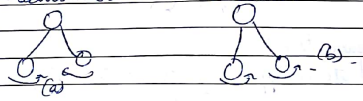
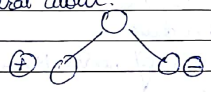
ii) In plane bending
Atoms remain in the same plane as the nodal plane.
Of 2 types:-
a) Scissoring
2 atoms approach each other & move away like 2 arms of scissors
b) Rocking
both atoms move in same direction.



3) Twisting
One atom moves up the plane and other moves down the plane w.r.t central atom.



NOTE:
Takes more energy in stretching than bending. Hence stretching vibration takes place at higher frequency

#
Infrared Active & inactive molecules.
° Only those molecules which undergo a net change in dipole moment because of its vibrational or rotational motion absorb in IR region

nerst, catalysis (lock & key), P^H, electronegativity, periodic prop.

Diatomic molecules like H_2, O_2, N_2 or Cl_2 do not show change in dipole moment and hence do not absorb IR. such molecules are called IR active molecules

Molecules like (>C=O) on stretching show a change in the its dipole moment and hence absorb/emit IR easily in the IR region heavily & are called as infrared active molecule.

Fundamental vibrational bands.
linear ⇒ $3n-5$
non linear ⇒ $3n-6$
] molecule.

Applications
→ Identification of functional groups.
(frequency of absorption are characteristic features of functional grps)
→ Check presence of ring-strain, conjugation & inductive effect

__/__/____

* Periodic Table and properties

- As new elements were being discovered there was a need to arrange these elements in a systematic manner to make their study easy.
- Its called 'Periodic Table' as coz of Periodicity or repetition of properties after in elements.
- Dobereiner's Theory
  → In a triad he created,

A	B	C
x	$\frac{(x+y)}{2}$	y

mass

Demerits: 1) as new elements were discovered many elements did not fit in Triad
eg Cl, Br, I.

- Newland's Theory
  → He brought the term 'octave' which means that every eighth element has same/similar properties

Demerits: Noble gas did not follow this.

- Mendeleev's:
  → He introduced 'groups' and 'periods'.
  → He also made some subgroups for elements with similar properties

Al → To be discovered.
Eka-Aluminium
Ga

__/__/____

→ Arranged elements in increasing order of atomic mass

Demerits: 1) Some elements in same group did not have similar property
2) Some elements in ~~same~~ group do ~~not~~ have similar property.
3) No discussion about isotopes.

* Raman Spectroscopy (instrumentation ✗ theory ✓)

- Used by detecting scattering of light (Raman effect)
- If an EMR photon hits a molecule without exchange of energy, it is called elastic collision. Happens in molecules (no charge).

Such scattering is Rayleigh's SC.

$E_1 \rightsquigarrow O \rightsquigarrow E_1$

In charged particles, collisions are inelastic collision gain or reduction of energy takes place
Such scattering is called Compton effect.

$E_1 \rightsquigarrow O \rightsquigarrow E_2 (> \text{or} < E_1)$

But some molecules do show ~~as~~ exchange of energy and such one in a million scattering is called Raman effect.

TOA
TSC

__/__/__

- Used to identify that whether a solution will give scattering of light or not.

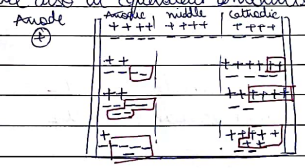
__/__/__

Unit 1
Electrochemistry

In an electrolytic cell, electricity is produced by ions i.e. cation & anion. But their contribution is not same. Their contribution depends on ion's mobility.

* Hittorf Method

- During electrolysis, because of different speeds of anions and cations, the change in concentration of electrolytic solution in the immediate vicinity of anodes and cathodes is also different.
- Solution as a whole is always electrically neutral.
- Amounts of cations & anions liberated at their respective electrodes are also in equivalent amounts.



