5.2 Hess's Law

Question Paper

Course	DP IB Chemistry
Section	5. Energetics / Thermochemistry
Topic	5.2 Hess's Law
Difficulty	Easy

Time allowed: 20

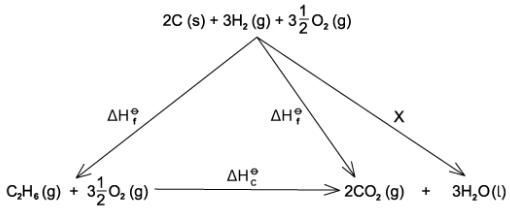
Score: /10

Percentage: /100

Question 1

Enthalpy changes that are difficult to measure directly can often be determined using Hess' Law to construct an enthalpy cycle.

Which enthalpy change is indicated by X in the enthalpy cycle shown?



A. + 1 x Enthalpy of formation of water

B. - 1 x Enthalpy of formation of water

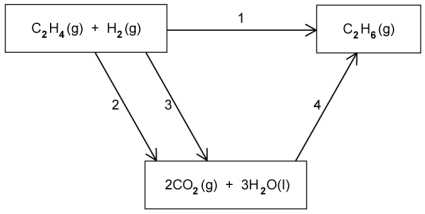
C. + 3 x Enthalpy of formation of water

D. - 3 x Enthalpy of formation of water

[1 mark]

Question 2

A student drew a Hess cycle to calculate the enthalpy of reaction to produce ethane from ethene and hydrogen.



The student used the following enthalpy of combustion data

	$C_2H_4(g)$	$H_2(g)$	$C_2H_6(g)$
$\Delta H^{\ominus}_c$ / kJ mol^{-1}	-1411	-286	-1560

What are the correct labels for the arrows for the student's Hess cycle?

	Arrow 1	Arrow 2	Arrow 3	Arrow 4
A	$\Delta H^{\ominus}_r$	-1411	-286	-1560
B	$\Delta H^{\ominus}_c$	-1411	+286	-1560
C	$\Delta H^{\ominus}_c$	+1411	-286	+1560
D	$\Delta H^{\ominus}_r$	-1411	-286	+1560

[1 mark]

Question 3

Which is the correct equation to calculate the enthalpy of reaction using enthalpy of formation data?

A. $\Delta H_r = \Sigma\Delta H_{f\ products} + \Sigma\Delta H_{f\ reactants}$

B. $\Delta H_r = \Sigma\Delta H_{f\ products} - \Sigma\Delta H_{f\ reactants}$

C. $\Delta H_r = \Sigma\Delta H_{f\ reactants} - \Sigma\Delta H_{f\ products}$

D. $\Delta H_r = \Sigma\Delta H_{f\ reactants} + \Sigma\Delta H_{f\ products}$

[1 mark]

Question 4

Enthalpy of formation data is often used to calculate the enthalpy of reaction. Which of the following does **not** have a standard enthalpy of formation of 0 kJ mol^{-1}?

A. C (s)

B. N_2 (l)

C. O_2 (g)

D. F_2 (g)

[1 mark]

Question 5

Iron(II,III) oxide, Fe_3O_4, is reduced by graphite according to the following equation:

$$Fe_3O_4\,(s) + 2C\,(s) \rightarrow 3Fe\,(s) + 2CO_2\,(g)$$

The standard enthalpy of formation values for iron(II,III) oxide and carbon dioxide are -1118 kJ mol^{-1} and -394 kJ mol^{-1} respectively.

The standard enthalpy of reaction can be determined using which of the following calculations?

A. -1118 - (2 x -394)

B. -394 + 1118

C. (2 x -394) - 1118

D. (2 x -394) + 1118

[1 mark]

Question 6

Hydrogen peroxide slowly decomposes to form water and oxygen:

$$2H_2O_2(l) \rightarrow 2H_2O(l) + O_2(g)$$

	$\Delta H^{\ominus}_f$, kJ mol^{-1}
$H_2O_2(l)$	-188
$H_2O(l)$	-286

Which calculation gives the correct enthalpy of reaction for the decomposition of hydrogen peroxide?

