Thermochemical equations – heat capacity of water and its uses in determining the ΔH_c
Lesson 6

1) Energy output of a reaction can be measured by using this energy to heat a known mass of water and measuring the temperature rise of the water. The heat capacity of water is 4.18 J/g/^{o}C . That is it takes 4.18 Joules of energy to raise one gram of water by one degree Celsius. The formula is used to calculate the energy, in Joules, needed to raise the temperature, Celsius, of a given mass, in grams, of water

Energy = 4.18 J/g/^{o}C X mass X ΔT

Let's try some examples. ***Always give answers to the right number of significant figures****.*

a) 100 mL of water was heated from 25.0^{o}C to 28.5 ^{o}C. What amount of energy, in kJ, was used assuming no energy is lost to the environment?

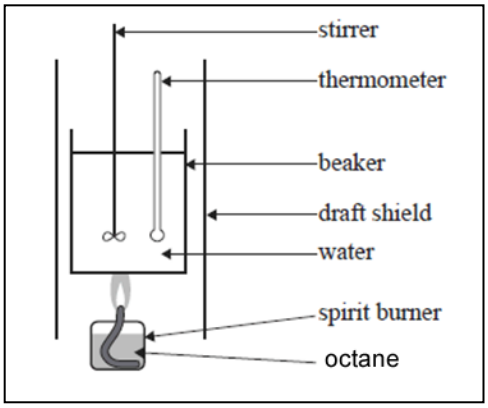
b) 84.7 kJ of heat energy was used to heat 300.0 grams of water at 25.0^{o}C. What was the final temperature of the water assuming no energy was lost to the environment?

c) 100.5 kJ of energy is used to heat a body of water from 25.0 ^{o}C to 49.9 ^{o}C. What is the mass of water heated?

d) What amount of energy, in kJ, was used to raise the temperature of 125 grams of water from 25.1 ^{o}C to 50.0 ^{o}C.

2) Pure octane is placed in a spirit burner and used to heat 100 mL of water. Complete combustion of 0.03510 grams of octane takes place and the temperature of the water rises from 25.0 ^{o}C to 28.10 ^{o}C.

a) Calculate the amount of energy absorbed by the water.



b) Calculate the molar heat of combustion (ΔH_c)
Molar mass of octane =***114.23g/mol***

c) Write a balanced thermochemical equation for the complete combustion of octane.

d) Compare the ΔH_c of octane derived above in question b) with the Data Sheet.
i. What do you notice? Offer an explanation.

e) From the data given above and given that the density of octane is 0.702 g/mL calculate the energy density of octane in kJ/L.

3) a) 80 mL of water was heated from 25.0°C to 35.5 °C. What amount of energy, in kJ, was used assuming no energy is lost to the environment?

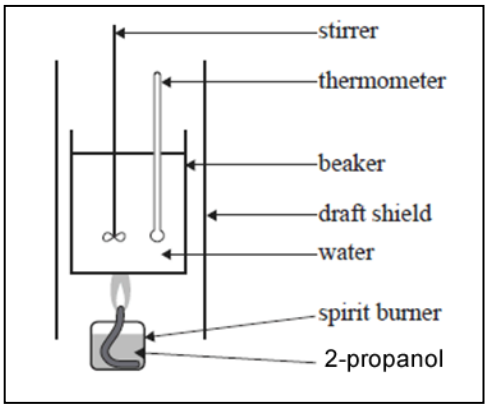
b) 34.2 kJ of heat energy was used to heat 300.0 grams of water at 23.4°C. What was the final temperature of the water assuming no energy was lost to the environment?

c) 43.5 kJ of energy is used to heat a body of water from 25.0 °C to 28.9 °C. What is the mass of water heated?

d) What amount of energy was used to raise the temperature of 245 grams of water from 25.1 °C to 47.3 °C.

4) Pure 2-propanol is placed in a spirit burner and used to heat 100 mL of water. Complete combustion of 0.120 grams of 2-propanol takes place and the temperature of the water rises from 25.0 °C to 31.10 °C.

a) Calculate the amount of energy absorbed by the water.



b) Calculate the molar heat of combustion (ΔH_c)
Molar mas of propanol= 60.09 g/mol

c) Write a balanced thermochemical equation for the complete combustion of liquid 2-propanol.

d) The ΔH_c of 2-propanol given in the literature is 2004kJ/mol. How does this compare with the derived value above in question b) . Explain how this low value can be obtained .

e) From the data given above and given that the density of 2-propanol is 0.785 g/mL calculate the energy density of 2-propanol in kJ/L.