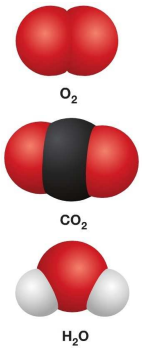
SNC1D CHEMISTRY

ATOMS, ELEMENTS, & COMPOUNDS

- How Compounds Form (P.210-214)

Putting Atoms Together

*Most substances are not made up of individual atoms. Instead, they are made up of molecules. A **molecule** is a group of atoms that are chemically joined together. For example, the air you breathe contains many kinds of molecules. These molecules include oxygen (O_2), carbon dioxide (CO_2), and water vapour (H_2O).*

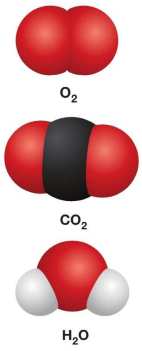


MOLECULE

- two or more atoms that are chemically joined

Putting Atoms Together

*Each oxygen molecule is made up of two atoms of oxygen joined together. A **chemical formula** is used to describe the number and type of atom in each substance. The chemical formula for an oxygen molecule is O_2. The **subscript** 2 tells you that there are two atoms of oxygen in each molecule of oxygen. (Recall that a pure substance is made up of only one type of particle.)*



CHEMICAL FORMULA

- indicates the type and number of atoms in a pure substance

Putting Atoms Together

PRACTICE

1. Indicate which elements and how many atoms of each there are in the following molecules.
   - (a) F_2 — 2 fluorine
   - (b) KBr — 1 potassium, 1 bromine
   - (c) C_3H_8 — 3 carbon, 8 hydrogen
   - (d) $CaCO_3$ — 1 calcium, 1 carbon, 3 oxygen
   - (e) $AgNO_3$ — 1 silver, 1 nitrogen, 3 oxygen
   - (f) Fe_2O_3 — 2 iron, 3 oxygen

Putting Atoms Together

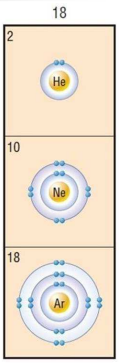
PRACTICE

2. Why do atoms combine? How do they combine?

next page

Putting Atoms Together

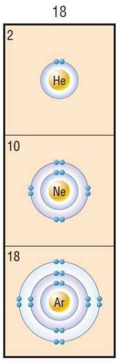
Atoms combine to become more stable. The most stable elements in the periodic table are the noble gases. They are considered to be the most stable because they have the maximum number of electrons in their outermost orbits: 2 for helium, 8 for the others. Elements that do not have the maximum number of electrons in their outermost orbits combine with other elements to obtain this maximum number of electrons.



Putting Atoms Together

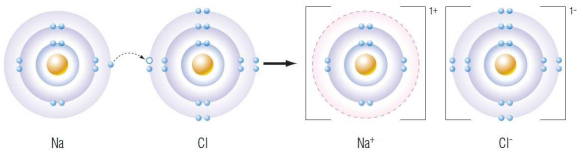
WHY DO ATOMS COMBINE? HOW?

- to become more stable (full outer orbit)
- gain, lose, or share electrons until the outer orbit is full (depends on whether the atoms are metals or non-metals)



Metals & Non-Metals – Ionic

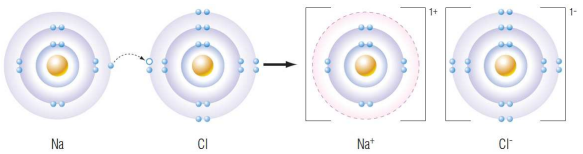
Although millions of compounds have been discovered, almost all of them can be classified as one of two types: ionic or molecular. ***Ionic compounds*** *are pure substances usually consisting of at least one metal and one non-metal. While combining, each atom changes into an ion. (Recall ions form when one or more electrons move from a metal atom over to a non-metal atom.) The resulting positive and negative ions attract each other forming an* ***ionic bond****.*



Metals & Non-Metals – Ionic

IONIC COMPOUND

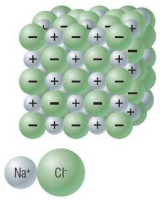
- consists of at least one metal and one non-metal
- metal loses electrons ☞ becomes +ve ion (cation)
- non-metal gains electrons ☞ becomes –ve ion (anion)
- attraction between the +ve and –ve ions is called an ionic bond



Metals & Non-Metals – Ionic

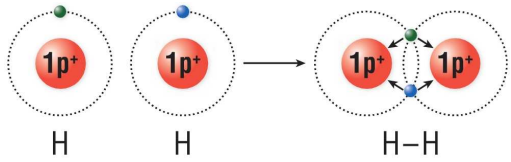
All ionic compounds are solids at room temperature and most share the following properties:

- *have high melting points (ie salt's melting point is 800°C)*
- *form crystals, which are very regular arrangements of particles*
- *dissolve in water to form solutions that conduct electricity*



Non-Metals & Non-Metals – Molecular

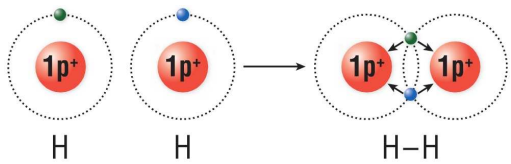
*When non-metals combine with other non-metals, a pure substance called a **molecular compound** is formed. But they do not become ions by losing or gaining electrons the way metals and non-metals do. Instead, the nucleus of one atom forms a strong attraction to an electron in the outermost orbit of another atom and vice versa. A "tug of war" for electrons occurs, but neither atom wins. The two atoms share each other's electrons. A chemical bond that results from atoms sharing electrons is called a **covalent bond**.*



Non-Metals & Non-Metals – Molecular

NOTE!

