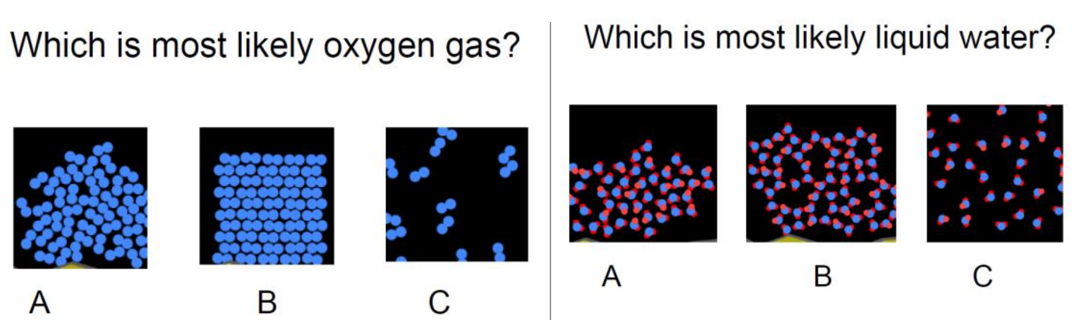
Heat, Energy and the States of Matter

Name: ____________________

Predictions:

1. Describe how atoms of a solid differ from atoms of a liquid. Include an illustration.
2. Describe how atoms of a liquid appear compared to a gas. Include an illustration.
3. What happens to atoms when you add heat to them?
4. 

Great questions from kids (still predictions for this assignment):

5. Do you think air can freeze? Not graded but answer is Yes
6. Can all substances change into solid, liquid and gas form? Yes

Investigation: Open the *States of Matter* PhET simulation: http://PhET.colorado.edu
Play around with the first tab for awhile, trying everything out.

1. How does solid Neon or Argon look compared to liquid Neon or Argon?

Describe the structure and motion. STRUCTURE: Solids are very ordered and tightly packed and the molecules in the liquids are not well ordered and take up a bit more space. MOTION: In the solid the molecules are vibrating and in the liquids they are moving faster and can move around until they bounce off another molecule.

2. How about liquid Neon or Argon versus gas Neon or Argon?

The gas takes up quite a bit more space than the liquid and has molecules bouncing all over the container. The liquid molecules stay towards the bottom but one or two do make it all the way to the top. The molecules in the gas are also moving faster than the molecules in the liquid phase.

3. How do the Oxygen and Water molecules compare to Neon and Argon? Draw each. Why do you think that could be?

The oxygen gas comes in pairs and the water has three atoms making up each molecule. The water also appears to be made of two different types of atoms because there are two different colors used to make each molecule.

4. What is the white part of each water molecule and what are the red parts of the water molecules? Include an illustration (black and white is fine)

   I know water is H_2O, which is 2 hydrogens and one oxygen. It stands to reason that the two white atoms are hydrogen and the red one represents an Oxygen atom.

5. Have you heard that ice takes up more space than water? If your pipes freeze, they split!! Can you see why that is the case? Include an illustration.

When water is in its solid phase, ice, you can see that the structure leaves empty spaces inside a ring of oxygen molecules. So the solid phase, instead of being more tightly packed, actually creates empty pockets of space and takes up more room that the same volume of liquid water.

6. How about the other molecules, do they take up more space as a liquid or as a solid? Include an Illustration.

All the other molecules shown take up less space as solids because they organize themselves in nice tight rows.

☆ ***Check your conlcusions for qusetions 4-6 with your instructor***

1. Can you get the molecules to stop wiggling? If so, how?

   Yes, cool the substance down to absolute zero or 0 K.

2. What happens to the molecules when heat is added?

   They move faster

3. What is in the bubbles of boiling water?

Water molecules in gas form. If I heat liquid water in the sim, I see that as it passes from liquid to a gas, which is what is happening when water boils, I see the molecules speed up. Eventually they are floating around the entire container because they are a gas. The water molecules stay water molecules the entire time.

☆ ***Check your conclusions with your instructor***

Open the PhET simulation *Friction* and play around.

1. Describe what you observe.
   As you rub the books together, the molecules on the surface vibrate faster as they warm up.

2. What happens to the energy you put into rubbing the books together?
   It turns into kinetic energy of the molecules – they move faster.

