

# MATTER COMPOSITION

# Definitions: Matter and Mass

- Matter

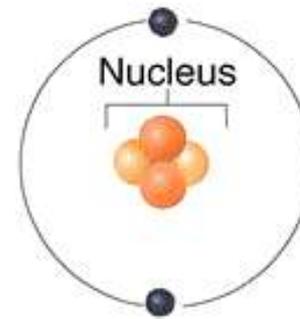
- All living and nonliving things consist of **matter**
  - matter - anything which occupies space and has mass
  - liquid, solid or gas (the phases which matter takes)
- Mass vs. Weight
  - mass is the actual amount of matter an object contains
  - weight is a measure of the force of gravity on a mass
    - mass is same everywhere
    - weight varies with the position of an object on or above earth

# Composition of Matter

- Elements and Atoms
  - Element
    - a substance which cannot be split into simpler substances by ordinary chemical reactions
    - composed of specific types of atoms
  - 112 elements (at least)
    - 90 occur naturally in nature
    - 25 occur naturally in the body
    - most common: H, C, O, N

# • Atomic structure

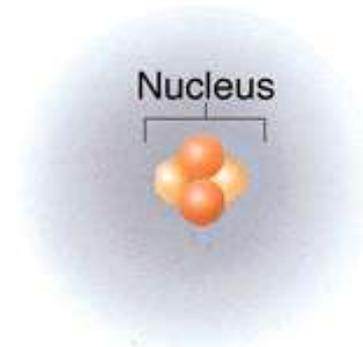
- Protons, neutrons, electrons
  - protons = positively
  - neutrons neutral
  - Electrons=negative
- Number of protons = Number of electrons – each atom is electrically neutral
- Protons and neutrons in the nucleus; electrons orbit the nucleus



Helium atom

2 protons ( $p^+$ )  
2 neutrons ( $n^0$ )  
2 electrons ( $e^-$ )

(a) Planetary model



Helium atom

2 protons ( $p^+$ )  
2 neutrons ( $n^0$ )  
2 electrons ( $e^-$ )

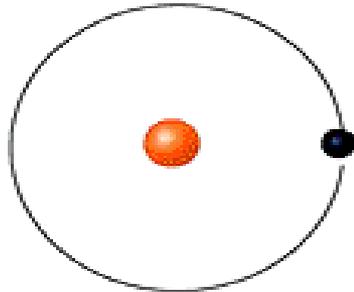
(b) Orbital model

Key:  = Proton     = Electron  
 = Neutron     = Electron orbital

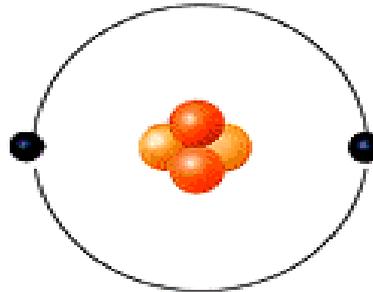
# Atomic Number

- The number of protons in the nucleus
  - This is the large number on the periodic table
- The number of protons in the nucleus makes atoms of one element differ from the atoms of other elements
  - Hydrogen: 1 proton, helium: 2 protons, carbon: 6 protons, etc.

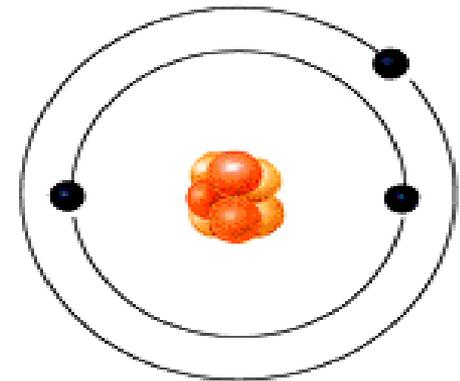
**Key:**  
● = Proton  
● = Neutron  
● = Electron



Hydrogen (H)  
(1p<sup>+</sup>; 0n<sup>0</sup>; 1e<sup>-</sup>)



Helium (He)  
(2p<sup>+</sup>; 2n<sup>0</sup>; 2e<sup>-</sup>)

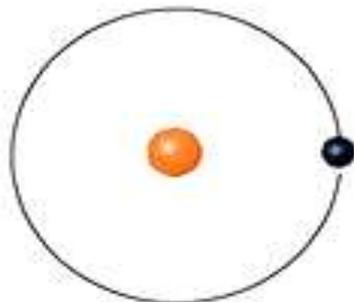


Lithium (Li)  
(3p<sup>+</sup>; 4n<sup>0</sup>; 3e<sup>-</sup>)

