Matter & The Atom

Matter

The term matter describes all of the physical substances around us: your table, your body, a pencil, water, and so forth

Matter

- Anything that has mass and takes up space (has volume)

Matter

- Includes all things that can be seen, tasted, smelled, or touched
- Does not include heat, sound, or light

Matter is made of atoms

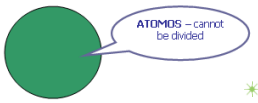
Models

Models are often used for things that are too small or too large to be observed or that are too difficult to be understood easily

Models

- In the case of atoms, scientists use large models to explain something that is very small
- Models of the atom were used to explain data or facts that were gathered experimentally.
- So, these models are also theories

Early Models of the Atom
Democritus



- Universe was made of empty space and tiny bits of stuff
- Called these tiny bits of stuff “atomos”

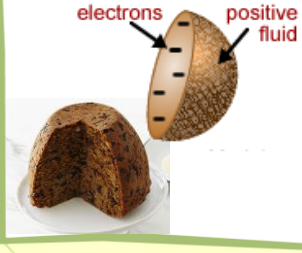
370 BC

Early Models of the Atom
Dalton

- All elements are composed of indivisible particles.
- Atoms of the same element are the same
- Atoms of different elements are different.
- Compounds consisted of atoms of different elements combined together

1803

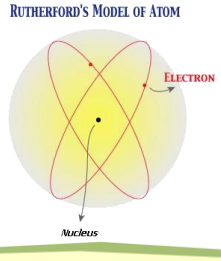
Early Models of the Atom
Thomson



- Plum pudding model
- Atom made of a positively charged material with the negatively charged electrons scattered through it.

1897

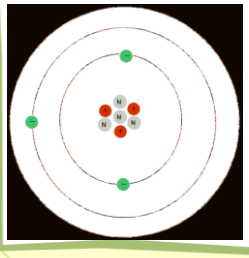
Early Models of the Atom
Rutherford



- Mostly empty space
- Small, positive nucleus
- Contained protons
- Negative electrons scattered around the outside

1911

Early Models of the Atom
Bohr

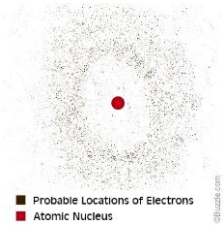


- Electrons move in definite orbits around the nucleus

1913

Modern Model of the Atom
The electron cloud

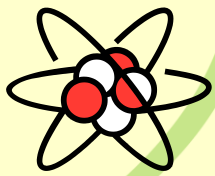
- Spherical cloud of varying density
- Varying density shows where an electron is more or less likely to be



Atomic Structure

Nucleus
- Protons
- Neutrons

Electrons



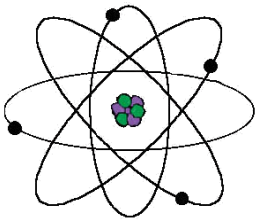
The nucleus of every atom (except hydrogen) contains two particles:

- **Protons (+ charge / mass 1amu)**
- **Neutrons (no charge / mass 1amu)**

In energy levels outside the nucleus we find:

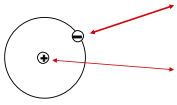
- **Electrons (– charge / mass 1/2000amu)**

Atomic Structure



- Neutrons
- Protons
- Electrons

Most stable atoms are neutral (no charge) because the positive charge of the nucleus is equal to all of the negative charges of the electrons added together.



- **11 electrons = 11 negative charges**
- **11 protons = 11 positive charges**

Your Turn

- **Member A: Atomic Number Expert.**
  - What Atomic Number means. Explain how atomic number is found using the periodic table and relate atomic number to number of electrons and protons.
- **Member M: Mass Number Expert**
  - What Mass Number means. They explained how to find mass number and how it relates to any subatomic particles (proton and neutron).
- **Member I: Isotope Expert**
  - What an Isotope is. How isotopes of one element are the same and how they are different.
- **Member N: Nuclear Atom Expert**
  - This person was responsible for teaching the other members of the group how to show Atomic Number and Mass Number using the Nuclear Atom shorthand and the Isotope shorthand.

