled the greatest distance?

4. Which tropical cyclone became a category 5 hurricane?

5. List two reasons for tracking hurricanes.
Laboratory Activity 4.4

Collecting Weather Data

Introduction

One of the most frequently asked questions is “How’s the weather?” It is a question that is on our minds every day, as we often have to plan our day and/or week around it. Predicting (forecasting) weather is a meteorologist’s job, and often we take for granted how difficult this task is. If it were easy, we would have month-long forecasts approaching 100% accuracy. Instead, in our supposedly high-tech and advanced 21st Century world, a weather forecast is good if it accurately predicts the weather for just a few days in a row. In Laboratory Activity 4.4, you will use Microsoft Excel or a similar spreadsheet program to compare a 10-day weather forecast to the observed weather data. You will finish by making and observing a “tornado”.

Methods

Equipment: Microsoft Excel or similar program, 10-day weather forecast and weather history report for your town (or use data listed below), tornado tube, two empty, 1 or 2 liter plastic soda bottles.

Chemicals: Water

Procedure: Refer to video lab.

Part 1: Forecast trends

Question: Does forecast accuracy decrease with time?

Hypothesis: Write your educated guess here:

Results

<table>
<thead>
<tr>
<th></th>
<th>Days 1-5 (mean % difference)</th>
<th>Days 6-10 (mean % difference)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Temp.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Temp.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Precipitation (% correct)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Discussion:

1. Was your hypothesis correct? Why or why not?

2. List at least two sources of error.

3. Considering the question answered in this experiment, list some similar questions that could be answered about weather data by conducting a science experiment.
Part 2: Make a tornado!

Watch the video lab and make your own tornado, then answer the following questions

1. What did you have to do in order to make the tornado form?

2. What did you have to do in order to make a bigger tornado?

3. Based on your observations using a tornado tube, along with what you learned in Lesson 4.4, what are some factors that affect the formation and strength of real tornadoes?
Laboratory Activity 4.5

Kepler’s Laws

“Needless to say, mathematics to Kepler provided the key that unlocked the rational order and harmony of God’s creation.”


Introduction

Johannes Kepler (1571-1630) was a humble Christian man with a brilliant mind. He believed that mankind’s study of nature should be for extracting practical uses, but first and foremost it should be about arriving at a deeper knowledge of God and His creativity. This is one reason I have asked you to memorize so many facts about nature in this course. If you know some basic facts, you are more likely to think of questions and contemplate further about God’s creation, and you may end up discovering some deep, underlying truth as a result, just like Kepler did. It is good and necessary to learn to use the Earth materials God gave us to make useful things, but it is also good to contemplate the beauty and harmony that He incorporates into His creation. After years of studying data, much of which was collected by his predecessor, Tycho Brahe, Kepler captured some of the beauty and harmony of planetary motion in three laws:

First Law: The path of each planet around the Sun is an ellipse, with the Sun at one focus.

Second Law: Each planet revolves around the Sun so that an imaginary line connecting it to the Sun sweeps over an equal area in an equal amount of time.

Third Law: The orbital periods of the planets, and their distances to the Sun, are proportional.

In Laboratory Activity 4.5, you will learn more about these three laws, and use actual planetary data to understand them.

Methods

Equipment: tacks (2), cardboard, string or fishing line

Procedure: Refer to video lab. Record your data on the following page.
**Part 1: Kepler's 1st Law**

Anatomy of an elliptical orbit: Watch the video lab and label the following ellipse.

![Elliptical Orbit Diagram](image)

Make some of your own ellipses below.

Does the eccentricity of planetary orbits result in a more circular-shaped or more oval-shaped orbit?
Part 2: Kepler’s 3rd Law

More specifically, the ratio of the square of a planet’s orbital period in years to the cube of its semi-major axis in meters is constant. Use your calculator (or make a spreadsheet program) and fill in the blanks below.

<table>
<thead>
<tr>
<th>Planet</th>
<th>T (years)</th>
<th>a ((10^{10} \text{ m}))</th>
<th>T²</th>
<th>a³</th>
<th>T²/a³ ((10^{-34}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mercury</td>
<td>0.241</td>
<td>5.79</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Venus</td>
<td>0.615</td>
<td>10.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Earth</td>
<td>1.0</td>
<td>15.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mars</td>
<td>1.88</td>
<td>22.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jupiter</td>
<td>11.9</td>
<td>77.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saturn</td>
<td>29.5</td>
<td>143</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uranus</td>
<td>84</td>
<td>287</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neptune</td>
<td>165</td>
<td>450</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pluto</td>
<td>248</td>
<td>590</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Mathematics is considered the language of science. Do you think the variability in your \(\frac{T^2}{a^3}\) calculations was enough to reject that idea? Why?

2. In his book, *Epitome of Copernican Astronomy*, Kepler wrote “I consider it a right, yes a duty, to search in cautious manner for the numbers, sizes and weights, the norms for everything He has created. For He Himself has let man take part in the knowledge of these things and thus not in a small measure has set up His image in man.”

