LESSON PLAN

A. Lesson/Unit Title

Inquiry thinking through the curriculum

This project does not fit nicely into a lesson plan format given that it is a concept that is woven into the yearlong curriculum.

The basic concept is teaching inquiry thinking through a series of inquiry labs and question development for a research, science fair project.

B. Area of Focus:

Inquiry thinking

C. Subject and Grade

Earth Science
6th Grade

D. Duration

All year

E. Necessary Equipment and Materials

See attached page of Web Sites good for research on varied earth science topics
See attached Materials List for Inquiry Labs

F. Necessary Technology Tools

Computer
Word Processing program
Power Point

G. Standards Addressed

Science:

The Shaping of the Earth's Surface
Heat and Thermal Energy
Energy
Ecology
Investigation and Experimentation

7a: Develop a hypothesis
7b: Select and use appropriate tools to perform tests, collect data, and display data.
7c: Construct appropriate graphs from data and develop qualitative statements about the relationships between variables
7d: Communicate the steps and results from an investigation in written reports and verbal presentations.

Writing:

ELD Standards that support Organization and Focus

Strategies: 1.6: Revise writing to improve organization and consistency of ideas within and between paragraphs.

Application: 2.3: Write a research report

a. Pose relevant questions with a scope narrow enough to be thoroughly covered.
b. Support the main ideas with facts, details, examples, and explanations from multiple author sources.
c. Include a bibliography

H. Learning Objectives

- Students will be able to formulate their own question for experimentation and research.
- Students will answer open-ended questions using observations, evidence, and previously accepted explanations.
- Students will demonstrate an understanding or knowledge of the concepts and skills being taught through their performance of inquiry labs.
- Students will evaluate their own progress and knowledge
- Students will ask related questions that encourage further investigation

I. Instructional Design

Introductory Activities:

Inquiry Lab: Whoosh Bottle (See Handouts for teacher and student.)

Teachers Activities

- Guiding Questions in developing inquiry thinking
- Guiding the Development of the research project
- Demonstrations

Students Activities

- Inquiry labs through out the year
- Development of a researchable question and science fair project

Culminating Activities

- Final Inquiry Lab
- Final Research/Science Fair Project

J. Assessments

- Guideline for scoring Inquiry labs
- Rubric for Research Paper
- Rubric for Science Fair Experiment
- Rubric for Display Board

Website Description

According to the National Research Council, 1996, p. 105 *All students should have the opportunity to use scientific inquiry and develop the ability to think and act in ways associated with inquiry, including asking question, planning and conducting investigations, using appropriate tools and techniques to gather data, thinking critically and logically about relationships between evidence and explanations, constructing and analyzing alternative explanations, and communicating scientific arguments.*

The following set of worksheets, inquiry labs, and websites are an attempt to develop a construct that aids 6th grade earth science students in developing the above skills and provide them with a venue for practicing those skills. The project begins with inquiry labs, weaves in the construct for a science fair project and ends with assessments that document growth in students abilities to ask meaningful questions, demonstrate understanding through proper use of tools, self evaluate their own growth in thinking and dig deeper into evidence provided.

INQUIRY THINNKING LABS
MATERIALS LIST

5-gallon plastic water bottle
Matches
Alcohol
Empty jar with lid
Dry sand
Thermometer
Several 30 cm lengths of wire hanger
Ruler
Thick pencil
Eraser
Strong flashlight
Corks
Large needle
Eyedropper
Black and white paper
Small jar with lid
Large drinking straws
Scissors
Bottles
Empty tin soda can
Hot plate
Bowl
Small, medium and large beakers
Erlenmeyer flask
Alcohol burner
Mothballs
Large steel nail
Glass baby food jar
Hammer
Streak plates
Magnifying glass
Safety goggles
Pennies
Newspaper
Cloth sacks
Rock samples
Clear plastic cups
Pie pan
Cardboard bath tissue tubes
Eggs
Broom
Pyrex funnel-medium
Bottle caps
cardboard box
straight pins
paper clips
cello tape
paper cards
clay
empty soda pop bottles
small electric fan
copper wire
activated charcoal
detritus
pH strips
ring stands
sand
vinegar
dishwashing detergent
heat resistant gloves
small nail
gravel
soil
hand lens
plastic spoons
graduated cylinders
rubbing alcohol
blocks of wood
scoop
string
transparent plastic container
sandwich bags
rice
metric rulers
paper cups

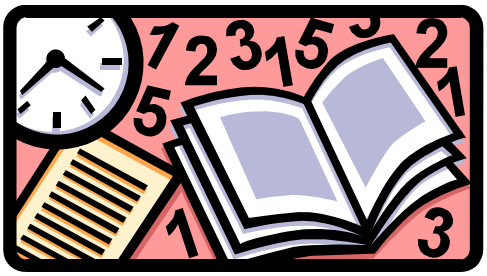
Earth Science Research Ideas.

