- The enthalpy change for a reaction can be found by measuring the temperature change in a reaction.

- The heat energy given out (or taken in) is used to heat (or cool) a known mass of water. We know that it takes 4.18 J of energy to raise the temperature of 1 g of water by 1°C (i.e. 1 K).

- The amount of energy needed to make 1 g of a substance 1°C (1 K) hotter is called the *specific heat capacity* (measured in $J\ g^{-1}\ K^{-1}$).

- The following equation is then used to find the amount of heat energy give out (or absorbed).

$$q = m\ c\ \Delta T$$

    q = heat energy given out (J)
    m = mass of substance heated (g)
    ΔT = temperature rise (K)
    c = specific heat capacity ($J\ g^{-1}\ K^{-1}$)

- To find the enthalpy change in terms of J (or kJ) per mole, the following expression is needed: (***THINK*** kJ per mole!)

$$\text{Enthalpy change (per mole)} = \frac{q}{\text{number of moles reacting}}$$

- Heat loss is a major problem with calorimetry and can lead to errors in the results. The techniques used in calorimetry are designed to reduce heat loss (one way to reduce errors from heat loss is to measure the heat capacity of the calorimeter as a whole (see flame calorimeters and bomb calorimeters)

1) Reactions taking place in solution

- The reaction is carried out in an insulated beaker and the temperature change measured.

- The reaction must be fast so that the maximum temperature is reached quickly (before it starts to cool).

- The specific heat capacity of the solution must be taken as being the 4.18 $J\ g^{-1}\ K^{-1}$ (the same as water) and we usually use the mass of the water (not the solution) in the calculation.

2) Flame calorimeters

- Flame calorimeters are usually used to find the enthalpy of combustion of substance (usually a fuel).

- The fuel, which is in a bottle with a wick, is burned so that the heat is passed to water which it heats.

- Sometimes the specific heat capacity of water is used, but in more accurate flame calorimeters, the actual heat capacity of the flame calorimeter can be determined and used (by finding the temperature rise when a known amount of a substance with an accurately known enthalpy of combustion is tested).
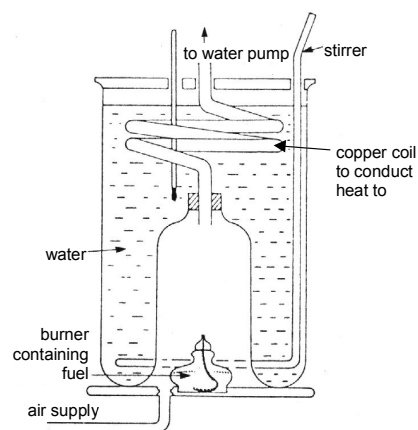
Calorimetry calculations – worked examples

1) In an experiment, 0.600 g of propane (C_3H_8) was completely burned in air. The heat evolved raised the temperature of 100 g of water by 64.9°C. Use this data to calculate the enthalpy of combustion of propane (the specific heat capacity of water is 4.18 J g^{-1} K^{-1}).

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2) 50.0 cm^3 of 1.00 mol dm^{-3} hydrochloric acid was added to 50.0 cm^3 of 1.00 mol dm^{-3} sodium hydroxide solution. The temperature rose by 6.8°C. Calculate the enthalpy of neutralisation for this reaction. Assume that the density of the solution is 1.00 g cm^{-3}, the specific heat capacity of the solution is 4.18 J g^{-1} K^{-1}.

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3) 100 cm^3 of 0.200 mol dm^{-3} copper sulphate solution was put in a calorimeter and 2.00 g of magnesium powder added. The temperature of the solution rose by 25.1°C. Work out which reagent was in excess and then calculate the enthalpy change for the reaction. Assume that the density of the solution is 1.00 g cm^{-3}, the specific heat capacity of the solution is 4.18 J g^{-1} K^{-1}. Ignore the heat capacity of the metals.

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