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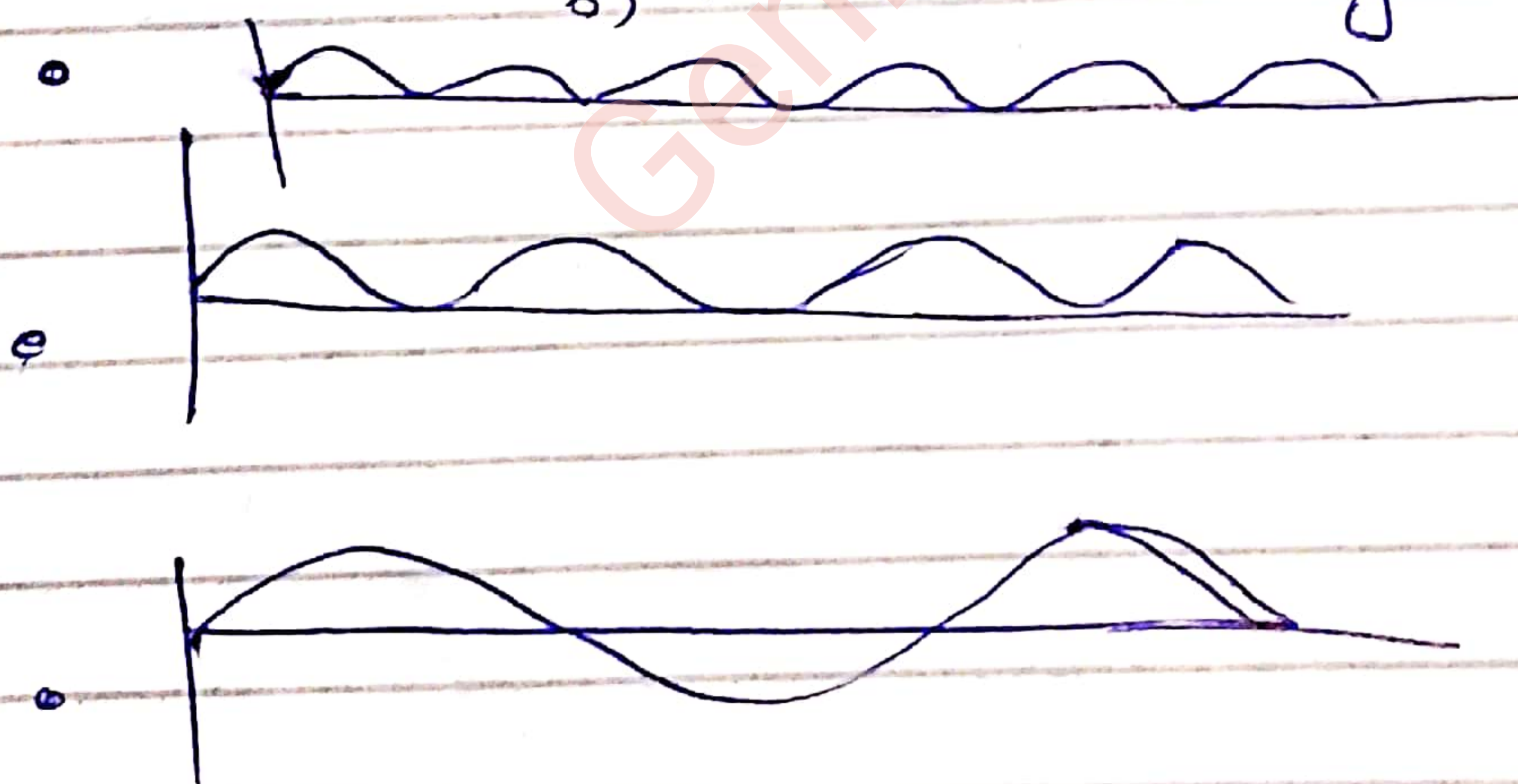
## ► Cavity Pumping:-

Organic dyes introduce with hydrochloric acid in active medium so this is used in Q-switching and material are saturable. That switching is used in passive switching.

Vertical  $\rightarrow$  Linear  $\rightarrow$  plate change  $\rightarrow$  horizontally  
(vertical, horizontal) <sup>circularly polarized light</sup>

◉ Cavity pumping  $\rightarrow$  dump the all light  $\rightarrow$  that will increase the quality factor  $\rightarrow$  small time duration and large pulse we achieve

- 1) Cavity dumping
- 2) Q-switching
- 3) Mode locking



approximately  
 $10^9 W$ ,  
 $10^8, 10^9 W$

modes (with  
different frequencies)

Pulses achieve in mode locking by using saturable absorber. Only specific mode can be achieved in femtoseconds (high power and high intensity) using the mode-locking technique greater than  $10^9$  W.

Mode locking and Q-switching are very important in lasers.

- High energetic
- high intensive
- high power laser.

## Types of Lasers:-

- Classification of laser depends on their pumping schemes, properties, etc.
- Threshold of four level laser is less
- Classification of laser is according to active medium.
  - 1- Solid state Laser.
  - 2- Gas Laser
  - 3- Liquid Laser.
  - 4- Semi-conductor Laser.

