

# 5.2 Hess's Law

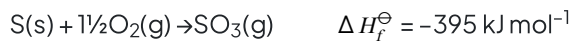
## Question Paper

Course	DPIB Chemistry
Section	5. Energetics / Thermochemistry
Topic	5.2 Hess's Law
Difficulty	Hard

**Time allowed:** 20  
**Score:** /10  
**Percentage:** /100

### Question 1

The equations below show the formation of sulfur oxides from sulfur and oxygen.



What is the enthalpy change of reaction,  $\Delta H^\ominus$ , of  $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{SO}_3(\text{g})$  in  $\text{kJ mol}^{-1}$ ?

- A. (794 - 594)
- B. (296 + 395)
- C. (-395 + 297)
- D. (-790 + 594)

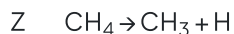
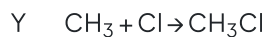
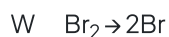
[1 mark]

### Question 2

Some bond energy values are listed below.

bond	bond energy / $\text{kJ mol}^{-1}$
Br-Br	193
Cl-Cl	242
C-H	414
C-Cl	324

These bond energy values relate to the following four reactions.



What is the correct order of enthalpy changes of the above reactions from most negative to most positive?

- A.  $\text{Y} \rightarrow \text{Z} \rightarrow \text{W} \rightarrow \text{X}$
- B.  $\text{Z} \rightarrow \text{W} \rightarrow \text{X} \rightarrow \text{Y}$
- C.  $\text{Y} \rightarrow \text{X} \rightarrow \text{W} \rightarrow \text{Z}$
- D.  $\text{X} \rightarrow \text{Y} \rightarrow \text{Z} \rightarrow \text{W}$

[1 mark]

### Question 3

A student calculated the standard enthalpy change of formation of propane,  $C_3H_8$ , using a method based on standard enthalpy changes of combustion.

He used correct values for the standard enthalpy change of combustion of propane

( $-2220 \text{ kJ mol}^{-1}$ ) and hydrogen ( $-286 \text{ kJ mol}^{-1}$ ) but he used an incorrect value for the standard enthalpy change of combustion of carbon. He then performed his calculation correctly. His final answer was  $-158 \text{ kJ mol}^{-1}$ .

What did he use for the standard enthalpy change of combustion of carbon?

A.  $-2220 + (286 \times 4) + 158$

B.  $\frac{-2220 + [286 \times 4] + 158}{3}$

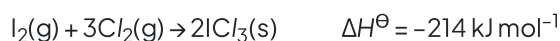
C.  $\frac{+2220 - [286 \times 4] - 158}{3}$

D.  $\frac{3}{-2220 + [286 \times 4] + 158}$

[1 mark]

### Question 4

Given the following enthalpy changes,



What is the correct value for  $\Delta H_f^\ominus$  of iodine trichloride,  $ICl_3(s)$ ?

A.  $2(38 - 214)$

B.  $2(214 - 38)$

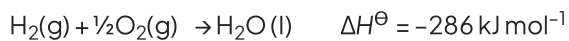
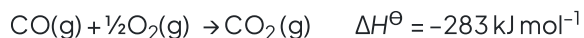
C.  $\frac{1}{2}(38 - 214)$

D.  $\frac{1}{2}(214 - 38)$

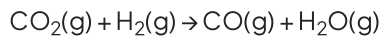
[1 mark]

### Question 5

Using the following information:



What is the enthalpy change,  $\Delta H^\ominus$ , for the following reaction?

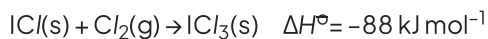


- A.  $-286 - 44 - 283$
- B.  $-286 + 44 + 283$
- C.  $-286 - 44 + 283$
- D.  $-286 + 44 - 283$

[1 mark]

### Question 6

Iodine trichloride,  $\text{ICl}_3$ , is made by reacting iodine with chlorine.



By using the data above, what is the enthalpy change of the formation for solid iodine trichloride?

