Analytical chemistry

Chemical analysis

a) Qualitative analysis

b) Quantitative analysis

Qualitative analysis

Definition: Knowing the of substance present in the solution.(i.e. it's quality).

Examples: (Iron (Fe), Copper (Cu), Calcium, ……etc.)

Identification of chemical components is done by:

1) Physically : (Color, Odor, Shape)

2) Chemically : (Components of the sample)

Quantitative analysis

Definition: Knowing quantity of substance present in the solution.

Examples : the quantity of a certain substance in the sample solution (10% Fe, 3% Na, 5% Cl, ……etc.).

1) Traditional method:

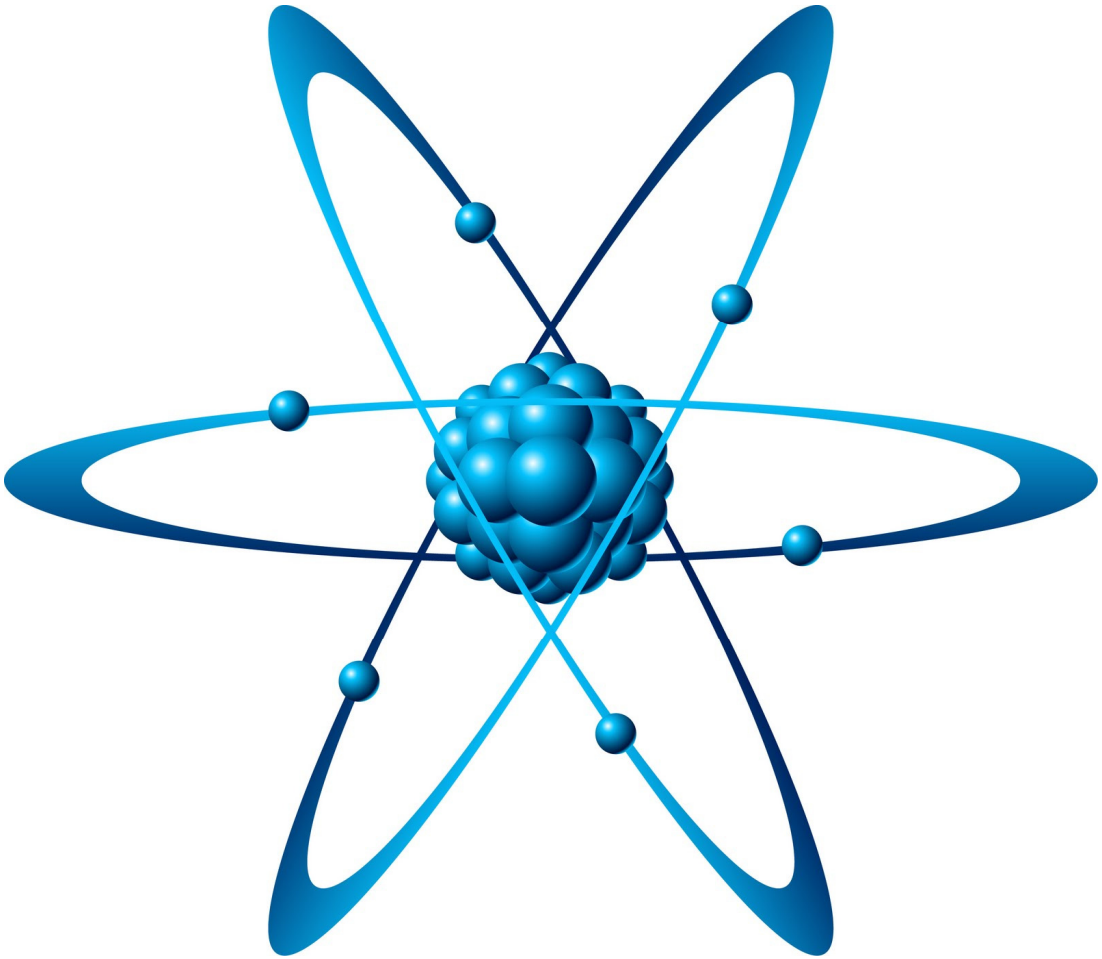
Volumetric analysis: Knowing the concentration of the sample, example: (titration method).

