

## Ch. 10&11 Review

1) Diamond and graphite are both made of pure carbon, however diamond is one of the hardest substances known and is an excellent insulator. While graphite is extremely soft and is an excellent conductor of electricity. Explain how the bonding in the two substances can explain these differences.

*Diamonds are formed from a three dimensional network of covalently bonded carbon atoms. This crystal structure locks the electrons in place making diamonds hard and preventing the flow of electrons. In Graphite the carbon atoms are bonded in two dimensional sheets with delocalized electrons above and below the sheets. The delocalized electrons allow the easy flow of electrons and the weak London dispersion forces between the sheets make the graphite soft.*

2) Sterling silver is made by alloying silver with copper. Typically this is done because pure silver is generally considered too soft to form useful objects.

A) Based on the information in the table below explain why alloying silver with copper will create a harder material.

Metal	Atomic Radii (pm)	Hardness (Mohs)
Silver	160	2.5
Copper	135	3.0
Gold	135	2.5

*Silver and copper have fairly different atomic radii, this means that the addition of the copper atoms will disrupt the crystal lattice and make the silver significantly harder.*

B) Based on the information above would rose gold, an alloy of copper and gold, be harder or softer than sterling silver? Explain your answer.

*Softer, when alloys have similar atomic radii then the alloy will generally remain soft and malleable.*

3) Explain why adding phosphorus to a silicon crystal will increase the conductivity.

*Silicon is a semi-conductor that as a pure crystal generally does not conduct electricity very well, we can change the electrical properties of a semi-conductor by adding an impurity to the crystal that has a different number of valence electrons. Silicon has four valence electrons while phosphorus has five valence electrons. The addition of atoms with a greater number of electrons will create free electrons that can move around the crystal more readily.*

4) Two types of intermolecular forces present in liquid  $\text{H}_2\text{S}$  are London (dispersion) forces and dipole-dipole forces.

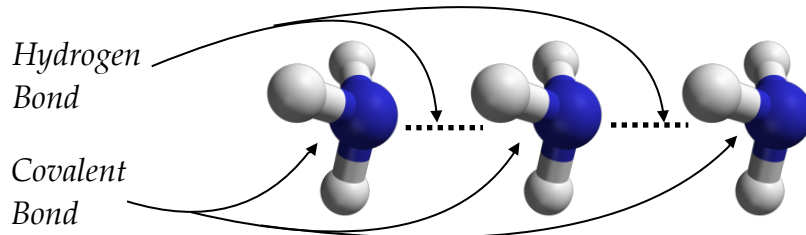
(i) Compare the strength of the London (dispersion) forces in liquid  $\text{H}_2\text{S}$  to the strength of the London (dispersion) forces in liquid  $\text{H}_2\text{O}$ . Explain.

*The London dispersion forces in  $\text{H}_2\text{S}$  would be stronger than the London dispersion forces in  $\text{H}_2\text{O}$ , this is because sulfur has more electrons than oxygen and is therefore more polarizable. Leading to stronger London dispersion forces.*

(ii) Compare the strength of the dipole-dipole forces in liquid  $\text{H}_2\text{S}$  to the strength of the dipole-dipole forces in liquid  $\text{H}_2\text{O}$ . Explain.

*The dipole-dipole forces in  $\text{H}_2\text{O}$  are much stronger than the dipole-dipole forces in  $\text{H}_2\text{S}$ . Water is much more polar than hydrogen sulfide, there is a greater difference in electronegativity between hydrogen and oxygen than between hydrogen and sulfur. The bonds between water molecules would generally be called hydrogen bonds because of the extreme polarity of the water molecule.*

5) Draw a diagram of at least 3 ammonia molecules showing how they would interact make sure to label and name both intermolecular and intramolecular bonds.



6) The normal boiling point of  $\text{N}_2\text{H}_4$  is  $114^\circ\text{C}$ , whereas the normal boiling point of  $\text{C}_2\text{H}_6$  is  $-89^\circ\text{C}$ . Explain, in terms of the intermolecular forces present in each liquid, why the boiling point of  $\text{N}_2\text{H}_4$  is so much higher than that of  $\text{C}_2\text{H}_6$ .

*$\text{N}_2\text{H}_4$  is a highly polar molecule and the intermolecular forces are much stronger than the intermolecular forces in the non-polar  $\text{C}_2\text{H}_6$ .  $\text{N}_2\text{H}_4$  has hydrogen bonding between molecules in addition to London Dispersion forces, which  $\text{C}_2\text{H}_6$  has only relatively weak London dispersion forces. The stronger the intermolecular forces the higher the boiling point will be.*

7) Use appropriate chemical principles to account for each of the following observations. In each part, your response must include specific information about both substances.

(a) At  $25^{\circ}\text{C}$  and 1 atm,  $\text{F}_2$  is a gas, whereas  $\text{I}_2$  is a solid.

