

# UNIT 2

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BIOCHEMISTRY: ATOMIC STRUCTURE, WATER PROPERTIES, MACROMOLECULES, & ENZYMES

# UNIT 2 (BIOCHEMISTRY) TOPIC 1: ATOMIC AND MOLECULAR STRUCTURE

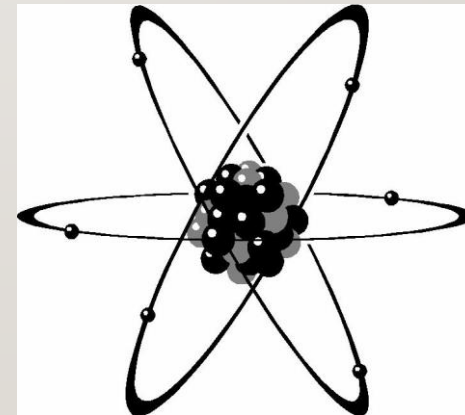
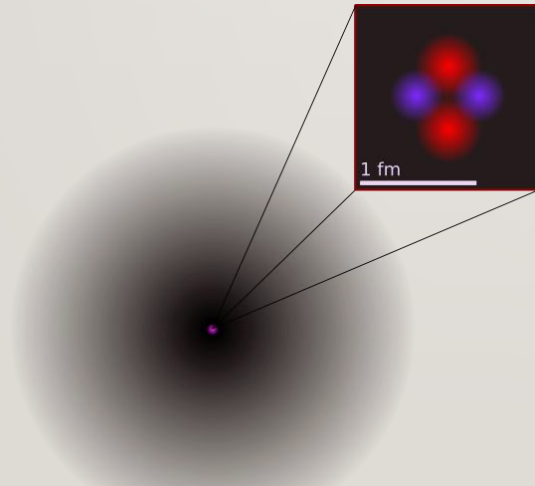
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- By the end of this topic, you should be able to...
  1. Label an atom and its subatomic particles
  2. Identify the charge of each subatomic particle
  3. Differentiate between different types of bonds (covalent & ionic)
  4. Explain the similarities and differences between the following terms: atom, ion, element, compound, molecule
  5. List the six main elements in living things

# ATOMS

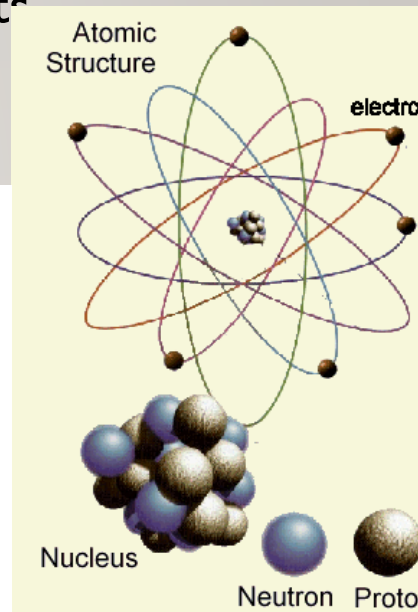
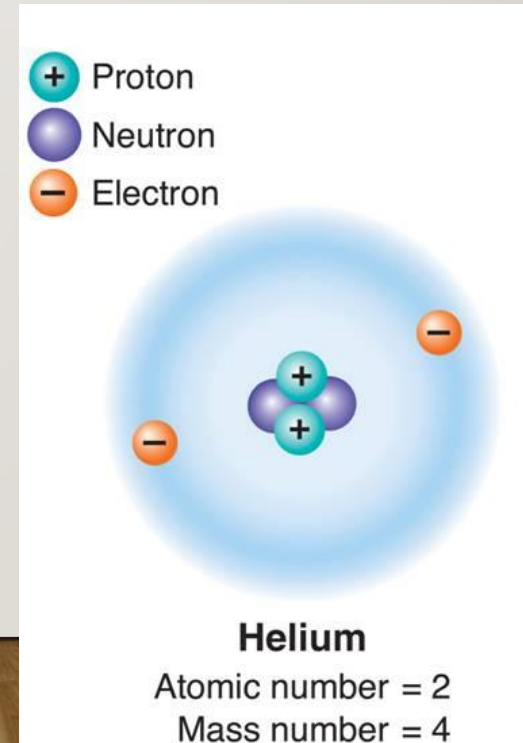
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- What is an atom?
  - Basic unit of matter
  - **Smallest** particle of an element that contains all properties of that element (92 occur in nature)



