Friday Worksheet **Name: ……**

Heat of reaction worksheet 2

1) What is the enthalpy change when 60.0 g of NaOH is dissolved in one litre of water, given that the temperature of the solution increased by 15.8 °C?

   Step 1 Calculate the amount of energy released by 60.0 grams of NaOH

   Energy = 4.18 J/g/ ^{o}C X mass X ΔT = 4.18 J/g/ ^{o}C X 1,000 X 15.8 = 66.0kJ

   Step 2 Calculat ethe mol of NaOH

   60.0 / 40.0 = 1.50

   Step 3 Calculate the energy per mol of NaOH

   66.0 / 1.50 = -44.0 kJ mol^{-}

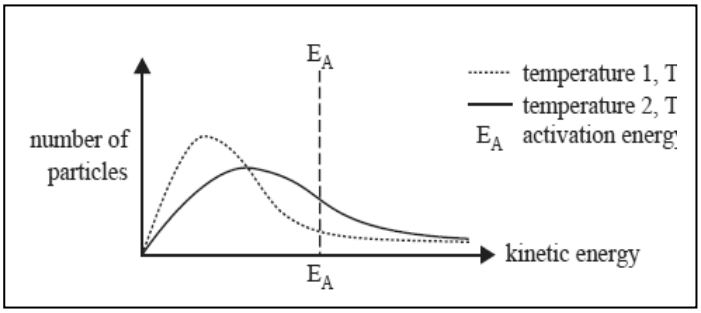
2) The diagram below represents the distribution of the kinetic energy of reactant particles at two different temperatures. Assume that the areas under the curves are equal

   a) Which is the greatest temperature T_1 or T_2?

   T_2

   b) Which temperature has the highest number of particles with sufficient energy to react?

   T_2



3) Calculate the enthalpy for the reaction below $2C(s) + H_2(g) \rightarrow C_2H_2(g)$ ΔH = ?

   Given the following thermochemical equations:

   $2C_2H_2(g) + 5O_2(g) \Rightarrow 4CO_2(g) + 2H_2O(l)$ ΔH = -2599 kJ mol^{-} -------- 1)

   $C(s) + O_2(g) \Rightarrow CO_2(g)$ ΔH = -393.5 kJ mol^{-}-------- 2)

   $H_2(g) + ½ O_2(g) \Rightarrow H_2O(l)$ ΔH = -285.8 kJ mol^{-}-------- 3)

   Step 1 multiply equation 1) by ½ and reverse

   $2CO_2(g) + H_2O(l) \Rightarrow C_2H_2(g) + 5/2 O_2(g)$ ΔH = 1300 kJ mol^{-} -------- 4)

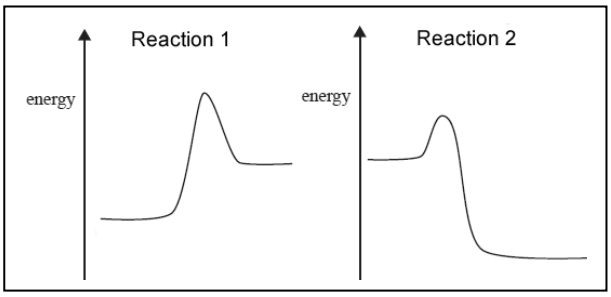
   Step 2 multiply equation 2) by 2

   $2C(s) + 2O_2(g) \Rightarrow 2CO_2(g)$ ΔH = -787 kJ mol^{-} -------- 5)

   Step 3 Add equations 3), 4) and 5)

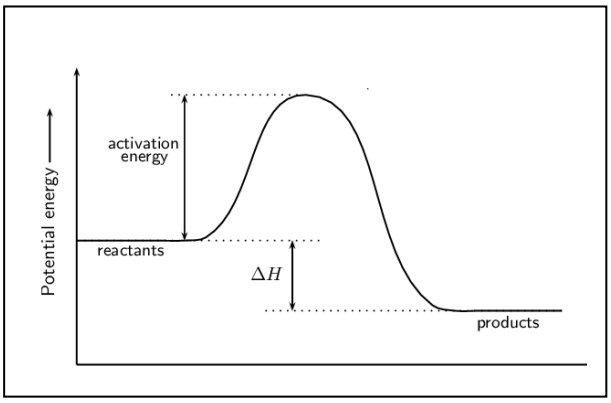
   $2C(s) + H_2(g) \rightarrow C_2H_2(g)$ ΔH = 1300 + -787 + - 285.8 = +227 kJ mol^{-}

4) On the right are the energy profiles of two chemical reactions drawn to the same scale and carried out at the same temperature.



