

## 7.3 Molecular Compounds & Covalent Bonds

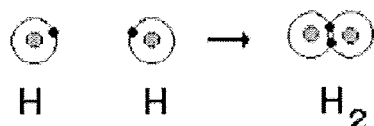
**Learning Goals/Success Criteria:** *At the end of this lesson, I will be able to:*

- Draw Lewis dot diagrams for molecular compounds
- Write the formula and names of molecular compounds (non-metal + non-metal)

When non-metals combine with other non-metals, they do not become ions by losing or gaining electrons. Instead, non-metals **share** electrons to gain a full outermost orbit and become stable.

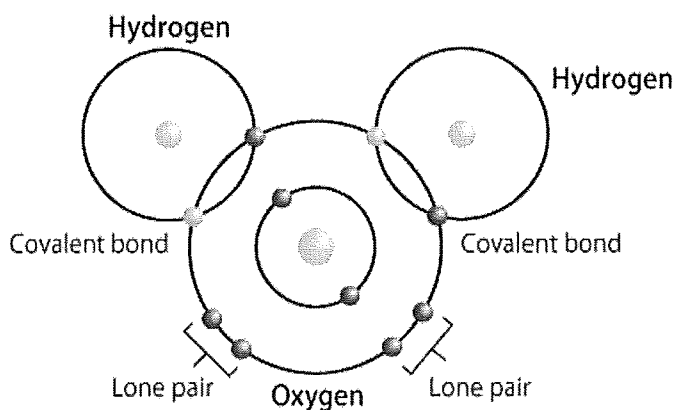
A covalent bond is formed when two non-metals share electrons. These bonded atoms form a molecule or a covalent compound.

For example, hydrogen gas,  $H_2(g)$ , is formed when two hydrogen atoms are chemically joined together. The hydrogen atoms need to share 1 electron to gain a full outermost shell and become stable.



This can also be represented by a dashed line to represent the covalent bond. Each of these lines represent two electrons.

Consider water,  $H_2O$ :

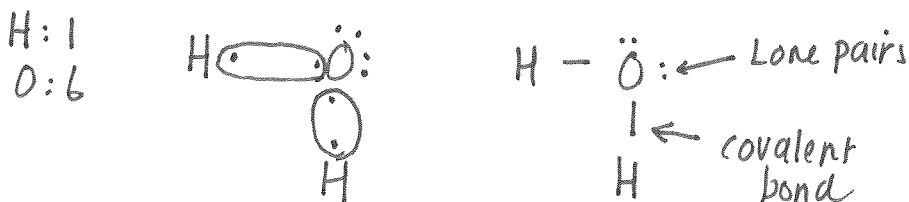


We can draw the Bohr-Rutherford diagrams for each element and then overlap the outermost shells so they can share their valence electrons.

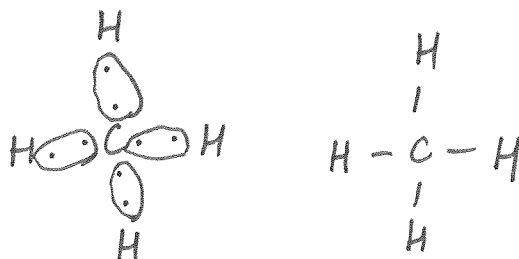
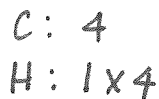
Now, hydrogen has a full duet (2 electrons) in its outermost shell, and oxygen has a full octet (8 electrons) in its outermost shell. Both atoms are the stable now.

Notice that only the valence electrons are involved in bonding. We can simplify our B-R drawings by just drawing the valence electrons.

These are called Lewis structures:



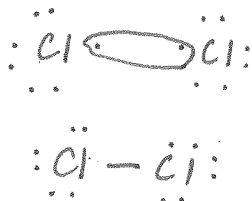
**Practice:** Draw Lewis structures to show how 1 carbon atom and 4 hydrogen atoms combine to form methane,  $CH_4$ .



Draw the Lewis structures for the following compounds:

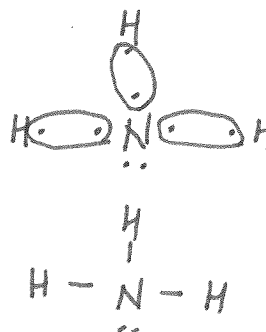
a. Chlorine gas,  $\text{Cl}_2$  (g)

Cl: 7



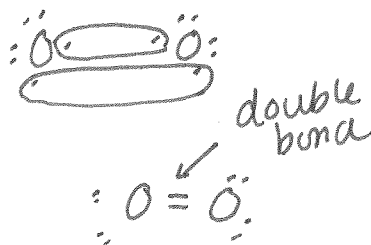
b. Ammonia,  $\text{NH}_3$  (g)

