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.

$q = mc\Delta T$

$q = 200 \times 4.18 \times 45$

$q = 37620\ J$

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

$\Delta H = \frac{37.620}{0.015} = 2510\ kJ\ mol^{-1}$

(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

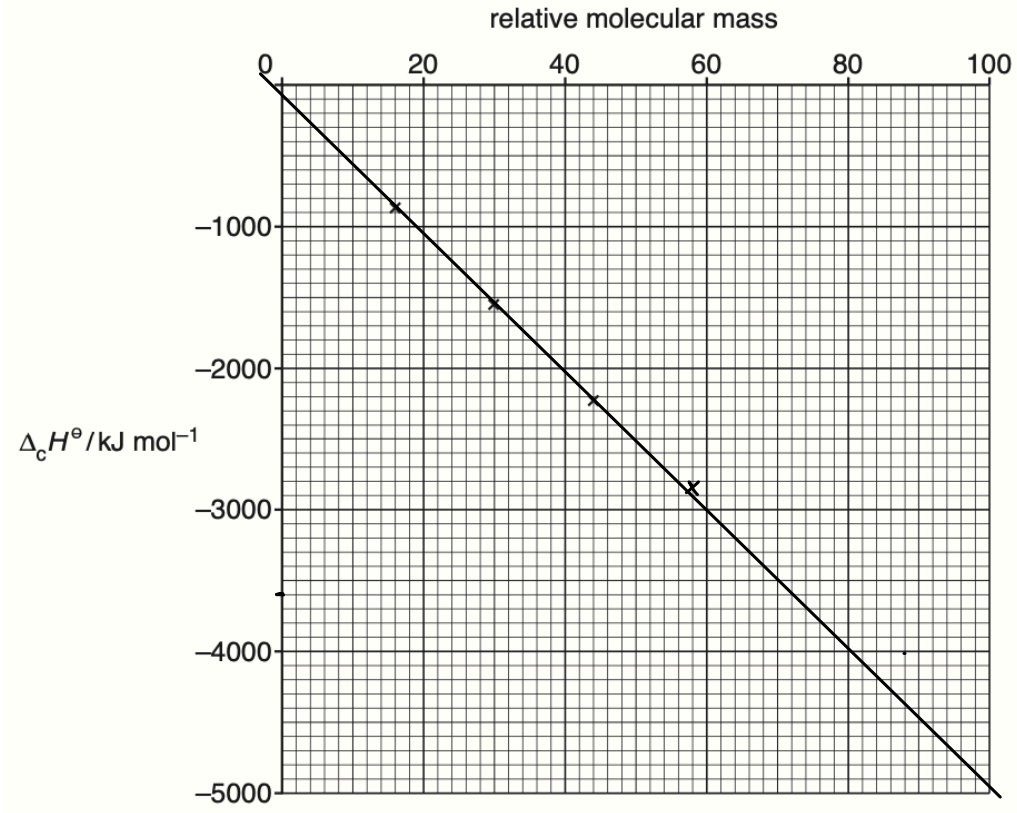
some of the heat energy was used to heat up the calorimeter

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

Alkane	methane	ethane	propane	butane
$\Delta_c H^{\ominus}$ / 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]**

C_5H_{12} = 72

Mr 72 = −3600 (for 1 mole)

Show relevant working below and on the graph.

Moles = $\frac{1.80}{72}$ = 0.025

−3600 x 0.025 = −90

energy released = ... −90 ..... kJ

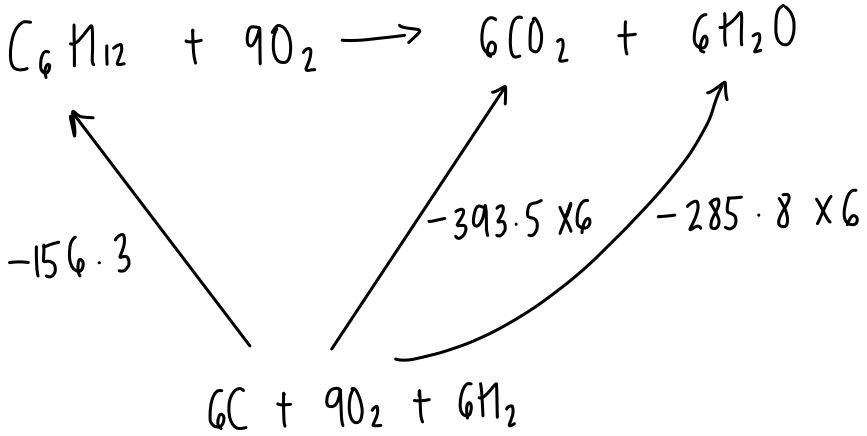
(c) The equation for the complete combustion of cyclohexane is shown below. **[3]**

$C_6H_{12}(l) + 9O_2(g) \rightarrow 6CO_2(g) + H_2O(l)$

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

Substance	$C_6H_{12}(l)$	$CO_2(g)$	$H_2O(l)$
$\Delta_f H^\ominus$ / 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