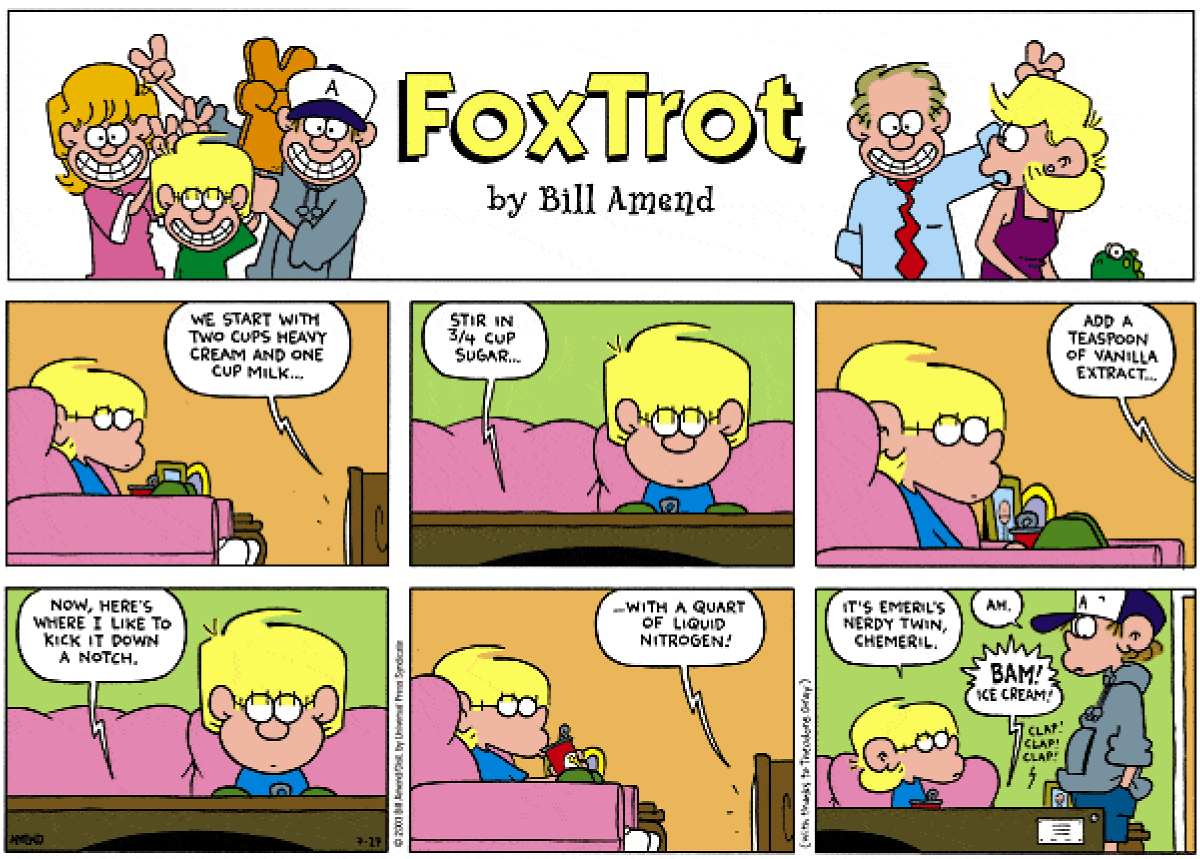
NAME____________________________________ **PERIOD**________

UNIT 3 NOTES: MATTER AND ITS CHANGES

STUDENT OBJECTIVES: Your fascinating teachers would like you amazing learners to be able to…