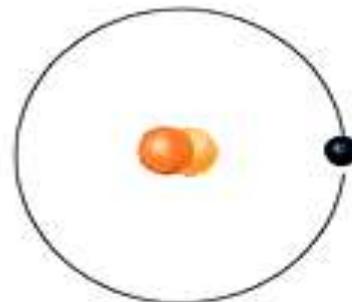
# Mass Number

- Mass number = total number of protons + neutrons
  - Mass number may vary among the atoms of an element because of different numbers of neutrons (isotopes)
  - All isotopes of an element have:
    - the same number of protons
    - the same chemical characteristics
  - Radioactive isotopes are unstable isotopes which “decay” into other isotopes, even into other types of elements

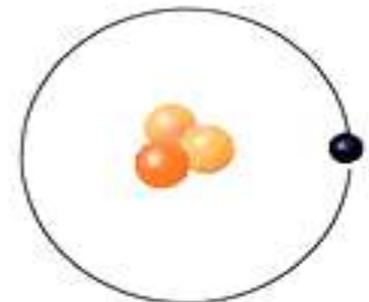
**Key:**  
● = Proton  
● = Neutron  
● = Electron



Hydrogen ( ${}^1\text{H}$ )  
( $1\text{p}^+$ ;  $0\text{n}^0$ ;  $1\text{e}^-$ )



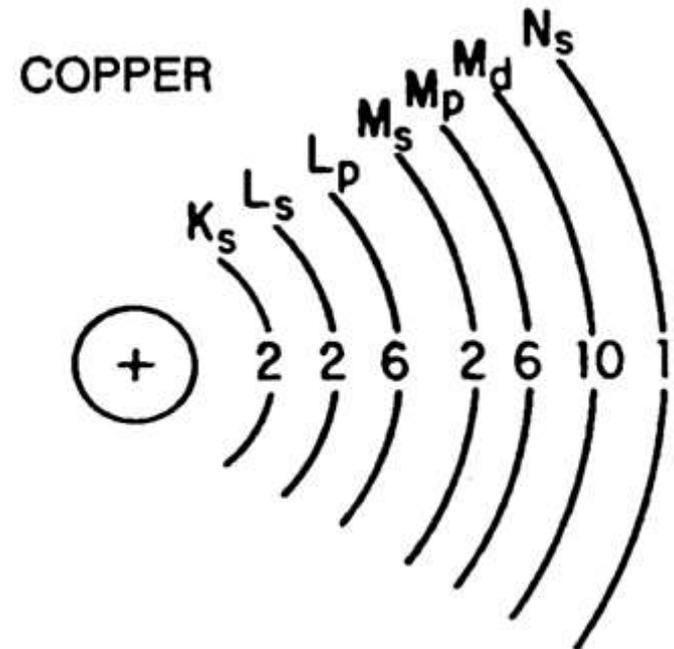
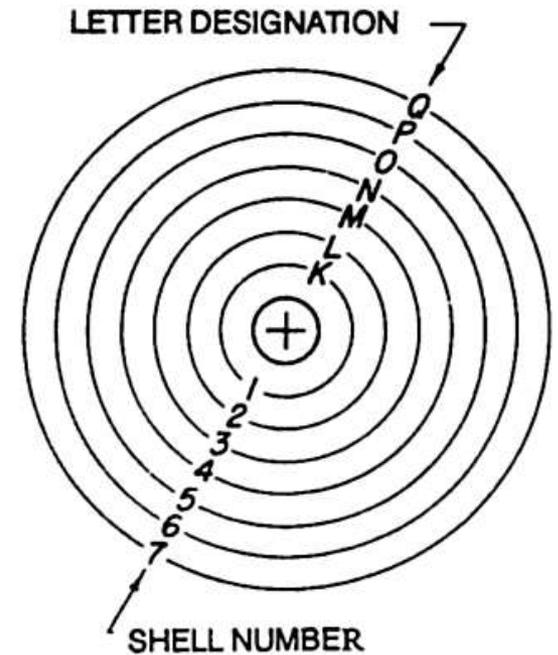
Deuterium ( ${}^2\text{H}$ )  
( $1\text{p}^+$ ;  $1\text{n}^0$ ;  $1\text{e}^-$ )



Tritium ( ${}^3\text{H}$ )  
( $1\text{p}^+$ ;  $2\text{n}^0$ ;  $1\text{e}^-$ )

- **Electron structure**

- Electrons orbit nucleus in shells
- Shells contain subshells
- The outer shell is the valence shell
- Electrons last shell are called valence electrons
- Atoms are stable when they have the last shell filled



