Raffles Institution Raffles Programme
Year Four Chemistry

Name: _____ ( ) Class: _____ Date: _____

2022 FE Revision Chemical Bonding ANSWERS

Elements may be classified as metals or non-metals.
Ionic bonds are formed by the **loss** of electrons, usually from a metal atom to a non-metal atom. The metal atom forms a positive ion or **cation**. The non-metal atom gains electrons to form a negative ion or anion. In an ionic compound, strong **electrostatic** forces of attraction exist between the ions of **opposite** charges.

A **covalent bond** forms when two atoms **share** a **pair** of electrons.
Atoms of an element combine with other atoms to form ionic or covalent bonds.
The atoms achieve a **noble** gas electronic configuration (e.g. in water: H, 2; O, 2,8)

A **metallic bond** is the electrostatic force of attraction between **positively** charged metal ions and negatively charged **delocalised** outer shell electrons.

Physical properties

substance	electrical conductivity
ionic compound	**molten** and **aqueous** states, the ions are **mobile/freely moving** and can therefore act as charge carriers.
covalent element or compound	(one exception – Graphite, which has **delocalised electrons** as charge carriers.)
metallic element	good conductors of electricity in the **solid** and **liquid/molten** states, **delocalised electrons** are the charge carriers.

Covalent bonds and bond polarity

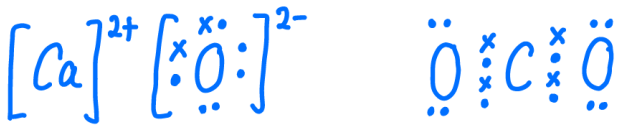
A covalent bond may be polar or non-**polar**. A polar bond is formed between 2 atoms of different electronegativities. The **more** electronegative atom pulls the shared electrons toward itself, forming a $\delta-$ end of the bond. The opposite end is thus labelled $\delta+$. The greater the difference in electronegativities between the 2 bonded atoms, the **greater** the polarity of the bond. Molecules with polar bonds may or may not be polar molecules. Polar molecules can interact with water molecules (which are polar). This explains why simple covalent substances made up of polar molecules (e.g. ammonia, NH_3) are soluble in water. A substance that is made up of molecules which are more **polar** will be more **soluble** in water because the molecules can form stronger **attractions** to the water molecules.

Practice Questions

1 A 2 D 3 B 4 C 5 D 6 (a) D (b) C 7 C

8 **(a)** $CaCO_3(s) \rightarrow CO_2(g) + CaO(s)$

(b) **(i)** calcium oxide carbon dioxide

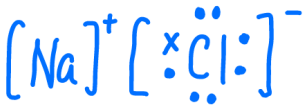


(ii) For **calcium oxide**, strong **electrostatic** forces of **attraction** exist between calcium **ions** and **oxide** ions. The solid has a giant **ionic** structure.
High **heat** is required to overcome the above strong attractions between the ions when melting. Calcium oxide has a **high** melting point.

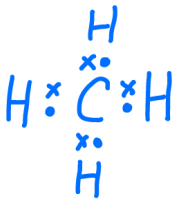
For **carbon dioxide**, weak **intermolecular forces** of attraction exist between carbon dioxide **molecules**.
Solid carbon dioxide has a simple **molecular/covalent** structure.
Hence, only **low** heat energy is needed to overcome the weak attractions between molecules. Carbon dioxide has a **low** melting point.
Note: The strong **covalent** bonds between C and O atoms in each CO_2 molecule are not broken.

9 **(a)**

sodium chloride



methane



(b) Methane exists as simple or discrete molecules. Low heat is required to overcome the weak intermolecular forces of attraction. Hence, at room temperature, methane already exists as a gas.

Sodium chloride is a giant ionic solid with strong electrostatic forces of attraction between ions of opposite charge. A lot of energy is needed to overcome these attractions, so at room temperature, it is a solid.

(c) sodium hydride
(i) ionic bonding

(ii)

10 **(a)** Sodium chloride is made up ions that are held in fixed positions in a giant ionic lattice by strong electrostatic forces of attraction. The ions are not freely-moving or not mobile and cannot act a charge carriers.

(b) S: **12** outer shell electrons

(c) Dilute sulfuric acid is fully dissociated into ions in aqueous solution. So the ions are mobile and can acts as charge carriers to conduct electricity.

$H_2SO_4(aq) \rightarrow 2H^+(aq) + SO_4^{2-}(aq)$

11 **(a)** XCl_2 liquid YCl_2 solid

(b) **(i)** XCl_2 covalent bonding between X and C*l* atoms,
with weak intermolecular forces, between XCl_2 molecules that are easily overcome by a small amount of energy, hence a low melting point.
(ii) YCl_2 ionic bonding, which are strong
thus requiring a lot of energy to overcome, hence a high melting point.

(c) **(i)** X is a non-metal, since it forms a covalent compound with chlorine (a non-metal).
(ii) Y is a metal, since it forms an ionic compound with chlorine (a non-metal).