INVESTIGATION: MEASURING THE ENTHALPY CHANGE OF COMBUSTION OF DIFFERENT FUELS

Introduction:

In this investigation you will measure the enthalpy change of combustion (ΔH_c) for two fuels.

Figure 1 shows the basic apparatus set up for a liquid fuel. You will burn the fuel and arrange for as much of the energy as possible to be transferred to water in the conical flask/beaker by heating. Then you can use the fact that 4.18 J of energy are required to raise the temperature of 1 g of water by 1°C.

The enthalpy change of combustion of the fuel is a measure of the energy transferred when *one mole* of the fuel burns completely. You will need to measure the quantity of fuel burned in your experiment, then convert this to moles.

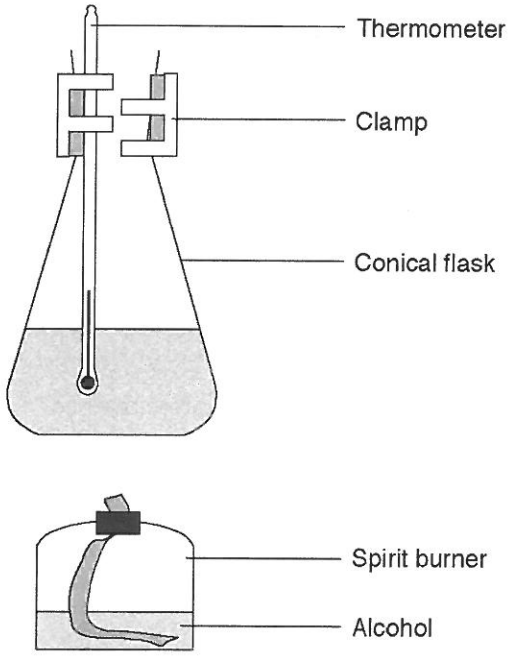

Figure 1: Simple apparatus for measuring the enthalphy change of a liquid fuel

Before you start:

Carefully read the method and plan how you will perform the investigation

Prepare a suitable results table to record (for each fuel)
(i) the volume of water used in the conical flask
(ii) the initial temperature of the water in the conical flask
(iii) the final temperature of the water in the conical flask
(iv) the temperature change
(v) mass of the fuel used (final mass of burner - initial mass of burner)
(vi) energy absorbed by the water/gram
(vii) energy released by the fuel/mole

Precautions:

Hexane and methanol are highly flammable liquids. Keep bottles stoppered when not in use and well away from naked flames. Avoid skin contact and do not inhale hexane or methanol vapour. Do not open the spirit burner (to refill it for example) in a laboratory with naked flames. **Wear eye protection.**

Equipment:

- 250 mL conical flask
- 0-110°C thermometer
- 100 mL measuring cylinder
- access to a balance
- spirit burner containing hexane
- spirit burner containing methanol
- spirit burner containing ethanol
- retort stand & clamp

Method:

Use this basic experiment to measure the enthalpy change of combustion (ΔH_c) for these different liquid fuels:

hexane (C_6H_{14}) is a component of petrol
methanol (CH_3OH) is an alcohol, which can be used as an alternative fuel for cars, either alone or blended with petrol.

1 Put 200 mL of cold water in a conical flask. Record the temperature of the water.

2 Support the conical flask over a spirit burner containing the liquid fuel you are going to test.

3 Weigh the spirit burner. Record your results in your table.

4 Replace the burner under the conical flask and light the wick. Use the thermometer to stir the water all the time it is being heated. Continue heating until the temperature has risen by about 15-20°C.

5 Extinguish the burner. Keep stirring the water and note the *highest* temperature reached.

6 Weigh the burner again.

7 Use your results to work out:
- the mass of water used
- the temperature rise of water
- the mass of fuel used.

8 Complete steps 8 and 9 for <u>each</u> fuel:

Assuming that all the energy from the burning fuel is transferred to the water:
Energy transferred to water by burning fuel = (mass of water x 4.18 x change in temperature).
or $\Delta H = mc\Delta T$
Use the formula above to work out the energy transferred to the water by the fuel burnt.

Energy transferred to the water = _____ J

9 You now need to work out the energy that would be transferred to the water per mole of fuel:

mass of 1 mole of fuel (M) _____ g/mol
mass of fuel burned (m) _____ g
no. of moles of fuel used (n = m/M) _____ mol

Energy transferred by this no. of moles (from step 8) _____ J
Energy transferred by one mole _____ J

Enthalphy change (ΔH) of combustion: _____ kJ/mol

Questions:

1. Identify parts of the procedure that may have led to inaccuracy in your overall result. For each factor identified, determine if this factor would have made your final value higher or lower.

2. Which of the factors you identified in Question 1 would be most likely to have had the most impact on the accuracy of your final results? Explain.

3. Suggest ways in which the accuracy of this investigation could be improved.

4. The enthalpy of combustion of methanol = – 715.0 $kJmol^{-1}$, whereas the enthalpy of combustion of hexane = – 4163 $kJmol^{-1}$.

(i) Examine your figures and give reasons why the above values differ from your results.

(ii) Hexane provides more than twice the energy per gram (48.31 kJg^{-1}) than methanol (22.31 kJg^{-1}). Suggest reasons why hexane releases far more energy when burnt than methanol.

FUEL	FORMULA	MOLAR MASS (g mol^{-1})
Methanol	CH_3OH	32.042
Hexane	C_6H_{14}	86.172

Your Report:

Prepare a report for this investigation; include in your report

(i) an aim
(ii) a hypothesis
(iii) independent, dependent and controlled variables
(iv) results table
(v) analysis - answers to the questions above
(vi) conclusion