How are tornadoes formed and what causes them?
What Causes Dew? Frost? How are they related to humidity?
How does fog form?
Is there a relationship between cloud shape, temperature and height?
What is our local precipitation compared to the rest of the world?
Which affects evaporation the most.. air temperature, water temp or wind speed?
How does barometric air pressure predict weather?
Why is the sky blue and then sometimes changes color?
How are mountains created?
What causes sea floor spreading?
How is coal formed? Are there different types?
Does the type of soil have an effect on whether or not a sinkhole will form?
How can I measure the size of the earth?
How can I determine the difference between two different minerals?
Does temperature affect the size of crystals and the rate at which they grow?
How do synclines, anticlines, and faults form?
Will filtration or evaporation help clean pollutants from water?
Why do some parts of the ocean turn over while others do not?
Do molecules move in a liquid?
How does heat affect the dissolving time of substances and the movement of molecules?
How is heat transmitted by radiation, convection and conduction?
What effect does heat have on the states of matter?
How do birds differ from mammals?
What are minerals and how do we test for them?
How clean is the air you breath?
What are some effects of water pollution?
How can we try to reverse the effects of an oil spill?
Can we use phosphates to reverse the effects of water pollution?
What are air pollutants and how are they formed?
How might pollutants in the air affect plant growth?
How can we find out if vehicles pollute the air?
What is smog and how is it formed?
How does air pollution affect the physical things in an environment?
Why does it appear that there are phases of the moon?
How are clouds and fog formed?
How can solar energy be used?
How can you measure air pressure changes?
How can you measure humidity?
Why are the days shorter in winter and longer in summer?
Does water in a lake have energy?

WOW! EARTH SCIENCE IS INTERESTING!

Look through the contents in your textbook. Find something that looks interesting. Go to that section and look through it.
Keep doing this until you find at least FIVE things that you think are cool, interesting, you did not know.

Write them down.



1. Subject_____ page _____
   Main idea _____

   _____

   _____

   _____

   _____

   _____

   _____

2. Subject_____ page _____
   Main idea _____

   _____

   _____

_____

_____

3. Subject_____ page _____
Main idea _____

_____

_____

_____

_____

4. Subject_____ page _____
Main idea _____

_____

_____

_____

_____

5. Subject_____ page _____
Main idea _____

_____

_____

_____

_____

NARROW YOUR TOPIC

You now have several topics that you found interesting. Choose ONE of those topics and do a little research on it.

TOPIC _____

Find books, newspaper articles, and magazines on your topic, go on the Internet. Read about your topic.

Write down some of the things you learned about this topic

tach more paper if you need it.

Name _____ ___

Period _____

What is a "Good" Question?

Now that you have chosen your topic and done some early research on it your next step is to ask some good questions about it and think about what the answer to the question might be (hypothesis). The trick is to find a question

that you can conduct an experiment to solve, a question that is not too big or too small.

Some things to think about are:

What do you already know about this topic?
What would you like to know? What makes you say…"How…..What…..Why?"
How might you go about finding out the answers to what you want to know?

A good question usually sounds like: "Can I improve results by doing this?" or "If I try different ways of getting something done what gets the best results?" A **BAD** question is "If I do that, what happens?"

As you think of your questions write down what you think the possible answer to your question might be.

TOPIC _____

Three Questions I have are:

1. Question_____

Hypothesis _____

2. Question_____

Hypothesis _____

3. Question_____

Hypothesis _____

Teachers Comments

RESEARCH NOTES

Author(s) _____

Resource: Title_____

Publisher _____

Publication Date _____**Volume No.**_____ **Page(s)** _____

Information _____

"Rubric for Research Paper"

Score	Format	Content	Resources

High	• Paper is Typed, 12 font, double spaced • All headings are bold and 14 font • Spelling/Grammar is 95% + correct. • All paragraphs are tabbed. • Includes a title page in proper format.	Contains all sections: Abstract, Hypothesis, data, analysis, conclusion • Question is relevant and narrow enough. • Content is in own words • Content is accurate and supported by facts from multiple sources	• At least 4 resources were used, 3 from a different medium • Format of bibliography is 95% + correct.
Medium	• Paper is typed. • Headings are used. • Spelling/grammar is 80%+ correct. • All paragraphs are indented. • Includes a title page with name, title no picture	Contains all sections listed above. • Question is relevant. • Majority of the paper is in own words. • Content is mostly accurate.	• 3 resources were used, 2 from a different medium • Format of bibliography is 80% + correct.
Low	• Paper is handwritten • Spelling/Grammar is 65%+ correct. • Paragraphs are indented • Includes a title page	Contains less than the five sections listed in "high" category • Question is irrelevant. • Majority of the paper is in someone else's words.	• 2 resources were used from a different medium • Format of bibliography is 70% + correct.
Not Acceptable	• Paper is difficult to read or unreadable. • Spelling/Grammar is less than 65% accurate • No paragraphs. • No title page	Contains less than the five sections mentioned in High Category • Question is irrelevant. • Any part of the paper is plagiarized.	• 1 resource was used. • No bibliography.

_____ Format Comments:

_____ Content Comments:

_____ Resources Comments:

"Rubric for ELD Research Paper"

Score	Organization and Focus

High	Contains all sections: abstract, hypothesis, data, analysis, conclusion in order • Includes a completed and thorough outline of research • Information is thoroughly summarized • Research is focused • Standard grammatical forms are used. • Contains original ideas • Includes a bibliography in correct format • A minimum of 3 sources are used
Medium	Contains all sections: Abstract, Hypothesis, data, analysis, conclusion • Created an Outline of topic. • Information is summarized • Research is fairly focused • Standard grammatical forms are mostly used. • Contains 1 original idea • Includes a bibliography A minimum of 2 sources are used
Low	Contains less than the five sections listed in "high" category/ May be out of order • Outline is incomplete • Information is copied • Research is unfocused. • Standard grammatical forms are attempted. • Contains no original ideas • Includes a bibliography A minimum of 1 source is used
Not Acceptable	Sections not labeled, missing and/or out of order • No Outline of topic. • Summarized information missing • Research is unfocused. • Standard grammatical forms are not attempted • Contains no original ideas • No bibliography

Comments:

"Rubric for Display Board"

