



KS3 Science

Atomic Structure and Bond Energy

Question Paper

Time available: 26 minutes

Marks available: 26 marks

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1.

The table gives the numbers of protons, neutrons and electrons in some atoms and ions of elements. The letters used in the table are **not** the chemical symbols of the elements.

atom or ion	protons	neutrons	electrons
J	16	16	16
L	10	10	10
M	11	12	11
Q	12	14	10
R	17	20	17
X	9	10	10
Z	17	18	17

Use this information to answer the following questions.
Each letter can be used once, more than once or not at all.

- (a) Give the letters of:
 - (i) **two** atoms of the same element; and
 - (ii) a positive ion;
 - (iii) a negative ion;
 - (iv) an atom or ion which has a mass number of 20;
 - (v) an atom of a very reactive metal;

5 marks

- (b) How many electrons does an atom with an atomic number of 12 have?

.....

1 mark

- (c) (i) **X** is an ion. In which group of the periodic table is the element from which **X** is formed?

.....

1 mark

- (ii) From the table above, give the letter of another atom which reacts in a similar way to the element from which ion **X** is formed.

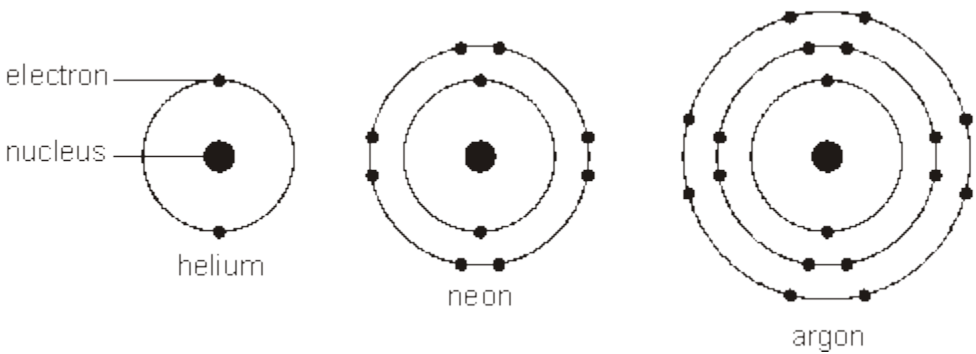
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1 mark

Maximum 8 marks

2.

The diagrams represent three stable atoms with complete outer shells.



Lithium fluoride is formed when lithium reacts with fluorine. Lithium fluoride is made of lithium ions, Li^+ , and fluoride ions, F^- . Its formula is LiF .

The arrangement of electrons around Li^+ is like the arrangement around helium.

The arrangement of electrons around F^- is like the arrangement around neon.

- (a) The atomic number of potassium is 19. Potassium fluoride is formed when potassium reacts with fluorine.

Write the symbol for a potassium ion.

.....

1 mark

- (b) Oxygen atoms have six outer electrons.

- (i) Write the symbol for an oxide ion.

.....

1 mark

- (ii) Write the formula for potassium oxide.

.....

1 mark

- (c) Magnesium has two outer electrons.

- (i) Write the formula for magnesium fluoride.

.....

1 mark

- (ii) Write the formula for magnesium oxide.

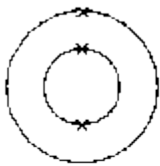
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1 mark

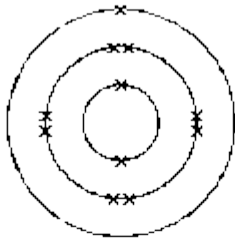
Maximum 5 marks

3.

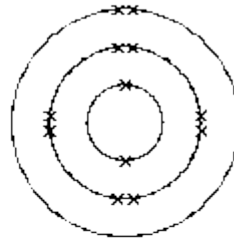
(a) The electronic arrangements of six elements are shown in the diagrams below. They are labelled A-F. Each electron is shown by an x.



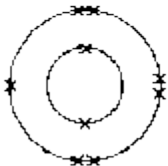
A



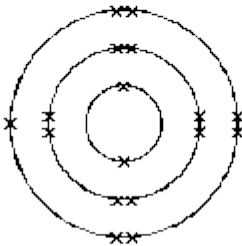
B



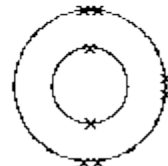
C



D



E



F

(i) Which element is in group 6 of the periodic table?

