Enthalpy Changes
AS & A Level

Question Paper 1

Level	A Level
Subject	Chemistry
Exam Board	OCR
Module	Periodic Table & Energy
Topic	Enthalpy Changes
Paper	AS & A Level
Booklet	Question Paper 1

Time allowed: **35 minutes**

Score: **/26**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E
>85%	73%	60%	47%	34%	21%

Question 1

Which enthalpy change(s) is/are endothermic? **[1]**

1 The bond enthalpy of the C–H bond

2 The second electron affinity of oxygen

3 The standard enthalpy change of formation of magnesium

A. 1, 2 and 3

B. Only 1 and 2

C. Only 2 and 3

D. Only 1

Enthalpy values are provided below.

$H_2(g) + I_2(g) \rightarrow 2HI(g)$ $\quad \Delta_r H = -9\,kJ\,mol^{-1}$

Bond	Bond enthalpy / kJ mol^{-1}
H–H	+436
I–I	+151

What is the bond enthalpy, in kJ mol^{-1}, of the H–I bond? **[1]**

A –596

B –298

C +298

D +596

Question 3

The table shows standard enthalpy changes of combustion, $\Delta_c H$.

Substance	$\Delta_c H$ / kJ mol^{-1}
C(s)	–393.5
$H_2(g)$	–285.8
$C_4H_{10}(g)$	–2876.5

What is the enthalpy change for the following reaction? **[1]**

$4C(s) + 5H_2(g) \rightarrow C_4H_{10}(g)$

A –2197.2 kJ mol^{-1}

B –126.5 kJ mol^{-1}

C +126.5 kJ mol^{-1}

D +2197.2 kJ mol^{-1}

Question 4

Many organisms use the aerobic respiration of glucose, $C_6H_{12}O_6$, to release useful energy.

(a) The overall equation for aerobic respiration is the same as for the complete combustion of $C_6H_{12}O_6$.

(i) Write the equation for the aerobic respiration of $C_6H_{12}O_6$. [1]

(ii) Explain, in terms of bond breaking and bond form Δ_l, why this reaction is exothermic. [2]

(b) The table shows some enthalpy changes of combustion, H_c.

substance	ΔH_c / kJ mol^{-1}
C(s)	–394
$H_2(g)$	–286
$C_6H_{12}O_6(s)$	–2801

(i) What is meant by the term *enthalpy change of combustion*, ΔH_c? [2]

(ii) The enthalpy change of formation, ΔH_f, of glucose, $C_6H_{12}O_6$, cannot be determined directly. The equation for this enthalpy change is shown below.

$$6C(s) + 6H_2(g) + 3O_2(g) \longrightarrow C_6H_{12}O_6(s)$$

Suggest why the enthalpy change of formation of $C_6H_{12}O_6$ **cannot** be determined directly. [1]

(iii) Use the ΔH_c values in the table to calculate the enthalpy change of formation of $C_6H_{12}O_6$. [3]

[Total: 9 Marks]

Enthalpy changes of combustion, ΔH_c, are amongst the easiest enthalpy changes to determine directly.

(a) Define the term *enthalpy change of combustion*. [2]

(b) A student carried out an experiment to determine the enthalpy change of combustion of pentan-1-ol, $CH_3(CH_2)_4OH$.

In the experiment, 1.76 g of pentan-1-ol was burnt. The energy was used to heat 250 cm^3 of water from 24.0 °C to 78.0 °C.

(i) Calculate the energy released, in kJ, during combustion of 1.76 g pentan-1-ol.

The specific heat capacity of water = 4.18 $J\,g^{-1}\,K^{-1}$.

Density of water = 1.00 $g\,cm^{-3}$. [1]

(ii) Calculate the amount, in moles, of pentan-1-ol that was burnt. [2]

(iii) Calculate the enthalpy change of combustion of pentan-1-ol.

Give your answer to **three** significant figures. [3]

(c) The standard enthalpy change of formation of hexane can be defined as:

The enthalpy change when 1 mol of hexane is formed from its constituent elements in their standard states under standard conditions.

Hexane melts at –95 °C and boils at 69 °C.

(i) What are *standard conditions*? [1]

(ii) An incomplete equation is shown below for the chemical change that takes place to produce the standard enthalpy change of formation of hexane.

Add state symbols to the equation to show each species in its standard state.

$$6C(.....) + 7H_2(.....) \rightarrow C_6H_{14}(.....)$$ [1]

(iii) It is very difficult to determine the standard enthalpy change of formation of hexane directly. Suggest a reason why. [1]

(iv) The standard enthalpy change of formation of hexane can be determined indirectly.

Calculate the standard enthalpy change of formation of hexane using the standard enthalpy changes of combustion below. [3]

substance	$\Delta H_c^{\ominus}$ / kJ mol^{-1}
C	–394
H_2	–286
C_6H_{14}	–4163

[Total 14 Marks]