

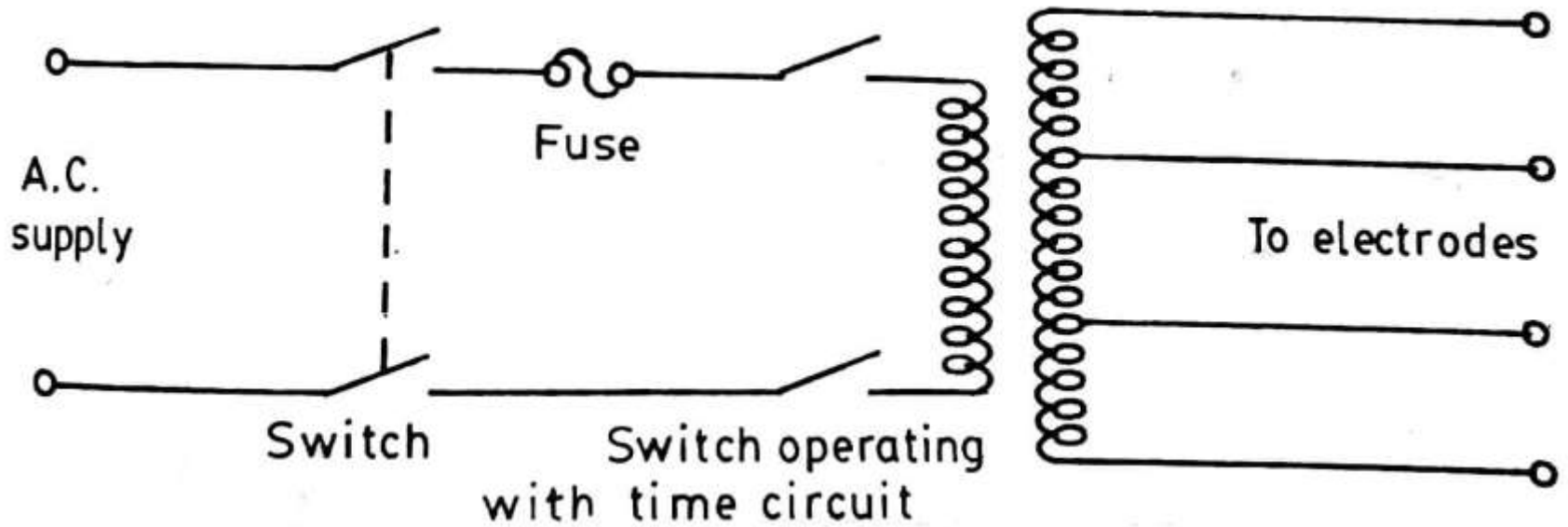
# Medical Physics

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# DEFIBRILLATORS

- During fibrillation condition, the myocardial fibres are continuously stimulated by adjacent cells so that there is no synchronised contraction/expansion
- Ventricular fibrillation occurs due to asynchronous contraction of the heart muscles
- The ventricle simply quiver but do not pump blood effectively so cardiac output will steeply fall, which can lead to death if adequate steps are not taken
- Atrial fibrillation happens for the young people who always smoke, which reduces cardiac output, but it is not fatal
- A Defibrillator is an electronic device to stop ventricular/atrial fibrillation by applying a high voltage shock to the heart