2) Modern method:

Instrumental technique: (Spectrophotometric analysis)

Important Definitions

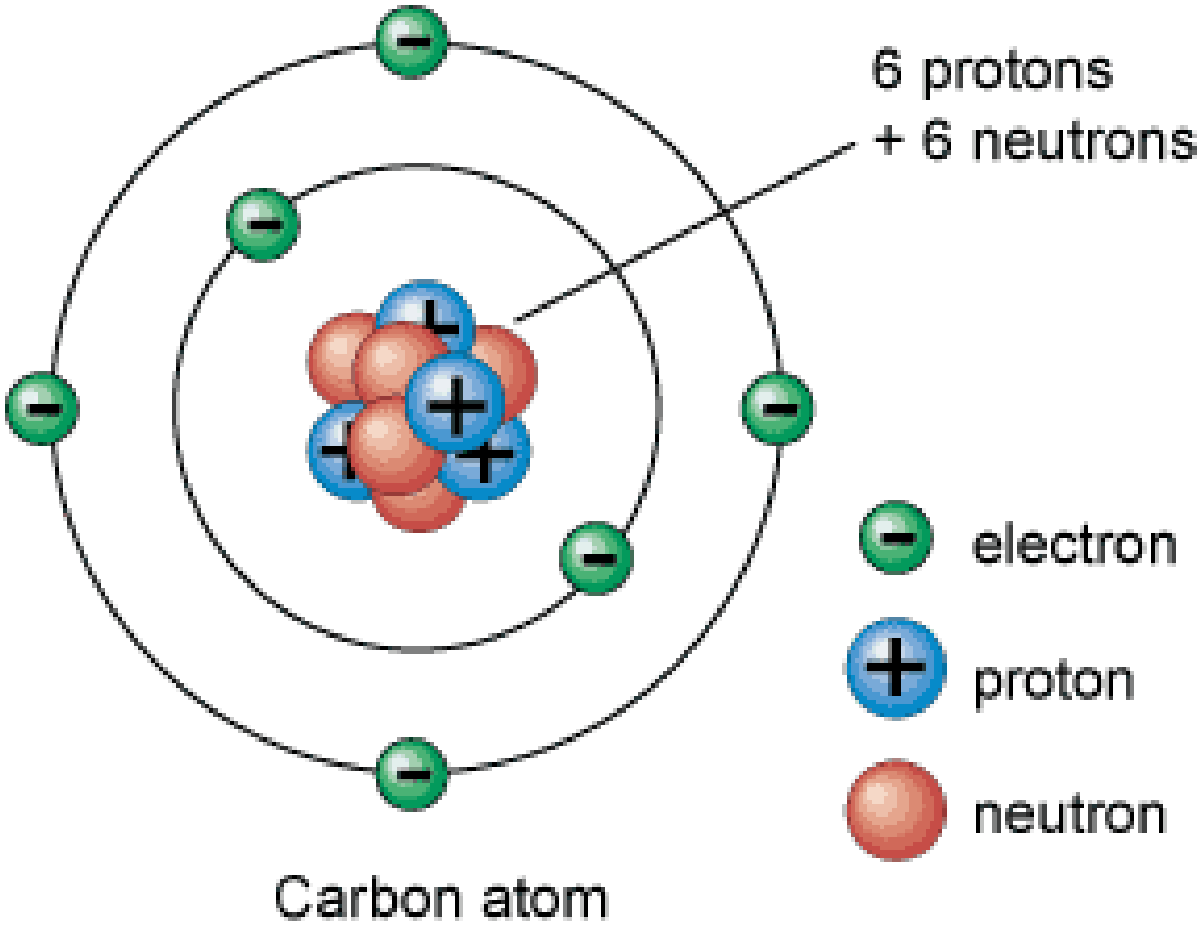
Atom



Atom

- It’s the smallest building unit for an element.
- It consists of a nucleus containing combination of neutrons and protons.
- The number of protons determines the identity of the element.
- One of more electrons bound to the nucleus by electrical attraction.
- **Examples :** Carbon (C), Hydrogen (H), Oxygen (O), Nitrogen(N), Iron (Fe), Sulfur (S), Aluminum (Al), …….etc.

Atom



Atomic weight (At.wt)

- Its the weight of a single atom.
- Its the summation of number of protons and neutrons .
- It’s unit atomic mass unit (a.m.u.)
- It’s written under elements in the periodic table
- **Examples:**
  1. At.wt of Hydrogen (H) = 1 a.m.u.
  2. At.wt of Carbon (C) = 12 a.m.u.
  3. At.wt of Oxygen (O) = 16 a.m.u.
  4. At.wt of sodium (Na) = 23 a.m.u.
  5. At.wt of Chloride (Cl) = 35.5 a.m.u.