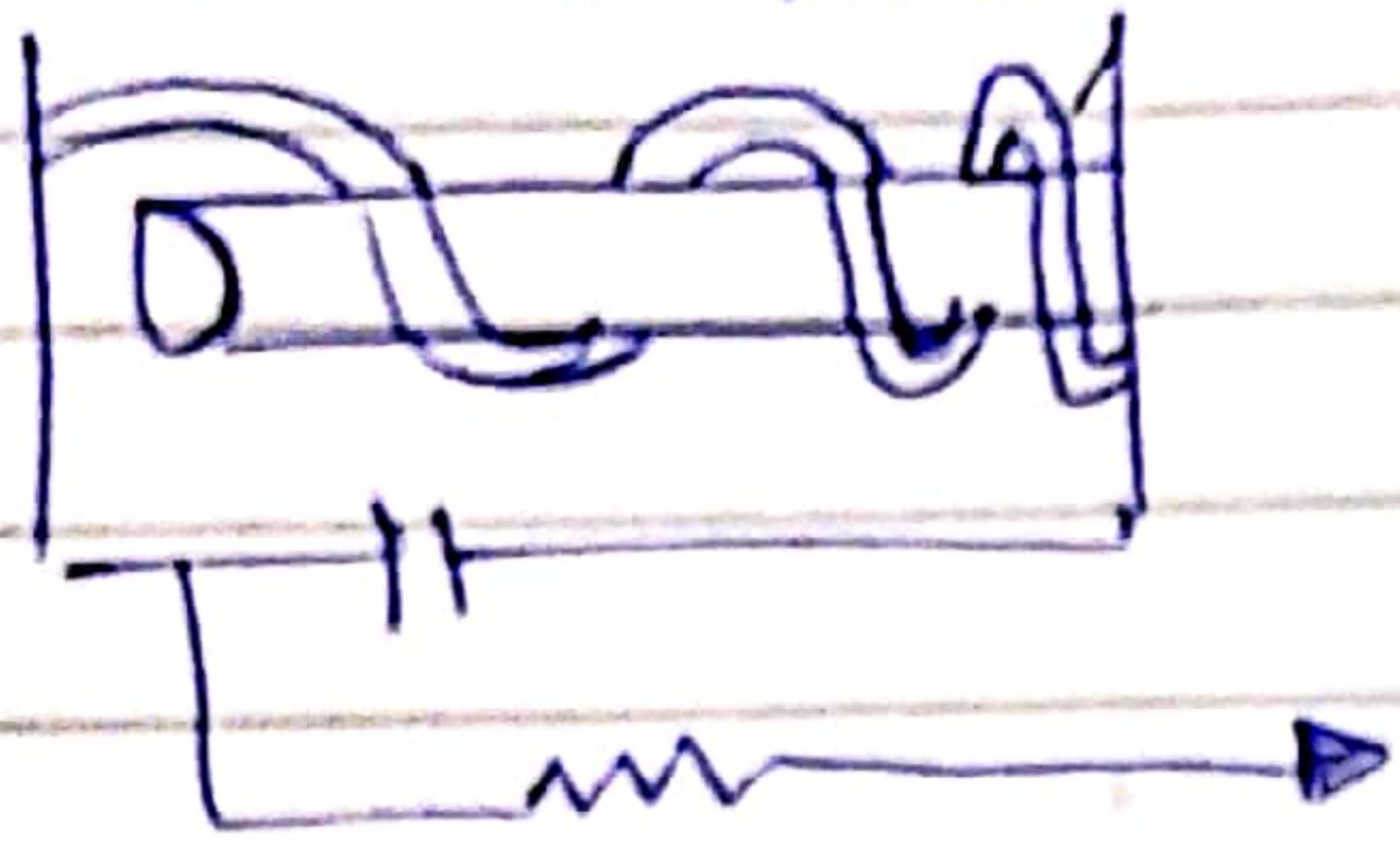
## 1- SOLID - STATE LASER:-

- i) Ruby Laser
- ii) Nd YAG, Nd - Glass Laser.
- iii) Alexandrite Laser

(iv) Coloured centered laser

(v) Fibre laser

### ① Rubby Laser



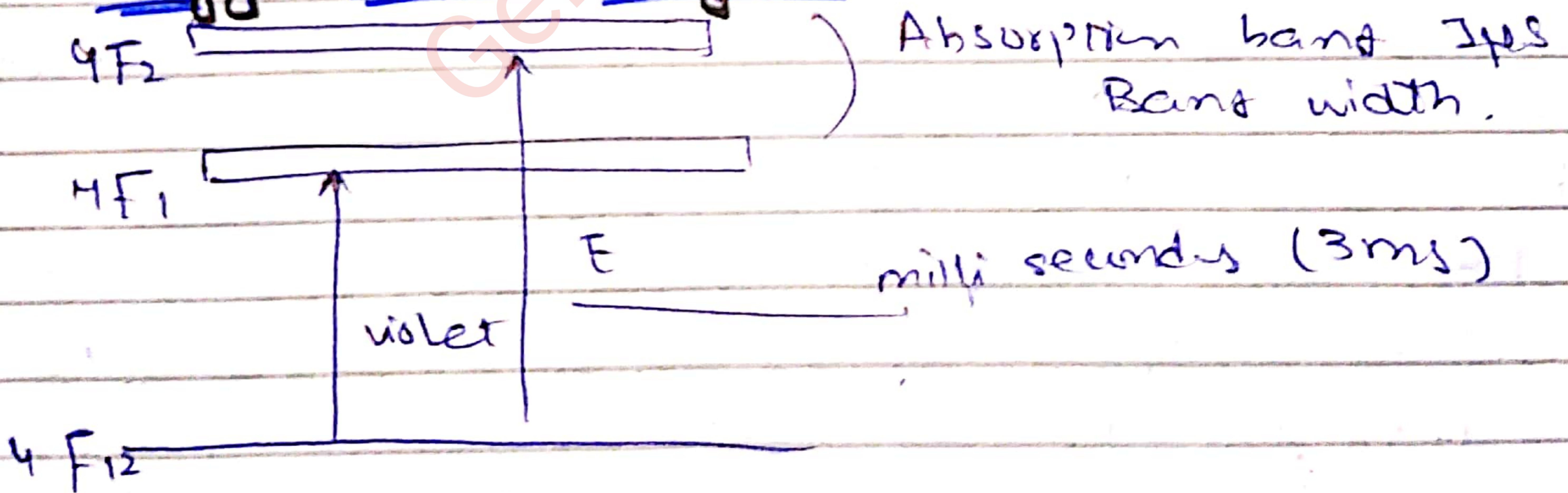
$Al_2O_3$  + Chromium ions  