\# Transport Number

Fraction/Percentage of current carried by an ion in electrolysis is transport number.

represented by t_+ or t_- for cation for anion

Current carried by cation $\propto \mu_+$ (mobility)

" " " anion $\propto \mu_-$

Total current $\propto \mu_+ + \mu_-$

$$t_+ = \frac{\mu_+}{\mu_+ + \mu_-}$$

Q1 Speed ratio of Ag^+ & NO_3^- ions in a soln of $AgNO_3$ electrolysed between silver electrodes is 0.916. Find transport number of Ag & NO_3^- ions.

$$\frac{\mu_+}{\mu_-} = 0.916.$$

$$\Rightarrow \mu_+ = 0.916\,\mu_-$$

$$t_+ = \frac{0.916}{1.916} = 0.478$$

$$t_- = 0.522.$$

$\Rightarrow$ NOTE

$$\frac{\text{loss around cathode}}{\text{loss around Anode}} = \frac{\mu_-}{\mu_+}$$

$$\frac{\text{loss around cathode}}{\text{Total loss}} = t_-$$

similarly for t_+

Case 1 : Electrodes are non attackable (Pt).

SHE, glass electrode, calomel electrode, silver-silver chloride diagram, Ken, operating.

conc. of Ag^+ around anode before electrolysis = x gm-eq.

conc. of Ag^+ around anode after electrolysis = y gm-eq.

(clearly $x > y$)

$$t_+ = \frac{\text{Loss at anode}}{\text{Total loss}}.$$

$$t_+ = \frac{x - y}{z}. \qquad t_- = 1 - t_+.$$

Ex: During electrolysis of $AgNO_3$ solution, loss in the anodic compartment is 0.589 gm. In a volta-meter connected in series 1.259 g Ag was deposited. Find the transport number of both ions.

$$t_+ = \frac{0.589}{1.259} = 0.4678 \qquad t_- = 1 - 0.4678 = 0.532$$

Case 2: Electrodes are attackable.

because the electrode is participating if they are participating, NO_3^- ion will attack Ag electrode & bring some Ag^+ ion into solution (example)

So $y > x$.

All this happens at anode.

$$t_- = \frac{y - x}{z}. \qquad t_+ = \frac{z - (y - x)}{z}.$$

Ex: A solution of $AgNO_3$ containing 1.06 mg of Ag^+ per g of solution was electrolysed b/w Ag electrodes

anod anodic solution after electrolysis contain 42.94 mg Ag^+ ion in 25 g of soln. If a silver voltameter connected in series 31.1 mg of Ag was deposited t_+?

$$t_+ = \frac{31.1 - \left(\frac{42.94}{25} - 1.06\right) \times 25}{31.1}$$

$$= 0.978 \cdot 0.471$$

cation potential
affinity
negative

Unit 1
Periodic Properties

Dobereiner's Law of Triads

- Dobereiner observed that properties of several groups of 3 elements / triads
- The middle element of each triad had an atomic weight @ half way b/w other 2.
- Also properties of middle element were in b/w those of others

eg

Li	Na	K
7	23	39

$(7+39)/2 = 23$

$\rightarrow X + H_2O \longrightarrow XOH + H_2$

Merit
→ Made study easier

Demerits
→ Could only classify 3 Triads
→ Property of 3 elements was same but mass not mean
eg N P As

Newland's Law of Octaves

- Newland arranged the elements in increasing order of their atomic weights and noted that every eighth element resembles the first element in property
- Relationship was just like every 8th note that resembles first in octaves of music.

⇒ Merits
→ Systematic study
→ First to bring periodicity
⇒ Demerits
→ He could arrange elements only till Ca, i.e. not all elements followed this trend
→ No place for H.
→ Elements like Fe & Co & Ni which had similar properties were far away.
→ 2 elements were kept at same place to follow property of

Mendeleev's Periodic Table

"The perso properties of the elements are a periodic function of the atomic weights"

- Mendeleev's arranged elements in horizontal rows & vertical columns of a table in increasing order of atomic weight
- He realised that some of elements did not fit with his scheme if order of atomic weight was strictly followed.
- He ignored the order of atomic weights, thinking that the atomic measurements are X.
  eg mass of I was less than Te but was placed with F
- Some places were left blank for elements to be discovered
  eg element below Al (i.e. Ca) was not discovered & hence called Ea-Aluminium

⇒ Merits
- Regular production of physical & chemical property.
- Predicted existence of new elements
- Helped to correct mass of a number of elements

⇒ Demerits
- The arrangement of elements on atomic mass was not absolute
- Unable to locate H.
- There were some elements in same group whose properties did not match.
- Elements with similar property were in different eg - Au, Pt
- Isotopes created problem.