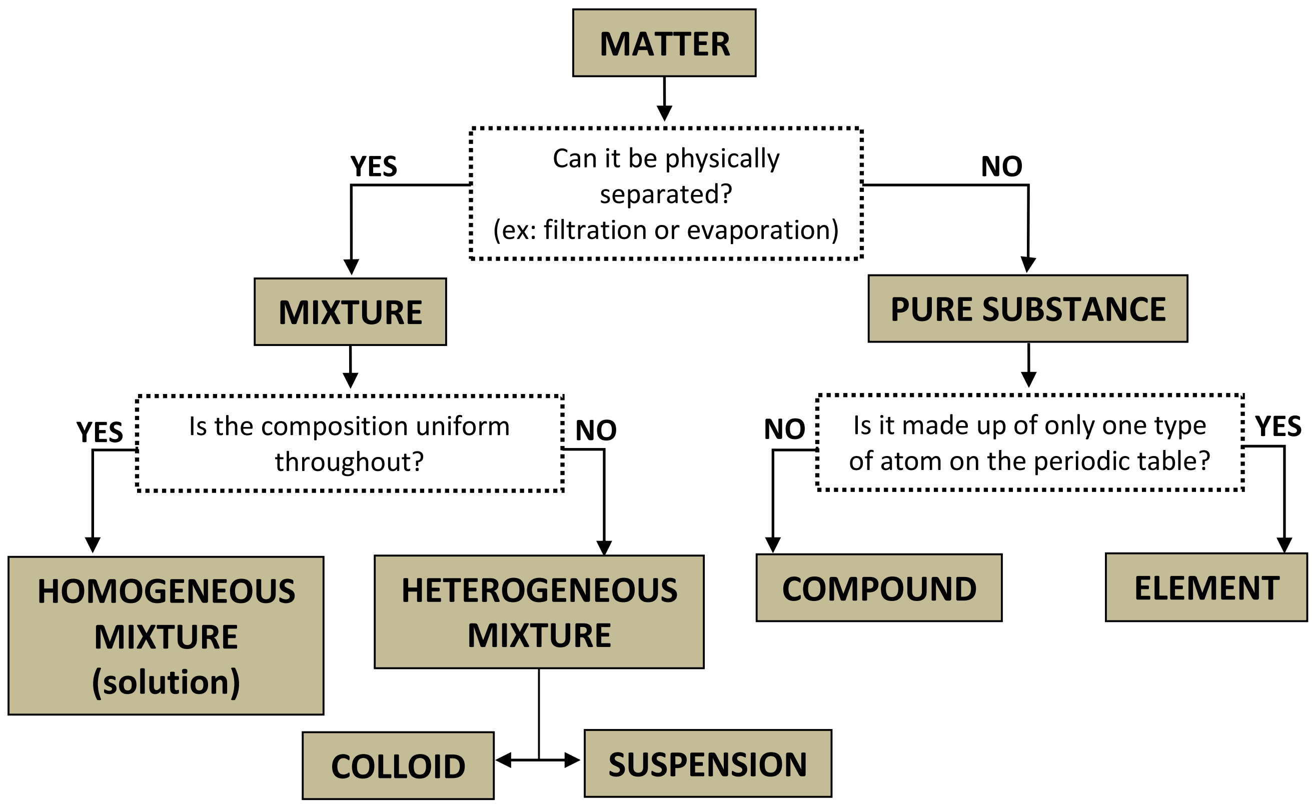
Understand the difference between a pure substance and a mixture.
Classify a substance as being a compound, element, homogeneous mixture, or homogeneous mixture.
Understand the difference between a colloid and suspension.
Understand the appropriate use of filtration and evaporation for the separation of mixtures.
Distinguish between physical and chemical properties.
Distinguish between intensive and extensive physical properties.
Distinguish between physical and chemical changes.
Understand the difference between intramolecular bonding and intermolecular forces.
Compare solids, liquids, and gases in terms of compressibility, structure, shape, volume, density, freedom of motion, expansion, force strength, and rates of diffusion.
Define the following phase changes in terms of process and energy: melting, vaporization, sublimation, freezing, condensation, and deposition.
Understand which phase changes are endothermic, and which are exothermic.
Identify the three factors as defining the state of a substance: pressure, temperature, and intermolecular force.
Analyze a phase diagram for phase changes and the triple point.
Draw and label a heating / cooling curve.



PAP 3-1 Matter classification (12:12)	http://youtu.be/lq6bX6ZXG6o	http://vimeo.com/49975149

I. CLASSIFICATION OF MATTER:

MATTER is defined as anything that has mass and takes up space (has a volume).
Before we can talk about changes in matter, we need to address some basics about the differences between elements, compounds, heterogeneous mixtures, and homogeneous mixtures (solutions).



A ____________________________ has a uniform, unchanging composition. Every sample of a pure substance has exactly the same characteristic properties and composition. Pure substances exist as either elements or compounds.

____________________ are found on the ______________________. An element cannot be separated into simpler substances by physical or chemical means. It takes a nuclear reaction to break them apart!

______________________ are combinations of two or more elements that are chemically _________________. A chemical change (which we will talk about soon!) is required to combine elements into compounds, or to separate compounds back into elements.

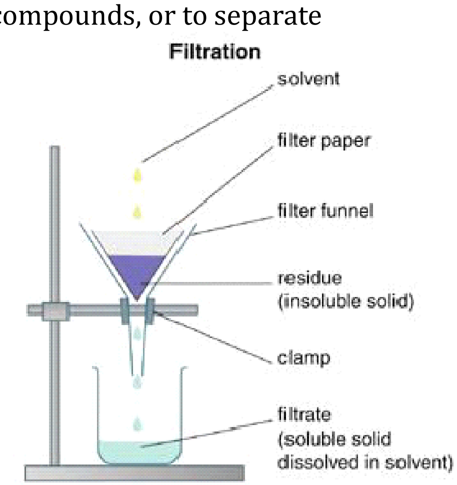
A ____________________ is a combination of two or more pure substances in which each pure substance retains its individual chemical properties.

