Higher Chemistry: Unit 1 – Chemical Changes and Structure

Part B – Bonding, Structure and Properties

Lesson 1 – Bonding: Revision of Covalent and Ionic Bonding

Learning Outcomes

By the end of this lesson you should know:

1. The bonding, structure and properties of covalent substances
2. The bonding, structure and properties of ionic bonding

Success Criteria

You will have been successful in this lesson if you:

1. Read and learn the notes given
2. Watch the links provided
3. Complete revision questions provided

There is also a further reading section to help you gain more depth of understanding for this section.

MS Teams will be monitored throughout the week by a chemistry teacher. If you need help or clarification with either the task or the content of the lesson, just ask.

Links to Prior Knowledge

You may wish to revise the following to help you understand this lesson:

- National 5 chemistry – bonding structure and properties

For reference, the periodic table is given in the data booklet. Download or print a copy of the Higher Chemistry Data Booklet from MS Teams or from the SQA website - https://www.sqa.org.uk/sqa/files_ccc/ChemistryDataBooklet_NewH_AH-Sep2016.pdf

Notes – You do not need to copy these as it is National 5 revision only

Types of bonding

All atoms in the world (apart from the monatomic noble gases) are held together by chemical bonds. There are 3 possible ways atoms can bond to one another:

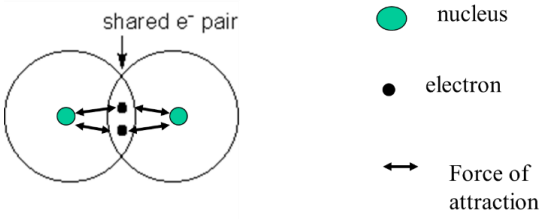
- Covalent bonding – usually between non-metal atoms
- Ionic bonding – usually between metals and non-metla atoms
- Metallic bonding – always between metal atoms *(described in lesson 1)*

Below is a summary of important points about bonding that you should remember from the National 5 course. Metallic bonding has already been covered in Lesson one and is not detailed below.

Covalent Bonding

WATCH - https://www.twigscotland.com/film/covalent-bonding-1356/

Covalent bonding usually occurs between non-metal atoms. In a covalent bond, atoms share a pair of electrons creating a strong force that holds the atoms together



Covalent substances do not conduct electricity because there is no free charged particles. The only exception is carbon graphite, which does conduct electricity.

There are two types of covalent structures:

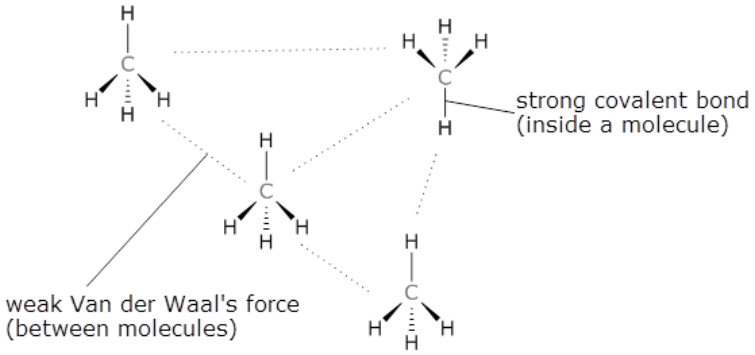
1. **Covalent molecular** – *sometimes called simple covalent or discrete molecular*

2. **Covalent network** – *sometimes called giant lattice or giant network*

1. Covalent molecular

E.g. CO_2, N_2, CH_4

Made up of discrete (individual) molecules.

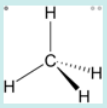
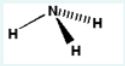
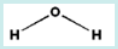


The bonds within the molecules are very strong covalent bonds but the bond between molecules are weak.

Melting and boiling points - Covalent molecules have a **low** melting and boiling points because only the weak bonds are broken, not the covalent bonds.

Covalent molecules form specific three dimensional shapes, depending on their formula. Here are some examples:

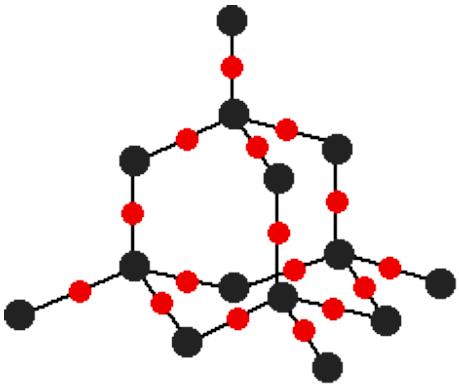
In the table to the right, the dashed line represents a bond going behind the rest of the atoms, a dark "wedge" line represent a bond coming out in front of the other atoms. Single line represent a flat bond in line with other atoms.

