A. What do you know about science? Think, Pair, Share!

Think!
What do you think of when you think of "science"? What do scientists do? Can ordinary people do science?

Pair!
Turn to your partner and share at least three things from your answer above. Write down below the ideas which your partner said and be ready to share one of them with the class.
Partner's Name: ________________________________
1. 
2. 
3. 
4. 

Share!
Listen carefully as the teacher leads the class discussion and jot down at least two ideas that you agree with.
1. 
2. 
3. 
4.
### B. Anticipation Guide: “Ursula Franklin Interview”

Mark the following sentences with an “A” (agree) or a “D” (disagree) before and after we read the interview article and then explain your reasoning after the reading.

<table>
<thead>
<tr>
<th>Before</th>
<th>After</th>
<th>Explain</th>
</tr>
</thead>
<tbody>
<tr>
<td>_____ 1. Nancy Leven is a high school student.</td>
<td>_____</td>
<td></td>
</tr>
<tr>
<td>Explain:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>_____ 2. Ursula Franklin is well known for her work in science and her efforts for peace.</td>
<td>_____</td>
<td></td>
</tr>
<tr>
<td>Explain:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>_____ 3. Franklin became a scientist because she enjoyed it both in school and out.</td>
<td>_____</td>
<td></td>
</tr>
<tr>
<td>Explain:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>_____ 4. A science professor only teaches students and does research.</td>
<td>_____</td>
<td></td>
</tr>
<tr>
<td>Explain:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>_____ 5. It takes a lot of education to become a scientist.</td>
<td>_____</td>
<td></td>
</tr>
<tr>
<td>Explain:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>_____ 6. Scientists are only interested in science.</td>
<td>_____</td>
<td></td>
</tr>
<tr>
<td>Explain:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
C. Types of Science Vocabulary
(Source: http://tlc.ousd.k12.ca.us/~acody/7cif2.html, 7/17/03)

There are two main categories of science:
  1. Biological science: which is the study of _______________ things
  2. Physical science: which is the study of _______________ things

Examples of Biological science:
  1. _________________: the study of plants
  2. _________________: the study of insects
  3. _________________: the study of animals
  4. _________________: the study of humans
  5. _________________: the study of DNA

Examples of Physical science:
  1. _________________: the study of stars moons and planets
  2. _________________: the study of matter
  3. _________________: the study of earth
  4. _________________: the study of energy, forces, and motion
  5. _________________: the study of the weather

What do you think the suffix -ology means?

Prefixes:

<table>
<thead>
<tr>
<th>anthro-</th>
<th>geo-</th>
</tr>
</thead>
<tbody>
<tr>
<td>bio-</td>
<td>bot-</td>
</tr>
<tr>
<td>chem-</td>
<td>zoo-</td>
</tr>
</tbody>
</table>

Using the above prefixes, try to define the following words:

1. Botanist:

2. Anthropologist:

3. Biological:

4. Biologist:
Science Classroom Safety

A. Following Directions

Everyone knows how to make a peanut butter and jelly sandwich, right! Well let’s pretend that your teacher has never made a peanut butter and jelly sandwich before and you need to teach her how to do it. Just like in science it is important to write out how you do things in a way that anyone will understand. In the space below write down directions for how you make peanut butter and jelly sandwiches.

________________________________________________________________
________________________________________________________________
________________________________________________________________
________________________________________________________________
________________________________________________________________
________________________________________________________________
________________________________________________________________
________________________________________________________________
________________________________________________________________
________________________________________________________________
________________________________________________________________
________________________________________________________________
________________________________________________________________

How well did you write your directions? Was there anything missing?
B. Science Class Safety Rules
(Source: Life Science, Holt, Rinehart & Winston, Austin, 2001.)

Creating, exploring, inventing, investigating—these are essential to the study of science. Frequently, scientists do their best work in the lab. To make sure that your laboratory experiences are safe as well as exciting and productive, some safety guidelines should be established. It’s important that safety rules! So what do you need to know about safety? The following pages offer important guidelines for staying safe in the science classroom. Your teacher will also have safety guidelines and tips that are specific to your classroom and laboratory.

Start Out Right!

• Clutter chaos! Extra books, jackets, and materials will only get in the way of experiments and create clutter that could interfere with your tasks. On lab days, follow teacher instructions and only have out the books and materials you will need to complete the lab.

• Caught in a bind? Loose clothing, jewelry, and long hair can get in the way of your scientific investigations, so secure loose clothing, remove dangling jewelry, and tie back long hair.

• Toe trouble! Avoid wearing sandals or open-toed shoes in the laboratory environment. They will not protect your feet if a chemical or a sharp or heavy object is dropped on them.

• Flaming beauty? Certain hair products, such as aerosol hair spray, are flammable and should not be worn while working near an open flame; avoid wearing hair spray or hair gel on lab days.

Check It Out!

• Who ya’ gonna call? Where is the nearest telephone? For any emergency dial 911.