PERIODIC TABLE OF THE ELEMENTS

http://www.ktf-split.hr/periodni/en/

PERIOD	1 IA	2 IIA	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8	9 VIIIB	10	11 IB	12 IIB	13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA
1	1 1.0079 **H** HYDROGEN																	2 4.0026 **He** HELIUM
2	3 6.941 **Li** LITHIUM	4 9.0122 **Be** BERYLLIUM											5 10.811 **B** BORON	6 12.011 **C** CARBON	7 14.007 **N** NITROGEN	8 15.999 **O** OXYGEN	9 18.998 **F** FLUORINE	10 20.180 **Ne** NEON
3	11 22.990 **Na** SODIUM	12 24.305 **Mg** MAGNESIUM											13 26.982 **Al** ALUMINIUM	14 28.086 **Si** SILICON	15 30.974 **P** PHOSPHORUS	16 32.065 **S** SULPHUR	17 35.453 **Cl** CHLORINE	18 39.948 **Ar** ARGON
4	19 39.098 **K** POTASSIUM	20 40.078 **Ca** CALCIUM	21 44.956 **Sc** SCANDIUM	22 47.867 **Ti** TITANIUM	23 50.942 **V** VANADIUM	24 51.996 **Cr** CHROMIUM	25 54.938 **Mn** MANGANESE	26 55.845 **Fe** IRON	27 58.933 **Co** COBALT	28 58.693 **Ni** NICKEL	29 63.546 **Cu** COPPER	30 65.39 **Zn** ZINC	31 69.723 **Ga** GALLIUM	32 72.64 **Ge** GERMANIUM	33 74.922 **As** ARSENIC	34 78.96 **Se** SELENIUM	35 79.904 **Br** BROMINE	36 83.80 **Kr** KRYPTON
5	37 85.468 **Rb** RUBIDIUM	38 87.62 **Sr** STRONTIUM	39 88.906 **Y** YTTRIUM	40 91.224 **Zr** ZIRCONIUM	41 92.906 **Nb** NIOBIUM	42 95.94 **Mo** MOLYBDENUM	43 (98) **Tc** TECHNETIUM	44 101.07 **Ru** RUTHENIUM	45 102.91 **Rh** RHODIUM	46 106.42 **Pd** PALLADIUM	47 107.87 **Ag** SILVER	48 112.41 **Cd** CADMIUM	49 114.82 **In** INDIUM	50 118.71 **Sn** TIN	51 121.76 **Sb** ANTIMONY	52 127.60 **Te** TELLURIUM	53 126.90 **I** IODINE	54 131.29 **Xe** XENON
6	55 132.91 **Cs** CAESIUM	56 137.33 **Ba** BARIUM	57-71 **La-Lu** Lanthanide	72 178.49 **Hf** HAFNIUM	73 180.95 **Ta** TANTALUM	74 183.84 **W** TUNGSTEN	75 186.21 **Re** RHENIUM	76 190.23 **Os** OSMIUM	77 192.22 **Ir** IRIDIUM	78 195.08 **Pt** PLATINUM	79 196.97 **Au** GOLD	80 200.59 **Hg** MERCURY	81 204.38 **Tl** THALLIUM	82 207.2 **Pb** LEAD	83 208.98 **Bi** BISMUTH	84 (209) **Po** POLONIUM	85 (210) **At** ASTATINE	86 (222) **Rn** RADON
7	87 (223) **Fr** FRANCIUM	88 (226) **Ra** RADIUM	89-103 **Ac-Lr** Actinide	104 (261) **Rf** RUTHERFORDIUM	105 (262) **Db** DUBNIUM	106 (266) **Sg** SEABORGIUM	107 (264) **Bh** BOHRIUM	108 (277) **Hs** HASSIUM	109 (268) **Mt** MEITNERIUM	110 (281) **Uun** UNUNNILIUM	111 (272) **Uuu** UNUNUNIUM	112 (285) **Uub** UNUNBIUM		114 (289) **Uuq** UNUNQUADIUM				