Name	Molecular formula	Number of bonds	True shape
Methane	CH_4	4	Tetrahedral 
Ammonia	NH_3	3	Pyramidal 
Water	H_2O	2	Angular 
Hydrogen Chloride	HCl	1	Linear

2. Covalent networks

E.g. C (Diamond), C (graphite), SiO_2 and SiC

Contain a giant structure (lattice) of atoms covalently bonded to each other.

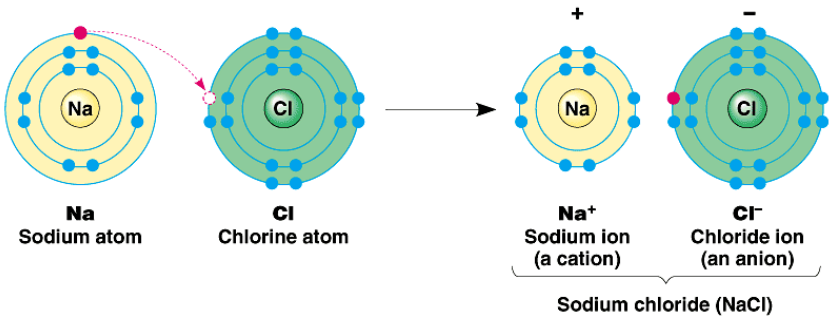


Melting and boiling points - Covalent networks have a **high** melting and boiling points because only the weak intermolecular bonds are broken, not the covalent bonds.

Ionic Bonding

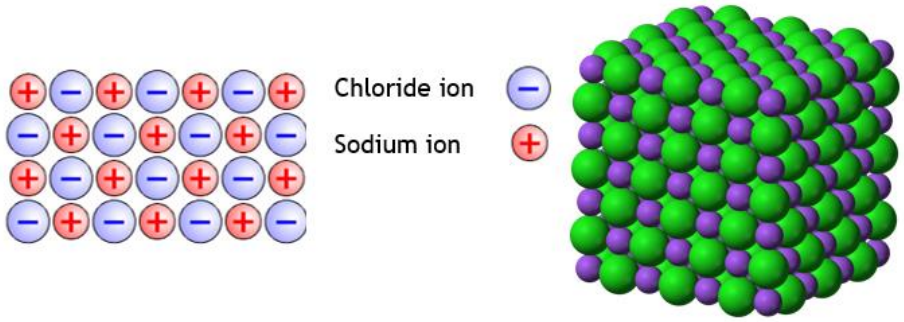
WATCH - https://www.twigscotland.com/film/ionic-bonding-1355/

In ionic bonding, atoms obtain a full outer shell by either gaining or losing electrons to become negative or positive ions. Ionic bonding is the force of attraction between oppositely charged ions



Solid ionic substances do not conduct electricity when solid because ions are "not free to move". Ionic substances which are molten or in solution conduct electricity because the ions are "free to move".

Ionic compounds form a giant 3D structure called an ionic lattice:

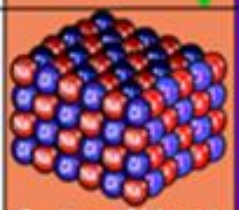
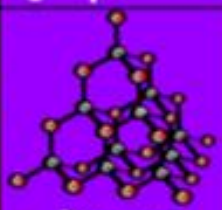
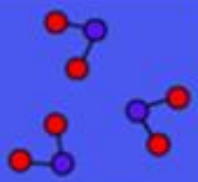


NaCl Ionic formula Na^+Cl^- (simplest ratio)

Melting and boiling points - Ionic bonds are very strong and therefore have high melting and boiling points to overcome the forces of attraction

ALL Ionic compounds are solid at room temperature.

