

GCSE Chemistry (9 – 1)

Bond Energy Calculations

Name:

Group:

Instructions

- Read each question carefully before you begin to answer it.
- Use black ink or black ball-point pen for your answers.
- Fill in the boxes at the top of this page with your name and group.
- Attempt to answer every question in the booklet.
- Answer the questions in the spaces provided – there may be more space than you need in some answer spaces.
- Calculators may be used for this booklet.
- For any calculations, you **must** show all your working.
- Any and all drawings or graphs should be completed in pencil.



For markers use	
Question	Mark
1	/7
2	/7
3	/4
4	/4
5	/4
6	/4
7	/5
8	/5
9	/10
10	/10
Total	/60
%	
Grade	

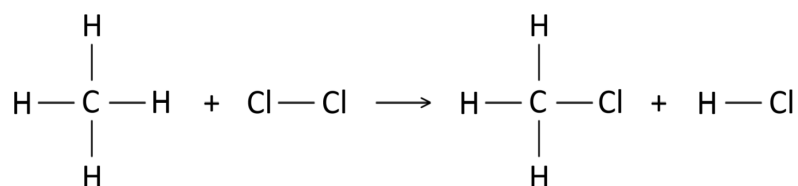
Information

- The maximum mark for this paper is 60 marks.
- The marks for each question are shown in brackets.
- Please be aware that good English and clear presentation are required in your answers.



1. Methane gas CH_4 (g), reacts with chlorine gas Cl_2 (g), in the presence of ultraviolet light to produce chloromethane CH_3Cl (g) and hydrogen chloride HCl (g).

The figure below shows the displayed formula equation for the reaction.



The table below gives the bond energies for the bonds in the equation.

Bond	H-C	Cl-Cl	C-Cl	H-Cl
Bond energy	413	243	346	432

- a) Calculate the energy needed to break the bonds in the reactant molecules.

..... kJ

(1 mark)

- b) Calculate the energy released when the bonds are formed in the product molecules.

..... kJ

(1 mark)

- c) Calculate the overall energy change for the reaction between the methane gas and chlorine gas.

..... Unit:

(3 marks)

- d) State whether the overall energy change is endothermic or exothermic and give a reason for your answer.

.....

(2 marks)

(Total for Question 1 is 7 marks)

2. Hydrogen gas, H_2 (g) reacts with oxygen gas, O_2 (g) to form water vapour, H_2O (g).

The figure below shows the displayed formula equation for the reaction.



The table below gives the bond energies for the bonds in the equation.

Bond	H—H	O=O	O—H
Bond energy	436	498	464

- a) Calculate the energy needed to break the bonds in the reactant molecules.

..... kJ

(1 mark)

- b) Calculate the energy released when the bonds are formed in the product molecules.

..... kJ

(1 mark)

- c) Calculate the overall energy change for the reaction between the hydrogen gas and oxygen gas.

..... Unit:

(3 marks)

- d) State whether the overall energy change is endothermic or exothermic and give a reason for your answer.

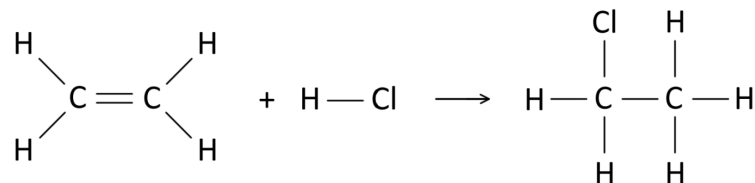
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(2 marks)

(Total for Question 2 is 7 marks)

3. Ethene gas, C_2H_4 (g) reacts with hydrogen chloride gas, HCl (g) to produce chloroethane, $\text{C}_2\text{H}_4\text{Cl}_2$.

The figure below shows the displayed formula equation for the reaction.



The table below gives the bond energies for the bonds in the equation.

Bond	H—C	C=C	H—Cl	C—Cl	C—C
Bond energy	413	612	431	338	347

Use the bond energies to calculate the energy change for the reaction.

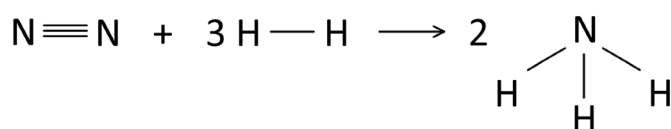
..... Unit:

(4 marks)

(Total for Question 3 is 4 marks)

4. The Haber process is the reaction between nitrogen, N_2 and hydrogen, H_2 which produces ammonia NH_3 .

The figure below shows the displayed formula equation for the reaction.



The table below gives the bond energies for the bonds in the equation.

Bond	$\text{N} \equiv \text{N}$	H—H	N—H
Bond energy	944	436	388

Use the bond energies to calculate the energy change for the reaction.

..... Unit:

(4 marks)

(Total for Question 4 is 4 marks)

5. Hydrogen gas, $\text{H}_2(\text{g})$, reacts with fluorine gas $\text{F}_2(\text{g})$ to produce hydrogen fluoride. Hydrogen fluoride can be used in the production of Teflon for nonstick coatings on cooking pans.

