Friday worksheet 4 – Latent heat

1. The latent heat of vaporisation of acetone (molar mass 58.1g/mol) is 31.3 kJ/mol. Calculate the amount of energy, in kJ, required to evaporate 21.4 g of acetone at boiling point.
   Step 1 convert mass to mol of acetone.
   => 21.5 / 58.1 = 0.370 mol
   Step 2 calculate the amount of energy required
   => E = Latent heat of vaporisation X mol
   => 31.3 kJ/mol X 0.370 mol = 11.58 kJ

2. Refer to the information included in the table below.

Latent Heats of Fusion and Vaporization

Substance	ΔH_{fus} (kJ/mol)	ΔH_{vap} (kJ/mol)
Ammonia (NH_3)	5.65	23.4
Ethanol (C_2H_5OH)	4.60	43.5
Methanol (CH_3OH)	3.16	35.3
Oxygen (O_2)	0.44	6.82
Water (H_2O)	6.01	40.7

Table 1

   a. Exactly 1 kg of ethanol is heated to its boiling temperature. Calculate the amount of energy, in kJ, that is required to vaporise the entire sample of ethanol?
   Step 1 convert mass to mol of ethanol.
   => 1000 / 46.0 = 21.7 mol
   Step 2 calculate the amount of energy required
   => E = Latent heat of vaporisation X mol => 43.5 kJ/mol X 21.7 mol = 944 kJ
   b. How much energy is required, in kJ, to convert 23.4 kg of ammonia from a liquid to a gas at the same temperature?
   Step 1 convert mass to mol of ammonia.
   => 23,400 / 17.0 = 1376.5 mol
   Step 2 calculate the amount of energy required
   => E = Latent heat of vaporisation X mol => 23.4 kJ/mol X 1376.5 mol = 32,210 kJ
   c. How much energy, in joules, is released when 10.0 g of steam at 100 °C condenses to water at 100 °C?
   Latent heat of fusion (absorbed) = Latent heat of condensation (given out)
   So the amount of energy released is the same as the amount of energy absorbed to change 10.0 g of water into steam at 100°C.
   Step 1 find the mol of water
   => 10.0/18.0 = 0.556
   Step 2 find the amount of energy released
   => 40.7 kJ/mol X 0.556 = 22.6 kJ
   d. A furnace delivers an accurate amount of energy every minute. If it takes 30 seconds to convert 1.50 X 10^3 g of liquid water at 100°C to 1.50 X 10^3 g of water vapour also at 100°C, how long would the same furnace take to convert 100 g of liquid aluminium at the boiling point of 2,470 °C to 100 g of aluminium gas also at 2,470 °C? Explain your reasoning with the use of a calculation.
   (latent heat of vaporisation of aluminium 284kJ/mol)
   Step 1 find the amount of energy required to change the water into steam.
   => Find the mol of water
   => 1500 / 18.0 = 83.3 mol
   => Find the amount of energy required
   => E = 83.3 X 40.7 kJ/mol = 3392 kJ

Step 2 Find the rate of energy delivery in kJ/s
=> 3392/30 = 113 kJ/s
Step 3 Find the amount of energy required to vaporise 100g of liquid aluminium at 2470°C.
=> Find the mol of aluminium
=> 100/27.0 = 3.703 mol
=> find the energy required
=> 3.703 mol X 2840 kJ/mol = 10,519 kJ
Step 4 Find the time in seconds
=> 10,519 / 113 kJ/s = 93 seconds