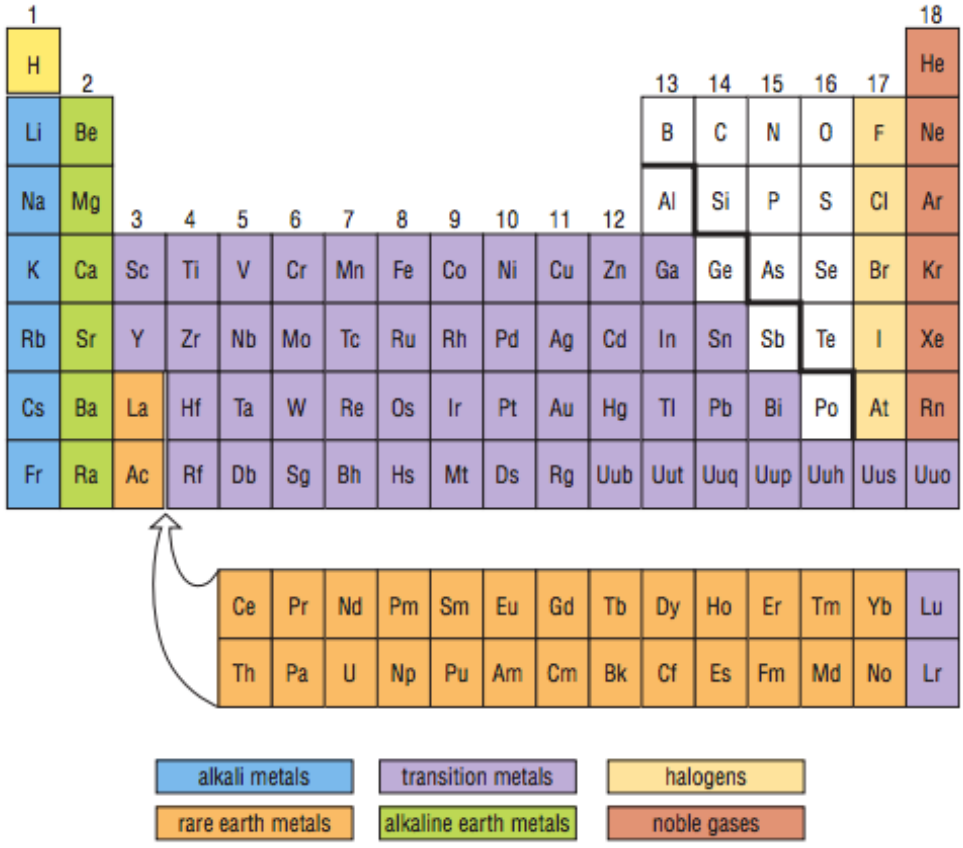
Grade 9 Science

Atoms, Elements and Compounds

Class 2

The Periodic Table

- Group/Family – a column in the periodic table
  - All elements in a group have similar chemical and physical properties
  - Group 1: Alkali Metals
  - Group 2: Alkaline Earth Metals
  - Group 17: Halogens
  - Group 18: Noble Gases
- Period – a row in the periodic table



Group 1: Alkali Metals

- Ex: Li, Na, K
- Physical: Shiny, silvery, soft
- Reactivity: High
- Common Uses: NaCl (table salt), $NaHCO_3$ (baking soda), potassium in bananas

Group 2: Alkaline Earth Metals

- Ex: Be, Mg, Ca, Sr, Ba, Ra
- Physical: Shiny, silvery, not as soft
- Reactivity: Medium-High
- Common Uses: Calcium in bones, strontium in coral, magnesium in fireworks


Group 17: Halogens

- Ex: F, Cl, Br, I
- Physical: F, Cl (gases), Br (liquid), I (solid)
- Reactivity: High
- Common Uses: Cl in pools, weapons, bleach; iodine in disinfectants

Group 18: Noble Gases

- Ex: He, Ne, Ar, Kr, Xe
- Physical: Colourless, Odourless Gases
- Reactivity: Low
- Common Uses: He in balloons, Ne on lights

