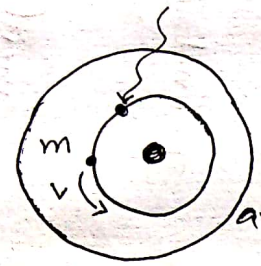
Bohr's Atomic model :

- atom — nucleus
  - non-nucleic area



- electrons orbit around the nucleus
- mid-orbit area is electronless. Nodal plane

momentum = mv

angular " = $mvr = \frac{nh}{2\pi}$

- orbitals further from the nucleus are higher in energy. The electrons, too have higher energy.

if light is shined upon an electron, the electron absorbs energy.

- if the energy absorbed < higher orbit electron's energy, the electron spins faster with higher kinetic energy in its own orbit.
- if the energy absorbed => higher orbit electron's energy, it quantum jumps to the higher orbit → radiates energy → returns.

Atomic No = Z

$q_1 = e \times Z = Ze$ ← nucleus' charge

↑ proton's charge

$q_2 = e$

$$F_1 = K\frac{q_1 q_2}{r^2}$$

$$= K\frac{Ze \times e}{r^2} = \frac{KZe^2}{r^2}$$

$$\boxed{F_1 = \frac{KZe^2}{r^2}} \quad \text{——} (1)$$

electron's anti-centripetal force $F_2 = \frac{mv^2}{r}$ is equal to the attractive force of the nucleus.

$$\boxed{F_2 = \frac{mv^2}{r}} \quad \text{——} (II)$$

$$F_1 = F_2$$

$$\frac{KZe^2}{r^2} = \frac{mv^2}{r}$$

$$\boxed{mv^2 = \frac{KZe^2}{r}}$$

$$v = \frac{nh}{2\pi m r}$$

$$m\frac{n^2h^2}{4\pi^2 m^2 r^2} = \frac{KZe^2}{r}$$

$$\boxed{r = \frac{n^2h^2}{4\pi^2 m Ze^2 K}}$$

m = known

K = n $9 \times 10^9\ Nm^2kg^{-2}$

Z = "

v = fluctuates. must be removed

e = known

r = ?

n = the orbit number

$$r = \frac{h^2}{4\pi m Ze^2 K}[n^2]$$

radius — Orbital number এর বর্গের সমানুপাতিক
— Z এর ব্যস্তানুপাতিক

$$E = E_k + E_p$$

$$= \frac{1}{2}mv^2 + E_p$$

$$= \frac{1}{2}mv^2 + E_p$$

$$= \frac{1}{2}\frac{kZe^2}{r} - \frac{kZe^2}{r}$$

$$= -\frac{1}{2}\frac{kZe^2}{r}$$

$$= -\frac{1}{2}kZe^2 \frac{4\pi^2 mZe^2 k}{n^2h^2}$$

$$= \frac{2\pi^2 k^2 Z^2 me^4}{n^2h^2}$$

$$\boxed{E = \frac{-2\pi^2 k^2 Z^2 me^4}{h^2}\left[\frac{1}{n^2}\right]}$$

$$\Delta E = \cancel{2\pi^2}\ E_2 - E_1$$

$$\boxed{\Delta E = \frac{2\pi^2 k^2 Z^2 me^4}{h^2}\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]}$$

$$= h\nu$$

$$\boxed{\nu = \frac{2\pi^2 k^2 Z^2 me^4}{h^3}\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]}$$

$$V = \frac{w}{q}$$

$$w = vq = E_p$$

$$V = \frac{kQ}{r}.$$

$$E_p = \frac{kQ}{r} \times q$$

$$= \frac{k \cdot Ze}{r}(-e)$$

$$= \frac{-kZe^2}{r}$$

Q is the charge of the field.

$R_H = 10.97 \times 10^6$

$e = 1.6 \times 10^{-19}$ C

$m = 9.1 \times 10^{-28}$ g

10^{-31} kg

Atomic Scale

$12\text{C} \times \frac{1}{12} = 1$

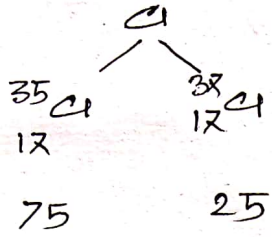
1.64×10^{-27} kg

1.64×10^{-24} g

$1.64 \times 10^{-24} \times 6.023 \times 10^{23}$

1.008

Relative isotopic mass:



$$R.A.M = \frac{a_1P_1 + a_2P_2 + \dots\dots}{100} = \frac{(35\times75)+(37\times25)}{100}$$

$$= 35.5$$

Mass defect Binding energy

Theoretical mass $= (m_p \times n_p + m_N \times n_N)$

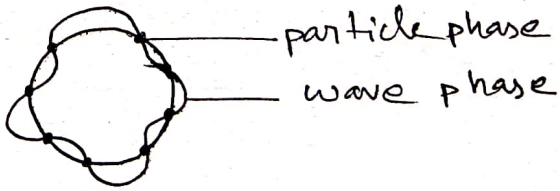
mass defect, Δm = Theoretical mass − Isotope mass

$$\Delta m = m_T - m_I$$

the mass defects generate energy to hold the protons together. This energy is binding energy.

De-Broglie's equation (Dual property)

electrons revolve around the nucleus interchanging between its particle and wave property.



particle phase,

$$E = mc^2$$
$$E_1 = mv_e^2$$

wave phase,

$$E_2 = h\nu = \frac{hc}{\lambda} = \frac{hv}{\lambda} \qquad v \approx c$$

To constantly change between two phases, the energy must be the same in both cases.

$$\therefore \quad E_1 = E_2$$

$$mv^2 = h\frac{v}{\lambda}$$

$$\boxed{\lambda = \frac{h}{mv}}$$

$\boxed{\lambda \approx 10^{-16} - 10^{-18}}$ ⟹ if the λ found is smaller than this wavelength is unreasonable. (eg. too small to matter)

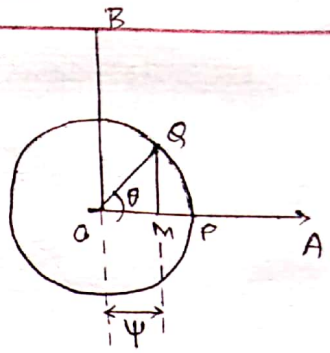
Example : cricket ball

$$m = 0.250 \text{ kg} \quad ; \quad v = \frac{161 \times 1000}{3600} \text{ ms}^{-1}$$

$$\lambda = \frac{6.63 \times 10^{-34} \times 3600}{0.25 \times 161 \times 1000}$$

$\lambda = x$; not reasonable, so the ball doesn't have wave property

$OP = OQ$



$\cos\theta = \frac{OM}{OQ}$

$OM = OQ\cos\theta = \psi$

$\psi = a\cos\theta$

$\psi = a\cos\frac{2\pi x}{\lambda}$

Path	Angle
λ	2π
x	$\frac{2\pi x}{\lambda}$

$\therefore \theta = \frac{2\pi x}{\lambda}$

Partial differenciacion :

$$\frac{\partial\psi}{\partial x} = -a\sin\frac{2\pi x}{\lambda}\cdot\frac{2\pi}{\lambda}$$

$$\frac{\partial^2\psi}{\partial x^2} = -\boxed{a\cos\frac{2\pi x}{\lambda}}\,\frac{2\pi}{\lambda}\cdot\frac{2\pi}{\lambda}$$

$\boxed{a\cos\frac{2\pi x}{\lambda}} \rightarrow \psi$

$$\frac{\partial^2\psi}{\partial x^2} = -\frac{4\pi^2}{\lambda^2}\psi$$

$$\frac{\partial^2\psi}{\partial x^2} + \frac{4\pi^2}{\lambda^2}\psi = 0$$

$$\frac{\partial^2\psi}{\partial x^2} + \frac{4\pi^2}{\left(\frac{h}{mv}\right)^2}\psi = 0$$

$$\frac{\partial^2\psi}{\partial x^2} + \frac{4\pi^2 m^2 v^2}{h^2}\psi = 0$$

$E = E_k + U$

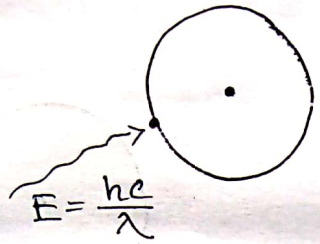
$E_k = \frac{1}{2}mv^2 = E - U$

$$\frac{\partial^2\psi}{\partial x^2} + \frac{8\pi^2 m\left(\frac{1}{2}mv^2\right)}{h^2}\psi = 0$$

$$\frac{\partial^2\psi}{\partial x^2} + \frac{8\pi^2 m(E-U)}{h^2}\psi = 0$$

$$\frac{\partial^2\psi}{\partial x^2} + \frac{\partial^2\psi}{\partial y^2} + \frac{\partial^2\psi}{\partial z^2} + \frac{8\pi^2 m(E-U)\psi}{h^2} = 0$$

Uncertainty Principle:



$$E_K = \frac{1}{2}mv^2$$

$$= \frac{1}{2}\frac{(mv)^2}{m} = \frac{1}{2}\frac{p^2}{m}$$

to catch the electron with light, the λ of the light must be $< 10^{-11}$. which in turn increases E and thus increases the momentum of the electron. Moreover Larger λ lights are ~~two s~~ too slow to catch the electron.

$$\Delta x \cdot \Delta p \approx \frac{h}{4\pi}$$

$$\Rightarrow \Delta x \cdot \Delta(mv) \approx \frac{h}{4\pi}$$

here, Δx is the distance travelled by the electron during slower light projection.

$$\boxed{m \cdot \Delta x \cdot \Delta v \approx \frac{h}{4\pi}}$$

less ~~momen~~ energy light → momentum
higher energy light → position

Quantum Number:

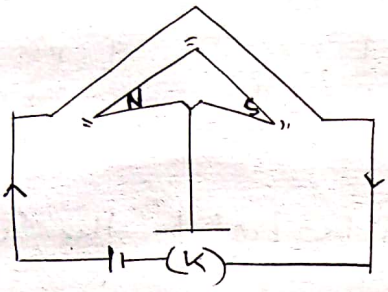
explains the overall condition of the electron.

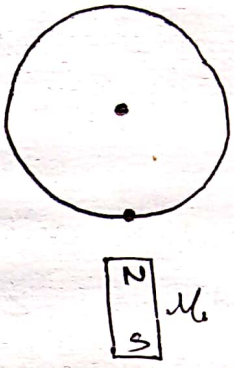
1. Principal Quantum Number (n): 1, 2, 3, 4, 5, 6, ...
2. Azimuthal Quantum Number (l): n-1

$n=4$ $l = 4-1 = 3$
fundamental → f
0, 1, 2, 3
4s 4p 4d 4f

$n=1$; $l=0$ sharp → s ; 1s
$n=2$; $l=1$ principal/pure → p
$= 0, 1$ 2s, 2p
$n=3$; $l=0, 1, 2$ Diffused → d
$l = 3-1 = 2$
3s 3p 3d

(3.) Magnetic Quantum Number (m):





The 3D orientation of electron.

$$\boxed{m = \pm\sqrt{l(l+1)}\,\mu} \longrightarrow \text{bohr magneton}$$

$$\mu = \mu_0 \cos\theta$$

$l = 0 \longrightarrow s\ (2)$
$m = 0$

$l = 1 \longrightarrow p\ (6)$

$m = \pm\sqrt{1(1+1)}\,\mu = \pm\sqrt{2}\,\mu = \pm 1.4142\,\mu$

$= \pm 1 = -1, 0, -1$

$\mu = \mu_0 \cos\theta$ gives us θ which tells us how much magnetic energy to project upon the electron.

$1.4142\,\mu = \pm 1$

$\mu = \pm \frac{1}{1.4142}$

$l = 2 \longrightarrow d\ (10)$.