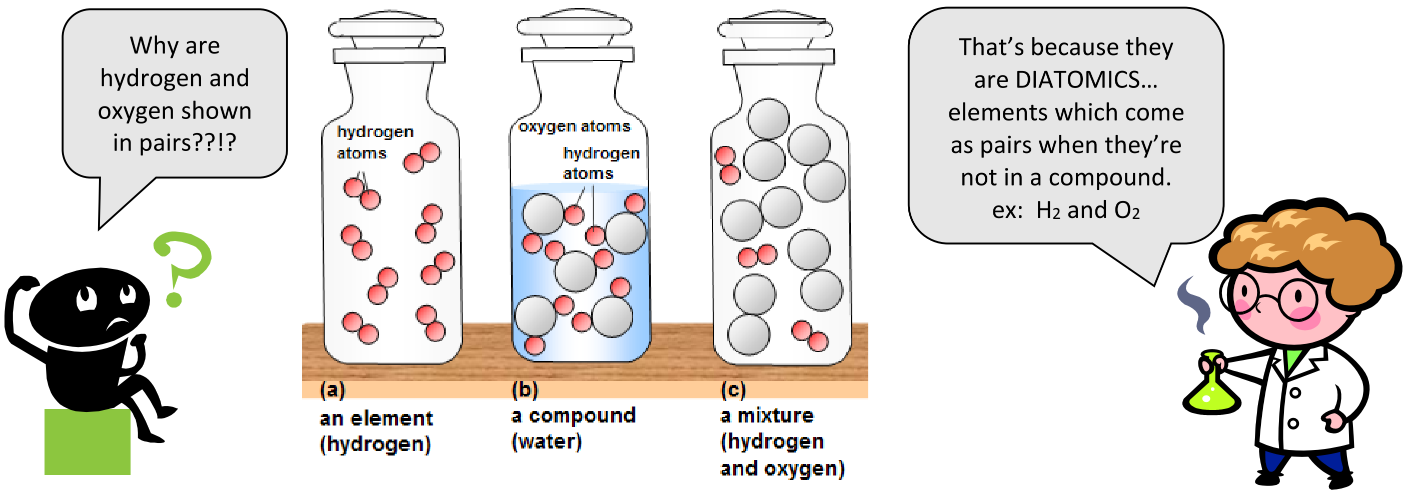
A ______________________________ is required to combine pure substances into mixtures, or to separate mixtures back into pure substances.

Some examples of physical separation include…

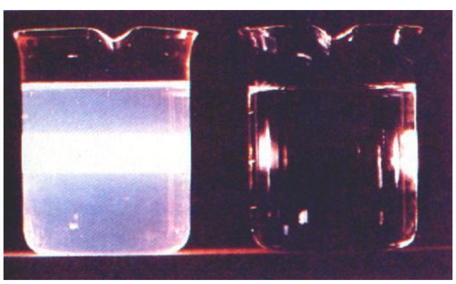
__________________: Separating a solid from a liquid with use of a filter paper

__________________: Allow a liquid to evaporate off to leave behind a solid residue





Heterogeneous Mixtures do not look the same throughout… they have pretty big pieces, and some are even big enough to separate them out by filtration. Because of these bigger pieces, most heterogeneous mixtures will scatter light when a beam is passed through.



The "scattering" of light when passed through a mixture is known as the

____

There are two types of Heterogeneous mixtures…

_________________and ______________________

____________________ Mixtures (also known as _________________) do look the same all the way throughout… the "pieces" inside a solution are usually atoms, ions, or molecules. Because of these super-small pieces, homogeneous mixtures cannot be separated by filtration, nor do they scatter light. However, evaporation can be used as a means of separation.

We usually think of solutions as being a solid mixed in a liquid, but this doesn't always have to be the case! We can have any combination of the different states of matter…

Gas / Liquid:

Gas / Gas:

Liquid / Liquid:

Solid / Solid:

24-karat gold is pure gold.

14-karat gold is an alloy of gold and silver.
14-karat gold is 14/24, or 58.3%, gold.

PAP 3-2 Matter classification (7:20)	http://youtu.be/jNveUnBbX2g	http://vimeo.com/49975153

MIXTURES COMPARISON CHART

	SOLUTIONS	COLLOIDS	SUSPENSIONS
Type of Mixture	Homogeneous	Heterogeneous	Heterogeneous
Particle Size and Type	Small (.01 – 1 nm), can be atoms, ions, or molecules	Medium (1-1000 nm), dispersed throughout, can be large molecules	Large (over 1000 nm), large particles
Separate on Standing?	No	No	Yes – Particles settle out
Separate by Filtration?	No	No	Yes
Scatter Light?	No	Yes	Yes
Example	Salt Water	Milk	Vinaigrette Salad Dressing

If you had a substance that you were trying to identify as being a solution, colloid, or suspension, what steps would you take in order to make your decision?