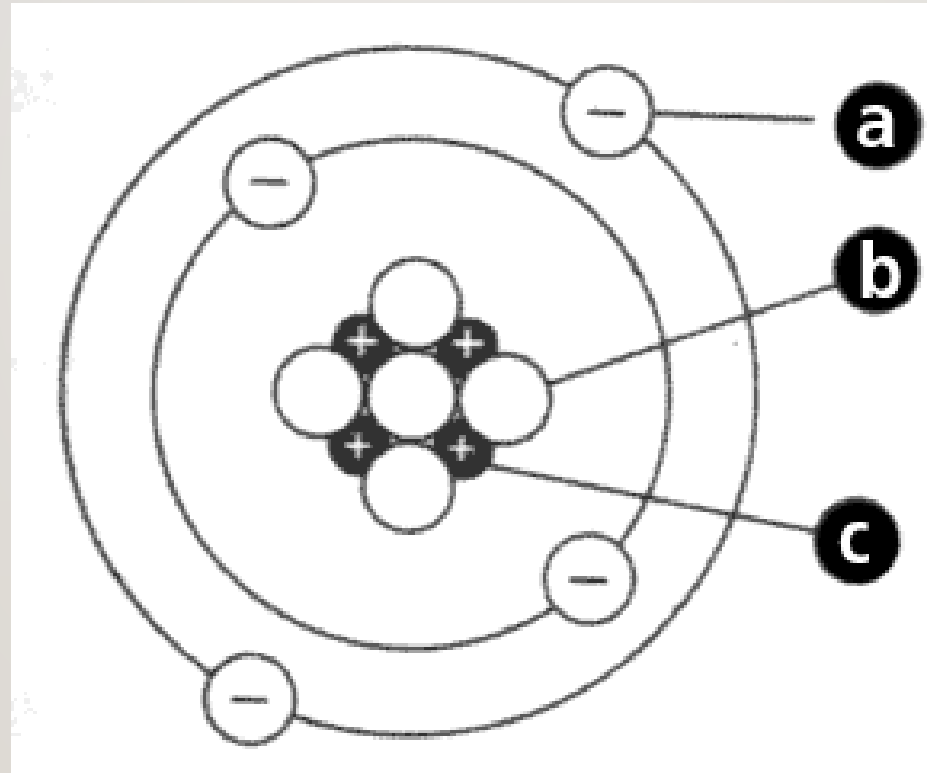
# SUBATOMIC PARTICLES

- While an atom is the smallest unit of matter, it is made of even smaller components (subatomic particles)
  - Proton: positive charge (+); located in the nucleus of atom
  - Neutron: neutral/no charge(0); in the nucleus of atom
  - Electron: negative charge(-); surrounds nucleus of atom



# LABEL THE FOLLOWING ATOM:

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A:

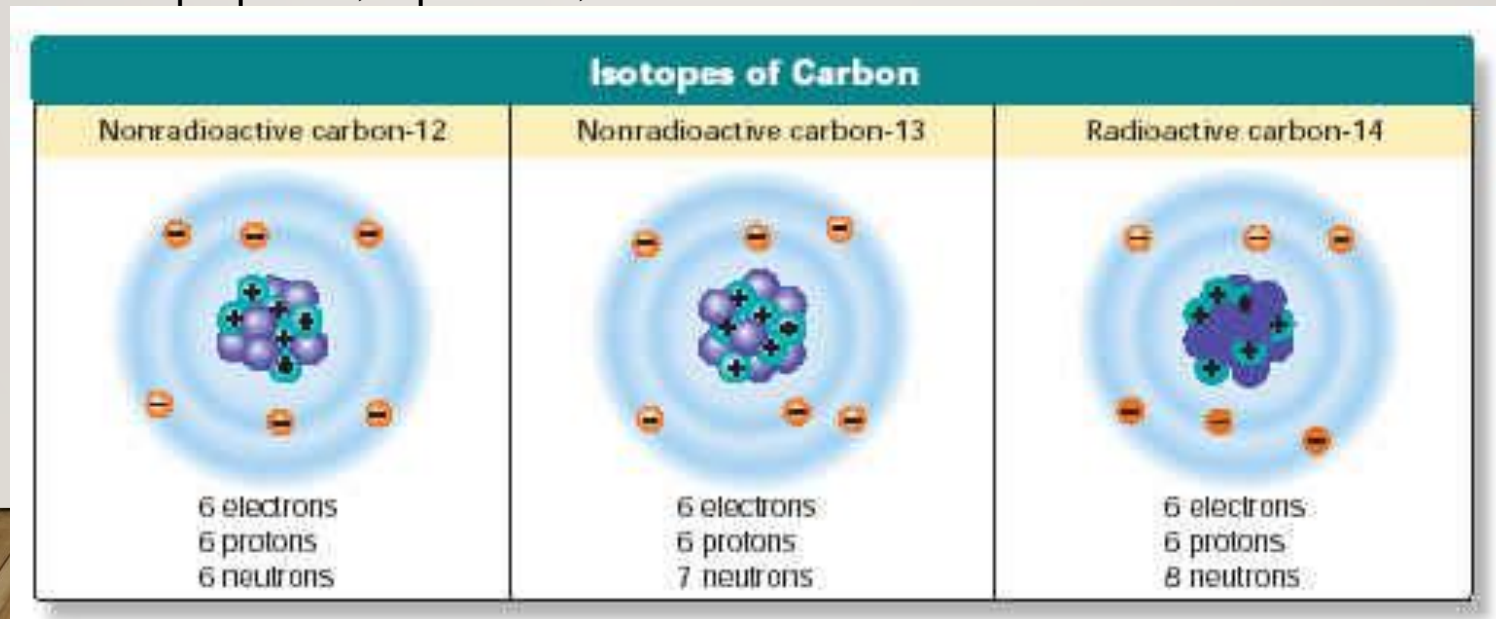
B:

C:



# NEUTRONS

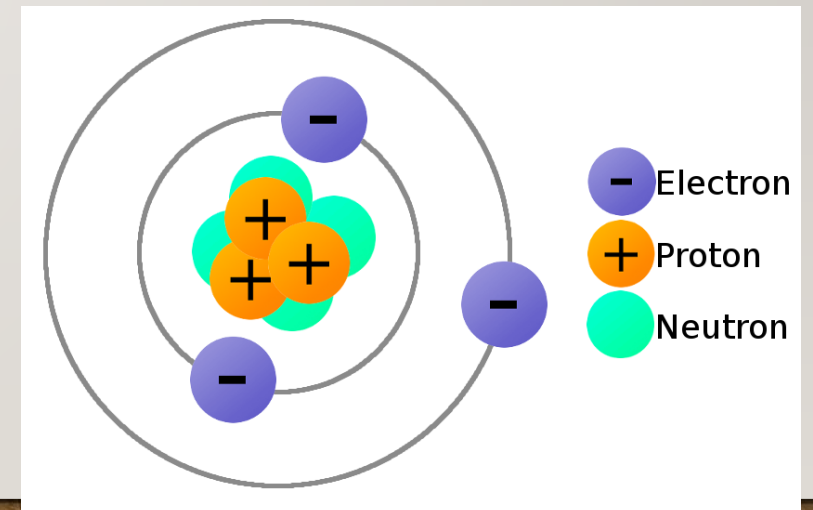
- Atoms of the same element may have different numbers of neutrons
  - If this is the case, we are looking at **isotopes** of that element
    - Isotope: each of two or more forms of the same element that contain equal numbers of protons but different numbers of neutrons in their nuclei, and hence differ in relative atomic mass but not in chemical properties; in particular, a **radioactive** form of an element.