The figure below shows the displayed formula equation for the reaction.



The table below gives the bond energies for the bonds in the equation.

Bond	H-H	F-F	H-F
Bond energy	436	158	562

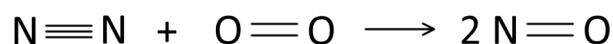
Use the bond energies to calculate the energy change for the reaction.

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(4 marks)

(Total for Question 5 is 4 marks)

6. Nitrogen gas, $\text{N}_2(\text{g})$ reacts with oxygen gas $\text{O}_2(\text{g})$ to produce nitrogen monoxide $\text{NO}(\text{g})$.

The figure below shows the displayed formula equation for the reaction.



The table below gives the bond energies for the bonds in the equation.

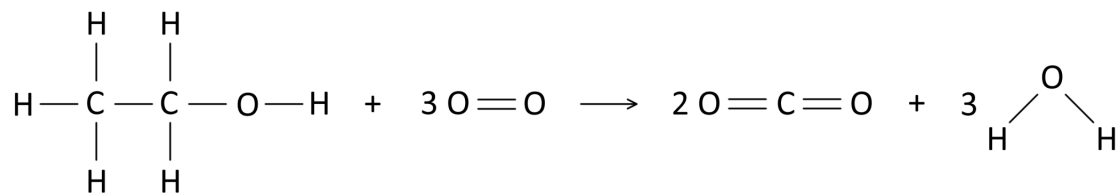
Bond	$\text{N} \equiv \text{N}$	$\text{O} = \text{O}$	$\text{N} = \text{O}$
Bond energy	944	498	607

Use the bond energies to calculate the energy change for the reaction.

.....
(4 marks)

(Total for Question 6 is 4 marks)

7. Ethanol is often used as a fuel. The combustion of ethanol, C₂H₅OH, is an exothermic reaction. The figure below shows the displayed formula equation for the reaction.



The table below gives the bond energies for the bonds in the equation.

Bond	C-H	C-C	C=O	C-O	O=O	O-H
Bond energy	413	347	x	358	498	464

In the reaction the energy released forming new bonds was -1270 kJ/mol.

Use this information and the bond energies above to calculate the bond energy x for the C=O bond. Give your answer to three significant figures.

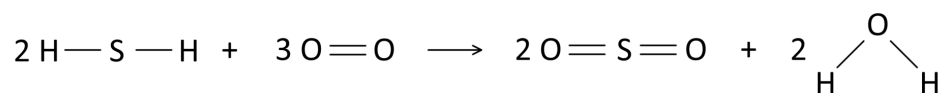
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(5 marks)

(Total for Question 7 is 5 marks)

8. Hydrogen sulfide reacts with oxygen to produce sulfur dioxide and water.

The figure below shows the displayed formula equation for the reaction.



The table below gives the bond energies for the bonds in the equation.

Bond	H-S	O=O	S=O	O-H
Bond energy	364	498	x	464

In the reaction the energy released forming new bonds was 1034 kJ/mol more than the energy required to break the bonds of the reactant molecules.

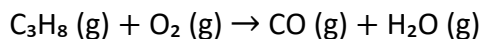
Use this information and the bond energies above to calculate the bond energy x for the S=O bond.

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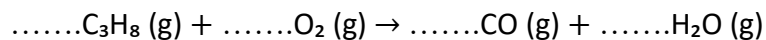
(5 marks)

(Total for Question 8 is 5 marks)

9. The incomplete combustion of propane, C₃H₈, can produce carbon monoxide, CO, and water, H₂O, as shown in the following **unbalanced** equation:



- a) Balance the equation for the reaction.



(2 marks)

- b) Draw the displayed formula equation for this reaction.

(4 marks)

The table below gives the bond energies for the bonds in the equation.

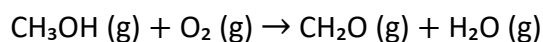
Bond	C–C	C–H	O=O	C≡O	O–H
Bond energy	347	413	498	1077	464

- c) Use the bond energies to calculate the energy change for the reaction.

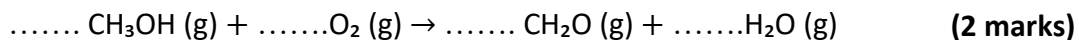
(4 marks)

(Total for Question 9 is 10 marks)

10. The reaction of methanol, CH₃OH, and oxygen ,O₂, produces methanal, CH₂O, and water, H₂O, as shown in the following **unbalanced** equation:



a) Balance the equation for the reaction.



b) Draw the displayed formula equation for this reaction.

(4 marks)

The table below gives the bond energies for the bonds in the equation.

Bond	C–H	C–O	O–H	O=O	C=O
Bond energy	413	358	464	498	<i>x</i>

c) The overall energy change for this reaction is –328 kJ/mol.

Use the overall energy change and the bond energies above to calculate the bond energy *x* for the C=O bond.

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(4 marks)

(Total for Question 10 is 10 marks)