N: 5  
H: 1x3



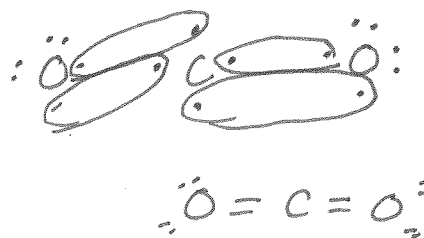
c. Oxygen gas,  $\text{O}_2$  (g)

O: 6



d. Carbon dioxide,  $\text{CO}_2$  (g)

C: 4  
O: 6x2



### Nomenclature & Formulas

	1	2	3	4	5	6	7	8	9	10
<b>Prefix</b>	mono	di	tri	tetra	penta	hexa	hepta	octa	nona	deca

#### Naming:

- Given the formula, write the name of each element in the same order.
- Use the subscripts to determine the prefix for each element in the name. If there is no subscript, use the prefix "mono". Drop "mono" for the first element.
- Drop the second o in mono before a vowel (e.g. mono + oxide = monoxide)
- Drop the a in the prefix before a vowel (e.g. penta + oxide = pentoxide)

#### Formulas:

- Given the name of the compound, write the symbol for each element in the same order.
- The prefix of each element indicates the number of atoms in the formula, so the formula needs a subscript that matches the prefix (no prefix means a subscript of 1).

\*\*\*Do not use the "criss-cross" method\*\*\*

#### Practice Questions

Write the formula for each of the following molecular compounds.

carbon dioxide

CO<sub>2</sub>

phosphorus trichloride

PCl<sub>3</sub>

sulphur hexafluoride

SF<sub>6</sub>

nitrogen monoxide

NO

1. Write the formulas for each of the following compounds.

- |                         |                                   |                            |                                   |
|-------------------------|-----------------------------------|----------------------------|-----------------------------------|
| a) carbon dioxide       | <u>CO<sub>2</sub></u>             | k) diphosphorus trioxide   | <u>P<sub>2</sub>O<sub>3</sub></u> |
| b) silicon dioxide      | <u>SiO<sub>2</sub></u>            | l) nitrogen monoxide       | <u>NO</u>                         |
| c) water *              | <u>H<sub>2</sub>O</u>             | m) chlorine dioxide        | <u>ClO<sub>2</sub></u>            |
| d) carbon disulphide    | <u>CS<sub>2</sub></u>             | n) dinitrogen monoxide     | <u>N<sub>2</sub>O</u>             |
| e) sulphur trioxide     | <u>SO<sub>3</sub></u>             | o) carbon monoxide         | <u>CO</u>                         |
| f) ammonia X            | <u>NH<sub>3</sub></u>             | p) arsenic tribromide      | <u>AsBr<sub>3</sub></u>           |
| g) carbon tetrachloride | <u>CCl<sub>4</sub></u>            | q) phosphorus pentabromide | <u>PBr<sub>5</sub></u>            |
| h) hydrogen peroxide *  | <u>H<sub>2</sub>O<sub>2</sub></u> | r) dinitrogen tetroxide    | <u>N<sub>2</sub>O<sub>4</sub></u> |
| i) methane *            | <u>CH<sub>4</sub></u>             | s) silicon monocarbide     | <u>SiC</u>                        |
| j) ozone *              | <u>O<sub>3</sub></u>              | t) sulphur dioxide         | <u>SO<sub>2</sub></u>             |

2. Write the names for each of the following compounds.

- |                                  |                              |                                  |                                 |
|----------------------------------|------------------------------|----------------------------------|---------------------------------|
| a) CF <sub>4</sub>               | <u>carbon tetrafluoride</u>  | k) P <sub>2</sub> O <sub>5</sub> | <u>diphosphorus pentoxide</u>   |
| b) NH <sub>3</sub>               | <u>ammonia</u>               | l) CH <sub>4</sub>               | <u>methane</u>                  |
| c) PBr <sub>3</sub>              | <u>phosphorus tribromide</u> | m) SO <sub>3</sub>               | <u>sulphur trioxide</u>         |
| d) O <sub>3</sub>                | <u>ozone</u>                 | n) H <sub>2</sub> O              | <u>water</u>                    |
| e) F <sub>2</sub><br>(gas)       | <u>fluorine gas</u>          | o) SiO <sub>2</sub>              | <u>silicon dioxide</u>          |
| f) CS <sub>2</sub>               | <u>carbon disulphide</u>     | p) PCl <sub>5</sub>              | <u>phosphorus pentachloride</u> |
| g) N <sub>2</sub> O <sub>4</sub> | <u>dinitrogen tetroxide</u>  | q) I <sub>2</sub><br>(solid)     | <u>iodine</u>                   |
| h) H <sub>2</sub> O <sub>2</sub> | <u>hydrogen peroxide</u>     | r) NO <sub>2</sub>               | <u>nitrogen dioxide</u>         |
| i) CO                            | <u>carbon monoxide</u>       | s) SF <sub>4</sub>               | <u>sulphur tetrafluoride</u>    |
| j) SiC                           | <u>silicon monocarbide</u>   | t) H <sub>2</sub><br>(gas)       | <u>hydrogen gas</u>             |