$m = \pm\sqrt{2(2+1)}\,\mu$

$= \pm\sqrt{6}\,\mu = \pm 2.48\,\mu = \pm 2 = -2, -1, 0, 1, 2$

$l = 3 \longrightarrow f$ (14)

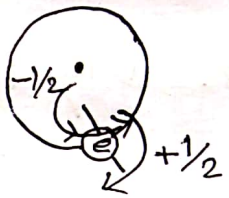
$m = \pm\sqrt{3(3+1)}\ \mu$

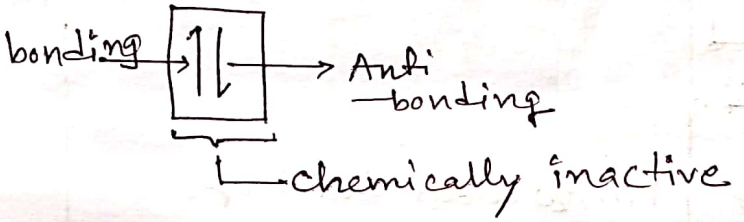
$= \pm\sqrt{12}\ \mu$

$= \pm 3$

$= -3, -2, -1, 0, 1, 2, 3$

(4.) Spin Quantum Number (s)





the ½ rotation of an electron is nutralized by another opposite rotating electron which creates an anti-magnetic field which nullifies the previo magnetic field rendering the atom chemically inactive.

n+l rule :

$1s = 1+0 = 1$

$2s = 2+0 = 2$

$2p = 2+1 = 3$

$3s = 3+0 = 3$

$3p = 3+1 = 4$

$3d = 3+2 = 5$

$4s = 4+0 = 4$

$4p = 4+1 = 5$

$4d = 4+2 = 6$

$4f = 4+3 = 7$

$5s = 5+0 = 5$

$5p = 5+1 = 6$

$5d = 5+2 = 7$

$5f = 5+3 = 8$

electron enters the orbital first which has the lowest $(n+l)$ value. If two values are equal, the orbital with the lower n value takes e first.

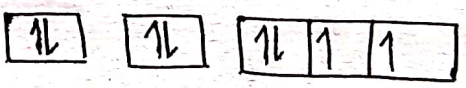
Hund's Rule

same-faced spins enter and complete orbitals first.

C $\longrightarrow$ $1s^2 2s^2 2p_x^1 2p_y^1 2p_z$

N $\longrightarrow$ $1s^2 2s^2 2p_x^1 2p_y^1 2p_z^1$

O $\longrightarrow$ $1s^2 2s^2 2p_x^2 2p_y^1 2p_z^1$



Stability & Half Stability

$^{14}_{28}N(7) \rightarrow 1s^2\ 2s^2\ 2p^3 \rightarrow$ half Stability as 2orbital has 5 e⁻

$^{16}_{32}O(8) \rightarrow 1s^2\ 2s^2\ 2p^4$

$Ne(10) \rightarrow 1s^2\ 2s^2\ 2p^6 \rightarrow$ Stability

$Cr(24) \rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^4$
$\quad 4s^1\ 3d^5$ } exception.

$Cu(29) \rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^9$
$\quad 4s^1\ 3d^{10}$ } exception

$s^1 \rightarrow$ IA
$s^2 \rightarrow$ IIA
$p^1 \rightarrow$ IIIA
$p^2 \rightarrow$ IVA
$p^3 \rightarrow$ VA
$p^4 \rightarrow$ VIA
$p^5 \rightarrow$ VIIA
$p^6 \rightarrow$ 0

$d^1 \rightarrow$ IIIB
$d^2 \rightarrow$ IVB
$d^3 \rightarrow$ VB
*$d^4 \rightarrow$ VIB
$d^5 \rightarrow$ VIIB
$d^{6,7,8} \rightarrow$ VIII
*$d^9 \rightarrow$ IB
$d^{10} \rightarrow$ IIB

$4f^{1-14} \rightarrow$ La
$5f^{1-14} \rightarrow$ Ac

$Sc(21) \rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^1$
$4s \rightarrow 4$; period 4
$3d^1 \rightarrow$ IIIB

$As(33) \rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^3$
VA
period 4

বেঞ্চ → বিজারক

$$10FeSO_4 + 2KMnO_4 + 8H_2SO_4 \rightarrow 5Fe_2(SO_4)_3 + 2MnSO_4 + K_2SO_4 + 8H_2O$$

$2Fe^{2+} = 2Fe^{3+} + 2e$

$2Mn^{7+} + 5e \times 2 = 2Mn^{2+}$

$10Fe^{2+} + 2Mn^{7+} \equiv 10Fe^{3+} + 2Mn^{2+}$

Technique

6 4 2

BNA

Why not use the cheaper HCl ?

$Cl(17) \rightarrow 1s^2\ 2s^2 2p^6\ 3s^2\ 3p^5$

HCl

$Cl^- \rightarrow 3s^2 3p^6 \rightarrow$ cannot take electrons.

so its বিজারক।

$KMnO_4 + HCl \longrightarrow KCl + MnCl_2 + Cl_2 + H_2O$

Here, both $KMnO_4$ and HCl Give electrons. So, its impossible to determine the amount of Fe with respect to $KMnO_4$. Because $KMnO_4$ is not the only entity providing electrons.

Block Elements

s p d f

P(15) → $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^3$

↳ p block

IA

alkali elements

↳ reacts quickly with water to produce OH^-

3 Li	Standard
11 Na	ns^1
19 K	(+1)
37 Rb	
55 Cs	
87 Fr	

IIA

alkaline

4 Be	ns^2
12 Mg	(+2)
20 Ca	
38 Sr	
56 Ba	
88 Ra	

0

Inert gas

2 He	ns^2np^6
10 Ne	0
18 Ar	
36 Kr	
54 Xe	
86 Rn	

VIIA

Halogen

↳ Produces anion of sea salt.

9 F	ns^2np^5
17 Cl	(−1)
35 Br	
53 I	
85 At	

VIA

Chalcogen

↳ Ore-forming elements

8 O	ns^2np^4
16 S	(−2)
34 Se	
52 Te	
84 Po	

VA

7 N	ns^2np^3
15 P	(−3)
33 As	
51 Sb	
83 Bi	

IV A

6 C
14 Si
32 Ge
50 Sn
82 Pb

ns^2np^2

(+4)

III A

5 B
13 Al
31 Ga
49 In
81 Tl

ns^2np^1

(+3)

IB — Coinage element

29 Cu
47 Ag
79 Au

IIB

30 Zn
48 Cd
80 Hg

Exceptional electron configurations memorization needed.

d-block
Transition

f-block
Intertransition

Sc(21) → $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^1$
Ti(22) → $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^2$
> They're both d-block but might not be transition.

Transition conditions:
- Last e must set in d orbital
- d orbital e must participate in reaction
- after reaction, e must still remain in d orbital

So, Sc(21) is d block but not transition. (only e is used up)
Ti(22) is d block and transition. (one e remains)

not all d-block elements are transition.

Intertransition conditions:
- Last e. in f orbital
- e from f must participate
- e must remain in f after reaction.

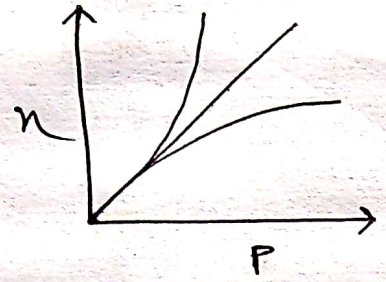
Periodic Table

n/p ratio $= \tan\theta$

$= \tan 45°$ $\quad \frac{\pi}{2}$

$= 1$

the element doesn't show radioactivity.

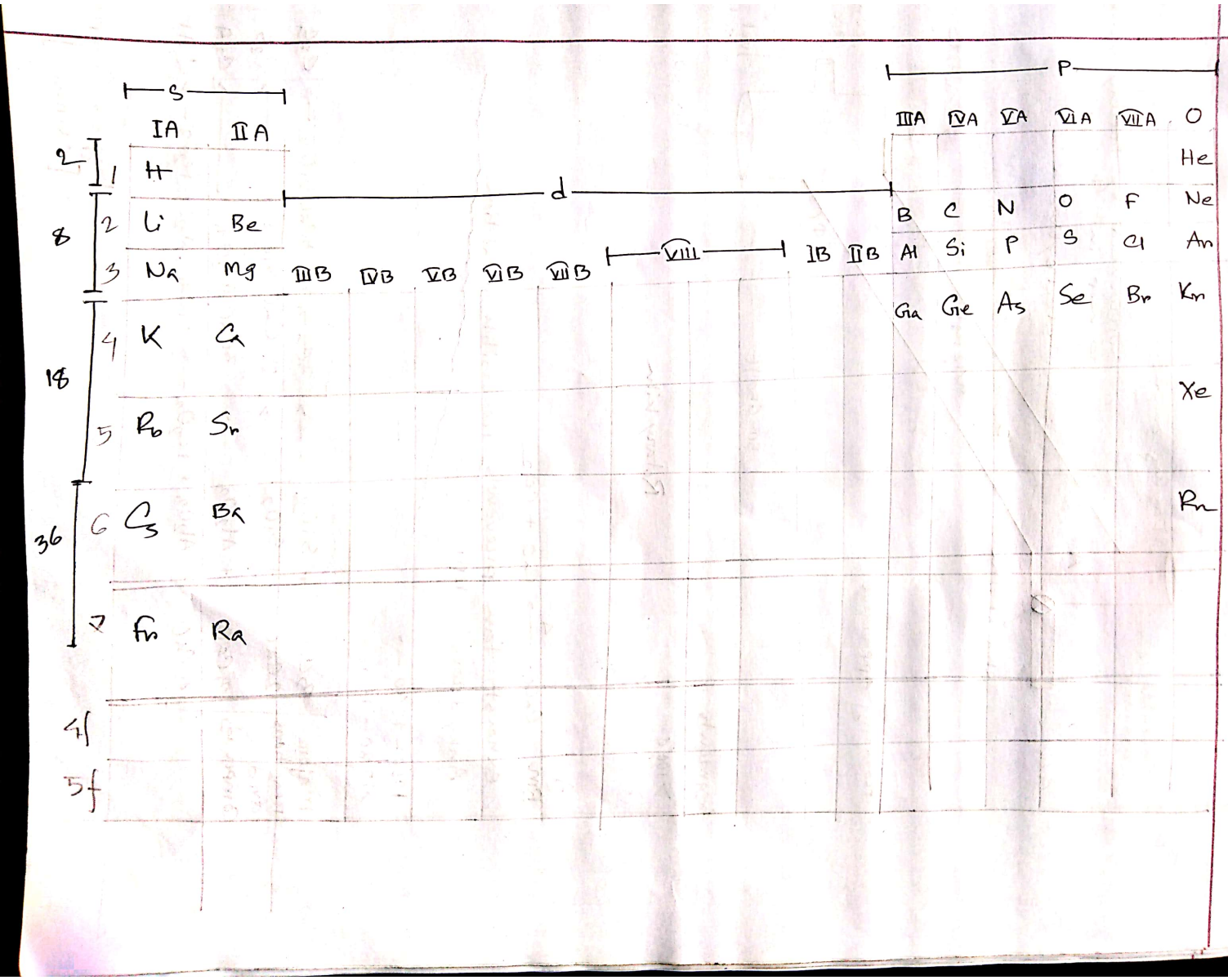


elements 1 → 40 have n/p ratio of almost 1. So, they are non radioactive.

Octate theory

Li	Be	B	C	N	O	F	Ne
Na	Mg	Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	M	Fe

→ not working.



Shortcomings of Modern Periodic Table:

IA } Position of Hydrogen.
VIIA }

- electronic configuration Group IA এর ক্ষেত্রে শেষ কক্ষপথে s orbital এ ১টি e, H এও same.
  - 1 টি e দান করে Positive, বিজারক. H same
  - Halogen + IA → Halogen + H → Same
  - IA Oxide তৈরি করে। [H_2O]
  - IA Sulphide তৈরি করে [H_2S]
- He এর পূর্ণ মিল হিসেবে H VIIA তে
- দ্বিপারমানবিক Gas 1 পারমানবিক ধাতুর সাথে থাকা উচিত নয়।
- ধাতু + Halogen → Halide [$NaCl^-$]
  ধাতু + Hydrogen → Hydride [NaH^-]

Position of Lanthanide & Actinide

Very Modern Periodic table:

IA → ns_1 → 1 — AB থাকবে না। 1-18 থাকবে।

IIA → ns_2 → 2

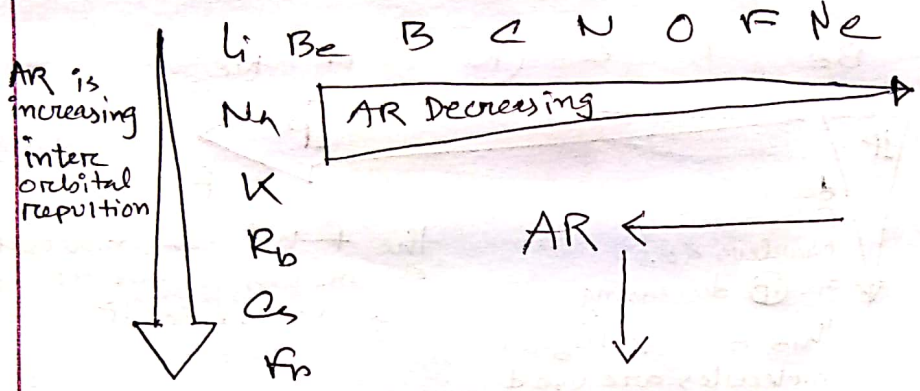
6s এর পর e 4f এ যায়। IIIB তে। All Lanthanide

7s এর পর e 5f এ যায়। IVB তে। All Actinide.