Score	Display

High	• On Time • Testable question • Hypothesis based upon early research • Materials list and Methods thorough and complete • Results and Conclusion thorough and complete • Includes pictures/sketches • Includes explainable graphs • Idea is original • Strong Eye Appeal, very creative layout, easily read
Medium	• On Time • Testable question • Hypothesis based upon research • Materials list and Methods complete • Results and Conclusion complete • Includes pictures/sketches • Includes graphs • Idea is somewhat original • Eye Appeal, creative layout, easily read
Low	• Project is late but in time for the science fair • Testable question • Hypothesis • Materials list and Methods • Results and Conclusion • Poor pictures/sketches • Graphs difficult to understand, unclear to reader • Poor layout, looks rushed, lacks attention to detail
Not Acceptable	• Too late for science fair • Lacks a testable question • Hypothesis is unclear/unrelated to question • Materials list and Methods incomplete • Results and Conclusion incomplete • No pictures/sketches • No graphs • No attention to detail/creativity

Comments:

GRADE SHEET FOR DISPLAY BOARD

	Point Possible	Points Earned
1. Display in on Time	10	
2. Question	5	
3. Hypothesis	10	
4. Completeness of Materials and Method	15	
5. Results	10	
6. Conclusion	10	
7. Pictures/Sketches	10	
8. Graphs	10	
9. Originality of Idea	5	
10. Eye appeal	10	
11. Measurements/Sturdiness	5	
TOTAL	100	
PERCENT		
GRADE		

"Step Sheet: Creating a PowerPoint Presentation"

PowerPoint Presentation

This step sheet will help you create a Microsoft PowerPoint presentation.

Using Microsoft PowerPoint

To create a presentation, follow these steps.

- **Opening Microsoft PowerPoint**

  (Note: If the Clip Gallery installed with your Microsoft suite does not include the images you need, use the step sheet titled "Gathering and Inserting Electronic Images" to find the images through other avenues.)

Step 1
Find the Microsoft PowerPoint icon, which could be in your application folder or in a Microsoft Office folder.

Step 2
Double-click the Microsoft PowerPoint icon to open the Project Gallery.

Step 3
In the file menu choose Format and Apply Design Templates. If the designs automatically appear choose the first slide, top row and click OK. This will be your Title Slide.

- **Inserting Text and Clip Art**

Step 1
On the title page, click in the text field and type: "HIV/AIDS." Click in the bottom dialogue box and write a catchy subtitle.

Step 2
From the Insert menu choose New Slide or command "M" on the keyboard and choose a layout for your first slide.

Step 3
Repeat Step 2 three more times for a total of five slides. (You may choose to do more than 5 slides for your presentation.)

Step 4
In Normal View, toggle between slides by clicking on the thumbnail icon displayed to the left on the screen.

Step 5
Return to the second card. Click the text field and enter the data for your slide.

Step 6
To add clip art, click beneath the text field. From the Insert menu choose Picture, then Clip Art.

Step 7
Adjust the size of the clip art by clicking it until the box handles appear around it. From the file menu select Format, then Picture, then from clipart.

Step 8
Choose the picture from the clipart file you would like to insert and click Insert.

Step 9
To change the size of your clipart, click on the picture so that there are small black boxes surrounding the picture. Choose Format, then Picture from the file menu. Click on the thumbnail Size and choose percentage of height and width you would like to scale the picture to.

Step 10
Continue with each slide.

- **Insert a Picture From a File**

Step 1
Choose Insert, then Picture, then From File.

Step 2
Navigate to file folder where the picture is currently located.

Step 3
Click on the picture you would like to insert then choose Insert. To size the picture follow step 9 in "Inserting Clipart."

- **Inserting Electronic Images**

See Step Sheet: "Inserting Electronic Images."

➢ Animating Text

Step 1
Toggle to Slide 1. Click the text box. From the Slide Show menu choose Animation, Custom. Click the Effects tab. From the Entry effect pull down menu choose an Entry effect.

Step 2
From the Entry sound pull down menu, choose an Entry sound.

Step 3
Click the Order and Timing tab. Click the radio button Automatically. Select three seconds.

Step 4
Click the Options tab. From Text entry options, select "By word." Click OK>

Step 5
Toggle to each slide and repeat the steps above, choosing your own animations for each slide.

- **Creating a Slideshow**

With the PowerPoint presentation open and the text and clip are in place, it is time to connect the slides and create the slideshow.

Step 1
From the Slide Show menu, choose Slide Transition. From the pull down menu beneath the picture of the dog choose a transition for the slides.

Step 2
Select "On a mouse click" for slide advancement. This allows you to manually move the slides at your pace, which allows for discussion.

Step 3
Select a sound from the pull down menu to accompany the transition if desired.

Step 4
From the upper right corner of the dialog box, select Apply to All. Save your presentation.

Step 5
To show the presentation, return to the Slide Sorter View. Click the title page. From the slide presentation control menu (bottom left corner) click the small screen icon (last one on the right). The presentation will open and begin as you click the mouse.

"Rubric for Power Point Presentation"

Score	Content	Presentation	Tools
High	• All information is correct and accurate • No spelling/grammar errors. • Includes all necessary information	Contains six + slides of the following: • Title Slide • Question slide • Hypothesis • Experiment/research • Analysis • Conclusion	• Different transition to each slide. • Contains 5 different animations with sound. • Contains 4 different slide layouts. • Contain 4 different clip art pictures. • Contains a graph/chart
Medium	• Information is mostly correct and/or accurate • 5 or fewer spelling/grammar errors. • Most information is included	Contains five of the six slides mentioned in High Category	• Two slide transitions are the same • Contains 4 different animations with sound. • Contains 3 different slide layouts • Contains 3 different clip art pictures. • Contains a graph/chart
Low	• 70% or less of the information is correct. • More than 5 spelling/grammar errors. • Less than 70% of the information is included	Contains four of the six slides mentioned in High Category	• More than two slides have the same transition • Contains 3 different animations with sound. • Contains 2 different slide layouts. • Contains 1 clip art.
Not Acceptable	• Information is largely inaccurate • More than 10 spelling/grammar errors. • Less than 50% of information is included.	Contains less than four of the five slides mentioned in High Category	• All transitions are the same. • Contains less than 3 different animations. • All slides have the same layout. • Contains no clipart.

