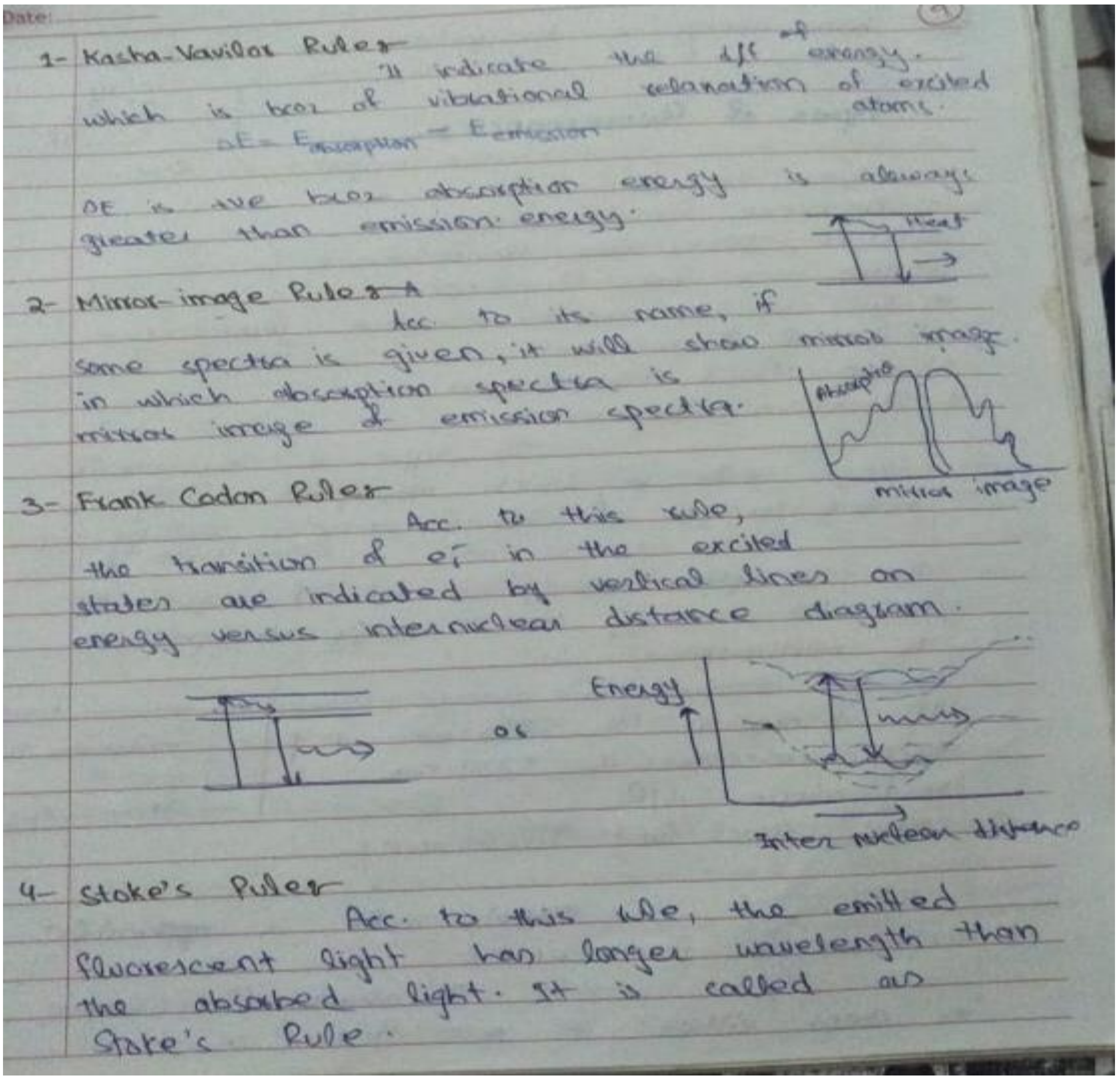
Rules of Fluorescence:

1) Kasha Vavilor Rule
2) Mirror Image Rule
3) Frank codon Rule
4) Stoke Rule



1- Kasha-Vavilor Rule:- It indicate the diff of energy which is bcoz of vibrational relaxation of excited atoms.

$\Delta E = E_{absorption} - E_{emission}$

ΔE is +ve bcoz absorption energy is always greater than emission energy.

2- Mirror-image Rule:- Acc to its name, if some spectra is given, it will show mirror image in which absorption spectra is mirror image of emission spectra.

3- Frank Codon Rule:- Acc. to this rule, the transition of e^- in the excited states are indicated by vertical lines on energy versus internuclear distance diagram.

4- Stoke's Rule:- Acc. to this rule, the emitted fluorescent light has longer wavelength than the absorbed light. It is called as Stoke's Rule.