# Atoms Are Combined into Molecules or Compounds

- Molecule - 2 or more atoms held together by chemical bonds (they may be the same element)
- Compound
  - Molecules which can be broken down into 2 or more **different** elements by chemical means, e.g.,  $\text{H}_2\text{O}$
  - Demonstrates **new** characteristics of the combined atoms which may be quite different than the characteristics of the individual elements, e.g., H and O are gases at temperatures at which  $\text{H}_2\text{O}$  is a liquid or solid

# How Molecules Are Mixed

- Mixtures - Substances composed of two or more components physically intermixed, may be a gas, a solid or a liquid
  - *Solutions* – e.g., salt water and blood plasma
    - Homogeneous with each molecule a separate entity in the mix
    - Mixture of two or more components (types of molecules)
      - Solvent – the medium in which the other materials are mixed
      - Solute – the various other components in the mix
  - *Colloids* – e.g., Jell-O and cell cytoplasm
    - heterogeneous mixtures that appear translucent or milky
    - smaller particles (clumps of similar molecules) which scatter light
  - *Suspensions* - blood (red blood cells suspended in plasma)
    - heterogeneous mixture with larger, often visible particles
    - particles will settle out due to gravity

# Types of Chemical Bonds

- From Strongest to Weakest:
  - Covalent
  - Ionic
  - Hydrogen
  - van der Waals (hydrophobic)

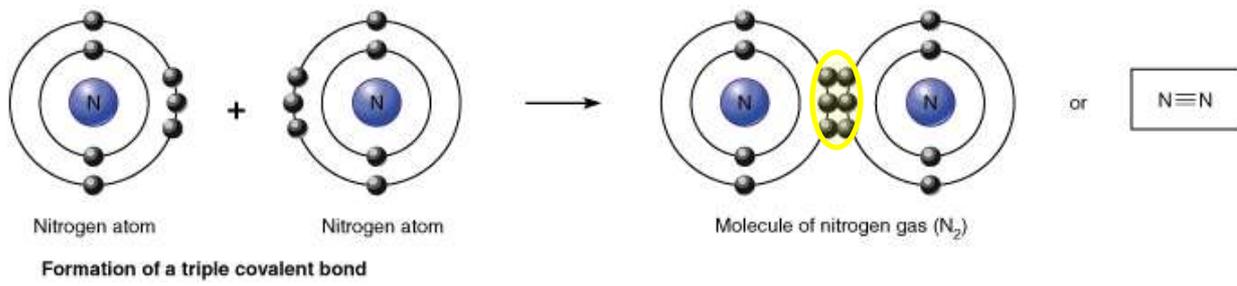
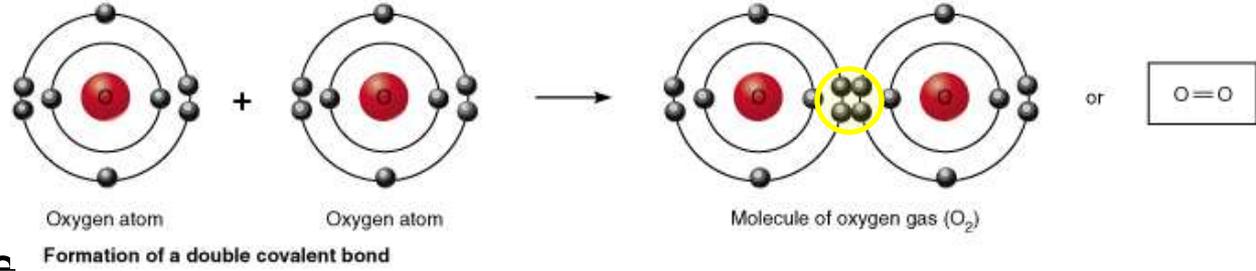
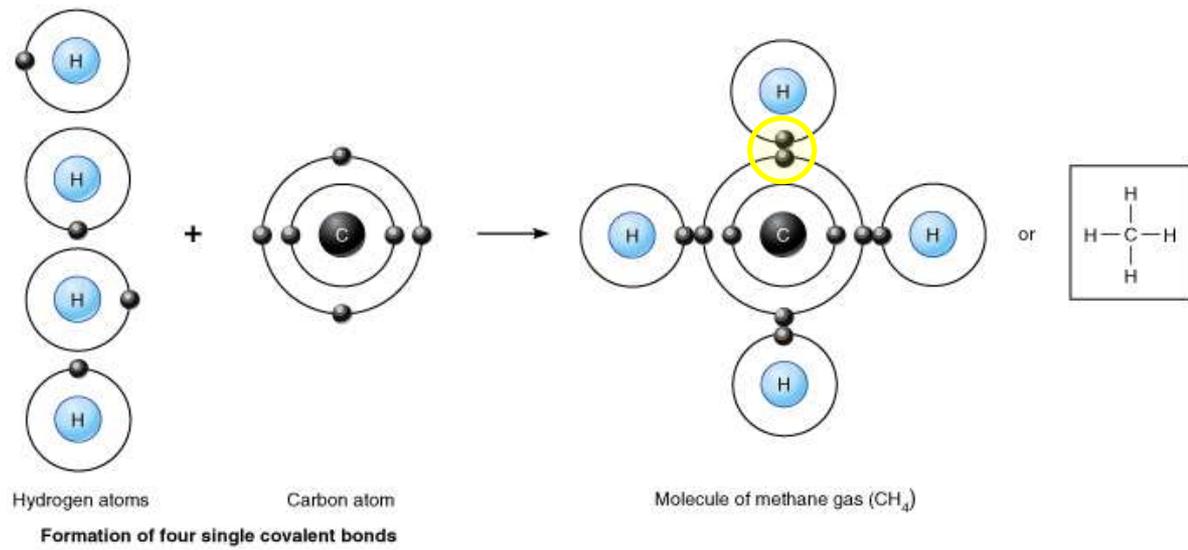
# Covalent Bonds

