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EB Education Revision Guide

How to work with Covalent Bonding: Part 1

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Covalent bonding

What is a covalent bond?

A covalent bond forms when a pair of electrons is shared between two atoms. They form a strong bond.

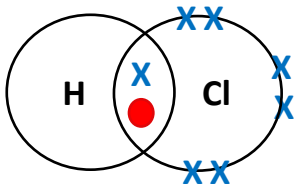
The shared electrons are found in the outer shells of the atoms. Each atom wants to gain a full outer shell (2 electrons in the first shell and 8 in the others).

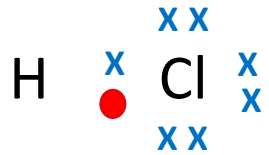
Simple molecular substances are made of molecules which consist of a few atoms joined together by covalent bonds.

The bonding in these molecules can be modelled using dot and cross diagrams, in which:

- the outer shell of each atom is drawn as a circle
- circles overlap where there is a covalent bond
- electrons from one atom are drawn as dots, and electrons from another atom as crosses

Hydrogen Chloride, HCl



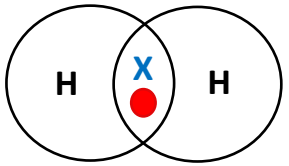


This shows Hydrogen Chloride, HCl
Hydrogen shares its outer electron with chlorine.
Chlorine shares one of its outer electrons with hydrogen.

It can also be represented as H—Cl

Examples

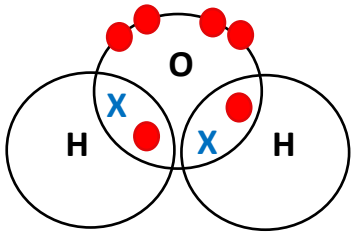
Hydrogen, H_2



Hydrogen atoms have 1 electron.
They need 1 more electron to gain a full outer shell.
They will form **single covalent** bonds with other atoms, including other hydrogen atoms.

TOP TIP:
You only need to show the electrons in the outer shell.

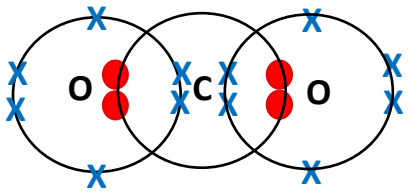
Water, H_2O



Hydrogen atoms have 1 electron.
They need 1 more electron to gain a full outer shell.
Oxygen atoms have 6 electrons in the outer shell, so need another 2 electrons.
Oxygen will share a pair of electrons with two hydrogen atoms to form **two single covalent** bonds.

Examples

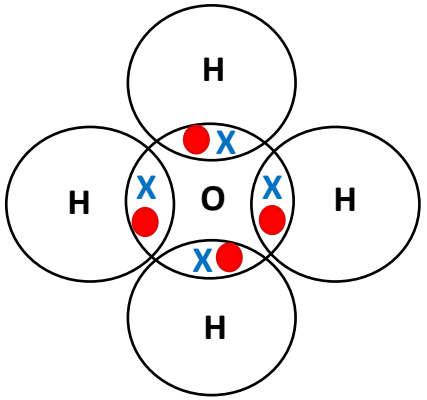
Carbon dioxide, CO_2



Carbon atoms have 4 electrons in the outer shell and need to share 4 electrons.
Oxygen atoms have 6 electrons in the outer shell and need to share 2 electrons.
The carbon atom shares 2 pairs of electrons with 2 oxygen atoms to form two **double covalent** bonds.

TOP TIP: Double covalent bonds are bonds made of two shared electron pairs.

Methane, CH_4



Carbon atoms have 4 electrons in the outer shell and need to share 4 electrons.
Hydrogen atoms have 1 electron and need to share 1 electron.
Carbon will **form four single covalent** bonds with 4 hydrogen atoms.