৪. পারমাণবিক ভর বা সংখ্যা বয় e-configuration ২ Periodic table এর মূল ভিত্তি।

Periodic Property

① Atomic Radius. Atomic nucleus ⟷ last orbit.



sequence maintain করে। ∴ AR is a periodic property

② Density :

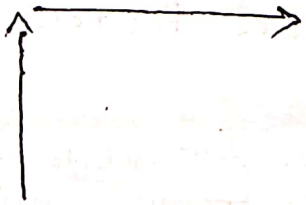
$$\rho = \frac{m}{V}$$

$$V = \frac{4}{3}\pi r^3$$

$$= \frac{4}{3}\pi (10^{-12})^3$$

$$\rho \propto \frac{1}{r^3}$$

③ Ionisation Potential :



② Ionisation Potential

The energy needed to free an electron from the last orbital and convert that molecule to a positive ion. This is a metallic property.

$HClO$ (Cl^{+1})
$HClO_2$ (Cl^{+3})
$HClO_3$ (Cl^{+5})
$HClO_4$ (Cl^{+7})

Li Be B C N O F Ne
Na
K
Rb
Cs
Fr

IP ↓ decreasing f between Nucleus & e. so IP decreasing

this is why higher molecules are used in photoelectric effect.

IP → $F \propto q_1 q_2$

the f between nucleus & e increases due to increased electrons. So, IP increases.

$F \propto \frac{1}{r^2}$

So, in short ↑ IP →

then why is the IP of N > O ?

$N(7) \rightarrow 1s^2 2s^2 2p^3$ → stability (half)

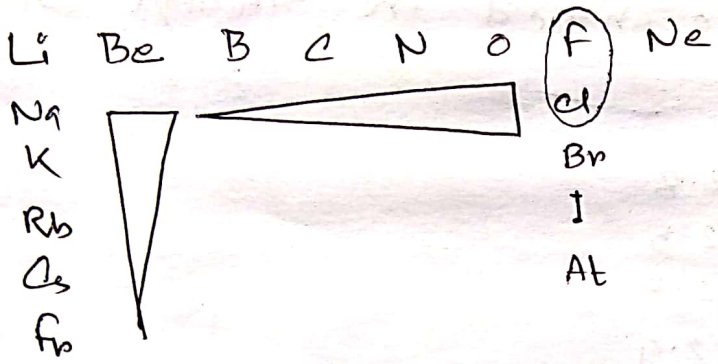
Q1 Define Ionisation potential. explain why its a periodic property. Which factors define and control IP?

↳ charge, distance, full orbits between Nucleus and last e, electronic configuration.

③ Electron Affinity.

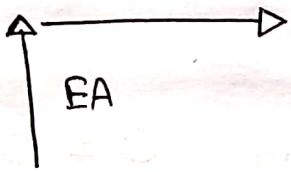
The energy released when adding an e^- to the last orbital and creating an anion.

$$Cl + e \rightarrow Cl^-$$
$$A + e \rightarrow A^-$$



in a group, as newer orbitals are introduce and the new electron if further from the nucl

in short:



So, why is fluorin's EA < Cl's ?

$F \rightarrow 1s^2 2s^2 2p^5$ → No d orbital. Inter-e^- repultion is high.

$Cl \rightarrow 1s^2 2s^2 2p^6 3s^2 3p^5 3d$

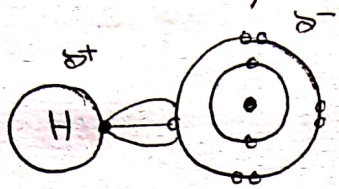
so, the energy released is mostly used to counter that inter-e^- ~~reputat~~ repultion Highly dense in electron.

Key words

1. Inter-electron repultion.
2. Energy needed to counter the inter electron repultion.
3. Electron density.

④ Electronegetivity

HF



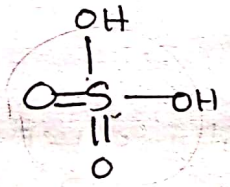
The affinity of a molecule to attract the last e of another molecule shared in असमधुवीय Bonds.

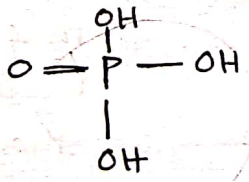
F → 4.0
O → 3.5
N → 3
Cl → 3.0
H → 2.1

Br → 2.8
I → 2.5
C → 2.5
S → 2.4
P → 2.2
B → 1.8

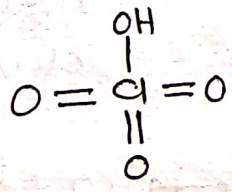
Oxo Acid main property is O = OH⁻

H_2SO_4 ⇒ O → 2 OH → 2





H_3PO_4



$HClO_4$

If the central molecule of two Oxo acid is has the same oxidation number, then the one having a bigger electronegativity is stronger.

Otherwise, the one having larger oxydation number is stronger.

Cl(17) $1s^2 2s^2 2p^6 3s^2 3p_x 3p_y 3p_z 3d_{xy} 3d_{yz} 3d_{zx} 3d_{x^2-y^2} 3d_{z^2}$

Oxydation number

⟶ +1, +3, +5, +7

Ionic Bonding

NaCl is an ionic ~~combined~~ compound.

$Na(11) \longrightarrow 1s^2\ 2s^2 2p^6\ 3s^1$

$Cl(17) \longrightarrow 1s^2 2s^2 2p^6\ 3s^2 3p^5$

$Na \longrightarrow Na^+ + e^-$

$Cl + e^- \longrightarrow Cl^-$

Na^+Cl^-

$O + 2e \longrightarrow O^{2-}$

$2Na \longrightarrow 2Na^+ + 2e$

Na_2O

Ionic compound : created by e receiving and giving. Must also follow the characteristics.

$AlCl_3$

$Al(13) \longrightarrow 1s^2 2s^2 2p^6 3s^2\ 3p^1$

$Al \longrightarrow Al^{3+} + 3e$

ionic compound characteristic

- High melting Point
- High vapor Point
- Soluble in polar sol^n

} $AlCl_3$ doesn't follow these. Not ionic compound.

$Fe(26) \longrightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2 3p^6 (4s^2) 3d^6$

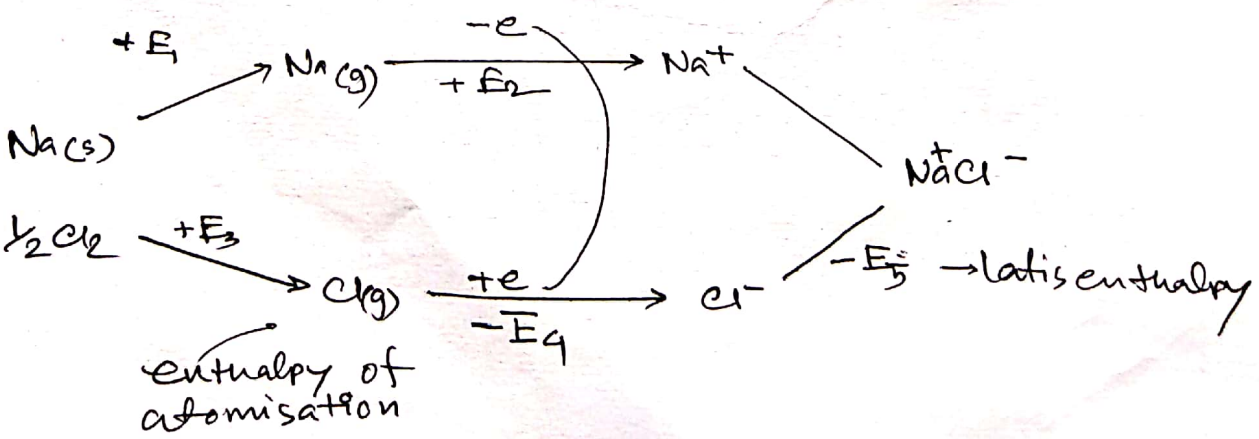
doesn't attain neutral configuration but still follows all ionic characteristic.

So the neutral configuration idea goes down the drain.

New definition

→ Created through e transfer

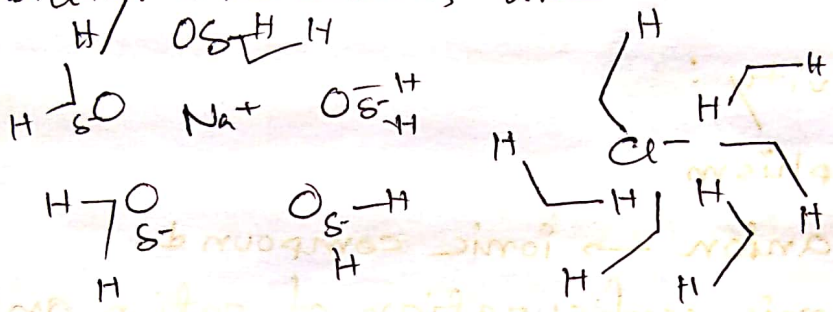
→ follows ionic characteristics.



Ionic Characteristics

- crystal
- isomorphism
- solid at room temp
- high melt/boil
- Hard and brittle
- reactions fast
- soluble in polar
- individuality
- non polymer

1. Melting Point > 600°C
2. Boiling Point > 800°C
   Root Mean Square velocity
3. Individuality (Only one formula)
4. Polarity
5. Solubility. Like dissolves like



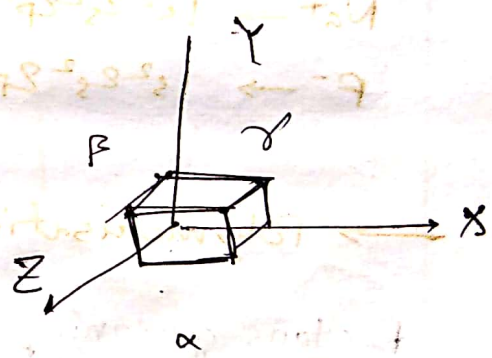
Crystal Structure

The definable unit in ~~torture chamber~~ an object is a crystal. There are two ~~angles~~ properties

→ Angle
— ~~Arm~~

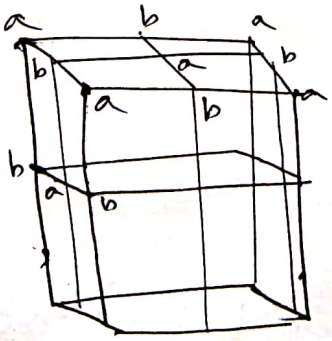
$\alpha = \beta = \gamma = 90°$
$a = b = c$

$\alpha = \beta = \gamma = 90$
$a = b \neq c$



Ionic compounds will have crystal structure.

No of



Na → a
Cl → b

→ Amorphism

Semicrystallized : has both ionic, covalent property

→ Conductivity :

→ Isomorphism

cation + anion → ionic compound.

if the electronic configuration of cation and anion match with that of another ionic compound, the crystal structure of the two is similar.

Na^+ F^- $\quad$ Mg^{2+} O^{2-}

$Na^+ \rightarrow 1s^2 2s^2 2p^6 3s^0$ $\quad$ $Mg^{2+} \rightarrow 1s^2 2s^2 2p^6 3s^0$

$F^- \rightarrow 1s^2 2s^2 2p^6$ $\quad$ same $\quad$ $O^{2-} \rightarrow 1s^2 2s^2 2p^6$

→ Polymerisation : not viable for ionic compound

Factors governing ionization :

① ionization energy : lower IE ; greater chance

② Electron affinity

③ Lattice energy : Higher LE; stronger ionic bond.