For each of the following, indicate if it is an element, compound, homogeneous mixture, or heterogeneous mixture.

Air
Rust
Iced Tea
Chicken Soup
Dirt
Chlorine
Sugar
Gasoline
Water
Hydrogen
Ketchup
Granite Rock
Orange Juice
Sodium Chloride
Baking Soda
Oxygen
Sugar Water
Concrete
Carbon Dioxide
Aluminum

PAP 3-3 Chem Phys Prop (12:54)	http://youtu.be/Haz-k63sU-k	http://vimeo.com/49975151

II. CHEMICAL VS. PHYSICAL PROPERTIES

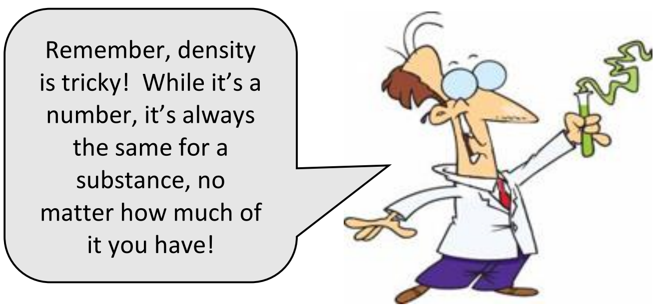
A property is a characteristic that distinguishes a substance. Some examples of properties include:

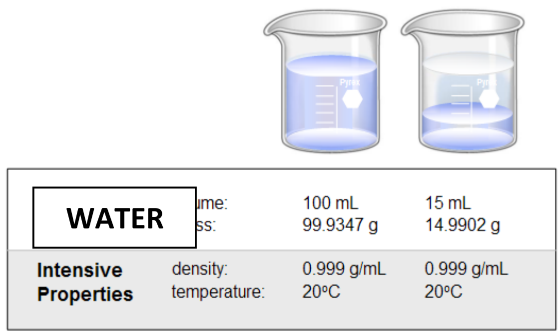
Amount of energy
Area
Boiling point
Clarity
Color
Ability to conduct electricity
Ability to conduct heat
Consistency
Density
Dissolves in water
Ductility (ability to be molded)
Ability to explode (combust)
Flammability (burning)
Hardness
Length
Luster (shine)
Malleability (hammer into sheet)
Mass
Melting point
Odor
Ability to react with acid
Ability to react with base
Ability to react with water
Ability to rust
Ability to tarnish
Viscosity (resistance to flow)
Volume

_________________ properties describe the substance itself. They can be observed or measured without altering the chemical identity of the substance (meaning no chemical reaction is necessary to view these properties). Physical properties can be broken down into two different categories...

__________________ physical properties depend on the amount of matter present. These properties vary with the amount of substance present, and therefore cannot be used to uniquely identify a substance.
Write only the extensive physical properties given in the list above.

__________________ physical properties do not depend on the amount of matter present. These properties stay the same regardless of the amount of substance present, and therefore are frequently used to identify a substance.
Write only the intensive physical properties given in the list above.





__________________ properties describe the ability of a substance to undergo changes that transform it into different substances. Some sort of chemical reaction must be performed in order to observe these properties.

Write only the chemical properties given in the list above.

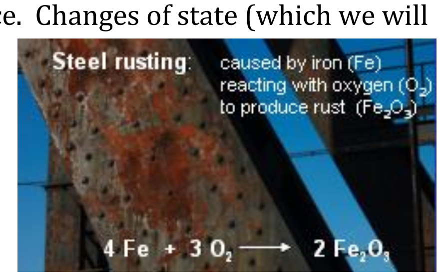
Consider the following properties (underlined) for sodium metal: Sodium is a soft(1), silvery-colored(2) metal with a density of 0.97 g/cm3(3). When a 2 gram sample(4) of sodium metal is ignited, it burns with a yellow flame(5). It reacts vigorously with chlorine gas(6) to form the salt sodium chloride. Sodium melts at 97.7°C(7) and boils at 883°C(8).

Which are physical properties?
Which are extensive physical properties?
Which are intensive physical properties?
Which are chemical properties?

PAP 3-4 Chem Phys changes (6:31)	http://youtu.be/hUA_vJJ4BP4	http://vimeo.com/49976397

1. CHEMICAL VS. PHYSICAL CHANGES

   a. ______________________ do not change the identity of a substance. Changes of state (which we will talk more about later) are all considered to be physical changes. Many physical changes are reversible.