Based on Kepler’s words, answer the following questions.

Do you think patience or impatience is the mark of a good scientist?

Do you think faith in God encouraged or discouraged Kepler as He studied nature?

Do you believe you were created in God’s image? Why?
Laboratory Activity 4.6

Rockets

Introduction

Rockets are defined as cylindrical projectiles that can be propelled to a great height or distance by the combustion of their fuel. Rockets are used for the majority of space flights, especially now with the cancellation of the Space Shuttle program in 2011. The NASA Saturn V rocket shown below was used during the Apollo 11 mission to the Moon you studied in Lesson 4.6. Rockets are an amazing example of mankind’s creative abilities, and are a testimony that we truly are created in the image of the best Creator of all. He designed us to be creative, too!

In Laboratory Activity 4.6, you will design and launch a model rocket, and estimate its altitude. If this is your first time to build a model rocket, be patient, read the instructions carefully before you build, and most of all, have fun!

Methods

Equipment: Alpha III model rocket launch set, protractor, string, weight, wood glue or Elmer’s glue, ruler, sharp knife (razor blade or hobby knife), 4 AA batteries.

Chemicals: Estes A8-3 engines

Procedure: Refer to video lab. Record your data on the following page.
Week 30

**Results:**
Estimate the height of your rocket

\[ H = b \tan \theta \]

<table>
<thead>
<tr>
<th>Launch</th>
<th>( b )</th>
<th>( \theta )</th>
<th>( \tan \theta )</th>
<th>( H = b \tan \theta )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Discussion**

1. What units did you use to measure your launch height?

2. What was the average height of a rocket launch?

3. List at least 3 sources of error in calculating your launch height.

4. What are 2 questions about model rockets you could answer by doing an experiment?

Lab 4.7: There are several computer programs used in next week’s lab activity. You are not required to download them, but if you want to, it would be a good idea to install them between now and next week. They all work on Windows or Macintosh computers. Here they are:

**Google Earth:** earth.google.com

**Stellarium:** stellarium.org

**Eyes on the Solar System:** solarsystem.nasa.gov/eyes/
Laboratory Activity 4.7

Computer-based Astronomy

Introduction

There are many powerful programs available to study the night sky. In Laboratory Activity 4.7, you will learn to use several astronomy programs. Make sure you at least have the planets and constellations memorized from your Facts Practice, as this will help make the learning experience more meaningful. Also, you will want to download the following programs (you should have Google Earth already installed from Lab 1.2):

Google Earth: earth.google.com
   If you have a smart phone, download Google Sky.
Stellarium: stellarmium.org

Eyes on the Solar System: solarsystem.nasa.gov/eyes/

Methods

Equipment: Software programs listed above. PLEASE NOTE: Do not feel obligated to download these programs to your computer. You can just watch the video lab.

Procedure: Refer to video lab. Record your data on the following pages.

Part 1: Google Sky

right ascension (RA) - like geographic longitude, measured relative to a zero point in the sky where the sun crosses the celestial equator at the March equinox.

declination (Dec) - like geographic latitude, measured relative to the celestial equator, which is in the same plane as Earth’s equator.
Use Google sky to identify the right ascension and declination for the following objects.

<table>
<thead>
<tr>
<th>Object</th>
<th>RA</th>
<th>Declination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sirius</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Polaris</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Betelgeuse</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small Magellanic Cloud</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Andromeda Galaxy</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Optional: Use Google Sky on your smartphone to locate celestial objects relative to your current position.

**Part 2: Stellarium**

List 3 constellations visible in your location from the North, South, East and West.

**North:**

**South:**

**East:**

**West:**

Find the North Star (Polaris). Click on it and record its RA/DE(J2000). Is it the same as you found on Google Sky?

Besides Polaris, list 5 other stars in the constellation Ursa Minor.
Part 3: Eyes on the Solar System

Name at least one spacecraft orbiting each of these objects. If nothing is orbiting the object, leave it blank.

<table>
<thead>
<tr>
<th>Planetary Object</th>
<th>Spacecraft Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earth</td>
<td></td>
</tr>
<tr>
<td>Earth’s Moon</td>
<td></td>
</tr>
<tr>
<td>Mars</td>
<td></td>
</tr>
<tr>
<td>Venus</td>
<td></td>
</tr>
<tr>
<td>Jupiter</td>
<td></td>
</tr>
<tr>
<td>Saturn</td>
<td></td>
</tr>
</tbody>
</table>

Make a sketch of the Aqua satellite orbiting Earth. What is Aqua’s main purpose?
Week 32

End of Section 4

No Lab Activity This Week
Other products from Digitial Interactive Video Education:

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- Math 65 2nd and 3rd edition
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- Algebra 1/2 2nd and 3rd edition
- Algebra 1 3rd edition
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