RELATIVE ATOMIC MASS (1)
GROUP IUPAC
GROUP CAS
ATOMIC NUMBER
SYMBOL
ELEMENT NAME
5 10.811 **B** BORON

Metal · Semimetal · Nonmetal
1 Alkali metal
2 Alkaline earth metal
Transition metals
Lanthanide
Actinide
16 Chalcogens element
17 Halogens element
18 Noble gas

STANDARD STATE (25 °C; 101 kPa)
Ne - gas
Ga - liquid
Fe - solid
Tc - synthetic

LANTHANIDE

57 138.91 **La** LANTHANUM	58 140.12 **Ce** CERIUM	59 140.91 **Pr** PRASEODYMIUM	60 144.24 **Nd** NEODYMIUM	61 (145) **Pm** PROMETHIUM	62 150.36 **Sm** SAMARIUM	63 151.96 **Eu** EUROPIUM	64 157.25 **Gd** GADOLINIUM	65 158.93 **Tb** TERBIUM	66 162.50 **Dy** DYSPROSIUM	67 164.93 **Ho** HOLMIUM	68 167.26 **Er** ERBIUM	69 168.93 **Tm** THULIUM	70 173.04 **Yb** YTTERBIUM	71 174.97 **Lu** LUTETIUM

ACTINIDE

89 (227) **Ac** ACTINIUM	90 232.04 **Th** THORIUM	91 231.04 **Pa** PROTACTINIUM	92 238.03 **U** URANIUM	93 (237) **Np** NEPTUNIUM	94 (244) **Pu** PLUTONIUM	95 (243) **Am** AMERICIUM	96 (247) **Cm** CURIUM	97 (247) **Bk** BERKELIUM	98 (251) **Cf** CALIFORNIUM	99 (252) **Es** EINSTEINIUM	100 (257) **Fm** FERMIUM	101 (258) **Md** MENDELEVIUM	102 (259) **No** NOBELIUM	103 (262) **Lr** LAWRENCIUM

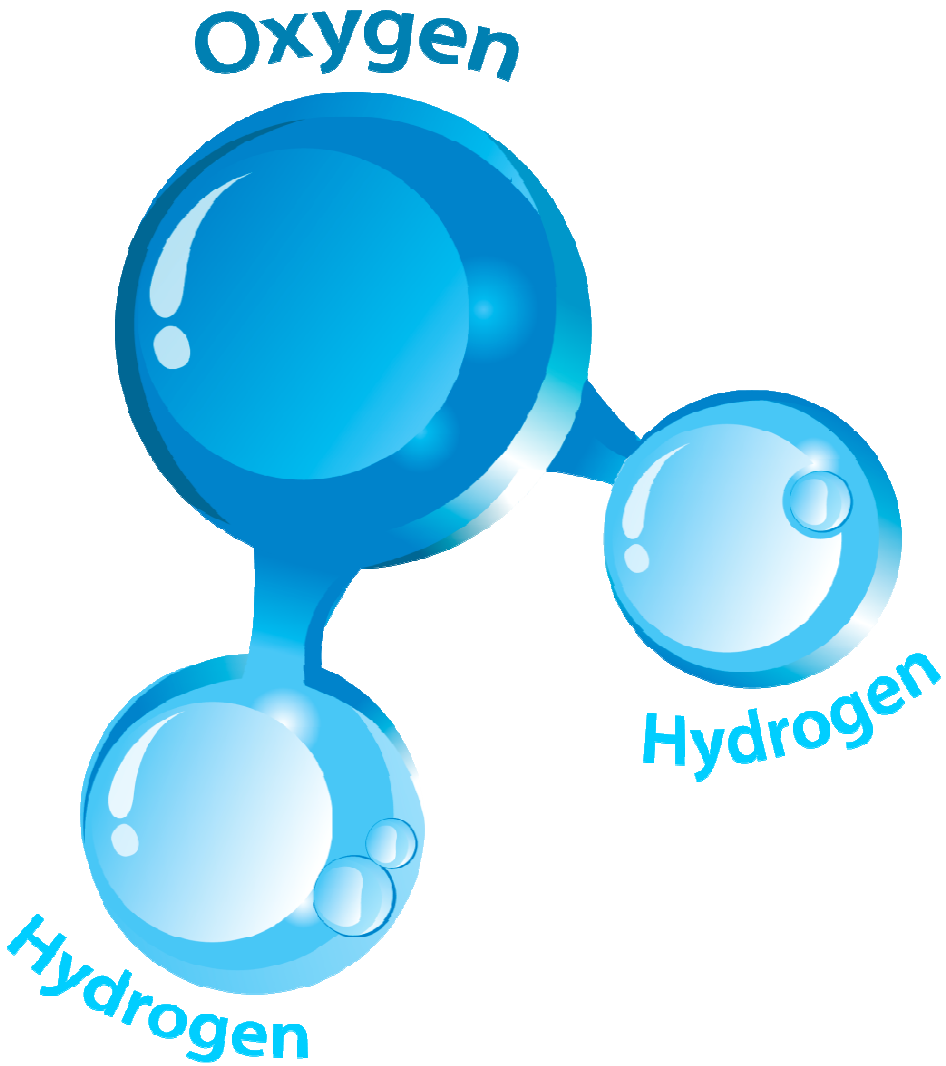
(1) Pure Appl. Chem., 73, No. 4, 667-683 (2001)

