Hello, welcome to AP Chemistry,

It's really not as bad as it seems….

… mostly.

Name: ______________________________

Complete as many or few of these problems as you need to fully understand each topic- this is the BASE of understanding for the rest of the year. We WILL cover these topics in class, but we will move through them more quickly with the expectation that you have an understanding.

In addition to the review, page 1 contains information on ***significant figures (aka sig figs)*** which you will also need to know at the start of this class.

A few days into class we will have a test that covers all the topics in this packet for a grade.

Topic 0 – Significant Figures

1.1 - Moles and molar mass.

Need To Brush Up? Scan here →

You Try!

1. What is the molar mass of the following compounds?

a. NaOH

b. H_2SO_3

c. $Al_2(CO_3)_3$

d. $PbCl_4*3H_2O$

^^^^ this is a hydrate, it is $PbCl_4$ PLUS 3 waters

2. How many moles are there in a 12.5-gram sample of NaOH?

3. How many atoms are in a 3.4 mole sample of Al metal?

4. How many grams are there in a sample that contains $5.8*10^{24}$ molecules of H_2O?

5. You have two containers- one has a mole of $CaCl_2$ and one has a mole of $BaCl_2$. Which container weighs more? Which has more particles?

6. You have a container of $1.58*10^{24}$ molecules of NiO_2. How many grams is this?

7. You have a container with 15 grams of NO_2. How many N atoms is this? How many O atoms is this?

1.5 - Electron configuration/ Atomic structure

Need To Brush Up? Scan here →

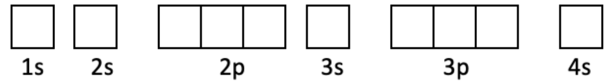
You Try!

1. Fill in the table.

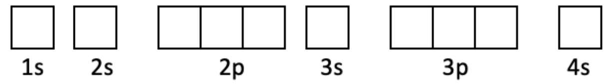
Proton			
Neutron			
Electron	0.0005 AMU (.05% of a proton)		
	Mass (AMU)	Location	Charge (eV)

2. Write the electron configurations ***and*** fill in the orbital diagrams for each of the elements or ions below.

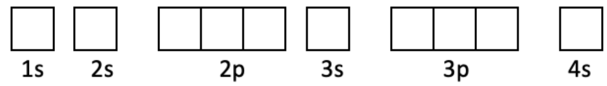
a. Na



b. O^{2-}



c. Mg^{2+}



3. Match each of the quantum numbers with their descriptions (some may be used more than once).

i.	_____ Determines the shape of the orbital	a. principal quantum number
ii.	_____ Determines the energy level of the electron	b. angular momentum quantum number
iii.	_____ Determines the way the electron rotates	c. magnetic quantum number
iv.	_____ Determines the way the orbital faces	d. spin quantum number
v.	_____ Determines the distance from the nucleus	
vi.	_____ s,pd,f	
vii.	_____ n=3	
viii.	_____ Up or down	

4. How many electrons would be in each of the following:

b. Any orbital _______ c. A full p sublevel ________ e. 2nd energy level ______

c. A full s orbital _____ d. A full d sublevel ________

5. Define valence electron:

1.7 - Periodic Trends

Need to Brush Up? Scan here! →

You Try!

1. Define the following

a. Period

b. Family/Group

2. Elements in the

3. Define each of the following words and describe the direction of the trend on the periodic table.

a. Ionization Energy:

b. Atomic Radii:

c. Electronegativity:

2. For each of the following- rank them based on the biggest ionization energy based on approximation. (Big → little)

a. Na, Ar, P

b. F, He, Si

c. Ba, Mg, Ca

3. For each of the following- rank them based on the biggest electronegativity based on approximation (big → little) .

a. C, Li, F, Ne

b. N, Bi, P,

4. For each of the following- rank them based on the biggest atomic radius based on approximation (big → little) .

a. Na, Ar, P

b. Ba, Mg, Ca

1.8 - Valence Electrons & ionic Compounds

ENDURING UNDERSTANDING

SAP-2

The periodic table shows patterns in electronic structure and trends in atomic properties.