# AC DEFIBRILLATOR



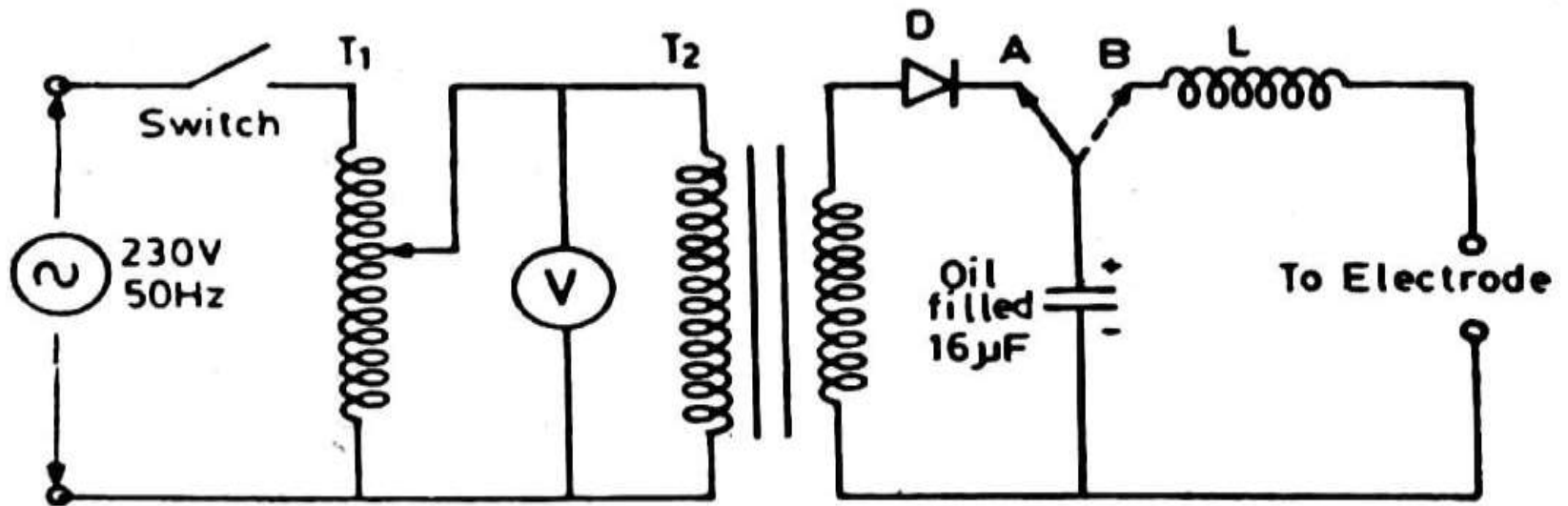
- ❖ It is the earliest and simplest type of defibrillator
- ❖ The step up transformer with four switches in the primary. Among them one has electronic timer circuit of R-C network triggered by foot switch or hand operated push button switch
- ❖ There is a fuse in the primary for electrical safety
- ❖ The secondary is isolated from earth for safety
- ❖ The secondary has various tappings to supply different voltage shock to patient
- ❖ The electrodes are fastened with the patient by chest band

- ❖ For external defibrillation 250V to 750V is used
- ❖ For internal defibrillation 60V to 250V is used
- ❖ The electrical shock is delivered for a predetermined duration (0.1 to 1 sec) depending on the voltage to be applied
- ❖ Large currents are required in external defibrillation to have simultaneous contraction of heart muscle fibres