Expert Review

Member A: Atomic Number Expert.
– What Atomic Number means.
Member M: Mass Number Expert
– What Mass Number means.
Member I: Isotope Expert
– What an Isotope is.
Member N: Nuclear Atom Expert
– show Atomic Number and Mass Number using shorthand

Describing Atoms

- Atomic Number = number of protons
- In a neutral atom, the # of protons = the # of electrons

Describing Atoms

- Mass Number - equal to the number of protons plus neutrons.

Describing Atoms

- Atomic Weight - average mass of the naturally occurring isotopes of an element .

Ions

- An atom that carries an electrical charge is called an **ion**
- If the atom loses electrons, the atom becomes positively charged (because the number of positively charged protons will be more the number of electrons)

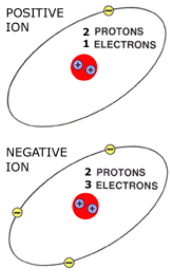
Ions

- An atom that carries an electrical charge is called an **ion**
- If an atom gains electrons, the atom becomes negatively charged (more negative charges than positive charges)

Ions

- The number of protons does not change in an ion
- The number of neutrons does not change in an ions
- So, both the atomic number and the atomic mass remain the same.

Ions



This atom has lost an electron. Now it has one more proton than electron.

One more proton means one more positive charge.

This makes the total charge of the atom POSITIVE.

This atom has gained an electron. Now it has one less proton than electron.

One less proton means one less positive charge.

This makes the total charge of the atom NEGATIVE.

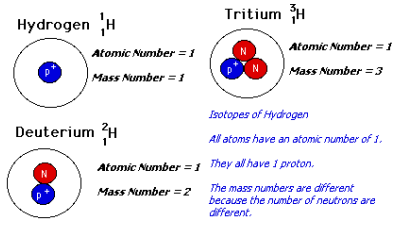
Isotopes

- The number of protons for a given atom never changes.
- The number of neutrons can change.
- Two atoms with different numbers of neutrons are called **isotopes**

Isotopes

- Have the same atomic number (number of protons)
- Have different atomic mass numbers (number of protons + neutrons)

Isotopes



Nuclide notation – how many protons, neutrons, and electrons in atoms?

Mass number (protons + neutrons) → 37

Atomic number (number of protons) → 17

number of neutrons → 20

$^{37}_{17}Cl$

As atoms have no charge, the number of electrons is the same as the number of protons. This atom has 17 electrons.

Nuclide notation – how many protons, neutrons, and electrons in ions?

Mass number (protons + neutrons) → 16

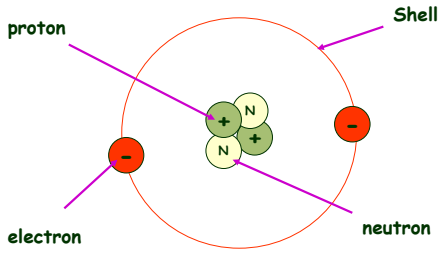
Atomic number (number of protons) → 8

number of neutrons → 8

O^{2-}

2– charge means 2 electrons more than the number of protons. This atom has 10 electrons.

HELIUM ATOM



What do these particles consist of?

ATOMIC STRUCTURE

Particle	Charge	Mass
proton	+ ve charge	1
neutron	No charge	1
electron	-ve charge	nil

ATOMIC STRUCTURE

He

2 Atomic number
the number of protons in an atom

4 Atomic mass
the number of protons and neutrons in an atom

number of electrons = number of protons

ATOMIC STRUCTURE

Electrons are arranged in Energy Levels or Shells around the nucleus of an atom.

- first shell — a maximum of **2** electrons
- second shell — a maximum of **8** electrons
- third shell — a maximum of **8** electrons