- A.  $-162 \text{ kJ mol}^{-1}$
- B.  $-81 \text{ kJ mol}^{-1}$
- C.  $-74 \text{ kJ mol}^{-1}$
- D.  $-60 \text{ kJ mol}^{-1}$

[1 mark]

### Question 7

Shown below are three enthalpy changes:



Use the information given to deduce the correct expression for the enthalpy change of the following reaction:

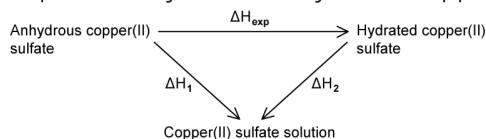


- A.  $x + y + z$
- B.  $2x + y + z$
- C.  $2x + 2y + z$
- D.  $2x + 2y + 2z$

[1 mark]

### Question 8

The hydration enthalpy of anhydrous copper(II) sulfate, labelled as  $\Delta H_{\text{exp}}$ , cannot be measured directly. It can be found indirectly by determining the solution enthalpies of anhydrous and hydrated copper(II) sulfate.



Which of the following statements correctly explains why the value for  $\Delta H_{\text{exp}}$  for this reaction cannot be measured directly?

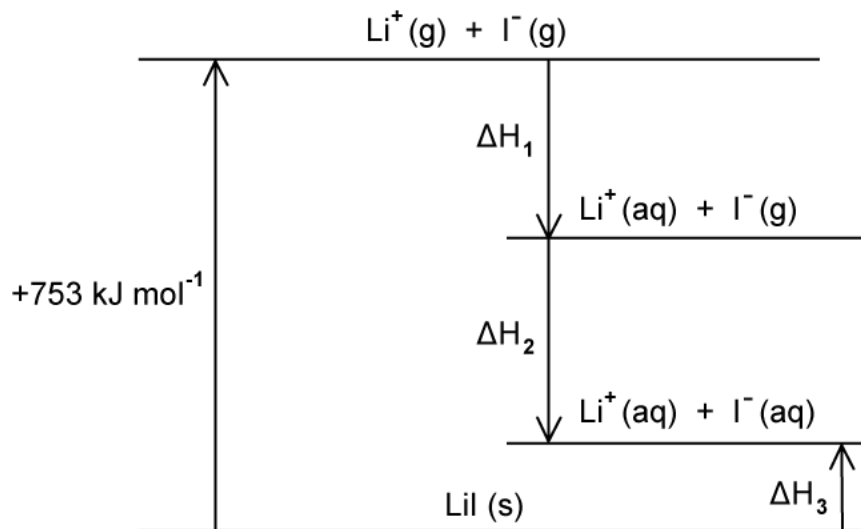
- I. Hydrated copper(II) sulfate is not produced in a controlled manner
- II. Dissolving of the solid is difficult to avoid
- III. Heat energy is trapped inside the solid copper(II) sulfate

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

[1 mark]

### Question 9

Lithium iodide solution can be produced by two different reaction paths, according to the following diagram:



Which labels could be added to complete the diagram

	$\Delta H_1$	$\Delta H_2$	$\Delta H_3$
<b>A</b>	$+364 \text{ kJ mol}^{-1}$	$\Delta H_{\text{hyd}}$	$+82 \text{ kJ mol}^{-1}$
<b>B</b>	$\Delta H_{\text{hyd}}$	$\Delta H_{\text{sol}}$	$+82 \text{ kJ mol}^{-1}$
<b>C</b>	$\Delta H_{\text{hyd}}$	$-307 \text{ kJ mol}^{-1}$	$\Delta H_{\text{sol}}$
<b>D</b>	$-364 \text{ kJ mol}^{-1}$	$\Delta H_{\text{sol}}$	$\Delta H_{\text{hyd}}$

[1 mark]

### Question 10

Bond energy calculations show the enthalpy of combustion for propene to be  $-1572.0 \text{ kJ mol}^{-1}$ .

Compound	$\text{C}_3\text{H}_6(\text{g})$	$\text{CO}_2(\text{g})$	$\text{H}_2\text{O}(\text{l})$	$\text{H}_2\text{O}(\text{g})$
$\Delta H_f^\ominus / \text{kJ mol}^{-1}$	+20.0	-393.5	-285.8	-241.8

Using the enthalpy of formation data, which calculation correctly shows the percentage error between propene's enthalpy of combustion values obtained from bond energy calculations and Hess's Law calculations, assuming the bond energy calculation value is correct?

- A.  $\frac{-1572.0}{((3 \times -393.5) + (3 \times -241.8) - (20)) - 1572.0} \times 100$
- B.  $\frac{(3 \times -393.5) + (3 \times -241.8) - (20)}{-1572.0} \times 100$
- C.  $\frac{(3 \times -393.5) + (3 \times -241.8) + (20)}{-1572.0} \times 100$
- D.  $\frac{((3 \times -393.5) + (3 \times -241.8) - (20)) - (-1572.0)}{-1572.0} \times 100$

[1 mark]