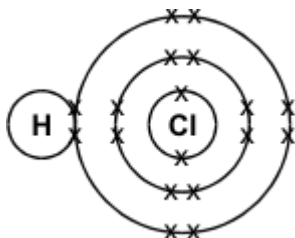


Covalent Bonding

1. The hydrogen halides (hydrogen fluoride, hydrogen chloride, hydrogen bromide and hydrogen iodide) are important chemicals.

The diagram below represents a molecule of hydrogen chloride.



- (i) What type of particles are represented by the crosses (X)?

..... (1)

- (ii) What type of chemical bond holds the atoms in this molecule together?

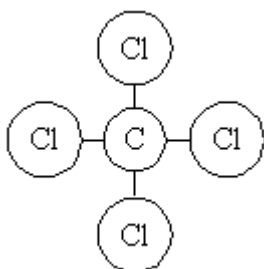
..... (1)

- (iii) Would you expect hydrogen chloride to be a gas, a liquid or a solid, at room temperature and pressure? Explain your answer.

.....

 (3)
(Total 5 marks)

2. Chlorine will combine with the non-metal element, carbon, to form this molecular compound:



- (a) What is the symbol equation for this molecule?

.....
 (1)

- (b) Explain how these bonds are formed. (You may use a diagram).

.....

 (2)
(Total 3 marks)

What's my grade??

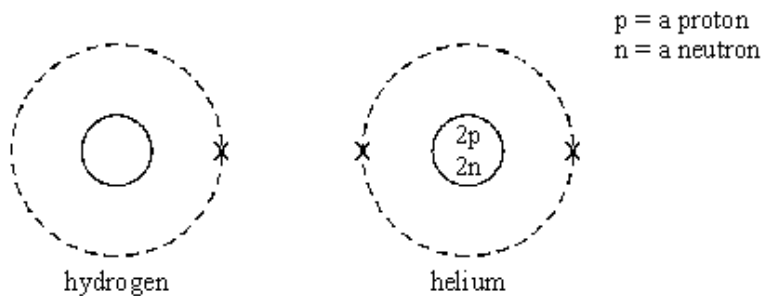
5/14 = D

7/14 = C

9/14 = B

11/14 = A

3. (a) The diagrams represent the atomic structures of two gases, hydrogen and helium.



Hydrogen gas is made up of diatomic molecules (molecules with two atoms).
Helium gas exists as single atoms.

(i) How is a molecule of hydrogen formed from two hydrogen atoms?
(You may use a diagram as part of your answer)

.....

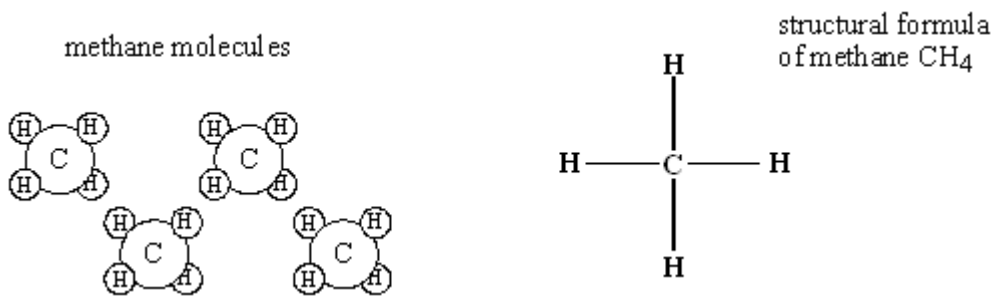
(2)

(ii) Why does helium exist only as single atoms?

.....

(2)

(b) Hydrogen combines with carbon to form methane.
Each molecule contains four hydrogen atoms strongly bonded to a carbon atom.



Explain why methane has a low boiling point

.....

(2)
(Total 6 marks)

Marking scheme

1. (i) electrons 1
for 1 mark
- (ii) covalent 1
for 1 mark
- (iii) made of small molecules:
usually gas or liquid) dependent on
have low melting points) having first
have low boiling points) point above
forces between molecules are weak *any 1 for 1 mark* 3

[5]

2. (a) CCl₄ *for 1 mark* 1
- (b) any reference to shared electrons *gains 1 mark*
but idea that bond is shared **pair** of electrons *gains 2 marks* 2

[3]

3. (a) (i) *idea that*
- two hydrogen atoms share one pair of electrons
 - linked by a covalent bond
 - each then has two outer electrons / a full outer shell / two
 - electrons in the highest (occupied) energy level
- (2 marks may be awarded for a correct electron diagram i.e. with electrons on boundary of or within marked area). any two for 1 mark each* 2

- (ii) *idea that*
- helium atoms do not give / take / share electrons / react
 - because the (outer) shell / orbit is full
 - or** • highest (occupied) energy level is full
- (but not just "contains two electrons") for 1 mark each* 2

- (b) *idea that*
- the (attractive) forces between molecules are weak (**not** bonds between atoms)
 - so little energy is required / it is easy for molecules to escape from the liquid* / escape from other molecules* (*allow* evaporate / change into a gas) *for 1 mark each*

2

[6]

Ionic Bonding

Q1. When sodium reacts with chlorine, the reaction forms sodium chloride.