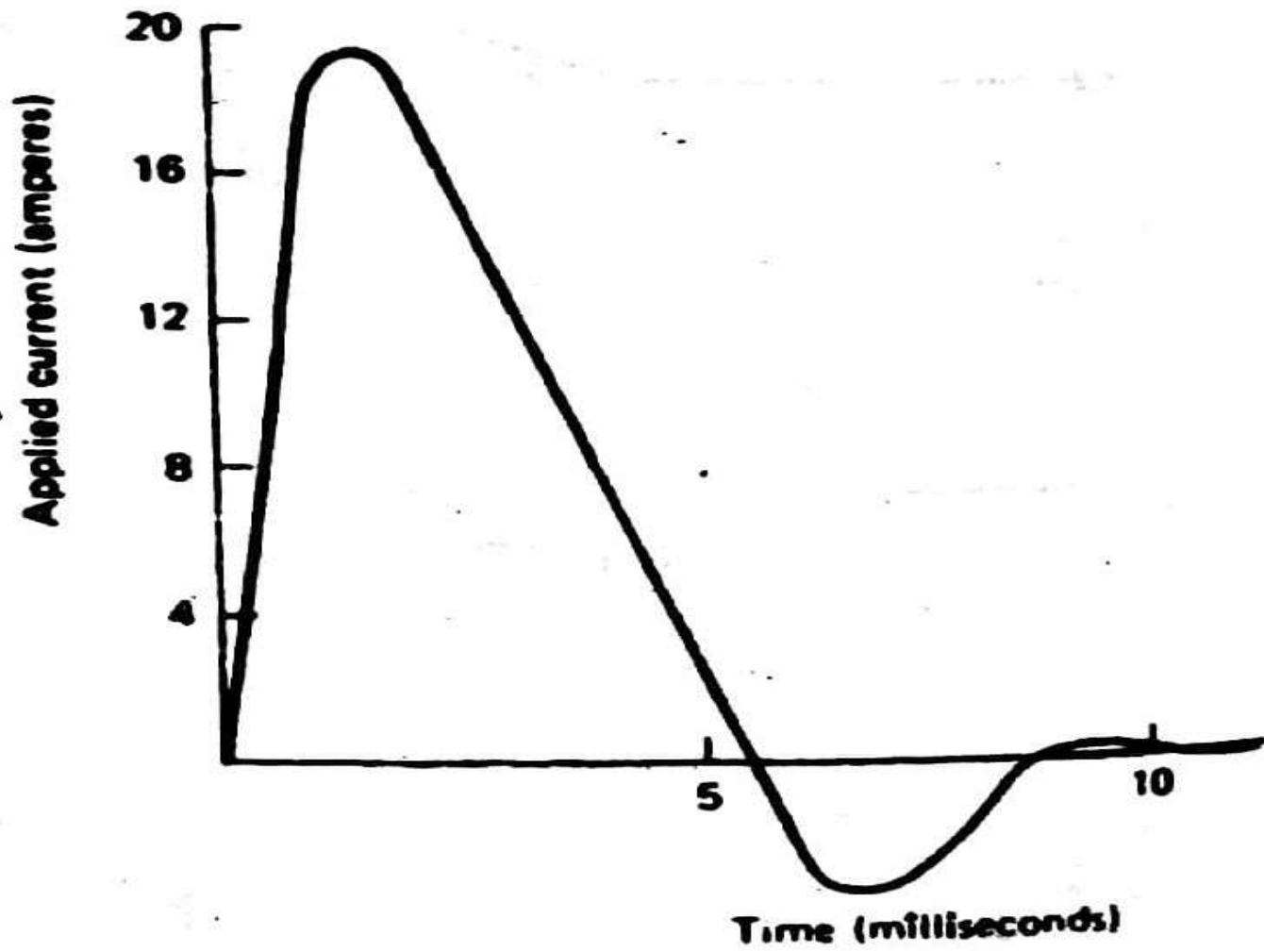
## **DISADVANTAGES**

- ❖ The shock not only contracts the heart muscles but also burn the skin under the electrodes
- ❖ It produces atrial fibrillation while arresting ventricular fibrillation

# DC DEFIBRILLATOR



- ❖ A variable autotransformer (T1) forms the primary of a high voltage transformer (T2)
- ❖ Output of T2 is rectified by the diode rectifier (D), whose output is connected to a vacuum type high voltage (foot/hand operated) change over switch
- ❖ In position 'A', DC output of D is connected to an oil filled capacitor ( $16\mu\text{F}$ )
- ❖ When the capacitor is fully charged, the change over switch is changed to position 'B'
- ❖ Now the oil filled capacitor begins to discharge across the heart through the electrode
- ❖ The discharge from the capacitor is slowed down by the counter induced voltage produced in an induction coil 'L' placed in one of the electrode leads
- ❖ This gives favourable shape to the waveform which depends on L & C values





- ❖ For internal defibrillation energies up to 100 joules are used
- ❖ For external defibrillation energies up to 400 joules are used
- ❖ For both external and internal defibrillation 0-400 joules of energy is sufficient

- ❖ If 6000V is used for defibrillation

$$\begin{aligned} E &= (1/2) CV^2 \\ &= (1/2) \times 16 \times 10^{-6} \times 6000 \times 6000 \\ &= 288 \text{ joules} \end{aligned}$$