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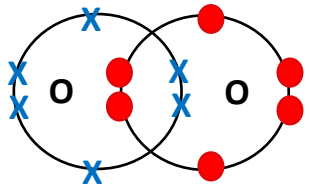
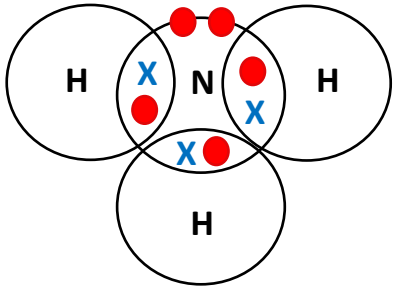
Examples

Oxygen, O_2



Oxygen atoms have 6 electrons in the outer shell.
Each oxygen atom will form a **double covalent** bond with another oxygen atom.

Ammonia, NH_3



Nitrogen atoms have 5 electrons in the outer shell.
The nitrogen atom will form **three single covalent** with 3 hydrogen atoms.

Your turn:

1a) Carbon has an atomic number of 6.
Hydrogen has an atomic number of 1.
Draw a dot and cross diagram for a molecule of methane, CH_4.
Show the outer shell electrons only.

b) Carbon dioxide is a gas present in the air. There are covalent bonds between the atoms of a molecule of carbon dioxide.

i) Describe what is meant by a covalent bond.

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ii) The electronic configuration of oxygen is 2,6.
Give the electronic configuration of carbon.

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iii) Draw a dot and cross diagram for a molecule of carbon dioxide.
Show the outer electrons only.

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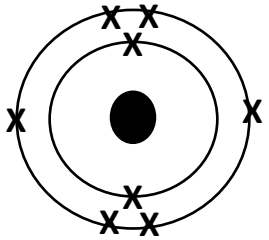
Your turn:

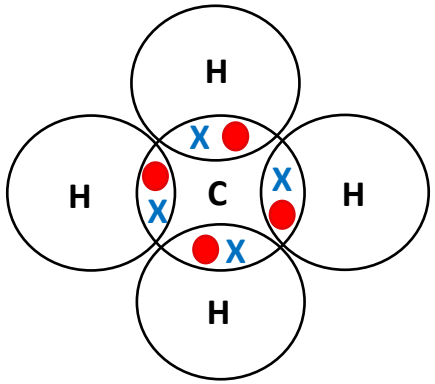
2. The diagram below shows how the electrons are arranged in an atom of oxygen.

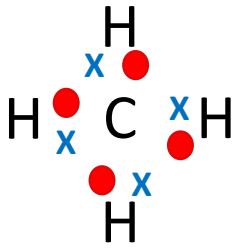


Oxygen atoms can form both covalent and ionic bonds.
Water is formed when two atoms of hydrogen combine with one atom of oxygen.
Draw a dot and cross diagram of a molecule of water.
Show the outer shell electrons only.

Answers:

1a) Carbon has an atomic number of 6.
Hydrogen has an atomic number of 1.
Draw a dot and cross diagram for a molecule of methane, CH_4.
Show the outer shell electrons only.





b) Carbon dioxide is a gas present in the air. There are covalent bonds between the atoms of a molecule of carbon dioxide.

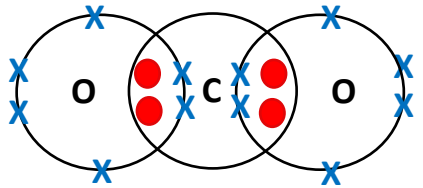
i) Describe what is meant by a covalent bond.

Pairs of electrons shared between atoms

ii) The electronic configuration of oxygen is 2,6.
Give the electronic configuration of carbon.

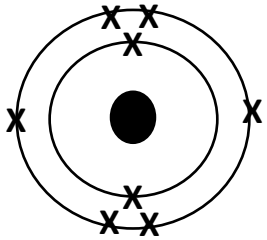
2, 4

iii) Draw a dot and cross diagram for a molecule of carbon dioxide.
Show the outer electrons only.

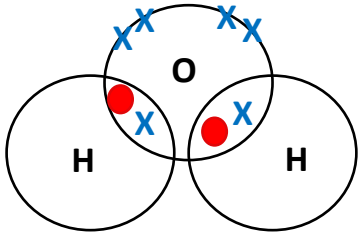


Your turn:

2. The diagram below shows how the electrons are arranged in an atom of oxygen.



Oxygen atoms can form both covalent and ionic bonds.
Water is formed when two atoms of hydrogen combine with one atom of oxygen.
Draw a dot and cross diagram of a molecule of water.
Show the outer shell electrons only.



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