History of the Periodic Table

- Developed in 1869 by Dmitri Mendeleev
  - First arranged elements by mass
  - Then he organized the elements based on chemical and physical properties in columns
- There were gaps in the periodic table
- Mendeleev correctly predicted the properties of elements that had not yet been discovered

Property	Properties predicted by Mendeleev in 1871	Observed properties of germanium, discovered in 1886
colour	grey	grey
mass of element	72	72.6
density	5.5 g/cm^3	5.4 g/cm^3
melting point	high	947 °C
number of elemental oxygen particles it combines with	2	2
number of elemental chlorine particles it combines with	4	4

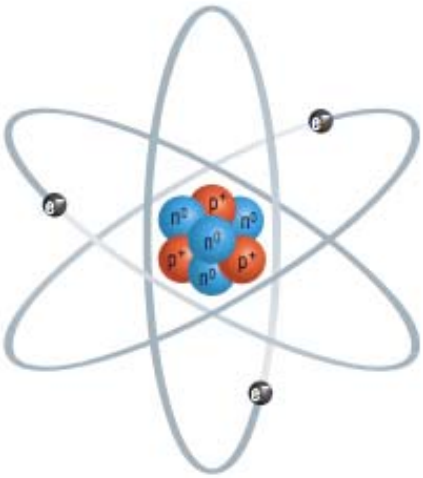
Theories of an Atom

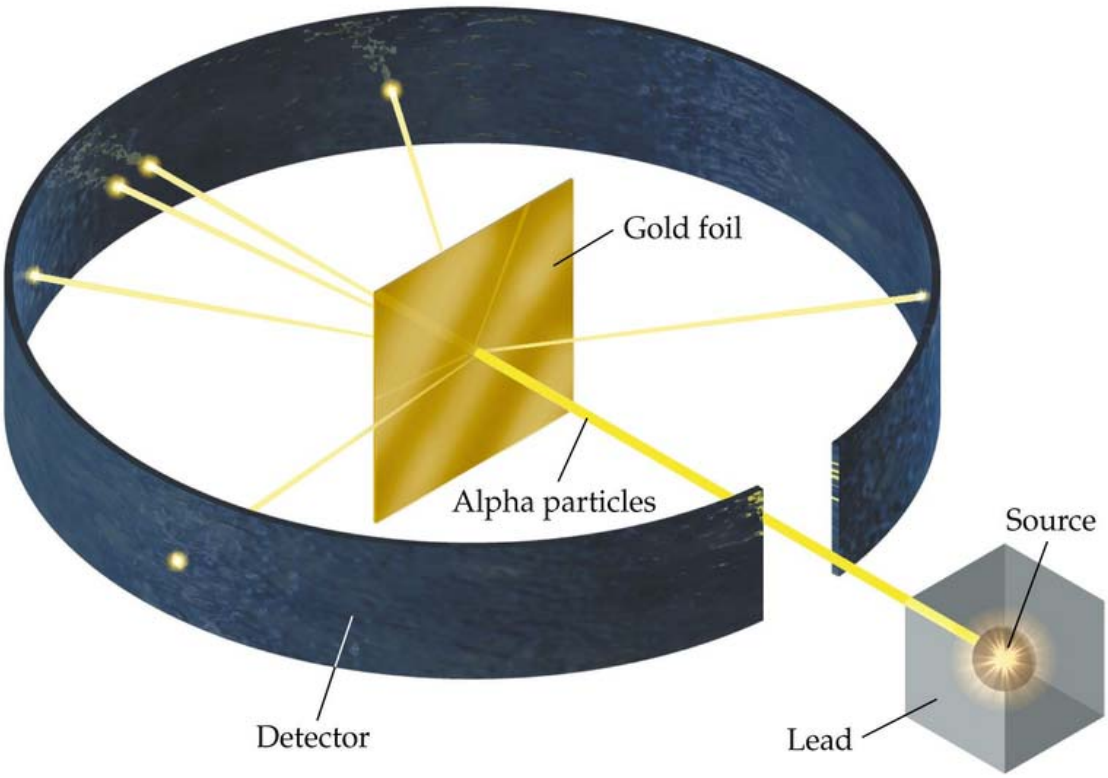
- Democritus (400BCE) – all matter can be divided into smaller pieces until an indivisible particle is reached → **the atom**
- Dalton (1807) – **Billiard Ball Model**
  - All matter is made of atoms
  - All atoms of a single element are identical
  - Atoms of different elements are different
  - Atoms are rearranged to form new substances but are never created or destroyed