- ❖ Shock duration is 5 – 10 milliseconds

### **ADVANTAGE:**

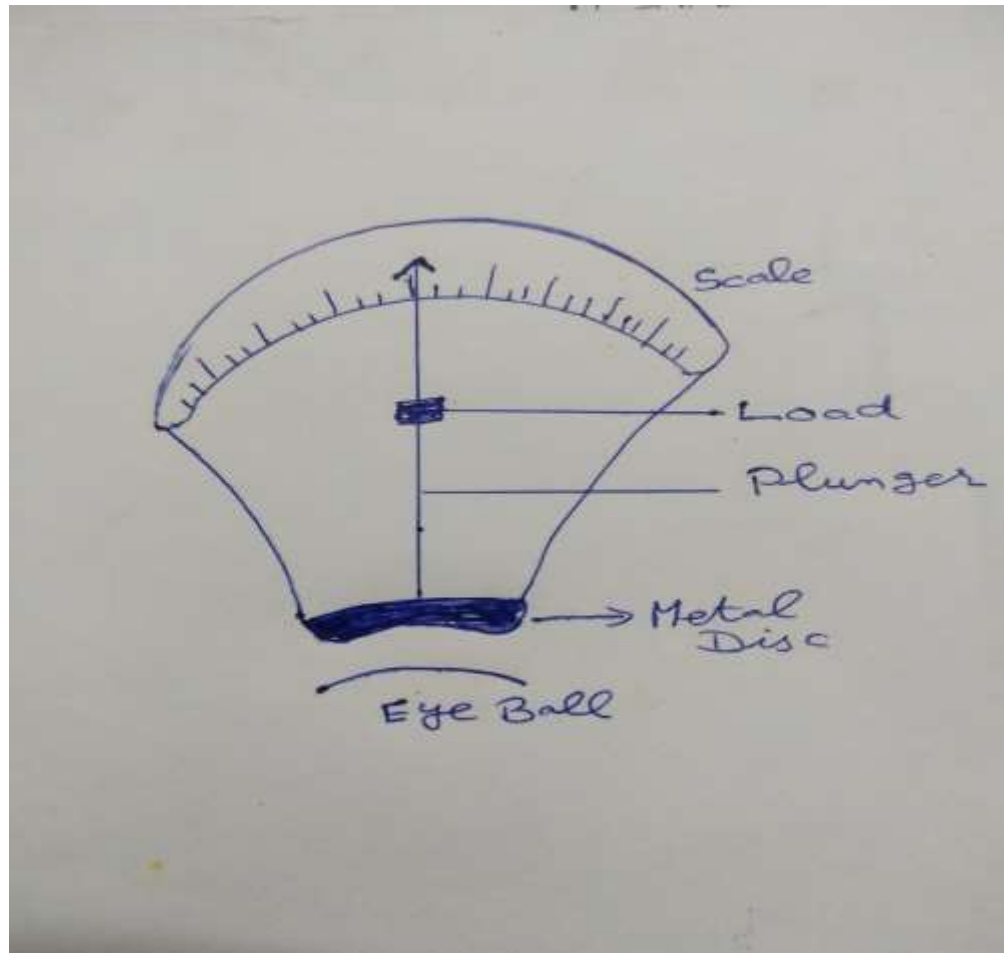
- It produces normal heart beat without burning the skin under the electrodes
- Ventricular fibrillation is removed without the occurrence of atrial fibrillation

# EYE PRESSURE MEASUREMENT

- Aqueous humor and vitreous humor clear fluids are in the eye ball, which transmit light to retina are under pressure and maintain the eyeball in a fixed size and shape
- The dimensions of the eye are important for good vision, a change in 0.1 mm of its diameter has a significant effect on the clarity of the vision
- The fluid in the front part of the eye (aqueous humor) is mostly water, it is continuously produced by the eye and a drain system allows the surplus liquid to escape
- The pressure in normal eye ranges from 12-23 mm Hg

- If a partial blockage of this drain system occurs, the pressure increases and the increased pressure can restrict the blood supply to the retina and thus affect the vision. This condition is called as **“GLAUCOMA”**
- Early physicians estimated the pressure inside the eye by ‘FEEL’, as they pressed on the eye with their finger tips
- Now, the eye pressure (Ocular pressure) is measured with **‘TONOMETERS’**
- There are two types of tonometers as
  - **SCHIOTZ TONOMETER**
  - **GOLDMANN TONOMETER**

