**Year 10 Chemical Sciences**

**Week 4 – Covalent Molecular Substances**

**Objectives:**

* Show an understanding that covalent molecular substances (elements or compounds) consist of a combination of non metal elements only, ie identify covalent molecular substances from their formula. (At this stage not expected to know covalent network exceptions).
* Describe covalent bonding between a pair of atoms in terms of a sharing of electrons.
* Use electron dot diagrams to represent simple singly bonded molecules.
* Describe the structure of a molecule in terms of two or more non metal atoms covalently bonded into a single entity.
* Compare the electrical conductivity of molecular solutions with ionic solutions
* Describe the structure of covalent molecular substances as consisting of a large number of molecules with very little attraction between the molecules.
* Know the names and formula for the following covalently bonded elements and compounds:

N2, O2, F2, Cl2, Br2, I2, H2O, CO2, CO, NO2, SO2, SO3, HNO3, HCl, H2SO4, H3PO4, CH3COOH.

**Covalent** bonding is the **sharing** of electrons between non-metal atoms to achieve a more stable state. To achieve this, atoms must attain the electron configuration of noble gases; I.e. eight electrons in their valence shell (***Octet Rule***).

This is achieved by the sharing of electrons between atoms. This creates a strong bond between atoms within the molecule (intramolecular) but the forces of attraction between molecules is usually weak and is the reason for the low melting and boiling points.

For electron dot diagrams in covalent bonding, **no** brackets are shown and all of the **valence** electrons are shown to indicate the **sharing** of electrons between the **non-metal** atoms. The example above shows the electron dot diagram for an atom of fluorine and the electron dot diagram for two atoms of fluorine bonding together.

The following are rules for correctly drawing the electron dot diagrams of covalent compounds:

* Step 1) Find valence electrons in all atoms involved. Add them together.
* Step 2) Find the ***octet*** electrons for each atom. Add them together.
* Step 3) Subtract step 1 from step 2. This will give you the bonding electrons.
* Step 4) Divide the number from step 3 by 2 (each bond is made up of 2e-).
* Step 5) Subtract step 3 from step 1. This will give you the non-bonding or lone electrons.

Example 1 – draw Lewis structure for CCl4.

* Step 1) 4 +(7 × 4) = 32.
* Step 2) 8 × 5 = 40.
* Step 3) 40 – 32 = 8
* Step 4) 8 ÷ 2 = 4 (4 bonds)
* Step 5) 32 – 8 = 24 (12 non-bonding pairs of e-).

Covalent molecular substances are **soft** because the forces holding them together are **weak**. (weak intermolecular forces) If the forces holding the particles are weak, then little energy is required to separate the particles. This results in a **low melting point** and **low boiling point** for the substance.

Covalent molecular substances do not conduct electricity because there are **no free moving charged particles** (they are made up of atoms/molecules which are neutral). Most covalent molecular substances are insoluble in water. Those that do dissolve often react with the water or are capable of forming hydrogen bonds with the water and therefore are neutral molecules and do not conduct electricity. e.g. sugar

Rules for naming covalent compounds:

1. The element that is closer to the left side of the periodic table is named first and keeps its normal name. (If two elements are in the same group, the one closer to the bottom is named first)
2. The element closer to the right hand side of the periodic table is named second and has the end of its name changed to end in –ide.
3. Prefixes are used to indicate the number of atoms of that element present in the molecule

mono – 1, di – 2, tri – 3, tetra – 4, penta – 5

1. If there is only one atom of the first element present, the prefix mono is not used.
2. Molecules composed of only one element have the name of that element.

|  |  |
| --- | --- |
| **Chemical Formula** | **Name of Compound** |
| H2 | hydrogen |
| N2O4 | dinitrogen tetraoxide |
| PCl3 | phosphorous trichloride |
| CO2 | carbon dioxide |

**Week 4 – Revision Questions**

1. Draw electron dot diagrams for the following molecules.

1. Fluorine, F2

2. Chlorine, Cl2

3. Oxygen, O2

4. Hydrogen, H2

5. Hydrogen chloride, HCl

6. Nitrogen, N2

7. Iodine, I2

8. Methane, CH4

9. Carbon dioxide, CO2

10. Bromine, Br2

11. Fluorine chloride, FCl

12. Sulfur dioxide, SO2

1. Complete the following word close using the terms provided in the box

bonding react electrons configuration

bond 8 stability shell

group shared outermost (valence) non-metal

Covalent \_\_\_\_\_\_\_\_\_\_\_ involves electrons being \_\_\_\_\_\_\_\_\_\_\_between \_\_\_\_\_\_\_\_\_\_\_ atoms.

\_\_\_\_\_\_\_\_\_\_\_ will be shared so that each atom in the \_\_\_\_\_\_\_\_\_\_\_ends up with \_\_\_\_\_\_\_\_\_\_\_ electrons in its \_\_\_\_\_\_\_\_\_\_\_ electron \_\_\_\_\_\_\_\_\_\_\_.

We know there is special chemical \_\_\_\_\_\_\_\_\_\_\_ attached to 8 electrons in the outermost (valence) e- shell because all \_\_\_\_\_\_\_\_\_\_\_18 have this electron \_\_\_\_\_\_\_\_\_\_\_ and do not \_\_\_\_\_\_\_\_\_\_\_.

The only exception is He which only has 2 electrons in its outer shell.

1. Complete the following table

|  |  |
| --- | --- |
| **Name** | **Chemical Formula** |
| oxygen |  |
|  | Cl2 |
| nitrogen |  |
|  | I2 |
| nitric acid |  |
|  | H2SO4 |
| hydrochloric acid |  |
|  | H3PO4 |
| carbon dioxide |  |
|  | SO2 |
| dinitrogen pentoxide |  |
|  | CCl4 |
| sulfur trioxide |  |
|  | P2O5 |