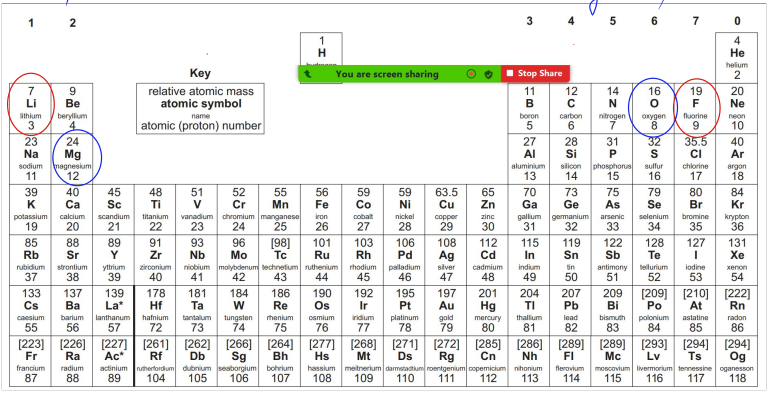
Chemical Bonding.

1- Ionic Bonding (metal + non metal)
2- covalent bonding (non metals only)
3- giant covalent / macromolecular (non metals only).
4- metallic bonding / alloys.

Ionic Bonding   metal + non metal.

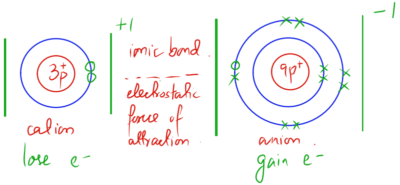
metals / lose e^- → gain e^- / non metals



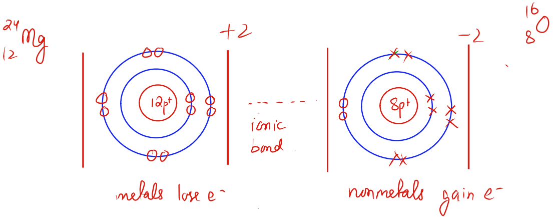
Key
relative atomic mass
atomic symbol
name
atomic (proton) number

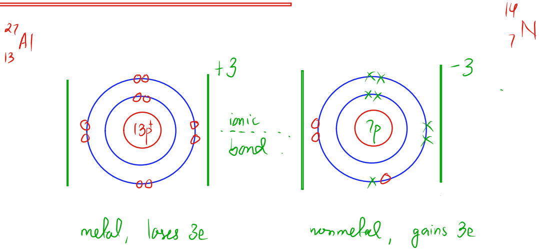
1	2											3	4	5	6	7	0
							1 **H**										4 **He** helium 2
7 **Li** lithium 3	9 **Be** beryllium 4											11 **B** boron 5	12 **C** carbon 6	14 **N** nitrogen 7	16 **O** oxygen 8	19 **F** fluorine 9	20 **Ne** neon 10
23 **Na** sodium 11	24 **Mg** magnesium 12											27 **Al** aluminium 13	28 **Si** silicon 14	31 **P** phosphorus 15	32 **S** sulfur 16	35.5 **Cl** chlorine 17	40 **Ar** argon 18
39 **K** potassium 19	40 **Ca** calcium 20	45 **Sc** scandium 21	48 **Ti** titanium 22	51 **V** vanadium 23	52 **Cr** chromium 24	55 **Mn** manganese 25	56 **Fe** iron 26	59 **Co** cobalt 27	59 **Ni** nickel 28	63.5 **Cu** copper 29	65 **Zn** zinc 30	70 **Ga** gallium 31	73 **Ge** germanium 32	75 **As** arsenic 33	79 **Se** selenium 34	80 **Br** bromine 35	84 **Kr** krypton 36
85 **Rb** rubidium 37	88 **Sr** strontium 38	89 **Y** yttrium 39	91 **Zr** zirconium 40	93 **Nb** niobium 41	96 **Mo** molybdenum 42	[98] **Tc** technetium 43	101 **Ru** ruthenium 44	103 **Rh** rhodium 45	106 **Pd** palladium 46	108 **Ag** silver 47	112 **Cd** cadmium 48	115 **In** indium 49	119 **Sn** tin 50	122 **Sb** antimony 51	128 **Te** tellurium 52	127 **I** iodine 53	131 **Xe** xenon 54
133 **Cs** caesium 55	137 **Ba** barium 56	139 **La*** lanthanum 57	178 **Hf** hafnium 72	181 **Ta** tantalum 73	184 **W** tungsten 74	186 **Re** rhenium 75	190 **Os** osmium 76	192 **Ir** iridium 77	195 **Pt** platinum 78	197 **Au** gold 79	201 **Hg** mercury 80	204 **Tl** thallium 81	207 **Pb** lead 82	209 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac*** actinium 89	[261] **Rf** rutherfordium 104	[262] **Db** dubnium 105	[266] **Sg** seaborgium 106	[264] **Bh** bohrium 107	[277] **Hs** hassium 108	[268] **Mt** meitnerium 109	[271] **Ds** darmstadtium 110	[272] **Rg** roentgenium 111	[285] **Cn** copernicium 112	[286] **Nh** nihonium 113	[289] **Fl** flerovium 114	[289] **Mc** moscovium 115	[293] **Lv** livermorium 116	[294] **Ts** tennessine 117	[294] **Og** oganesson 118

