ATOMS, ELEMENTS, MOLECULES & COMPOUNDS

VISUAL CHEM CARDS

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Atoms & Molecules

All substances are made from tiny particles called **atoms**.

Elements are made from only ONE type of atoms.

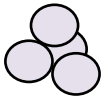
There are over 100 elements, about 92 of which occur naturally.

Monatomic elements
He, Ne, Ar, Kr, Xe

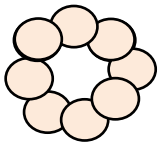
Diatomic elements
H_2, N_2, O_2, F_2, Cl_2, Br_2, I_2

Polyatomic elements

P_4



S_8



Two or more atoms bonded together are called **molecules**.

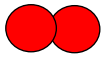
The word "atom" comes from the Greek word for "uncuttable" or "undivided".
Atoms are very small.
Average atom is about one tenth of a billionth of a meter across.
The largest atom (cesium) is approximately nine times bigger than the smallest atom (helium).

Atoms & Molecules

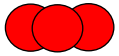
All substances are made of **atoms**.
Elements are made of only one type of atom.
Compounds contain more than one type of atom.
Compounds are held together by **bonds**.

carbon atom
(C)

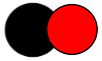
oxygen atom
(O)



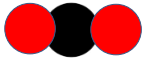
oxygen molecule
(O_2)



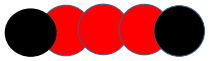
ozone molecule
(O_3)



carbon monoxide molecule
(CO)

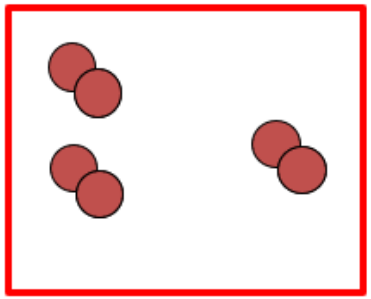


carbon dioxide molecule
(CO_2)

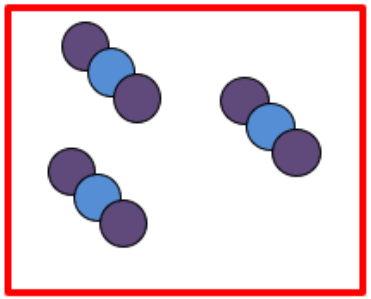


carbon suboxide molecule
(C_2O_3)

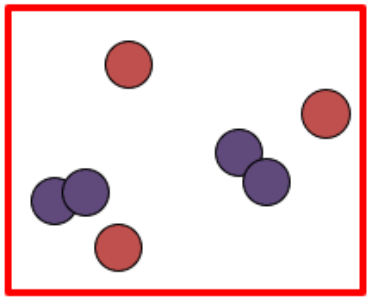
Elements, Compounds & Mixtures



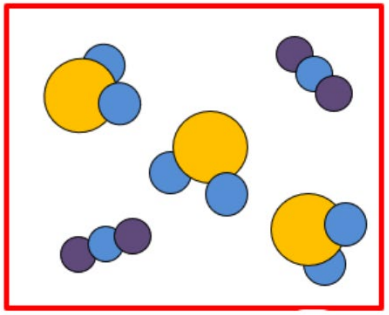
Element



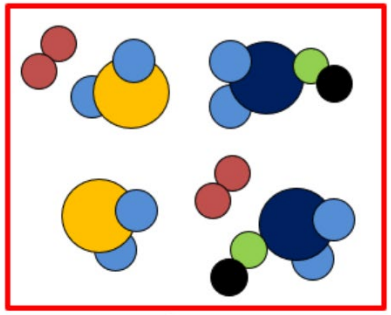
Compound



Mixture



Mixture



Mixture

Elements

Atoms are the basic building blocks of everything.

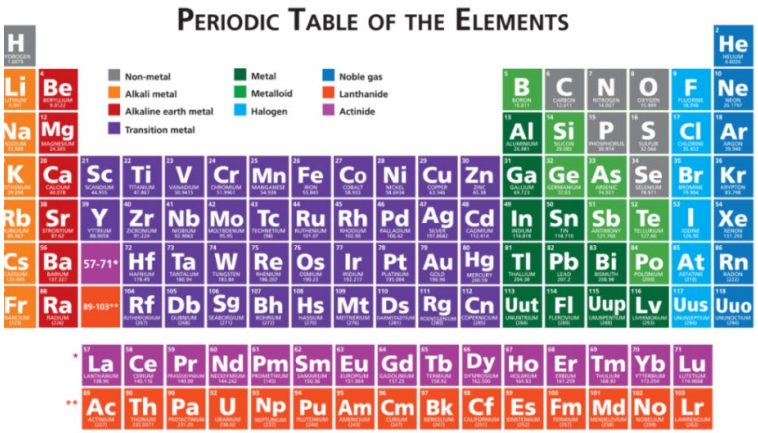
Elements are substances that are made from one type of atom.