• Safety patrol. Where is the safety equipment for the laboratory? Know the location of all safety and emergency equipment, such as fire extinguishers and eye wash, and know how to operate this equipment.

• Quick exit! Know the fire-evacuation routes established by your school.

• What’s up? Before you begin an experiment, review the supplies you will be using and any safety issues you should be concerned about.

Prevention? Precisely!

• Safety in numbers. Never work alone in the laboratory.

• Better safe than sorry. Use lab equipment only in the manner that your teacher has demonstrated. If you have a great idea for a new experiment, first share the idea with your teacher—perhaps the whole class will benefit!

• Food for thought. The laboratory environment is no place for food, drinks, or cosmetics. Never eat food, drink a beverage, or apply cosmetics while in the lab.

• Stylin’ for safety! Find out what safety equipment you should be wearing for the lab. Be sure to wear safety goggles and gloves, during the experiment if your teacher instructs you to do so.

• The eyes have it! Wear safety goggles when using heat or chemicals and when handling objects that may break, expand, or in some way endanger your eyes.

• Gain no stain! Certain chemicals can stain your clothing.

• Solar power! Never look directly at the sun through any optical device, and never use direct sunlight to illuminate a microscope. Doing so could seriously damage your eyes.

• Some sharp thinking! Sometimes sharp objects such as scissors, scalpels, razor blades, knives, and probes are needed in the laboratory. Always exercise extreme caution when using a sharp object in the lab. Never cut an object while holding it in your hand—always use an appropriate work surface. Never use a double-edged razor in the lab.
• **Don’t crack up!** Never use glassware that is chipped, scratched, or cracked. Chips, scratches, and cracks cause stress points at which glass can break.

• **Hot news!** Whenever possible, use an electric hot plate instead of an open flame unless the experiment specifically calls for an open flame.

**Electrifying idea!** Use caution with electrical equipment. Never use equipment with frayed cords, and make sure that equipment cords are not located where someone could trip over them. Never use an electrical appliance if your hands or clothing are wet. Never use an electrical appliance around water.

• **Keep your cool!** Before working with a flammable liquid or gas, check for the presence of any source of flame, spark, or heat.

• **Chem care.** Always use caution when working with a chemical or a chemical solution. Some chemicals are corrosive, some are poisonous, some are flammable, and some that seem harmless can become hazardous when combined with another chemical.

• **In poor taste.** Never touch, taste, or smell a chemical unless your teacher specifically instructs you to do so. That chemical could cause a reaction when inhaled, touched, or ingested.

• **Don’t mix for kicks!** Never mix any chemical unless your teacher specifically instructs you to do so.

• **Do as you oughta, add acid (or base) to water!** Never do the opposite! Pouring water into an acid or base could produce thermal energy and cause dangerous spattering.

• **Aim for the stars.** When heating a chemical in a test tube, never point the test tube at yourself or anyone else.

• **Animal rights and wrongs.** You may occasionally work with living animals in the laboratory. Always show respect for any animal you work with. Always obtain your teacher’s permission before bringing an animal to the classroom. Never abuse an animal in any way.

• **Handle with care!** Living plants should also be handled carefully in the laboratory. Never ingest any plant or plant part unless your teacher specifically directs you to do so. When in nature, do not pick any wild plants unless your teacher instructs you to do so.

• **Accidents happen.** In the event of an accident, notify your teacher no matter how minor the accident seems to be, and follow his or her directions immediately.

**A Neat Way to End It!**

• **Clean scene!** When you have completed an experiment, clean up your area and return all equipment to its proper place.

• **Sudsational!** Wash your hands with soap after completing an experiment.

• **Don’t be a fool, leave it at school!** Never take anything from the laboratory without permission from your teacher.

---

I ______________________ have read and understand the safety rules of the science classroom. I agree to follow these rules. If I do not I understand that I may lose my privilege to participate in lab activities.

__________________________                                   __________
Name (first and last)                                                                        Date
Observe and discuss what safety precautions are not being followed. How can the student improve his safety procedures?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
A. Observations

**Observation** (uhb-zur-vay-shuhn) **noun**  Something you have noticed by carefully using your senses; Examples: 1. *We made several observations during our experiment.* 2. *Scientists are making careful observations of the meteor’s path through space.* **verb** to observe

When we make observations we use our senses.

What are our five senses?
1. __________________________
2. __________________________
3. __________________________
4. __________________________
5. __________________________

We are going to test your observational powers!

