Class-12 (Viva questions for Physics Practicals)

Current Electricity

Ohm's Law

1. How do the drift velocity, resistance and resistivity of conductor change when
   (a) Potential difference is doubled
   (b) Length is doubled
   (c) Temperature is increased?
2. What is the basic principle involved in the working of battery eliminator?
3. Which has higher resistance, ammeter or milliammeter?
4. Why are the resistance coils double coiled in resistance box>
5. How can you calculate emf and internal resistance of battery eliminator from its V-I graph?
6. What do you understand from short circuiting of a cell?
7. On what factors does the internal resistance of a cell depend?
8. Differentiate between emf of a cell and terminal potential difference.
9. Show graphically the variation of resistance of a conductor with its area of cross section.

Meter Bridge

1. Why should balancing length in meter bridge lie between 40cm to 60cm?
2. What happens to the galvanometer reading if the positions of battery and galvanometer are interchanged at the balance point?
3. What will happen to the balance point when the meter bridge wire is made thicker
4. Will the null point change if the meter ridge wire is replaced y another wire of the same diameter but of different material? Give reason.
5. When the Wheatstone is bridge most sensitive?
6. If the copper strips have significant resistance, then how does the balance condition get modified?

POTENTIOMETER

1.What is the principle of potentiometer?

2.How can we increase the sensitivity of potentiometer?

3.Why is resistance box connected in series with the galvanometer?

4.What are the three reasons for one sided deflection in the galvanometer?

5. How does the sensitivity of a potentiometer vary with potential gradient?

6. What happens if the battery used in the primary circuit of a potentiometer has less emf compared to the emf of the cell used in the secondary circuit?

7..Define emf. Why emf is said to be a misnomer?

8. What happens if the battery used in the primary circuit of a potentiometer has less emf compared to the emf of the cell used in the secondary circuit?

9.What are the electrolytes and electrodes in Lechlanche and Daniel cell?

10.What is the material used for making potentiometer wire and why?

11.Why should the potentiometer wire have a low temperature coefficient of resistance?

12. what is the function of rheostat used in potentiometer circuit?

13. What does the no deflection position in the galvanometer tell us about the flow of current?

14.Will there be any change in the internal resistance of a cell when the cell is (i) in open and (ii) in closed circuit?

15.What is the accuracy of a slide wire potentiometer commonly used in a laboratory?

HALF DEFLECTION

1. What do you mean by figure of merit of a galvanometer?

2.Why is it called half deflection?

3.What is the principle of galvanometer?

4.What is the role of radial magnetic field and how do we get it?

5.What is the function of soft iron cylinder placed in between the two pole pieces?

6. What is the material of the suspension fibre in moving coil galvanometer and why?

7. Why do we prefer copper wire over manganin wire in making coil of galvanometer?

8. Why should an ammeter have lowest possible resistance?

9. What is dead beat galvanometer?

10. State Lenz's law

A.C. Mains

1. What is resonance?

2. What is the principle involved in Sonometer experiment?

3. Which type of waves are produced in Sonometer experiment?

4. Which type of transformer is used in Sonometer experiment and why?

5. Why does the wire vibrate??

6. Where are nodes and antinodes are formed??

7. What is the frequency of a.c mains in INDIA?

8. Why the sonometer box contains holes?

9. What are the differences between free vibrations and forced vibrations?

Note. 1. Since electrical resistivity for copper is low and its electrical conductivity is high, hence **copper wire is used as connecting wire.**

2. Since electrical resistivity for alloys like manganin (Cu – 84% + Mn – 12% + Ni – 4%) and constantan (Cu – 60% + Ni – 40% invariable ratio) is high, their smaller lengths are required for the wires of given diameter in making the standard resistances.

10. Can we use battery eliminator in place of transformer??
11. How do you explain that the shock of A.C. is strong and sudden?
12. Define RMS value of AC.
13. What do you mean by frequency of AC?
14. Why the power supply to our houses is AC and not DC?
15. What are the advantages of AC over DC?
16. What is a choke coil? Why a choke coil is considered better than resistor to regulate AC?
17. How is resonance attained in sonometer experiment?
18. Why can't we use a transformer in dc circuits?