_____ Content Comments:

_____ Presentation Comments:

_____ Tools Comments:

Guideline for Growth in Inquiry Thinking

Student _____ Inquiry Lab # _____

GOAL: A score of 9 or higher.

a = 3 points
b = 1 point

1. Questions/Conclusions

    a. Answers open-ended questions using observations, evidence, and previously accepted explanations.

    b. Draws conclusions, not using evidence or previously accepted explanations.

Comments _____

2. Understanding

    a. Demonstrates an understanding or knowledge of the concept or skill

    b. Offers only yes-or-no answers, memorized definitions, or explanations as answers.

Comments _____

3. Self Evaluation

    a. Evaluates his or her own progress and knowledge

    b. Fails to express satisfactory explanations in his or her own words.

Comments _____

4. Reaching further

    a. Asks related questions that would encourage further investigation

    b. Introduces new, irrelevant topics

Comments _____

SCORE: _____

DATA SHEET FOR GROWTH IN INQUIRY THINKIN

Students Name	Period	Lab 1	Lab 2	Lab 3	Lab 4	Lab 5	Lab 6	Lab 7	Lab 8	L

Individual Record sheet

Name _____

Period _____

Score		Things to think about
	LAB 1:Whoosh Bottle	
	LAB 2:The Collapsing Can	
	LAB 3:Changing Gas into Crystals	
	LAB 4:Rocks: All the Same?	
	LAB 5:Eggciting	
	LAB 6:How Does a Geyser Work?	
	LAB 7: Which is the Best Wind vane?	
	LAB 8: The Heat Race	
	LAB 9:Clean Up Your Act	
	LAB 10: 2+2=4?	
	LAB 11:Rising Mountains	
	LAB 12:Adaptation Behooves You.	

INQUIRY THINKING
LAB 1
(Teachers Page)
The Whoosh Bottle

MATERILAS:

5 gallon plastic water bottle
Rubbing alcohol
Matches
Graduated cylinder

PROCEEDURE:

1. Discuss with students what energy is.
2. Pour 10 mL of alcohol into the water bottle and swoosh around the sides. Dump out any extra liquid.
3. Turn the lights out and make sure there is enough ceiling height and that all the kids can see the bottle.
4. Wearing goggles, light a match and put into the water bottle.

QUESTIONS:

1. What did you see, hear, feel and/or smell?
2. Why did the bottle make noise?
3. What made the noise?
4. What was in the bottle afterwards?
5. Where did this liquid come form?

EXPLANATION:
The match provides heat, which causes the highly volatile alcohol molecules to react. This reaction produces heat and light. The reaction also pulls oxygen molecules out of the atmosphere within the bottle. This creates a less dense environment compared to the atmosphere outside the bottle. This causes air to go rushing into the bottle creating the sound we here.

ENERGY DISCOVERY MATERIALS

Table 1:

Empty jar with lid
Dry Sand
Thermometer

Table 2:

Several 30 cm lengths of coat wire hanger

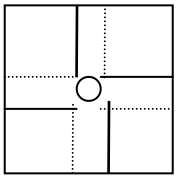
Table 3:

Book
Ruler
Thick pencil
Eraser

Table 4:

Strong Flashlight
Piece of cork
Large needle
Eyedropper without the plunger, small end sealed shut with a flame and 1-1/2 to inches cut off at the other end.

Piece of paper black on one side and white on the other cut and folded as shown:



Small jar with lid

Table 5:

Several large drinking straws
Scissors

Table 6:

3 identical bottles
Pitcher of water
Wooden ruler

INQUIRY THINKING
LAB 1
(Student Page)
The Whoosh Bottle

1. What is Energy? How do we know what energy is?

2. Draw what you see:
   BEFORE AFTER

3. What are three questions that come to your mind after the demonstration?
   I.

   II.

   III.

4. What results did you see?
   A: sight _____
   B: sound _____
   C: touch _____
   D: smell _____
   E: other _____

5. How does this prove what energy is?

6. What materials do you have at your table?

7. How could you use these materials to also show that energy exists?

COOL SCIENCE

INQUIRY LAB WORKSHEET

LAB #: _____

TITLE: _____

OBSERVATION:

QUESTIONS:

Choose one of your questions and research an answer to it. (Attach more paper if necessary.)

_____

_____

_____

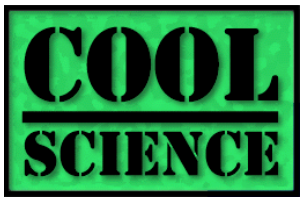
_____

_____

_____

What could you do to test or conduct an experiment to test out your question?

What other questions does this bring up?



INQUIRY LAB WORKSHEET

LAB #: _____

TITLE: _____

QUESTION:

HYPOTHESIS:

WHAT DID YOU DO TO TEST YOUR HYPOTHESIS?

WHAT MATERIALS DID YOU USE?

WHAT DID YOU FIND OUT?

WHAT OTHER QUESTIONS DO YOU HAVE?