Types of fluorescent compounds:

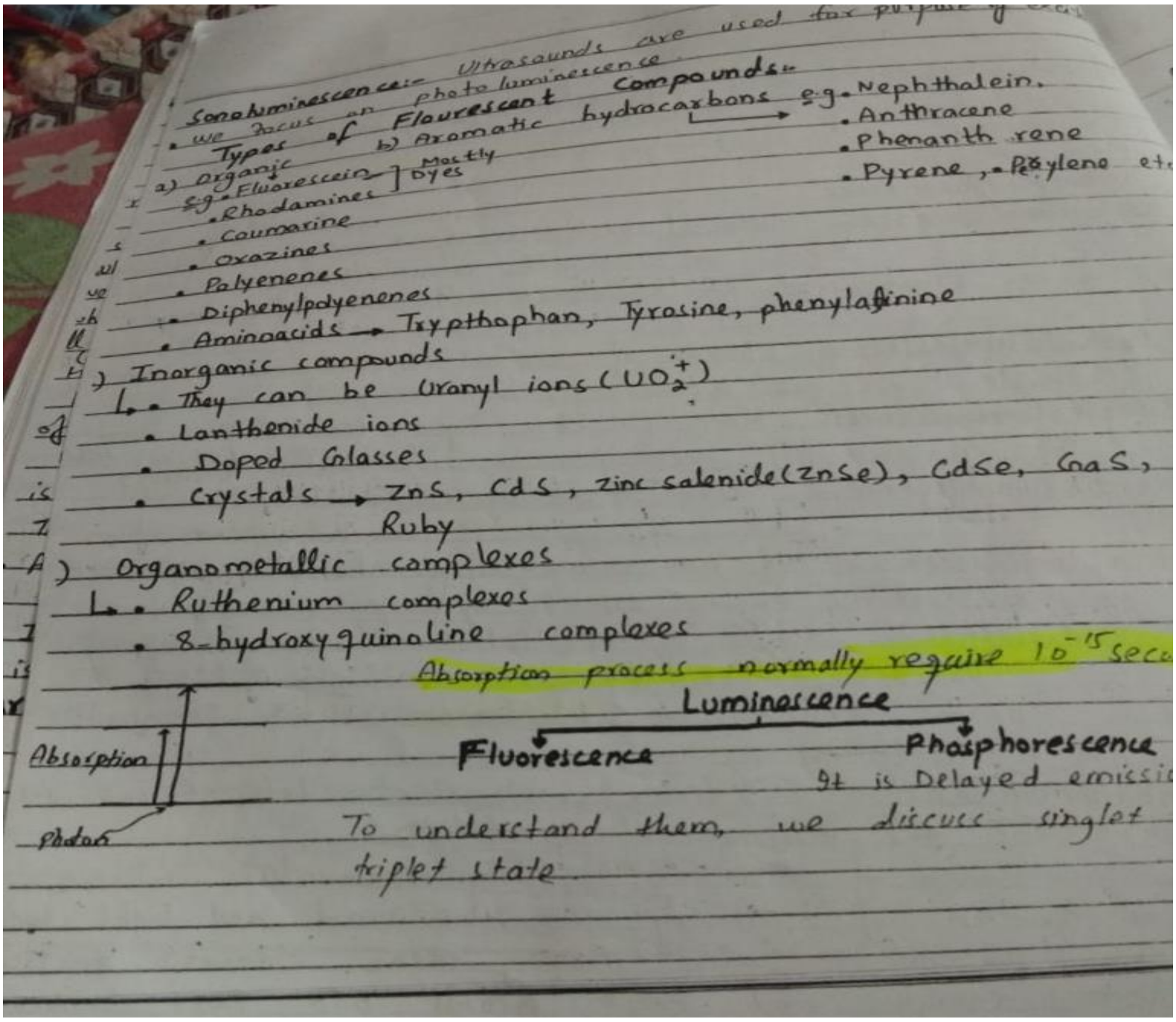
It have following types

1) Organic compounds

2) Inorganic compounds

3) Aromatic hydrocarbons

4) Organometallic complexes



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Interesting fluorescent materials:

1) Light bulb

2) Glow in dark toys

3) Glow in dark cosmetics

4) Phosphorescence in sea creatures

5) Clock, watches

Phosphor is used in fluorescent material. Phosphorous can be transition metal compound and rare earth metal.

Composition of phosphor: It consist of

a) Host

b) Activator

... have long λ' ... longer λ

Fluorescence is very very sensitive technique
It can ability to study very small amount

→ Emission technique are very more sensitive than absorption tech

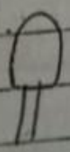
e.g Stadium → have 50 thousand bulb glow, 5 off → then no change occur

and in dark stadium → glow 5 bulb → change c realise

Absorption → continuous light come and characteristic can vanish
it can be minor change

Emission → small change can notice in it

Interesting Fluorescent Material:-

i) Light bulb 

Inside bulb have vaccume and very small amount of mercury and bulb surface is coated with phosphor. when supply elect... Under the vaccum mercury goes from groun...