(a) Use words from the box to answer the questions.

compound element hydrocarbon mixture

Which word best describes:

(i) sodium

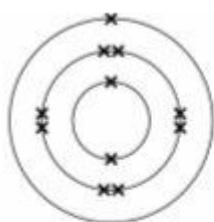
(1)

(ii) sodium chloride?

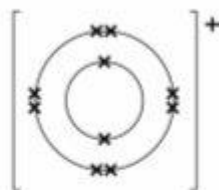
(1)

(b) When sodium reacts with chlorine the sodium atoms change into sodium ions.

The diagrams below represent a sodium atom and a sodium ion.



Sodium atom (Na)



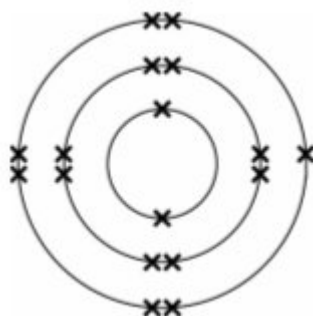
Sodium ion (Na⁺)

Use the diagrams to help you explain how a sodium atom turns into a sodium ion.

.....
.....
.....
.....

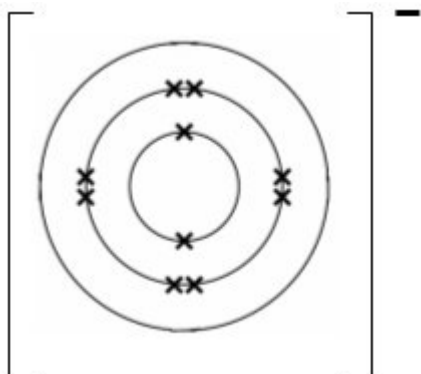
(2)

(c) (i) The diagram below represents a chlorine atom.



When chlorine reacts with sodium the chlorine forms negative chloride ions.

Complete the diagram below to show the outer electrons in a chloride ion (Cl^-).



(1)

(ii) Chloride ions are strongly attracted to sodium ions in sodium chloride.

Explain why.

.....

.....(1)

(Total 6 marks)

Q2. Calcium and magnesium are elements. They are found in the Earth's crust as compounds, often carbonates and sulphates. Magnesium is also found as its chloride.

(a) Use the Data Sheet to help you to answer this question.

(i) Write the chemical formula of magnesium chloride.

.....(1)

(ii) Name the type of bonding in magnesium chloride.

.....(1)

(Total 2 marks)

Q3. (a) The table gives information about the atoms of three elements.

Name of element	Chemical symbol	Number of electrons in:		
		1 st shell	2 nd shell	3 rd shell
Fluorine	F	2	7	0
Neon	Ne	2	8	0
Sodium	Na	2	8	1

Two of these elements can react together to form a chemical compound.

(i) What is the name and the formula of this compound?

Name Formula

(2)

(ii) What type of bonding holds this compound together?

.....

(1)

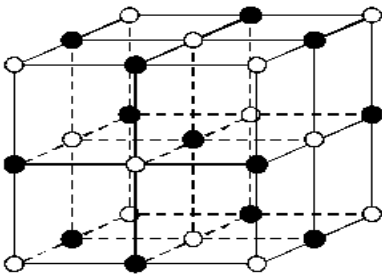
(iii) Explain, in terms of electron transfer, how the bonding occurs in this compound.

.....

(2)

(Total 5 marks)

Q4. (a) The diagram shows part of the ionic lattice of a sodium chloride crystal.



(i) Complete the spaces in the table to give information about **both** of the ions in this lattice.

Name of ion	Charge
.....
.....

(2)

(ii) When it is solid, sodium chloride will not conduct electricity. However, molten sodium chloride will conduct electricity. Explain this difference.

.....

(2 marks)