Need To Brush Up? Scan here!

You Try!

ESSENTIAL KNOWLEDGE

SAP-2.B.1

The likelihood that two elements will form a chemical bond is determined by the interactions between the valence electrons and nuclei of elements.

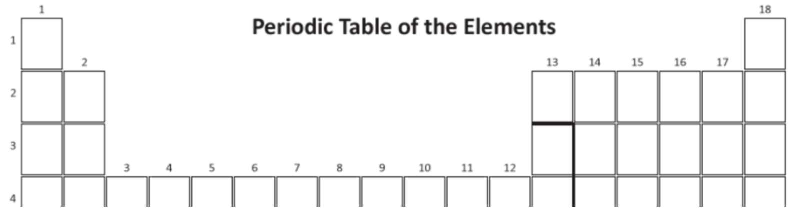
SAP-2.B.2

Elements in the same column of the periodic table tend to form analogous compounds.

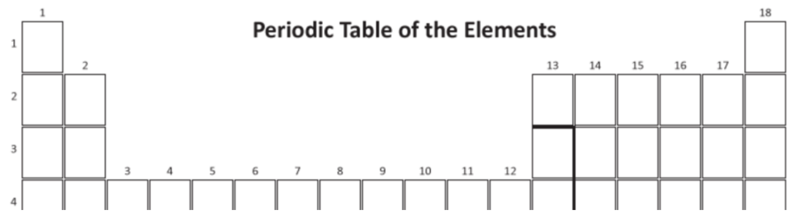
SAP-2.B.3

Typical charges of atoms in ionic compounds are governed by their location on the periodic table and the number of valence electrons.

1. Fill in the table below with the charges of ions formed in each of the main group elements.



2. Fill in the table below with the number of valence electrons in each of the main group elements.



3. Using the charges of the main group elements- form the ionic compounds below.

a. Na + O

c. Mg + Cl

b. Al + F

d. Al + O

4. Using approximation, which of the following are ionic? Which are covalent?

a. NO b. NaCl c. Al_2S_3 d. $Cu(NO_3)_2$ e. $SiCl_4$

5. Which elements have more than one charge?

6. What is a polyatomic ion? (This is a great time to start memorizing the core group of them – hydroxide, cyanide, sulfate, phosphate, nitrate, permanganate, and chlorate).

2.1- Types of chemical bonds

ENDURING UNDERSTANDING

SAP-3

Atoms or ions bond due to interactions between them, forming molecules.

Need To Brush Up? Scan here!

ESSENTIAL KNOWLEDGE

SAP-3.A.1

Electronegativity values for the representative elements increase going from left to right across a period and decrease going down a group. These trends can be understood qualitatively through the electronic structure of the atoms, the shell model, and Coulomb's law.

SAP-3.A.2

Valence electrons shared between atoms of similar electronegativity constitute a nonpolar covalent bond. For example, bonds between carbon and hydrogen are effectively nonpolar even though carbon is slightly more electronegative than hydrogen.

SAP-3.A.3

Valence electrons shared between atoms of unequal electronegativity constitute a polar covalent bond.

a. The atom with a higher electronegativity will develop a partial negative charge relative to the other atom in the bond.

b. In single bonds, greater differences in electronegativity lead to greater bond dipoles.

c. All polar bonds have some ionic character, and the difference between ionic and covalent bonding is not distinct but rather a continuum.

ESSENTIAL KNOWLEDGE

SAP-3.A.4

The difference in electronegativity is not the only factor in determining if a bond should be designated as ionic or covalent. Generally, bonds between a metal and nonmetal are ionic, and bonds between two nonmetals are covalent. Examination of the properties of a compound is the best way to characterize the type of bonding.

SAP-3.A.5

In a metallic solid, the valence electrons from the metal atoms are considered to be delocalized and not associated with any individual atom.

You Try!