→ Amorphism
Semicrystallized : has both ionic, covalent property

→ Conductivity :

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$F^- \rightarrow 1s^2 2s^2 2p^6$ $\quad$ $O^{2-} \rightarrow 1s^2 2s^2 2p^6$

same

→ Polymerisation : not viable for ionic compound

Factors governing ionization :

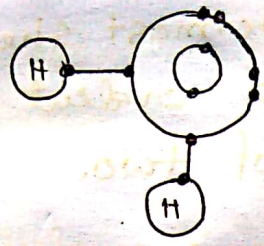
① ionization energy : lower IE ; greater chance

② Electron affinity

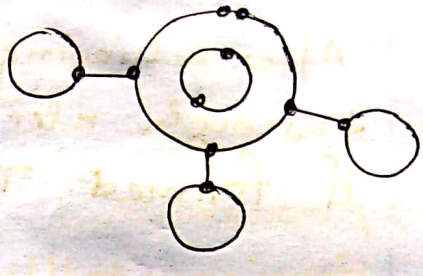
③ Lattice energy : Higher LE; stronger ionic bond.

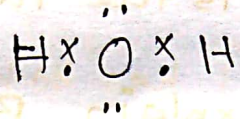
Covalent Compound

H_2O



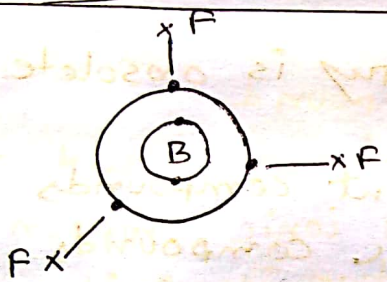
NH_3





Incomplete octale complications:

BF_3

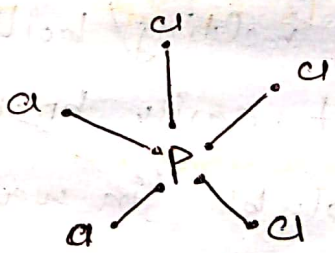


Boron doesn't achieve octate completion but still BF_3 acts like a covalent compound. satisfies all properties.

Octate expantion complication:

P – $1s^2 2s^2 2p^6 3s^2 3p^3$

Cl – $1s^2 2s^2 2p^6 3s^2 3p^5$



P gets 20 e⁻ in the last orbital 2 more than what it needs to achieve argon(18) config.

But PCl_5 is a pure covalent compound following all characteristics.

So, in case of covalent compound, the sharing of electron is important. Not neutral molecule electron config.

Rule of two

After achieving pairs of all outermost shell electrons, through electron sharing, a covalent compound if formed. This is the rule of two.

This is how we explain BF_3, PCl_5

The main idea here is to achieve magnetic neutrality of pair electrons.

The neutral molecule theory is obsolete.

The characteristics of covalent compounds are completely opposite of ionic compounds.

Characteristics

(i) Gas/liquid/solid at room temp.
(ii) low melting/boiling point
(iii) soft, easily broken
(iv) Insoluble in water
(v) Non-conductors of electricity
(vi) Exhibit isomerism
(vii) Slow molecular reactions.

Condition

(i) Number of valence e⁻ both 5, 6, 7
(ii) Equal Electronegativity
(iii) Equal Sharing of electron.

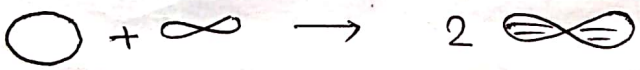
Hybridization

1. Hybridization always takes part among the orbitals of same energy level.
2. Before and after hybridization, the number of orbitals will be same.
3. Hybridized orbitals bear same energy. (2s-2p)
4. Only orbitals participate in hybridization. not electrons
5. Although electron rearrangement happens.
5. σ bond always occurs between the hybridized orbital.

Classification →

→ the total number of orbitals stay the same.

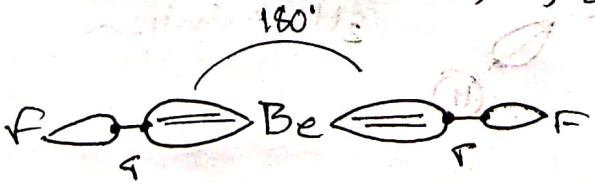
SP



P > s before hybr.
P = s after hybr.

$Be(4) \rightarrow 1s^2 \boxed{2s^2 \; 2p_x} \; 2p_y \; 2p_z$

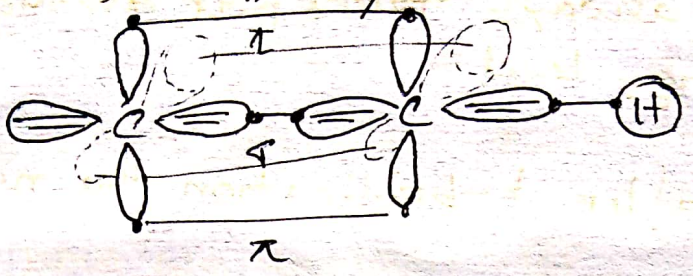
$1s^2 \; 2s^1 \; 2p_x^1 \; 2p_y \; 2p_z$



Linear

C(6) → $1s^2 \boxed{2s^2\ 2p^2}$

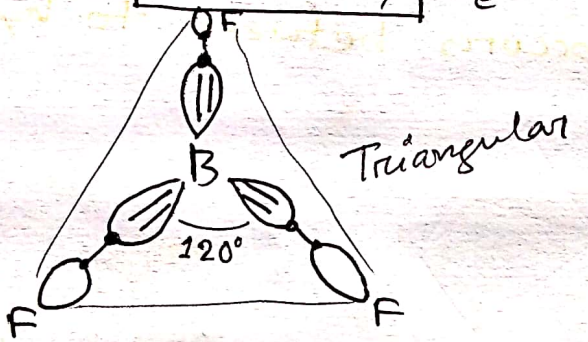
$1s^2\ 2s^1\ 2p_x^1\ 2p_y^1\ 2p_z^1$



$-C \equiv C-$

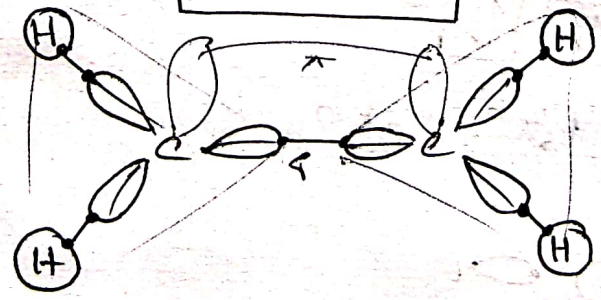
SP₂ ○ + 2 ∞ → 3 ⊂⊃

B(5) $1s^2 \boxed{2s^1\ 2p_x^1\ 2p_y^1}\ 2p_z$



Triangular

C(6) $1s^2 \boxed{2s^1\ 2p_x^1\ 2p_y^1\ 2p_z^1}$

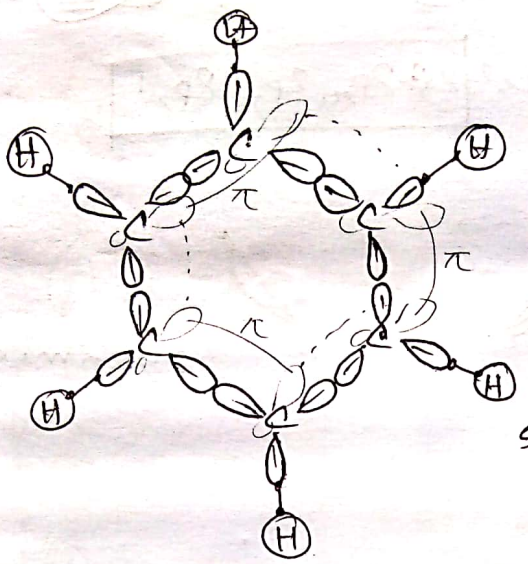


$>C=C<$

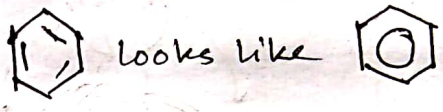
$C_2H_4 \rightarrow C_nH_{2n}$

Aromatic compound

(★) সাধারণ Alkene এর sp_2 আর বেনজিন এর sp_2 এর মাঝে পার্থক্য আছে।



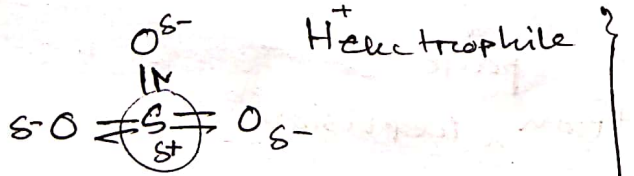
C_6H_6
একাদিক্রমে π bond
10^{-8}s এ π bond shift হয়।

so,  looks like

the least dense area → nodal plane. the superfast π bonds nullify any such nodal effect. they seem to be everywhere at the same tyme.

Delocalisation
Delocalised electron

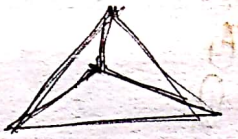
attacking — electrophile [electronegative, positive ion]
nucleophile [negative ion]



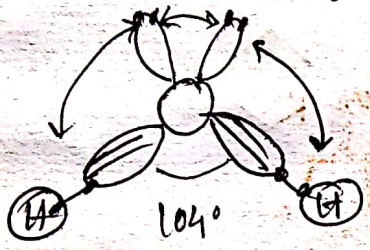
(★) electrophile's can easily locate and attack the stationary π-bond e^-. on the other hand, they cannot easily attack benzene's superfast π electrons.
Alkene → যুক্ত
∴ benzene → প্রতিস্থাপন

SP^3 $O + 3\infty \rightarrow 4$ 

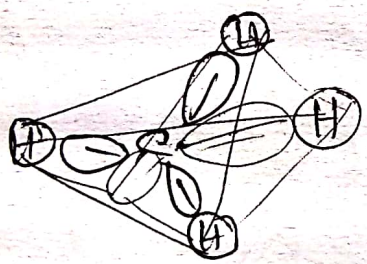
$N(7) \rightarrow 1s^2 \boxed{2s^2 2p_x 2p_y^1 2p_z^1}$



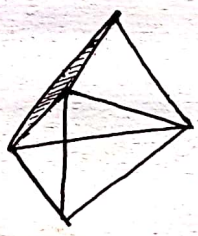
pyramid



$C(6) \rightarrow 1s^2 \boxed{2s^1 2p_x^1 2p_y^1 2p_z^1}$



109.28'



tetrahydral

sideview

top view

VSEPR

Valency shell electron pair repulsion

$LP\text{-}LP > LP\text{-}bp > bp\text{-}bp$

piridin

Aromatic → hetero / carbocyclic (only c)

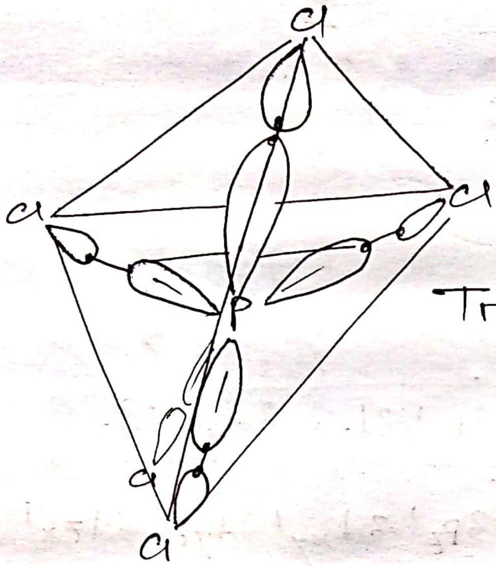
→ SP_2 Nitrogen.

Sp^3d

1s + 3p + 1d → 5

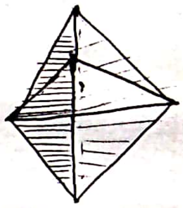
P(15) → $1s^2$ $2s^2$ $2p^6$ $3s^2$ $3p_x^1$ $3p_y^1$ $3p_z^1$ $3d_{xy}$ $3d_{yz}$ $3d_{zx}$ $3d_{x^2-y^2}$ ...

