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: 60

Score: /45

Percentage: /100

Question 1a

a)
State Hess's Law.

[1 mark]

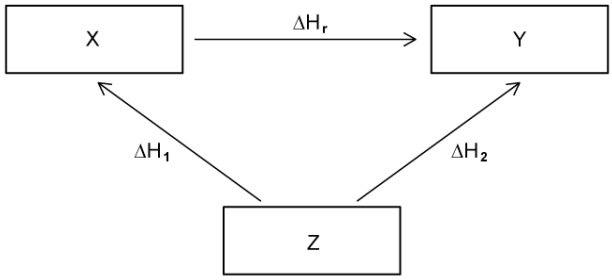
Question 1b

b)
State the type of system in which the total amount of matter present is always constant.

[1 mark]

Question 1c

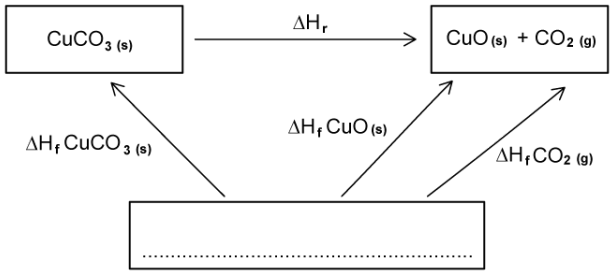
c)
Using the image below, construct an equation that can be used to determine ΔH_r from ΔH_1 and ΔH_2.



[1 mark]

Question 1d

d)
Complete the following Hess's Law cycle for the decomposition of copper carbonate.



[3 marks]

Question 2a

a)
Define *standard enthalpy of formation*, ΔH_f.

[2 marks]

Question 2b

b)
Write an equation to show the enthalpy of formation of 1 mole of the following compounds. Include state symbols in your equations.
Methanol, CH_3OH ……..
Carbon dioxide, CO_2 ……..
Ethane, C_2H_6 ……..

[8 marks]

Question 2c

c)
Using the equations given, construct a Hess's Law cycle for the following reaction. Include the values for ΔH_f in your cycle.

$$BaCl_2(s) + Zn(s) \rightarrow Ba(s) + ZnCl_2(s)$$

$Ba(s) + Cl_2(g) \rightarrow BaCl_2(s) \quad \Delta H_f = -858.6\ kJ\ mol^{-1}$

$Zn(s) + Cl_2(g) \rightarrow ZnCl_{2(s)} \quad \Delta H_f = -415.1\ kJ\ mol^{-1}$

[3 marks]

Question 2d

d)
Calculate the enthalpy of reaction, ΔH_r, for the reaction given in part (c).

[3 marks]

Question 3a

a)
Aluminium oxide reacts with magnesium to form magnesium oxide and aluminium in a displacement reaction via the following reaction.
Construct a Hess's Law cycle for this reaction

$$Al_2O_3\,(s) + 3Mg\,(s) \rightarrow 3MgO\,(s) + 2Al\,(s)$$

Enthalpy of formation	Enthalpy of formation ($kJ\,mol^{-1}$)
$\Delta H_f\,(Al_2O_3)$	-1675.7
$\Delta H_f\,(MgO)$	-601.7
$\Delta H_f\,(Mg)$	
$\Delta H_f\,(Al)$	

[4 marks]

Question 3b

b)
Outline why no values are listed for Al (s) and Mg (s) in the table given in part (a).

[1 mark]

Question 3c

c)
Calculate the enthalpy change of reaction, ΔH_r, for the reaction in part (a).

[2 marks]

Question 4a

a)

Determine the enthalpy change of reaction, ΔH_r, for the following equations if they are reversed.

$2Na + Cl_2 \rightarrow 2NaCl$ $\Delta H_r = -790$ kJ ……

$C_2H_4 + H_2 \rightarrow C_2H_6$ $\Delta H_r = -65.6$ kJ ……

$2H_2O \rightarrow 2H_2 + O_2$ $\Delta H_r = +571$ kJ ……

[3 marks]

Question 4b

b)

Using the information given in part (a), determine the enthalpy change for the following reaction.

$$2C_2H_4 + 2H_2 \rightarrow 2C_2H_6$$

[1 mark]

Question 4c

c)

Using the information in the table, deduce which equation should be reversed to determine the enthalpy change for the following reaction.

$$SiO_2 + 3C \rightarrow SiC + 2CO$$

Equation number	Equation	Enthalpy change (kJ)
1	$Si + O_2 \rightarrow SiO_2$	-911
2	$2C + O_2 \rightarrow 2CO$	-211
3	$Si + C \rightarrow SiC$	-65.3

[1 mark]

Question 4d

d)
Use the information in part (c) to produce an overall cancelled down equation which can be used to determine the overall enthalpy change for the following reaction.

$$SiO_2 + 3C \rightarrow SiC + 2CO$$

[2 marks]

Question 4e

e)
Deduce the overall enthalpy change, in kJ, using the information in part (c) for the reaction $SiO_2 + 3C \rightarrow SiC + 2CO$

[2 marks]

Question 5a

a)
State the equation required to calculate the enthalpy change of reaction, ΔH_r, given enthalpy of formation, ΔH_f, data.

[1 mark]

Question 5b

b)
Using section 12 in the data booklet and the data in the table calculate the enthalpy change of reaction, ΔH_r, for the following reaction.

$$SO_2(g) + 2H_2S(g) \rightarrow 3S(s) + 2H_2O(l)$$

	$SO_2(g)$	$H_2S(g)$
ΔH_f (kJ mol^{-1})	-297	-20.2

[3 marks]

Question 5c

c)
Show how the equations can be used to produce an alternative route for this reaction.

$$C_2H_4 + H_2 \rightarrow C_2H_6$$

	ΔH (kJ mol^{-1})
$C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$	-1411
$C_2H_6 + 3½O_2 \rightarrow 2CO_2(g) + 3H_2O$	-1560
$H_2 + ½O_2 \rightarrow H_2O$	-285.8

[2 marks]

Question 5d

d)
Calculate ΔH

[1 mark]