 $Cr^{+3}$

length 4cm

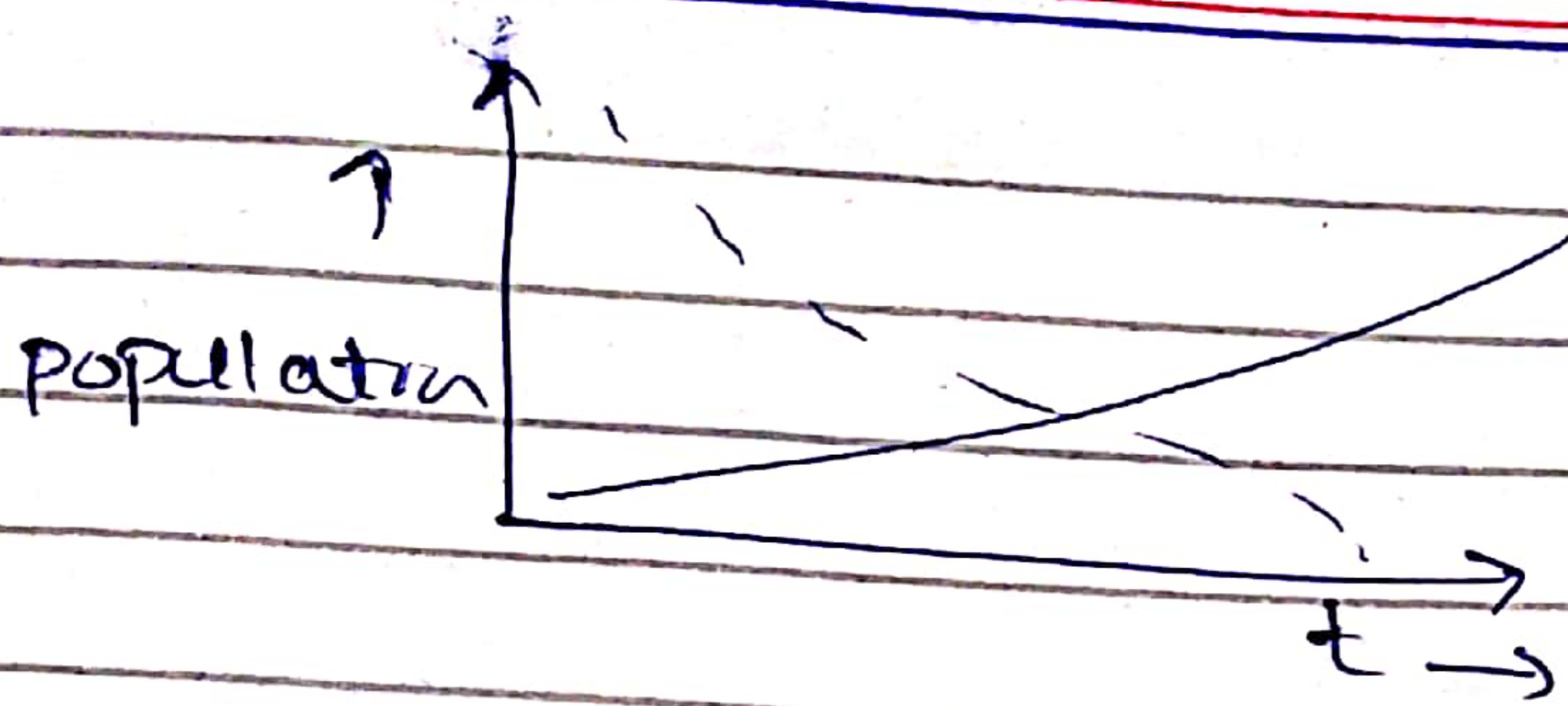
Silver coating on mirror one is fully ref.  
one is partially ref.

→ Concentration of Chromium tells that the rod  
emit which type of light  
Concentration of  $Cr = 0.05\%$   
" of  $Al_2O_3 = 99.95\%$

