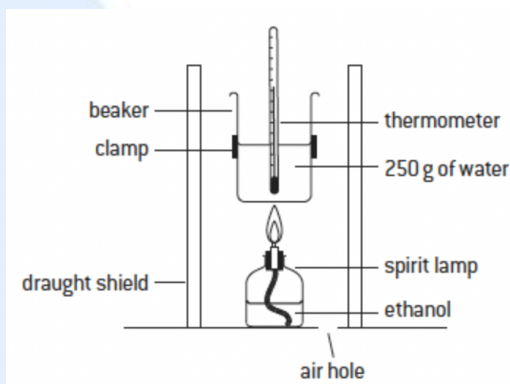


SL HL Paper 3 Section A Experimental work (4) **with worked answers**

A student determined the enthalpy of combustion of ethanol using a spirit lamp to heat up a known mass of water as shown in the diagram below:



A mass of 0.553 g of ethanol was combusted. This was measured by filling the spirit lamp with ethanol, and weighing it before and after the experiment, Other than when the ethanol was being combusted a cap was placed on the spirit lamp. The temperature of the 250 g of water increased by 10.4 °C during the experiment.

(a) State why it is necessary to use a cap on the spirit lamp apart from when the ethanol is being combusted. **[1]**

To prevent any of the ethanol from evaporating (particularly when the spirit lamp was hot after the combustion), as this would have affected the mass. **[1]**

b) Show that the enthalpy of combustion of ethanol determined from the experiment is equal to -906 kJ mol^{-1} if the specific heat capacity of water is taken as $4.18 \text{ kJ kg}^{-1} \text{ K}^{-1}$. **[2]**

Heat evolved by combusting 0.553 g = $4.18 \times 0.250 \times 10.4 = 10.868 \text{ kJ}$ **[1]**

$M(\text{C}_2\text{H}_5\text{OH}) = (2 \times 12.01) + (6 \times 1.01) + 16.00 = 46.08 \text{ g mol}^{-1}$

$\Delta H = - (46.08 \div 0.553) \times 10.868 = -906 \text{ kJ mol}^{-1}$ (minus as it is exothermic) **[1]**

(c) Use Section 13 of the data booklet to determine the experimental error. **[1]**

Experimental error = $((1367 - 906) \div 1367) \times 100 = 33.7\%$ **[1]**

(d) In his write-up of the experiment the student listed the following reasons which contributed to the experimental error.

- There was incomplete combustion as the ethanol was being combusted in air, not oxygen.
- There was considerable heat loss from the apparatus during the combustion.
- The ethanol may not have been completely pure.
- The water used in the beaker was tap water, not distilled water.
- All of the 0.553 g of ethanol was assumed to have combusted.
- Only one result was obtained - The experiment should have been repeated several times and an average taken.

Suggest two more reasons that contributed to the experimental error. **[2]**

Any two from:

The water in the beaker needed to be stirred to ensure a uniform temperature throughout.

The heat content of the glass, thermometer and stirrer (if used) needed to be taken into account as these were also being heated up.

The experimental error was obtained by comparing the result obtained with the standard enthalpy of combustion but the reaction was not carried out under standard conditions. **[2 max]**