Compounds are substances made from atoms of different elements joined by chemical bonds.

Mixtures are made by simply mixing together elements and compounds.

An element is a substance that **cannot** be broken down into any other substance. Every element is made up of its **own type of atom**. This is why the chemical elements are all very different from each other.

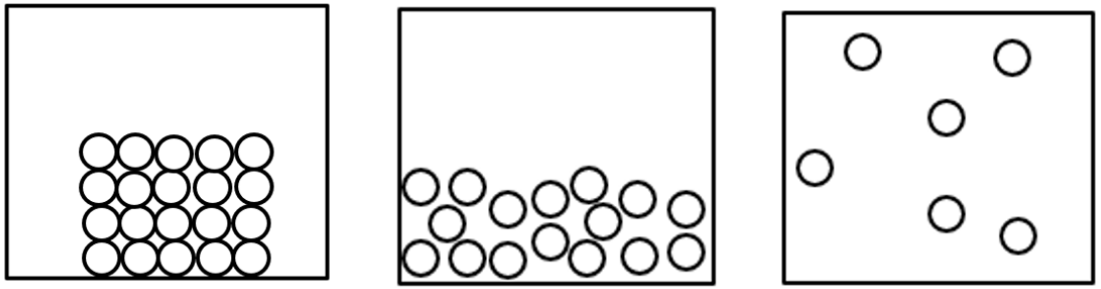
Periodic Table of Elements



The periodic table lists all the known elements, grouping together those with similar properties. Most elements are **metals**, which are **shiny and conduct electricity well**. Metals include gold, aluminium and iron which are all solid at room temperature. Mercury is the only metal that is liquid at room temperature.

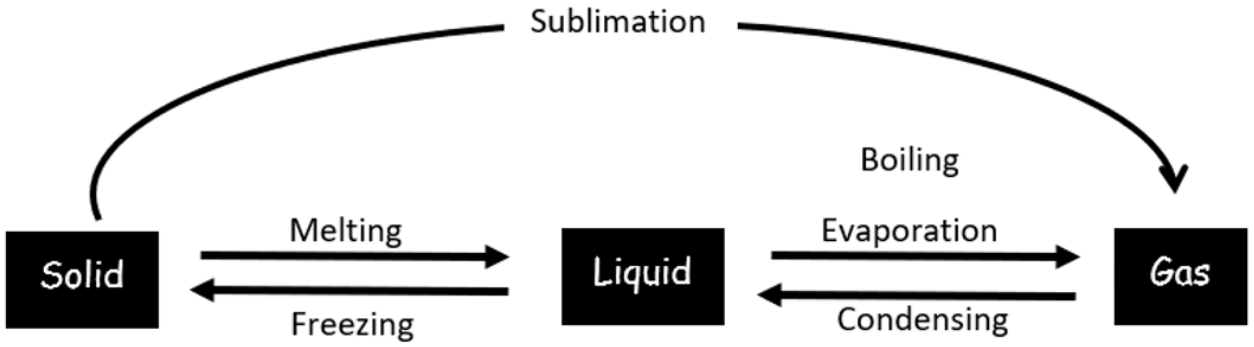
Some elements are **non-metals**. Most non-metals are **gases** at room temperature and **do not conduct electricity.** Non-metal elements with these properties include oxygen, hydrogen and chlorine. A few non-metals, such as carbon and sulphur, are in a **solid state** at room temperature.

