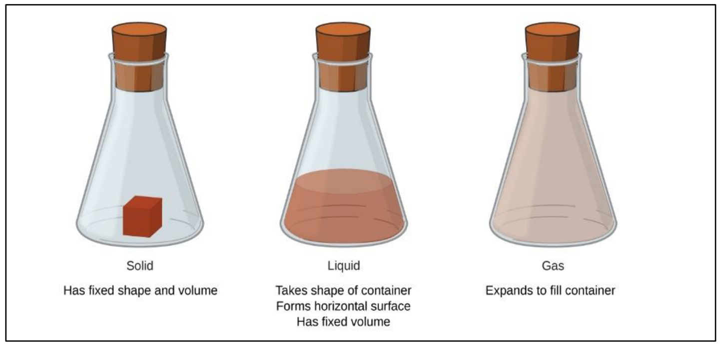
Lesson 5 Physics Experiment (All Series Combined – SS, CS, SS+, CP)

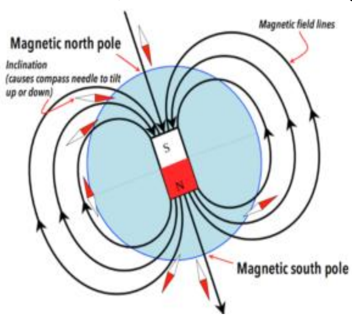
Student Challenge (Lessons 5A & 5B) Classical Physics

OBSERVE:
Look at the world around you.
Describe objects or substances as:



SOLID, LIQUID, OR GAS

1. Note how the STATES of MATTER differ from one another →
2. State in your own words:
   a) "Liquid has a fixed volume?" It won't automatically fill its container, like gas.
   b) "Liquid takes/assumes the shape of the container?" It's shape conforms.
3. What if a gas, like oxygen or nitrogen (our air), acted like a liquid.
   a) How would you breathe? (couldn't without gills????)
   b) How would you walk? (couldn't except by swimming)
   c) What if all the oxygen flowed to the floor, around your feet, rather than filling the room? (no oxygen in lungs)



EXPLORE:
Most magnets are solid. Earth has a solid-iron inner core, but its liquid-iron outer core lets the inner core spin, creating Earth's magnetic field.

1. Do positives **attract** positives or negatives? negatives
2. Do negatives **repel** negatives or positives? negatives
3. Earth's magnetic field lines pull to the north; but a bar magnet's field lines pull to the south. Draw vector arrows on the bar magnet above showing it's field lines.

EXPERIMENT: Kinetic Thermal Energy

Using a Project 5 campstove and an outdoor fire pit, observe the following: a) temperature changes over time, b) pinwheel motion, c) color changes. Temperature is a measure of kinetic energy; pinwheel motion is kinetic; some color changes are evidence of kinetic energy.

RECORD TEMPS: At 10 cm from vents (use gloves/tongs)
1. Include start temp; record 10 minute intervals, and final temp.
2. Use time/temp data to make a graph. (See ANALYZE on next page.)

STEP ONE: Set up a small firepit area for the campstove. Before starting a fire, test air movement near your campstove with a pinwheel (search wind directions).

STEP TWO Create a small fire. Place the campstove over the fire.

STEP THREE: Test the temperature of the campstove (10 cm from the upper vents) using a thermometer or sensor. Record beginning Temp & time (T_0 and t_0) then every 10 mins while cooking, finally record final Temp & time (T_f and t_f)

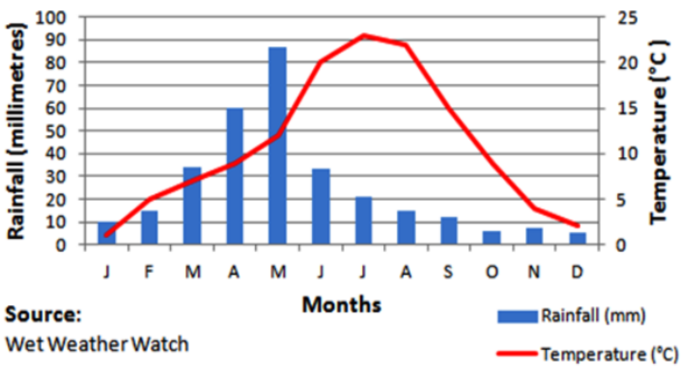
STEP FOUR: Check also, **AIR MOTION** with the **pinwheel**, at 10 cm from the upper vent.

