

AS level Chemistry A

H032/02 Depth in chemistry

Question Set 3

3. Alkanes are saturated hydrocarbons with the general formula C_nH_{2n+2} .

(a) A student carries out an experiment to measure the enthalpy change of combustion, $\Delta_c H$, of hexane.

The student finds that combustion of 1.29 g of hexane changes the temperature of 200 g of water from 20.5 °C to 65.5 °C.

(i) Calculate the enthalpy change of combustion, $\Delta_c H$, of hexane, in kJ mol^{-1} . [4]

Give your final answer to an **appropriate** number of significant figures.

$$q = mc\Delta T$$
$$q = 200 \times 4.18 \times 45$$
$$q = 37620 \text{ J}$$

moles of hexane = $\frac{1.29}{86} = 0.015$
(C_6H_{14})

$$\Delta H = \frac{37620}{0.015} = 2510 \text{ kJ mol}^{-1}$$

(ii) The calculated value of $\Delta_c H$ for hexane from this experiment is different from the databook value.

Suggest **two** reasons for this difference. [2]

incomplete combustion

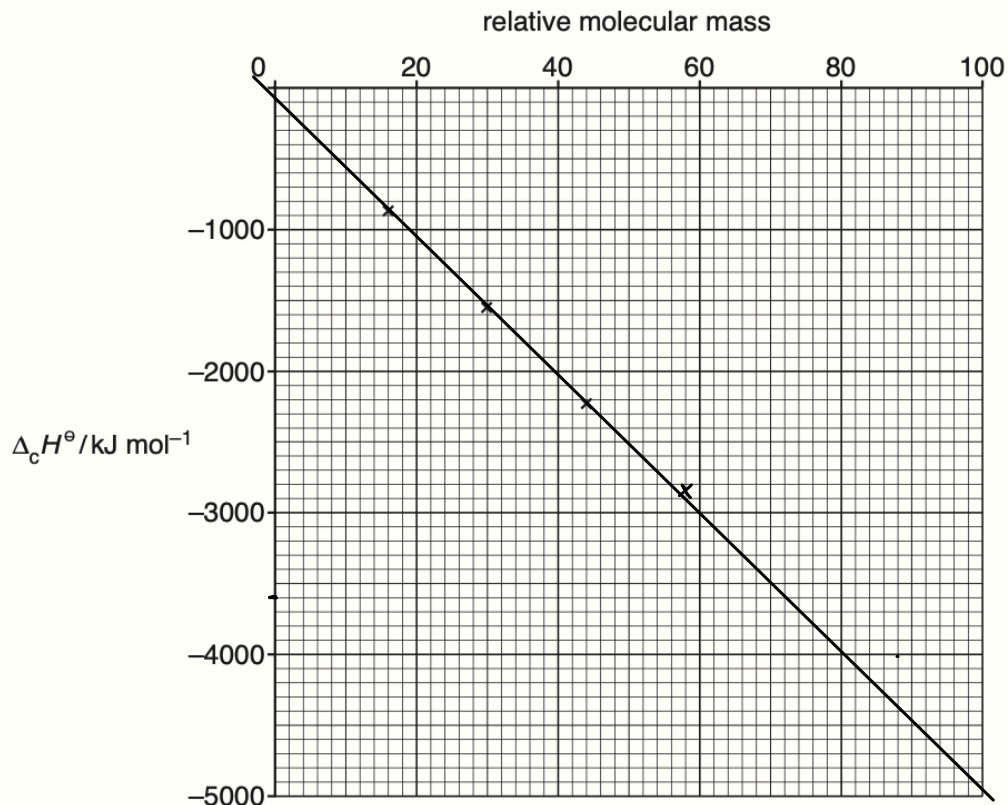
some of the heat energy was used to heat up the calorimeter

(a) Data book values for the standard enthalpy changes of combustion, $\Delta_c H$, of the first four alkanes are shown in the table.

Alkane	methane	ethane	propane	butane
$\Delta_c H^\ominus / \text{kJ mol}^{-1}$	-890	-1560	-2219	-2877

(i) The values for the first three alkanes are plotted on the graph below. [1]

Plot the value for butane on the graph.



(ii) Use the graph to estimate the energy released, in kJ, during complete combustion of 1.80 g of pentane. [3]

Show relevant working below and on the graph.

$$\text{moles} = \frac{1.80}{72} = 0.025$$

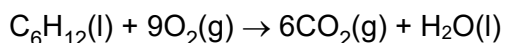
$$C_5H_{12} = 72$$

$$Mr\ 72 = -3600 \text{ (for 1 mole)}$$

$$-3600 \times 0.025 = -90$$

energy released = -90 kJ

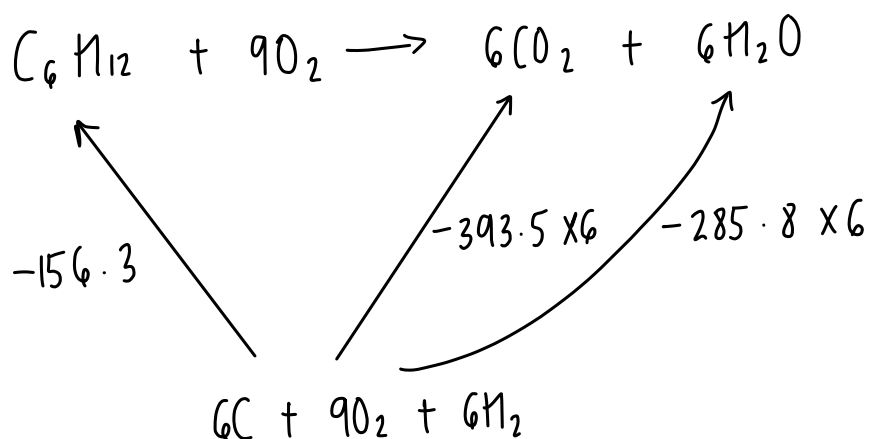
(c) The equation for the complete combustion of cyclohexane is shown below. [3]



Standard enthalpy changes of formation, $\Delta_f H$, are shown in the table.

Substance	$C_6H_{12}(l)$	$CO_2(g)$	$H_2O(l)$
$\Delta_f H^\ominus / \text{kJ mol}^{-1}$	-156.3	-393.5	-285.8

Calculate the standard enthalpy change of combustion, $\Delta_c H$, in kJ mol^{-1} , of cyclohexane.



$$\Delta_c H = 156.3 + (-393.5 \times 6) + (-285.8 \times 6)$$

$$\Delta_c H = -3919.5 \text{ kJ mol}^{-1}$$

$$\Delta_c H = -3920 \text{ kJ mol}^{-1}$$

Total Marks for Question Set 3: 13

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