# SCHIOTZ TONOMETER



- The tonometer is placed on the anesthetized cornea with the patient lying face up (SUPINE)
- The central plunger alone has a mass of 11 grams with a standard 5.5 grams mass (totally 16.5grams) rests on a small area of the cornea causes a slight depression in the cornea
- This increases the intraocular pressure about 15mm Hg depending on the rigidity of the eye
- The position of the plunger indicates the internal pressure on the eye on the scale
- The force of the plunger can be varied by adding various weights ( 5.5, 7.5, 10 and 15 grams mass)

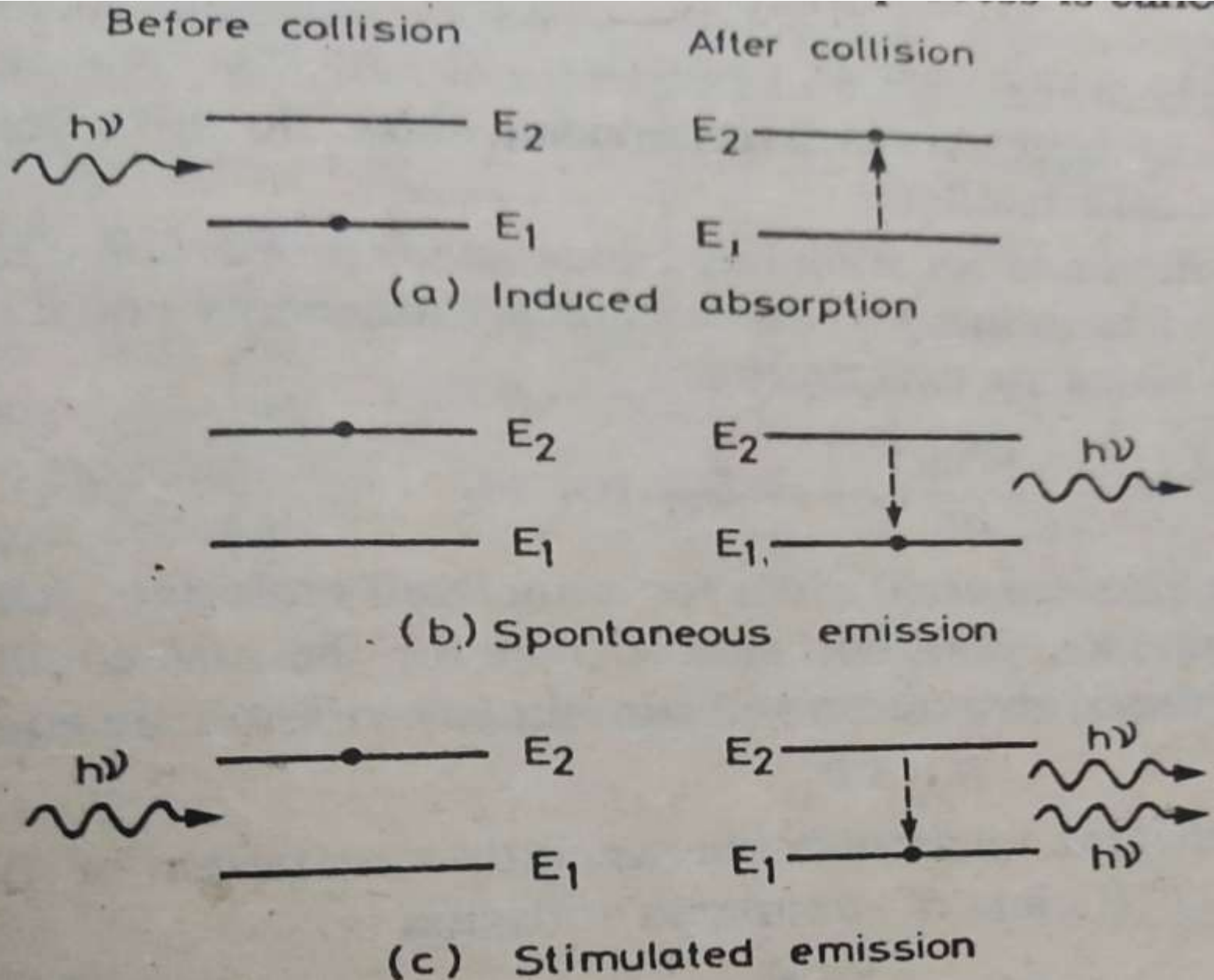
# GOLDMANN TONOMETER

- It gives more accurate ocular pressure measurement. The measurement is taken with the patient in a sitting position
- The force required to flatten an area of 3.06mm in diameter on the front of the cornea is measured
- The operator looks through the optical system and adjusts the small force required to produce required flattening
- The force needed for a normal eye is equivalent to the weight of 1.7gram mass
- This small force raises the internal pressure only by 0.5mm Hg