$3s^1$ $3p_x^1$ $3p_y^1$ $3p_z^1$ $3d_{xy}^1$



PCl_5

Triangular Bipyramidal

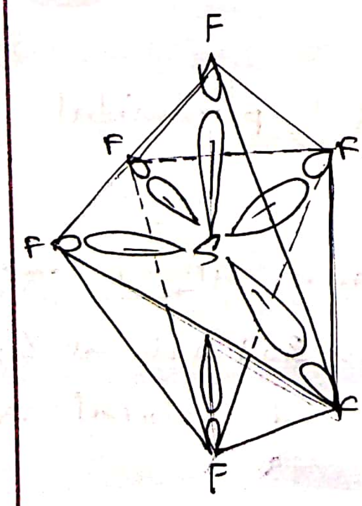


Sp^3d^2

s + 3P + 2d → 6

S(16) → $1s^2$ $2s^2$ $2p^6$ $3s^2$ $3p_x^2$ $3p_y^1$ $3p_z^1$ $3d_{xy}$ $3d_{yz}$ ....

$3s^1$ $3p_x^1$ $3p_y^1$ $3p_z^1$ $3d_{xy}^1$ $3d_{yz}^1$



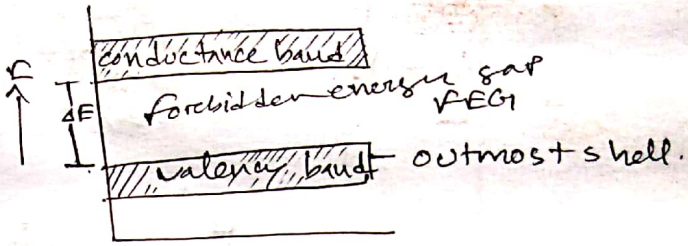
SF_6

Octahedral

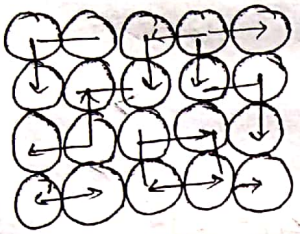
O, S same group
O (H_2O: −2), −1, (F_2O: +2)
S^{+2}, S^{+4}, S^{+6} } whe the diff?

Metallic Bonding

Band theory.



electron cloud



- electron moves everywhere creating an extremely strong magnetic field that holds the molecules tight.

VB তে e থাকে FEG বেশি { conductor (CB তে e থাকে)
insulator (CB তে e নেই)

Semi-conductor
(VB তে থাকবে, CB তে সংখ্যা থাকবে না, FEG ছোট)

Doping agent
trivalent → Al
pentavalent → As, P

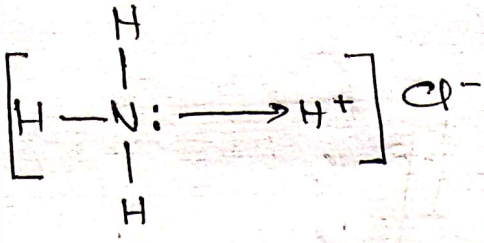
excess of e → n type
lack of e → p type

(1) conductivity { thermal / electrical

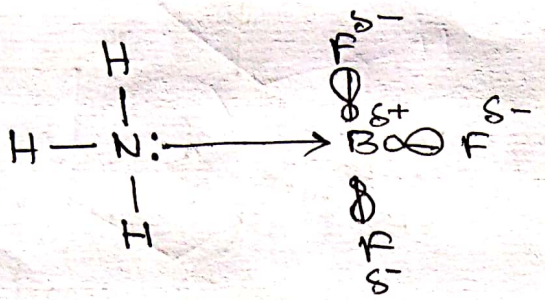
(2)

system { Molecular orbital theory
VSEPR

Co-Ordinate Bonding



$HCl \longrightarrow H^+ + Cl^-$



B $1s^2 2s^2 2p^1$

f → 4.0

$Fe^{2+}SO_4$ $\quad Fe(26) \longrightarrow 1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^6$

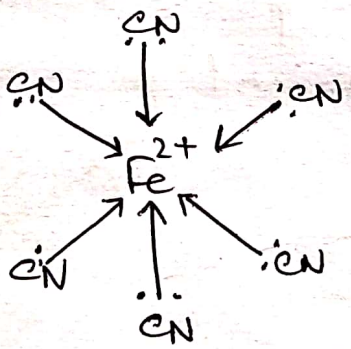
$Fe \longrightarrow Fe^{2+} + 2e$

$Fe^{2+} \longrightarrow Fe^{3+} + e$

$K_4[Fe(CN)_6]SO_4$ $\quad HCN \longrightarrow H^+ + :\dot{C}N$

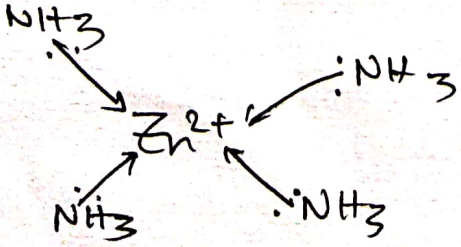
Fe^{2+}

Fe gains Kr's electronic config.



$[Zn(NH_3)_4]SO_4$ $\quad Zn(30) \longrightarrow 1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10}$ (2e⁻ from 4s)

$Zn^{2+} \longrightarrow 28\ e^-$



$CuSO_4$

$[Cu(NH_3)_4]SO_4$

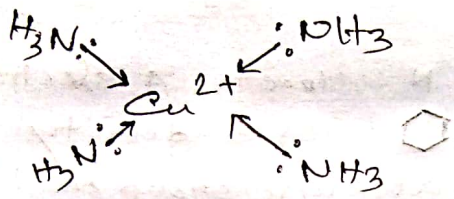
$Cu(29) \rightarrow 1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^{10}$ (→ 1e⁻)

$Cu \rightarrow Cu^+ + e$

Cuprous ion

$Cu^{2+} + 2e \longrightarrow 2 \times e^-$

Cupricion

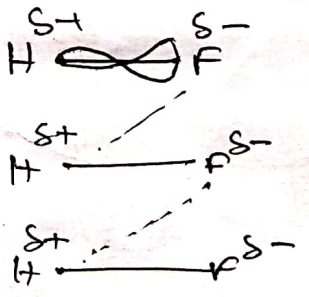


neutral gas config attainance. } observed in complex compounds.
octate filling
octate expansion

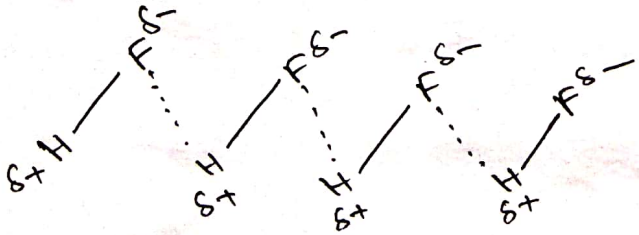
Hydrogen bonding:

Condition—

1. Hydrogen molecule must connect with other molecule.
2. The 'other' molecule must have greater electronegativity than hydrogen.



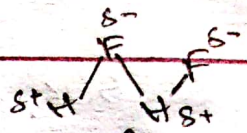
সমযোজী বন্ধনের অন্তর্গত বিভিন্ন?



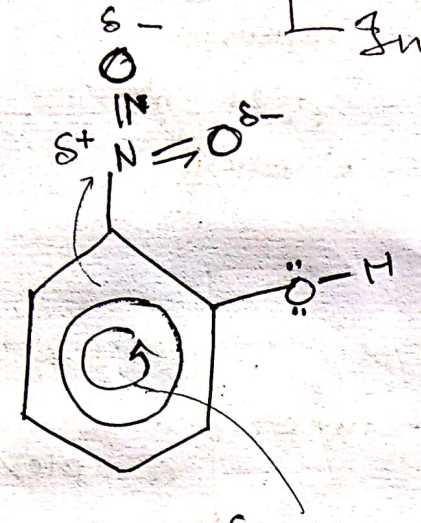
Characteristics

- Abnormally high melt/boil
- Highly soluble
- 3d lattice

Hydrogen bonding



- Intermolecular [two separate molecule]
- Intramolecular [same ~~group~~ molecule – diff. group]



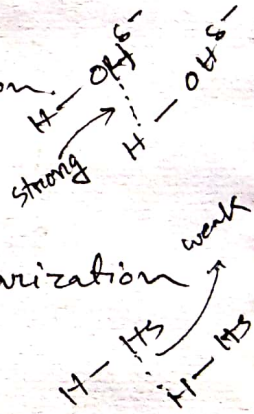
N attracts ↑ electrons
⬡ loses e density
attacking group can't find e
reactivity কমে
নিষ্ক্রিয়কারী গ্রুপ

[for centripetal force here, O's electrons are sucked in and so the density of e⁻ increases. OH is a সক্রিয়কারী গ্রুপ]

Importances:

- Liquid H_2O
- DNA RNA

2.1 H_2O (l) — 3.5 → polarization. explain.
H_2S (g) — 2.4 → low polarization



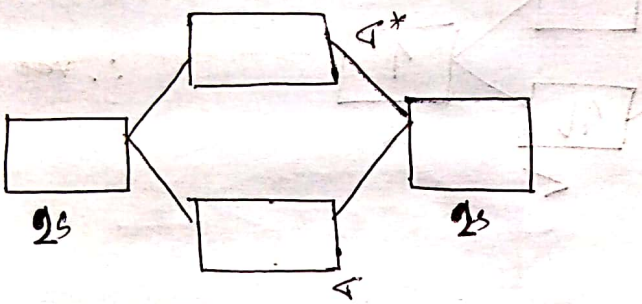
Molecular orbital Theory.

N_B = Number of bonding electrons

N_A = Number of anti bonding electron

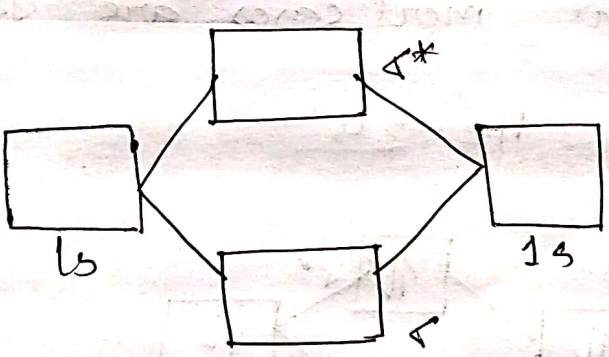
Bond Order

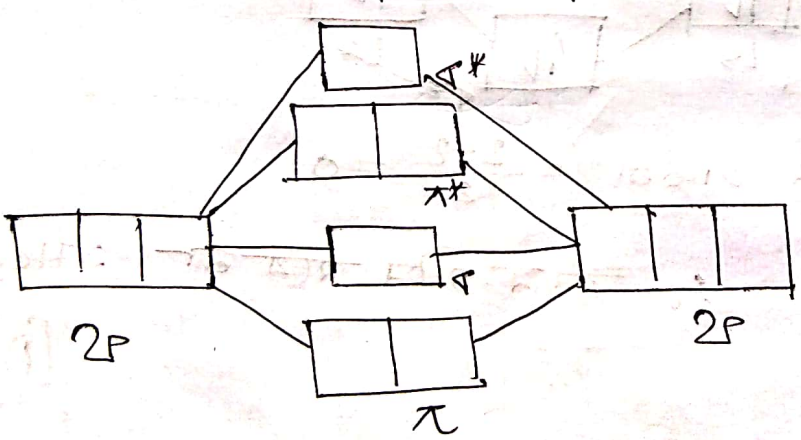
$$= \frac{N_B - N_A}{2}$$



σ sigma bonding

σ* " anti "

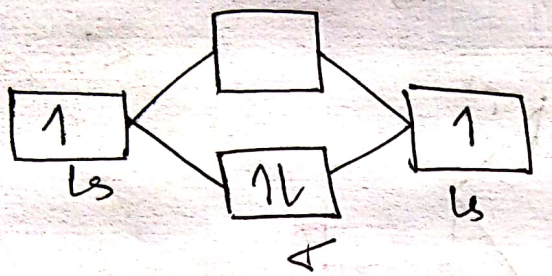




H পরমাণু + অন্য পরমাণু মিলে যে যৌগ হয় তার

first check

1. if its possible
2. dia or para

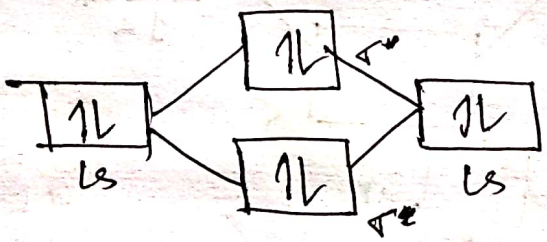


bond order = $\frac{2-0}{2} = 1$

∴ H molecule possible.

