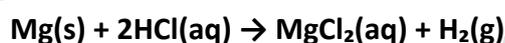# Chemistry Worksheet: Thermochemistry and Calorimetry 2

GCE O Level and Integrated Programme

Structured Question 1 (12 Marks)

A student investigates the reaction between magnesium metal and hydrochloric acid according to the following equation:

$$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$$

The experiment is carried out by adding 1.50 g of magnesium ribbon to 100 cm³ of 1.00 M HCl in an insulated polystyrene cup calorimeter. The initial temperature of the acid is 26.0 °C and the maximum temperature recorded during the reaction is 38.0 °C. Assume that:

- The density of the solution is 1.00 g/cm³ (thus 100 cm³ ≈ 100 g).
- The specific heat capacity, c, of the solution is 4.18 J/g°C.
- Molar mass of Mg = 24.3 g/mol.
- The reaction is exothermic (heat is released).

Answer the following:

(a) Calculate the number of moles of magnesium used. [2 marks]

(b) Determine the change in temperature, ΔT, of the solution. [1 mark]

(c) Calculate the heat released (q) by the reaction using the formula:

   $q = mc\Delta T$

Assume the mass m of the solution equals 100 g. [3 marks]

(d) Determine the enthalpy change, ΔH (in kJ/mol), for the reaction per mole of magnesium reacted. Express ΔH with an appropriate negative sign to indicate an exothermic reaction. [4 marks]

Structured Question 2 (12 Marks)

An experiment is performed to determine the enthalpy change for the dissolution of ammonium nitrate in water. In the experiment, 5.00 g of ammonium nitrate (NH_4NO_3) is dissolved in 50.0 g of water in a polystyrene cup calorimeter. The initial temperature of the water is 25.0 °C, and after complete dissolution, the temperature drops to 17.0 °C. Assume that:

● The density of the resulting solution remains 1.00 g/cm³.
● The specific heat capacity, c, is 4.18 J/g°C.
● Molar mass of NH_4NO_3 = 80.05 g/mol.
● The dissolution is endothermic (heat is absorbed).

Answer the following:

(a) Calculate the change in temperature, ΔT, for the solution. [2 marks]

(b) Determine the heat absorbed by the solution, q, using q = mcΔT. Use the mass of the solution (water plus dissolved salt) as 50.0 g (assume the mass of the solute is negligible compared to the water mass if necessary). [3 marks]

(c) Calculate the number of moles of ammonium nitrate dissolved. [2 marks]

(d) Calculate the enthalpy change (ΔH) per mole of ammonium nitrate for the dissolution process in kJ/mol. Express your answer with a positive value to indicate endothermicity. [3 marks]