# PROTONS

- Atoms of the same element **must** all have the same number of protons in the nucleus of the element
- The number of protons is also equal to the **atomic number**
- The number of protons is balanced by the number of electrons

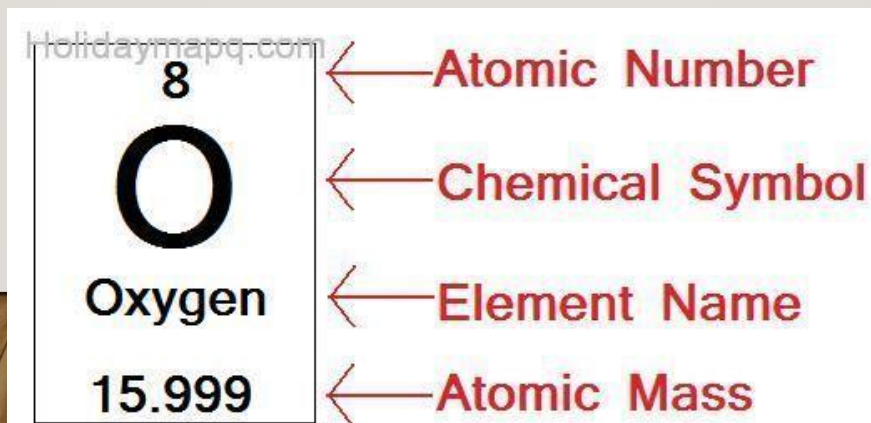
Atomic Number	→ 1		
		H	← Symbol
		1.01	← Relative Atomic Mass
Name	→	Hydrogen	



# PERIODIC TABLE INFORMATION

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- Atomic number = number of protons
- Atomic mass = number of protons + number of neutrons (essentially, add together everything found in the nucleus)
  - Protons & neutrons each have a mass of 1 amu (atomic mass unit)
  - Mass of electrons is negligible, so we do not add that in