INQUIRY THINNKING
LAB 2

The Collapsing Can

MATERIALS:

Empty tin soda can
Hot plate or burner
Bowl of ice water

PROCEEDURE:

1. Put just enough water in the bottom of the can to cover the bottom.
2. Heat the can over the hot plate or burner.
3. Let the water boil vigorously.
4. Invert can in a bowl of ice water.

QUESTIONS:

1. What was in the can besides water?
2. What happens when the water is boiled?
3. What will the air in the can do when water vapor is formed?
4. What are three questions that come to your mind after seeing this demonstration?

EXPLANATION:

Before heating, the can was filled with water and air. By boiling the water, it changed states, from liquid to gas. The water vapor pushed the air that was inside, out of the can. In inverting the can in cold water we trap the air outside of the can and prevent it from going back into the can. The cooling of the can condenses the water vapor back to water. All the vapor, which took up the interior space of the can before, is now turned into a few drops of water, which takes up much less space. This causes the pressure to drop and the atmospheric pressure is therefore pushing on the can and crushing it.

The total force working on the outside of the can is the total of the can's surface area in cm2 multiplied by 1 kg.

INQUIRY THINNKING
LAB 3

Changing Gas Into Crystals

MATERIALS:

Medium size beaker
Erlenmeyer flask or beaker with larger base than 1st beaker
Alcohol burner and stand
Mothballs

PROCEEDURE:

1. Place 4 or 5 mothballs or a scoop of flakes in the beaker and heat it slowly over a small flame.
2. Fill the flask (second beaker) halfway with cold water and stack it on top of the beaker holding the mothballs.
3. Leave the alcohol burner on until all the mothballs are melted, then blow the flame out and leave the flask on top of the beaker for another 5-10 minutes. (A longer time is even better.)
4. Lift the flask carefully and slant the bottom towards the students to show the crystals.

QUESTIONS:

5. What is the process of solid to liquid change called?
6. What is the process of solid to gas change called?
7. What is the process of gas to solid change called?
8. Where does the solid to gas change occur in daily life?
9. What purpose does the cold water have in the flask?
10. What other material behaves like the mothballs when heated?

EXPLANATION:

By heating the mothballs, they change from solid into liquid state and also into the gaseous state directly. This first process is called melting or liquefying and the second is sublimation. Other processes are named in the following scheme:

		GAS		
	Condensation		Evaporation	
Sublimation		LIQUID		Sublimation
	Solidifying		Liquefying	
	(freezing)	SOLID	(melting)	

Other materials that sublimate like mothballs are sulfur (found in craters of volcanoes, iodine and ice.

INQUIRY THINNKING
LAB 4

Rocks: All the same?

MATERIALS:

Large Steel nail	Magnifying glass	Newspaper
Glass baby food jar	Safety goggles	Cloth sack
Hammer	Penny	Rock Samples
Streak plates		

QUESTIONS:

11. Where would you find different kinds of rocks?
12. How are rocks the same and different?
13. When you feel or look at a rock how might they differ?
14. How might we test rocks for similarities or differences?

PROCEEDURE:

1. After completing the on line tutorial about rocks and the rock cycle see if you can come up with different tests to find out what type of rock you have
2. Using the materials at your table how could you test and categorize the rocks?
3. Be sure to create charts, diagrams and write down careful notes about what you did.

EXPLANATION:

The Mohs hardness scale ranks rocks from 1 to 10, with talc being the softest at 1 and diamond hardest at 10. Rocks can be identified by the following characteristics

Metallic Luster

Suspect a sulfide first, especially if you can detect a sulfur smell. Next most likely is an oxide, then perhaps a metallic element or compound of one of the semi-metals (As, Se, Bi, Te). Non-metallic luster could indicate any other group. However, some of the sulfide minerals are non-metallic, notably sphalerite, orpiment, realgar and cinnabar. The last three are identified by their bright colors.

Not many minerals can appear either metallic or non-metallic. Hematite and sphalerite are the most common. Muscovite mica can appear silvery.

High Density

Suspect a sulfide first, especially if you can detect a sulfur smell. Next most likely is an oxide, then perhaps an element or compound of one of the semi-metals (As, Se, Bi, Te). Few non-metallic minerals have high density; barite and sphalerite are the most common. Light colored dense minerals are most likely barium or lead minerals.

Hardness

If a mineral can scratch glass and is non-metallic, suspect a silicate first, then perhaps one of the oxide minerals like corundum or rutile. Always suspect quartz first, then feldspar. If it's metallic in luster, suspect an oxide. Very soft non-metallic minerals

that can be scratched easily with a knife are most likely to be carbonates, halides or sulfates.

Cleavage

* Cubic or octahedral, soft, non-metallic: suspect a halide
* Cubic and metallic: suspect a sulfide
* Rhombohedral: suspect a carbonate. Check with acid test
* Other soft mineral with good cleavage: suspect a sulfate
* Thin sheets: suspect mica
* Hard splintery mineral: suspect a chain silicate
* Hard, with good blocky cleavage: suspect feldspar

Color

Color is far down the list because it is easily the least reliable characteristic of minerals. Color can always be due to an impurity or surface stain. As an undergraduate, I was once asked to try to identify a hard bright blue mineral. I even had X-ray data to help. After running through all the copper minerals with no luck, I looked at the X-ray data for all minerals and found a perfect match with diopside. We had a common pyroxene mineral that is normally white, but in this case was stained by copper. So always suspect that color may be due to impurities.

