Name: _____

AP Chemistry Big Idea Review

Background
The AP Chemistry curriculum is based on 6 Big Ideas and many Learning Objectives associated with each Big Idea. This review will cover all of the Big Ideas and Learning Objectives (LO).

Directions
Working as directed by your teacher, complete all of the questions in the packet. Be sure to write out your thinking and justifications for all of your answers to the questions in the packet. For all multiple choice questions, describe why the correct answer is correct and why the other answers are not correct. For the calculations, show all work and label all units.

When you are finished with the packet, identify which Big Ideas and Learning Objectives are your strengths and which are your weaknesses. This will help you focus your studies for the remainder of your review time before the exam. Good Luck.

Big Idea 2: Structure and Properties of Matter
Chemical and physical properties of materials can be explained by the structure and the arrangements of atoms, ions, or molecules and the forces between them.
When all else fails, remember the INTERmolecular forces and INTRAmolecular forces. The intramolecular forces are the bonds within molecules (covalent, polar, ionic). Intramolecular forces (bonds) are broken and re-formed in reactions. The intramolecular forces are the interactions between molecules of a sample. They contribute to the melting point, boiling point, vapor pressure, and other properties related to the phase of matter that the substance exists.

LO 2.1 Students can predict properties of substances based on their chemical formulas, and provide explanations of their properties based on particle views.
Example:
Which of the following will be more soluble at lower temperatures than at higher temperatures?
a) $KNO_3(s)$
b) $O_2(g)$
c) $C_6H_{14}(l)$
d) $NaCl(s)$

LO 2.2 The student is able to explain the relative strengths of acids and bases based on molecular structure, interparticle forces, and solution equilibrium.
Example:
Which of the following is the strongest acid?
a) $HClO_2$
b) $HClO$
c) $HClO_3$
d) $HClO_4$

LO 2.3 The student is able to use aspects of particulate models (i.e., particle spacing, motion, and forces of attraction) to reason about observed differences between solid and liquid phases and among solid and liquid materials.
Example: Describe why a gas is able to expand to fill its container.

LO 2.4 The student is able to use KMT and concepts of intermolecular forces to make predictions about the macroscopic properties of gases, including both ideal and nonideal behaviors.
Example:
   Under what conditions are the assumptions of Kinetic Molecular theory most likely to fail?
   a) High pressure and high temperature
   b) High pressure and low temperature
   c) Low pressure and low temperature
   d) Low pressure and high temperature

LO 2.5 The student is able to refine multiple representations of a sample of matter in the gas phase to accurately represent the effect of changes in macroscopic properties on the sample.
Example:
   Use the kinetic molecular theory model to predict what would happen to a closed sample of a gas if the temperature decreased while its pressure increased.
   a) The volume would increase
   b) The volume would decrease
   c) The average kinetic energy of the molecules would increase
   d) The moles of gas molecules would increase

LO 2.6 The student can apply mathematical relationships or estimation to determine macroscopic variables for ideal gases.
Example:
   Calculate the number of molecules in a deep breath of air whose volume is 2.25 L at a body temperature of 37 ^{0}C and a pressure of 735 torr

LO 2.7 The student is able to explain how solutes can be separated by chromatography based on intermolecular interactions.
Example:

   Chromatography is a good way to separate the

   a) elements in a compound

   b) the components in a mixture

   c) the atoms in an element

   d) the phases of a pure substance

LO 2.8 The student can draw and/or interpret representations of solutions that show the interactions between the solute and solvent.
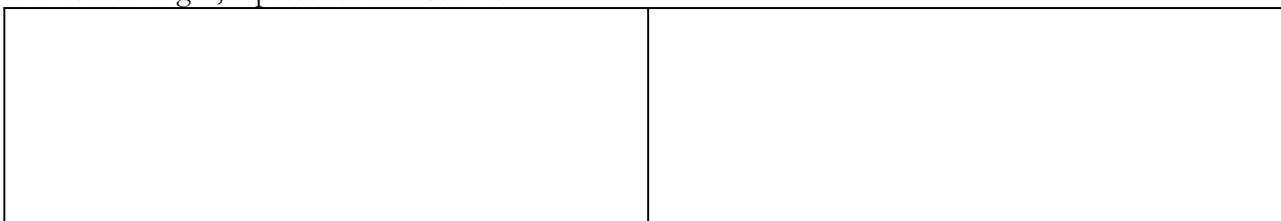Example:

In the box below, draw a particle representation of how water molecules would interact with a Chloride ion.