# EXAMINING THE PERIODIC TABLE

Periodic Table of the Elements

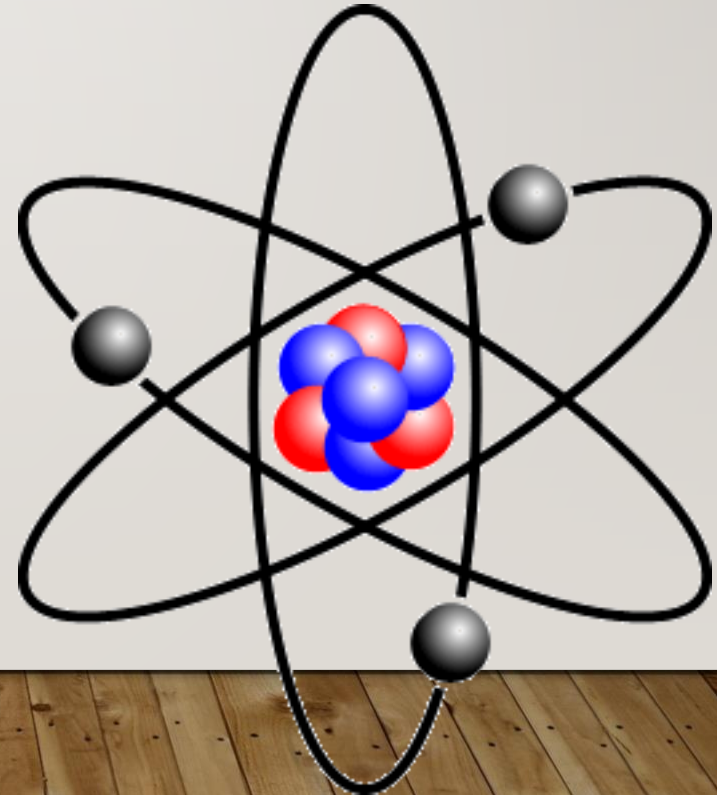
1 H Hydrogen 1.01																	2 He Helium 4.00
3 Li Lithium 6.94	4 Be Beryllium 9.01											5 B Boron 10.81	6 C Carbon 12.01	7 N Nitrogen 14.01	8 O Oxygen 16.00	9 F Fluorine 19.00	10 Ne Neon 20.18
11 Na Sodium 22.99	12 Mg Magnesium 24.31											13 Al Aluminum 26.98	14 Si Silicon 28.09	15 P Phosphorus 30.97	16 S Sulfur 32.06	17 Cl Chlorine 35.45	18 Ar Argon 39.95
19 K Potassium 39.10	20 Ca Calcium 40.08	21 Sc Scandium 44.96	22 Ti Titanium 47.88	23 V Vanadium 50.94	24 Cr Chromium 51.99	25 Mn Manganese 54.94	26 Fe Iron 55.93	27 Co Cobalt 58.93	28 Ni Nickel 58.69	29 Cu Copper 63.55	30 Zn Zinc 65.39	31 Ga Gallium 69.73	32 Ge Germanium 72.61	33 As Arsenic 74.92	34 Se Selenium 78.09	35 Br Bromine 79.90	36 Kr Krypton 84.80
37 Rb Rubidium 84.49	38 Sr Strontium 87.62	39 Y Yttrium 88.91	40 Zr Zirconium 91.22	41 Nb Niobium 92.91	42 Mo Molybdenum 95.94	43 Tc Technetium 98.91	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.91	46 Pd Palladium 106.42	47 Ag Silver 107.87	48 Cd Cadmium 112.41	49 In Indium 114.82	50 Sn Tin 118.71	51 Sb Antimony 121.76	52 Te Tellurium 127.6	53 I Iodine 126.90	54 Xe Xenon 131.29
55 Cs Cesium 132.91	56 Ba Barium 137.33	57-71 Lanthanides	72 Hf Hafnium 178.49	73 Ta Tantalum 180.95	74 W Tungsten 183.85	75 Re Rhenium 186.21	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.97	80 Hg Mercury 200.59	81 Tl Thallium 204.38	82 Pb Lead 207.20	83 Bi Bismuth 208.98	84 Po Polonium [208.98]	85 At Astatine 209.98	86 Rn Radon 222.02
87 Fr Francium 223.02	88 Ra Radium 226.03	89-103 Actinides	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [269]	109 Mt Meitnerium [268]	110 Ds Darmstadtium [269]	111 Rg Roentgenium [272]	112 Cn Copernicium [277]	113 Uut Ununtrium unknown	114 Fl Flerovium [289]	115 Uup Ununpentium unknown	116 Lv Livermorium [296]	117 Uus Ununseptium unknown	118 Uuo Ununoctium unknown
57 La Lanthanum 138.91	58 Ce Cerium 140.12	59 Pr Praseodymium 140.91	60 Nd Neodymium 144.24	61 Pm Promethium 144.91	62 Sm Samarium 150.36	63 Eu Europium 151.97	64 Gd Gadolinium 157.25	65 Tb Terbium 158.93	66 Dy Dysprosium 162.50	67 Ho Holmium 164.93	68 Er Erbium 167.26	69 Tm Thulium 168.93	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.97			
89 Ac Actinium 227.03	90 Th Thorium 232.04	91 Pa Protactinium 231.04	92 U Uranium 238.03	93 Np Neptunium 237.05	94 Pu Plutonium 244.06	95 Am Americium 243.06	96 Cm Curium 247.07	97 Bk Berkelium 247.07	98 Cf Californium 251.08	99 Es Einsteinium [254]	100 Fm Fermium 257.10	101 Md Mendelevium 258.10	102 No Nobelium 259.10	103 Lr Lawrencium [262]			

- Alkali Metal
- Alkaline Earth
- Transition Metal
- Basic Metal
- Semimetal
- Nonmetal
- Halogen
- Noble Gas
- Lanthanide
- Actinide