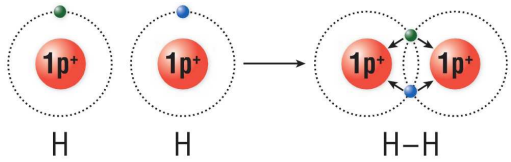
*There are seven non-metals that form molecular compounds consisting of two atoms. These molecular elements are commonly called **diatomic molecules**, where the prefix "di" means two. The seven diatomic molecules, sometime referred to as the "magnificent seven", are H_2, N_2, O_2, F_2, Cl_2, Br_2, and I_2.*



Non-Metals & Non-Metals – Molecular

MOLECULAR COMPOUND

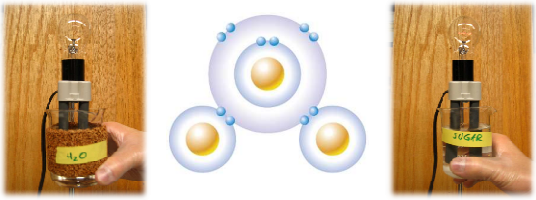
- consists of at least two non-metals
- atoms share electrons
- chemical bond between the atoms is called a covalent bond
- 7 common diatomic molecules ☞ H_2, N_2, O_2, F_2, Cl_2, Br_2, I_2



Non-Metals & Non-Metals – Molecular

Most molecular compounds share the following properties:

- *can be solids, liquids, or gases at room temperature*
- *usually good insulators but poor conductors of electricity (solid or liquid)*
- *have relatively low boiling points*



Metals & Metals – Alloys

*Metals form mixtures with other metals, not compounds. These mixtures are called **alloys**. Alloys are created by melting two or more metals and then mixing these hot liquids. For example, sterling silver is a solution of silver and copper. After mixing, the alloy is allowed to solidify. Alloys are different from compounds because in compounds, atoms join chemically in specific ratios to form pure substances. Alloys are solutions of metals – the metals do not combine chemically.*

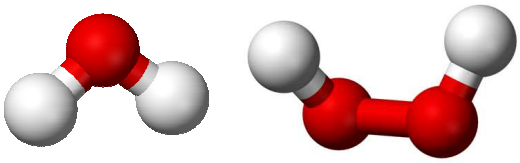
Metals & Metals – Alloys

ALLOY

- solution of metals (i.e. the metals do not combine chemically)

Putting Atoms Together – DYK?

A small change in the way atoms combine can make a big difference in the chemical and physical properties of a compound. For example, water (H_2O) is a compound consisting of hydrogen and oxygen. Hydrogen peroxide (H_2O_2) is also a compound of hydrogen and oxygen but with completely different properties than water.

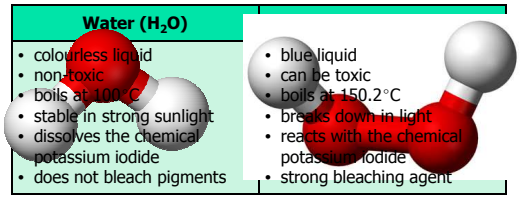


Putting Atoms Together – DYK?

PRACTICE

3. Besides their chemical formula, what are some of the differences between water (H_2O) and hydrogen peroxide (H_2O_2)?

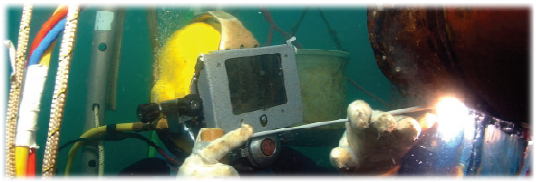
Water (H_2O)	
• colourless liquid • non-toxic • boils at 100 °C • stable in strong sunlight • dissolves the chemical potassium iodide • does not bleach pigments	• blue liquid • can be toxic • boils at 150.2 °C • breaks down in light • reacts with the chemical potassium iodide • strong bleaching agent



Putting Atoms Together

NOTE!

Understanding the properties of compounds gives us the knowledge to make use of compounds safely and responsibly. For example, the diver below is using a torch that burns hydrogen gas (H_2) with a flame so hot that the torch can be used effectively underwater.



✔ Check Your Learning

1. Nitric oxide (NO) and nitrogen dioxide (NO_2) are air pollutants produced by automobiles. Nitrous oxide (N_2O) is used in dentistry to relax patients and as a power booster in racing.
   (a) How are the chemical formulas of these compounds alike?

   (a) all contain the elements nitrogen and oxygen

✔ Check Your Learning

1. Nitric oxide (NO) and nitrogen dioxide (NO_2) are air pollutants produced by automobiles. Nitrous oxide (N_2O) is used in dentistry to relax patients and as a power booster in racing.
   (b) How are they different?

   (b) the number of each element varies in each formula – as a result their properties vary as well

✔ Check Your Learning

2. What is the difference between a molecule that is an element and a molecule that is a compound? Give an example of each.

molecule & element: H_2 or O_2 – 2 or more of the same element
molecule & compound: H_2O or CO_2 – combinations of elements

✔ Check Your Learning

3. Can compounds have different properties than their elements have? Explain, using an example.

yes!
water (H_2O) – together hydrogen and oxygen are a liquid but separately hydrogen is an explosive gas and oxygen is a gas we breathe