**Observation Stations:** Write your observations.

1. ____________________________________________
2. ____________________________________________
3. ____________________________________________
4. ____________________________________________
5. ____________________________________________
B. Observation and the eye

Structure and function of the eye:

Match the following structures of the eye with their functions:

- **choroid**: A layer of light sensitive cells which line the inner eyeball.
- **cornea**: A muscle that controls how much light is let into the eye.
- **iris**: A clear structure which changes shape to focus light on the retina.
- **lens**: The opening in the iris through which light passes.
- **optic nerve**: White, outer layer of the eye which protects the eye and helps it keep its shape.
- **pupil**: Cord at the back of the eyeball which carries the signal from the eye to the brain.
- **retina**: Dark colored layer underneath the retina which contains the blood vessels which supply the eye.
- **sclera**: A clear, tough covering over the iris and the pupil that helps protect the eye and begins focusing the light.

Find your blind spot: Look at the cross with your right eye and close your left eye. Move the paper slowly towards or away from your face until the circle disappears.
**Eye Dissection:**

**Review:**

1. Name two structures what function to help focus the light rays entering the eye.
   a. __________________________
   b. __________________________

2. Name the three layers that make up the wall of the eyeball.
   a. __________________________
   b. __________________________
   c. __________________________

3. Analogies: a comparison between similar things
   a. The aperture of a camera is like a pupil because they both
      ____________________________________________________________
   b. Both the lens in a camera and in an eye ______________________________
      ____________________________________________________________
   c. The retina in the eye and film in a camera are similar because they both
      ____________________________________________________________

**Observations:**

Describe the following structures of the eye (size, shape, color, texture etc.) and draw pictures if appropriate:

1. sclera

2. iris

3. lens

4. retina

5. optic nerve
C. Observation vs. Inference

**inference** (in-fur-uhn-se) **noun** a belief or opinion you have, based on information that you have learned: 1. *You'll have to draw your own inferences from the evidence.* 2. *While looking at the boiling water he made the inference that it was hot.*

**verb** to infer

It is important that we know the difference between the observations that we make and the conclusions or inferences that we draw from them. For example:

**Observation:** It is a sunny cloudless day.
**Inference:** It will not rain today.

**Observation:** Betty, Karen and Leah always sit together at lunch and talk.
**Inference:** Betty, Karen and Leah are friends.

**Observation:** The liquid is clear and colorless without a smell.
**Inference:** The liquid is water.

1. **Eye Spy!**

Find an object in the room and don’t tell anyone what it is. On the index card you get from your teacher write down at least four observations as you can about the object without saying what it is. Consider all five senses! On the back of the card, write down the name of the object. The object of this game is to write down such good observations about the object that everyone can infer from your observations what the object is!
2. Archaeology Puzzle
Look at the picture below and on the lines on the right write down some observations and inferences about the footprints. Draw a circle around all your inferences.

What do think happened here?

(Source: Life Science, Holt, Rinehart & Winston, Austin, 2001.)
D. International System of Units

In order to make the best observations we can, sometimes we need to use tools like the ruler in “Jeepers Peepers” (pg. 15). We use these tools to measure the things that we are observing.

In the United States we use a system of measurement called the English Standard System where we measure length with inches, feet and miles, weight with pounds, and we measure temperature with degrees Fahrenheit (°F). Most of the world and especially in science a different system of measurement is used. It is called the International System of Units or SI. Scientists use this system for three main reasons:

1. ____________________________________________
   ____________________________________________
   ____________________________________________

2. ____________________________________________
   ____________________________________________
   ____________________________________________

3. ____________________________________________
   ____________________________________________
   ____________________________________________

Try these two math problems and decide which is easier.

1. 12 x 5280 =

2. 100 x 1000 =

Which was easier?
Now look at these same problems:
1. How many inches are in a mile?
   12 inches x 5280 feet = 63,360 inches per mile

2. How many centimeters in a kilometer?
   100 centimeters x 1000 meters = 100,000 centimeters per kilometer

Number 1 is the English System and number 2 is SI. All the calculations using measurements in SI multiply and divide by the number 10.

E. Powers of Ten
A power is a number that is written above the number to the right. For example: 2 to the power of 3 = 2³

In math this means that three 2’s are multiplied together.
   2 x 2 x 2 = 8
   WARNING! the answer is NOT 2 x 3 = 6

SI uses powers of 10:
10⁰ =
10¹ = 1 x 10 = 10
10² = 1 x 10 x 10 = 100
10³ = 1 x 10 x 10 x 10 = 1,000
10⁴ = 1 x 10 x 10 x 10 x 10 = 10,000
10⁵ = 1 x 10 x 10 x 10 x 10 x 10 = 100,000

As the powers go up the numbers get bigger and bigger very fast. Do you observe anything special about the power and the number of zeros?

1. 10¹⁶ = ________________________________

2. 100,000,000,000 = 10—
What about really small numbers? To make the numbers smaller we make the power a negative.

\[ 10^{-1} = 1 \div 10 = 0.1 \]
\[ 10^{-2} = 1 \div 10 \div 10 = 0.01 \]
\[ 10^{-3} = 1 \div 10 \div 10 \div 10 = 0.001 \]
\[ 10^{-4} = 1 \div 10 \div 10 \div 10 \div 10 = 0.0001 \]
\[ 10^{-5} = 1 \div 10 \div 10 \div 10 \div 10 \div 10 = 0.00001 \]

Do you observe anything special about the number of spaces after the decimal (including the 1) and the power?