Relative atomic mass is shown with five significant figures. For elements have no stable nuclides, the value enclosed in brackets indicates the mass number of the longest-lived isotope of the element.

However three such elements (Th, Pa, and U) do have a characteristic terrestrial isotopic composition, and for these an atomic weight is tabulated.

Editor: Aditya Vardhan (adivar@netlinx.com)

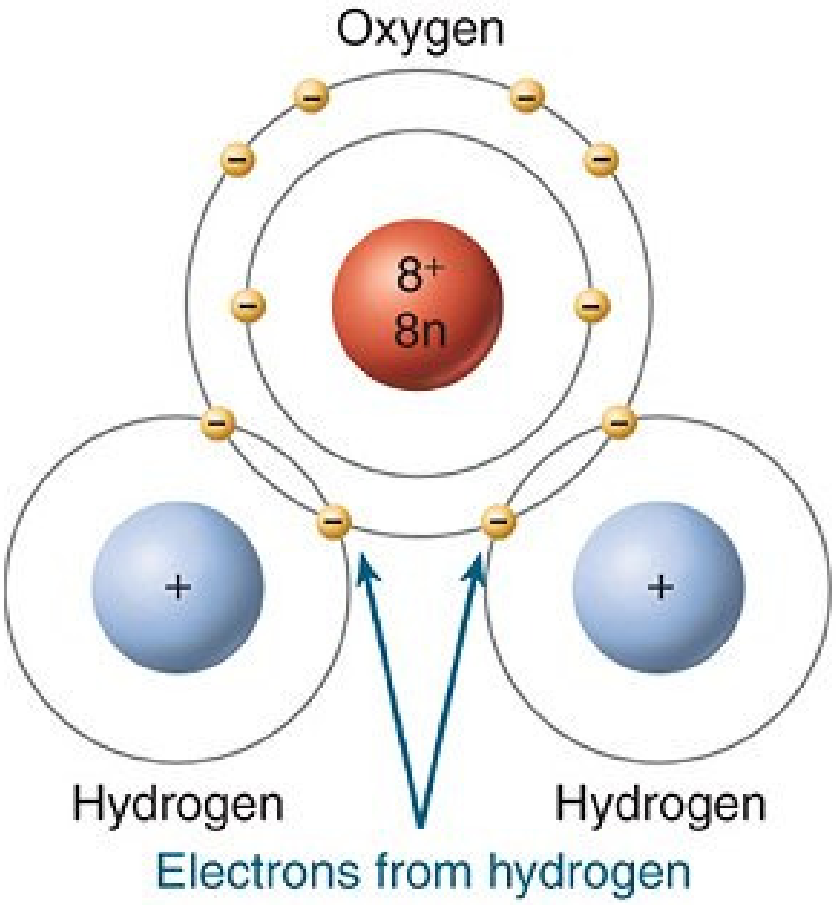
Molecule



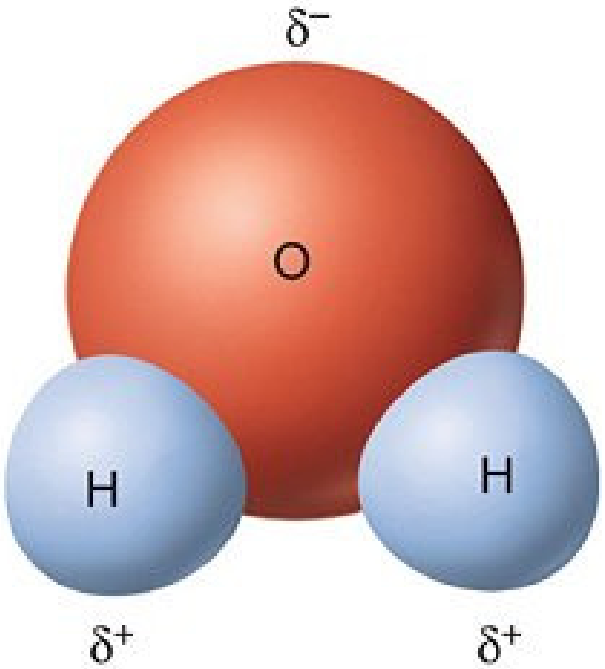
