Introduction to Science

Chapter 1

The Nature of Science

Section 1.1

Key Ideas

- How do scientists explore the world?
- How are the many types of science organized
- What are scientific theories, and how are the different than scientific laws?

How Science Takes Place

- A scientist may perform experiments to find a new aspect of the natural world, to explain a known phenomenon, to check the results of other experiments, or to test the predictions of current theories.
- What does this mean?

What do scientists do?

- Investigate
- Plan Experiments
- Observe
- Test the Results
- On a separate sheet of paper, write down these 4 steps and Complete the "Quick Activity" on the next slide.
  - Write down how you completed the 4 steps

The Branches of Science

- **Science:** the knowledge obtained by observing natural events and conditions in order to discover facts and formulate laws or principles that can be verified or tested
- How often do you think you perform "science"?
  - Examples

The Branches of Science

- There are 2 Main Branches…

1. Social Sciences
   1. Individual and group behaviors
2. Natural Sciences
   1. Tries to understand how nature (or universe) works

What is an example of a social science class?
Natural science class?

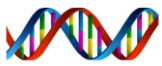
The Branches of Science

Natural Sciences

- **Biological Science**: living things
  - Botany, Ecology
- **Physical Science**: Matter and Energy (NRG)
  - Chemistry: Matter and its changes
  - Physics: Forces and NRG
- **Earth Science**: Earth, Atmosphere, and Weather
  - Geology, Meterology

The Branches of Science

- Do these natural sciences work together or ever overlap?
- Of Course!
- What science are overlapping?
  - Looking at the makeup of DNA
  - Studying Earthquakes
  - Launching a rocket into space
  - Fertilizing a plant



The Branches of Science

- Science and Technology work together!
  - **Technology**: the application of science for practical purposes
- What are some examples of technology and what are their practical purposes?

Scientific Laws and Theories

- What are scientific theories, and how are they different from scientific laws?
- **Theory**: is an explanation of things or events based on knowledge gained from many observations and investigations. **It is not a guess**
- **Law**: a descriptive statement or equation that reliably predicts events under certain conditions

Compare and Contrast…

- Theory
  - Open to be challenged
  - Explains many different laws
  - Explains how or why something happens
- Law
  - Is always TRUE
  - Does NOT explain how or why
  - Can be an equation

Scientific Laws and Theories

- Scientific theories are always being questioned and examined. To be valid, a theory must:
  - Explain the observations
  - Be repeatable
  - Be predictable

Quick Activity

- Get into groups of 2
- The Earth is flat is an example of a theory that was believed for a very long time.
  - Apply the 3 criteria (required for a theory to be supported) to this theory
    - Group A: Support it
    - Group B: Disprove it

Quick Activity (cont.)

- All group A's get together on the right side of the room
- All group B's get together on the left side of the room
  - Come up with your most promising reasons to support your view
- Time to Debate!

Scientific Laws and Theories

- *Qualitative statement*: describes something with words
  - Verbal (or written) explanation
- *Quantitative statement:* describes something with mathematical equations
  - Mathematical Equation

Qualitative

Quantitative

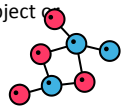
$$A = \pi r^2$$

Quick Activity

- Are the following qualitative or quantitative?
  1. This is Hot
  2. 45 m/s
  3. That is heavy
  4. Those are bright
  5. 100 mph

Scientific Laws and Theories

- Models can represent physical events:
  - **Model**: a representation of an object or event that can be studied to understand the real object or event



In groups of 2,
draw a model of something
that is to large, small, or
dangerous to be studied directly

More Model Examples

- Map (paper or mental)
- Diagram in your books
  - Even other classes!
- Computer/console games (COD, Minecraft, Need for Speed)
- Dinosaur skeleton

Scientific Laws and Theories

- Theories have been manipulated, or even discarded, over time
  - Caloric Theory

Exit Ticket

- What are scientific theories, and how are the different than scientific laws?

Assignment

- Section 1.1 Worksheet
- Take Own Notes (TON) 1.2

The Way Science Works

Section 1.2

Key Ideas

- How can I think and act like a scientist?
- How do scientists measure things?

Quick Activity

- In groups of 2…
  - You come home and all the lights are off.
    - Give me at least 3 reason as to WHY the lights are off.

You are "thinking" like a scientist!

Science Skills

- The most important skill to learning it learning how to THINK CRITICALLY or PROBLEM SOLVE!
- **critical thinking:** the ability and willingness to assess claims critically and to make judgments on the basis of objective and supported reasons
  - Or… "think" about it and make an educated guess

Which is a better deal?

- You and your friend are trying to save money so you could split a 26 oz tub of candy for $4.00 or each by a 1.75 cup container of candy for $2.00.
- Explain….