Total = 17 marks

M1.	(a)	(i)	element	1	
		(ii)	compound	1	
	(b)		an / one electron from the sodium atom	1	
			is lost / transferred to form a sodium ion	1	
	(c)	(i)	8 electrons drawn on outer energy level / shell	1	
		(ii)	because oppositely charged ions attract each other	1	
			or		
			because chloride ions are negative and sodium ions are positive	1	
					[6]
	M2.	(a)	Group 2 / Alkaline Earth Metals <i>for 1 mark</i>	1	
		(b)	(i) $MgCl_2/Mg^{2+} (Cl^-)_2$		
			(or equation with correct answer) <i>for 1 mark</i>	1	
		(ii)	ionic / electrovalent <i>for 1 mark</i>	1	
					[3]
M3.	(a)		<i>both correct in each row</i>		
			electron ...- (1) <i>allow negative</i>	1	
			1 0 <i>allow neutral or none</i>	1	
			proton+ (1) <i>allow positive</i>	1	
	(b)	(i)	protons...electrons <i>both correct in correct order</i>		
		(ii)	protons....neutrons <i>both correct in either order</i>	1	
	(c)	(i)	sodium fluoride do not credit sodium fluorine	1	
			<i>NaF must be correct in every detail do not credit NAF and the like</i>		
	(ii)		ionic	1	
			<i>accept ion (bonding) do not credit ionic or iron (bonding)</i>	1	
	(iii)		electron transferred from sodium to fluorine		
			<i>accept electron transferred from metal to non-metal</i>		
			either positive sodium ion and negative fluoride ion		
			or correctly identified by the symbols Na^+ and F^- <i>accept 'positive sodium ion and negative fluorine ion'</i>	1	
			or attracted because have opposite charge(s)		
			<i>or (atoms/ions) form an (ionic) lattice or (atoms/ions) form a crystal</i>		
			<i>e.g.</i>		
			$Na^{\cdot} + \begin{array}{c} \times \\ \times \\ \times \\ \times \\ \times \\ \times \\ \times \\ \times \\ \times \\ \times \end{array} F \begin{array}{c} \times \\ \times \\ \times \\ \times \\ \times \\ \times \\ \times \\ \times \\ \times \\ \times \end{array} \longrightarrow Na^+ + \begin{array}{c} \times \\ \times \\ \times \\ \times \\ \times \\ \times \\ \times \\ \times \\ \times \\ \times \end{array} F^- \begin{array}{c} \times \\ \times \\ \times \\ \times \\ \times \\ \times \\ \times \\ \times \\ \times \\ \times \end{array}$		
			or both marks may be gained by a suitable dot and cross diagram	1	

[10]

- M4.** (a) (i) sodium..... positive **or + both** required 1
chloride... negative **or – both** required **do not credit chlorine** 1
- (ii) ions not free (to move) in solid crystal / lattice 1
ions are free to move when sodium chloride is molten 1
or ions are mobile
do not credit when ions are molten
allow 'particles' for ions (1) mark
do not credit electrons etc 1
- (iii) dissolved in water 1
or in aqueous solution
accept in solution
accept in water
or when a gas/ vapour **or** solid it will not 1
- (b) (i) 40 1
(ii) (total) number of protons **and** neutrons (in the nucleus) 1
- (c) (i) $2\text{Ca} + \text{O}_2 \rightarrow 2\text{CaO}$ 1
accept any $2n : n : 2n$ ratio
do not credit if any other change has been made 1
- (ii) any **two** from 1
electron(s) is / are lost
from the outer shell / orbit / ring **or** from the shell
furthest the nucleus or from the 4th shell
two / both (electrons are lost)
accept two electrons are lost for (2)marks
accept both electrons are lost from the atom for (1) mark 2

[10]

- (i) Calcium reacts with chlorine to form calcium chloride.

Using the electronic structures given below, show by means of a **diagram** the electronic changes that take place during the formation of calcium chloride. Show the **charges** on the ions formed. [3]



- (ii) Chlorine can also react with hydrogen to produce hydrogen chloride. Using the electronic structures given below, show the bonding in hydrogen chloride. [2]



- (iii) Explain, in terms of bonding, why calcium chloride is a high melting point solid, whereas hydrogen chloride is a gas at room temperature. [2]

.....

.....

.....

The table below shows the electronic structures of four elements.

<i>Element</i>	<i>Electronic structure</i>
hydrogen	1
nitrogen	2,5
oxygen	2,6
calcium	2,8,8,2

Show, by means of diagrams or otherwise, the electronic changes that take place during the formation of

(i) calcium oxide from calcium and oxygen (include charges on the diagram of the ions), [3]

(ii) ammonia, NH_3 , from nitrogen and hydrogen. [2]

The table below shows the electronic structures of three elements.

Element	Electronic structure
hydrogen	1
fluorine	2,7
magnesium	2,8,2

Fluorine forms magnesium fluoride with magnesium and it forms hydrogen fluoride with hydrogen.

Show by means of diagrams, or otherwise, the electronic changes that take place during the formation of

(a) magnesium fluoride from magnesium and fluorine, [3]

(b) hydrogen fluoride from hydrogen and fluorine. [2]

Magnesium reacts with oxygen to form magnesium oxide.

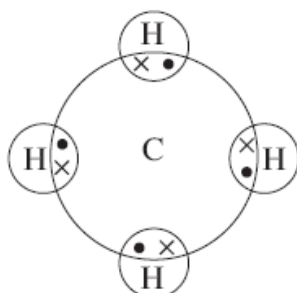
- (i) Using the electronic structures given below, show by means of a diagram the electronic changes that take place during the formation of magnesium oxide. Show the charges on the ions formed. [3]

magnesium = 2,8,2 oxygen = 2,6

- (ii) State why magnesium oxide is a high melting point solid. [1]

.....
.....

The diagram below shows the type of bonding present in methane, CH₄.



- (i) Name this type of bonding. [1]
- (ii) The bonds within the molecule are very strong. Despite this, methane has a low boiling point. Explain why. [1]

.....
.....

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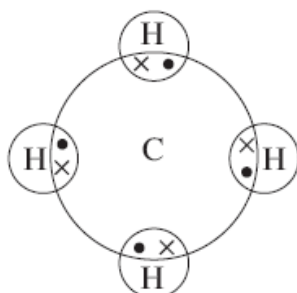
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