1) An engineer is selecting between burning liquid octane or gaseous butane, as an energy source for an internal combustion engine. Pollution is a critical factor in the decision she will make.

a) Use the known molar heat of combustion of both fuels to write a balanced thermochemical equations for the complete combustion of each where water, as a product, is in liquid form.

i. octane

$2C_8H_{18}(l) + 25O_2(g) \rightarrow 16CO_2(g) + 18H_2O(l)\ \Delta H = -10920\ kJ/mol$

ii. butane

$2C_4H_{10}(g) + 13O_2(g) \rightarrow 8CO_2(g) + 10H_2O(l)\ \Delta H = -5760\ kJ/mol$

b) If 1.14 X 10^4 kJ of energy is needed calculate the amount, in litres, of CO_2 that is released for each fuel at SLC.

Octane

=> obtain the ratio from the equation => CO_2/Energy = 16 /10920 = CO_2/ 11400

=> mol of CO_2 = 16 X 11400 / 10920 = 16.7 mol

Calculate the volume of CO_2

=> 16.7 X 24.8 =414 litres

Butane

=> obtain the ratio from the equation => CO_2/Energy = 8/5760 = CO_2/ 11400

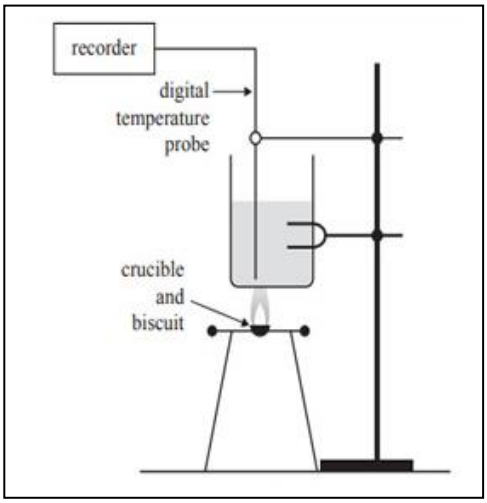
=> mol of CO_2 = 8 X 11400 / 5760 = 15.83 mol

Calculate the volume of CO_2

=> 15.83 X 24.8 =393 litres

2) A student analysed a special brand of crackers known as Razackers for their energy content.

23.45 grams of a sample of Razackers was burnt under a beaker containing 100 mL of water at 25.00 °C, as shown on the right.



The temperature of the water increased to 45.21°C

a) Calculate the energy in kJ, delivered to the water.

E =4.18 X (100 0.997) X (45.21 -25.00) = 8.42kJ

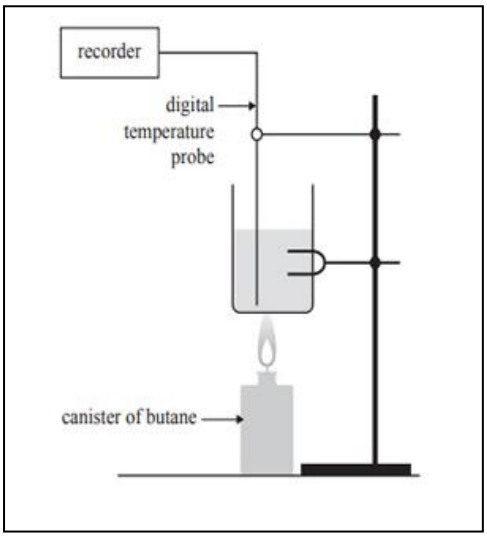
b) Calculate the energy content of Razackers in kJ/g.

8.42/23.45 = 0.359 kJ/g

c) Why is the energy content of Razackers measured in kJ/g and not in kJ/mol?

Razackers is not a pure substance and has no molar mass.

c) The student realised that not all the energy from the cracker finds its way into the water, so she tested the apparatus to see how much of the energy delivered by the burning of the butane actually gets into the water. Using the same apparatus the student burnt 0.291 grams of butane (molar mas 58.12g/mol). The temperature of the 100 g of water rose from 25.00°C to 48.90°C.



i. Calculate the amount of energy absorbed by the water

E = 4.18 X 100 X 23.90 = 9.99 kJ

ii. Calculate the amount of energy released by the butane

From the data book heat of combustion of butane is 49.7 kJ/g
=> Energy released = 0.291 X 49.7 =14.5

iii. Use the known enthalpy change for butane to calculate the percentage energy loss to the environment using the relationship shown below.

$$\text{percentage energy loss} = \frac{(\text{theoretical value of } \Delta H - \text{experimental value of } \Delta H)}{\text{theoretical value of } \Delta H} \times \frac{100}{1}$$

Percentage energy loss = (14.5 – 9.99)/ 14.5 = 0.311
=> 31.1%

iv. Knowing the percentage heat loss of this apparatus, calculate a more reliable value for the energy content of the crackers in kJ/g.

Energy given out by the crackers is
=> energy = 8.42 /0.689 = 12.2 kJ
=> Energy content of the crackers in kJ/g = 12.2/23.45 = 0.521kJ/g