# ELECTRONS

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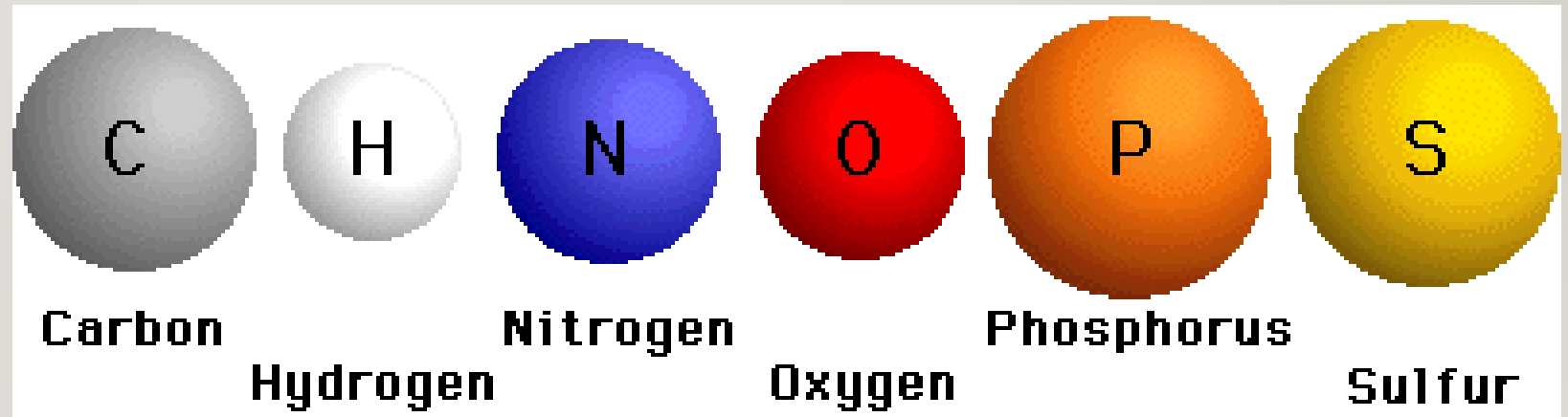
- Electrons are negatively charged subatomic particles that surround the nucleus of an atom
  - Little to no mass (not included in atomic mass)
  - Travel at high speeds around the nucleus
  - Play a large role in chemical bonding



# ELEMENTS

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- 92 natural elements
- An element is composed of only one type of atom
- **Six** main elements in living things:
  - **Carbon**
  - **Hydrogen**
  - **Nitrogen**
  - **Oxygen**
  - **Phosphorus**
  - **Sulfur**



# CHEMICAL COMPOUNDS

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- Atoms are the basic unit of matter
- Elements are made of atoms of one type
- **Compounds** are formed by the chemical combination of two (or more) elements in definite proportions
  - Compounds are chemically joined, so they differ from the elements that they are made of (H<sub>2</sub>O is very different than hydrogen and oxygen on their own)
  - Chemical formulas are used to show the kind and proportion of atoms of each element in the compound



# CHEMICAL FORMULAS

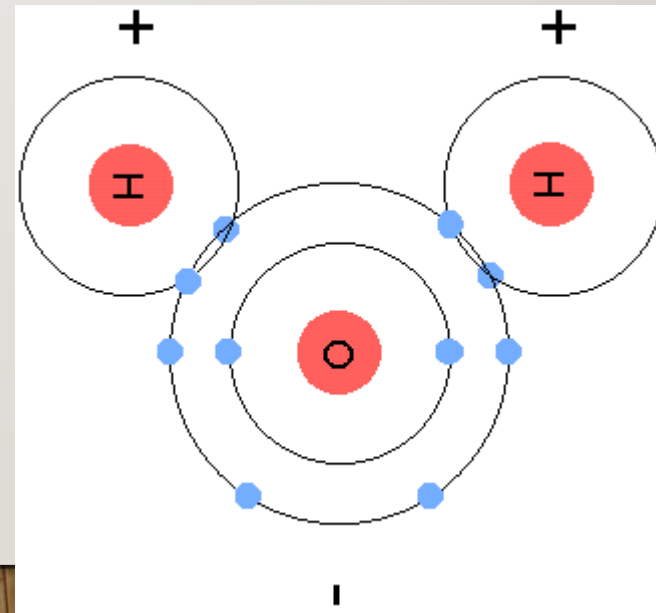
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- **Subscript** after a symbol tell the number of atoms of each element
- $\text{H}_2\text{O}$  has 2 atoms of hydrogen & 1 atom of oxygen
- **Coefficients** before a formula tell the number of molecules
  - $3\text{O}_2$  represents 3 molecules of oxygen or  $(3 \times 2)$  or 6 atoms of oxygen