...tate to excited state. And when it come back to ground state, p... of emission take place and emit UV light. This UV light is absorb by phosphor (Powdery material). It have tendency to absorb U... light and emit visible light

- Hg convert electricity to UV light

Hg^* ↑↓ ~~emission~~→ UV light —absorb by→ phosphor —emit→ visible light.
Hg

- If light bulb consume energy equal to tungsten bulb, then it glow 4 to 5 bulb.
- Phosphor is general term. It is not a single compound. It is very big class of compound
- Phosphor can be • transition metal compound
  • rare earth compounds

Composition of Phosphore → It consist of i) suitable host materia...
ii) Activator

Best known type of phosphore is
- **Copper Activated Zinc Salphide**
- **Silver Activated Zinc sulfide**

- Host Material are normally oxides, nitrides, oxynitrides, sulphides, selenides, zinc, Cadmium, Mangenese (Mn), Al, silicone and some rare earth metals.

Activator → Main work is they are going to prolong the emission time

- Television screen, Mobile screen have phosphore. Types of them varies on basis of applications.
- Some phosphore also show phosphorescence
Phosphore for fluorescence and phosphorescence are different

ii) Glow in the dark toys:-
Different phosphores used in it. Possibilities are

i) calcium sulphide with strontium sulphide with bismuth activator (Ca, Sr)S. Bi
↳ It will emit blue light and can glow upto 12hrs
ii) If using just SrS with Bi then emission colour is red → yellow or orange can also produce depend on comp
Phosphore material can be mix in plastic or ceramic of toys.

Glow in dark cosmetics
- In them ZnS with copper used as phosphor
  Cu act as activator
- Used in Halloween party Makeup.

Phosphorescence in Sea Creatures
→ Under water world
Fluorescence in jelly fish, flagellates, Dinoflagellates,
They have tendency to show fluorescence.
- Luminescence note in ocean at night.
- Luminescence in Cypridina (sea creature) → It is glow bright bluich colour. If dry cypridina and make powder, it can continue to produce light. This feature can be used by Japenese soldier in World wide II. They put powder on maps to see maps in night

Clock, watches also contain fluorescent material.
Radium Paint has ability to emit light
↳ This paint used in watch. It not use any external energy source because radium is radioactive, it emit energy itself. It is self luminating.

Quantitative estimation of fluorescence:

Intensity of fluorescence is directly proportional to concentration of emitted radiations. Mostly we applied the Lambert Beer Law

$A = Ebc$ or **$A/bc = E$**

$A = \text{constant } c$ b = for specific sample, thickness is constant

$A \alpha c$ A = absorbance

E = Extinction coefficient

c = concentration

As we know that

$T = I_t/I_o$ ………… equation 1 I_t = light emitted

also I_o = incident light

$T = e^{-Ebc}$ ………. equation 2 I = total light

so **$I_t/I_o = e^{-Ebc}$**

Now the fraction of light absorbed = **$I - I_t/I_o$ ………… equation 3**

Fraction of light absorbed also written as = $\mathbf{I - e^{-Ebc}}$**………… equation 4**

comparing **equation 3 and 4**

$$\mathbf{I - I_t/I_o = I - e^{-Ebc}}$$

Put $\mathbf{I = I_o}$ because maximum value of I = 1

So

$$\mathbf{I_o - I_t/I_o = I - e^{-Ebc}} \text{ ………… } \textbf{equation 5}$$

$$\mathbf{I_o - I_t = I_o (I - e^{-Ebc})} \text{ ……….. } \textbf{equation 6}$$

here $I_o (I - e^{-Ebc}) = I_{absorbed\ radiation}$

So $\mathbf{I_o - I_t = I_{absorbed\ radiation}}$

How fluorescence Intensity is related to absorbed radiations

The intensity of fluorescence emitted light can be obtained by multiplying the amount of light absorbed with the Quantum yield of fluorescence.

Quantum yield is defined as ratio of number of photons emitted to the number of photon absorbed. It is denoted by **φ**. Quantum yield of fluorescence is denoted by **φ_f**

So **Intensity of fluorescence $\alpha\ \varphi_f\ (I_o - I_t)$**

$F\ \alpha\ \varphi_f\ (I_o - I_t)$

$F = k\ \varphi_f\ (I_o - I_t)$ **now put value of $(I_o - I_t)$ from equation 6**

$F = k\ \varphi_f\ I_o\ (I - e^{-Ebc})$………… equation 7

By simplifying the equation 7

$F = k\ C$

$F \alpha C$