*Both  $\text{F}_2$  and  $\text{I}_2$  are non-polar molecules having only London dispersion forces to hold separate molecules together. The strength of LDFs depend mainly on the number of electrons in the molecule and therefore the molecules polarizability.  $\text{I}_2$  has many more electrons and stronger LDFs making it a solid while  $\text{F}_2$  is a gas.*

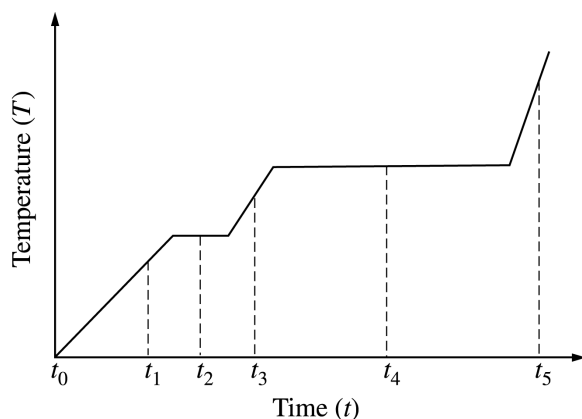
(b) The melting point of  $\text{NaF}$  is  $993^{\circ}\text{C}$ , whereas the melting point of  $\text{CsCl}$  is  $645^{\circ}\text{C}$ .

*Both  $\text{NaF}$  and  $\text{CsCl}$  are ionic compounds which are held together by ionic bonds. The stronger the ionic bonding the higher the melting point will be. The strength of an ionic bond depends on the charge of the ions involved and their size. The charges are the same for both compounds so it is only the sizes that are different.  $\text{Cs}$  and  $\text{Cl}$  ions have significantly larger radii than  $\text{Na}$  and  $\text{F}$  ions, the larger the radius the lower the attractive force will be, hence  $\text{CsCl}$  has weaker ionic bonds and melts at a lower temperature.*

(d) Ammonia,  $\text{NH}_3$ , is very soluble in water, whereas phosphine,  $\text{PH}_3$ , is only moderately soluble in water.

*The solubility of a substance depends on the similarity of the intermolecular forces. Water has hydrogen bonds as does  $\text{NH}_3$ , therefore  $\text{NH}_3$  will mix well with water.  $\text{PH}_3$  on the other hand has only dipole-dipole interactions, these are not as strong as hydrogen bonds so  $\text{PH}_3$  will be less soluble.*

8) The following questions refer to various points in time during an experiment conducted at 1.0 atm. Heat is added at a constant rate to a sample of a pure substance that is solid at time  $t_0$ . The graph below shows the temperature of the sample as a function of time.



a) During which time would the particles of the substance be the furthest apart? Justify your answer.

*The particles will be furthest apart in the gas phase. That means that at time  $t_5$  the particles will be at the greatest distance from each other.*

b) Describe what is happening to the substance during time  $t_4$ .

*At time  $t_4$  the substance is boiling. The intermolecular forces in the liquid are breaking as the molecules escape from the liquid to form a gas.*

c) Which phase of this substance would have the highest specific heat capacity? Why?

*The specific heat capacity is directly related to the slope of the lines. The lower the slope the higher the specific heat capacity will be. The slope at time  $t_1$  looked to be the lowest so the solid would have the highest specific heat capacity.*

d) As the substance is heated during certain times the temperature stops changing, why does this occur? Where is the heat energy being added going?

*The temperature stops changing when the substance undergoes a phase change. During a phase change the heat energy that is being added goes into breaking the intermolecular bonds, this is a change to the potential energy of the system. Since temperature is a measure of kinetic energy the temperature does not reflect this energy change.*

c) Is the enthalpy of fusion or the enthalpy of vaporization a larger value? Justify your answer.

*The enthalpy of vaporization would be a larger value. The larger the value the longer it will take for all of the substance to undergo the phase change, looking at the heating curve the line at time  $t_4$  is much longer than the line at  $t_2$ , so the enthalpy of vaporization must be larger.*

d) List what phases are present at each of the times indicated on the graph.

*$t_0$  &  $t_1$ - solid*

*$t_2$ - solid and liquid, the substance is melting*

*$t_3$ - liquid*

*$t_4$ - liquid and gas, the substance is boiling*

*$t_5$ - gas*

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$$33) a) M.M. = \frac{g}{n} \quad n = \frac{\Delta T \cdot k_{\text{solvr}}}{K_f}$$

$$M.M. = \frac{g \cdot K_f}{\Delta T k_{\text{solvr}}}$$

M.M. = molar mass

g = grams of solute

 $\Delta T$  = amount freezing point varies from normal $k_{\text{solvr}}$  = kilograms of solvent used.

b) Solute should be soluble in solvent of  $\Delta T$  will be very small

$$\Delta T = \left(\frac{n}{kg}\right) K_f$$

c) ①  $\Delta T$  will be smaller than it should be this will make M.M. appear larger, than true value

c) ② No change - Both values will be off by the same amount canceling the error out of the calculations

c) ③ kg of solvent measured will be greater than actual. This will make the M.M. appear larger than actual.

c) ④ This will make  $\Delta T$  larger than the non-dissociate value. So M.M. will be smaller.

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33) d) ① Average all three values the are about the same differences between each other.  $164 \text{ g/mol}$

d) ② We would need to disscard the 322 value it is much larger than the other 2 values. Average remaining 2 values.  $254 \text{ g/mol}$