1. \( 10^{-12} = \) ________________________________

2. \( 0.0000000000000000001 = 10^{__} \)

### Practice Problems

Convert the powers of ten to numbers:

1. \( 10^5 = \)
2. \( 10^{11} = \)
3. \( 10^7 = \)
4. \( 10^{-8} = \)
5. \( 10^{-1} = \)
6. \( 10^{-15} = \)

Convert the numbers to powers of ten:

1. \( 1,000,000 = \)
2. \( 10,000 = \)
3. \( 100,000,000,000 = \)
4. \( 0.0000001 = \)
5. \( 0.01 = \)
6. \( 0.000000000000000001 = \)
F. SI Units of Measurement

There are many common units in SI there are 10 listed on pg. 119 of your MLK planner. Today we are going to focus on three units of measurement the meter, the liter, and the gram.

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Unit</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>length</td>
<td>meter</td>
<td>m</td>
</tr>
<tr>
<td>volume</td>
<td>liter</td>
<td>L</td>
</tr>
<tr>
<td>mass</td>
<td>gram</td>
<td>g</td>
</tr>
</tbody>
</table>

(Source: Life Science, Holt, Rinehart & Winston, Austin. 2001.)

A meter might be helpful to measure the length of the room, but not the length of your pencil or the length of a soccer field. But SI has a very simple way of solving this problem! When we divide each unit by 10 we give it a new prefix and the same for when we multiply by 10.

Therefore, 1000 liters is a kiloliter(kL), 1000 grams is a kilogram(kg), and 1000 meters is a kilometer(km). And it works the same for all the prefixes in the table above. Try the following problems:

1. 100 grams =
2. 10¹ liters =
3. 0.1 meters =
4. 10⁻³ grams =
5. 0.01 liters =

(Source: Life Science, Holt, Rinehart & Winston, Austin. 2001.)

pg. 16
G. Volume, Mass, Length and Temperature

As we learned before our senses sometimes need a little help to make accurate observations about the things that scientists study. For example when a doctor needs to see if you have broken a bone they need some help with their sense of sight, so they use an x-ray machine. We will be learning how to use some common scientific tools which will help us make observations about four very important measurements: volume, mass, length, and temperature.

**length** (length) **noun** the distance from one end of something to another

**mass** (mass) **noun** 1. a large number of people or things together 2. the amount of physical stuff (matter) that makes up an object

**temperature** (tem-pur-uh-chur) **noun** a measure of how hot or cold something is

**volume** (vol-yuhm) **noun** 1. loudness 2. the amount of space that something takes up

Let's Go Metric-ing with Temperature!

“...You may not realize it, but the molecules that make up all matter are constantly moving. When energy (like heat) is transferred to these molecules, they move even more, which causes the temperature to increase... You are probably used to describing temperature using degrees Fahrenheit (°F). Scientists commonly use degrees Celsius (°C), although Kelvins are the official SI units for temperature.”

(Source: *Life Science*, Holt, Rinehart & Winston, Austin. 2001.)

Take a look at the three temperature scales to the left. Like all the other SI measurements Celsius is based on 10 where water freezes at 0°C and boils at 100°C. In our classes we will most often be using Celsius.
Let's Go Metric-ing with Mass!
Below are some basic mass measurements.

* Grain of sand
  1 mg
* Nickel (5¢)
  5 g
* Lemon
  100 g
* Liter of water
  1 kg
* Human adult
  50 to 100 kg
* Cubic meter of water
  1 Mg (metric ton)

(source: U.S. Metric Association, http://lamar.colostate.edu/~hillger/brownridge.html#mass, 7/17/03))

Let's Go Metric-ing with Volume!
There are two different ways to find the volume of an object. In math you learn that to find the volume of a square or rectangle you measure the length, width and height and multiply them together to find the volume. But what if the object you are measuring is not a rectangle or square? We will be using another method of determining an objects volume by using a tool called a graduated cylinder.

\[
V = \text{side} \times \text{side} \times \text{side} \\
V = 7 \text{ cm} \times 7 \text{ cm} \times 7 \text{ cm} \\
V = 343 \text{ cm}^3
\]

\[
V = \text{area of base} \times \text{height} \\
V = (16 \text{ m} \times 4 \text{ m}) \times 2 \text{ m} \\
V = 64 \text{ m}^2 \times 2 \text{ m} \\
V = 128 \text{ m}^3
\]

(Source: Life Science, Holt, Rinehart & Winston, Austin, 2001.)
Using a **Graduated Cylinder**:

(Source: *Life Science*, Holt, Rinehart & Winston, Austin. 2001.)

1. Make sure the cylinder is on a flat, level surface.
2. Move your head so that your eye is level with the surface of the liquid.
3. Read the mark closest to the liquid level, at the center of the curve or **meniscus**.