(*) Prove that the inert gases are এক-পরমাণুক।

প্রতি দ্বিপরমাণুক He → $1s^2$



Bond order = $\frac{2-2}{2} = 0$

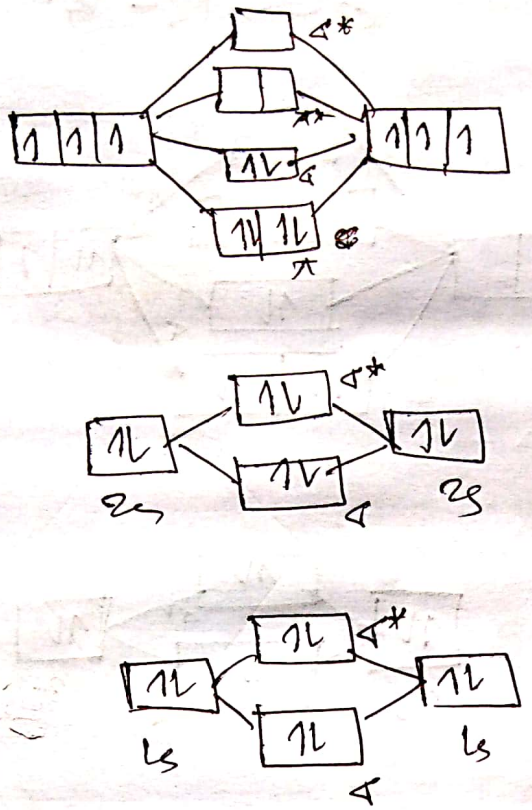
∴ তখন গঠন হবে না ∴ He_2 হবে না।

[Proved]

(*) Prove (N_2)

$N = 1s^2 2s^2 2p_x^1 2p_y^1 2p_z^1$

figure for N_2

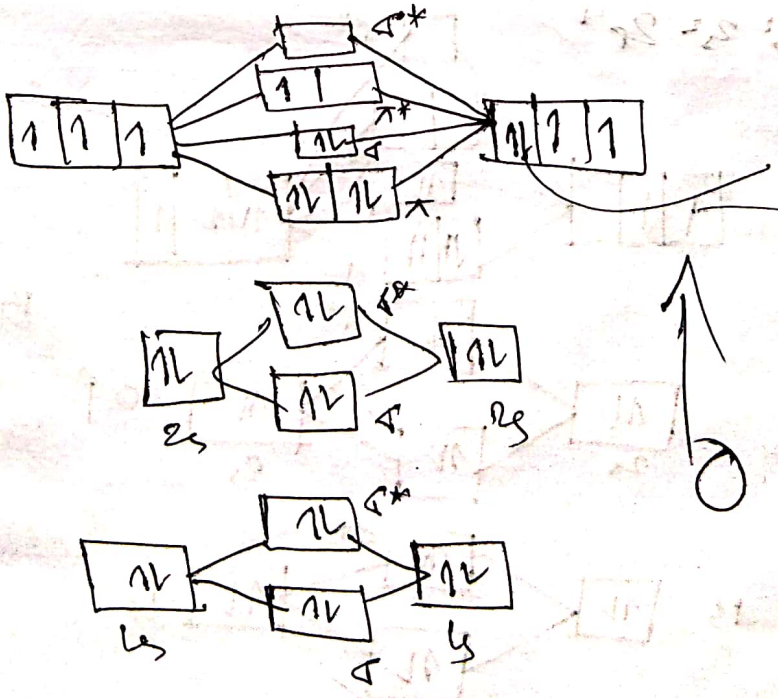


$$B.O = \frac{10-4}{2} = 3 \quad \therefore \text{possible}$$

NO possible?

$N \rightarrow 1s^2 2s^2 2p_x^1 \; 2p_y^1 \; 2p_z^1$

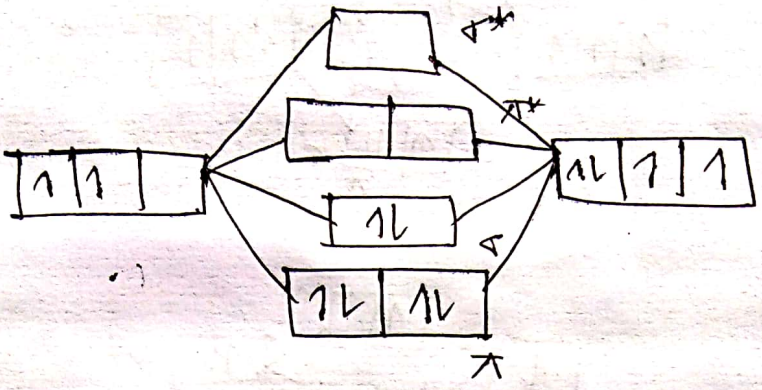
$O \rightarrow 1s^2 2s^2 2p_x^2 \; 2p_y^1 \; 2p_z^1$

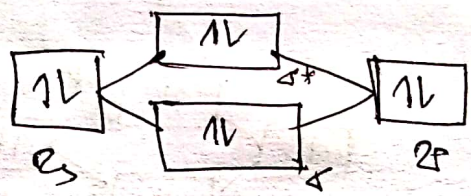


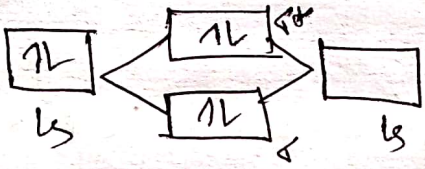
paramagnetic

$$B.O = \frac{10-5}{2} = 2.5$$

CO possible? C → $1s^2 2s^2$



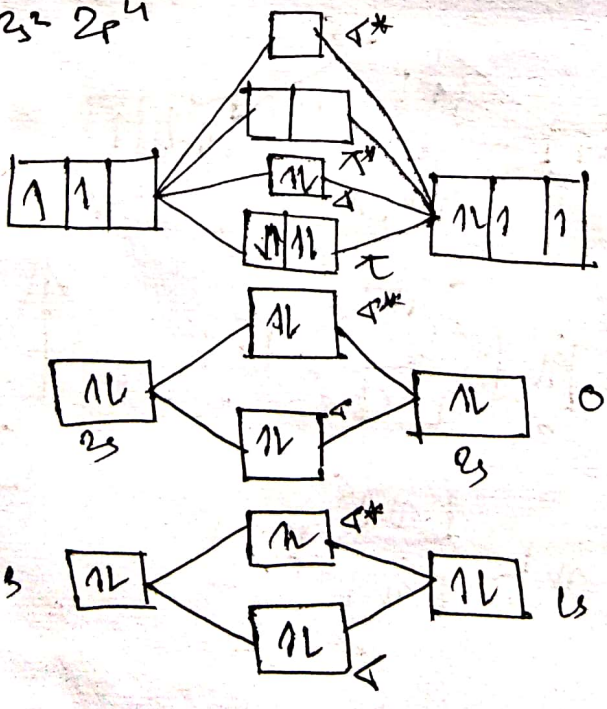




is CO possible?

C → $1s^2 2s^2 2p^2$

O → $1s^2 2s^2 2p^4$



$B_O = \frac{8-6}{2}$

$= 2 \text{ or } 1$

Chemical Equilibrium

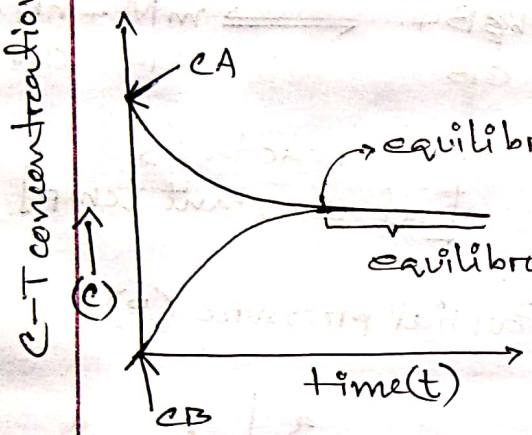
$NaCl + CaCO_3 \longrightarrow Na_2CO_3 + CaCl_2$

Terms used in chemical equilibrium : i) equilibrium
ii) equilibrium point
iii) Dual facing reaction
দ্বিমুখী বিক্রিয়া

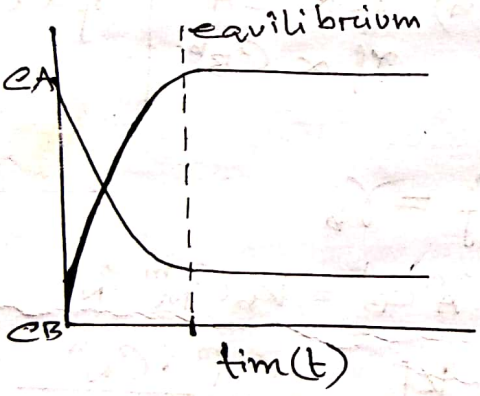
At equilibrium $\gamma_f = \gamma_b$

$A \rightleftharpoons B$

$\gamma_f \rightarrow$ forward rate
$\gamma_b \rightarrow$ backward rate



⇨ if half of the reactant reacts and acquires equilibrium



⇨ if more or less than half reactant reacts and creates product at equilibrium.

Dual-directional reaction ⟶ One directional

Method :

① $CaCO_3 \overset{\Delta}{\rightleftharpoons} CaO + CO_2 \uparrow (g)$ if the product is in open container ⟶ one dir.

② Precipitation Method :

$NaCl + AgNO_3 \longrightarrow AgCl \downarrow + NaNO_3$

white ppt.

④ Chemical Method :

$$CH_3-\overset{O}{\overset{\|}{C}}-OC_2H_5 + H-OH \longrightarrow CH_3COOH + C_2H_5OH$$

$$NaOH + CH_3COOH \longrightarrow CH_3COONa + H_2O$$

Law of mass-action: $aA + bB + \cdots \rightleftharpoons mM + nN + \cdots$

$C_A \quad C_B \qquad\qquad C_M \quad C_N$

Rate of reaction $\propto$ Active conc. of reactants [at constant temp]

Active concentration (c) # Partial pressure (P)

Mole fraction (X)

(Rate of reaction) $\gamma_f \propto C_A^a$ | $\gamma_f \propto C_A^a \cdot C_B^b$

$\gamma_f \propto C_B^b$

velocity constant

$$\boxed{\gamma_f = k_f \cdot C_A^a \cdot C_B^b} \quad \text{---(1)}$$

$$\gamma_f = \gamma_b$$

$$\gamma_b \propto C_M^m \propto C_N^n$$

$$\gamma_b = k_b C_M^m C_N^n$$

$$k_f C_A^a C_B^b = k_b C_M^m C_N^n$$

$$k_c = \frac{k_f}{k_b} = \frac{C_M^m \cdot C_N^n}{C_A^a \cdot C_B^b}$$

↓ equilibrium constant

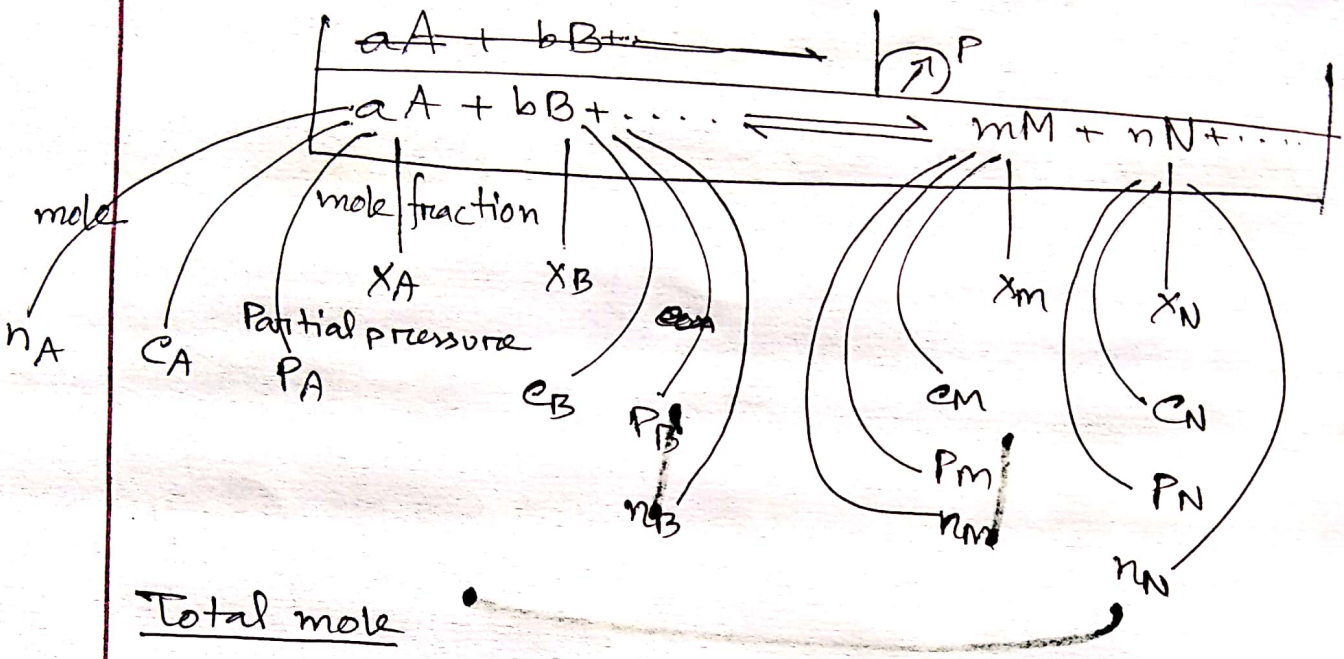
$$k_x = \frac{X_m^m \cdot X_N^n}{X_A^a \cdot X_B^b}$$

