Calculating Enthalpy

From Experimental Data (using a calorimeter)

$$\Delta H = m.s.\Delta T$$

$$\Delta_r H = \Delta E / n$$

ΔH = change in energy (J)
m = mass of substance (g)
s = specific heat capacity of substance (J g^{-1} $^oC^{-1}$)
ΔT = change in temperature (^oC)

Example
50.0 mL of 2.0 $molL^{-1}$ NaOH neutralised 50 mL of 2.0 $molL^{-1}$ HCl. The temperature of the solution rose from 21 ^oC – 35 ^oC. Calculate the heat of the reaction (assuming 1 mL of the solution requires 4.2 J of energy to raise its temperature by 1 ^oC)

$$NaOH_{(aq)} + HCl_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)}$$

m = 100 g
s = 4.2 J g^{-1} $^oC^{-1}$
ΔT = 14 ^oC

ΔH = m.s.ΔT
= 100 g x 4.2 J g^{-1} $^oC^{-1}$ x 14 ^oC
= 5880 J
= 5.9 kJ

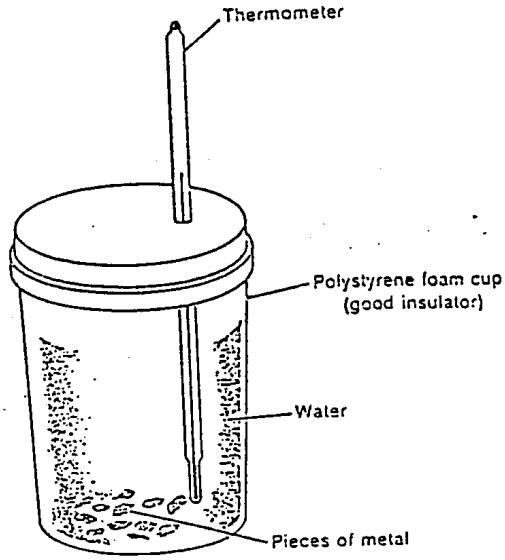
n(NaOH / HCl) = c x V
= 2.0 $molL^{-1}$ x 0.0500 L
= 0.1 mol

$\Delta_r H$ = ΔE / n
= 5.9 kJ / 0.1 mol
= 59 kJ mol^{-1}

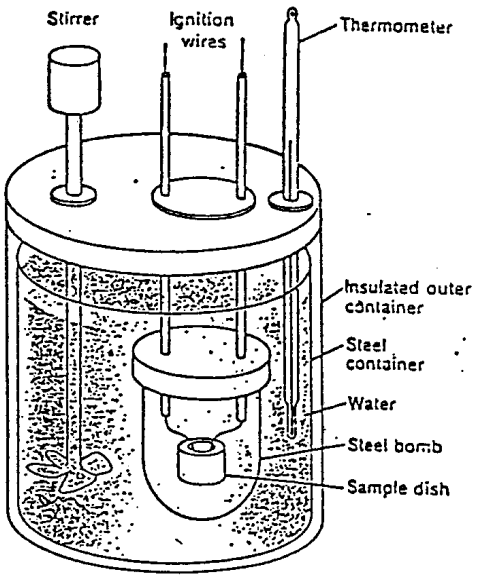
The temperature has increased, therefore reaction is **exothermic**
$\Delta_r H$ = **- 59 kJ mol^{-1}**

Calorimeters

- A well insulated container with a thermometer
- Used to measure the heat released / absorbed in a reaction
- Reaction takes place in water (or in a chamber surrounded by water)
    - The temperature of the water will either increase (exothermic as heat has been released)
    - or decrease (endothermic as heat from water has been absorbed)



Coffee cup calorimeter - polystyrene is a good heat insulator. Good for measuring enthalpy for reactions between species in solution or to measure heats of solution



Bomb Calorimeter - used to determine heat flow for combustion reactions. The heat liberated by the reaction is absorbed by the bomb and surrounding water