![Diagram of a graduated cylinder with liquid showing meniscus]

In a graduated cylinder or beaker, most liquids form a meniscus, or a curved upper surface. When you read the volume of a liquid, read it from the center of its meniscus, not from the curved edges.

---

**Let's Go Metric-ing with Length!**


**Purpose:** To practice estimating and measuring using the metric system.

First let’s look at a meter stick! The length of the whole stick is 1m.

1. If we divide 1 m by 10 we find 10 even parts, each is 1 dm.
2. If we divide 1 m by 100 we find 100 even parts, each is 1 ____.
3. If we divide 1 m by 1000 we find 1000 even parts, each is 1 ____.

1000 pieces is the smallest marking on a meter stick. If you look at the ruler on the back cover of your planner you will find the same markings.

As a memory aid complete the following table:

<table>
<thead>
<tr>
<th>King</th>
<th>Henry</th>
<th>Died</th>
<th>Drinking</th>
<th>Chocolate</th>
<th>Milk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kilo</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$10^3$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

pg. 19
Scientific Process

A. Vocabulary: *(based on "Academic Writing Scaffolds for Mixed-Ability Classrooms," 4-5/03 by Kate Kinsella)*

<table>
<thead>
<tr>
<th>Term</th>
<th>Synonym/Explanation</th>
<th>Example/Image/ Showing Sentence</th>
</tr>
</thead>
<tbody>
<tr>
<td>investigation, n.</td>
<td>An official attempt to find out the ______ for something, such as a crime or scientific problem.</td>
<td>The students performed an investigation into the ______ of baking soda and vinegar.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The official performed an investigation into the plane crash.</td>
</tr>
<tr>
<td>experiment, n.</td>
<td>A scientific ______ to see the effect of something, prove that an idea is true, or try a new method.</td>
<td>The researchers did experiments on ______ to test the new medicine.</td>
</tr>
<tr>
<td>hypothesis, n.</td>
<td>A temporary prediction or ______ that can be tested by an investigation</td>
<td>Joe had two plants, the one outside was growing very fast but the one inside was not; therefore, Joe hypothesized that the one outside must be doing better because it got more ______.</td>
</tr>
<tr>
<td>model, n.</td>
<td>A simple description of a system or structure that is used to ______ other similar systems or structures.</td>
<td>He worked hard to write a model that would explain why when two object rub against one another they get hot.</td>
</tr>
<tr>
<td>analyze, v.</td>
<td>Break the subject (object, event or concept) down into ______, and explain the various parts.</td>
<td>While analyzing the temperature data from the past 20 years, we found that the ______ on Earth have been rising.</td>
</tr>
<tr>
<td>conclude, v.</td>
<td>To arrive at a ______ or realization based on the facts that you have.</td>
<td>When I saw my book sitting on a shelf in Bill's room, I concluded that he must have ______ it.</td>
</tr>
<tr>
<td>error, n.</td>
<td>A _______, especially one which causes problems</td>
<td>Joe did well on his ______ because he made only one error.</td>
</tr>
<tr>
<td>variable, n.</td>
<td>The ______ in a controlled experiment which changes</td>
<td>Juan wants to know if the type of soil affects how plants grow, the ______ of soils he uses will be the variable.</td>
</tr>
</tbody>
</table>

Word Form Chart:

<table>
<thead>
<tr>
<th>Noun</th>
<th>Adjective</th>
<th>Verb</th>
<th>Adverb</th>
</tr>
</thead>
<tbody>
<tr>
<td>analyze</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>conclude</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>experiment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>hypothesis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>investigation</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
B. Scientific Method

The scientific method is a process that scientists use. To build a better scientific understanding about the world, scientists use the scientific method to investigate and discover more about our world. We are going to learn to use the scientific method in six steps. First, a scientist states a question. Scientists get their questions from their observations about the world around them. Second, a scientist forms a hypothesis. The hypothesis is an “educated guess” and a prediction of what the scientist thinks might happen based on the science they already know. Third, the scientist must test the hypothesis. Scientists test hypotheses by making observations and collecting data. Fourth, the scientist needs to analyze the results. The analysis section of the scientific method is where the scientist looks for patterns in the data. Fifth, the scientist needs to draw conclusions and formulate a model. At this point the scientist must decide whether her/his prediction was correct and decide what the data means for science and create a model. Finally, in the sixth step the scientist communicates her/his results in writing or in an oral report. It is important however to understand that the scientific process does not end here, because sometimes the results of our experiments bring up even more questions and the cycle starts all over again.

(photo source: http://hep.ucsb.edu/people/hnn/galileo.jpg, 7/17/03)
C. Questions and Hypotheses

Observation: (This is a situation that really happened to a group of students from Le Sueur, Minnesota, during a field trip) Adapted from: Life Science, Holt, Rinehart & Winston, Austin. 2001.

