Chemistry Unit C1: Structures, Trends, Chemical Reactions, Quantitative Chemistry and Analysis

C1.2 Bonding

Content - CCEA Double Award Chemistry 1 - Fort Hill Integrated College	Got it	Nearly	Haven't a clue
C1.2 Bonding			
Ionic bonding			
Can you describe and explain that an ion is a charged particle formed when an atom gains or loses electrons and a molecular ion is a charged particle containing more than one atom;			
Can you define the terms cation and anion;			
Can you explain, using dot and cross diagrams, how ions are formed and how ionic bonding takes place in simple ionic compounds, limited to elements in Groups 1 (I) and 2 (II) with elements in Groups 6 (VI) and 7 (VII), the ions of which have a noble gas electronic configuration;			
Do you understand that: • ionic bonding involves attraction between oppositely charged ions; • ionic bonds are strong; and • substantial energy is required to break ionic bonds;			
Do you recognise that ionic bonding is typical of metal compounds;			
Covalent bonding			
Can you describe a single covalent bond as a shared pair of electrons;			
Can you explain, using dot and cross diagrams, how covalent bonding occurs in H_2, Cl_2, HCl, H_2O, NH_3, CH_4 and similar molecules and label lone pairs of electrons;			
Can you draw dot and cross diagrams and indicate the presence of multiple bonds in O_2, N_2 and CO;			

Can you recognise covalent bonding as typical of non-metallic elements and compounds.			
Can you demonstrate knowledge and understanding that a molecule is two or more atoms covalently bonded and that diatomic means there are two atoms covalently bonded in a molecule;			
Can you recall that covalent bonds are strong and substantial energy is required to break covalent bonds;			
Can you recall that a covalent bond may be represented by a line;			
Metallic bonding			
Can you demonstrate describe and explain that metallic bonding results from the attraction between the positive ions in a regular lattice and the delocalised electrons.			

Examiner Only
Marks | Remark

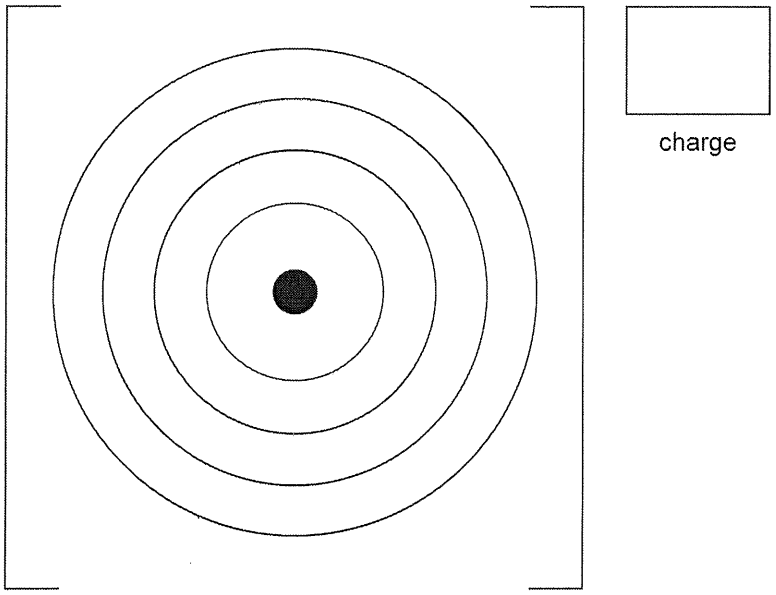
1 Some tap water contains dissolved calcium chloride ($CaCl_2$) and dissolved calcium hydrogen carbonate, $Ca(HCO_3)_2$.

(a) Give two reasons why calcium hydrogen carbonate and calcium chloride could be **ionic** compounds.

1. _____

2. _____ [2]

(b) Draw the electronic configuration of the calcium **ion** and give the charge.



[2]

(c) How many oxygen atoms are there in the formula $Ca(HCO_3)_2$?

_____ [1]

Some tap water can contain dissolved magnesium sulfate or dissolved potassium carbonate.

(d) Write the formulae for magnesium sulfate and potassium carbonate.

magnesium sulfate _____

potassium carbonate _____ [2]

(e) What colour are solid magnesium sulfate and solid potassium carbonate?