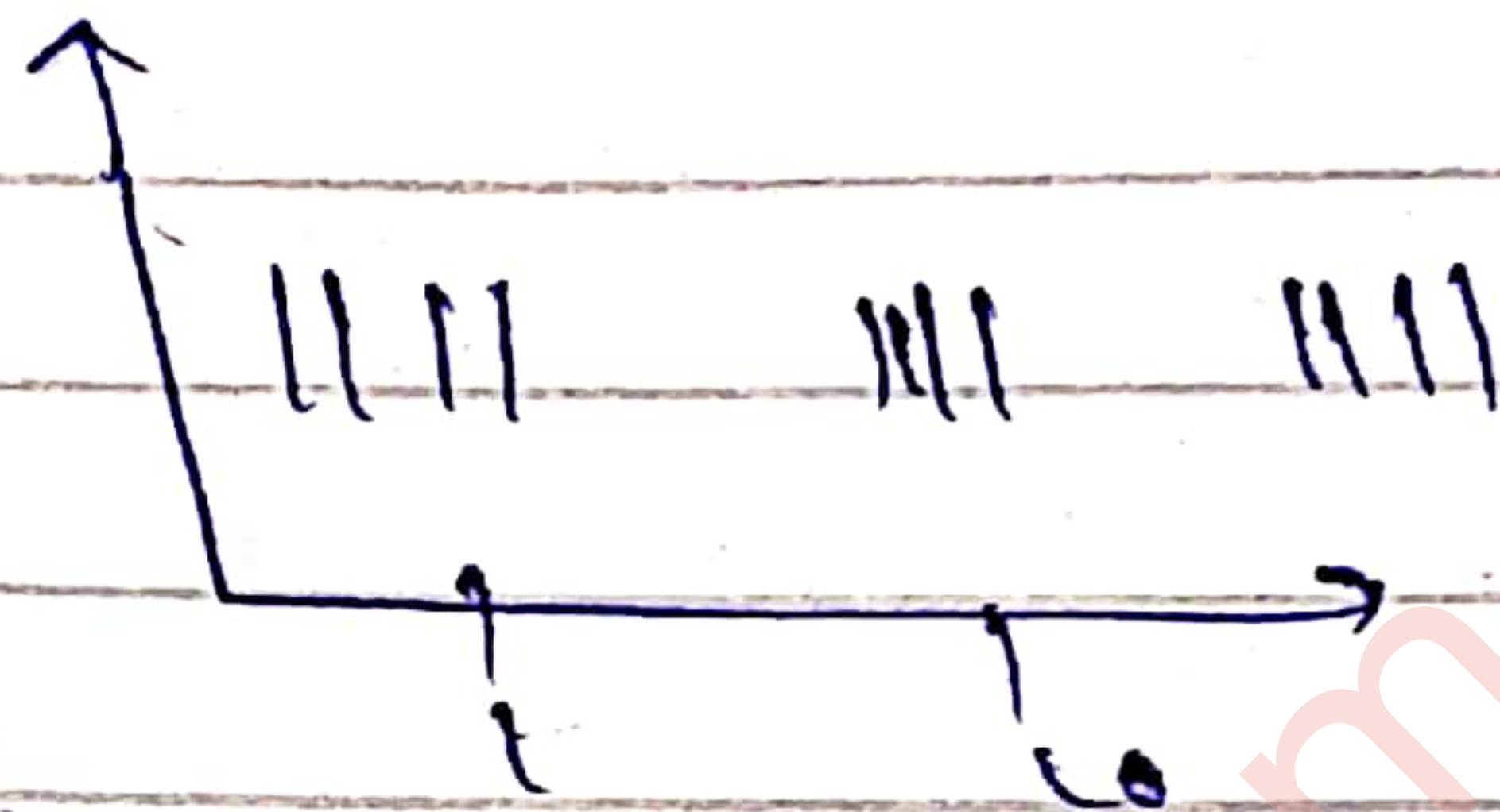
### Energy level Diagrams -



Threshold for 3 level laser is high



when population inversion achieved so we have spikes



Further Q-switching used so these spikes can be reduced

$$10^4 - 10^5 \text{ W}$$

694nm (lasing wavelength)  
6940 Å

Geniusnesthub.com

→ He-Ne laser :-

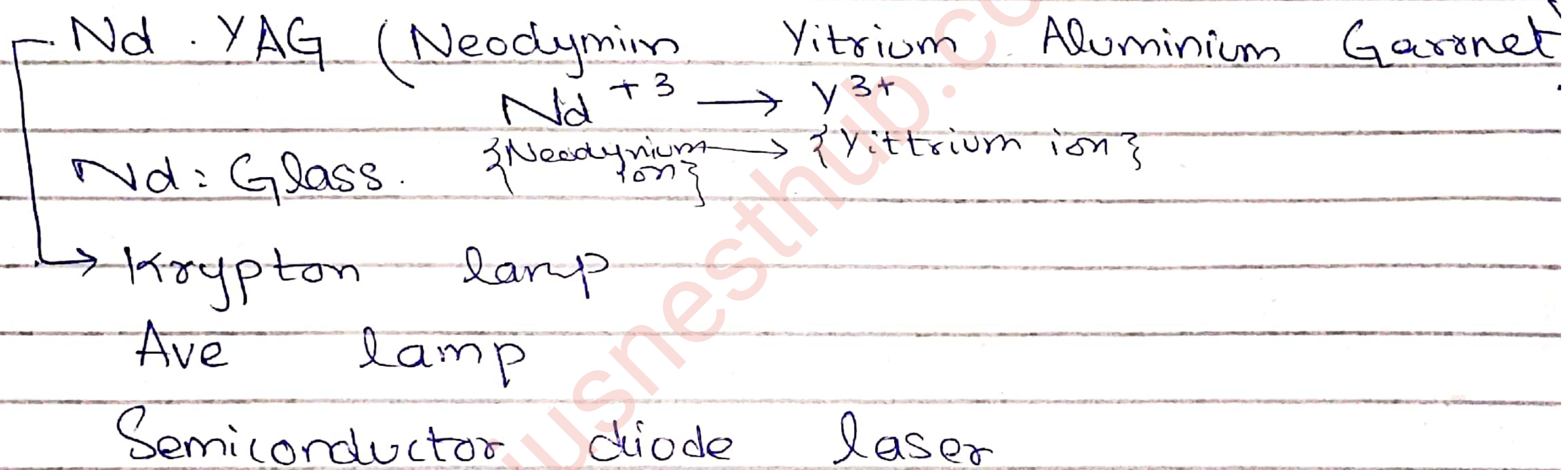
Lecture :-

## LASER SYSTEM

### • Neodymium laser:

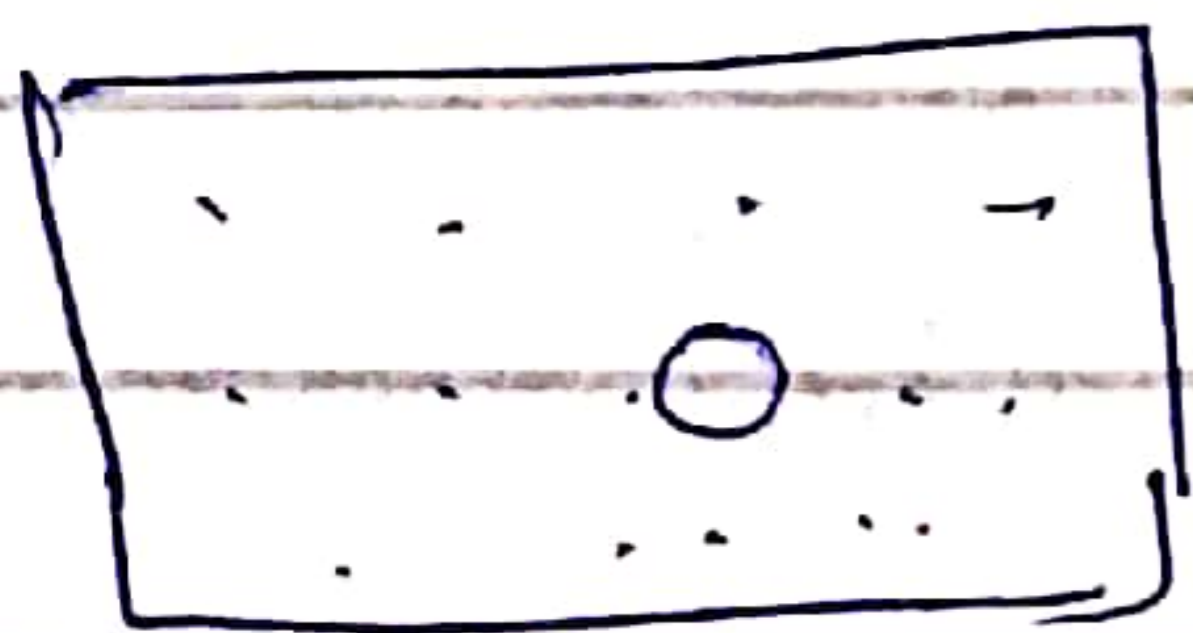
A solid state laser.

Here we deal with cost material  
to neodymium.



Construction :-

Suppose we have a crystal and it  
has same radius. Now replace  
one with large radius then we  
see strainness produced here.  
(intermolecular strain).



Nd-YAG laser → Elliptical Cavity

## Non-linear Crystals at output

### Applications:-

- ① Industry
- ② Basic Research Purposes.
- ③ Pulse Mode.
- ④ Surgical equipment.
- ⑤ Drilling, Cutting.  
↳ Pulse size that material is not wasted.

Optical instrument (that can split into two)

↳ Prism, grating.  
Mostly used.

↳ Prism used in Nd-YAG laser  
at output edge so splitting  
2 we have wavelength 1064nm  
and 502nm.

### Characteristic:-

Small fibre can be taken as Nd-YAG laser  
(small diameter)

↳ Glass laser.