List some examples of physical changes.

b. ______________________ transform one or more substances into new, different substances. They involve some sort of reaction taking place!

There are some key indicators that help us to know whether or not a chemical change has taken place:

(1) An unexpected change in _____________ energy (hotter or colder)

(2) A __________ is produced (bubbling)

(3) An unexpected ______________ change

(4) A solid _____________________ is produced (cloudiness)

(5) An unexpected apparent ______________ change (means that a gas was involved)

(6) New _____________ formed

(7) ______________ produced (fire)

List some examples of chemical changes. DO THIS ON YOUR OWN!

All of the processes listed below are part of the digestive breakdown of food. For each of the following, classify them as a chemical or physical change, and give a reason why.

Process	**C or P?**	**Process**	**C or P?**
Chewing food with the teeth		Food reacting with HCl in the stomach	
Breakdown of proteins into amino acids		Starch breakdown into simpler compounds by saliva	
Breakdown of carbohydrates into simple sugars		Churning of food caused by contraction of muscles in the walls of the stomach	

IT'S DEMO TIME!

You will be observing some chemical reactions, and recording some observations – both chemical and physical properties!!!

DEMO #1: Potassium Iodide with Lead (II) Nitrate	
Physical Properties of Potassium Iodide	
Physical Properties of Lead (II) Nitrate	
What happened when we reacted the two substances with each other?	

What evidence do we have that a chemical reaction took place?	
State a Chemical Property of the reactants.	

DEMO #2: Magnesium with Hydrochloric Acid	
Physical Properties of Magnesium	
Physical Properties of Hydrochloric Acid	
What happened when we reacted the two substances with each other?	
What evidence do we have that a chemical reaction took place?	
State a Chemical Property of the reactants.	
DEMO #3: Magnesium with Oxygen (Burning)	
Physical Properties of Magnesium	
Physical Properties of Oxygen	
What happened when we reacted the two substances with each other?	
What evidence do we have that a chemical reaction took place?	
State a Chemical Property of the reactants.	

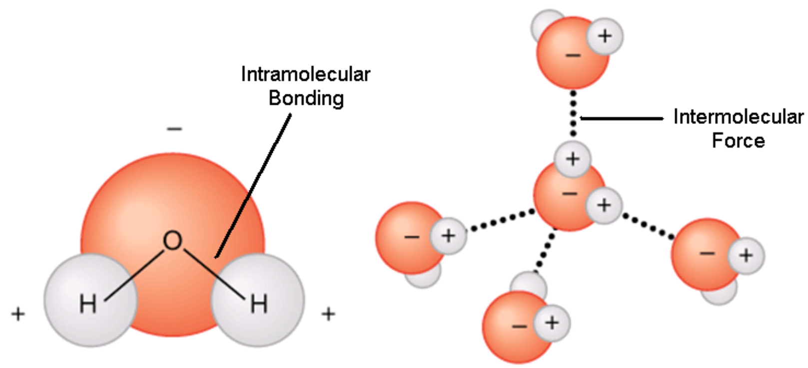
PAP 3-5 IMFs (7:30)	http://youtu.be/87NKakE7_94	http://vimeo.com/72608720

III. INTRAMOLECULAR BONDING VS. INTERMOLECULAR FORCES

Before we can discuss the difference between solids, liquids, and gases, we must first discuss the difference between intramolecular bonding and intermolecular forces.

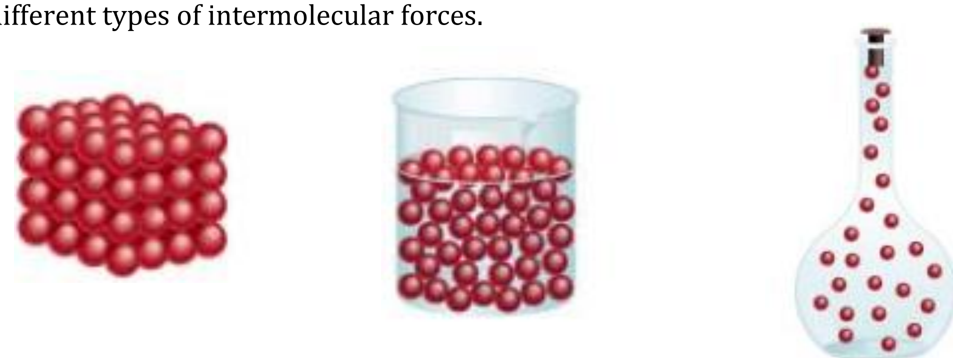
___________________________________: These are the bonds between atoms in a compound. They are inside ("intra") the molecule. For example, in water, the bonds holding oxygen to hydrogen would be considered intramolecular bonding. These are very strong interactions.