_____ [1]

H Nov'15

B

Examiner Only	
Marks	Remark

1 The box below shows the chemical symbols for some different types of ions.

K^+	S^{2-}	Mg^{2+}
Al^{3+}	Cl^-	NO_3^-
SO_4^{2-}	Na	N^{3-}

(a) From the box above choose

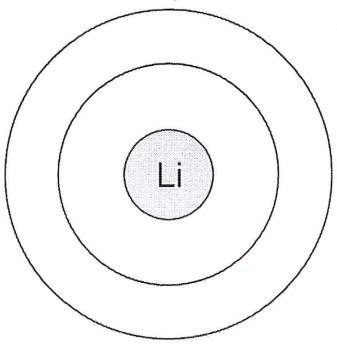
(i) a cation with a charge of 2 _____ [1]

(ii) a molecular ion _____ [1]

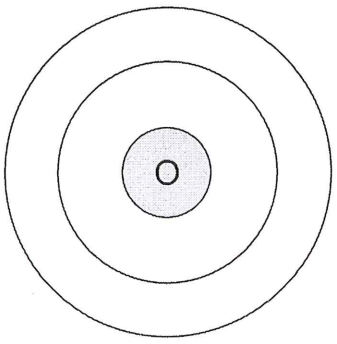
(iii) a symbol which is not an ion _____ [1]

(iv) the symbol for the nitrate ion _____ [1]

(b) Lithium reacts with oxygen to form lithium oxide, a solid white compound.
Draw diagrams to show all the electrons in an atom of lithium and an atom of oxygen.



lithium atom



oxygen atom

[2]

C1 H Feb 2012

C

(c) Explain how lithium and oxygen react to form the compound lithium oxide.

Examiner Only	
Marks	Remark

_____

_____

_____

_____

_____ [3]

(d) Give **two** physical properties of the compound lithium oxide.

1. _____

2. _____ [2]

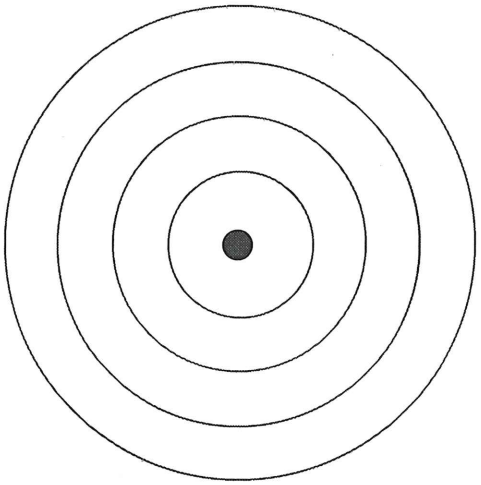
C1 H Feb 2012

1

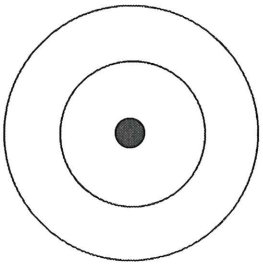
Examiner Only	
Marks	Remark

2 Potassium and fluorine react violently together to form the compound potassium fluoride.

(a) Complete the diagrams below to show the arrangements of **all** the electrons in a potassium atom and a fluorine atom.



potassium atom



fluorine atom

[2]

(b) Describe how a potassium atom becomes an ion and how a fluorine atom becomes an ion. You should state the formula of each ion.

_____

_____

_____

_____

_____ [4]

(c) How are the ions held together in potassium fluoride?

_____

_____ [1]

(d) What is the formula for potassium fluoride?

_____ [1]

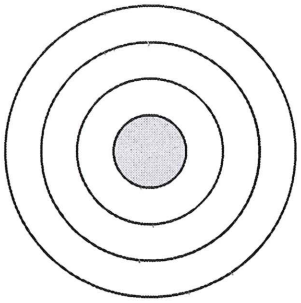
C1 H Feb 2013

E

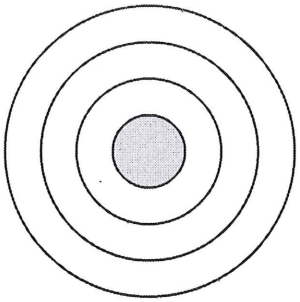
Examiner Only	
Marks	Remark

(c) (i) Sodium reacts with sulfur to form a compound called sodium sulfide.