A. -286 + 188

B. (2 x -286) - (2 x -188)

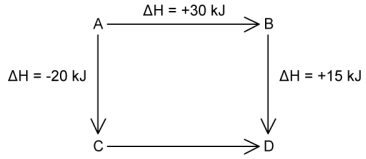
C. -286 + (2 x -188)

D. (2 x -188) - (2 x -286)

[1 mark]

Question 7

The diagram shows two possible reaction pathways for the reaction of A → D:



Which of the following statements are correct?

I. A → D ΔH = +45 kJ
II. C → D ΔH = -25 kJ
III. D → C ΔH = -65 kJ

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

[1 mark]

Question 8

The standard enthalpy of formation of sulfur dioxide cannot be measured directly.

Which equation(s) provide a suitable alternative pathway to determine the standard enthalpy of formation of sulfur dioxide?

A. $S(s) + O_2(g) \rightarrow SO_2(g)$

B. $S(s) + O(g) \rightarrow SO(g)$ $\quad$ $SO(g) + O(g) \rightarrow SO_2(g)$

C. $S(s) + 1.5O_2(g) \rightarrow SO_3(g)$ $\quad$ $SO_3(g) \rightarrow SO_2(g) + 0.5O_2(g)$

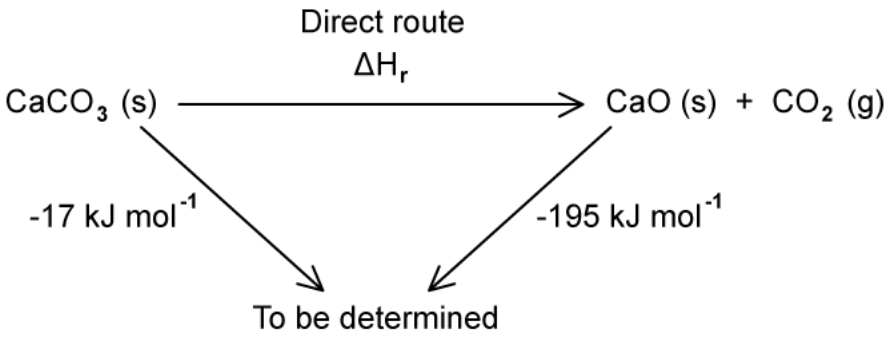
D. $S(s) + 0.5O_2(g) \rightarrow SO(g)$ $\quad$ $SO(g) + O_2(g) \rightarrow SO_3(g)$

[1 mark]

Question 9

The thermal decomposition of calcium carbonate is very slow and requires a high temperature to go to completion. This makes it impractical to measure the enthalpy change for the direct reaction.

The enthalpy change for the thermal decomposition of calcium carbonate can be determined by two chemical reactions with dilute hydrochloric acid.



Which set of chemicals correctly completes the Hess cycle diagram?

A. $CaCO_3 + CaO + HCl$

B. $CaCl + H_2O + CO_2$

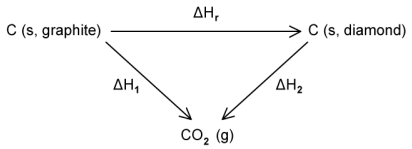
C. $CaCl_2 + H_2O$

D. $CaCl_2 + H_2O + CO_2$

[1 mark]

Question 10

Hess's Law can be used to calculate the enthalpy change for reactions that are difficult to measure experimentally, such as the conversion of graphite to diamond.



Which equation shows the correct application of Hess's law to calculate the enthalpy change for the conversion of graphite to diamond?

A. $\Delta H_r = \Delta H_1 + \Delta H_2$

B. $\Delta H_r = \Delta H_1 - \Delta H_2$

C. $\Delta H_r = \Delta H_2 - \Delta H_1$

D. $\Delta H_r = \Delta H_1 \times \Delta H_2$

[1 mark]