# COMPARISON BETWEEN SCHIOTZ TONOMETER AND GOLDMANN TONOMETER

No.	SCHIOTZ TONOMETER	GOLDMANN TONOMETER
1	Moderate Accuracy	High Accuracy
2	It increases the internal pressure by 15mm Hg	It increases the internal pressure by 0.5mm Hg only
3	Rigidity of eye ball has prominent effect on the reading	Rigidity of eye ball has little effect on the reading
4	There is a severe possibility for eye infection	There is a least possibility for eye infection
5	Maximum strain and pain to eyeball after testing	No strain and pain to eyeball after testing

# LASER PRINCIPLE





- $E_1$  is the energy and  $N_1$  is the number of the atoms of the lower energy state whereas  $E_2$  is the energy and  $N_2$  is the number of the atoms of the higher energy state

## **INDUCED ABSORPTION**

- If the atom is initially in the lower state  $E_1$ , it can be raised to  $E_2$  by absorbing a photon of energy  $(E_2 - E_1) = h\nu$ . This process is called as induced absorption

## **SPONTANEOUS EMISSION**

- If the atom is initially in the upper state  $E_2$ , it can drop to  $E_1$  by emitting a photon of energy  $h\nu$  which is spontaneous emission

## STIMULATED EMISSION

- If the atom is initially in the upper state  $E_2$  and an external photon of  $\nu'$  frequency is incident on the atom, the atom jumps to lower state  $E_1$  by emitting an additional photon of it is possible to force excited atom to emit a photon of  $\nu'$  frequency, thus two photons are emitted, which is known as stimulated emission

## POPULATION INVERSION

- Under ordinary conditions of thermal equilibrium, the number of atoms ( $N_2$ ) in the higher energy state ( $E_2$ ) is smaller than the number of atoms ( $N_1$ ) in the lower energy state ( $E_1$ ), so there is very little stimulated emission compared with absorption

- When there are more number of atoms in the higher energy state ( $E_2$ ) than in the lower energy state ( $E_1$ ), (i.e)  $N_2 > N_1$ , which is known as **population inversion**
- The method of producing population inversion is called as **Pumping**

# CHARACTERISTICS OF LASER

- ❖ Highly monochromatic – The laser beam has only one single wavelength
- ❖ Highly directional – The laser beam has no or least divergence
- ❖ Highly coherence – The laser beam is coherent with the waves all exactly in phase with one another
- ❖ Highly intense – The laser beam is extremely intense

