Review Packet #3 - Random Topics

Colligative Properties/Solutions

1) Elemental analysis of an unknown pure substance indicates that the percent composition by mass is as follows:
Carbon - 49.02% Hydrogen - 2.743% Chlorine - 48.23%
A solution that is prepared by dissolving 3.150 grams of the substance in 25.00 grams of benzene, C_6H_6, has a freezing point of 1.12°C. (The normal freezing point of benzene is 5.50°C and the molal freezing-point depression constant, K_f, for benzene is 5.12 C°/molal.)
(a) Determine the empirical formula of the unknown substance.
(b) Using the data gathered from the freezing point depression method, calculate the molar mass of the unknown substance.
(c) Calculate the mole fraction of benzene in the solution described above.
(d) The vapor pressure of pure benzene at 35°C is 150. millimeters of Hg. Calculate the vapor pressure of benzene over the solution described above at 35°C.

2) For each of the following, use appropriate chemical principles to explain the observation.
(a) Sodium chloride may be spread on an icy sidewalk in order to melt the ice; equimolar amounts of calcium chloride are even more effective.
(b) At room temperature, NH_3 is a gas and H_2O is a liquid, even though NH_3 has a molar mass of 17 grams and H_2O has a molar mass of 18 grams.
(c) C (graphite) is used as a lubricant, whereas C (diamond) is used as an abrasive.
(d) Pouring vinegar onto the white reside in a kettle used for boiling water results in fizzing/bubbling phenomenon.

3) The formula and the molecular weight of an unknown hydrocarbon compound are to be determined by elemental analysis and the freezing-point depression method.
(a) The hydrocarbon is found to contain 93.46 percent carbon and 6.54 percent hydrogen. Calculate the empirical formula of the unknown hydrocarbon.
(b) A solution is prepared by dissolving 2.53 grams of p-dichlorobenzene (molecular weight 147.0) in 25.86 grams of naphthalene (molecular weight 128.2). Calculate the molality of the p-dichlorobenzene solution.
(c) The freezing point of pure naphthalene is determined to be 80.2 °C. The solution prepared in (b) is found to have an initial freezing point of 75.7 °C. Calculate the molal freezing-point depression constant of naphthalene.
(d) A solution of 2.43 grams of the unknown hydrocarbon dissolved in 26.7 grams of naphthalene is found to freeze initially at 76.2 °C. Calculate the apparent molecular weight of the unknown hydrocarbon on the basis of the freezing-point depression experiment above.
(e)What is the molecular formula of the unknown hydrocarbon?