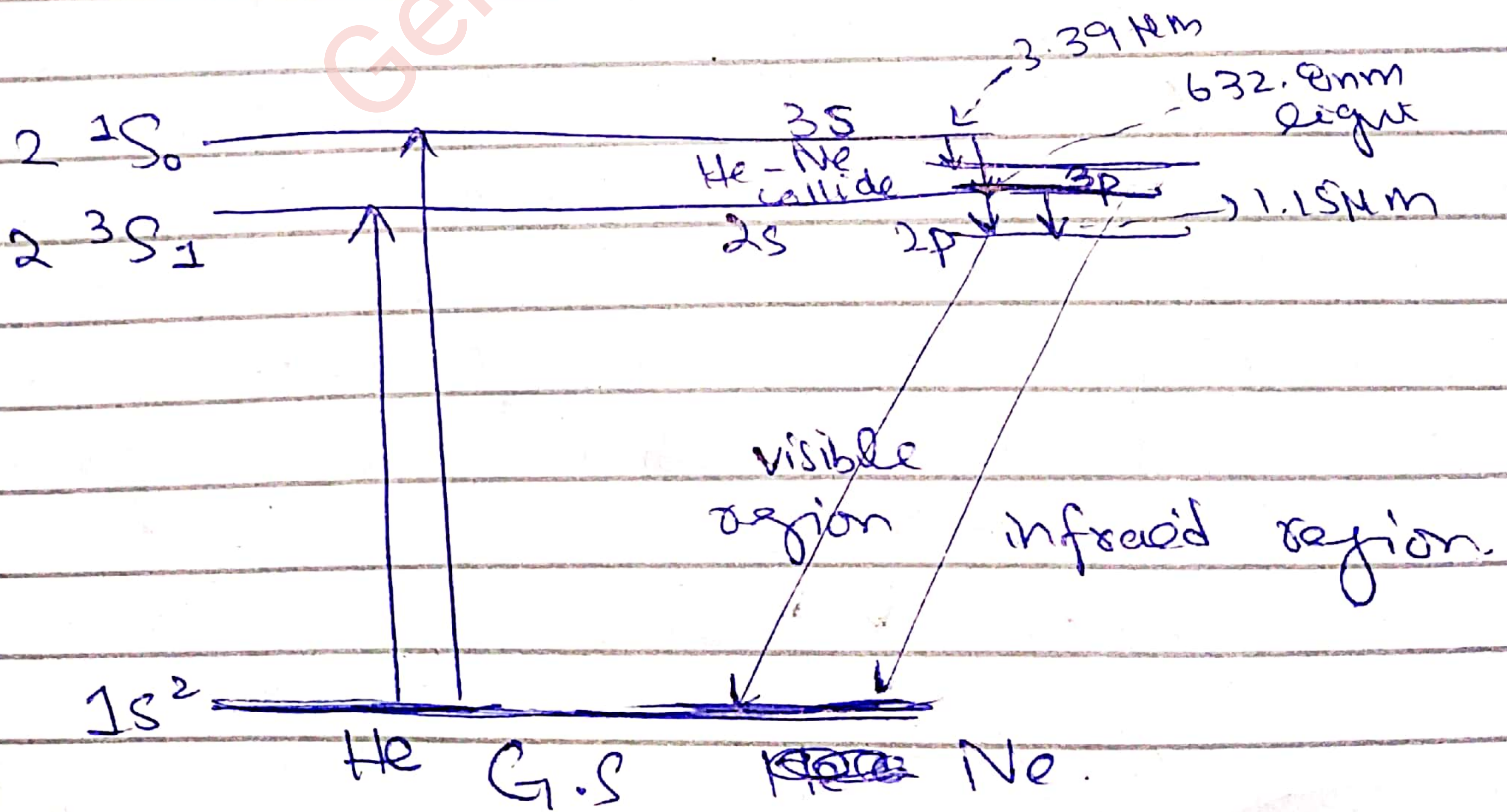
Small volume laser.

# → He-Neon Laser: -

First gas laser formed in 1960 by Ali-Javan. Pumped through electrical discharge. In He-Ne laser active medium is Ne. so ratio is 1/10. Atomic no He:1 Ne:10. (means that excited state of helium is neon ground state due to atomic ratio 1:10.)

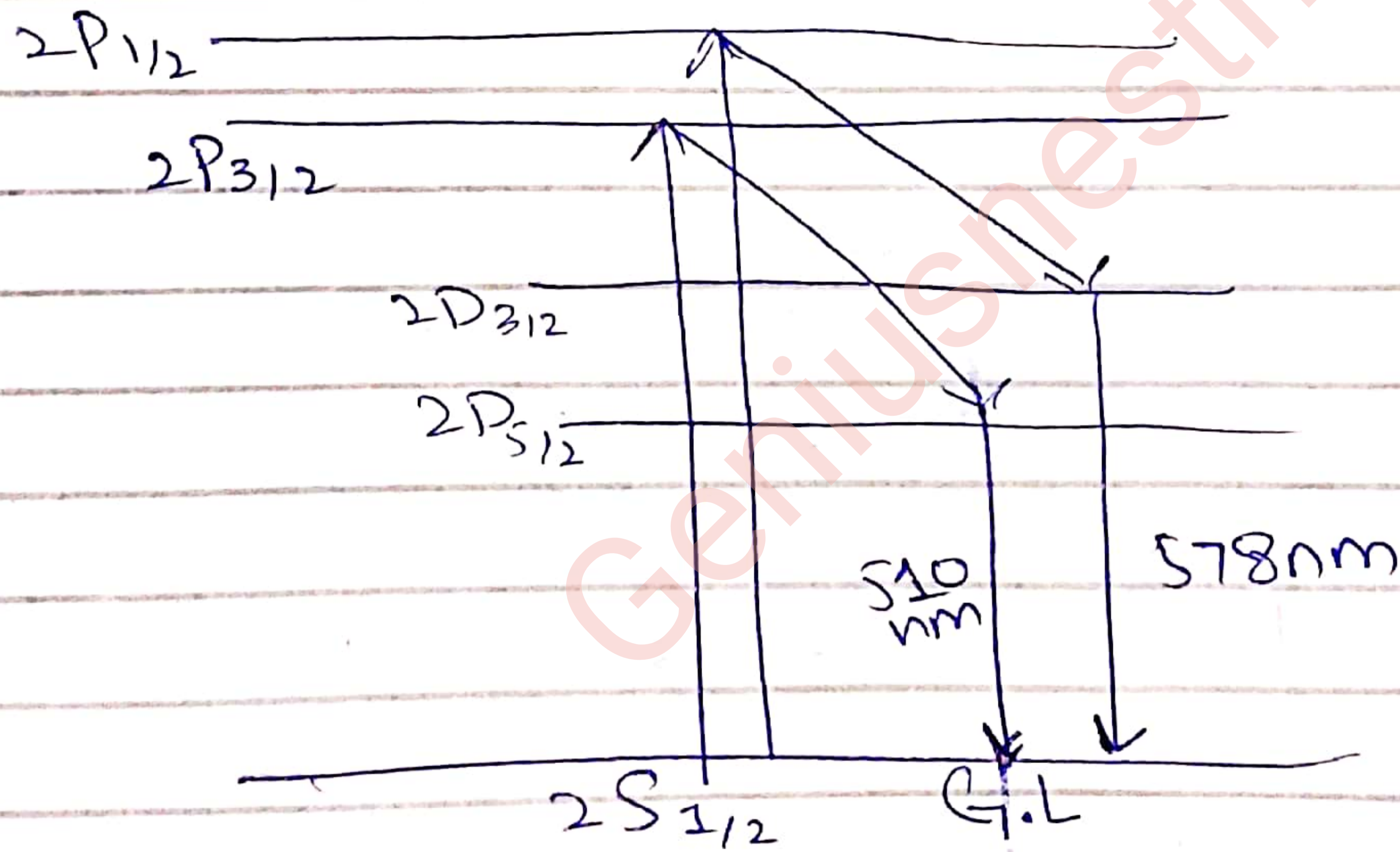
Glass tube. It Neon He at heavy pressure and connected with battery. Discharge created so that Helium atoms excite and they collide with Neon atom and energy transferred to upper level. Helium → Neon (Metastable stable). Then Decay to lower state

- \* He → Supporting medium
- \* Ne → Active Medium



# Copper Vapor Laser (CVL)

→ Cylinder cavity (at one end reflective mirror and at other end partially reflective mirror)



Power

2 kilowatt



Books for laser:-

\* Laser fundamentals by  
William Silfvast.