$^{7}_{3}Li$ $^{19}_{9}F$



* e- lost and gained are equal



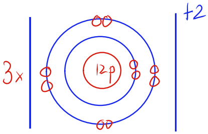


Stregnth of Ionic Bonds

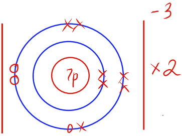
- greater charge on ion → stronger ionic bond.
- smaller ions, are closely packed, → stronger ionic bond.

dot and cross : unequal e- gained and lost

$_{12}Mg$ $_{7}N$



metal, lose 2e
× 3
= 6e

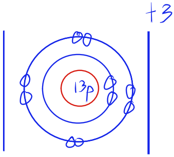


nonmetal, gains 3e
× 2
= 6e

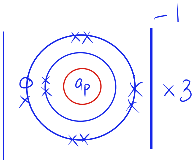
Magnesium ~~Nitrogen~~
Nitride

Mg_3N_2

Al + F :



metal, loses 3e

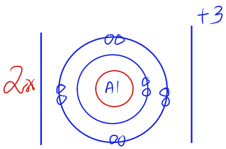


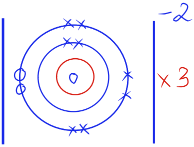
nonmetal, gain 1e
×3
= 3e

Aluminium ~~Florine~~ Floride

AlF_3

a) Na + P
b) Li + O
c) Al + O
d) Ca + Cl
e) Mg + S
f) Na + O
g) K + S





Aluminium oxide
Al_2O_3

metal lose 3e × 2

= 6e.

non metal gains 2e × 3

= 6e

✱ "– ide" -ve ion of nonmetal

Chloride → Cl^{-1}.

Sulfide → S^{-2}.

Iodide → I^{-1}.

Compound

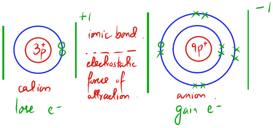
~~Cl_2~~, NO, NaCl, ~~O_2~~.

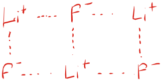
when two or more atoms of different elements bonded together

Physical Properties

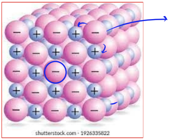
∘ Structure giant ionic lattice. → regular arrangement of oppositely charged ions

$^{7}_{3}Li$ $^{19}_{9}F$





simplest ratio in which the ions exist.



NaCl lattice

Ionic Compounds are represented by formula units, which tell you the ratio in which ions are present in the lattice

NaCl. → 1000, 1000.

MgF_2 → 1000, 2000

note
ionic → compound or Lattice (not a molecule)
covalent → molecule
giant covalent }
giant metallic } Lattice

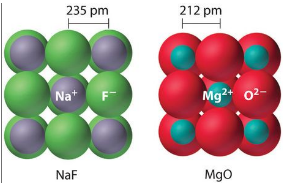
Property

1- high Melting Points : +ve and -ve ions have strong ionic (electrostatic force) bonds in the giant ionic lattice

$\overset{+1}{Na}\overset{-1}{Cl}$ 801°C

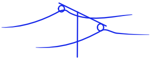
$\boxed{\overset{+2}{Mg}\overset{-2}{O}}$ 2852°C

→ stronger ionic lattice
greater charge on
the ions, smaller ions



Examples of ionic compounds (everyday).
cement, plaster, marble, baking soda, chalk.

ceramics | MgO → very high MP, furnace lining / refractory material.
| Al_2O_3 → high voltage transmission



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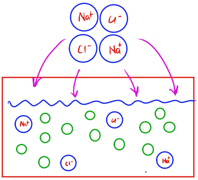
3 - Solubility

Ionic compounds are usually soluble (solubility varies)
chalk → lower solubility.
table salt → very soluble.