1. Compare and contrast the role of electrons in covalent, ionic, and metallic bonds.

2. Without looking at an electronegativity chart- approximate the following bonds as nonpolar covalent, polar covalent, or ionic. For polar covalent bonds draw a polarity arrow towards the more electronegative atom and add partial +/- charges.

a. Cl-H   b. C=O   c. F-F   d. Na-F   e. Mg-Cl

f. Cu-Cl   g. H-N   h. O-Cl   i. C-F   j. K-O

3. HF, H_2O, and NH_3 all contain polar covalent bonds. Rank them from most to least polar. What would you expect regarding IMFs formed between molecules with each of these bonds?

4. Describe some of the properties we see/experience in ionic, polar covalent, nonpolar covalent and metallic bonded compounds.

2.5- Lewis Diagrams (let's lump a tiny bit of VSEPR in here for

SAP-4

Molecular compounds are arranged based on Lewis diagrams and Valence Shell Electron Pair Repulsion (VSEPR) theory.

Need To Brush Up? Scan here

ESSENTIAL KNOWLEDGE

SAP-4.A.1

Lewis diagrams can be constructed according to an established set of principles.

You Try!

1. In a Lewis Dot structure – most elements have ________ total electrons- three common exceptions are

______, ______, and ______.

2. Draw Lewis Structures for the following covalent compounds- attempt to provide VSEPR shapes.

a. CH_4

b. CS_2

c. HCP

d. OH^{-1}

e. C_3H_6

f. NF_3

g. BCl_3

h. SF_6

i. O_3

3.1- IMFs

ENDURING UNDERSTANDING

SAP-5

Intermolecular forces can explain the physical properties of a material.

Need To Brush Up? Scan here!

ESSENTIAL KNOWLEDGE

SAP-5.A.1

London dispersion forces are a result of the Coulombic interactions between temporary, fluctuating dipoles. London dispersion forces are often the strongest net intermolecular force between large molecules.

a. Dispersion forces increase with increasing contact area between molecules and with increasing polarizability of the molecules.

b. The polarizability of a molecule increases with an increasing number of electrons in the molecule; and the size of the electron cloud. It is enhanced by the presence of pi bonding.

c. The term "London dispersion forces" should not be used synonymously with the term "van der Waals forces."

SAP-5.A.2

The dipole moment of a polar molecule leads to additional interactions with other chemical species.

a. Dipole-induced dipole interactions are present between a polar and nonpolar molecule. These forces are always attractive. The strength of these forces increases with the magnitude of the dipole of the polar molecule and with the polarizability of the nonpolar molecule.

ESSENTIAL KNOWLEDGE

b. Dipole-dipole interactions are present between polar molecules. The interaction strength depends on the magnitudes of the dipoles and their relative orientation. Interactions between polar molecules are typically greater than those between nonpolar molecules of comparable size because these interactions act in addition to London dispersion forces.

c. Ion-dipole forces of attraction are present between ions and polar molecules. These tend to be stronger than dipole-dipole forces.

SAP-5.A.3

The relative strength and orientation dependence of dipole-dipole and ion-dipole forces can be understood qualitatively by considering the sign of the partial charges responsible for the molecular dipole moment, and how these partial charges interact with an ion or with an adjacent dipole.

SAP-5.A.4

Hydrogen bonding is a strong type of intermolecular interaction that exists when hydrogen atoms covalently bonded to the highly electronegative atoms (N, O, and F) are attracted to the negative end of a dipole formed by the electronegative atom (N, O, and F) in a different molecule, or a different part of the same molecule.