a) Is the air flowing? Test periodically and note any change in speed.
b) What is happening to the gas/air molecules near the stove?
c) Do heated gases increase the motion of the air? Why?
d) Is the hot air rising or sinking? (try testing with a stiff feather or the pinwheel)
e) Does hot air push or move the cooler outside air?

STEP FIVE: Measure final Temp & time (T_f and t_f) when the fire dies down.

Use your data to create a graph. See the <u>ANALYZE</u> Section below the GRAPH Example.

GRAPH EXAMPLE 1



CAN YOU READ THIS GRAPH?
This graph has 3 weather variables:

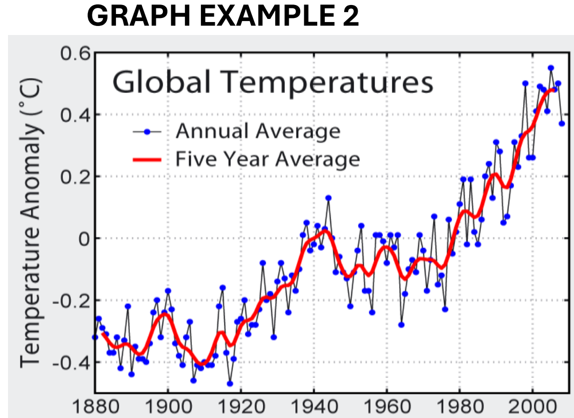
1. Rainfall in mm (blue bars)
2. Temperature (red line)
3. Time (months on the y axis.

Time is often represented. What do these data points represent? A year, **<u>month</u>**, day, hour, minute, or other?

TIME (MONTHS) IS ON THE X AXIS

Graphs are essential tools for science and math. Think of a graph as a picture that saves you lots of reading. Data (in words and numbers) are rarely fun to read; but, a picture is worth a thousand words.

GRAPH EXAMPLE 2



<u>ANALYZE:</u>
Draw your own graph showing the Time and Temperatures recorded from your campfire stove. Mark off 10 min time intervals on the x axis, and degree intervals on the y axis. Divide your Temp measurements from lowest at t_0 and to highest Temp (or a little more) and determine an appropriate interval, such as (50°F or 25°C).

The x axis will be your time in minutes.
The y axis will be the Temperature ($^{\circ}$F or $^{\circ}$C)

Basic (SS)

Math Skills

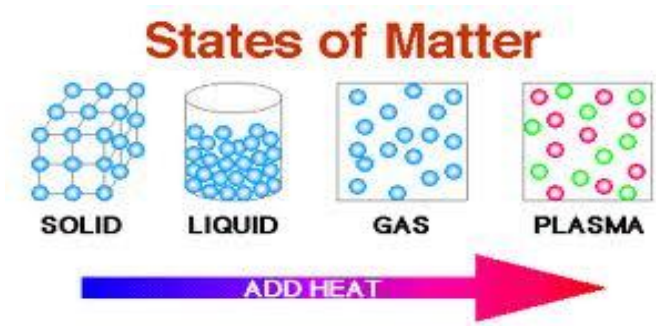
1. Water is the standard for the Celsius scale. Water freezes at 0° C, melts at just over 0° C, and boils at 100° C degrees. How many whole "units or degrees" are there from freezing to boiling water in ° C?

Equation: 100 – 0 = __100 degrees__ ° C

2.Kinetic (thermal) energy can be measured with calories. A calorie is the amount of energy needed to raise 1 cm^3 of water 1 degree C. If one cm^3 of water changes from 10° C to 100° C, how many calories (energy units) were used.