- Thomson (1897) – **Plum Pudding Model** – electrons are located inside a positively charged space

- Rutherford (1909) – **Gold Foil Experiment** – shot positively charged particle through gold foil and found the deflected particles bounced off a **nucleus** with a **proton** inside
- Chadwick (1932) – nucleus contains **neutrons**
- Bohr (1913) – electrons occupy outside the nucleus in **electron orbits**

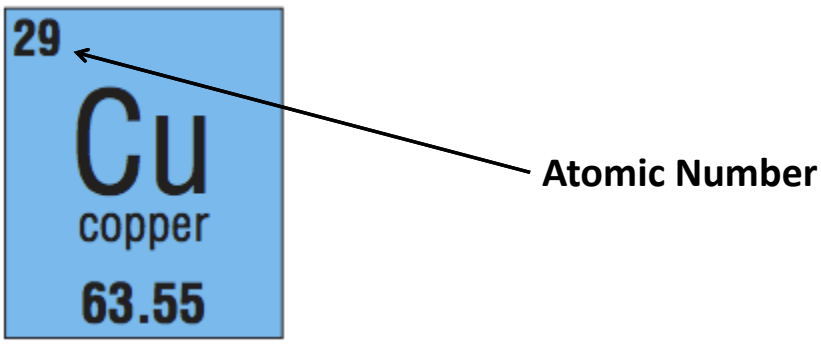
	Proton	Neutron	Electron
charge	+	0	–
location	in nucleus	in nucleus	orbiting nucleus
relative mass	1	1	$\frac{1}{2000}$
symbol	p^+	n^0	e^-





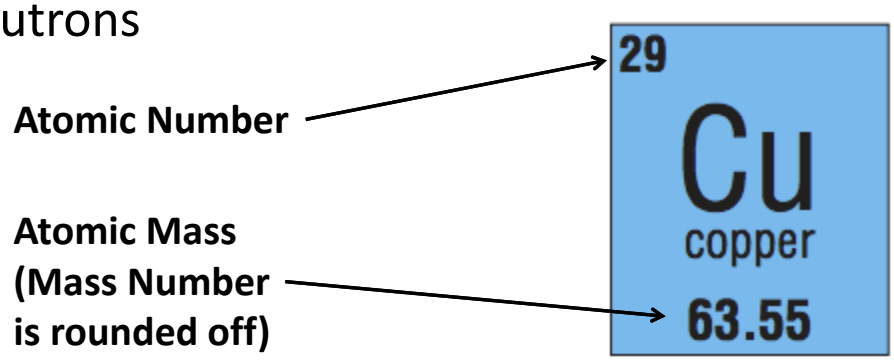
Atomic Number (Z)

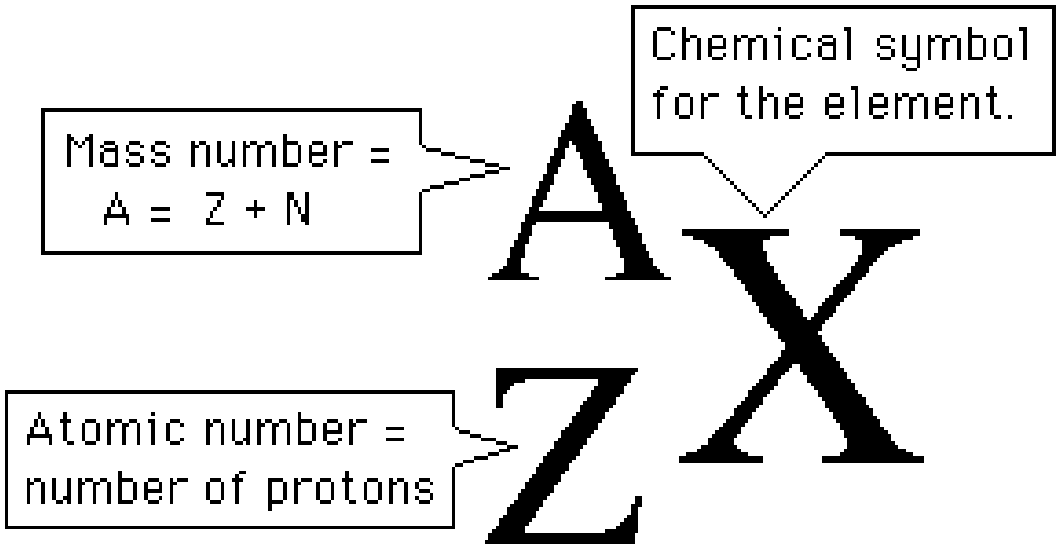
- Elements are different due to their number of protons
- Atomic Number = Number of protons
- Ex: What is the atomic number for Copper?