* Bright blue to green: suspect a copper mineral. Dull greens are usually not copper greens, nor are blues that have a violet cast.
* Earth tones are almost always due to iron, either as a principal ingredient or as an impurity or surface coating.
* *Bright* yellow, orange or red: suspect one of the non-metallic sulfides, then one of the transition metal radicals (chromate, vanadate, etc.). A few oxides are also brightly colored. Some uranium minerals are bright yellow or yellow-green.
* Pink: if hard, suspect potassium feldspar. The common manganese minerals rhodonite (silicate) and rhodochrosite (carbonate) are also pink, and manganese can stain other minerals pink as well. Some lithium silicates are also pink or lavender.
* Black or dark green: if hard, suspect a ferromagnesian silicate

INQUIRY THINNKING
LAB 5

An Egg citing Experiment

MATERIALS:

3 drinking glasses or clear plastic cups
Tap water
Pie pan
3 cardboard bathroom tissue tubes
3 eggs
Broom

PROCEEDURE:

4. Fill the glasses in a triangle near an edge of the table.
5. Set the pie pan on top of the glasses so that one edge of the pie pan extends over the edge of the table.
6. Place a cardboard tube vertically over each glass. Then place an egg sideways on top of each tube.
7. Stand the broom at the edge of the table so that the handle touches the edge of the pie pan. Carefully step on the bristles of the broom to hold it in place.
8. Tell the students that you are going to knock the edge of the pie pan with the broom and challenge them to predict what will happen.
9. Pull the broom handle toward you and release it.
10. The broom handle should spring forward, driving the pie pan and the tubes out from under the eggs. The eggs should drop into the glasses of water directly below them.

QUESTIONS:

1. Have students write down 3 questions of their own. And discuss the events with them.
2. Be sure to explain Newton's first law of motion. **An object at rest tends to stay at rest and an object in motion tends to stay in motion with the same speed and in the same direction unless acted upon by an unbalanced force.**
3. Have kids develop their own simple experiment to demonstrate this first law.

EXPLANATION:

The broom applied force to the pie pan. When the edge of the pie pan struck the tubes, some of the force was transferred to the tubes. The tubes did not transfer enough of this force to the eggs to overcome their inertia. Therefore, the eggs remained in place until their support was removed. Gravity pulled the eggs downward until the water cushioned their fall and absorbed their downward energy.

INQUIRY THINNKING
LAB 6

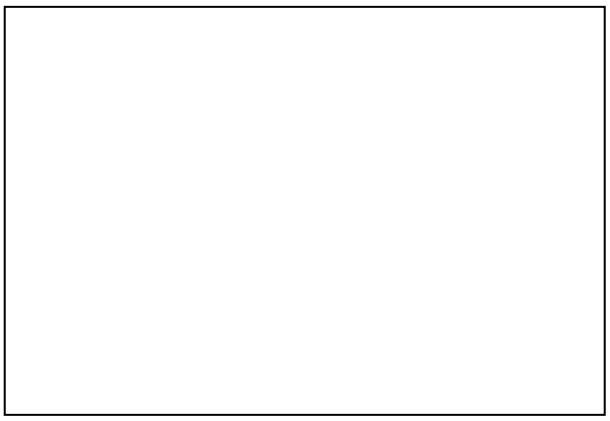
How Does a Geyser Work?

MATERIALS:

Pyrex or aluminum pie plate
Medium sized Pyrex funnel
Three bottle caps
Hot plate or burner and stand
Cardboard box

PROCEEDURE:

11. Fill the pie plate half full with water and place the funnel on it, resting on the three bottle caps.
12. Place the pie plate on the hot plate or over the burner.



13. Heat the water in the pie plate until boiling. Make a hole in the bottom of the box, cover the whole set-up with it and let the funnel stem protrude through the hole. Observe geyser action!

QUESTIONS:

1. What did the water do when it was heated?
2. What made the water spurt out of the funnel?
3. What can we compare the cardboard surface to?
4. Why does the got water inside the earth escape to the surface?
5. What will happen when the heat is turned off?
6. How can we let the geyser erupt again?
7. How similar is volcanic action compared to geyser action?

EXPLANATION:

By heating the water it expands. At the moment that it boils, water vapor is formed, pressure is built up under the funnel and this force pushes the water out of the

funnel. When the heat is taken away, the water cools down and the eruptions stop. In order to start the geyser to erupt again, the water needs to be heated to boiling.

This demonstration illustrates clearly the similar working of the hot water under the earth's surface, the build-up of pressure, and the release of the water through small cracks in the earth's surface: called the Geyser. Volcanic action is quite similar except that instead of water, we have molten magma, which comes out of the mouths of volcanoes as lava.

To make it inquiry oriented, conceal the set-up and let students find out the reason why the water spurts out.

INQUIRY THINNKING
LAB 7

Which is the Best Wind-vane?

MATERIALS:

Drinking straws	Clay
Straight pins	Scissors
Paperclips	Empty soda pop bottle
Cello tape	Small electric fan
Paper cards	

PROCEEDURE:

1. Provide students with straws, paper cards, pins, scissors, cello tape, paper clips and pop bottles
2. Ask students to construct a good working wind-vane (the best one will turn fastest into the wind direction)
3. Ask students what the conditions are for the wind-vane to work.

QUESTIONS:

1. What is the difference between the front and the rear part of the wind-vane? Is there a difference in surface area?
2. What must the horizontal bar be able to do to turn in the directions of the wind?
3. Where must the pivot of the arrow (horizontal bar) be located?
4. What can be used as a base or stand for the wind-vane?
5. How could you construct a wind-vane that points where the wind is blowing to (opposite to where it comes from)?

EXPLANATION:

In order for a wind-vane to work, one end must be wider in surface area than the other end. By taping a cutout card to one end of the straw, the area is increased at this end, but the weight at this end is also increased. To counterbalance this, paper clips are inserted at the other end. This makes it possible to place the pivot in the center of the bar.