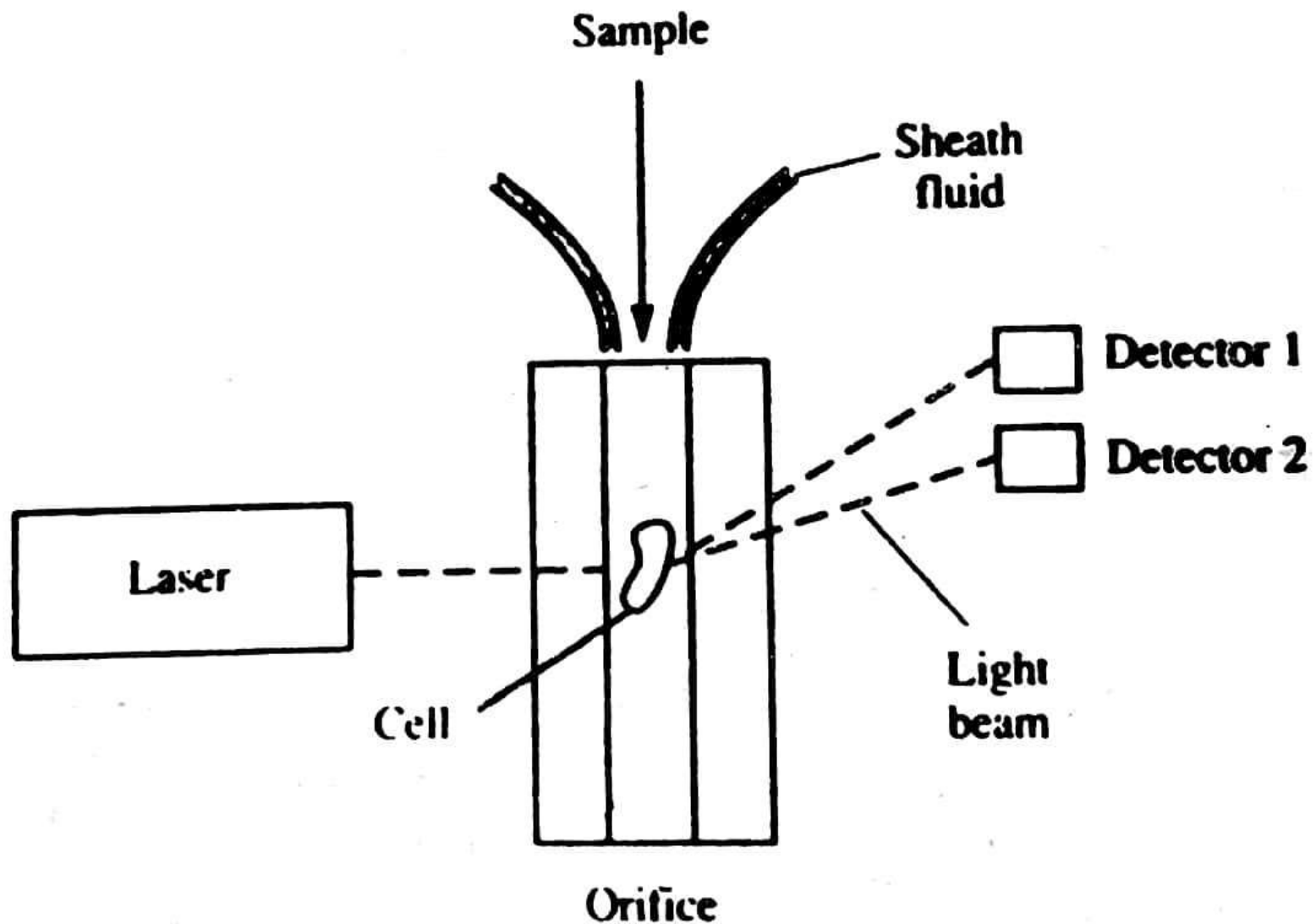
# LASER BASED BLOOD CELL COUNTER

➤ It is used to calculate the number of

- RBC
- WBC
- Platelets

➤ It is used to calculate the

- Haematocrit
- Mean Cell Volume of RBC
- Concentration of Haemoglobin



**Principle of laser based blood cell counting**

## **PRINCIPLE:**

- ❖ Angle of Scattered Light Intensity is different for different sized particles
- ❖ RBCs and WBCs scatter light in same angle whereas Platelets scatter light in another angle

## **PROCEDURE:**

- The blood sample is heavily diluted to reduce the number of particles counted at a time
- A sheath fluid is directed around the blood stream so that the blood flow is along the exact central portion of the aperture
- Blood sample is illuminated by laser and blood cells scatter laser light

- RBCs and WBCs scatter laser in same angle, detected and counted by Photo detector I (A)
- Platelets scatter laser in highly different angle, detected and counted by Photo detector II (B)
- Now '**Lysing Agent**' is added with blood sample to destroy RBCs
- The procedure is repeated
- Photo detector I will display the count of WBC alone (C)
- Photo detectorII will display the same Platelet count (B)
- (A-C) will give the RBC count