States of Matter



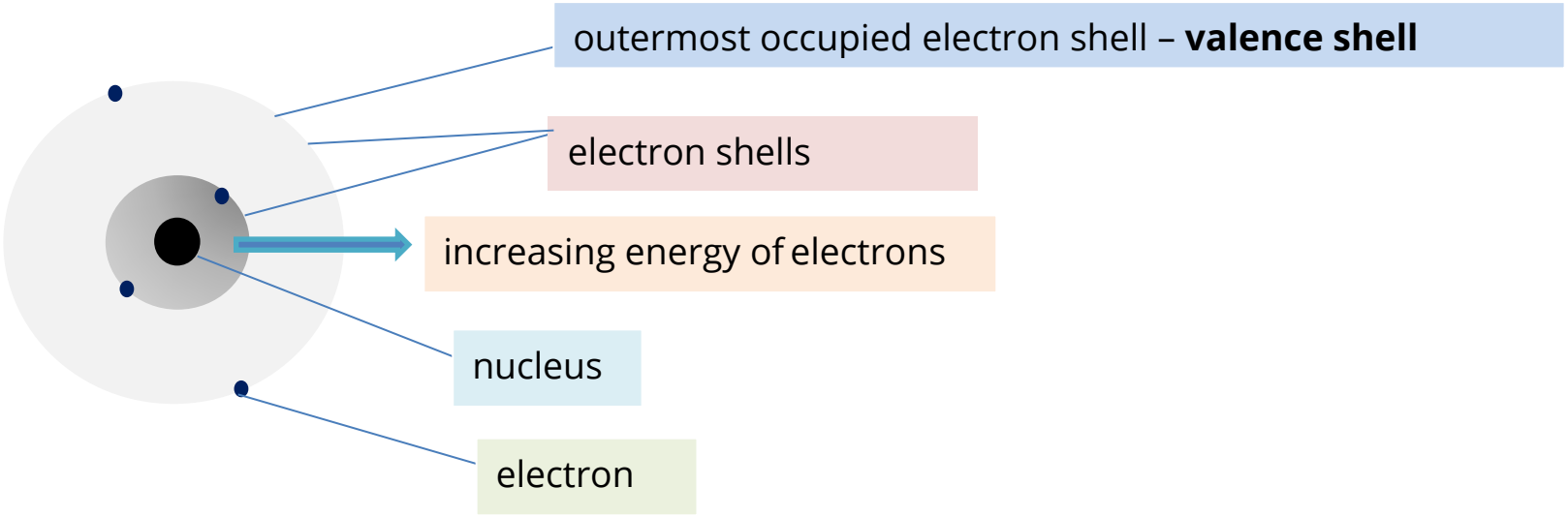
Solid Liquid Gas

Changes of State



Atomic Structure

Solar System Model of the Atom

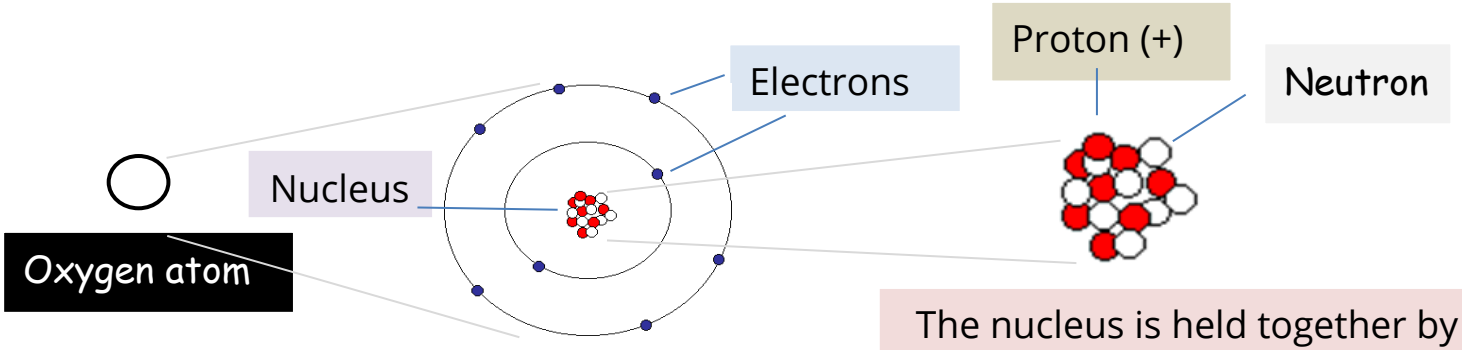


Subatomic Particles

Name	Symbol	Mass	Charge	Location
Proton	p^+	1	+1	part of the nucleus
Neutron	n^0	-1	0	part of the nucleus
Electron	e^-	1/1837	-1	'orbits' the nucleus

Atomic Structure

Electrostatic attraction holds electrons in orbit around the nucleus

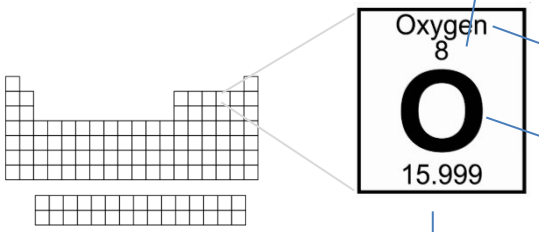


99.9% of the volume occupied by an atom is empty space

atom diameter c. 0.0000001 mm

The nucleus is held together by strong and weak nuclear forces. Repulsion between protons is overcome by very powerful short-range forces (c. 1000 times stronger than gravity).