LO 2.9 The student is able to create or interpret representations that link the concept of molarity with particle views of solutions.
Example:

In the box below, draw a representation of two NaCl solutions. On the left, represent a 1M solution and on the right, represent a 2M solution.

LO 2.10 The student can design and/or interpret the results of a separation experiment (filtration, paper chromatography, column chromatography, or distillation) in terms of the relative strength of interactions among and between the components.
Example:

On the illustration on the left, you have a diagram of paper chromatography. The ink spots are represented at the bottom of the paper and the separated dyes are at different distances towards the top of the paper. Why do the components of the dyes move to different heights?
   a) Different molecules that make up dyes have different particle sizes and affinity for the paper and solvent.
   b) Different dyes are made of a single molecule that breaks apart in the solution
   c) Dyes separate on paper when they get wet
   d) Filter paper has special properties that separates dye

LO 2.11 The student is able to explain the trends in properties and/or predict properties of samples consisting of particles with no permanent dipole on the basis of London dispersion forces.
Example:
Methane, ethane, propane, and butane are gases at room temperature, while pentane, hexane, and heptane are liquids. In terms of ldf, why does boiling point of hydrocarbons increase as more carbons are added to the molecule?
   a) Molar mass increases and boiling point increases because the molecules are heavier and more likely to be liquids
   b) As the molecules become larger, there are more electrons per molecule, which makes the larger molecules more polarizable and have stronger ldf forces.
   c) As the molecules become smaller, there are more electrons per molecule, which makes the larger molecules more polarizable and have stronger ldf forces.
   d) As molar mass decreases, boiling point increases.

LO 2.12 The student can qualitatively analyze data regarding real gases to identify deviations from ideal behavior and relate these to molecular interactions.
Example:

| According to the graph to the right, what are the ideal conditions, when a gas behaves most like an ideal gas? a) High pressure, high volume b) Low pressure, high volume c) Low pressure, low volume d) High pressure, low volume	
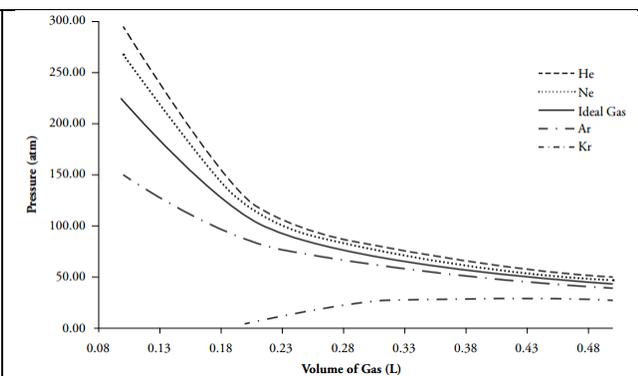
LO 2.13 The student is able to describe the relationships between the structural features of polar molecules and the forces of attraction between the particles.
Example:

Draw a particle-level representation of methanol, CH_3OH, and differentiate between the intermolecular forces (attractions) and intramolecular forces (bonds). Draw at least 3 molecules in the box to the right.	
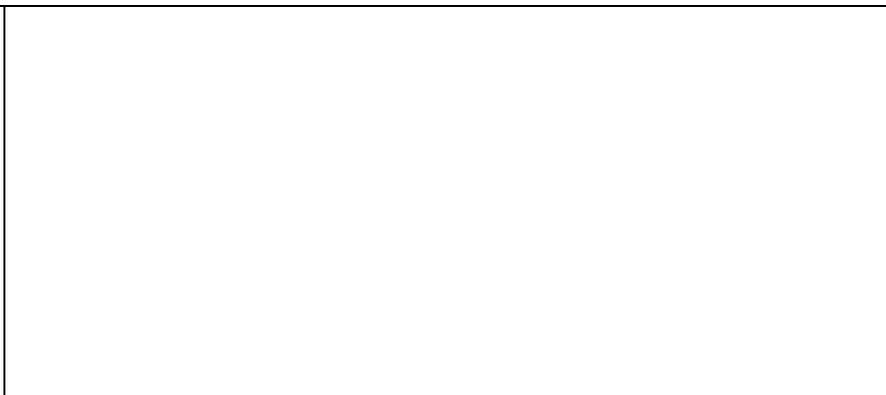
LO 2.14 The student is able to apply Coulomb's Law qualitatively (including using representations) to describe the interactions of ions, and the attractions between ions and solvents to explain the factors that contribute to the solubility of ionic compounds.

Example:

Based on size and charge, which of the following would be the most soluble in water?
a) RbCl
b) $MgCl_2$
c) AgCl
d) $ScCl_3$

LO 2.15 The student is able to explain observations regarding the solubility of ionic solids and molecules in water and other solvents on the basis of particle views that include intermolecular interactions and entropic effects.

Example:

	In the box on the left, draw a salt crystal with at least 3 formula units. In the box on the right, draw the same salt crystal dissolved in water. Which sample allows for more freedom of movement? Which box represents a sample with a higher entropy value? a) Left b) Right c) Both d) Neither	

LO 2.16 The student is able to explain the properties (phase, vapor pressure, viscosity, etc.) of small and large molecular compounds in terms of the strengths and types of intermolecular forces.

Example:

Which of the following molecules would be expected to have the lowest viscosity (resistance to flow)?
a) H_2O
b) Hg
c) CF_4
d) $C_{12}H_{26}$

LO 2.17 The student can predict the type of bonding present between two atoms in a binary compound based on position in the periodic table and the electronegativity of the elements.

Example:

Which of the following molecules would be expected to be the most nonpolar?
a) F_2
b) NF_3
c) SF_2
d) CH_2F_2

LO 2.18 The student is able to rank and justify the ranking of bond polarity on the basis of the locations of the bonded atoms in the periodic table.

Example:

Which of the following bonds has the highest electronegativity difference?
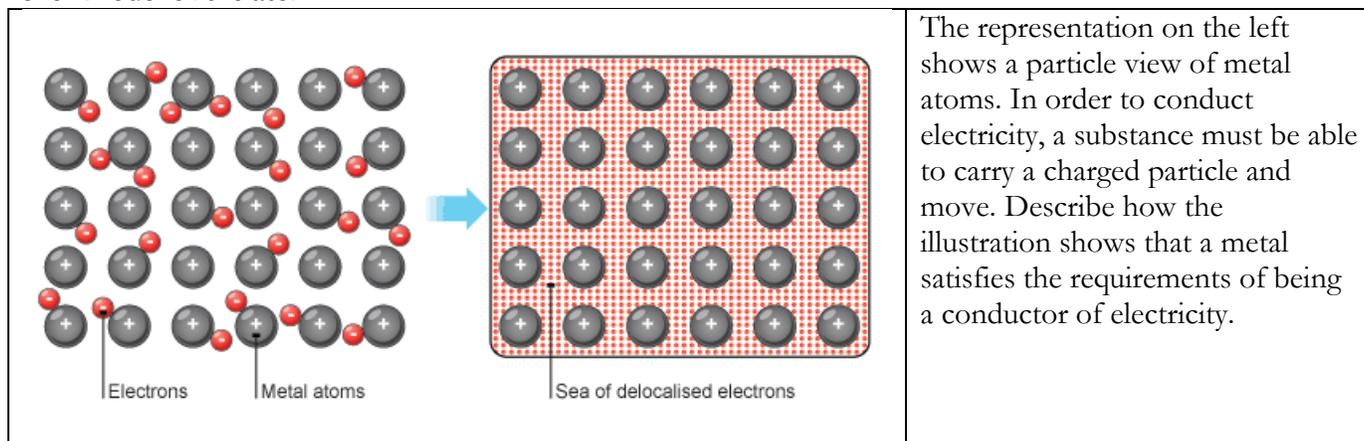
a) C – O
b) Si – O
c) Ge – O
d) Sn – O

