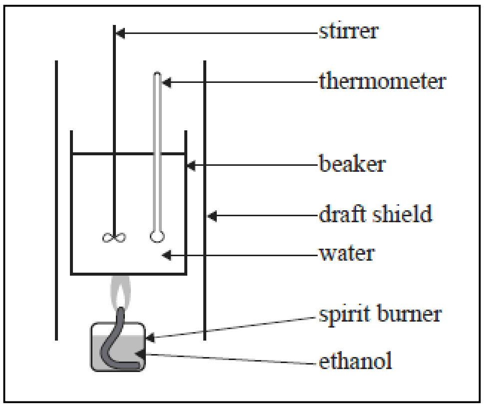
Thermochemical equations – calculating heat of combustion– determining the energy released by a specified amount of fuel.
Lesson 5

Define the following

- Heat of combustion

- Specific heat capacity of water (4.18 J/g/C°)

- How do we use the specific heat capacity of water to calculate energy released of a given amount of pure fuel? (Energy (J) = 4.18 X Mass X ΔT)



- Consider the apparatus shown on the right. It is used to measure the heat released from fuels.
  i. What three things do we need to measure
  - mass of water, ΔT and change in mass of spirit burner.

  ii. Why is the result only an estimate and not an accurate measure of the total energy released? *The equipment is poorly insulated and hence a great deal of energy is not absorbed by the water but is lost to the surroundings.*

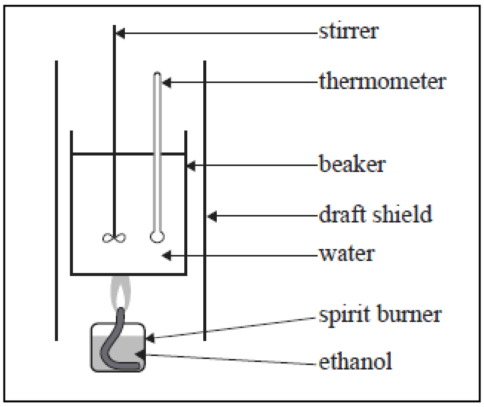
  iii. When measuring the heat of combustion of fuels what do we need to assume when using the apparatus shown on the right?
  No heat is lost to the surroundings

1) a) Calculate the amount of energy in kJ required to increase the temperature of 500.0 grams of water from 25.00 °C to 31.50 °C?
(Energy (J) = 4.18 X Mass X ΔT)
E = 4.18 X (500.0) X 6.50 = 13.6 kJ (3 sig figs)
b) Calculate the amount of energy in kJ required to increase the temperature of 100.0 grams of water from 25.0 °C to 37.0 °C?
E = 4.18 X (100.0) X 12.0 = 5.02 X 10^3 J (3 sig figs)

c) The apparatus shown on the right was used to heat 100.0 mL of water at 25.0 °C to 29.1 °C.

i. How much energy was needed in kJ?

E = 4.18 X (100.0 X 0.997) X 4.1 = 1.7 kJ (2 sig figs)



ii. If 4.6 grams of ethanol was consumed calculate the heat of combustion in kJ/mol.

Step 1 find the mol of ethanol
=> 4.6/46.1 = 0.10 mol
Step 2 find the molar heat of combustion
=> 1.7 kJ / 0.10 mol = 17 kJ mol^{-}.

iii. Give the answer in ii. above in kJ/g

1.7 kJ / 4.6 g = 0.37 kJ/g

iv. What is assumed in ii. and iii above?

i. complete combustion occurred

ii. 100% of the energy released was absorbed by the water

d) A student used the same apparatus as in c) above to determine the heat of combustion of methanol.

i. If 6.00 grams of methanol was used to increase the temperature of 20.0 grams of water at 22.00 °C to 23.70 °C what is the molar heat of combustion of methanol?

Step 1 find the mol of methanol.
=> 6.00 / 32.04 = 0.187 mol
Step2 find the amount of energy released to heat the water.
=> E = 4.18 X 20.0 X 1.70 = 0.142 kJ (if temp is not given at 25°C assume densityof water to be 1.00g/mL
Step 3 find the energy released per mol

- ⇨ *0.142 kJ / 0.187 = 0.759 kJ/mol*

ii. Why is this only an estimate?

Energy is lost to the surroundings that cannot be accounted for by simply measuring the temperature increase of the water.