1 cup = 8 oz
1.75 cup = 14 oz
So… $2.00 = 1.75 cups is a better deal

Scientific Method

- **Hypothesis**: a possible explanation or answer that can be tested Movie
- You can test your hypothesis by preforming a controlled experiment
  - **controlled experiment**: an experiment in which the variables that could affect the experiment are kept constant (controlled) except for the one that you want to measure
  - **Variable**: a factor that changes in an experiment in order to test a hypothesis

Quick Assignment

- Worksheet on **page 5**
  - Complete this in groups of 2
  - You have 10 minutes….. GO!

Scientific Method

- **Scientific Method**: a series of steps followed to solve problems including collecting data, formulating a hypothesis, testing the hypothesis, and stating conclusions
  - This is a "general" description of how to problem solve
    - You do NOT have to do every step every time
- See 1.2 Worksheet **Pages 6-9**

Being Objective

- A **bias** occurs when what the scientist expects changes how the results are viewed.
- This expectation might cause a scientist to select a result from one trial over those from other trials.
- Example:
  - A scientist is being paid by Colgate to test how effective Colgate toothpaste is.
  - What may be wrong with this?

Scientific Method

- You notice that when you open the door, it squeaks.
- Come up with a hypothesis as the WHY it squeaks.

- If your hypothesis was <u>not</u> supported… was the experiment a failure?
- Explain

Measurements

- Get into groups of 2.
- Measure how many "____" it takes to get across the floor (carpeted area to carpeted area)
- Write the number on the board (with a label!)
- Answer the following question
  - Which of the measurements on the board is the largest?

Measurement System

- Suppose the label on a ball of string indicates that the length of the string is 150.
- Will the string stretch across the room?
- Is the length 150 feet, 150 m, or 150 cm?
- For a measurement to make sense, it must include a number and a unit.

Measurement System

- The English system of measurement is commonly used in the United States.
- Most other nations use the metric system - a system of measurement based on multiples of ten.
- Does anyone know the 3 countries that use the English system?
- USA, Liberia, Burma

Measurements

- Scientists use standard units of measure that together form the International System of Units, or SI.

Quantity	Unit	Abbreviation
Length	meter	m
Mass	kilogram	kg
Time	second	s
Temperature	kelvin	K
Electric current	ampere	A
Amount of substance	mole	mol
Luminous intensity	candela	cd

SI units are used for consistency

- There are 7 base units
- Each type of SI measurement has a base unit.
- For example, the meter is the base unit of length.
- Copy this info in your notes.

Quantity	Unit	Abbreviation
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Derived Units

- Derived Unit: is a combination of base units
  - Km/h, m/s, kg/L
  - Density, speed

SI Prefixes

Kilo Hecto Deca Base Unit Deci Centi Milli

K h da g,m,s d c m

Think up a mnemonic to remember this!

Kids Have Dropped Over Dead Converting Metrics

Km --> kilometer cm -->centimeter

hg --> _____ ds --> _____ dag --> _____

Converting between SI Units

- A conversion factor is a ratio that is equal to one and is used to change one unit to another.
- For example, there are 12 eggs in 1 dozen eggs

$$\frac{1\ dozen\ eggs}{12\ eggs} = 1$$

- What are some more?

Converting between SI Units

K h da g,m,s d c m

How many cm in 3 dm?

Start with what you know (3 dm) and convert to what you are looking for (cm).

$$\frac{3\ dm}{} \left| \frac{10\ cm}{1\ dm} \right. = 30\ cm$$

Place a 1 in the LARGER prefix
And the conversion in the smaller Prefix.

$$\frac{3\ \cancel{dm}}{} \left| \frac{10\ cm}{1\ \cancel{dm}} \right. = 30\ cm$$

Multiply the top and divide the bottom

Cancel out labels

Practice

- Convert the following
  - 45 km = _____ cm
  - 5 cm = _____ mm
  - 3 s = _____das
  - 4.5 g = _____ kg
  - 2000 kg = _____ hg

Activity

- Get into groups of 4
- Using a ruler and a meterstick, measure objects around the room and answer the following.
- What best represents…
- 1 cm, 1 dm, 1 m
- 5 cm, 10 cm, 15 cm

Units of Measure

- **Length**: a measure of the straight-line distance between two points
- **Mass**: a measure of the amount of matter in an object
- **Volume**: a measure of the size of a body or region in three-dimensional space
- **Weight**: a measure of the gravitational force exerted on an object
- **Video**

Volume

- If you want to know the volume of a solid rectangle, such as a brick, you measure its length, width, and, height and multiply the three numbers and their units together ($V = l \times w \times h$).
- For a brick, your measurements probably would be in centimeters.
- The volume would then be expressed in cubic centimeters, cm^3.