LO 2.19 The student can create visual representations of ionic substances that connect the microscopic structure to macroscopic properties, and/or use representations to connect the microscopic structure to macroscopic properties (e.g., boiling point, solubility, hardness, brittleness, low volatility, lack of malleability, ductility, or conductivity).

Example:

Would the substance illustrated on the right be hard and brittle, or soft and malleable? Explain.	
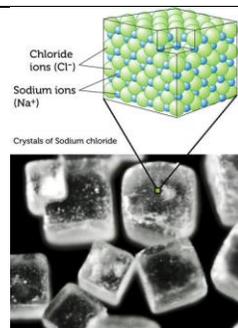
LO 2.20 The student is able to explain how a bonding model involving delocalized electrons is consistent with macroscopic properties of metals (e.g., conductivity, malleability, ductility, and low volatility) and the shell model of the atom.

	The representation on the left shows a particle view of metal atoms. In order to conduct electricity, a substance must be able to carry a charged particle and move. Describe how the illustration shows that a metal satisfies the requirements of being a conductor of electricity.

LO 2.21 The student is able to use Lewis diagrams and VSEPR to predict the geometry of molecules, identify hybridization, and make predictions about polarity.

Example:

Which of the following molecules would be the most polar overall?

a) CH_4
b) CF_4

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c) H_2O

d) BeH_2

LO 2.22 The student is able to design or evaluate a plan to collect and/or interpret data needed to deduce the type of bonding in a sample of a solid.

Example:

You are given a set of white solids and are asked to determine whether the substances are ionic or covalent compounds. Describe the steps you would take to determine whether the substances were ionic or covalent, including expected results.

LO 2.23 The student can create a representation of an ionic solid that shows essential characteristics of the structure and interactions present in the substance.

Example:

Describe how Coulomb's Law is related to the formation and properties of an ionic crystal lattice.

LO 2.24 The student is able to explain a representation that connects properties of an ionic solid to its structural attributes and to the interactions present at the atomic level.

Example:

Consider three hypothetical ionic compounds; one is composed of 1+ and 1- ions, another is 2+ and 2-, and a third is 3+ and 3-. Which of the three would you expect to have the highest melting point?

a) The 1+ and 1-

b) The 2+ and 2-

c) The 3+ and 3-

d) None of the above

LO 2.25 The student is able to compare the properties of metal alloys with their constituent elements to determine if an alloy has formed, identify the type of alloy formed, and explain the differences in properties using particulate level reasoning.
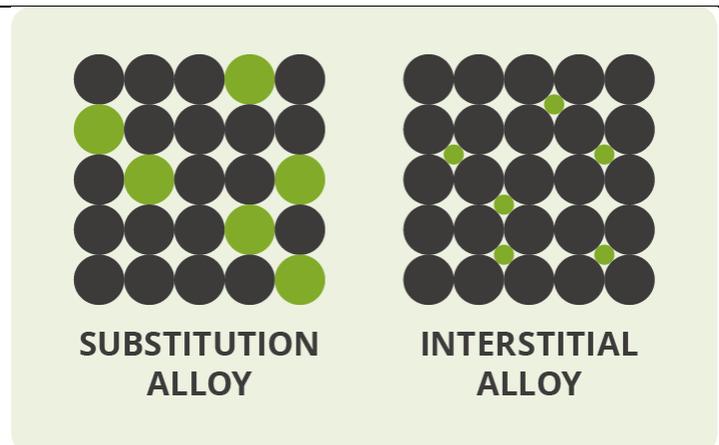
Example:

Bronze and brass are 2 alloys of copper. Bronze is a mixture of copper and tin, while brass is copper and zinc. Based on the components of the alloys, which alloy would be more resistant to corrosion and why?