SAP-5.A.5

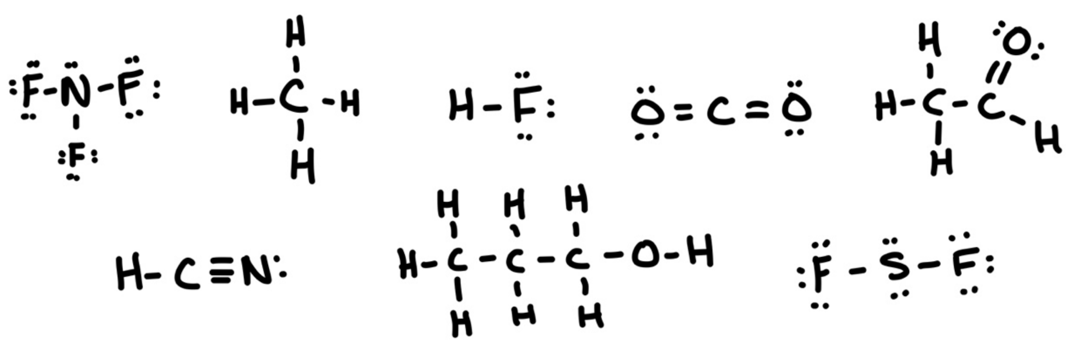
In large biomolecules, noncovalent interactions may occur between different molecules or between different regions of the same large biomolecule.

You Try!

1. Briefly describe the 4 major types of IMFs from chem 1 (London dispersion, dipole-dipole, hydrogen bonding, and ion-dipole).

2. (Briefly) describe how IMFs impact the properties listed here – viscosity, melting point/boiling point, state of matter, and surface tension.

3. Below are several molecules – label the molecules as polar or nonpolar – if they are both – label any polar and nonpolar regions. Label the polar areas with partial +/- charges. Then list any IMFs the molecules may experience with an identical neighboring molecule.



3.3 - Solids, Liquids, Gases

ENDURING UNDERSTANDING

SAP-6

Matter exists in three states: solid, liquid, and gas, and their differences are influenced by variances in spacing and motion of the molecules.

Need To Brush Up? Scan here!

ESSENTIAL KNOWLEDGE

SAP-6.A.1

Solids can be crystalline, where the particles are arranged in a regular three-dimensional structure, or they can be amorphous, where the particles do not have a regular, orderly arrangement. In both cases, the motion of the individual particles is limited, and the particles do not undergo overall translation with respect to each other. The structure of the solid is influenced by interparticle interactions and the ability of the particles to pack together.

SAP-6.A.2

The constituent particles in liquids are in close contact with each other, and they are continually moving and colliding. The arrangement and movement of particles are influenced by the nature and strength of the forces (e.g., polarity, hydrogen bonding, and temperature) between the particles.

ESSENTIAL KNOWLEDGE

SAP-6.A.3

The solid and liquid phases for a particular substance typically have similar molar volume because, in both phases, the constituent particles are in close contact at all times.

SAP-6.A.4

In the gas phase, the particles are in constant motion. Their frequencies of collision and the average spacing between them are dependent on temperature, pressure, and volume. Because of this constant motion, and minimal effects of forces between particles, a gas has neither a definite volume nor a definite shape.

1. Describe and draw the particles of a solid, a liquid, and a gas. Compare the relative energies, particle attractions, particle motions.

2. Describe the changes that occur between each of the states of matter.

3.4 - Ideal Gas law

ENDURING UNDERSTANDING

SAP-7

Gas properties are explained macroscopically—using the relationships among pressure, volume, temperature, moles, gas constant—and molecularly by the motion of the gas.

Need To Brush Up? Scan here!

ESSENTIAL KNOWLEDGE

SAP-7.A.1

The macroscopic properties of ideal gases are related through the ideal gas law:

EQN: $PV = nRT$.

You Try!

1. Write the equations for the ideal gas law and the combined gas law below- label all variables.

SAP-7.A.3

Graphical representations of the relationships between P, V, T, and n are useful to describe gas behavior.

2. A container of hairspray is at STP and is thrown into a fire where it is heated to a temperature of 100 C. Describe what happens in the container and complete a math calculation to solve for final pressure.

3. A bag of chips has a volume of 0.21 L at a pressure of 14.7 psi. The pressure in the cabin of an airplane is 13.85 psi. Describe what happens in the container and complete a math calculation to solve for the final volume of the bag.

4. A chemical reaction produces 15 grams of oxygen gas at a temperature of 23 C, and a pressure of 98.75 kPa. What is the volume of gas produced?

5. The chemical reaction $2H_2O_2 \rightarrow 2H_2O + O_2$ is performed in a room of temperature 28 C and pressure 0.87 atm. Calculate the volume of oxygen gas produced when 150 grams of H_2O_2 is reacted.

