Bond energies

Chemistry calculations | AQA Combined Science 8464 and AQA GCSE Chemistry 8462 | 12 questions, 44 marks

GCSE science calculations

Scan for the solutions

Equations for this topic (cover this box to practise recalling them)

- energy change = energy needed to break bonds - energy released making bonds learn this one
- number of moles = $\frac{\text{mass (g)}}{\text{Mr}}$ learn this one

Name: _____ **Date:** _____ **Score:** _____ **/ 44**

1 **Higher tier**

In a reaction:

- the energy needed to break all the bonds in the reactants is 2648 kJ/mol
- the energy released making all the bonds in the products is 2391 kJ/mol.

a. Calculate the overall energy change for the reaction.

b. Is the reaction exothermic or endothermic?

(2 marks)

Answer _____

2 **Higher tier**

Hydrogen reacts with iodine vapour to make hydrogen iodide.

H-H + I-I → 2 H-I

Bond	Bond energy in kJ/mol
H-H	436
I-I	151
H-I	299

Calculate the overall energy change for this reaction.

(3 marks)

Answer _____

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3 **Higher tier**

In a hot car engine, nitrogen and oxygen from the air react to make nitrogen monoxide.

$N \equiv N + O=O \rightarrow 2\ N=O$

Bond	Bond energy in kJ/mol
N≡N	945
O=O	498
N=O	607

a. Calculate the overall energy change for this reaction.

b. Explain how your answer shows the reaction is endothermic.

(3 marks)

Answer _____

4 **Higher tier**

In sunlight, methane reacts with chlorine.

$CH_4 + Cl_2 \rightarrow CH_3Cl + HCl$

A molecule of CH_4 has 4 C-H bonds. A molecule of CH_3Cl has 3 C-H bonds and 1 C-Cl bond.

Bond	Bond energy in kJ/mol
C-H	412
Cl-Cl	243
C-Cl	346
H-Cl	431

Calculate the overall energy change for this reaction.

(3 marks)

Answer _____

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5 **Higher tier**

Hydrogen reacts with bromine.

H-H + Br-Br → 2 H-Br

Bond	Bond energy in kJ/mol
H-H	436
Br-Br	193
H-Br	366

a. Calculate the overall energy change for this reaction in kJ/mol.

b. Calculate the energy released when 0.40 mol of hydrogen reacts. Give your answer in joules, in standard form.

(4 marks)

Answer _____

6 **Higher tier**

Some model aircraft engines burn methanol as a fuel.

$2CH_3OH + 3O_2 \rightarrow 2CO_2 + 4H_2O$

A methanol molecule has 3 C-H bonds, 1 C-O bond and 1 O-H bond. A carbon dioxide molecule has 2 C=O bonds. A water molecule has 2 O-H bonds.

Bond	Bond energy in kJ/mol
C-H	412
C-C	347
C-O	358
C=O	799
O=O	498
O-H	463

Calculate the overall energy change for the reaction as written.

(4 marks)

Answer _____

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7 **Higher tier**

Hydrogen reacts with fluorine.

H-H + F-F → 2 H-F

The overall energy change for this reaction is −538 kJ/mol.

Bond	Bond energy in kJ/mol
H-H	436
F-F	158
H-F	x

Calculate the bond energy x of the H-F bond. (3 marks)

Answer _____

8 **Higher tier**

Ammonia is being tested as a carbon-free fuel for ships.

$4NH_3 + 3O_2 \rightarrow 2N_2 + 6H_2O$

The overall energy change is −1260 kJ/mol. Each ammonia molecule has 3 N-H bonds. Each water molecule has 2 O-H bonds.

Bond	Bond energy in kJ/mol
N-H	391
O=O	498
O-H	463
N≡N	y

Calculate the bond energy y of the N≡N bond. (3 marks)

Answer _____

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9 **Higher tier**

Margarine makers add hydrogen to vegetable oils. A simple model of this is the reaction of ethene with hydrogen.

$C_2H_4 + H_2 \rightarrow C_2H_6$

- Ethene has 1 C=C bond and 4 C-H bonds.
- Ethane has 1 C-C bond and 6 C-H bonds.
- The overall energy change is −123 kJ/mol.

Bond	Bond energy in kJ/mol
C=C	*z*
C-C	347
C-H	412
H-H	436

Calculate the bond energy *z* of the C=C bond. (4 marks)

Answer _____

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10 **Higher tier**

A camping stove burns propane.

$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

A propane molecule has 2 C-C bonds and 8 C-H bonds. A carbon dioxide molecule has 2 C=O bonds. A water molecule has 2 O-H bonds.

Bond	Bond energy in kJ/mol
C-C	347
C-H	412
O=O	498
C=O	799
O-H	463

Relative atomic masses (A_r): H = 1, C = 12

The canister holds 0.44 kg of propane.

Calculate the energy released when all the propane in the canister burns. Give your answer in MJ to 2 significant figures. Show your working.

(5 marks)

Answer _____

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11 **Higher tier**

A city bus company is comparing hydrogen and methane as fuels.

$2H_2 + O_2 \rightarrow 2H_2O$

Bond	Bond energy in kJ/mol
H-H	436
O=O	498
O-H	463

Relative atomic mass (A_r): H = 1

a. Calculate the overall energy change for the equation as written.

b. Calculate the energy released per gram of hydrogen burnt.

c. Burning methane releases 50 kJ per gram. How many times more energy per gram does hydrogen release? Give your answer to 2 significant figures. Show your working.

(5 marks)

Answer

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12 **Higher tier**

Hydrogen peroxide slowly decomposes.

$2H_2O_2 \rightarrow 2H_2O + O_2$

A hydrogen peroxide molecule (H-O-O-H) has 2 O-H bonds and 1 O-O bond.

Bond	Bond energy in kJ/mol
O-H	463
O-O	146
O=O	498

Relative atomic masses (A_r): H = 1, O = 16

A bottle holds 200 g of solution, which contains 6.8 g of hydrogen peroxide.

Calculate the energy released when all the hydrogen peroxide in the bottle decomposes. Give your answer in joules. Show your working.

(5 marks)

Answer _____

End of questions | Total 44 marks

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