Equation: 100 – 10 = __90 degrees__ ° C

3. What is added to change the state of matter? (There are several correct answers.) Heat, Kinetic Energy, Motion



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Advanced (CS)

Math Skills – calories, joules, and Newton meters are all units or measures of energy or work. Power is the rate energy is used, turning Joules into Watts.

Power

Power is the rate at which energy is transferred or the rate at which work is done.

$$P = \frac{W}{t}$$

$$P = \frac{\Delta E}{t}$$

P = power (Watt)
W = work done (J)
ΔE = energy transferred (J)
t = time (s)

Power (in Watts) = Change (Δ) in Energy/t

Watts = 1 kgm^2/s^3

Problem #1: Review Power (left image). If...

a) Power is equal to Work divided by time; &

b) Power is equal to the Change (Δ) in Energy divided by time, then: **Work = ΔEnergy**

HINT: Joules = Newton meters

1 Nm = 1 kgm^2/s^2 = 1 J (Joules)

1 Newton meter = 1 kgm^2/s^2

If... Change (Δ) in Energy = **10 Nm (in Newton meter)**, then, what is the Δ Energy in Joules?

ANSWER: __10_Joules

Problem #2: An LED light bulb uses 10 Joules each second it's on. What is the Power of this light bulb in Watts?

ANSWER: __10__Watts

Applied (SS+) Free Body Diagrams

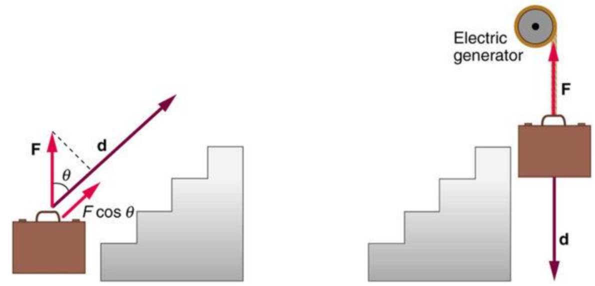
Math Skills

Vector Arrows:

Length = magnitude

Direction = direction/angle of force, distance, motion

Labels = (Force, distance, height, friction, gravity, mass, acceleration, angle, velocity, momentum, Energy) are common



Problem #1: If an electric generator lifts 100 kg, 1 meter in 5 secs, against the force of gravity, how much power is being used (per second). P = W/t W = F x d F = ma

m = 100 kg a = 10 m/s² d = 1 m t = 5 s

Equation: **100 kg x 10 m/s^2 x 1 m ÷ 5 s = <u>200 Watts</u>** (for the RATE Energy was used)

Hint: P = m x a x d ÷ t 100 kg x 10 m/s^2 x 1 m ÷ 5 s =

Problem #2: Using the same example as Problem #1, determine how much total Energy was used or Work was done?

Equation: **100 kg x 10 m/s^2 x 1 m = <u>1000 Joules</u>** (for the TOTAL Energy used)

Hint: E = m x a x d 100 kg x 10 m/s^2 x 1 m =

Compute (CP)

Math Skills

Draw a Free Body Diagram (on a separate sheet) showing forces for a teetertotter with 50 kg weight on one end and 10 kg weight on the other end which is 1 meter off the ground.

1. Which end has potential gravitational energy?

2. Add vector arrows to show work done if... a) the 50 kg weight is moved .1 meter off the lever/teetertotter; b) the conversion of PE to KE when the 10 kg weight and lever drop 1 meter and hit the ground.

SS ANSWERS: #1 100°C degrees from freezing to boiling
#2 90 °C to raise 1 cm^3 water 90 degrees C

CS ANSWERS: #1 10 Nm = 10 kgm²/s² = <u>10 J (Joules)</u>
#2 10 Watts (which are equal to 10 J per sec or 10J/s)

SS+ ANSWER: #1 Power Used: 100 kg x 10 m/s² x 1 m ÷ 5 s = 200 kgm²/s³ <u>= 200 Watts</u>
#2 Total Energy 1000 J (1000 kgm²/s²) = 1000 Nm