# CHEMICAL BONDS

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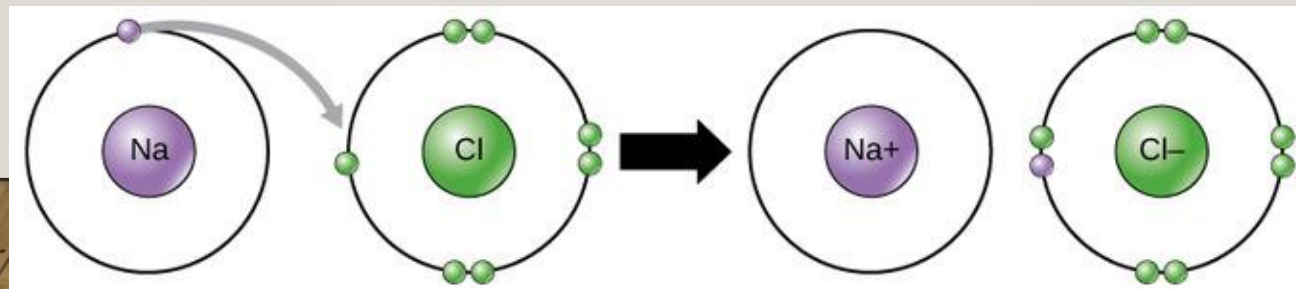
- Atoms in a compound are held together by chemical bonds
  - The electrons in the outermost shell that are used to form these bonds are called valence electrons
- Types of bonds:
  - Ionic (electrons gained/lost, ions formed)
  - Covalent (electrons shared)
  - Hydrogen (weak- discuss later)