___________________________________: These are forces holding one molecule to another. Due to polarity within molecules, there are "pulls" between positive and negative ends of molecules. These forces help to hold substances together as a solid or liquid. These interactions are not as strong as intramolecular bonding.



Intermolecular Forces (often abbreviated IMF) help to hold a substance together as a ___________________ _______________. The reason why gas particles can go anywhere they want to is because the intermolecular forces between the molecules have been broken, giving gas particles complete freedom of motion. As we get later on into the year, we will discuss the different types of intermolecular forces.

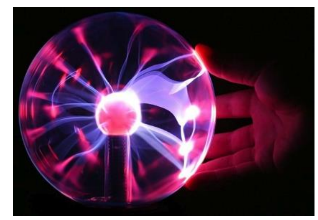
STATES OF MATTER



	SOLID	LIQUID	GAS
	Molecules VERY close	Molecules CLOSE	Molecules FAR apart
IMF = intermolecular force	STRONG IMFs	Fewer and WEAKER IMFs	NO IMFs
	DEFINITE shape DEFINITE volume	Takes shape of CONTAINER DEFINITE volume	Takes shape of CONTAINER Takes volume of CONTAINER
______________: ability of a substance to flow	VERY RESTRICTED motion – rotation and vibration in place only	LIMITED freedom of motion – there is some degree of fluidity	FREE TO MOVE in all directions – high degree of fluidity

	SOLID	LIQUID	GAS
____________: how tightly packed the molecules are together	HIGH density (typically measured in g/mL)	MEDIUM-HIGH density (less than that of solid EXCEPT for water!)	LOW density (typically measured in g/L)
______________: to force a substance into less space	NOT compressible (incompressible)	SOMEWHAT compressible	EASILY compressed into smaller volumes
______________: to increase in the space occupied	Does NOT expand much with increases in temperature	Expands SLIGHTLY with increases in temperature	HIGHLY expansive with increases in temperature (assuming the volume of the container can change!)
______________: an intermingling of molecules	Diffusion SO SLOW you can hardly notice it – must ramp temperature up really high to facilitate diffusion	Diffuses EASILY by less rapidly than the gaseous state	Diffuses EASILY and QUICKLY

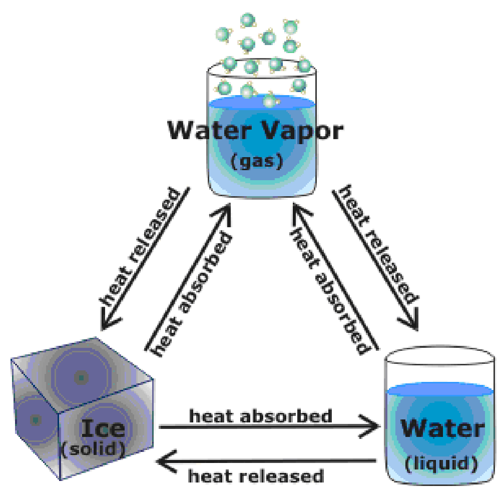
So, there is a fourth "state of matter"…
PLASMA: Plasma is ionized gas… meaning electrons are floating free, rather than being bound to an atom or molecule! (We aren't really going to get into it at the Pre-AP level. Sorry.) Examples include Stars, Plasma Lamps, Solar Wind, and Lightning.



PAP 3-6 Phase Changes (8:00)	http://youtu.be/8uxwpl4EP9M	http://vimeo.com/72608719

IV. PHASE CHANGES

What is happening as you are changing state? To make a long story short, you are either strengthening or weakening ____. If the particles are going from being closer together to farther apart, that process will require an energy input in order to give the molecules enough energy (speed & movement) to overcome the IMFs holding them together. If molecules are losing energy, this will slow the molecules down enough that they will start to experience the IMFs again and be pulled back together.



The types of phase changes include…

_________________: liquid changing to vapor

liquid + **energy** → vapor (gas)

_________________: vapor changing to liquid

vapor → liquid + **energy**

_________________: solid changing to liquid

solid + **energy** → liquid

_________________: liquid changing to solid

liquid → solid + **energy**

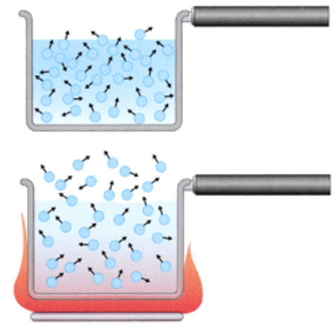
_________________: solid changing directly to vapor without going through the liquid phase

solid + **energy** → vapor

_________________: vapor changing directly to solid without going through the liquid phase

vapor → solid + **energy**

What's the deal with evaporation and boiling??!?!?



