

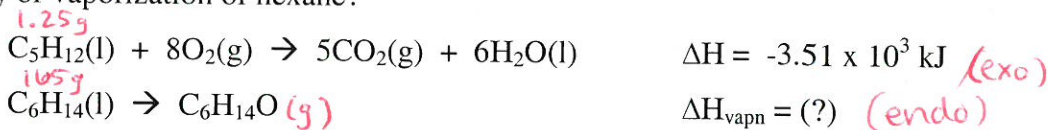
Chapter 10: States of Matter and IMF's

1. How many kilojoules of heat are absorbed when 1.25 moles of water are converted from liquid at 15.0°C 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: $q = mC\Delta T = \left(\frac{1.25 \text{ moles} \times 18 \text{ g H}_2\text{O}}{1 \text{ mol}} \right) (4.18 \frac{\text{J}}{\text{g}^\circ\text{C}}) (100^\circ - 15^\circ\text{C})$
 $q = 0.941 \text{ kJ}$

Vaporizing: $q = n \Delta H_{\text{vap}} = (1.25 \text{ mol}) (44.0 \text{ kJ/mol}) = 55.0 \text{ kJ}$
 $\Delta H = 55.0 \text{ kJ} + 0.941 \text{ kJ} = \boxed{55.9 \text{ kJ}}$

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?



$\frac{1.25 \text{ g C}_5\text{H}_{12}}{72.17 \text{ g C}_5\text{H}_{12}} \times 1 \text{ mol C}_5\text{H}_{12} = 0.0173 \text{ mol C}_5\text{H}_{12} \rightarrow \frac{0.0173 \text{ mol C}_5\text{H}_{12} \times (-3.51 \times 10^3 \text{ kJ})}{1 \text{ mol C}_5\text{H}_{12}} = \underline{60.79 \text{ kJ}}$

$\frac{165 \text{ g C}_6\text{H}_{14}}{36.2 \text{ g C}_6\text{H}_{14}} \times 1 \text{ mol C}_6\text{H}_{14} = 4.558 \text{ mol C}_6\text{H}_{14}$
 $q = n \Delta H_{\text{vap}} \quad 60.79 \text{ kJ} = (1.91 \text{ mol C}_6\text{H}_{14}) (\Delta H_{\text{vap}})$
 $\Delta H_{\text{vap}} = \boxed{31.8 \text{ kJ/mol}}$

3. The density of methanol vapor in equilibrium with liquid methanol, CH₃OH, at 25°C is 0.207 g/L.

What is the vapor pressure of methanol, in mmHg, at 25°C?

$PM = DRT$

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

$\frac{0.158 \text{ atm} \times 760 \text{ mmHg}}{1 \text{ atm}} = \boxed{120. \text{ mmHg}}$

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? $\Delta H_{\text{fus}} = 6.01 \text{ kJ/mol}$ and the specific heat of water = 4.18 J/g°C.

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

$q_{\text{warm}} = mC\Delta T = (15 \text{ g}) (4.18 \frac{\text{J}}{\text{g}^\circ\text{C}}) (x - 0^\circ\text{C}) \Rightarrow (0.0627 \frac{\text{kJ}}{^\circ\text{C}}) x$ > ice

$q_{\text{cool}} = mC\Delta T = (85 \text{ mL}) (1 \text{ g/mL}) (4.18 \frac{\text{J}}{\text{g}^\circ\text{C}}) (x - 30^\circ\text{C})$ > water

$\Rightarrow 3553x - 10.66 \text{ kJ}$

+ ice = water
 $5.00 \text{ kJ} + 0.0627x = 3553x - 10.66 \text{ kJ}$
 See back!

$\boxed{13.5^\circ\text{C}}$

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 barometric 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

C₆H₅NH₂ 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.

- Using the symbols: R, Y, l, and g, indicate the phases present in the diagram marked (?).
- Identify the triple points and indicate the phases present at each one.
- Label the normal melting point and the normal boiling point.
- Label the critical point.
- Label the region where you would find a supercritical fluid.
- 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: C₅H₁₂ or 2, 2-dimethylpropane: CH₃C(CH₃)₂CH₃
 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?

(CH₃)₂O CH₄ NH₃ CH₃COOH
 P NP weakest IMFs P, H P, H

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

NaOH CH₃OH LiOH C₆H₅OH
 ③ Ionic MM=32 Li is a smaller ion mm=94
 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. What is the volume of the unit cell in cm³?

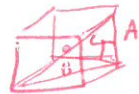
$$\frac{(124.9 \text{ pm})^3}{(10^{12})^3 \text{ pm}^3} = \frac{(10^3)^3 \text{ cm}^3}{(10^{12})^3 \text{ pm}^3} = 2.399 \times 10^{-23} \text{ cm}^3$$

c. Calculate the density of chromium.

7.201 g/cm³

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

2 atoms/cell	1 mol	52.09
$2.399 \times 10^{-23} \text{ cm}^3$	$6.02 \times 10^{23} \text{ atoms/mol}$	mol
= <u>7.201 g/cm³</u>		



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

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

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

$$A = x$$

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

$$x^2 + 2x^2 = C^2$$

$$3x^2 = C^2$$

$$C = \sqrt{3} x = 499.6 \text{ pm}$$

$$x = \frac{499.6}{\sqrt{3}} = 288.4 \text{ pm}$$