CHIJ ST. NICHOLAS GIRLS' SCHOOL Sec 2 Science 2024 Diversity

D 1. Exploring Diversity of Matter by their Physical Properties

D 1.3 Covalent Bonding

- (a) Describe the formation of a covalent molecule by the sharing of a pair of electrons in order to obtain electronic configuration of a noble gas.
- (b) Describe the formation of covalent bonds between two non-metallic elements. Eg. HCl, CO₂ and CH₄, using 'dot and cross' diagrams to illustrate
- (c) Deduce the arrangement of electrons in other covalent molecules
- (d) Relate the physical properties (including electrical property) of covalent substances to their structure and bonding
- (e) State the number and types of atoms of each element from a given chemical formula of a substance ; highlight the various categories ; simple ions, polyatomic ions, prefixes such as mono-, di-, tri-

(A) Covalent Bonding between two atoms of the same non-metallic element

Covalent bonds: https://www.youtube.com/watch?v=LkAykOv1foc

Example 1: Covalent bonding between hydrogen atoms



Definition of covalent bond:	
It is electrostatic forces of	between the 2 positively-charged and the pair
of negatively-charged	_ they

Example 2: Covalent bonding between oxygen atoms



There are _____ pairs of electrons shared; hence it is a ______ covalent bond.

Molecular Formula: _____ (____ molecule) Structural Formula: _____

Example 3: Covalent bonding between nitrogen atoms



There are _____ pairs of electrons shared; hence it is a ______ covalent bond.

Molecular Formula: _____ (diatomic molecule)

Structural Formula: _____

The above elements exist as diatomic molecules.

The structural diagrams and chemical formulae of the diatomic molecules are given below.

X - X	0=0	$N \equiv N$
Hydrogen & Group VII elements (X ₂)	Oxygen (O ₂)	Nitrogen (N ₂)

Non-metallic element	Chemical symbol	Molecular formula of the molecule	Structural formula
Hydrogen	Н		
Fluorine	F		
Chlorine	C/		
Bromine	Br		
lodine	I		
Oxygen	0		
Nitrogen	N		

Conclusions:

- 1. Two ______ of the ______ may share electrons to achieve stable full valence shell electron configuration.
- 2. The atoms held together by sharing electrons is called a ______.
- 3. The ______ of electrons the two atoms ______ is determined by the no of electrons each atom ______ to complete its valence shell.
- 4. All non-metallic elements exist as _____ except for noble gases.
- 5. Therefore, hydrogen exists as ______, _____, _____ oxygen exists as ______, ____ and etc. But, helium exists as ______ neon as ______ and etc

(B) Covalent Bonding between atoms of different non-metallic elements to form compounds

Example 1: Covalent bonding between hydrogen atom and chlorine atom



Chemical name :	
Molecular Formula:	
Structural formula:	.()

Example 2: Covalent bonding between hydrogen atom and oxygen atoms



Points to note when drawing dot-and-cross diagram for covalent molecules

- 1. Use dots and crosses to represent electrons of different elements
- 2. Include the atomic symbols of the elements
- 3. Make sure that all the atoms in the substances drawn have fully-filled valence shells
- 4. Make sure that each atom retains its original number of electrons no "missing" or "extra" electrons except the ones being shared
- 5. Make sure electrons are shared in pairs.

Practice

Draw the dot-and-cross diagrams to show how the electrons are arranged in the following substances, showing only the valence electrons: (answers in power point slides)

(a)	CO ₂	(b)	NH₃
(c)	CH4	(d)	H ₂ O ₂
(e)	CHFC <i>I</i> Br	(f)	CH₃OH

(More practice qns on the power point slides)

Names and Chemical Formulae of Covalent molecules (compounds)

In some cases, the names of covalent compounds have **prefixes** (starters) that tell you how many of each element is required in the formula.

o Prefixes:

Mono – 1	Di – 2	Tri – 3	Γetra – 4
Name	Formula	Name	Formula
	CO		HC/
	CO ₂		H₂S
	SO ₂		NH ₃
	SO₃		CH4
	NC/ ₃		CC/4
	H ₂ O		

True or false ?

- 1, Molecules are made up of two or more atoms sharing electrons.
- 2. There are both molecules of elements and molecules of compounds.
- 3. Sodium chloride is made up of molecules.