Example

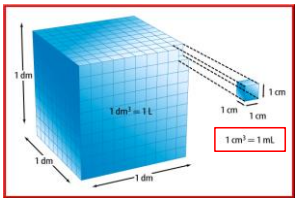
5 cm x 5 cm x 10 cm = 250 cm^3

Measuring Liquid Volume

- In measuring a liquid's volume, you are indicating the capacity of the container that holds that amount of liquid.
- The most common units for expressing liquid volumes are liters and milliliters.

Measuring Liquid Volume

- A liter occupies the same volume as a cubic decimeter, dm^3.
- A cubic decimeter is a cube that is 1 dm, or 10cm, on each side.



Measuring Liquid Volume

- Sometimes, liquid volumes such as doses of medicine are expressed in cubic centimeters.
- Suppose you wanted to convert a measurement in liters to cubic centimeters.
- You use conversion factors to convert L to mL and then mL to cm^3.

$$\frac{1.5\ L}{}\left|\frac{1000\ mL}{1\ L}\right|\frac{1\ cm^3}{1\ mL} = 1500 cm^3$$

Practice

- 389 mL → _____ cm^3
- 45 cm^3 → _____ L

Density

- Density = mass / volume
- Your volume can be of a solid (cm^3, etc.) or of a liquid or gas (mL, L, etc.)
  - Make sure you use the correct labels!!!
- What is the density of a 45 g brick with the following dimensions? (3 cm x 4 cm x 2 cm)

Assignment

- Section 1.2 Worksheet
- In class tomorrow
  - Math Skills (MS) – Conversions (odds)

Organizing Data

1.3

Key Ideas

- Why is organizing data an important science skill?
- How do scientists handle very large and very small numbers?
- How can you tell the precision of a measurement?

Presenting Data

- Why is organizing data an important science skill?
- This is how you share your results!
- Data tables and graphs are wonderful things!

Section 3 Worksheet

- In groups of 2, complete the "Section 3 worksheet"

Class discussion

- Why were the particular graph types chosen for each data set?
- Give examples of when each type would be used. Explain why you chose that graph type.

Writing Numbers in Scientific Notation

- **How do scientists handle very large and very small numbers?**
- They use scientific notation to reduce the number of zeros

- **Scientific Notation**: a method of expressing a quantity as a number multiplied by 10 to the appropriate power

Scientific Notation

- This is similar to moving the decimal for SI prefixes
  - $10^3 = 1{,}000$
  - $10^2 = 100$
  - $10^1 = 10$
  - $10^0 = 1$
  - $10^{-1} = 0.1$
  - $10^{-2} = 0.01$
  - $10^{-3} = 0.001$

Multiplying and Dividing Sci Not.

- Use the math rules for powers of 10
- When multiplying you add the powers
- When dividing you subtract the powers

- More help in Appendix B
  - Page 674

Practice problems

- Page 25 (all)
- page 26 (all)

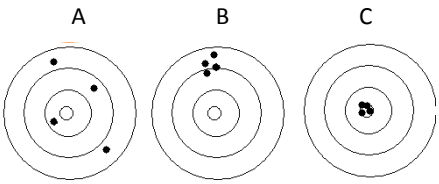
How to use your calculator

- Get out YOUR calculator
- Use the EE button

Significant Figures

- **Accuracy**: How close a measurement is to the true value
  - How close your darts are to the bullseye
- **Precision**: The "exactness" of a measurement
  - The number of decimals

Accurate, Precise, Both, Neither



- Can you be accurate and NOT precise? Vise Versa?

Precision

- Your measurement is determined by the precision of your instrument
- WHAT am I talking about……

Quick Activity

- In groups of 2, find the degree of precision for the following
  - Beaker
  - Graduated cylinder
  - Ruler
  - Meter stick
  - Glass thermometer

Sig Figs

- **Significant Figures (Sig Figs)**: a particular decimal place that determines the amount of rounding off to be done on the precision of the measurement
- Sig Fig Handout
- Picture

Sig Figs

- When multiplying and dividing you need to round your answers to the correct number of sig figs
  - The number with the **fewest** sigs figs
- You do this because this number determines how many numbers you "know"
- 5.2 *1.1 = 5.7
- 5.2 * 3.22 = 17

Sig figs

- What do you do if your answers has more sig figs than the number with the lowest number of sig figs?

  9.9 * 552.2 = 5466.78

- You use…….. Scientific Notation!!!

  5466.78 = 5.5×10^3

Examples

- Make sure to label your answers!
  - Careful with 6

1) 5.25 m * 25.1 m
2) 50.2 m/5 s
3) 456 cm * 0.09 cm
4) 789.444 g /1.55 L
5) 5.76 m * 7.22 m * 5.22 m
6) 1234 cm * 1.5 m * 6.3 m

Assignment

- Section 1.3 Worksheet