Complete the diagrams below to show **all** the electrons in a sodium atom and in a sulfur atom.

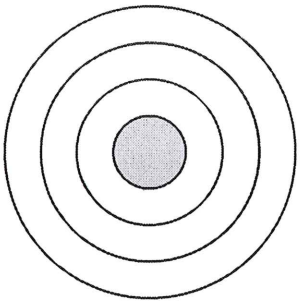


sodium atom

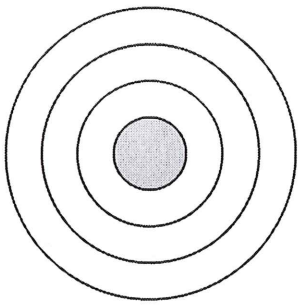


sulfur atom [2]

(ii) In the space below draw diagrams to show **all** the electrons in a sodium ion and in a sulfide ion.



sodium ion



sulfide ion [2]

(iii) How are the ions held together in sodium sulfide?

_____ [1]

(iv) What is the chemical formula for sodium sulfide?

_____ [1]

C1 H Feb 2014

F

Examiner Only	
Marks	Remark

5 (a) (i) Draw a dot and cross diagram to show how **all** the electrons are arranged in a molecule of water.

[3]

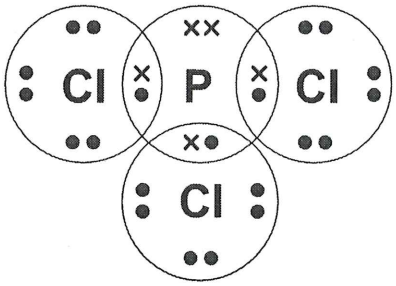
(ii) Describe a **chemical** test for water.

_____

_____ [2]

(b) When phosphorus reacts with chlorine it forms phosphorus trichloride.

The diagram shows a molecule of phosphorus trichloride. Use this diagram to answer the questions which follow.



(i) How many covalent bonds does this molecule have?

_____ [1]

(ii) How many lone pairs are there in this molecule?

_____ [1]

Cl H Feb 2014

G

(c) Draw a dot and cross diagram to show how **all** the electrons are arranged in a molecule of nitrogen, N_2.

[2]

Examiner Only	
Marks	Remark

H

3 (a) Draw diagrams to show the electronic arrangements for a hydrogen atom and a chlorine atom. **All** electrons should be shown.

Examiner Only	
Marks	Remark

hydrogen atom **chlorine atom**

[2]

(b) Explain fully, in terms of the electrons, how hydrogen and chlorine combine to form the gas hydrogen chloride. Your answer should include the type of bonding.

_____

_____

_____

_____

_____ [3]

I

Examiner Only	
Marks	Remark

3 Carbon-12 ($^{12}_{6}C$) atoms have 6 electrons, 6 protons and 6 neutrons.

(a) Complete the table to show the relative charge and mass of the different particles found in an atom.

Particle	Relative charge	Relative mass
electron		
proton		
neutron		

[3]

(b) Carbon-14 ($^{14}_{6}C$) and carbon-12 ($^{12}_{6}C$) are isotopes of carbon.

Compare, in terms of the particles in the atoms, an atom of carbon-14 ($^{14}_{6}C$) with an atom of carbon-12 ($^{12}_{6}C$).

_____

_____

_____

_____ [3]

(c) Methane and carbon dioxide are molecules which contain carbon.

(i) Explain what is meant by the term **molecule**.

_____

_____

_____ [2]

(ii) Draw a dot and cross diagram of a molecule of methane (CH_4). Show the outer electrons only.

C1 H Nov 2013

[2]

J

Examiner Only	
Marks	Remark

(iii) Draw a dot and cross diagram of a molecule of carbon dioxide (CO_2). Show the outer electrons only.

[3]

(iv) On your diagram of the molecule of carbon dioxide above label a lone pair of electrons. [1]

(v) Give two typical physical properties of molecules such as methane and carbon dioxide.

1. _____ [1]

2. _____ [1]

(d) When carbon dioxide dissolves in water it forms carbonic acid, H_2CO_3 with a pH range of 4–5.