# IONIC BONDS

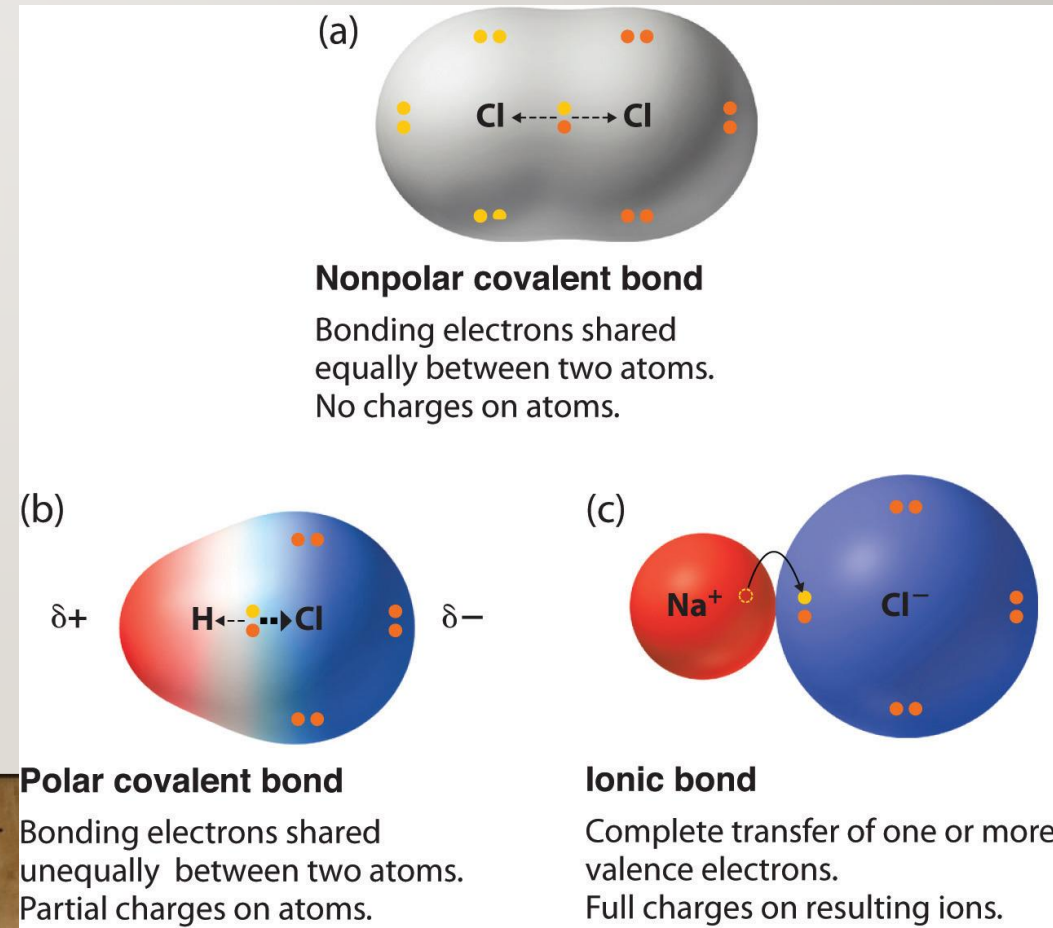
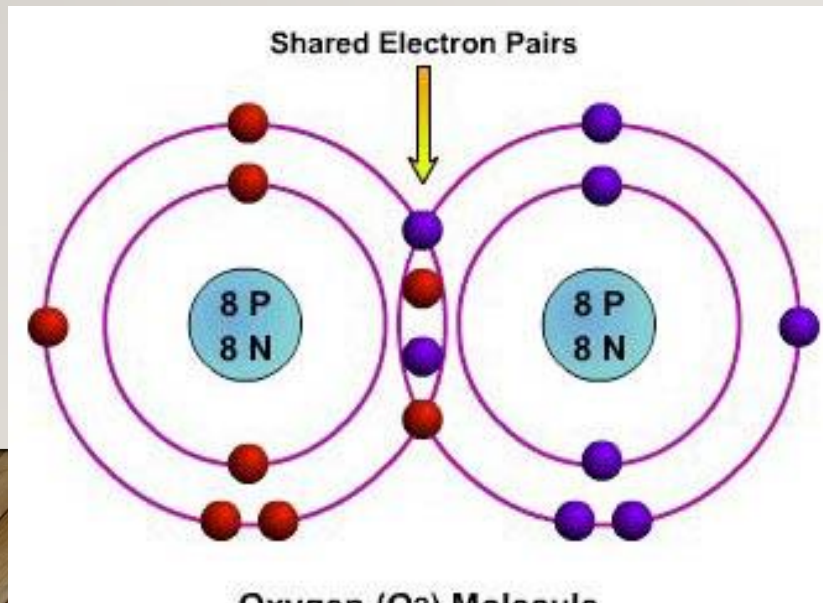
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- Oppositely charged ions are attracted to one another
  - Ion = atom that has gained or lost an electron
    - Positive ions have lost electrons (now there are more protons than electrons, giving this ion a positive charge)
    - Negative ions have gained electrons (now there are fewer protons than electrons, giving this ion a negative charge)
- Electrons are transferred



# COVALENT BONDS

- Two atoms combine by sharing electrons
- No net charge
- Strength of bond depends on # of e- shared





# MOLECULES

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- Atom – smallest unit of matter
- Element – made of one type of atom
- Compound – two or more elements chemically bonded together
- Molecule – two or more atoms joined together chemically
  - All compounds are molecules, but not all molecules are compounds

# VAN DER WAALS FORCES

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- When molecules are close together, a slight attraction can develop between the oppositely charged regions of nearby molecules.

