

5.3 Bond Enthalpy

Question Paper

Course	DPIB Chemistry
Section	5. Energetics / Thermochemistry
Topic	5.3 Bond Enthalpy
Difficulty	Hard

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

Question 1

In the gas phase, phosphorus pentachloride can be thermally decomposed into gaseous phosphorus trichloride and chlorine.



The table below gives the relevant bond energies found in these compounds.

bond	bond energy / kJ mol ⁻¹
P-Cl (in both chlorides)	x
Cl-Cl	y

What is the enthalpy change in the decomposition of the reaction?

- A. $y - 2x$
- B. $2x - y$
- C. $8x + y$
- D. $x + y$

[1 mark]

Question 2

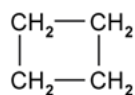
Which equation correctly shows how the bond energy for the covalent bond Y-Z can be calculated by dividing ΔH by n ?

- A. $n\text{YZ}(\text{g}) \rightarrow n\text{Y}(\text{g}) + \frac{n}{2} \text{Z}_2(\text{g})$
- B. $\text{Z}(\text{g}) + \text{YZ}_{n-1}(\text{g}) \rightarrow \text{YZ}_n(\text{g})$
- C. $2\text{YZ}_n(\text{g}) \rightarrow 2\text{YZ}_{n-1}(\text{g}) + \text{Y}_2(\text{g})$
- D. $\text{YZ}_n(\text{g}) \rightarrow \text{Y}(\text{g}) + n\text{Z}(\text{g})$

[1 mark]

Question 3

The diagram shows the skeletal formula of cyclobutane.



The enthalpy change of formation of cyclobutane is $+75.1 \text{ kJ mol}^{-1}$, and the enthalpy change of atomisation of graphite is $+712 \text{ kJ mol}^{-1}$.

The bond enthalpy of C-H is 414 kJ mol^{-1} and of H-H is 436 kJ mol^{-1} .

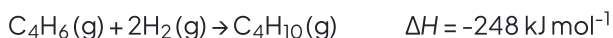
What is the average bond enthalpy of the C-C bond in cyclobutane?

- A. $712 - 436 + 2(414) + \frac{75.1}{4}$
- B. $712 + 436 - 414 - \frac{75.1}{4}$
- C. $712 + 436 - 2(414) - \frac{75.1}{4}$
- D. $712 + 436 - 2(414) - 75.1$

[1 mark]

Question 4

Butane can be produced by the hydrogenation of buta-1,3-diene.



Bond	C-C	C-H	H-H
Mean bond enthalpy / kJ mol^{-1}	346	414	436

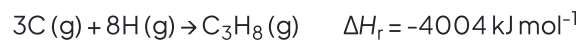
Using the information, which calculation shows the bond enthalpy for the C=C bond in buta-1,3-diene?

- A. $-248 - (2 \times 436) + (2 \times 346) + (4 \times 414)$
- B. $-124 - 436 + 346 + (2 \times 414)$
- C. $(2 \times 346) + (4 \times 414) + 248 - (2 \times 436)$
- D. $346 + (2 \times 414) + 124 - 436$

[1 mark]

Question 5

The equations to form methane and propane from their gaseous atoms are:



What is the bond enthalpy of a C-C bond?

A. $\frac{-4004 + 2 \times (1656)}{3}$

B. $2002 - 1656$

C. $1656 - 2002$

D. $\frac{-4004 - 2 \times (1656)}{3}$

[1 mark]

Question 6

Ultraviolet radiation is split into three regions:

- UV A (wavelength 400 - 320 nm)
- UV B (wavelength 320 - 280 nm)
- UV C (wavelength < 280 nm)

High energy photons are present in the solar spectrum at high altitude. The maximum wavelength of a photon that has enough energy to break the O=O bond in oxygen is 240 nm, which is in the UV C region of ultraviolet radiation..

The energy per mole required to break an O=O bond can be calculated using the following equation:

$$\frac{\text{Bond energy per mole}}{\text{Avogadro's constant}} = \text{Energy per bond}$$

Using the supplementary equations $c = \nu\lambda$ and $E = h\nu$, which is the correct calculation to determine the bond energy of an O=O in kJ mol^{-1} ?

Avogadro's constant = 6.02×10^{23}

Planck's constant = 6.63×10^{-34} J s

Speed of light = 3.00×10^8 m s^{-1}

- A. $\frac{6.63 \times 3.00 \times 6.02 \times 10}{2.4}$
- B. $\frac{6.63 \times 3.00 \times 6.02 \times 10^4}{2.4}$
- C. $\frac{6.63 \times 3.00 \times 6.02 \times 10^{-3}}{2.4}$
- D. $\frac{6.02 \times 2.4 \times 10^{42}}{6.63 \times 3.00}$

[1 mark]

Question 7

Which of the following statements about the average bond enthalpy of the halogens are correct?

- Fluorine has the highest average bond enthalpy
- Average bond enthalpy generally decreases as the size of the atoms increases
- In general, increased shielding results in a lower bond enthalpy

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

[1 mark]

Question 8

What is the correct order to show the decreasing strength of the F-H, N-H and O-H bonds?

- A. N-H > O-H > F-H
- B. O-H > N-H > F-H
- C. F-H > N-H > O-H
- D. F-H > O-H > N-H

[1 mark]

Question 9

Water has two different bond enthalpies for the two O-H bonds that it contains:

The average O-H bond enthalpy from an accepted data table is 463 kJ mol^{-1} .

Which calculation correctly shows the percentage difference between the average O-H bond enthalpy of water and the data table average bond enthalpy value?

- A. $100 \div \left(\frac{502 + 427}{2 \times 463} - 1 \right)$
- B. $100 \times \left(\frac{502 + 427}{2 \times 463} - 1 \right)$
- C. $100 \times \left(\frac{2 \times 463}{502 + 427} - 1 \right)$
- D. $100 \times \left(\frac{502 + 427}{2 \times 436} - 1 \right)$

[1 mark]

Question 10

Some of the reactions involved in the formation and depletion of ozone are:

- I. $\text{O}_2 \rightarrow 2\text{O}^\bullet$
- II. $\text{O}_2 + \text{O}^\bullet \rightarrow \text{O}_3$
- III. $\text{O}_3 + \text{O}^\bullet \rightarrow 2\text{O}_2$

Which reactions are exothermic?

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

[1 mark]