Molecule

- It consists of 2 or more atoms which have chemically combined to form a single species.
- Its may be consist of same or different types of atoms.
- Examples : carbon dioxide (CO_2), water (H_2O), sulfuric acid (H_2SO_4), table salt ($NaCl$), acetic acid (CH_3COOH), hydrochloric acid (HCl).

Water molecule (H2O)

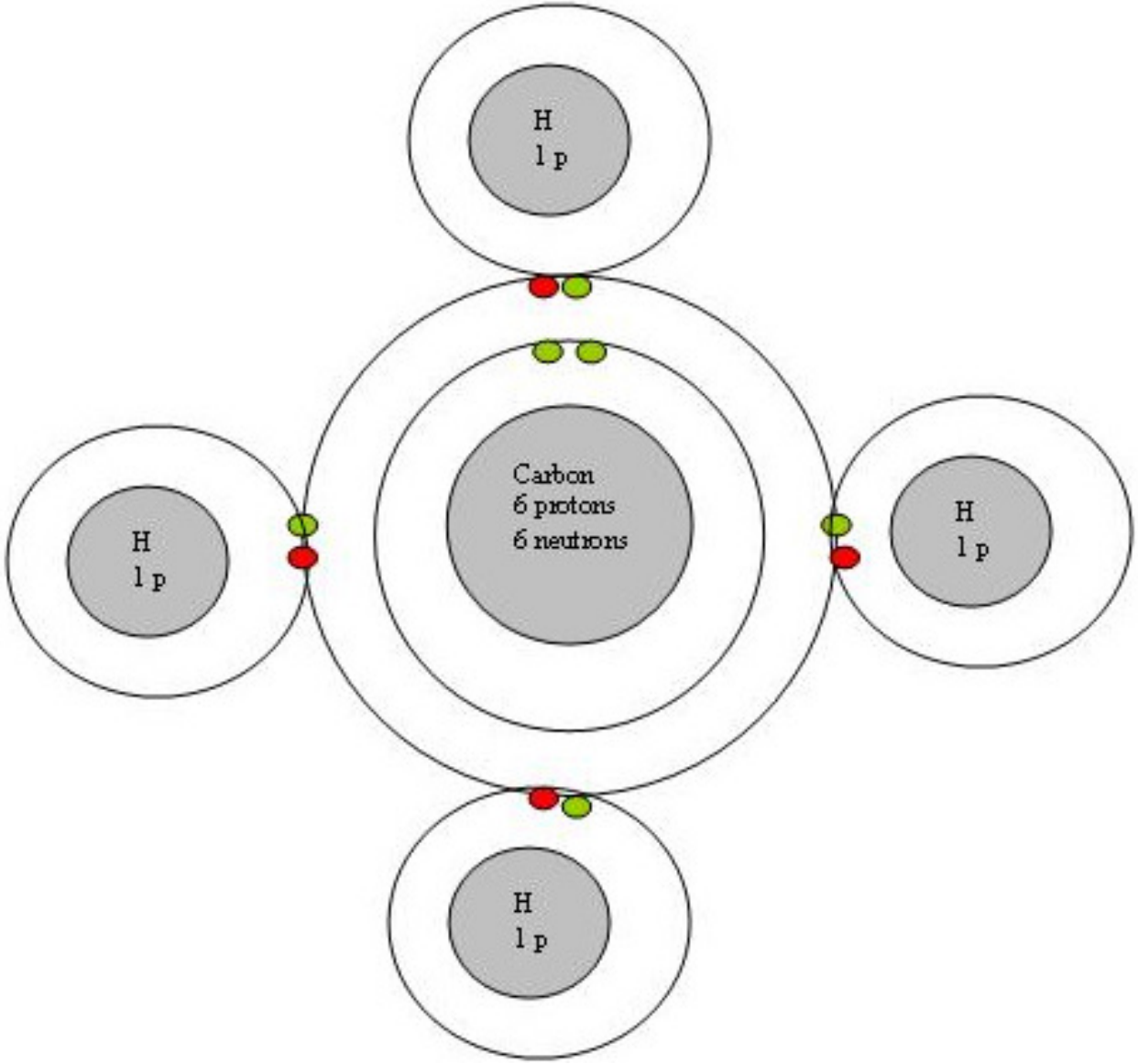


(a) Electron shells in a water molecule



(b) Distribution of partial charges in a water molecule

Methane molecule (CH_4)



