AP Chemistry Review

Name: Key

Chapter 10: States of Matter and IMF's

1. How many kilojoules of heat are absorbed when 1.25 moles of water are converted from liquid at 15.0oC to vapor at 100°C? The specific heat of liquid water is 4.18 J/g°C. The heat of vaporization of water is 44.0 kJ/mol at 100°C.

Heating: $q = mC\Delta T = \left(1.25\text{ moles} \left| \frac{18\text{ g H}_2\text{O}}{1\text{ mol}} \right.\right)\left(4.18\ \frac{\text{J}}{\text{g°C}}\right)(100° - 90°\text{C})$

$q = 0.941\text{ KJ}$

Vaporizing: $q = n\Delta H_{vap} = (1.25\text{ mol})(44.0\text{ KJ/mol}) = 55.0\text{ KJ}$

$\Delta H = 55.0\text{KJ} + 0.941\text{KJ} = \boxed{55.9\text{ KJ}}$

2. The combustion of 1.25 g of pentane produces enough heat to vaporize 165 g of hexane. What is the molar enthalpy of vaporization of hexane?

1.25 g
$C_5H_{12}(l) + 8O_2(g) \rightarrow 5CO_2(g) + 6H_2O(l)$ $\quad \Delta H = -3.51 \times 10^3\text{ kJ}$ (exo)

165 g
$C_6H_{14}(l) \rightarrow C_6H_{14}O\,(g)$ $\quad \Delta H_{vapn} = (?)$ (endo)

$1.25\text{ g } C_5H_{12} \left| \frac{1\text{ mol } C_5H_{12}}{72.17\text{ g } C_5H_{12}} \right. = 0.0173\text{ mol } C_5H_{12} \rightarrow 0.0173\text{ mol } C_5H_{12} \left| \frac{-3.51 \times 10^3\text{ KJ}}{\text{mol } C_5H_{12}} \right. = 60.79\text{ KJ}$

$165\text{ g } C_6H_{14} \left| \frac{1\text{ mol } C_6H_{14}}{86.2\text{ g}} \right. = 1.914\text{ mol } C_6H_{14}$

$q = n\Delta H_{vap}$ $\quad 60.79\text{ KJ} = (1.91\text{ mol } C_6H_{14})(\Delta H_{vap})$

$\Delta H_{vap} = 31.8\ \text{KJ/mol}$

3. The density of methanol vapor in equilibrium with liquid methanol, CH_3OH, at 25°C is 0.207 g/L. What is the vapor pressure of methanol, in mmHg, at 25°C?

$PM = DRT$ $\quad$ (298 K)

$P = \frac{DRT}{M} = \frac{(0.207\text{ g/L})\left(0.0821\ \frac{\text{L·atm}}{\text{mol·K}}\right)(298\text{K})}{32.05\text{ g/mol}} = 0.158\text{ atm}$

$0.158\text{ atm} \left| \frac{760\text{ mmHg}}{1\text{ atm}} \right. = \boxed{120.\text{ mmHg}}$

4. An ice cube weighing 15.0 g at a temperature of 0.0°C is added to 85.0 mL of water at 30.0°C in an insulated container. What will be the final temperature after the ice has melted? $\Delta H_{fusn} = 6.01$ kJ/mol and the specific heat of water = 4.18 J/g°C.

$q_{melt} = n\Delta H_{fus} = \left(15\text{ g} \left| \frac{1\text{ mol}}{18\text{ g}} \right.\right)\left(6.01\ \frac{\text{KJ}}{\text{mol}}\right) = 5.00\text{ KJ}$ to melt

$q_{warm} = mC\Delta T = (15\text{g})(.00418\ \text{KJ/g°C})(X - 0°\text{C}) \Rightarrow \left(0.0627\ \frac{\text{KJ}}{°\text{C}}\right)X$ > ice

$q_{cool} = mC\Delta T = (85\text{ mL})(1\text{g/mL})(.00418\ \frac{\text{KJ}}{\text{g°C}})(X - 30°\text{C})$ > water

$\Rightarrow .3553X - 10.66\text{ KJ}$

+ ice = water

$5.00\text{KJ} + 0.0627X = .3553X - 10.66$

See back!

$\boxed{13.5°\text{C}}$

5. Using the vapor pressure curves provided, predict:

~350 mmHg The vapor pressure of ethanol at 60°C.

~82 °C The boiling point of water when the baometric pressure is 350 mmHg.

(e) aniline, ↑ B.P. Which substance is least volatile.

(e) aniline Which substance has the strongest IMFs

Dipole-Dipole, H-bond, Dispersion What type(s) of IMFs are responsible for the high boiling point of aniline

$C_6H_5NH_2$ P, H

6. Use the phase diagram provided for mercury (II) iodide. At lower temperatures, the stable form of mercury (II) is red. Between 127°C and 259°C, the stable form is yellow.
   a. Using the symbols: R, Y, l, and g, indicate the phases present in the diagram marked (?).
   b. Identify the triple points and indicate the phases present at each one.
   c. Label the normal melting point and the normal boiling point.
   d. Label the critical point.
   e. Lable the region where you would find a supercritical fluid.
   f. Describe the phase changes that occur as the temperature of a sample is raised, at constant pressure, from point X to point Y.

7. Evaluate each of the following in terms of their IMFs.
   a. Which would you expect to have a higher boiling point and why?

   Pentane: C_5H_{12} or 2, 2-dimethylpropane: $CH_3C(CH_3)_2CH_3$

   MM = 72 g/mol, Long string = ↑ dispersion

   mm = 72 g/mol, Compact

   b. Which of the following substances is most likely to be a gas at STP and why?

   $(CH_3)_2O$ CH_4 NH_3 CH_3COOH

   P NP weakest IMFs P, H P, H

   c. Arrange the following in the expected order of increasing melting point and explain.

   NaOH CH_3OH LiOH C_6H_5OH

   MM = 32 Li is a smaller ion MM = 94

   ③ Ionic ① ④ ②

8. Chromium has an atomic radius of 124.9 pm and it has a *bcc* crystal structure.

   a. What is the length of the unit cell in picometers?

   288.4 pm

$B^2 = A^2 + A^2 = 2A^2$

$B = \sqrt{2}\,A = 1.414A$

$C = 4r = 4(124.9\text{ pm}) = 499.6\text{ pm}$

$A = X$

$A^2 + B^2 = C^2$

$X^2 + 2X^2 = C^2$

$3X^2 = C^2$

$C = \sqrt{3}\,X = 499.6\text{ pm}$

$X = 288.4\text{ pm}$

   b. What is the volume of the unit cell in cm^3?

$(288.4\text{ pm})^3 \left|\frac{(10^2)^3\text{ cm}^3}{(10^{12})^3\text{ pm}^3}\right. = 2.399\times10^{-23}\text{ cm}^3$

   c. Calculate the density of chromium.

7.201 g/cm³

BCC: $8\left(\frac{1}{8}\right)+1 = 2$ atoms/cell

$\left|\frac{2\text{ atoms}}{\text{cell}}\right| \left|\frac{\text{cell}}{2.399\times10^{-23}\text{ cm}^3}\right| \left|\frac{1\text{ mol}}{6.02\times10^{23}\text{ atoms}}\right| \left|\frac{52.0\text{ g}}{\text{mol}}\right| = 7.201\text{ g/cm}^3$