$NaCl_{(s)} + (aq) \longrightarrow Na^+_{(aq)} + Cl^-_{(aq)}$



vigorous stirring
ionic compound dissociates.

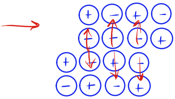
4. Ionic Compounds

conduct electricity in molten and aqueous state → free moving ions
no electricity conduction in solid state → it has no free moving ions.

electricity - moved of charged particles

5 - Brittle Crystalline Lattice

→ break or shatter when force applied.



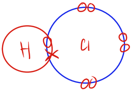
Covalent Bonding (simple molecules).

non metals

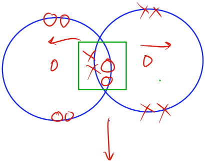
like to gain e

X ← e → Y

H — Cl.

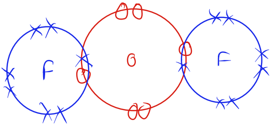


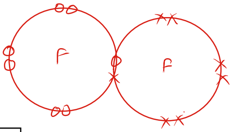
O_2



double covalent bond.

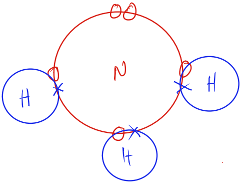
O and F





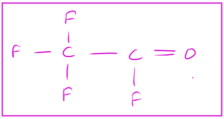
Gp7 - 1 bond
Gp6 - 2 bonds
Gp5 - 3 bonds
Gp4 - 4 bonds

H — 1 bond

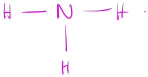


Structural formulas.

C	O	F
4bond	2bonds	1 bond

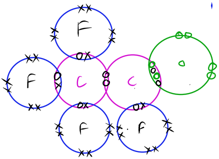


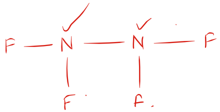
$\mathrm{F{-}CF_2{-}CF{=}O}$



Gp5 Gp7.

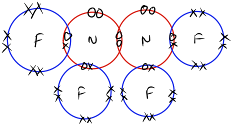
N_2F_4.

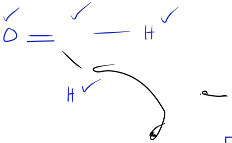




4 bonds 2 bonds 1 bond

COH_2





C_2F_2

4 bonds 1 bond

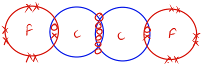
$\boxed{HCN}$

$H-C\equiv N$

$\boxed{HCON}$

$H-N=C=O$

$F-C\equiv C-F$



1- CF_3CFO

3- $HCOOH$

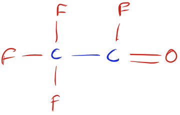
2. C_2F_3Cl

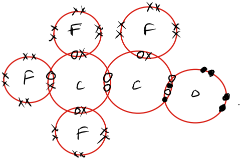
4- CS_2

structural formula + dot and cross

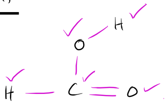
$\boxed{CF_3CFO}$ → 2 bond.

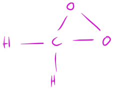
4 bonds 1 bond 4 bond

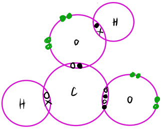




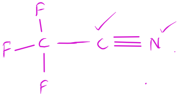
$HCOOH$





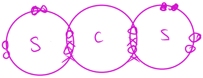


E.g CF_3CN.



E.g CS_2

$S = C = S$



Test structural formula / dot and cross

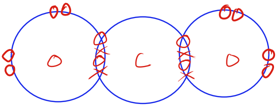
CO_2 C_2FCl.