INQUIRY THINNKING
LAB 8

The Heat Race

MATERIALS:

Two small corks
One long and two short pieces of copper wire
An alcohol burner

PROCEEDURE:

4. Cut the following lengths of copper wire: 10cm, two 4-1/2 cm.
5. Push the 10 cm. Wire through one of the small corks (see picture above).
6. Push the two short wires through each end of the other cork.
7. Let two students hold one end of the wire and keep the other end in the alcohol burner flame. (Do not tell the students that the wire in the one cork is split)

QUESTIONS:

6. Why did _____ have to let go of the wire?
7. Why can _____ keep on holding the wire?
8. What can you infer about the wire _____ is holding?
9. What is the method of heat transfer to _____ fingers?
10. What might _____ need to do in order to be able to heat the cork longer?

EXPLANATION:

The unbroken wire was let go of first because the heat from the alcohol burner was conducted to the end where it was being held making it too hot to handle. In order to keep holding the unbroken wire some non-conductor of heat needs to be put in place between the wire and the fingers.

INQUIRY THINNKING
LAB 9

Clean Up Your Act

MATERIALS:

Scissors	plastic 2L soda bottle with cap	small nail
Hammer	ring stand with ring	gravel
Activated charcoal	sand	400 mL beaker
2000 mL of water	1000 mL beaker (2)	soil
Detritus (grass and leaf clippings)	household vinegar	hand lens
	dishwashing detergent	2 plastic spoons
pH test strips	heat gloves	

PROCEEDURE:

1. Form a hypothesis about whether filtration will clean pollutants from water, FILTRATION
2. Use scissors to cut the bottom out of the empty soda bottle
3. Carefully punch for or five small holes through the plastic cap of the bottle using a small nail and hammer. Screw the plastic cap onto the bottle.
4. Turn the bottle upside down, and set its neck in a ring on the ring stand. Put a handful of gravel into the inverted bottle. Add a layer of activated charcoal, followed by thick layers of sand and gravel. Place a 400 mL beaker under the neck of the bottle.
5. Fill each of the large beakers with 1000 mL of clean water. Set one beaker aside to serve as the control. Add three or four spoonfuls of each of the following pollutants to the other beaker: detritus, soil, household vinegar, and dishwashing detergent.
6. Record all your data in a table similar to the one below.

	Before cleaning (clean water)	Before cleaning (polluted water)	After filtration (clean water)	After filtration (polluted water)
Color				
Particles				
Odor				
Suds				
pH				

7. Observe the color of the water in each beaker.
8. Use a hand lens to examine the water for visible particles
9. Smell the water, and note any unusual odors.
10. Stir the water in each beaker rapidly with a plastic spoon, and check for suds.
11. Use a pH test strip to find the pH of the water.

12. Gently stir the clean water, and then pour half of it through the filtration device.
13. Observe the water in the collection beaker for color, particles, odors, suds, and pH. Be patient, it may take several minutes.
14. Record your observations in the table.
15. Repeat steps 12-14 using the polluted water.

QUESTIONS:

15. How did the color of the polluted water change after the filtration?
16. Did the color of the clean water change?
17. Did the filtration method remove all of the particles from the polluted water? Explain your answer.
18. How much did the pH of the polluted water change?
19. Did the pH of the clean water change?
20. Was the final pH of the polluted water the same as the pH of the clean water before cleaning? Explain

INQUIRY THINNKING
LAB 10

Is 2 + 2 Always 4?

MATERIALS:

2 - 100 mL-graduated cylinders
Rubbing alcohol
Tap water

PROCEEDURE:

1. Pour 50 mL of rubbing alcohol into a graduated cylinder.
2. Pour 50 mL of water into a second graduated cylinder.
3. Have students carefully measure the two volumes and write the results on their lab sheets.
4. Ask students to predict what the total volume will be when the two liquids are combined.
5. Pour the contents of one cylinder into the other. Have another student measure the new volume.

QUESTIONS:

21. What happened to the missing liquid?
22. Where both liquids the same?
23. What could you do to test the liquids and find out what happened?
24. How else might you show that when two things are added together the result is not what is expected?

EXPLANATION:

Compounds are substances made up of more than one element. Water and alcohol are compounds. The smallest particle of a compound that still retains the properties of that compound is called a molecule. Molecules are often irregularly shaped. Because of this, a beaker full of molecules is also a beaker full of tiny spaces between those molecules, just as in a full cereal bowl there are spaces between the cereal pieces.

When liquids are combined, their total volume may be less than the sum of their individual volumes because, like alcohol and water, the molecules of each have different shapes and sizes. Although the two do not combine chemically, they do combine completely and uniformly. The spaces that exist between the molecules of each liquid are filled by the molecules of the other liquid.

INQUIRY THINNKING
LAB 11

Why Do Eroded Mountains Keep Rising?

MATERIALS:

A thin and thick block of wood
Sand
Scoop
Short piece of string
Transparent plastic container (or aquarium)

PROCEEDURE:

6. Tie two short pieces of string to the wooden blocks in such a way that about 10 cm. is separating the pieces of wood.
7. Fill the large container with water and let the two wooden blocks float on the water surface.
8. Place a heap of sand on the thick block so that it just floats above the surface of the water.
9. Transfer the sand little by little to the thin block with the scoop.
10. Observe the rising and sinking of each block.

QUESTIONS:

25. What do the two blocks represent?
26. How was the erosion of the mountain simulated?
27. How was the total height of the mountain affected by the transfer of the sand?
28. Why does the ocean floor stay relatively the same in depth?