* Modern Periodic Table

- Plot of $\sqrt{\nu}$ (of x ray emitted) vs. atomic number was drawn which gave a straight line & not the plot of $\sqrt{\nu}$ vs atomic mass.

"The physical & chemical properties of the element are periodic function of atomic numbers"

- There are 7 horizontal rows/periods & 14 vertical columns/groups.

* Ionisation Enthalpy

The energy required to remove an e^- from an isolated gaseous atom in ground state.

Energy is always required to remove an e^- hence it is always +ve.

→ increase (more Z_{eff})

↓ decrease (poor screening effect or shielding)

Q. Compare IE of F, O, N, C

C < O < N < F

N > O

as N has half filled stable configuration.

Q Compare Be & B.

Be > B

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

penetration of Be s subshell is more than that of p

s has higher shielding effect

* **Electron Affinity**

Amount of energy released by an isolated gaseous atom on gaining 1 e^- is called electron affinity.

→ EA ↑ as Z_{eff} ↑

↓ EA ↓ as shielding effect ↑.

Q. Compare F Cl Br I

Cl > F > Br > I.

Due to smaller size of F in F^-, interelectronic repulsion makes its EA less than Cl.

Q Compare O S Se Te Po

S > Se > Te > Po > O

same as F.

* **Electronegativity**

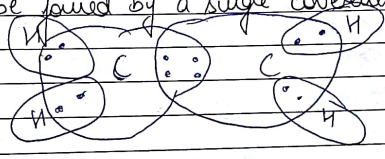
The quantitative measure of the ability of an atom in a chemical compound to attract a shared pair of e^- to itself is electronegativity.

→ e^- density ↑ as Z_{eff} ↑.

↓ e^- negativity ↓ as shielding ↑ Z_{eff} ↓

* **Covalent Bonds.**

When 2 atoms share one e^- pair they are said to be joined by a single covalent bond.



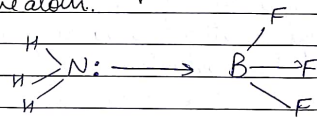
* **Ionic Bonds**

For the formation of bond, if there is a complete transfer of e⁻s from one atom to other, then that type of bond is called as ionic bond.

Chemical bond in which there is a complete transfer of valence e⁻ & the 2 of atoms are held together by electrostatic force of attraction is called ionic bond.

* **Coordinate bond.**

Coordinate bond is a 2 center -2e⁻ bond in which the 2 e⁻s taking part in bond formation derive from same atom.

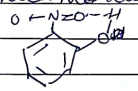
eg 

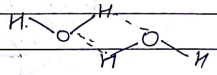
* **Hydrogen bond.**

It is a weak electrostatic force of attraction between highly e⁻negtive atoms F, N & O and Hydrogen.

It is of 2 types :-

a) Intramolecular b) Inter molecular





Read MOT & VSEPR

* **Redox Reaction**

A redox reaction is the one in which there is an exchange of e⁻s b/w molecules, ions and atoms.

eg $Fe^{2+} + Ce^{4+} \longrightarrow Fe^{3+} + Ce^{3+}$

Types

1) Intermole The specie losing e⁻(s) are said to have undergone oxidation

The specie gaining e⁻(s) is said be be reduced.

There are 4 types of redox reaction :—

1) Inter molecular

$K\overset{+1}{Mn}\overset{+7}{O_4} + \overset{+2}{Fe}Cl_2 \longrightarrow \overset{+3}{Fe}Cl_3 + \overset{+2}{Mn}Cl_2$

2) Intramolecular

$K\overset{+5}{Cl}\overset{-2}{O_3} \longrightarrow \overset{0}{O_2} + K\overset{-1}{Cl}$

ox. red.

3) Disproportionation

$\overset{-1}{OH^-} + \overset{0}{Cl_2} \longrightarrow \overset{-1}{Cl^-} + \overset{+1}{ClO^-}$

red ox.

4) Comproportionation

$H^+ + Cl^- + ClO^- \longrightarrow \overset{0}{Cl_2} + OH^-$.

Study p^H from notes.