3.7 - Solutions and Mixtures

ENDURING UNDERSTANDING

SPQ-3

Interactions between intermolecular forces influence the solubility and separation of mixtures.

Need To Brush Up? Scan here

ESSENTIAL KNOWLEDGE

SPQ-3.A.1

Solutions, also sometimes called homogeneous mixtures, can be solids, liquids, or gases. In a solution, the macroscopic properties do not vary throughout the sample. In a heterogeneous mixture, the macroscopic properties depend on location in the mixture.

SPQ-3.A.2

Solution composition can be expressed in a variety of ways; molarity is the most common method used in the laboratory.

EQN: $M = n_{solute}/L_{solution}$

You Try!

1. Represent 1 L of a 2 M solution of $CaCl_2$ below – draw the water as 5 molecules.

2. In the solution above, if you take a 15 mL sample, how many moles of $CaCl_2$ are present? How many moles of Cl^{-1} ion are present?

3. 10.5 grams of lead (II) nitrate are mixed into 300 mL of water. What is the molarity of the lead (II) nitrate? What is the molarity of the nitrate ion?

4. What is more concentrated? 10 grams of NaCl in 100 mL of water or 10 grams $MgCl_2$ in 200 mL of water?

4.1 - Reactions & 4.4 - Physical and Chemical Changes

ENDURING UNDERSTANDING

TRA-1

A substance that changes its properties, or that changes into a different substance, can be represented by chemical equations.

ENDURING UNDERSTANDING

TRA-1

A substance that changes its properties, or that changes into a different substance, can be represented by chemical equations.

ESSENTIAL KNOWLEDGE

TRA-1.A.1

A physical change occurs when a substance undergoes a change in properties but not a change in composition. Changes in the phase of a substance (solid, liquid, gas) or formation/separation of mixtures of substances are common physical changes.

TRA-1.A.2

A chemical change occurs when substances are transformed into new substances, typically with different compositions. Production of heat or light, formation of a gas, formation of a precipitate, and/or color change provide possible evidence that a chemical change has occurred.

ESSENTIAL KNOWLEDGE

TRA-1.D.1

Processes that involve the breaking and/or formation of chemical bonds are typically classified as chemical processes. Processes that involve only changes in intermolecular interactions, such as phase changes, are typically classified as physical processes.

TRA-1.D.2

Sometimes physical processes involve the breaking of chemical bonds. For example, plausible arguments could be made for the dissolution of a salt in water, as either a physical or chemical process, involves breaking of ionic bonds, and the formation of ion-dipole interactions between ions and solvent.

Need To Brush Up? Scan here!

You Try!

1. Label each of the changes as physical or chemical- for any chemical changes list the evidence of a chemical reaction that would be observed.

a. Water boils

b. Marshmallow is burned

c. Sodium is dropped into water

d. $AgNO_3 + Cu \rightarrow CuNO_3 + Ag$

e. Melted chocolate solidifies

f. A piece of wood is ground into dust

g. Milk goes bad in the fridge

h. Magnesium metal is exposed to flame

i. $NaHCO_3 + HC_2H_3O_2 \rightarrow NaC_2H_3O_2 + CO_2 + H_2O$

j. Solid CO_2 sublimates

k. $CH_4 + O_2 \rightarrow CO_2 + H_2O$

l. $S_{8\,(l)} \rightarrow 8S_{(g)}$

4.5 – Stoichiometry

ENDURING UNDERSTANDING

SPQ-4

When a substance changes into a new substance, or when its properties change, no mass is lost or gained.

Need To Brush Up? Scan here!

ESSENTIAL KNOWLEDGE

SPQ-4.A.1

Because atoms must be conserved during a chemical process, it is possible to calculate product amounts by using known reactant amounts, or to calculate reactant amounts given known product amounts.

SPQ-4.A.2

Coefficients of balanced chemical equations contain information regarding the proportionality of the amounts of substances involved in the reaction. These values can be used in chemical calculations involving the mole concept.