Mass Number (A)

- The mass of an atom comes from the total mass of the protons and neutrons (electrons have an insignificant mass)
- Mass Number = Number of protons and neutrons





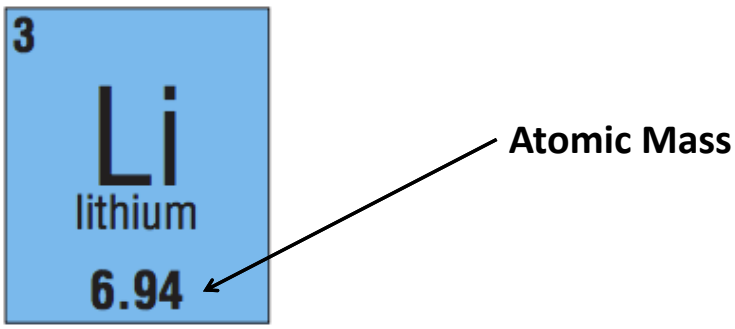
Checkpoint

How many protons, electrons and neutrons are in each of the following:

$^{7}_{3}Li$ $^{40}_{20}Ca$ Nitrogen-14

Atomic Mass

- The mass of an atom; the value below the element symbol on the periodic table
  - Measured in atomic mass units (μ)



Isotopes

- Why is atomic number a decimal number?
  - The atomic number is a weighted average of isotopes
- Isotopes – atoms with the same number of protons but a different number of neutrons
  - Ex: Lithium appears in nature with 6 neutrons or 7 neutrons (Li-6 and Li-7)
- When you round the atomic number, that is the most common isotope of the element

Checkpoint

What is the most common isotope of:

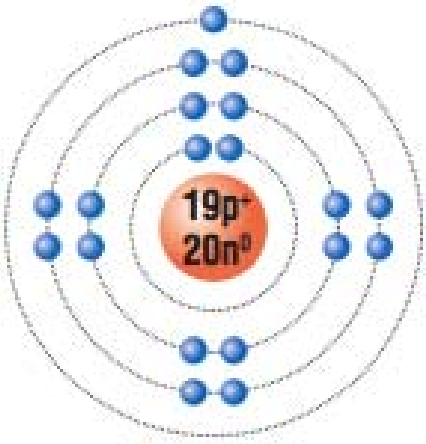
a) Aluminum (Z=13, atomic mass=26.982)

b) Oxygen (Z=8, atomic mass=15.999)

c) Neon (Z=10, atomic mass=20.180)

Bohr-Rutherford Diagrams

- Bohr-Rutherford Diagrams show the numbers and locations of protons, neutrons and electrons in an atom



How to Draw B-R Diagrams

Draw a Bohr-Rutherford Diagram of N-14.

1. Draw a nucleus – write the number of protons and neutrons inside the nucleus
2. Draw orbitals around the nucleus
3. Represent electrons as pairs of dots in the orbitals
    - 1^{st} orbital = 2 electrons
    - 2^{nd} orbital = 8 electrons
    - 3^{rd} orbital = 8 electrons
    - 4^{th} orbital = 18 electrons

Checkpoint

Draw the Bohr-Rutherford Diagram of:

a) Fluorine
b) Phosphorus
c) Potassium