.....

1 mark

(ii) Three of the elements are metals.
Give the letters of **two** elements which are metals.

.....

1 mark

(b) When element B reacts with another element, each atom of B loses its outer electron to leave an ion with a full outer shell of electrons.

What will be the charge on the ion formed from an atom of element B?

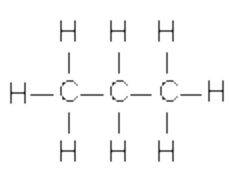
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1 mark
Maximum 3 marks

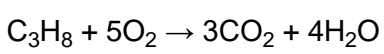
4.

In a hot-air balloon, propane is burned. This reaction is used to heat the air in the balloon.

- (a) in each propane molecule, carbon and hydrogen atoms are held together by bonds as shown below.



The equation for the burning of propane is:



- (i) Carbon-carbon and carbon-hydrogen bonds are broken during the reaction. State **another** chemical bond that is broken in this reaction.

.....

1 mark

- (ii) What new chemical bonds are formed during the burning of propane?

.....

2 marks

- (b) Energy is required to break chemical bonds, but energy is released when chemical bonds are formed.

In the reaction of propane and oxygen, the total energy required to break bonds is less than the total energy released by forming new bonds.

What is the evidence for this?

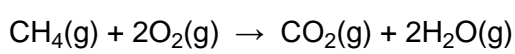
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1 mark

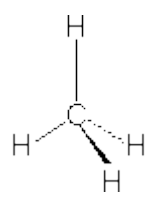
Maximum 4 marks

5.

Methane burns in oxygen. The equation below represents this reaction.



A molecule of methane has the following structure.



The following table gives the average bond energies for some bonds in kJ/mol of bonds.

bond	bond energy in kJ/mol
O = O	500
C = O	800
H - O	460

(a) (i) Use the information to calculate the bond energy in 1 mol of carbon dioxide.

.....
 kJ

1 mark

(ii) Calculate the total bond energy in 2 mol of water.

.....
 kJ

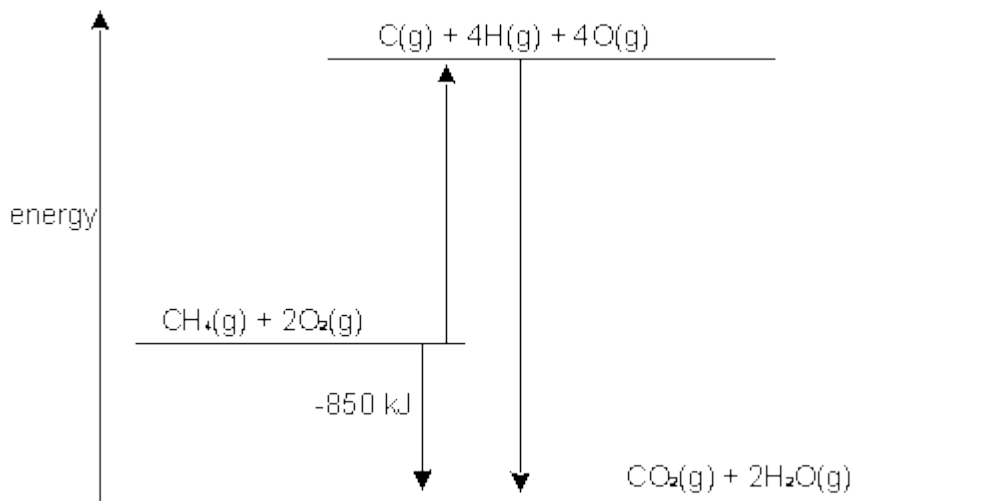
1 mark

(iii) Calculate the energy change when 1 mol of gaseous carbon dioxide and 2 mol of gaseous water are formed from their constituent atoms in their gaseous states. Show whether energy is absorbed or evolved.

.....
kJ

1 mark

The energy level diagram for the reaction of methane with oxygen is:



(b) Using the energy diagram, calculate the energy required to break all the bonds in 1 mol of methane gas and 2 mol of oxygen gas.

.....
.....
.....kJ

1 mark

(c) (i) Use your answer to part (b) to find a value for the total bond energy of 1 mol of methane gas.

.....
.....kJ

1 mark

(ii) Calculate the average bond energy of C–H.

.....
.....kJ/mol

1 mark

Maximum 6 marks