(i) What is the formula of the ion which is present in all acids?

_____ [1]

(ii) Why is carbonic acid described as a weak acid?

_____ [1]

C1 H Nov 2013

K

Examiner Only	
Marks	Remark

5 This question is about covalent structures and covalent bonding.

(a) What is a covalent bond?

_____ [1]

(b) Draw a dot and cross diagram to show the covalent bonding in a molecule of hydrogen chloride (HCl). Show outer electrons only.

[3]

(c) Complete the paragraph below which explains why giant covalent structures have much higher melting points than molecular covalent structures.

There are extremely strong forces of attraction between the _____ in a giant covalent structure which take a lot of heat energy to _____. There are weak forces of attraction between the _____ in a molecular covalent structure which do not require a lot of energy to _____. [3]

(d) Choose the **two** properties, from the list below, which are typical of many molecules which have molecular covalent or giant covalent structures. Place a tick (✓) in the two correct boxes.

can be compressed ☐

insoluble in water ☐

ductile ☐

non-conductors of electricity ☐

colourless gases ☐

[2]

L

5 Draw dot and cross diagrams to show how **all** the electrons are arranged in the bonding of:

Examiner Only	
Marks	Remark

(a) methane CH_4

[3]

(b) carbon dioxide CO_2

[3]

(c) Label a double bond, and a lone pair on the carbon dioxide diagram. [2]

(d) Describe fully in terms of the movement of electrons how magnesium bonds with oxygen.

_____

_____

_____

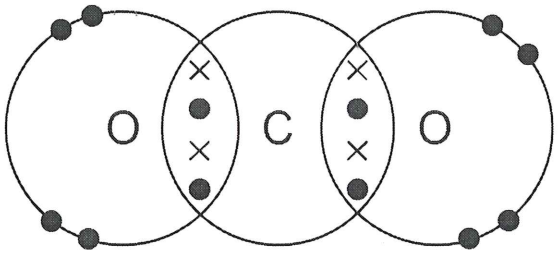
_____

_____ [4]

M

Examiner Only	
Marks	Remark

5 Covalent bonds form when atoms share electrons.
The diagram below shows the outer electrons in a molecule of carbon dioxide.



(a) On the diagram above, label using arrows:

(i) a double covalent bond

(ii) a lone pair. [2]

(b) Draw a dot and cross diagram for a molecule of ammonia NH_3. Show only the **outer** electrons.

[2]

(c) Most molecular covalent substances are insoluble in water. Give **two** other typical properties of molecular covalent substances.

1. _____

2. _____ [2]

C1 H Mar 2013

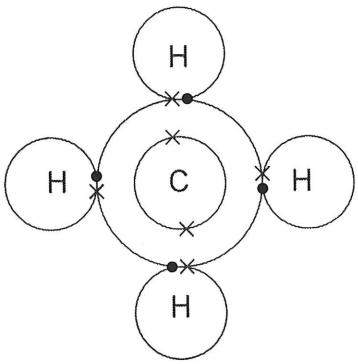
N

Examiner Only	
Marks	Remark

5 Methane and ammonia are both covalent compounds with very similar bonding.

(a) The diagram below shows the electrons in carbon and hydrogen in a molecule of methane.

Methane



In the space below draw a dot and cross diagram to show how **all** the electrons are arranged in a molecule of ammonia.

(i) Ammonia

[3]

(ii) Label the lone pair of electrons in ammonia. [1]

(b) Some covalent compounds have multiple bonds.
In the space below draw a **dot and cross diagram** to show the multiple bonds in a molecule of carbon dioxide.
Draw the **outer electrons only**.

[3]

C1 H Feb 2012

Examiner Only	
Marks	Remark

5 The formula for sodium oxide is Na_2O.

(a) Draw diagrams to show how two sodium ions and an oxide ion are formed when two sodium atoms react with an oxygen atom.

[4]

(b) Explain how the **ions** are held together in the compound, sodium oxide.

_____

_____

_____

_____ [2]

Cl H May 2014

P

Examiner Only	
Marks	Remark

6 **(a)** What do you understand by the term **covalent bond**?