Weighing Air Name ___

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All matter must possess two characteristics. If air is really a form of matter, it must have mass and it must take up space. It is relatively easy to observe that air takes up space. Just blow up a balloon. As more air is added, the balloon gets larger. However, determining the mass of air is more difficult. In today's activity, you will investigate the mass and volume of air.

It is easy to tell that air does not have very much mass but just how much mass does it have? Today, you will measure the mass of a bottle filled with air then mass it again after some air has been removed. To remove the air you will be asked "suck" it out yourself. You will need to use a sensitive balance to measure the mass because it is not very large. Since it is not possible to remove all the air, you will then have to determine how much air was actually removed.

PROCEDURE:

1. Make sure the pinch clamp is not tightened so tight that it seals the rubber tube. Then put the bottle (large 24 oz. POM bottle), tube and pinch clamp on the balance and determine the mass of the apparatus to the nearest 0.01 gram.

Mass of bottle with air ______________________

2. Next, remove the bottle and "suck" as much air as possible out of the bottle. Don't just take one big suck; you will need to take several attempts. When you have removed as much air as possible from the bottle, screw down the pinch clamp to seal the tube. Make sure you wipe any spit you have left on the tube.

3. Place the bottle with the removed air on the balance and mass again to the nearest 0.01 gram.

Mass of bottle with air removed______________________

(**Hint**: if you did not remove at least 0.10 grams you will have to try again)

4. Finally, you will need to determine the volume of air that was actually removed. To do this, put your evacuated bottle under water and *gently* open the pinch clamp. Water will rush into the bottle. The amount of water that enters the bottle is equal to the amount of air that was removed.

Volume of air that was removed______~ 100 ml_________

CALCULATIONS:

5. What was the mass of the air you removed? ______~0.1 g________________

6. According to your measurements what is the density of air in the room? You should give your answer in grams per milliliter or grams per cubic centimeter (remember ml and cm^3 are the same thing). SHOW WORK

Your calculated density of air (mass/Volume) = 0.1g/100ml = 0.001 g/ml Write your value on the board.

Class Average = _________________

8. After eating your *Wheaties* for breakfast what do you think is the maximum weight that you could lift? 150lbs ~ 68kg on Earth

9. Do you think you can lift all the air in this room? No way!

10. Determine an approximate value for the volume of air in the room. 16m x 11m x 3m = 528 m^3

☆ ***Class discussion*** *As a class calculate the mass of the air in the room. You'll need to estimate the volume of the room as a class. Then use that with the density from the class average to estimate the mass of the air in the room.*

: Using the rooms' volume and class average for density of air: First volume 528 m^3 $(100cm/m)^3$ = 5.28 x 10^8 cm^3

Mass = 0.001 g/ml (5.28 x 10^8 cm^3) = 5.28 x 10^5 g or 5.28 x 10^2 kg

On Earth there are 2.2 kg per pound so 5.28 x 10^2 kg (1 lb/2.2 kg) = 1160 lbs!!!

PRESSURE:

Here's what you do:

- Fill a cup part way with water.
- Carefully place a 3 x 5 card completely on top of the cup.
- Turn the cup over while supporting your 3 x 5 card.
- Remove the hand holding the 3 x 5 card.

What happens?

Why do you think this is?

What is holding up the card?

Air in the room

When you "suck" on a straw, why do you think your cool refreshing drink makes it into your mouth?

You remove some of the air in the top of the straw and then your drink fills in the empty space, just like the Pom bottle.

The rest of the air in the room is pressing down on the drink in your cup. When there is less air in the straw, the push from the room air is stronger and **pushes** your drink up into your straw!!

When you placed your partly empty (some air removed) Pom bottle in water, why did water flow into the bottle?

Air in the room pushed on the water in the bowl harder than the air in the bottle pushed back so the water moved into the bottle to fill the empty space left when you sucked the air out.

Have you ever filled your straw with water, juice, etc.., sealed the end with your finger and then pulled your full straw out of your glass? Why doesn't your drink come out of the straw?

Because the drink is filling the empty space in the straw that was left when you took the air out. The air pressure in the room is greater than the air pressure in the top of the straw so the air in the room holds the drink in the straw!

☆***Check your conclusions with your instructor***

Science never sucks!!

Forces are pushes and pulls.