SUMMARY

Bonding	Ionic	Covalent		Metallic
Structures	Ionic Lattice	Covalent Network	Covalent Molecular	Metallic Lattice
Melting Pt	High	High	Low	Can vary, usually high
Conducts electricity?	Solid ✗ Liquid ✓ Dissolved ✓	No (except graphite)	No	Yes
Example	 Sodium Chloride	 Diamond	 Water	 Iron

Learning Outcomes

By the end of this lesson you should know:

1. The bonding, structure and properties of covalent substances
2. The bonding, structure and properties of ionic bonding

Further Reading

To learn more about bonding. Follow the links below:

BBC Bitesize: https://www.bbc.co.uk/bitesize/guides/zjgmn39/revision/1

Evans2 chem web: https://www.evans2chemweb.co.uk/login/index.php#

Username: snhs password: giffnock

Select any teacher → revision material → National 5 → Bonding

Exercise 1.6 – Bonding Revision

1. Which of the following is the correct definition of ionic bonding

A two positive nuclei held together by their common attraction for a shared pair of electrons
B a group of positive ions held together by delocalised electrons
C the electrostatic attraction between positive and negative ions
D a compound that contains metals and non-metals

2. Which of the following compounds exists as **diatomic molecules**?

A Carbon monoxide
B Sulfur dioxide
C Nitrogen trihydride
D Carbon tetrachloride

3. The properties of a substance depend on its type of bonding and structure. You have learned about three types:

Discrete Covalent Molecular	Covalent network	Ionic lattice

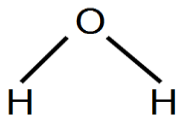
Copy and complete the table to match up each type of bonding and structure with its properties.

Bonding and Structure	Properties
	Do not conduct electricity and have high melting points
	Have high melting points and conduct electricity when liquid but not when solid
	Do not conduct electricity and have low melting points

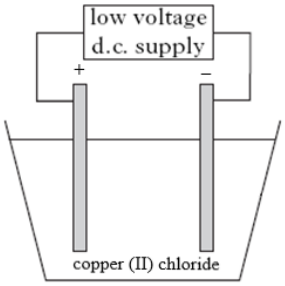
4. The shape of a water molecule can be drawn as shown:

(a) Draw the **shape** of a molecule of methane, CH_4, in the same way.

(b) **Name** this shape of the methane molecule.



5. A pupil dissolved a small amount of copper chloride in water.



(a) The pupil found that the solution of copper(II) chloride conducts electricity, but solid copper(II) chloride does not conduct electricity. Explain why this is the case.

(b) An electric current was put through the solution as shown in the diagram. A brown solid formed at one of the electrodes and pale green gas started to form at the other electrode. At which electrode, positive or negative, would the gas have formed?

6. Carbon dioxide is a covalent molecular substance and silicon dioxide is a covalent network substance. **Copy and complete** the following sentences by selecting the correct words.

(a) "Carbon dioxide has a **high/low** boiling point because, although there are **weak/strong** bonds between the atoms, the bonds between the molecules are **weak/strong**".

(b) "Silicon dioxide has a **high/low** melting point because **all/some** bonds between the atoms are **weak/strong**".

7. Give the chemical formula for the following compounds

(a) silver(I) oxide

(b) aluminium hydroxide

8. Give the ionic formula for the following compounds

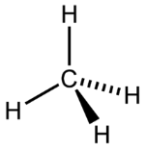
(a) magnesium chloride

(b) potassium sulfate

Exercise 1.6 – ANSWERS

1. **C**
2. **A**
3.

Bonding and Structure	Properties
Covalent network	Do not conduct electricity and have high melting points
Ionic lattice	Have high melting points and conduct electricity when liquid but not when solid
Discrete Covalent Molecular	Do not conduct electricity and have low melting points

4. (a)  (b) Tetrahedral Name this shape of the methane molecule.

5. (a) In a solid ionic lattice the ions are not "free to move". Ionic substances only conduct electricity when molten or in solution.

   (b) Chlorine gas would have formed at the negative electrode as chlorine ions are negative.

6. (a) "Carbon dioxide has a **low** boiling point because, although there are **strong** bonds between the atoms, the bonds between the molecules are **weak**".

   (b) "Silicon dioxide has a **high** melting point because **all** bonds between the atoms are **strong**".

7. (a) silver(I) oxide Ag_2O (b) aluminium hydroxide $Al(OH)_3$

8. (a) magnesium chloride $Mg^{2+}(Cl^-)_2$ (b) potassium sulfate $(K^+)_2SO_4^{2-}$