Molecular weight (M.wt)

- Its the weight of a whole molecule.
- i.e. the summation of the atomic weights of the atoms that present in the molecule.

How to estimate the molecular weight (M.wt)?

Ex(1): Find the M.wt of the water (H_2O)?

- **Given that :**

1. Atomic weight of Hydrogen(H) = 1 a.m.u.
2. Atomic weight of Oxygen (O) =16 a.m.u.

M.wt of the water (H_2O)

Solution:

- M.wt = (no. of the (H) atoms*At.wt of the H)+ (no. of the (O) atoms*At.wt of the O)
- M.wt = (2*At.wt of hydrogen) + (1*At.wt of oxygen)
- M.wt= (2*1) + (1*16) = 18 a.m.u.
- **The molecular weight of water is 18 a.m.u**

M.wt of Methane gas

- **Ex(2):** Find the M.wt of the methane gas (CH_4)?
- **Given that :**
  1. At.wt of (C) = 12 a.m.u.
  2. At.wt of (H) = 1 a.m.u.

M.wt of Methane gas

Solution:

- M.wt = (no. of the (H) atoms*At.wt of the H)+ (no. of the (C) atoms*At.wt of the C)
- M.wt = (4*At.wt of hydrogen) + (1*At.wt of carbon)
- M.wt= (4*1) + (1*12) = 16 a.m.u.
- **The molecular weight of methane is 16 a.m.u**

M.wt of Sulfuric acid

Ex(2): Find the M.wt of the sulfuric acid (H_2SO_4)?

- **Given that :**

1. Atomic weight of Hydrogen(H) = 1 a.m.u.
2. Atomic weight of Oxygen (O) =16 a.m.u.
3. Atomic weight of Oxygen (S) = 32 a.m.u.

M.wt of Sulfuric acid

Solution:

- M.wt = (no. of the (H) atoms*At.wt of the H)+ (no. of the (O) atoms*At.wt of the O)+(no. of the (S) atoms*At.wt of the S)
- M.wt = (2*At.wt of H) + (4*At.wt of O) + (1*At.wt of S)
- M.wt= (2*1) + (4*16) + (1*32) = 98 a.m.u.
- **The molecular weight of sulfuric acid is 98 a.m.u**

M.wt of Ferric sulfate

Ex(3): Find the M.wt of the Ferric sulfate ($(Fe)_2(SO_4)_3$)?

- **Given that :**
  1. At.wt of (Fe) = 56 a.m.u.
  2. At.wt of (S) = 32 a.m.u.
  3. At.wt of (O) = 16 a.m.u.

M.wt of Ferric sulfate

Solution:

- M.wt = (no. of the (Fe) atoms*At.wt of the Fe)+ (no. of the (S) atoms*At.wt of the S)+(no. of the (O) atoms*At.wt of the O)
- M.wt = (2*At.wt of Fe) + (3*At.wt of S) + (3*4*At.wt of O)
- M.wt= (2*56) + (3*32) + (3*4*16) = 400 a.m.u.
- **The molecular weight of Ferric sulfate is 400 a.m.u**

Home work

- **Find the M.wt of the Following compounds**:
  1. Acetic acid (CH_3COOH).
  2. Ferrous sulfate ($FeSO_4$).
  3. Aluminum Phosphate ($AlPO_4$).
  4. Potassium Nitrate (KNO_3).

Home work

- **Given that:**
  - At.wt of P = 31 amu
  - At.wt of C = 12 amu
  - At.wt of H = 1 amu
  - At.wt of Al = 27 amu
  - At.wt of S = 32 amu
  - At.wt of N = 14 amu
  - At.wt of O = 16 amu
  - At.wt of K = 39 amu
  - At.wt of Fe = 56 amu

Thank you