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Ne  $\rightarrow$  Active medium

He  $\rightarrow$  Excitation.

### Molecular Gas Laser:-

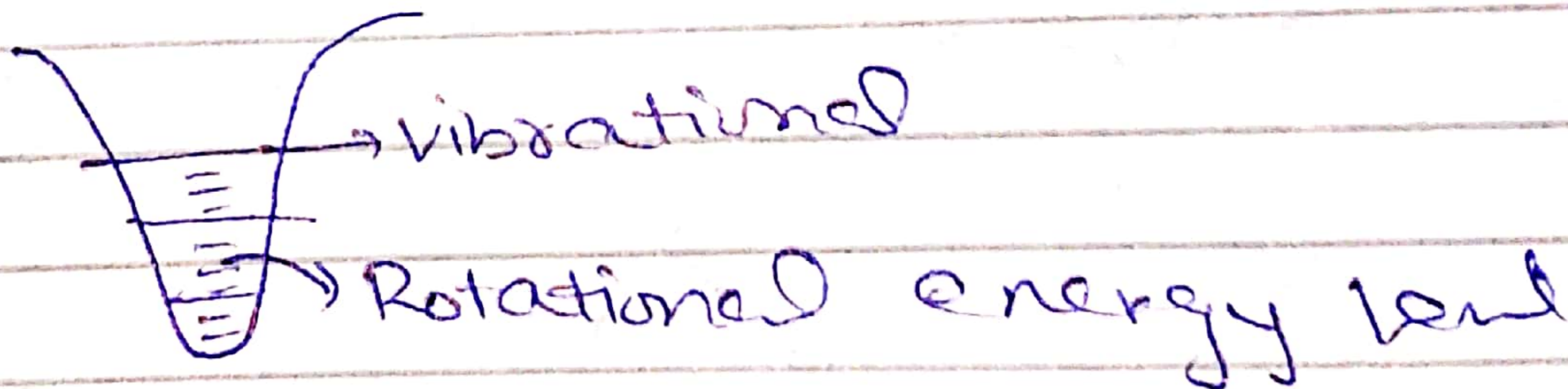
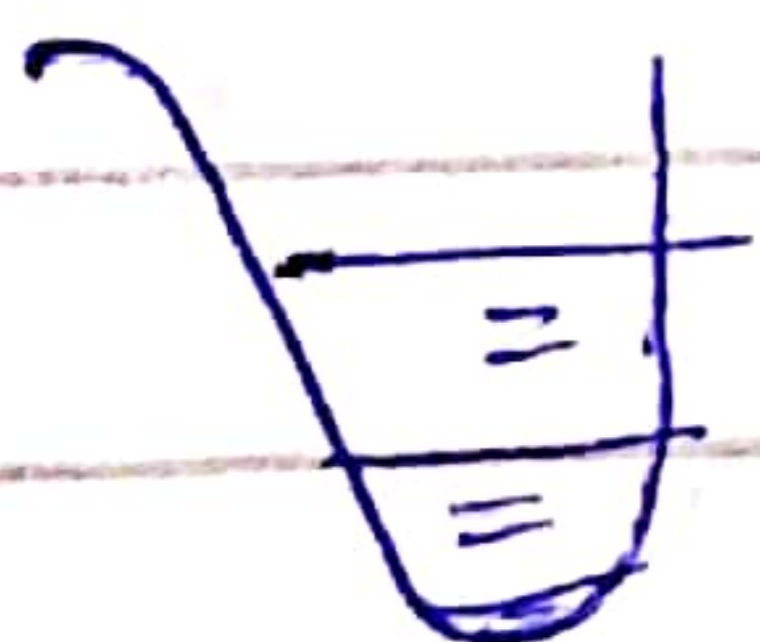
Molecules exist

e.g. Carbon dioxide  $\rightarrow$  Molecular gas.

These are relatively easier than the other molecules.

Atom  $\rightarrow$  Electronic energy levels.

Atoms combine  $\rightarrow$  to form molecules so they distribute their energy levels and have a rotational and vibrational energy levels.



two vibrational energy level  $\rightarrow$  Apply selection Rules

One electronic of vibrational E.L  $\rightarrow$  Transition  
 $\rightarrow$  Other electronic of vibration E.L which  
contribute the molecular Gas laser.  
Transitions so there is a laser achieved  
~~at a difference~~ difference  
in energy level  $\rightarrow$  infrared (high)

Power 1W  $\rightarrow$  10 kW (10<sup>4</sup>W) CO<sub>2</sub> laser

[10<sup>4</sup> - 10<sup>5</sup> W enhance to 10<sup>8</sup> - 10<sup>9</sup> W]

ND YAG - 4 level laser

CO<sub>2</sub> is more sufficient than ND-YAG

wavelength of CO<sub>2</sub> 10.5  $\mu$ m  
9.6  $\mu$ m

CO<sub>2</sub> is also 4 level laser, high output  
intense

Construction is same as a gas laser.