SPQ-4.A.3

Stoichiometric calculations can be combined with the ideal gas law and calculations involving molarity to quantitatively study gases and solutions.

You Try! $Li_2CO_{3\,(s)} + 2HCl_{(aq)} \rightarrow 2LiCl_{(aq)} + H_2O_{(l)} + CO_{2\,(g)}$

1. In the reaction above, 5 moles of HCl are reacted with unlimited Li_2CO_3 – how many moles of each product are made?

2. In the reaction above, 10.8 moles of Li_2CO_3 are reacted with 12.4 moles of HCl. How many moles of water are made?

3. In the reaction above, 10 grams of both reactants are reacted- how many grams of LiCl are made? How many grams of water are made? How many L of CO_2 are made (at STP)?

4. 15 grams of Li_2CO_3 is now mixed with 150 mL of a 0.8 M solution of HCl. How many grams of LiCl are made? How many grams of water are made? How many L of CO_2 are made at STP?

5. If you want to make 0.9 L of CO_2 (at STP), how many mL of 0.8 M HCl are needed? How many grams of Li_2CO_3?

6. (Challenge Problem) You react 14.2 grams of Li_2CO_3 in a room of temperature 21°C and a pressure of 1.21 atm. What volume of CO_2 gas will you produce?

7. Balance the following chemical reactions

_____ Dy + _____ I_2 → _____ DyI_3

_____ C_3H_8 + _____ O_2 → _____ CO_2 + _____ H_2O

_____ $FeCl_3$ + _____ NH_4OH → _____ $Fe(OH)_3$ + _____ NH_4C

_____ SF_4 + _____ H_2O → _____ SO_2 + _____ HF

_____ Fe + _____ O_2 + _____ H_2O → _____ $Fe(OH)_3$

_____ Al + _____ $CoCl_2$ → _____ $AlCl_3$ + _____ Co

6.1 - Endothermic and Exothermic Processes

ENDURING UNDERSTANDING

ENE-2

Changes in a substance's properties or change into a different substance requires an exchange of energy.

Need To Brush Up? Scan here!

ESSENTIAL KNOWLEDGE

ENE-2.A.1

Temperature changes in a system indicate energy changes.

ENE-2.A.2

Energy changes in a system can be described as endothermic and exothermic processes such as the heating or cooling of a substance, phase changes, or chemical transformations.

ENE-2.A.3

When a chemical reaction occurs, the energy of the system either decreases (exothermic reaction), increases (endothermic reaction), or remains the same. For exothermic reactions, the energy lost by the reacting species (system) is gained by the surroundings, as heat transfer from or work done by the system. Likewise, for endothermic reactions, the system gains energy from the surroundings by heat transfer to or work done on the system.

ENE-2.A.4

The formation of a solution may be an exothermic or endothermic process, depending on the relative strengths of intermolecular/interparticle interactions before and after the dissolution process.

You Try!

1. Describe what happens to the energy of a system during an endothermic process. How would this FEEL on your skin?

2. Describe what happens to the energy of a system during an exothermic process. How would this FEEL on your skin?

3. Which phase changes are exothermic? Which are endothermic?

Memorize this phrase – it takes to break and frees to form. We'll need this later.

PS- How yah doin friend? – There's only a little more to go- unless you did this out of order, either way.

<<< need a break? feeling blue? scan here.

6. 3 - Heat transfer and thermal equilibrium
6.4 - Heat capacity and calorimetry

Need To Brush Up? Scan here!

ENDURING UNDERSTANDING

ENE-2

Changes in a substance's properties or change into a different substance requires an exchange of energy.

ESSENTIAL KNOWLEDGE

ENE-2.C.1

The particles in a warmer body have a greater average kinetic energy than those in a cooler body.

ENE-2.C.2

Collisions between particles in thermal contact can result in the transfer of energy. This process is called "heat transfer," "heat exchange," or "transfer of energy as heat."

ENE-2.C.3

Eventually, thermal equilibrium is reached as the particles continue to collide. At thermal equilibrium, the average kinetic energy of both bodies is the same, and hence, their temperatures are the same.