LO 2.26 Students can use the electron sea model of metallic bonding to predict or make claims about the macroscopic properties of metals or alloys.
Example:

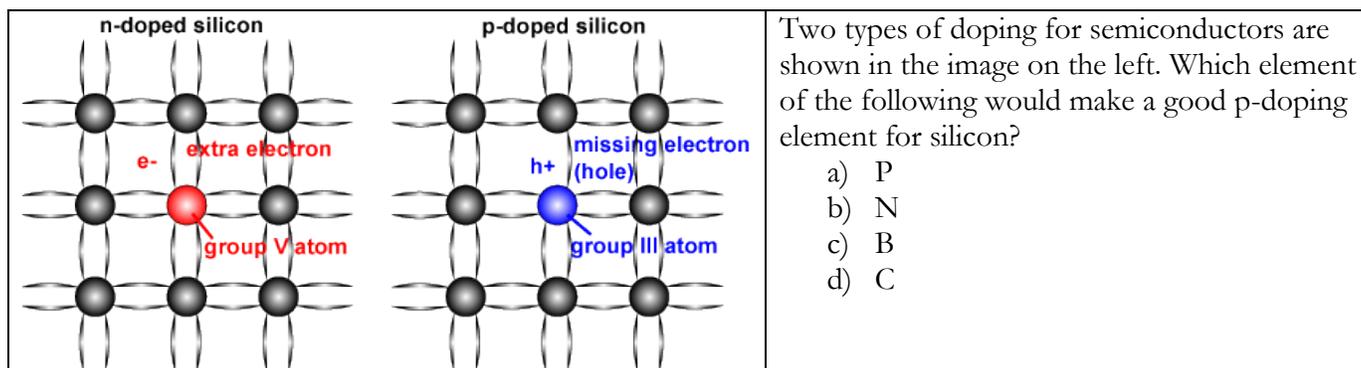| Of the two types of alloys pictured on the right, which one would you expect to have an increased density and melting point? Why?	 **SUBSTITUTION ALLOY** **INTERSTITIAL ALLOY**

LO 2.27 The student can create a representation of a metallic solid that shows essential characteristics of the structure and interactions present in the substance.
Example:
    Of the two types of alloys, substitution and interstitial, which would tend to take on an average of the properties of the component metals? Why?

LO 2.28 The student is able to explain a representation that connects properties of a metallic solid to its structural attributes and to the interactions present at the atomic level.
Example:

|	Two types of doping for semiconductors are shown in the image on the left. Which element of the following would make a good p-doping element for silicon?
	    a) P
	    b) N
	    c) B
	    d) C

LO 2.29 The student can create a representation of a covalent solid that shows essential characteristics of