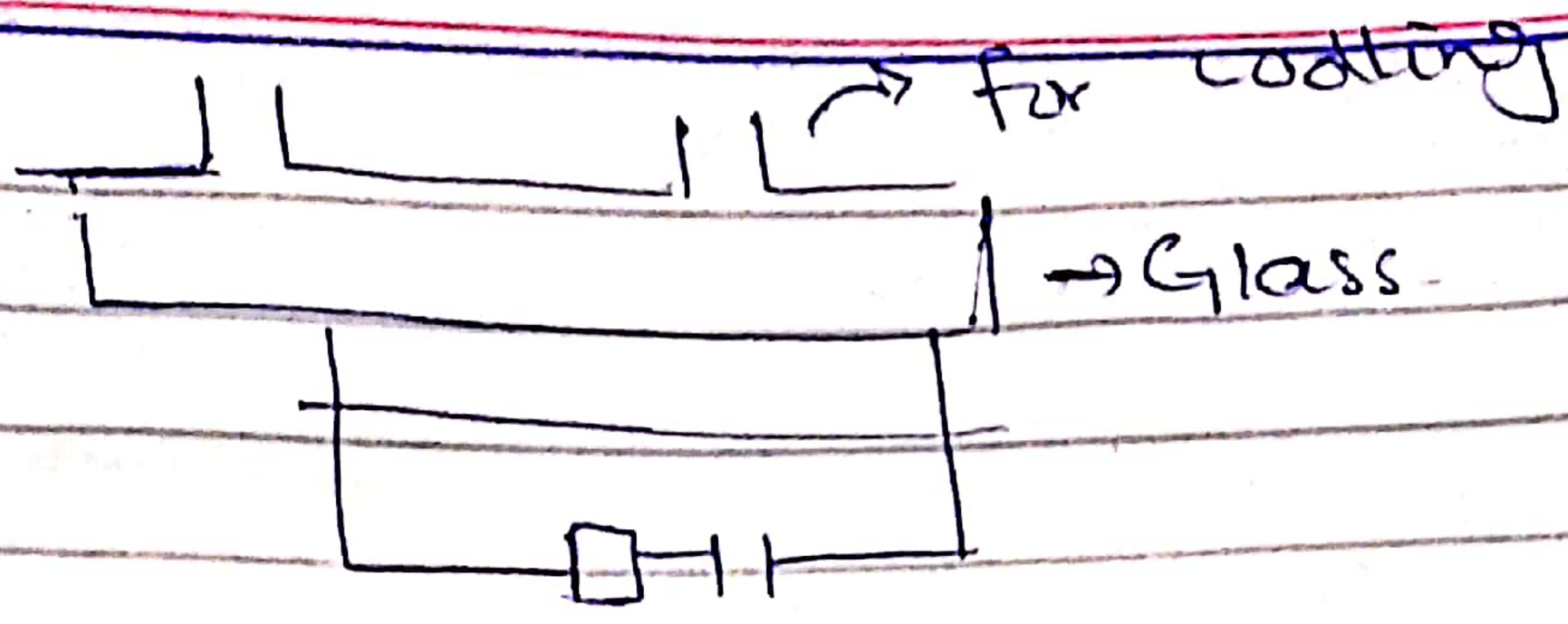
Nitrogen, Helium

$\downarrow$   
(excite the gas)

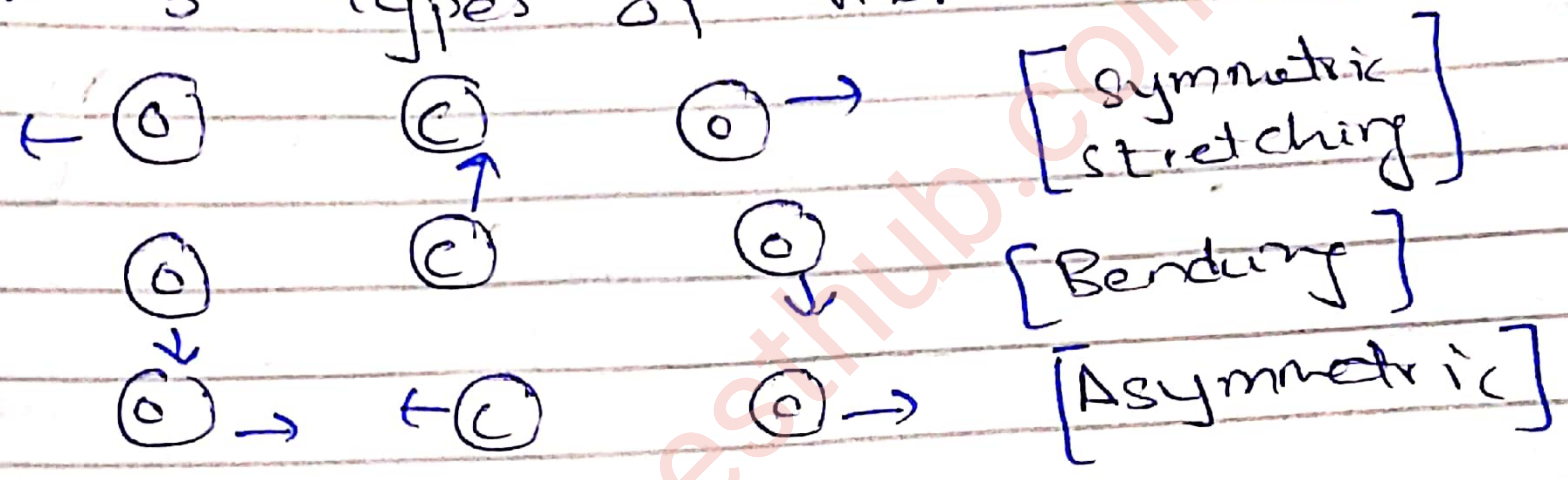
$\downarrow$   
(Deexcite the molecules  
to ground state)

CO<sub>2</sub> : N<sub>2</sub> : H<sub>2</sub>  
1 : 4 : 5

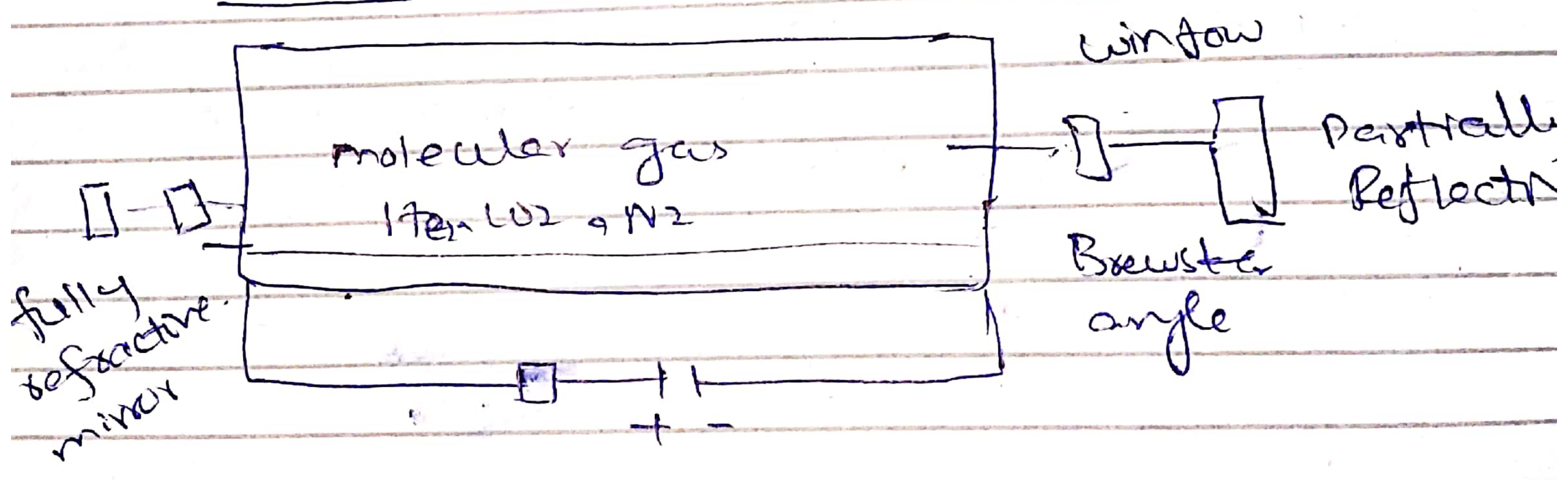
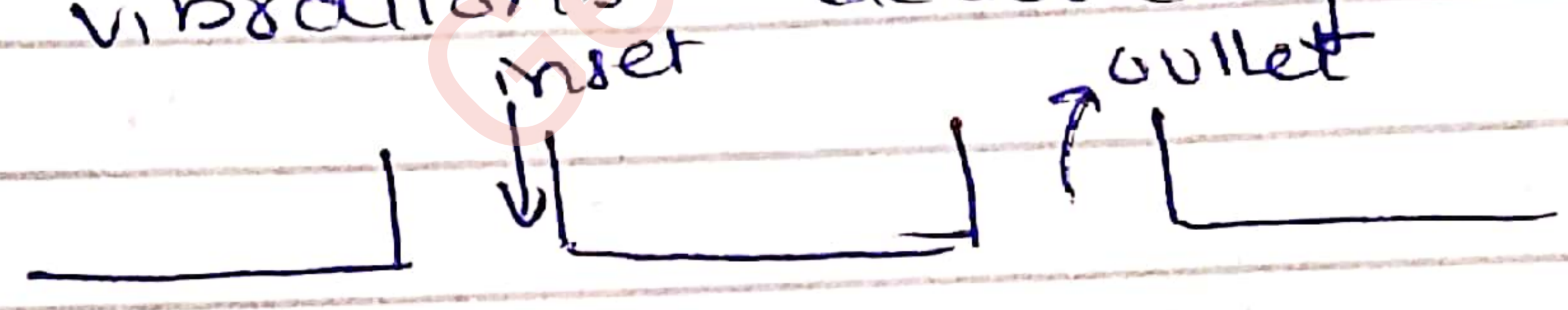
these gases are at different  
pressures