Relationship between k_p k_c & k_x

For pressure,

$$k_p = \frac{P_M^m \cdot P_N^n}{P_A^a \cdot P_B^b}$$

Relationship between K_p, K_c & K_x



Total mole

$$n = n_A + n_B + n_M + n_N + \dots\dots$$

$$PV = nRT$$

$$P = RT\frac{n}{V}$$

$$P = \frac{RT}{V} \cdot n \quad \text{—(i)}$$

$$P_A = \frac{RT}{V} n_A \quad \text{—(ii)}$$

$$P_B = \frac{RT}{V} n_B \quad \text{—(iii)}$$

$$P_M = \frac{RT}{V} n_M \quad \text{—(iv)}$$

$$P_N = \frac{RT}{V} n_N \quad \text{—(v)}$$

$$P_A + P_B + P_M + P_N + \dots = \frac{RT}{V}\left(n_A + n_B + n_M + n_N + \dots\right)$$

$$= \frac{RT}{V} \cdot n$$

$$= P$$

∴ the summation of fractional pressures are equal to the total pressure.

(II) ÷ (I)

$$\frac{P_A}{P} = \frac{n_A}{n} \quad ; \quad P_A = X_A P$$

;;

$$P_B = X_B \times P$$

$$P_m = X_m P$$

$$P_N = X_N P$$

$$P = \frac{RT}{V} \cdot n$$

$$P = RT \cdot \frac{n}{V} = RTC$$ (fixed, fixed, variable)

$$P_A = RTC_A$$

$$P_B = RTC_B$$

$$P_m = RTC_M$$

$$P_N = RTC_N$$

$$\Delta n = (m+n+\cdots) - (a+b+\cdots)$$

$$K_p = \frac{P_N^m \cdot P_M^N}{P_A^a \; P_B^b}$$

$$K_p = \frac{P_m^m \; P_N^n}{P_A^a \; P_B^b}$$

$$= \frac{(RTC_M)^m \; (RTC_N)^n}{(RTC_A)^a (RTC_B)^b}$$

$$= \frac{C_m^m \cdot C_N^n \cdots}{C_A^a \cdot C_B^b \cdots} \times \frac{(RT)^m \cdot (RT)^n \cdots}{(RT)^a \cdot (RT)^b \cdots}$$

$$= K_c \times RT^{(m+n+\cdots)-(a+b+\cdots)}$$

$$K_p = K_c (RT)^{\Delta n}$$

when $\Delta n = 0$

$$K_p = K_c$$

$$K_p = \frac{P_M^m \cdot P_N^n \cdots}{P_A^a \cdot P_B^b \cdots}$$

$$= \frac{(X_M P)^m \cdot (X_N P)^n \cdots}{(X_A P)^a \cdot (X_B P)^b \cdots} = \frac{X_m^m \cdot X_N^n \cdots}{X_A^a \times X_B^b \cdots} \times \frac{P^m \cdot P^n \cdots}{P^a \cdot P^b \cdots}$$

$$\Rightarrow K_x \cdot P^{(m+n+\cdots)-(a+b+\cdots)}$$

$$\Rightarrow K_x \cdot P^{\Delta n}$$

when $\Delta n = 0$; $K_p = K_x$

$$K_p = K_c (RT)^{\Delta n} = K_x P^{\Delta n}$$

$$K_x = K_c \left(\frac{RT}{P}\right)^{\Delta n}$$

$PV = RT$ when $n = 1$; $V = \frac{RT}{P}$

$$K_x = K_c (V)^{\Delta n}$$

Application

$$PCl_5 \rightleftharpoons PCl_3 + Cl_2$$

1	0	0
$1-\alpha$	α	α

$$\left[PCl_5\right] = \frac{1-\alpha}{V}$$

$$\left[PCl_3\right] = \frac{\alpha}{V}$$

$$\left[Cl_2\right] = \frac{\alpha}{V}$$

$$K_c = \frac{\left[PCl_3\right]\left[Cl_2\right]}{\left[PCl_5\right]}$$

$$= \frac{\frac{\alpha}{V} \times \frac{\alpha}{V}}{\frac{1-\alpha}{V}}$$

$$\boxed{K_c = \frac{\alpha^2}{(1-\alpha)V}}$$

for K_p

total mole $= 1 - \alpha + \alpha + \alpha = 1 + \alpha$

$$P_{PCl_5} = \frac{1-\alpha}{1+\alpha} \times P$$

$$P_{PCl_3} = \frac{\alpha}{1+\alpha} \times P$$

$$P_{Cl_2} = \frac{\alpha}{1+\alpha} \times P$$

PCl_5 থেকে PCl_3 উৎপাদন কিভাবে বাড়ানো যায়?

$K_p = \frac{\alpha^2 P}{1}$

$\alpha = \sqrt{\frac{K_p}{P}}$

$\alpha \propto \frac{1}{\sqrt{P}}$

P কমানো।

$K_c = \frac{\alpha^2}{(1-\alpha)V}$

$= \frac{\alpha^2}{1 \cdot V}$ (α negligible)

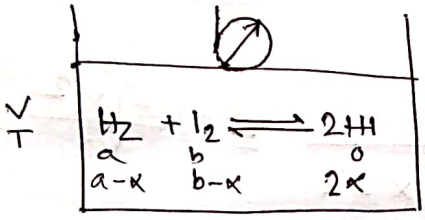
$\alpha = \sqrt{V \cdot K_c}$

$\alpha \propto \sqrt{V}$

V বাড়ানো।

16.04.2019

1 Dimensionless group.



$[H_2] = \frac{a-x}{V}$

$[I_2] = \frac{b-x}{V}$

$[HI] = \frac{2x}{V}$

$K_c = \frac{[HI]^2}{[H_2][I_2]}$

$= \frac{(2x)^2}{\frac{a-x}{V} \cdot \frac{b-x}{V}}$

$K_c = \frac{4x^2}{(a-x)(b-x)}$

$\Delta n = 0$

$\Delta n = 2-(1+1) = 0$

this is a dimensionless equation.

Total mole, $= a-x+b-x+2x$

$= a+b$

$P_{H_2} = \frac{a-x}{a+b} P$

$P_{I_2} = \frac{b-x}{a+b} P$

$P_{HI} = \frac{2x}{a+b} P$

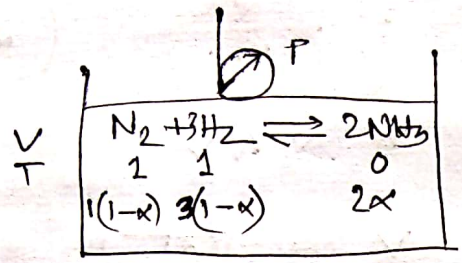
$K_p = \frac{P_{HI}^2}{P_{H_2} P_{I_2}}$

$= \frac{\left(\frac{2x}{a+b} \cdot P\right)^2}{\left(\frac{a-x}{a+x} P\right)\left(\frac{b-x}{a+b} \cdot P\right)}$

$= \frac{4x^2}{(a-x)(b-x)}$

(*) As there is no volume in the eq, we can't take any descision regarding volume.

if, $\Delta n = 0$ $\quad K_p = K_c$; both are dimensionless.



$[N] = \frac{1-\alpha}{V}$

$[H_2] = \frac{3(1-\alpha)}{V}$

$[NH_3] = \frac{2\alpha}{V}$

$$K_c = \frac{\left(\frac{2\alpha}{V}\right)^2}{\left\{\frac{3(1-\alpha)}{V}\right\}^3 \left(\frac{1-\alpha}{V}\right)}$$

$$= \frac{\frac{4\alpha^2}{V^2}}{\frac{1-\alpha}{V} \times \frac{(1-\alpha)^3}{V^3} \times 27} = \frac{4\alpha^2}{V^2} \times \frac{V^4}{27(1-\alpha)^4}$$

$$= \frac{4\alpha^2 V^2}{27(1-\alpha)^4}$$

total mole $= (1-\alpha) + 3(1-\alpha) + 2\alpha$

$= 2(2-\alpha)$

$P_{H_2} = \frac{1-\alpha}{2(2-\alpha)} P$

$P_{N_2} = \frac{3(1-\alpha)}{2(2-\alpha)} P$

$P_{NH_3} = \frac{2\alpha}{2(2-\alpha)} P$

$$K_p = \frac{\left(\frac{\alpha}{2-\alpha} P\right)^2}{\frac{1-\alpha}{2(2-\alpha)} P \left(\frac{3(1-\alpha)}{2(2-\alpha)} P\right)^3}$$

$$= \frac{\alpha^2 P^2}{(2-\alpha)^2} \times \frac{2 \times 8 (2-\alpha)^4}{27 (1-\alpha)^4 P^4}$$

$$= \frac{16\alpha^2 (2-\alpha)^2}{27 (1-\alpha)^4 P^2}$$

if $\alpha << 1$

$$k_e = \frac{4\alpha^2 v^2}{2\pi (1-\alpha)^4}$$

$$= \frac{4\alpha^2 v^2}{2\pi} \quad ; \quad \alpha = \sqrt{\frac{2\pi k_e}{4}} \cdot \frac{1}{v}$$

$$\alpha \propto \frac{1}{v}$$

(*) So, here, if v is reduced, production increases.

$$k_p = \frac{16\alpha^4 (2-\alpha)^2}{2\pi (1-\alpha)^4 p^2} = \frac{16\alpha^2}{2\pi p^2}$$

$$= \sqrt{\frac{16\alpha^2}{2\pi}} \cdot p \quad \therefore \alpha = \sqrt{\frac{2\pi k_p}{64}} \cdot p$$

$$\alpha \propto p$$

Chemical Kinetics The branch of physical chemistry which deals with the speed or rate of reaction is called Chemical Kinetics.

$A + B \rightleftharpoons C + D$

Reaction Rate: defined as the change in concentration of any reactant or product per unit time.

Rate laws or rate equation: Expression showing the relation between reaction rate is related to concentrations.

Example: $2N_2O_5 \longrightarrow 4NO_2 + O_2$ $\quad rate = K[N_2O_5]^2$

$H_2 + I_2 \longrightarrow 2HI$ $\quad rate = K[H_2][I_2]$

Order of a reaction: Sum of the power of the concentration terms in the rate equation.

$$Rate = KC_1^{n_1}C_2^{n_2}C_3^{n_3}\ldots$$

$$Order = n_1 + n_2 + n_3 + \ldots = n$$

might be zero or fractional.

The powers summed might not be the same as the equation, exact power of reactants that take part, are summed.

rate

Zero Order Reaction: if the reaction is independent of the concentration of the reactants.

consider a reaction:

$$A \longrightarrow \text{Product}$$

Initial conc.	a	0
Final conc.	a-x	x

Rate of reaction $= -\frac{d[A]}{dt} = k[A^0]$

or, $\frac{dx}{dt} = k(a-x)^0$

or, $\frac{dx}{dt} = k$

or, $dx = kdt$ ——— (1)

Integrating: $x = kt + c$

condition, $t = 0 \; ; x = 0$

$\therefore c = 0$

Hence $\boxed{x = kt}$ → Rate equation for zero order reaction

Example: H_2 & Cl_2 photochemical reacc. over water surface

Thermal decomposition of H_2 on gold surface.