EXPLANATION:

The thick block of wood and the sand on top of it represent land with a mountain on it. The rainwater and the weathering erode the mountain and transport the eroded material to the ocean floor; represented by the thin block of wood. The moving of the sand with the scoop simulates the erosion process. The total height of the mountain above the water surface stays the same, even after taking some sand off, because the block gets lighter and floats higher above the water surface.

Similarly, the ocean floor (thin block) does not get much higher relative to the water surface, as it becomes heavier and thus floats lower.

INQUIRY THINNKING
LAB 12

Adaptation Behooves You

MATERIALS:

Variety of objects to simulate a rocky terrain, such as books, blocks, rocks
2 small plastic sandwich bags
250 mL of rice
Small paper cup
Metric ruler

PROCEEDURE:

8. Scatter several objects over a desktop.
9. Have students make a hypothesis about which type of foot is best adapted to rocky terrain.
10. Fill both plastic bags with 125 mL of rice and seal them. Place one bag in the paper cup.
11. Tells students that the objects on the desktop represent a mountainous terrain and the bags of rice represent different hooves of two goats of the same species. The rice in the cup represents an individual with hard hooves, and the bag of rice alone represents an individual with soft, padded feet.
12. Call on several volunteers. Ask one of the students to drop the cup with rice from 30 cm. above the "terrain". Repeat this 10 times and have students record the number of times the "hoof" lands securely on the ground.
13. Repeat using the bag of rice.
14. Have students respond to their hypotheses.

QUESTIONS:

11. What might be an advantage and disadvantage of soft hooves? Hard hooves?
12. Which goat is more likely to live longer and pass on its genes?
13. Why might goats have adapted the way they have?

EXPLANATION:

The process by which an advantageous genetic feature increases in a population is called *natural selection*. According to this theory, individuals best adapted to their environment are more likely to become adults and pass on their genes. Genetic mutations occur all the time and that may have no effect on an individual's chances for survival. Genetic mutations occur randomly; they are not a direct response to an environmental condition.

The process of natural selection ensures that the individuals best suited to the specific environment survive. It takes many generations to eliminate one gene or to select another. A mutation is not a negative change; it is merely a change. The environment does not determine whether a mutation occurs, but whether the animal with the mutation thrives.

INQUIRY THINNKING
LAB 13
Density
(Teacher Page)

Post evaluation

MATERIALS:

Mercury, carbontetrachloride, kerosene (or gasoline)
Piece of steel (bolt or nut)
Piece of ebony wood
Paraffin
Cork
Long thin measuring cylinder (100 mL)
3 small beakers

PROCEEDURE:

15. Pour about 20 mL of mercury in the cylinder, followed by 20 mL each of carbontetrachloride, water and gasoline. Do this pouring by holding the cylinder slanted so the liquids will slide on top of each other.
16. Pick up the piece of ebony and ask students: "Where will this object end up?"
17. Pick up the steel bolt and ask the same question then drop it in the cylinder and observe.
18. Do the same with the piece of candle and the cork.

QUESTIONS:

14. Where did the piece of steel end up?
15. Where did the other pieces end up floating?
16. How do the densities of steel and mercury compare?
17. How do the densities of all the liquids compare?
18. If we now that the density of water equals 1, what can we say about the densities of ebony, steel, carbontetrachloride and mercury?
19. What property of a material determines its ability to sink or float?

EXPLANATION:

In ascending order the densities of the solids and liquids are as follows:

Cork
Kerosene
Paraffin
Water (1)
Ebony
Carbontetrachloride
Steel
Mercury

This demonstration shows that even steel can float on a liquid, as long as the liquid has a higher density that steel.

The four layers of liquid can be used to roughly determine the density of an object. This can be done by just dropping the object in the cylinder and observing where the object ends up floating. In the order above, all those preceding water have a density less than 1. Those that come after water have a density of greater than 1.

AT EACH STUDENT TABLE have the following materials and challenge them to use the materials to create a test for density.

Table 1:
- 2 identical beakers
- 2 watch glasses
- 1 small and one larger piece of candle
- Alcohol
- Water

Table 2:
- A graduated cylinder or narrow tall jar
- Four or five mothballs
- One or two Alka Seltzer tablets

Table 3:
- Fresh grapes
- 7-Up soda
- Clear drinking glass

Table 4:
- Molding clay
- Short wooden stick
- Technical balance or equal arm balance
- Two beakers

Table 5:
- Raw chicken egg
- Table salt
- 2 large beakers
- Stirrer
- Water

Table 6:
- Lump of molding clay
- Two large beakers
- Water

INQUIRY LAB FINAL

QUESTION:_____

HYPOTHESIS _____

WHAT MATERIALS DO YOU HAVE AT YOUR TABLE?

TELL STEP BY STEP WHAT YOU DID.

What other questions does this bring up?

Do you think you are right or wrong? Why?

Bibliography

1. Zemelman, Steven, and Daniels, Harvey, et.al. Best Practice New Standards for Teaching and Learning in America's Schools. Heinemann, Portsmouth, NH. 1998.

2. Carin, Arthur A. and Bass, Joel E. Activities for Teaching Science as Inquiry. Merrill Prentice Hall. 2001.

3. Liem, Tik L. Invitations to Science Inquiry 2nd Edition. Science Inquiry Enterprises, Chino Hills CA. 1992.

4. Effective Science Instruction http://www.people.memphis.edu. June 23, 2003.

5. Haury, David L. Teaching Science through Inquiry. ERIC/CSMEE Digest. http://www.ericfacility.net/ericdigests/ed359048.html. 1993-03-00

6. Holt Science & Technology Earth Science. Holt, Rinehart and Winston. 2001