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IB Chemistry: SL

5.2 Hess's Law

CHEMISTRY

SL

5.2 Hess's Law

Question Paper

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

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Time allowed: 20

Score: /10

Percentage: /100

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Question 1

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 kJ mol^{-1}) and hydrogen (–286 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 kJ mol^{-1}.

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

A. - 2220 + (286 x 4) + 158

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

C. $\frac{+2220 - [286 \times 4] - 158}{30}$

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

[1 mark]

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Question 2

Given the following enthalpy changes,

$I_2(s) \rightarrow I_2(g)$ $\Delta H\Theta = +38$ kJ mo^{-1}

$I_2(g) + 3Cl_2(g) \rightarrow 2ICl_3(s)$ $\Delta H\Theta = -214$ kJ mo^{-1}

What is the correct value for $\Delta H_f\Theta$ of iodine trichloride, ICl (s)?

A. 2 (38 – 214)

B. 2 (214 – 38)

C. ½ (38 – 214)

D. ½ (214 – 38)

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[1 mark]

Question 3

Using the following information:

$CO(g) + ½O_2(g) \rightarrow CO\ (g)$ $\quad \Delta H\Theta = -283\ kJ\ mol^{-1}$

$H_2(g) + ½O_2(g) \rightarrow H_2O\ (l)$ $\quad \Delta H\Theta = -286\ kJ\ mo^{-1}$

$H_2O(g) \rightarrow H_2O\ (l)$ $\quad \Delta H\Theta = -44\ kJ\ mo^{-1}$

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

$$CO_2(g) + H_2(g) \rightarrow CO(g) + H_2O(g)$$

A. −286 − 44 − 283

B. −286 + 44 + 283

C. −286 − 44 + 283

D. −286 + 44 − 283

[1 mark]

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Question 4

Iodine trichloride, ICl_3, is made by reacting iodine with chlorine.

$I_2(s) + Cl_2(g) \rightarrow 2ICl(s)$ $\quad \Delta H^o = +14\ kJ\ mol^{-1}$

$ICl(s) + Cl_2(g) \rightarrow ICl_3(s)$ $\quad \Delta H^o = -88\ kJ\ mo^{-1}$

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

A. $-162\ kJ\ mol^{-1}$

B. $-81\ kJ\ mol^{-1}$

C. $-74\ kJ\ mol^{-1}$

D. $-60\ kJ\ mol^{-1}$

[1 mark]

Question 5

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

$S(s) + O_2(g) \rightarrow SO_2(g)$ $\quad \Delta H_p^\circ = -297 \text{ kJ mol}^{-1}$

$S(s) + 1½O_2(g) \rightarrow SO_3(g)$ $\quad \Delta H_p^\circ = -395 \text{ kJ mol}^{-1}$

What is the enthalpy change of reaction, ΔH°, of $2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$ in kJ mol^{-1}?

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

[1 mark]

Question 6

Some bond energy values are listed below.

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

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These bond energy values relate to the following four reactions.

WBr2 → 2Br
X2Cl → Cl 2
YCH3 + Cl → CH3Cl
ZCH4 → CH3 + H

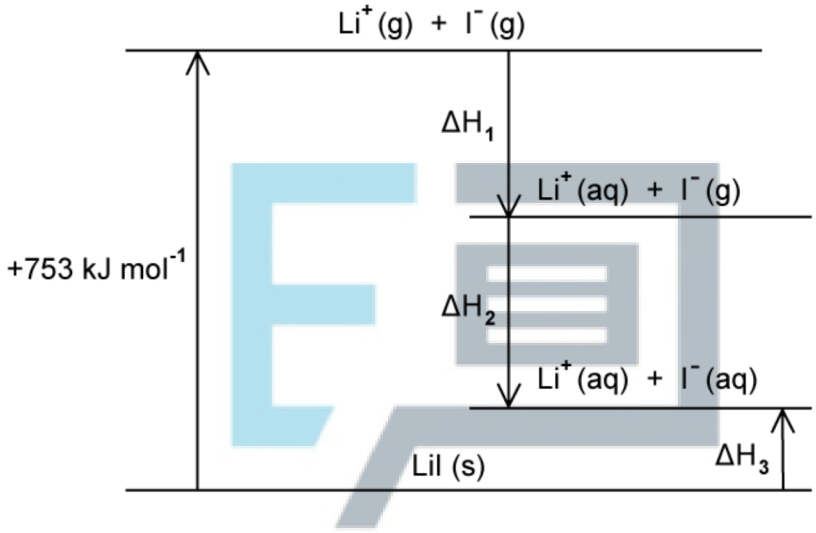
What is the correct order of enthalpy changes of the above reactions from most negative to most positive?

A. Y → Z → W → X
B. Z → W → X → Y
C. Y → X → W → Z
D. X → Y → Z → W

[1 mark]

Question 7

Lithiumiodidesolution can be produced by two di erent reaction paths, according to the following diagram:



Which labels could be added to complete the diagram

	ΔH_1	ΔH_2	ΔH_3
A	+364 kJ mol^{-1}	$\Delta H_{hyə}$	+82 kJ mol^{-1}
B	$\Delta H_{hyə}$	ΔH_{sol}	+82 kJ mol^{-1}
C	$\Delta H_{hyə}$	-307 kJ mol^{-1}	ΔH_{sol}
D	+364 kJ mol^{-1}	ΔH_{sol}	$\Delta H_{hyə}$

[1 mark]

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Question 8

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

Compound	$C_3H_6(g)$	CO_2 (g)	H_2O (l)	H_2O (g)
$\Delta H°_p$/ 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. $\dfrac{-1572.0}{((3 \times -393.5) + (3 \times -241.8) - (20)) - 1572.0} \times 100$

B. $\dfrac{(3 \times -393.5) + (3 \times -241.8) - (20)}{-1572.0} \times 100$

C. $\dfrac{(3 \times -393.5) + (3 \times -241.8) + (20)}{-1572.0} \times 100$

D. $\dfrac{((3 \times -393.5) + (3 \times -241.8) - (20)) - (-1572.0)}{-1572.0} \times 100$

[1 mark]

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Question 9

Shown below are three enthalpy changes:

$CH_4(g) + O_2(g) \rightarrow HCHO(l) + H_2O(l)$ $\Delta H = x$

$HCHO(l) + \frac{1}{2}O_2(g) \rightarrow HCOOH(l)$ $\Delta H = y$

$2HCOOH(l) + \frac{1}{2}O_2(g) \rightarrow (COOH)_2(l) + H_2O(l)$ $\Delta H = z$

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

$$2CH\ (g) + 3½\ O\ (g) \rightarrow (COOH)\ (l) + 3H\ O(l)$$

A. x + y + z

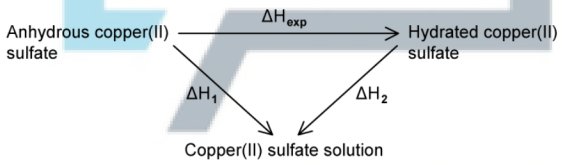
B. 2x + y + z

C. 2x + 2y + z

D. 2x + 2y + 2z **[1 mark]**

Question 10

The hydration enthalpy of anhydrous copper(II) sulfate, labelled as ΔH , cannot be measured directly. It can be found indirectly by determining the solution enthalpies of anhydrous and hydrated copper(II) sulfate.



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Which of the following statements correctly explains why the value for ΔH 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]

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