________________________ is changing from a liquid to a gas (vaporization) ____________ the boiling point. In evaporation, the surface molecules have enough energy to overcome IMFs and escape the surface of the liquid. (It is important to remember that because temperature is a measure of average kinetic energy, some molecules can have higher energy than others – meaning this can happen below the boiling point.)

___________________ is changing from a liquid to a gas (vaporization) _______ the boiling point. In boiling, because you are heating the substance, you are ensuring that ALL of the molecules have enough energy to overcome IMFs and change into a gas. This is the reason why boiling is much faster than evaporation.

You will notice that all of the phase changes above either required an input of energy (in order to give molecules enough speed to loosen/break IMFs), or they released energy (in order to slow the molecules down to bring them back together).

______________________: A process that releases heat (heat exits the system)

______________________: A process that takes in heat (heat enters the system)

Which phase changes are exothermic?

Which phase changes are endothermic?

PAP 3-7 Phase Change Diagram (5:46)	http://youtu.be/tKcmmXid6AY	http://vimeo.com/72608721

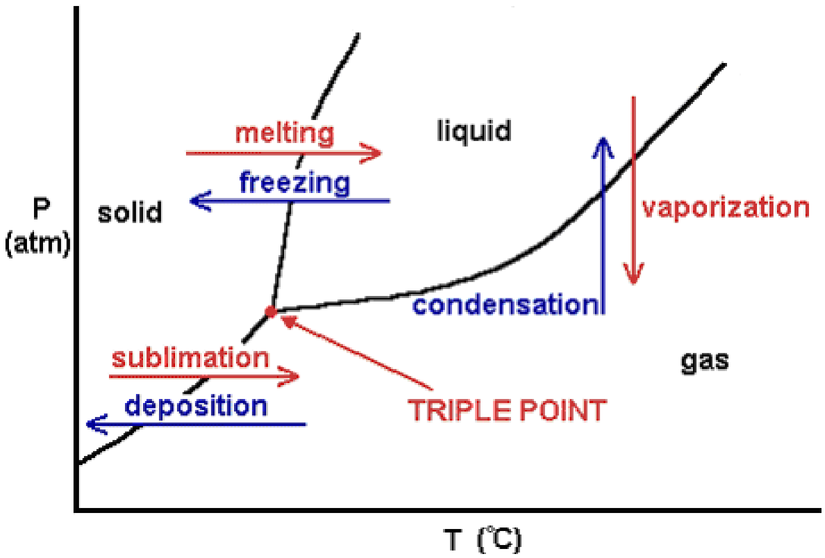
V. PHASE DIAGRAM

While intermolecular forces have a large role in determining whether a substance will be a solid, liquid, or gas, there are two other variables which also play a role – _________________ and ____________________.

Having a high pressure means that molecules are being pushed together more, while a low pressure means that the molecules have less collisions with each other – which in turn can allow the weakening of intermolecular forces.

Having a high temperature can mean that more molecules have enough energy to overcome intermolecular forces, while low temperatures mean less movement, and less likelihood of loosening IMFs.

A _________________________ is used to show at different combinations of temperature and pressure what state of matter is present (solid, liquid, or gas). Because of different strengths of IMFs in different substances, each substance has its own unique phase diagram.



This is an example of a phase diagram. Notice that different combinations of pressure and temperature will result in different __________.

As conditions change, a substance may transition from one state to another, resulting in a _______ ____________.

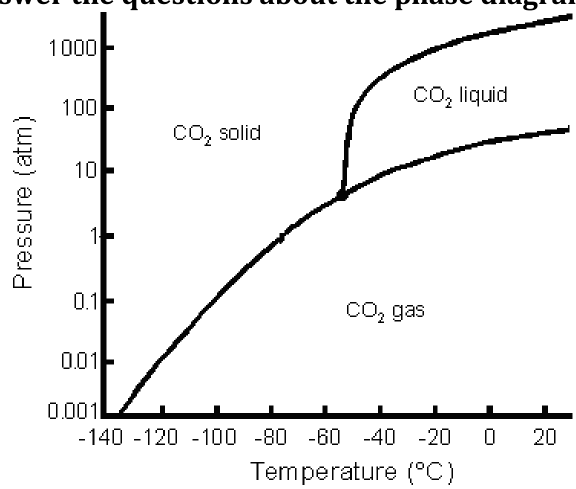
If conditions place a substance "on the line", that means that BOTH states are present at that time, and there is a phase equilibrium occurring between the two phase changes.

PHASE EQUILIBRIUM:

There is also a very special point called the TRIPLE POINT.

TRIPLE POINT:

Answer the questions about the phase diagram for CO_2 shown below.