You are walking through a field with some classmates. Suddenly you notice that there are frogs hopping around all over the place! You and your classmates start catching the frogs with a net, you notice something weird. Its legs seemed to be broken. You look at your friend's frog. It seems to be injured, too. So is another frog, and another! You look closer. There is a frog with no eyes! Wait a minute, these frogs aren't injured. The frogs are deformed!

The students did some research and found that frogs with deformities were being found not only in Minnesota but in many places in the United States. The students also learned that deformities can be caused by damage done to the frog while it is still an egg. The causes of this damage might be pollution in the water, an infection, or ultraviolet light from the sun.

Observation: ___________________________________________________

Possible Explanations:
1. The deformities were caused by ____________________________________
2. The deformities were caused by ____________________________________
3. The deformities were caused by ____________________________________

Before an experiment can be designed a scientist must pick only one of the above possible explanations of the frog deformities to work with. Each explanation contains a variable and only one variable can be tested at a time. In a controlled experiment we can only test one variable at a time so that we can be sure about the cause and effect. For example if we test both _____________________ at the same time how will we know which one caused the deformities?
Explanation #1:
Question: The question must be specific to what we want to know.

Hypothesis:
I think that the deformities (are/ are not) _________caused by pollution in the water.

1. **If** _____________________________.
   **then** _____________________________.
2. **If** _____________________________.
   **then** _____________________________.

Variable: _____________________

Explanation #2:
Question: The question must be specific to what we want to know.

Hypothesis:
I think that the deformities (are/ are not) _________caused by an infection.

1. **If** _____________________________.
   **then** _____________________________.
2. **If** _____________________________.
   **then** _____________________________.

Variable: _____________________

Explanation #3:
Question: The question must be specific to what we want to know.

Hypothesis:
I think that the deformities (are/ are not) _________caused by ultraviolet light from the sun.

3. **If** _____________________________.
   **then** _____________________________.
4. **If** _____________________________.
   **then** _____________________________.

Variable: _____________________
## D. Investigation and Experimentation Assessment:
**GJUHSD Middle School Rubric**

<table>
<thead>
<tr>
<th>Scientific Inquiry Process</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Question/ Purpose</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- The purpose of the lab or the question to be answered during the lab is clearly identified and written in complete sentences using appropriate questioning skills (ie. how, what)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- The purpose of the lab or the question to be answered during the lab is identified, but is not clearly stated.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- The purpose of the lab or the question to be answered during the lab is partially identified, and is not clearly stated.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- The purpose of the lab or the question to be answered during the lab is incorrect, illogical or missing.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Experimental Hypothesis</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- The hypothesis is clearly stated and predicts the outcome to the question/purpose based on what has been studied.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- The hypothesis is clearly stated and predicts the outcome to the question/purpose based on general knowledge and observations.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- The hypothesis is clearly stated and predicts the outcome to the question/purpose but appears to be based on flawed logic.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- No hypothesis has been stated.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Data | Professionally formatted (Neat, clear, readable, legible).  
Graphs and tables are appropriate for data collected, labeled and titled accurately. | Graphs and tables are appropriate for data collected, labeled and titled accurately. | Data is communicated in written form.  
No graphs or tables are presented. | Data is not shown or is inaccurate. |
| Analysis | The relationship between the variables is discussed.  
Trends/patterns are logically described and explained. | Trends/patterns are logically described and explained. | Patterns/trends are not logically based on the data. | Patterns/trends are not discussed (i.e. data is merely restated in sentence form) or analysis is missing. |
| Conclusion | Conclusion states whether the findings support or reject the hypothesis based on collected data and what has been studied.  
Possible sources of errors are discussed. | Conclusion states whether the findings support or reject the hypothesis based on collected data and what has been studied. | Conclusion states whether the findings support or reject the hypothesis. | Conclusion is missing or does not relate to the hypothesis. |
A. Table or graph?

(Source: Life Science, Holt, Rinehart & Winston, Austin. 2001.)

Many times the observations that scientists make can be put into a graph. Look at the following table of data and the graph. Both of them display the same information but in different ways.

<table>
<thead>
<tr>
<th>Grade Distribution of Students Enrolled in Science Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade</td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td>A</td>
</tr>
<tr>
<td>B</td>
</tr>
<tr>
<td>C</td>
</tr>
<tr>
<td>D</td>
</tr>
<tr>
<td>F</td>
</tr>
</tbody>
</table>

1. Which figure is easier to understand? Explain why you think so.

2. If you need to get specific data, such as the exact number of students who earned a B, which figure would you use? Explain your answer.
B. Choosing the Right Graph

Data tables provide an organized way of viewing information, and graphs are pictures of the information in a data table. Sometimes it is faster and easier to interpret data by looking at a graph. It is important to choose the type of graph that best illustrates your data. The following table summarizes the best uses for three of the most common graphs:

<table>
<thead>
<tr>
<th>Type of graph</th>
<th>Best use for this graph</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bar graph</strong></td>
<td>A bar graph is best used for comparing data quickly and easily, such as the grade distribution of students enrolled in science class or the growth of plants in different pots.</td>
</tr>
<tr>
<td>Grade Distribution of Students Enrolled in Science Class</td>
<td></td>
</tr>
<tr>
<td>Number of Students</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>Grade</td>
<td></td>
</tr>
<tr>
<td><strong>Pie graph</strong></td>
<td>A pie graph is best used for showing percentages, such as the percentage of the student body who picked certain entrees for lunch or the percentage of your allowance that will go toward purchasing various things.</td>
</tr>
<tr>
<td>Percentage of Students Picking Various Lunch Entrees</td>
<td></td>
</tr>
<tr>
<td>Chicken Keb</td>
<td>Corn dog</td>
</tr>
<tr>
<td>18%</td>
<td>15%</td>
</tr>
<tr>
<td><strong>Line graph</strong></td>
<td>A line graph is best used for looking at changes over time, such as the number of bathing suits sold each month during the year or the change in your sister’s height throughout the year.</td>
</tr>
<tr>
<td>Number of Bathing Suits Sold Each Month</td>
<td></td>
</tr>
<tr>
<td>Number of bathing suits sold</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>M</td>
</tr>
<tr>
<td>0</td>
<td>50</td>
</tr>
</tbody>
</table>

(Source: Life Science, Holt, Rinehart & Winston, Austin. 2001.)
Time to practice!
What graph type do you think best presents each set of data? Explain.
(Source: Life Science, Holt, Rinehart & Winston, Austin. 2001.)

1. The percentage of rabbits preferring various foods

<table>
<thead>
<tr>
<th>Food</th>
<th>Percentage preferring that food</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skippy’s Rabbit Chow</td>
<td>32</td>
</tr>
<tr>
<td>Homemade rabbit food</td>
<td>13</td>
</tr>
<tr>
<td>Happy Rabbit</td>
<td>10</td>
</tr>
<tr>
<td>Joe’s Special Food for Rabbits</td>
<td>44</td>
</tr>
<tr>
<td>Premium Rabbit Nutrition Diet</td>
<td>1</td>
</tr>
</tbody>
</table>

2. Albert's grades for each month of the school year

<table>
<thead>
<tr>
<th>Month</th>
<th>Grade in science class</th>
</tr>
</thead>
<tbody>
<tr>
<td>September</td>
<td>98</td>
</tr>
<tr>
<td>October</td>
<td>94</td>
</tr>
<tr>
<td>November</td>
<td>88</td>
</tr>
<tr>
<td>December</td>
<td>78</td>
</tr>
<tr>
<td>January</td>
<td>82</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Month</th>
<th>Grade in science class</th>
</tr>
</thead>
<tbody>
<tr>
<td>February</td>
<td>83</td>
</tr>
<tr>
<td>March</td>
<td>86</td>
</tr>
<tr>
<td>April</td>
<td>81</td>
</tr>
<tr>
<td>May</td>
<td>97</td>
</tr>
</tbody>
</table>

3. The pH of solutions in experimental test tubes

<table>
<thead>
<tr>
<th>Test-tube number</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6.7</td>
</tr>
<tr>
<td>2</td>
<td>7.1</td>
</tr>
<tr>
<td>3</td>
<td>7.4</td>
</tr>
<tr>
<td>4</td>
<td>7.1</td>
</tr>
<tr>
<td>5</td>
<td>7.0</td>
</tr>
</tbody>
</table>
**C. Graphing Data**

When graphing data it is important to make the graph as useful and easy to understand as possible; therefore, there are several things that are necessary to make a graph complete.

**Bar and Line Graphs**

- All bar and line graphs have an *x-axis* and a *y-axis*.

![Diagram of x and y axes]

- Before you draw your *x-axis* and *y-axis* you must decide on a scale. A *scale is a set of marks with regular spaces between them*. Look at your data table and decide how large to make your graph and what each line on the graph paper will be worth.

![Graph paper example]

- Both axes must be labeled and the appropriate units must be included.
- Give the graph a title. The title must tell the reader what is being tested.
- Finally plot your data on the graph.

**Pie Graphs**

(Source: *Life Science*, Holt, Rinehart & Winston, Austin. 2001.)

When you convert data to show percentages, you can use a pie graph. Pie graphs are shaped like a circle. The size of each “pie slice” is determined by the percentage it will represent. A **full pie is equal to 100 percent, half a pie is equal to 50 percent, and so on.** Pie graphs need to be labeled and titled as well.
Try It!

1. • Select the appropriate graph type: _____________________________
2. • Choose an appropriate scale.
3. • Label the axes.
4. • Give your graph a title.