H_2CS

CO_2

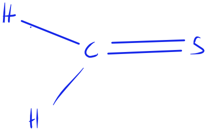
4 bonds   2 bonds

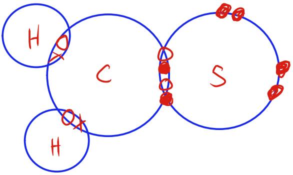
$O=C=O$



$\boxed{H_2CS}$

1 bond   4 bond   2 bonds

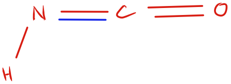


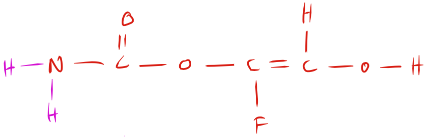


$\boxed{C_2FCl}$

$Cl-C\equiv C-F$

$\boxed{HNCO}$





H H
H
H H

$\boxed{H_2O}$

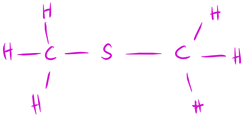
H — O — H

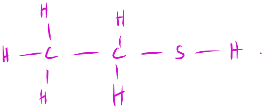
$\boxed{Cl_2}$

Cl — Cl.

$\boxed{HCl}$ $H - Cl$.

$\boxed{(CH_3)_2S}$.





Compound – when two (or more) different elements chemically bond

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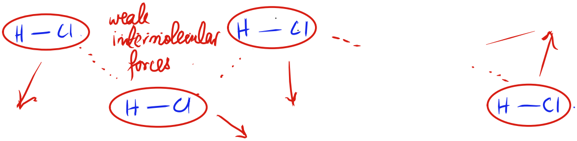
Properties of covalent molecules

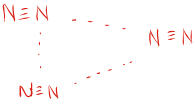


1. Simple molecular lattice

   simple molecules with weak intermolecular forces

2. Low MP / BP

   molecules have weak intermolecular forces (even though covalent bonds are strong)



[when melting or boiling, bonds b/w atoms are not broken).

mostly gases, low BP liquids, rarely solids (size increase, higher MP/BP).

CO_2, H_2O, O_2, NO_2, SO_3, HCl.

3. Solubility

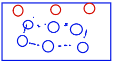
   varies from molecule to molecule.

   NH_3, C_2H_5OH, HCl, H_2SO_4 soluble

Cl_2 / CO_2 partially soluble

O_2, N_2, H_2, not soluble

polar molecules dissolve polar molecules
nonpolar molecules " nonpolar molecules



4. Electricity Conduction

no electricity conduction; covalent molecules don't have free moving e^- / or ions

* some molecules conduct electricity when aqueous acids etc like HCl

$H-Cl \xrightarrow[+\text{water}]{} H^+_{(aq)} + Cl^-_{(aq)}$ HCl dissolves and dissociates in water and ionize.

Giant Covalent Structures

Diamond Graphite

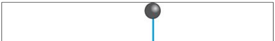
SiO_2 Silicon di Oxide
Silicon (IV) Oxide
Silica, glass, quartz, sand

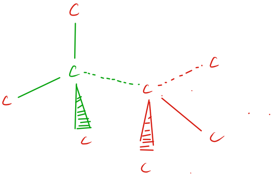
allotropes of carbon.
(same element, but different arrangement of atoms)

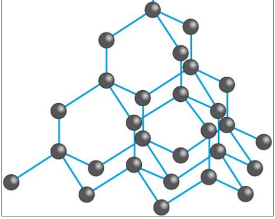
Carbon and its compounds → most living organisms

C - Gp4. 4 bond.

Diamond







tetrahedral, 109.5° bond angle
C makes 4 bonds with 4 other C atoms

1. Strong / Very high MP/ BP

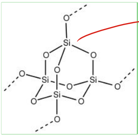
large amounts of energy needed to break the 3d network of strong covalent bonds

used for cutting / polishing / abrasive

2. No electricity

no mobile electrons
or ions

SiO_2 / silica   same structure as diamond

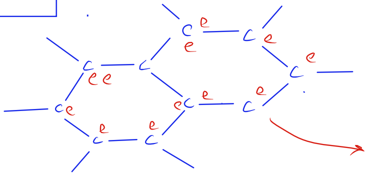


tetrahedral, 109.5°
each Si is bonded to 4 O atoms, and each O is bonded to two Si atoms

similar physical properties as diamond
- strong
- high MP/BP

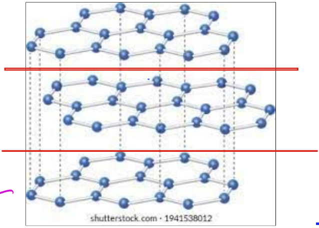
SiO_2 is used as
ceramic / strong / high MP/BP
no electricity conducts
clay ovens, clays.