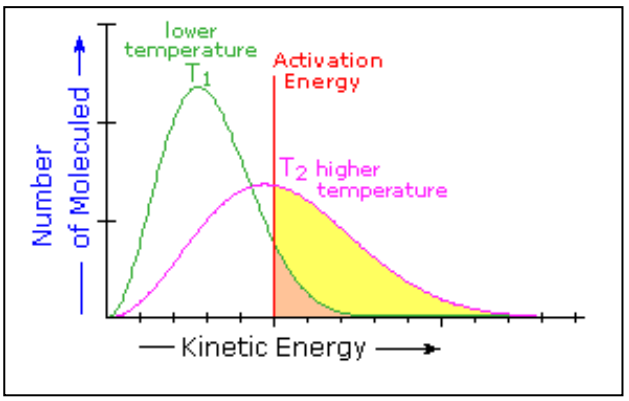
a) Which reaction is endothermic and which is exothermic? Explain

Reaction 1 is endothermic, because the enthalpy (energy) of the products is higher than the enthalpy of the reactants. Some students gave the reason that the activation energy for reaction 1 was greater than the magnitude of the ΔH.
Although this is true it does not categorise an endothermic reaction as many exothermic reactions also have this feature, as shown on the right.



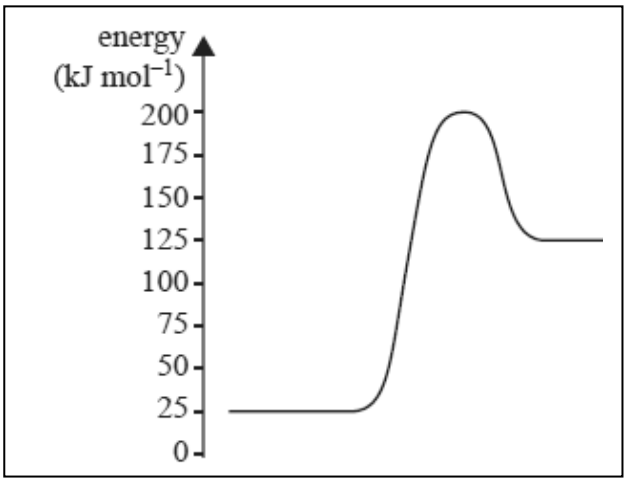
b) Which reaction occurs at the faster rate? Explain

Reaction 1 is slower than reaction 2 due to the fact that a higher activation energy is required for this reaction. Having a higher activation energy means that less particles will collide with sufficient energy to react as shown on the right



Students should note - because a reaction is endothermic it does not necessarily mean it will occur slowly.

5) Consider the following energy profile diagram for a reaction represented by the equation
2X + Y =>3 Z + 2A



a) What is the activation energy for this reaction?
175 kJ mol^{-}

b) Calculate the enthalpy.
100 kJ mol^{-}

6) If 108.0 kJ of energy is required to convert 2.00 mol of liquid water to steam at 100 °C, what is the amount of heat energy, in kilojoule, required to convert 80.0 g of water at 20 °C to steam at 100°C?

Step 1 Calculate the amount of heat energy required to raise the temperature of 80.0 grams of water from 20 to 100 ^{o}C.

Energy required = 4.18 J/g/ ^{o}C X mass X ΔT = 4.18 X 80.0 X 80.0 = 26.752 KJ

Step 2 Calculate the amount of energy required per mol to vaporise 1 mol of water at 100^{o}C

108.0 kJ /2 = 54.0 kJ

Step 3 Calculate the amount in mol of water

80.0 / 18.0 = 4.44 mol

Step 4 Calculate the amount of energy required to vaporise 4.44 mol of water at 100 ^{o}C

54.0 kJ X 4.44 = 239.8kJ

Step 5 Total energy = energy required to heat the water to 100 ^{o}C + energy to vaporise the water

Total energy = 26.752 + 239.8 kJ = 267 kJ