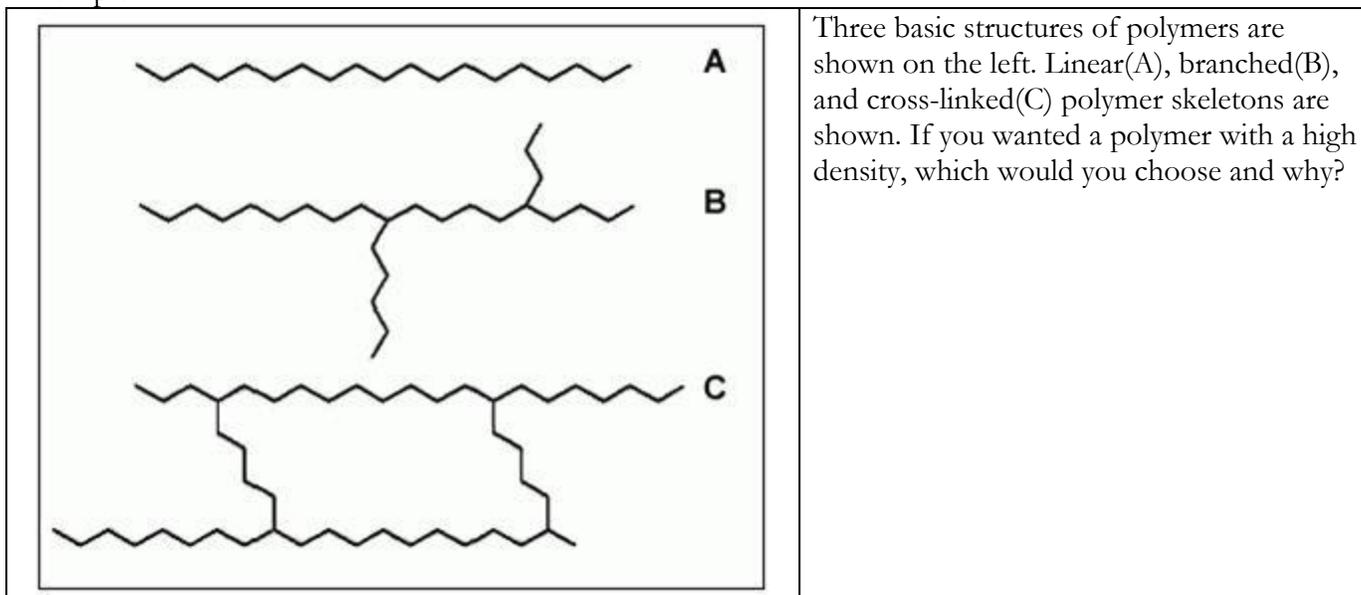the structure and interactions present in the substance.
Example:

The illustration on the right shows two covalent network solids, diamond(a) and graphite(b). With regards to intermolecular forces (attractions) and intramolecular forces (bonds), which is a harder solid, diamond or graphite? How is that illustrated in the model to the right?	 (a) Diamond (b) Graphite
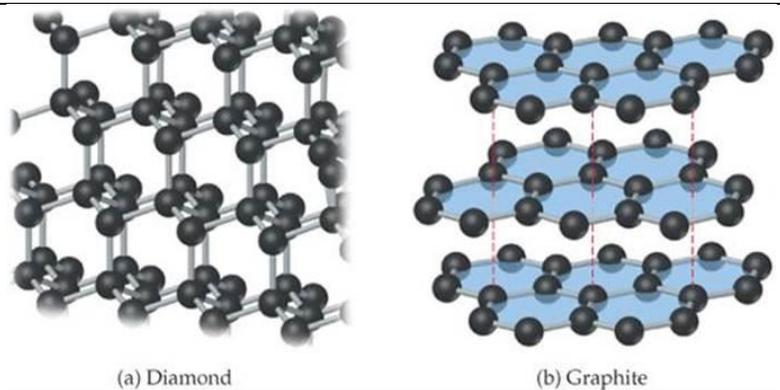
LO 2.30 The student is able to explain a representation that connects properties of a covalent solid to its structural attributes and to the interactions present at the atomic level.
Example:

	Three basic structures of polymers are shown on the left. Linear(A), branched(B), and cross-linked(C) polymer skeletons are shown. If you wanted a polymer with a high density, which would you choose and why?

LO 2.31 The student can create a representation of a molecular solid that shows essential characteristics of the structure and interactions present in the substance.
Example:

Solid iodine, I_2, is slightly soluble in water, but if the iodine is mixed with potassium iodide, KI, it becomes much more soluble. Draw an illustration of the interactions between water molecules and a sample of potassium iodide, dissolved in water.

LO 2.32 The student is able to explain a representation that connects properties of a molecular solid to its structural attributes and to the interactions present at the atomic level.
Example:

Iodine readily sublimes, goes straight from a solid to a gas. What forces are broken when iodine sublimes?

a) Covalent bonds
b) Hydrogen bonds
c) Dipole-dipole interactions
d) London dispersion forces