If a sample of CO_2 has a temperature of – 100°C and a pressure of 100 atm, what state is that sample in?

If you take the sample from part a and decrease the pressure to 0.01 atm, what phase change has been made?

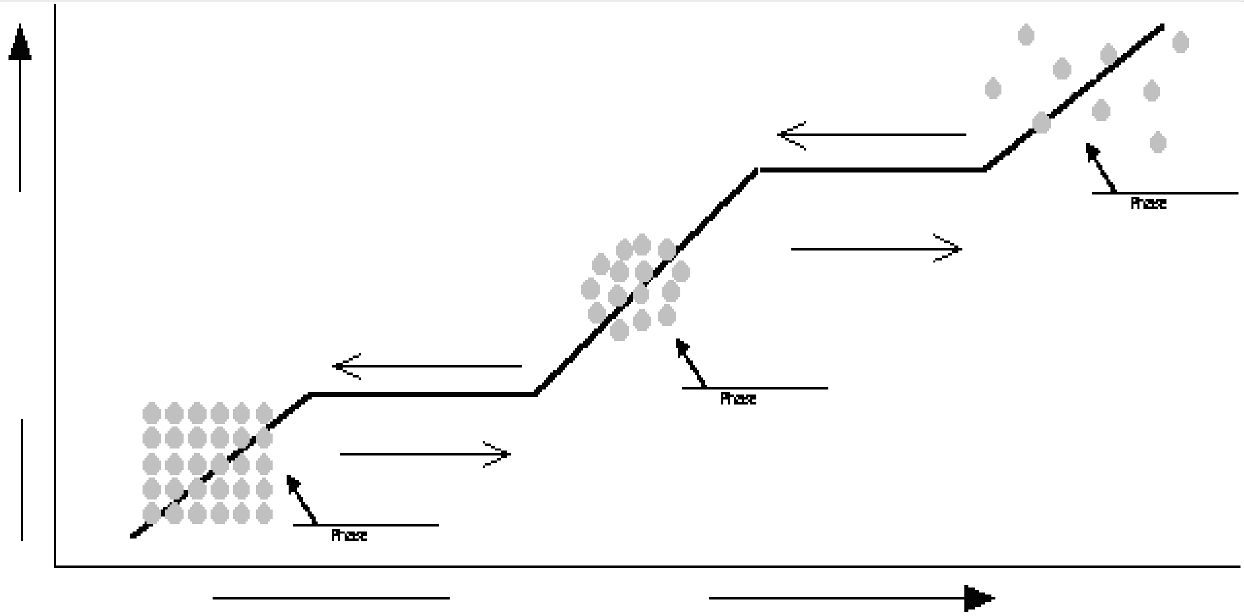
If you take the sample from part a and increase the temperature to – 20°C, what phase change has been made?

HEATING & COOLING CURVES

While a phase change can be achieved by changing either temperature or pressure, the more commonly used method of changing state is to change ___________________. However, we must be careful!

To change temperature, we would obviously alter ___________. But a change in heat does not always change temperature. Remember, temperature is a measure of ______________________________. But, if the heat we add goes to something besides kinetic energy, then a temperature increase does not result. This exact scenario occurs during a phase change.

To illustrate this phenomenon, we can observe a heating/cooling curve.



During a phase change, what is happening to the temperature of the substance?

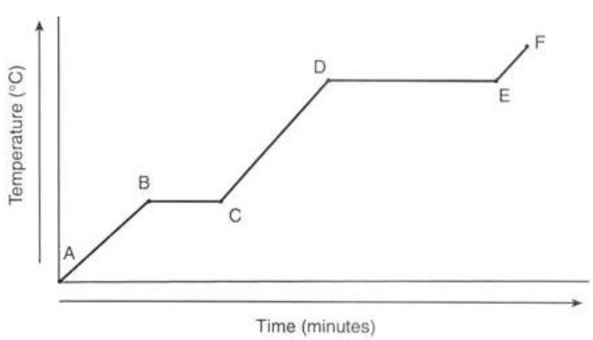
So, if during a phase change, we are heating the substance, but the temperature is not changing, then the question becomes: Where is the heat going during a phase change?

The answer to that lies with what is happening during a phase change. Remember, during a phase change, we are either weakening or strengthening _____________. In order to get those changes to happen, we need a little extra "oomph" in order to make the transition from one state to another.

For example, in a phase change from liquid to gas, the temperature does not change because the heat energy applied is used to break IMFs!

Sketch out the heating curve for bromine, labeling both the x and y axis. (Tb = 59°C & Tm = – 7°C)

Answer the following questions for the shown heating / cooling curve.



Between which points is there a phase change taking place?

What is taking place as you move from point E to point D?

What phase(s) exist between point A and point B?

What phase(s) exist between point B and point C?