<table>
<thead>
<tr>
<th>Type of fertilizer added to soil</th>
<th>Average height of plants (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grow Better</td>
<td>13 cm</td>
</tr>
<tr>
<td>Plant Grow</td>
<td>17 cm</td>
</tr>
<tr>
<td>Wondrous Plants</td>
<td>11 cm</td>
</tr>
<tr>
<td>Greener Plants</td>
<td>16 cm</td>
</tr>
</tbody>
</table>

Title: _________________________________
D. Data, Analysis and Conclusion

1. Pretend that you are a biologist and you are studying some microscopic bacteria. You perform the following experiment.

**Question/Purpose:** While studying bacteria that live in human intestines I noticed that the bacteria divide to become more bacteria at different rates depending on the temperature. I will perform an experiment to answer the question: At what temperature will the bacteria divide the fastest?

**Hypothesis:** I think that the higher the temperature the faster the bacteria will divide. If I increase the temperature then the bacteria will divide faster.

**Data:** I put the bacteria into a container and then starting at 10°C slowly increased the temperature to 50°C recording the time it took for the bacteria to divide at 8 points.

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>Time to Double (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>130</td>
</tr>
<tr>
<td>20</td>
<td>60</td>
</tr>
<tr>
<td>25</td>
<td>40</td>
</tr>
<tr>
<td>30</td>
<td>29</td>
</tr>
<tr>
<td>37</td>
<td>17</td>
</tr>
<tr>
<td>40</td>
<td>19</td>
</tr>
<tr>
<td>45</td>
<td>32</td>
</tr>
<tr>
<td>50</td>
<td>No growth</td>
</tr>
</tbody>
</table>

(Source: Life Science, Holt, Rinehart & Winston, Austin. 2001.)

**Graph the results:**
Analysis:

1. At what temperature did the bacteria divide the fastest?

2. Looking at your graph describe the pattern you see. How does the dividing of the bacteria change as the temperature increases?

Conclusion/Model:

1. Was the hypothesis correct?

2. Look at the following diagram and see if you can create a model to explain why the bacteria divide fastest at that temperature (remember where they live!)

(Source: Life Science, Holt, Rinehart & Winston, Austin. 2001.)
2. Pretend you are one of the students conducting an experiment on the deformed frogs we discussed earlier.

**Question:** What is causing the deformities observed in the frogs in Minnesota? Is ultraviolet light from the sun causing the deformities?

**Hypothesis:** I think that the deformities (are/ are not) ______________ caused by ultraviolet light from the sun.

\[ If \quad \text{______________________________} \quad then \]
\[ \text{____________________________________} \]
\[ If \quad \text{______________________________} \quad then \]
\[ \text{____________________________________} \]

**Experimental Design:** In order to test this hypothesis the students decided that the variable was __________________ and that everything else needed to be the same.

<table>
<thead>
<tr>
<th>Design of Experiment to Test the Effect of UV Light on Frogs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group</strong></td>
</tr>
<tr>
<td>Kind of Frog</td>
</tr>
<tr>
<td>#1</td>
</tr>
<tr>
<td>#2</td>
</tr>
</tbody>
</table>

(Source: Life Science, Holt, Rinehart & Winston, Austin. 2001.)

1. In the above experimental design the students created one control group and one experimental group. The difference between the control and experimental groups should only be the variable. The experimental group should be testing for the effects of the variable. In the above table let’s label which group is experimental and which is the control.

2. Why did the students use so many eggs for each group?

_________________________________________________________________
Data: The following table shows the results of the experiment.

<table>
<thead>
<tr>
<th>Group</th>
<th>Length of UVLight Exposure</th>
<th>Number of Deformed Frogs</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>0 days</td>
<td>0</td>
</tr>
<tr>
<td>#2</td>
<td>24 days</td>
<td>47</td>
</tr>
</tbody>
</table>

Graph the results:

Analysis: During the experiment _________ out of 100 frogs in the control group developed into deformed frogs, whereas, in the experimental group _________ out of 100 frog eggs developed into deformed frogs. Therefore in our experimental group _________% of the frog eggs developed deformities.

Conclusion/Model: The results of this experiment (support/reject) _________ my hypothesis that ultraviolet light (is/is not) _________ a cause of the frog deformities. Our variable which was _________ (did/did not) _________ have an effect on the development of frog deformities. Therefore, ultraviolet light is probably a factor which will help explain what is causing the deformities in the frogs which the students found in Minnesota.
E. Assessing Error
Whenever a scientist does research there is the possibility of *error*.

> *error* (er-ur) *noun* a mistake, especially one which causes problems: *Joe did well on his test because he made only one error.*

There are different kinds of error the following are a few of the most common types:

- **Human error:**

  - ____________________________________________________________
  - ____________________________________________________________
  - ____________________________________________________________

- **Equipment error:**

  - ____________________________________________________________
  - ____________________________________________________________
  - ____________________________________________________________

- **Sampling error:**

  - ____________________________________________________________
  - ____________________________________________________________
  - ____________________________________________________________