_____

_____ [1]

(b) **(i)** Draw a dot and cross diagram to show the bonding in a molecule of carbon dioxide, CO_2. Show outer electrons only.

[3]

(ii) Draw a dot and cross diagram to show the bonding in a molecule of ammonia, NH_3. Show outer electrons only.

[2]

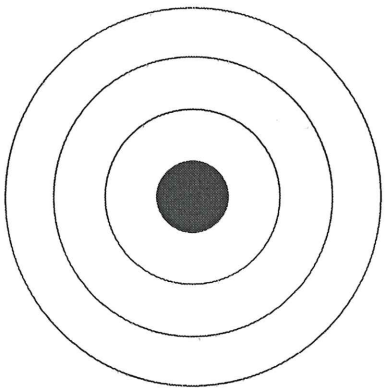
(iii) On your diagram of the molecule of ammonia above label a lone pair of electrons. [1]

H Feb '15

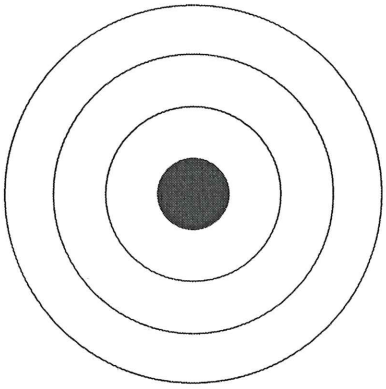
Q

6 Magnesium reacts with sulfur to form the compound magnesium sulfide.

(a) Complete the diagrams below to show the arrangement of **all** the electrons in a magnesium atom and a sulfur atom.



magnesium atom



sulfur atom

[2]

(b) (i) In the space below draw the electronic arrangements for the ions formed when magnesium and sulfur bond together.
Your answer should include the charges on the ions.

magnesium ion **sulfide ion**

[4]

(ii) What is the chemical formula for magnesium sulfide?

_____ [1]

[Turn over

H Nov '15

R

7 **(a)** What type of bonding is typical of non-metallic elements and compounds?

_____ [1]

(b) Draw dot and cross diagrams to show the outer electrons only in a molecule of water.

[3]

(c) Oxygen is a diatomic molecule which has a double bond.

Draw a diagram to show all the electrons in a molecule of oxygen.

Label:

(i) the double bond **(ii)** a lone pair

[4]

(d) What is meant by the term diatomic?

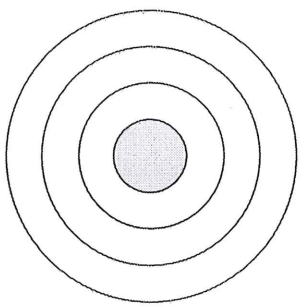
_____ [1]

S

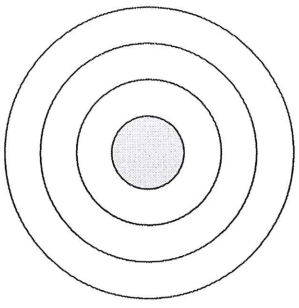
Examiner Only	
Marks	Remark

3 Hot magnesium metal will burn in chlorine gas to form magnesium chloride.

(a) Complete the diagrams below to show **all** the electrons in a magnesium atom and a chlorine atom.



magnesium atom



chlorine atom [2]

In part (b) you will be assessed on your written communication skills including the use of specialist scientific terms.

(b) Explain fully, **in terms of electrons**, how the atoms of magnesium and chlorine react together to form magnesium chloride.

Include in your answer the charges on the ions and an explanation of how the ions are held together in the compound.

[6]

T

(c) Using a **dot and cross** diagram, draw a molecule of hydrogen.

[2]

(d) Describe a test for hydrogen gas.

_____

_____

_____ [2]

Examiner Only	
Marks	Remark

C1 H May 2013

4

7 When chlorine gas is bubbled into a colourless solution of potassium iodide, a coloured solution is formed.

Examiner Only	
Marks	Remark

(a) Name the **type** of reaction which takes place between chlorine and potassium iodide.

_____ [1]

(b) Explain why a coloured solution is formed in the reaction.

_____

_____

_____ [3]

(c) Write an **ionic** equation for the reaction between chlorine and potassium iodide.

_____ [3]

THIS IS THE END OF THE QUESTION PAPER