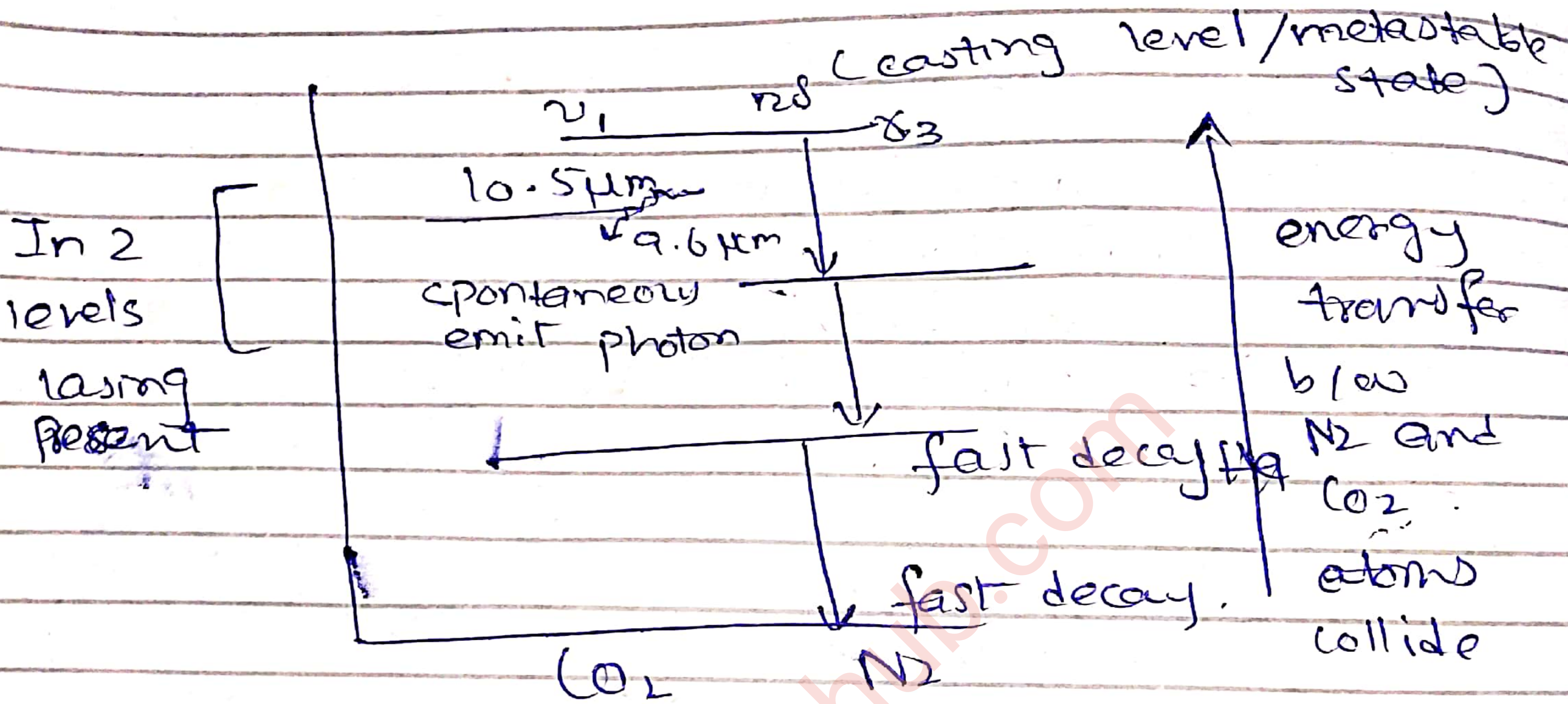
Electrons → gases collide → nitrogen excite and carbondioxide at ground state then N<sub>2</sub> transfer energy to CO<sub>2</sub> and we have 3 types of vibrations.



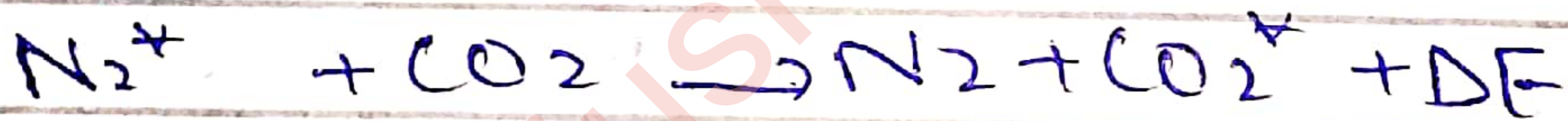
Vibrational energy level introduce due to their vibrational and we have different types of vibrations according to their types.



Window at specific angle provide path



non-radiative decay.



CO<sub>2</sub> again in ground state but there are a lot of levels in blw metastable state stay and we have move in downwards upper level then lower level and then in ground state (lower level (He) collide with CO<sub>2</sub> and deexcite (move to) ground state).