ENDURING UNDERSTANDING

ENE-2

Changes in a substance's properties or change into a different substance requires an exchange of energy.

ESSENTIAL KNOWLEDGE

ENE-2.D.1

The heating of a cool body by a warmer body is an important form of energy transfer between two systems. The amount of heat transferred between two bodies may be quantified by the heat transfer equation:

EQN: $q = mc\Delta T$.

Calorimetry experiments are used to measure the transfer of heat.

ENE-2.D.2

The first law of thermodynamics states that energy is conserved in chemical and physical processes.

ENE-2.D.3

The transfer of a given amount of thermal energy will not produce the same temperature change in equal masses of matter with differing specific heat capacities.

ENE-2.D.4

Heating a system increases the energy of the system, while cooling a system decreases the energy of the system.

ENE-2.D.5

The specific heat capacity of a substance and the molar heat capacity are both used in energy calculations.

ENE-2.D.6

Chemical systems change their energy through three main processes: heating/cooling, phase transitions, and chemical reactions.

You Try!

1. How does a change in energy impact how particles behave? How do we experience this change in particle behavior?

2. What does it mean for two substances to be in thermal equilibrium?

3. How much energy does it take to heat a sample of 100 g of water (c= 4.18 J/gC) from 7^{o}C to 67^{o}C?

4. What is the final temperature of water that starts at 80^{o}C and has 90 J of energy removed?

6.3 & 6.4 Continued:

5. You have two substances A (c_A = 0.50 J/g^{o}C) and B (c_B = 2.50 J/g^{o}C)…

   a. You place 5 g of each in a beaker of boiling water – which one will reach 100^{o}C first? Why?

b. You heat 5g of substance A to 100°C and leave 5 g of B at 25°C (room temp). Then you place them in contact in a sealed container- explain what would happen to the particles of each and the system with words.

c. Support your answer to b with math.

6. You take 50 g of an unknown metal and heat it to 100°C. You drop it into 1 L of water at 26°C. The metal and water come to equilibrium at 27.1°C. What is the specific heat of the metal?

6.5 - Energy of phase changes

ENDURING UNDERSTANDING

ENE-2

Changes in a substance's properties or change into a different substance requires an exchange of energy.

Need To Brush Up? Scan here!

ESSENTIAL KNOWLEDGE

ENE-2.E.1

Energy must be transferred to a system to cause a substance to melt (or boil). The energy of the system therefore increases as the system undergoes a solid-to-liquid (or liquid-to-gas) phase transition. Likewise, a system releases energy when it freezes (or condenses). The energy of the system decreases as the system undergoes a liquid-to-solid (or gas-to-liquid) phase transition. The temperature of a pure substance remains constant during a phase change.

ENE-2.E.2

The energy absorbed during a phase change is equal to the energy released during a complementary phase change in the opposite direction. For example, the molar heat of condensation of a substance is equal to the negative of its molar heat of vaporization.

You Try!

1. Describe the role of energy during heating/cooling.

2. Describe the role of energy during a phase change.

3. In the space below- draw the heating curve of water. Label each portion with the process, what is happening to the particles, and the equation used to solve for the energy in that portion.

4. How much energy does it take to melt 10 grams of water? How much energy does it take to boil 10 grams of water? Why are these values different? (H_{fus} = 6.02 kJ/mol H_{vap} = 40.7 kJ/mol)

5. How much energy does it take to cool 150 grams of water from 50 to 20 C? (C_{H2O} = 4.18 J/gC)

6. A 156 gram sample of water is heated from 10^{o}C to 29^{o}C. How much energy does this take?

Bonus Features!!!! (Because we have 1 extra page, why leave it blank?) - Here are some extra practice problems via a website and more in-depth videos!

More Practice Problems!

balancing.	electron configurations	Lewis Dots	Molar Conversions
Stoichiometry	Gas laws	Calorimetry	

More In-Depth Videos.

Periodic Trends	Quantum Numbers	Calorimetry	Lewis Dots	Heating Curves
Reaction Types	Gas Laws	IMFs	Bonding	Stoichiometry