Graphite



carbon makes 3 bonds
bonds angles 120°
hexagonal layered structure

delocalized e^- / conduct electricity
used as electrodes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weak intermolecular forces b/w sheets (no bonds b/w sheets) } graphite is soft, sheets can easily slip/slide

uses: dry lubricants

graphene .

high MP / BP

large energy needed to break large number of covalent bonds in the giant covalent structure

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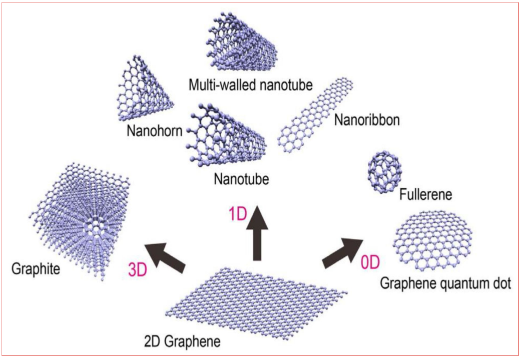
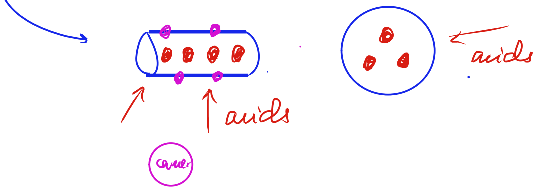
Nanomaterials



Applications of Nanomaterials

1- **Drug Delivery.**

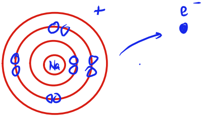
problem with medicine
- stomach acids destroy medicine
  large doses needed.
- targeted delivery

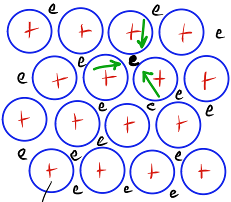


Metals and Metallic Bonding

metals

lose e⁻ / +ve ions





mobile e⁻ (delocalized)

ions don't move

Giant Metallic Lattice

lattice of +ve metal ions in a sea of free moving electrons.

-vely charged electrons attract the +ve metal ions. (e⁻ act as a glue keeping +ve ions in place)

1- High MP/BP (not all of them)

Transition metals have really high MP.

Gp1 metals melt below 100°c.

exception is Mercury (Hg), Francium.

2- Conduct Electricity in all states (also heat).

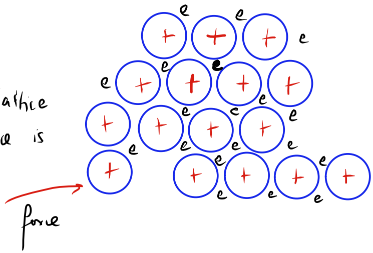
due to free moving electrons (ions dont move)

3- Malleable and Ductile

Malleable → reshape

Ductile → wires

+ve ions in giant metallic lattice slip and slide when a force is applied



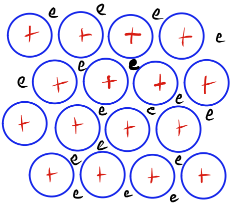
Aluminium : food containers (no rusting, good heat conduction).
aeroplanes (low density).
high voltage transmission (very good conductor)

Copper : Wires, pots and pans

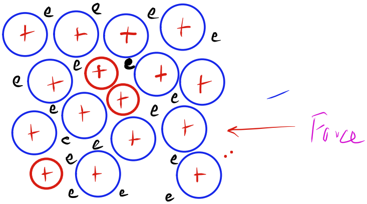
Alloy : mixture of metals (or metal + impurity).

pure metals = soft, more malleable and ductile

alloys = stronger, less malleable and ductile



Cu / same sized ions



Bronze : $Cu + Sn$

different sized ions, irregular metallic lattice formed, difficult for ions to slip and slide, less malleable and ductile

* more impurities added
more stronger / more brittle

Examples

Steel : Iron + Carbon

1- high carbon steel / wrought Iron / cast Iron / pig iron

very strong, brittle

raw usage, wheel barrow, gym weights,

2- mild steel / low carbon content

more flexible, more flexible

guitar wires, car bodies, machines

3- stainless steel.

Iron + carbon + chromium

does not rust

cutlery, surgical instruments,

Brass and Bronze

Brass ↓ Cu + Zn

Bronze ↓ Cu + Sn.

Revision

$2n^2$

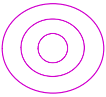
shell 1 ↓

2e

8e ✓

18e

32e

50e