### **ADVANTAGES:**

- Highly Accurate
- Instantaneous Result



# APPLICATIONS OF LASER

## ➤ IN INDUSTRIES

Cutting, welding

## ➤ IN MEDICINE

Cataract surgery, Cancer treatment,

## ➤ IN PHYSICS

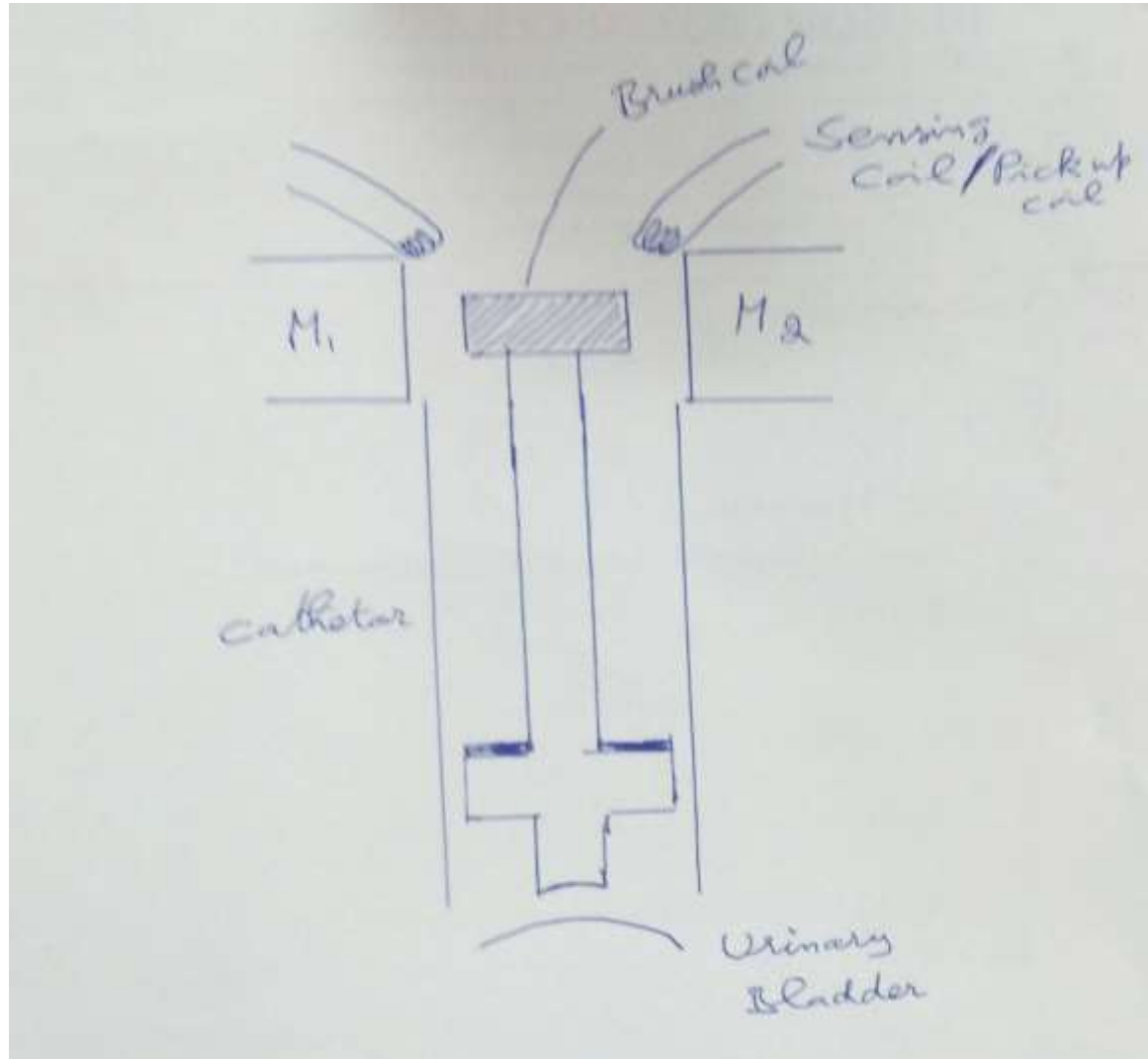
Accurate measurement in optical experiments,

## ➤ IN CHEMISTRY

Rare reactions can be activated with laser

## ➤ IN ASTRONOMY - Distance measurement

# URINARY BLADDER PRESSURE MEASUREMENT-CATHETER METHOD



# URINARY BLADDER PRESSURE MEASUREMENT- DIRECT METHOD