- Electrons are **shared** among two or more atoms

- Carbon + 4 Hydrogen = Methane

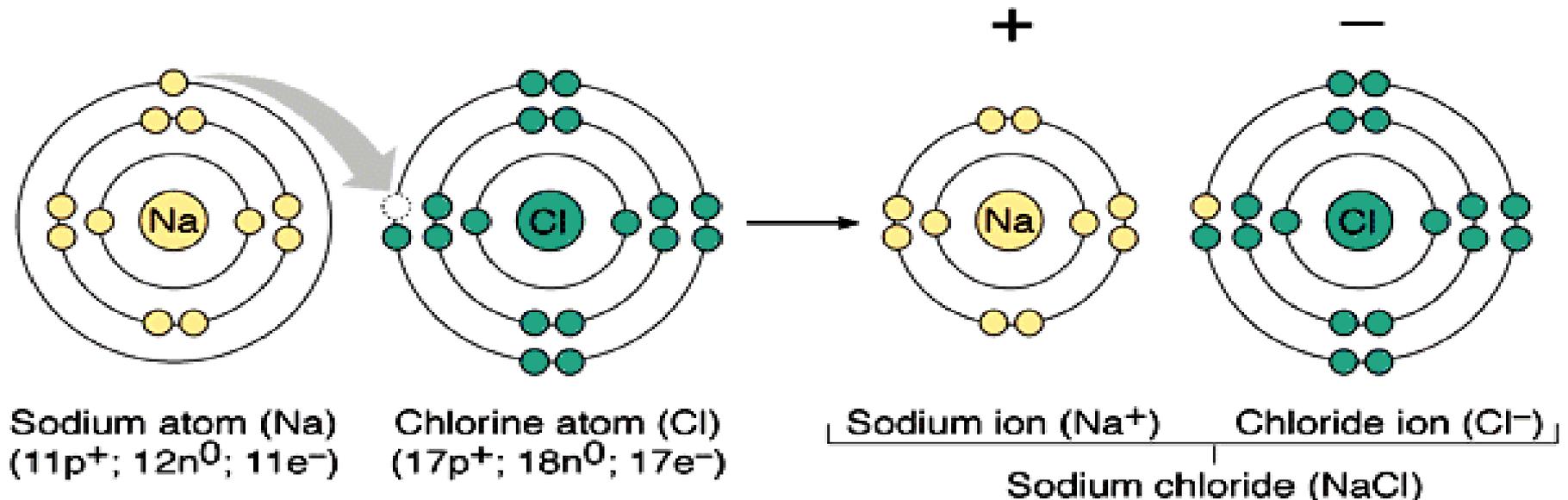
- carbon - 4 valence electrons to share
- hydrogen - 1 valence electron to share

- Single, double or triple bonds refer to the number of electrons shared between 2 atoms



# Ionic Bonds

- Electrons can be completely separated and ***transferred*** from one atom to another – forming positive and negative ions
  - **Cations:** Electron donors that have a net positive charge
  - **Anions:** Electron acceptors that have a net negative charge
  - Oppositely charged ions attract each other  $\Rightarrow$  ionic bonds



# Ionic Bonds

- Example: table salt (sodium chloride)
  - Sodium atom has one electron in its outer valence shell it can lose 1 electron for greater stability
  - Chlorine has 7 electrons in its outer shell – it needs 1 more for greater stability
  - Sodium transfers one electron to chlorine
    - $\text{Cl}^-$  becomes an anion and  $\text{Na}^+$  becomes a cation
  - Ions are created and they attract each other forming an ionic bond