STEM Activities

You are to research on the following molecules and share one thing about how these molecules relevant in everyday life.

- 1. Hydrogen chloride
- 2. Carbon dioxide
- 3. Hydrogen sulfide
- 4. Sulfur dioxide
- 5. methane
- 6. ammonia

Structures of Covalent Substances

Covalent substances may have 2 different types of structures with different properties

- Simple molecular_structure
- Giant molecular structure (will be covered in Secondary 3)

Simple Molecular Structure

- Most non-metallic ______ and their _____are made up of ______,
 e.g. hydrogen (H₂), oxygen(O₂), bromine(Br₂), water(H₂O), carbon dioxide (CO₂) and etc.
- These substances exist as individual simple molecules and have



- Within the molecule, the atoms are bonded by _____ bonds which is a _____bond.
- However, between them, the small molecules are held loosely together by

The significance of the intermolecular forces:

- The strength of the intermolecular forces directly affects the <u>amount of energy</u> needed to melt or boil the substance. And since intermolecular forces are generally ______, boiling points of substances made up of simple molecules are generally _____.
- In general however, the greater the _____ of the covalent molecules, the _____ the intermolecular forces and _____ energy required to overcome it in order to boil or melt the covalent substance.
- For examples:

substance	molecular formula	Mr (sum of A _r)	boiling point/°C
hydrogen			-253
nitrogen			-196
oxygen			-183
Methane	CH₄		-161
ethane	C ₂ H ₆		-89
Propane	C ₃ H ₈		-42

Note:

The ______ bonds within the molecule are ______ during the process of melting and boiling,

The ______ remain unbroken and merely ______ from each other. The covalent bonds would only be broken during chemical reactions, not during physical change.

Physical properties of substances with Simple Molecular Structure

Property	Explanation
Melting and boiling point	
melting and boiling points	• These substances (elements or compound)
(Many of these substances are gases	have covalent bonding and
or volatile at room temperature, e.g.	·
CO ₂ , H ₂ , N ₂ , CH ₄ etc.)	• energy is needed to overcome the
	of attraction
	between the simple molecules.
Electrical Conductivity	
to conduct electricity in	• These substances have simple molecular
state.	structure.
(exceptions: compounds such as	• are
ammonia and hydrogen chloride, which	Hence there are no mobile ions or free
form acids or alkalis when dissolved in	electrons to conduct electricity.
water)	(exceptional cases: Compounds like
	ammonia and hydrogen chloride dissolve in
	water to form solutions with mobile ions.
	Hence they can conduct electricity in the
	aqueous state.)
Solubility	
The substances are generally	
in water but soluble in	
organic solvents like ethanol, petrol and	NA
turpentine.	
(Some exceptions: hydrogen chloride	
and ammonia [mention acids & alkalis]	

(More examples like H₂O and CO₂ in the power point slides)

F

Pra	ctice				
(1)	The	proton numbers of e	lements A, B and C a	re 6, 9 and 12 respectively.	
	(a)	Write down the electronic configurations of each of the elements A, B and C.			
		A :	В:	C:	
	(b)	Giving a reason, na	ame the type of bond	formed between each of the	e following pairs of
		A and B :	bond		
		Reason :			
		B and C ·	bond		
		Reason :			

(2) An unknown element X chemically combines with chlorine to form a molecule with the following structural formula.



- What is the chemical formula of the molecule? (a)
- (b) What type of bond does X form with chlorine?
- Is element X a metal or non-metal? Give a reason for your answer. (C)
 - (d) In which group of the Periodic Table would you expect to find Element X?

(3). The table below shows some of the properties of five substances.

Substance	Melting	Boiling	Electrical	conductivity
	point (°C)	point (°C)	when solid	when molten
A	800	1470	nil	good
В	-114	-85	nil	nil
С	98	880	good	good
D	-30	58	nil	nil
E	114	444	nil	nil

From the substances A to E, choose one which fits each of the following descriptions :

- (a). is a gas at room temperature and pressure
- (b). is a liquid at room temperature
- (c). is a solid which is made up of simple molecules
- (b). is an ionic compound

Comparing the physical properties of ionic and covalent substances:

Ionic compounds	Covalent elements and compounds