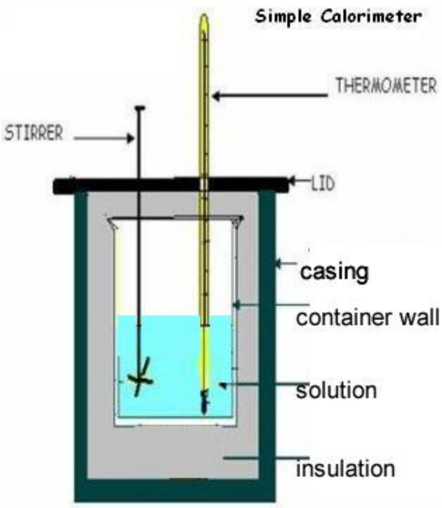
Friday Worksheet **Name: ……………….**

Calorimetry worksheet 3

1) An electric current of 1.40A at a potential difference of 6.50V was passed for 3.50 minutes through the heating coil of a small calorimeter, as shown below, containing 100.0 mL of water. The temperature rose from 23.21 to 25.35 ^{o}C.



a) Find the calibration factor of this calorimeter in J $^{o}C^{-}$

C_f = Energy/ ΔT

Step 1 find the amount of energy delivered through the heating coil.

E = VIt

=> E = 6.50 X 1.40 X 3.50 X 60.0 = 1911 J

Step 2 Find the C_f

=> C_f = 1911 / 2.14 = 893

b) 50.0 mL of a 1.00M NaOH is mixed with 50.0 mL of a 1.00M HCl. Each solution was originally at 20.00 ^{o}C and after mixing reached a maximum temperature of 23.10 ^{o}C.

i. Write a balanced chemical equation for the neutralisation reaction above.

NaOH(aq) + HCl(aq) => NaCl(aq) + H_2O(l)

ii. Calculate the ΔH of the reaction

Step 1 calculate the total amount of energy released using the calibration factor for the calorimeter.

=> E = C_f X ΔT = 893 J $^{o}C^{-}$ X 3.10 = 2.77 kJ

Step 2 calculate the mol of the limiting reactant.

The reactants are in the right stoichiometric ratio of 1:1.

So we can take the mol of any reactant.

n_{HCl} = C X V = 1.00 X 0.0500 = 0.0500

Step 3 find the energy per mol released

=> 2.77 kJ / 0.0500 = 55.4 kJ/mol

The sign of the ΔH must be shown as negative as this is an exothermic reaction.

c) Using the same calorimeter 50.0 mL of a 0.800M NaOH is mixed with 50.0 mL of a 1.00M HCl. Calculate the expected maximum temperature of the mixture if both solutions are originally at 20.0 ^{o}C

Step 1 find the limiting reactant

=> According to the stoichiometry NaOH and HCl must react in a ratio of 1:1. Hence NaOH is the limiting reactant.

Step 2 calculate the amount of energy released.

=> n_{NaOH} = C X V = 0.800 X 0.0500 = 0.0400

=> Energy released = 0.0400 X 55.4 = 2.216 kJ

Step 3 calculate the temperature increase

=> ΔT = Energy / C_f => 2.216 / 0.893 = 2.48 ^{o}C Hence maximum temperature = 22.5 ^{o}C.

2) Substance "X" has a molar mass of 87.1 g mol^{-} , a density of 0.891 g/mL and burns in oxygen according to the equation below.

$$2X(l) + 3O_2(g) \Rightarrow 3Z(g) + 2Y(g) \quad \Delta H = -25.4 \text{ kJ/mol}$$

1.15 mL of X is placed in a bomb calorimeter with excess oxygen gas. The bomb calorimeter contains 10.0 mL of water at 20^{o}C.

a) What amount of X , in mol, is placed in the calorimeter?

Step 1 Find the mass of X in 1.15 ml

=> mass = density X volume = 0.891 X 1.15 = 1.025 g

Step 2 find the mol of X

=> n_x = 1.025 / 87.1 = 0.0118

b) What amount of energy, in Joules, is given off by 1.15 mL of X?

Step 1 when two mol of X burns 25,400 J of energy is given off.

=> when 0.0118 mol of X burns (25,400 X 0.0118 / 2) 149.9 Joules of energy is released.

c) If 60.0% of the total energy generated by the combustion of X goes into heating the water, while 40% goes into heating the container or escapes into the environment, calculate the final temperature of the water in the calorimeter.

Step 1 calculate the amount of energy that goes into heating the water.

=> 149.9 J X 60/100 = 89.94 J

=> ΔT = 89.94 / (4.18 X 10) = 2.15

=> final temperature = 20.0 + 2.15 = 22.15 ^{o}C