Element Boxes and Atomic Structure



Oxygen
8
O
15.999

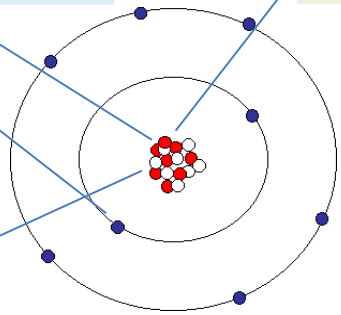
Proton (Atomic) Number (Z)
Z = number of protons in nucleus
Z = number of electrons

Element Name

Chemical Symbol

Atomic Mass (A) = number of protons + number of neutrons.

Atomic Mass (A) = weighted average of all the naturally occurring isotopes and hence is not a whole number.

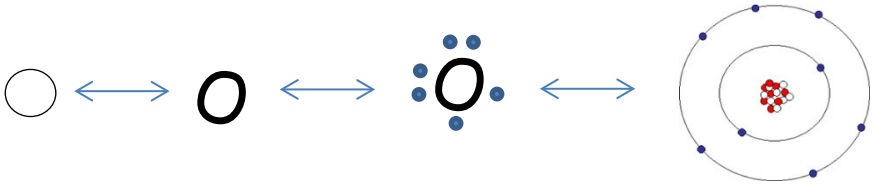


Almost all of the mass of an atom is in its nucleus.

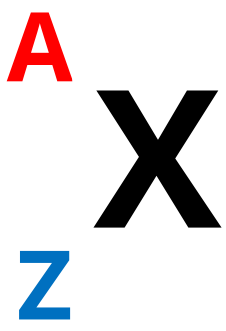
Number of Neutrons = Atomic Mass – Proton Number

Almost all of the volume of an atom is occupied by electrons.

Many different ways of representing atoms, e.g. oxygen (O_2)



Nuclear Notation



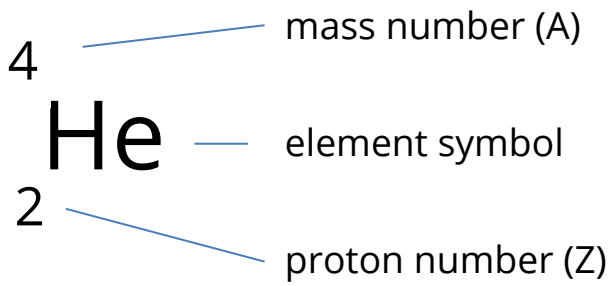
mass number

element symbol

proton number

Standard nuclear notation shows the chemical symbol, the mass number and the proton (atomic) number of the isotope.

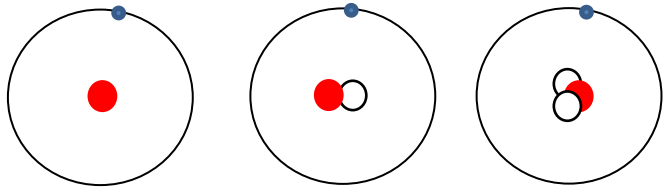
For Example:



Number of protons (Z)	Number of electrons	Number of neutrons (N = A – Z)
2	2	4 - 2 = 2

Isotopes

Isotopes of Hydrogen



1-H Hydrogen H

2-H Deuterium D

3-H Tritium T

● proton

○ neutron

Isotope	Number of protons (Z)	Number of electrons	Number of neutrons (N = A – Z)
1-H	1	1	0
2-H	1	1	1
3-H	1	1	2

Isotopes are variants of a particular chemical element which differ in neutron number, and consequently in mass number.

All isotopes of a given element have the same number of protons but different numbers of neutrons in each atom.

Most elements have more than one naturally occurring isotope. For instance, boron (B):

Isotope	Mass	Abundance
10-B	10	19.78%
11-B	11	80.22%

Atomic mass is the weighted average of the isotopes.

$$\text{Atomic mass} = \frac{(19.78 \times 10) + (80.22 \times 11)}{100} = 10.81$$