④ What if first order reactions actually ended?

Put $a_0 - x = 0$ in the equation.

$$\ln \frac{a_0}{0} = kt'$$

$$t' = \frac{\infty}{k}$$

$$t' = \infty$$

it would take infinite time to finish the reaction.

Half Life

$$A \longrightarrow P$$

a_0 — 0 — $t=0$

$a_0/2$ — $t = t_{1/2}$

$$\ln \frac{a_0}{a_0 - a_0/2} = k t_{1/2}$$

$$\ln \frac{a_0}{a_0/2} = k t_{1/2}$$

$$\ln(2) = k t_{1/2}$$

$$0.693 = k t_{1/2}$$

$$t_{1/2} = \frac{0.693}{k}$$

(1) First order reaction doesn't end.

(2) The time taken for a fraction of first order reaction to happen does not depend on the initial amount.

$$\ln \frac{a_0}{a_0 - x} = kt \quad \text{---(1)}$$

$$\ln \frac{ma_0}{ma_0 - mx} = kt'$$

$$\ln \frac{\cancel{m}a_0}{\cancel{m}(a_0 - x)} = kt' \; ; \quad \ln \frac{a_0}{a - x}$$

(3) changing the amount of reactant or product (m times) does not affect the equation.

2nd Order Reaction

$$2A \longrightarrow P$$

$a_0 \quad 0$

$a_0 - x = a -$ max

$$\frac{a_0 - a_0 + x}{(a_0 - x)\, a_0} = kt$$

$$\frac{x}{(a_0 - x)\, a_0} = kt \quad \text{---(1)}$$

$$\frac{1}{a_0 - x} - \frac{1}{a_0} = kt$$

$$\frac{1}{a_0 - x} = kt + \frac{1}{a_0}$$

$$y = mx + c$$

$2A \longrightarrow P$

2 types: $A + B \longrightarrow P$

$$\frac{dx}{dt} \propto a^2$$

$$= ka^2$$

$$\frac{dx}{a^2} = k\,dt$$

$$\int_0^x \frac{dx}{(a_0 - x)^2} = k \int_0^t dt$$

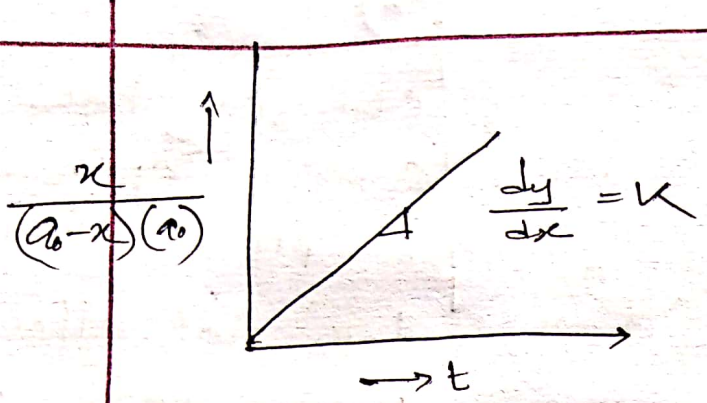
$$\int \frac{dx}{z^2} = k \int dt$$

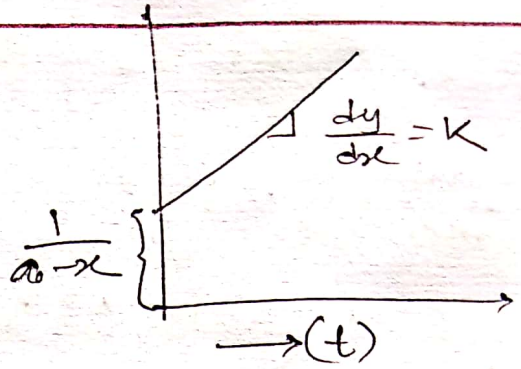
$$= \left[\frac{z^{-2+1}}{-2+1}\right] = k[t]$$

$$= \left[\frac{1}{z}\right] = k[t]$$

$$\Rightarrow \left[\frac{1}{a_0 - x}\right]_0^x = k[t]_0^t$$

$$\Rightarrow \frac{1}{a_0 - x} - \frac{1}{a_0} = kt$$





$$A + B \longrightarrow P$$

a	b	0
a−x	b−x	x

$$\frac{dx}{dt} = k(a-x)(b-x)$$

$$\frac{1}{b-a}\int\left[\frac{1}{a-x} - \frac{1}{b-x}\right]dx = \int k\,dt$$

$$\frac{1}{b-x}\int -\left[\frac{-1}{a-x} + \frac{-1}{b-x}\right] = \int k\,dt$$

$$\frac{1}{b-x}\left\{\left[-\ln(a-x)\right]_0^x + \left[\ln(b-x)\right]_0^x\right\} = k[t]_0^t$$

$$\frac{1}{b-x}\left\{\ln\frac{a-x}{a} + \ln\frac{b-x}{b}\right\} = k[t]_0^t$$

$$\boxed{\frac{1}{b-x}\ln\frac{a(b-x)}{b(a-x)} = kt}$$

Properties of 2nd order Reaction.

(1.) The time taken for a fraction to complete is dependant on initial reactant.

Half Life $\quad \frac{x}{a(a-x)} = kt$

$\therefore \frac{a/2}{a(a-a/2)} = kt_{1/2}$

$\Rightarrow t_{1/2} = \frac{1}{ka}$

$$t_{1/2} \propto \frac{1}{a}$$

(2) if reactant and product is altered times m, the equation is affected.

$$\frac{mx}{ma(ma-mx)} = kt$$

$$\frac{1}{m} \frac{x}{a(a-x)} = kt'$$

Now,

$$\frac{1}{a-b} \ln \frac{b(a-x)}{a(b-x)} = kt,$$

here, $a >> b$; so $a - b = a$ | also $a >> x$

$$\frac{1}{a} \ln \frac{b \cdot a}{a(b-x)} = kt$$

$$\ln \frac{b}{b-x} = (ka)\, t$$

$$\boxed{\ln \frac{b}{b-x} = k't}$$

→ behaves like first order if one of the two reaction reactants is extremely small.

3rd Order reaction: 3 types.

1. $3A \longrightarrow P$
2. $2A + B \longrightarrow P$
3. $A + B + C \longrightarrow P$

$3A \longrightarrow P$		
a_0	0	$t=0$
$a = a_0 - x$	x	t

$$\frac{dx}{dt} \propto a^3$$

$$= ka^3$$

$$\frac{dx}{dt} = k(a_0 - x)^3$$

$$\int_0^{x} \frac{dx}{(a_0 - x)^3} = k \int_0^{t} dt$$

$a_0 - x = z$

$dx = -dz$

$$\Rightarrow \int \frac{-dz}{z^3} = k \int dt$$

$$\Rightarrow \left[\frac{z^{-2}}{-2}\right] = k[t]$$

$$\Rightarrow \frac{1}{2}\left[\frac{1}{(a-x)^2}\right]_0^{x} = k[t]_0^{t}$$

$$\Rightarrow \frac{1}{2}\left\{\frac{1}{(a_0 - x)^2} - \frac{1}{(a_0 - 0)^2}\right\} = kt$$

$$\Rightarrow \frac{1}{2}\left\{\frac{a_0^2 - a_0^2 + 2a_0x - x^2}{a_0^2(a_0 - x)^2}\right\} = kt$$

$$\Rightarrow \frac{1}{2}\frac{x(2a_0 - x)}{a_0^2(a_0 - x)^2} = kt$$

In this case, half life will be affected by initial concentration. Besides changing the reactants and m times will change the eq.

Half life $\dfrac{\frac{1}{2}\frac{a_0}{2}\left(2a_0-\frac{a_0}{2}\right)}{a_0^2\left(a_0-\frac{a_0}{2}\right)^2} = k t_{1/2}$

$\Rightarrow \dfrac{1}{2}\dfrac{\frac{a_0}{2}\cdot\frac{3a_0}{2}}{a_0^2\cdot\frac{a_0^2}{4}} = k t_{1/2}$

$\Rightarrow \dfrac{3}{2}\dfrac{1}{a_0^2} = k t_{1/2}$

$t_{1/2} = \dfrac{1}{k}\cdot\dfrac{1}{a_0^2}\cdot\dfrac{3}{2}$

$t_{1/2} \propto k' \dfrac{1}{a_0^2}$

$t_{1/2} \propto \dfrac{1}{a_0^2}$

half life of reaction; $t_{1/2} \propto \dfrac{1}{a_0^{n-1}}$

1st order $t_{1/2} = \dfrac{0.693}{k}\cdot\dfrac{1}{a_0^{1-1}}$

2nd order $t_{1/2} = \dfrac{1}{k}\cdot\dfrac{1}{a_0^{2-1}}$

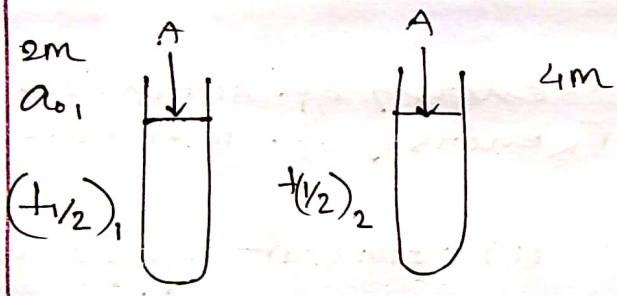
3rd order $t_{1/2} = \dfrac{1}{k}\cdot\dfrac{1}{a_0^{3-1}}$

trick 01: the question will include k. the unit of k will help to determine the order.

$k = mol^{-1} s^{-1}$ zeroth order.

$k = s^{-1}$ → first order

How can you determine the order of a reaction?



$$t_{1/2} \propto \frac{1}{a^{n-1}}$$

$$\boxed{t_{1/2} = k \frac{1}{a_o^{n-1}}}$$

$$(t_{1/2})_1 = k \frac{1}{a_1^{n-1}}$$

$$(t_{1/2})_2 = k \frac{1}{a_{o_2}^{n-1}}$$

$$\frac{(t_{1/2})_1}{(t_{1/2})_2} = \left(\frac{a_{o_2}}{a_{o_1}}\right)^{n-1}$$

$$\log \frac{(t_{1/2})_1}{(t_{1/2})_2} = (n-1) \log \frac{a_{o_2}}{a_{o_1}}$$

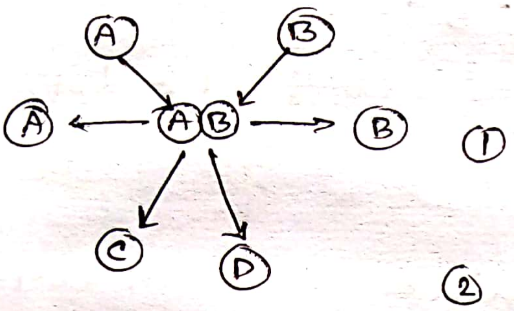
$$(n-1) = \frac{\log (t_{1/2})_1 - \log (t_{1/2})_2}{\log a_{o_2} - \log a_{o_1}}$$

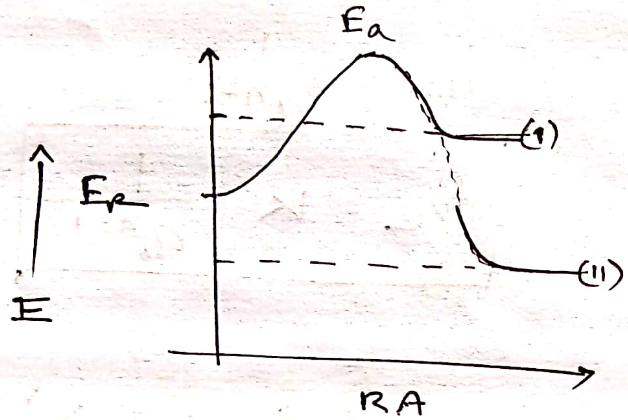
a_{o_1}, a_{o_2} } known.

gradual calculation and observation when a_{o_1} & a_{o_2} becomes half, we get $(t_{1/2})_1 / (t_{1/2})_2$.

Collision theory

$$A + B \longrightarrow C + D$$





E_a energy of activation.
E_R energy of reaction.

(I) তাপগ্রাহী | endothermic
(II) তাপোৎপাদী | exothermic

$$K = Ae^{-\frac{E_a}{RT}}$$