OPTICS

1. When lens or mirror is immersed in water, how does its focal length affected?
2. Give uses of spherical mirrors.
3. What is meant by spherical and chromatic aberration?
4. How can one minimize the spherical and chromatic aberration?
5. One half of a concave mirror is painted black. Will there be any change in the position, nature and size of the image?
6. An equi-convex lens of focal length f is cut into two equal halves (i) longitudinally (ii) transverse. What will be the focal length of each half in the two cases?
7. What is the difference in the virtual images formed by convex mirror and plane mirror?
8. Can a convex mirror and plane mirror form a real image?
9. Which of the quantities frequency, speed and wavelength change during (i) refraction (ii) reflection of light?
10. How diffraction, scattering and dispersion are are different from each other?
11. In prism experiment why should angle of incidence be less than 30°?
12. Define refractive index for a medium. On what factors does it depends?
13. What is meant by "removal of parallax"?
14. What is index correction?
15. How is total internal reflection (TIR) different than normal reflection?
16. Why a glass slab does not produce dispersion whereas a prism does?

SEMICONDUCTORS

1. Why mobility of hole is lesser than electron?
2. What is the net charge on p type semiconductor?
3. How does the width of depletion layer change when the doping is increased?
4. Difference between zener diode and normal diode?
5. How the break down voltage does changes if doping is decreased?

6. State the principle of rectifier.
7. How capacitor can help in smoothening of pulsation in output of rectifier?
8. Photodiode is used in reverse bias. Why?
9. What is the difference between photodiode and solar cell?
10. Why reverse current is very less as compared to forward current in a diode?
11. What is the difference between static and dynamic resistance?
12. What is the significance of negative resistance?
13. What are the applications of diode?
14. Can we measure the potential difference across the junction using voltmeter?
15. Why there is large current at the breakdown in a diode?

BATTERY ELIMINATOR

Battery Eliminator is a device used to convert high voltage alternating current into low voltage direct current. A circuit arrangement is employed with which 220 volt alternating current is converted into 4½ volt direct current. Since with the help of this appliance, the use of the battery is eliminated, therefore it is known as a battery eliminator. It consists of following parts :

TRANSFORMER :

Transformer device used to convert small alternating current at high voltage into low voltage alternating current or low voltage alternating current into high voltage alternating current. In our project step-down transformer is used.

RECTIFIER :

Rectifier device used to convert alternating current into direct current. Rectifier have two types.

(i) Half wave rectifier

(ii) Full wave rectifier.

V = IR

when V is constant R should increase while I decreases

therefore milliammeter will have greater resistance than ammeter

why coils in a resistance box are made up of doubled up insulated coils?

This is done to minimize the inductance of coils.The wire is doubled back on itself.As a result ,there are equal and opposite currents in each section of the coil.Therefore ,the coil has no net magnetic field and no net induced e.m.f.Such coils are called non - inductive coil.

You will be measuring the two section lengths (L1, L2) to use in the same equation to calculate the value of an 'unknown' resistance. For minimum % errors in both of these lengths they need to 'significant' lengths - which is achieved if balance lengths are both in the 40 to 60 cm region of a 100 cm wire.

Accounting for the zero 'location uncertainty' and end correction in a short length (eg 0 to 10 cm) will contribute a 'large' % error.

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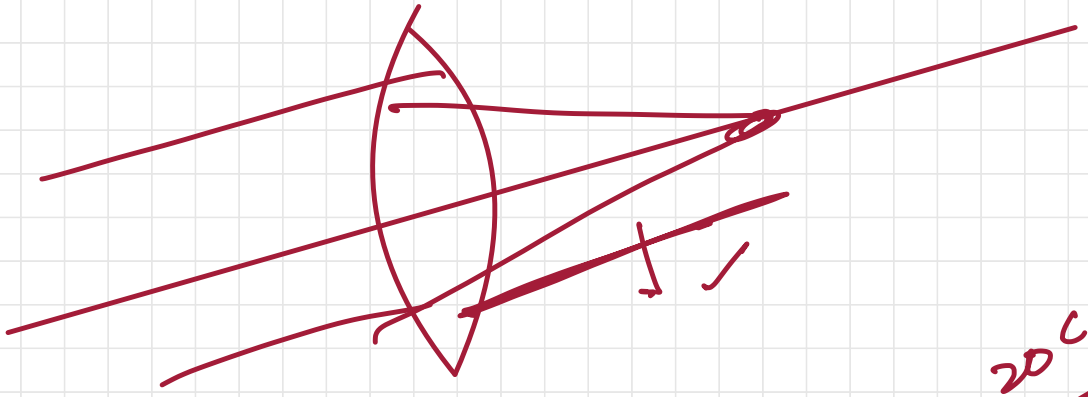
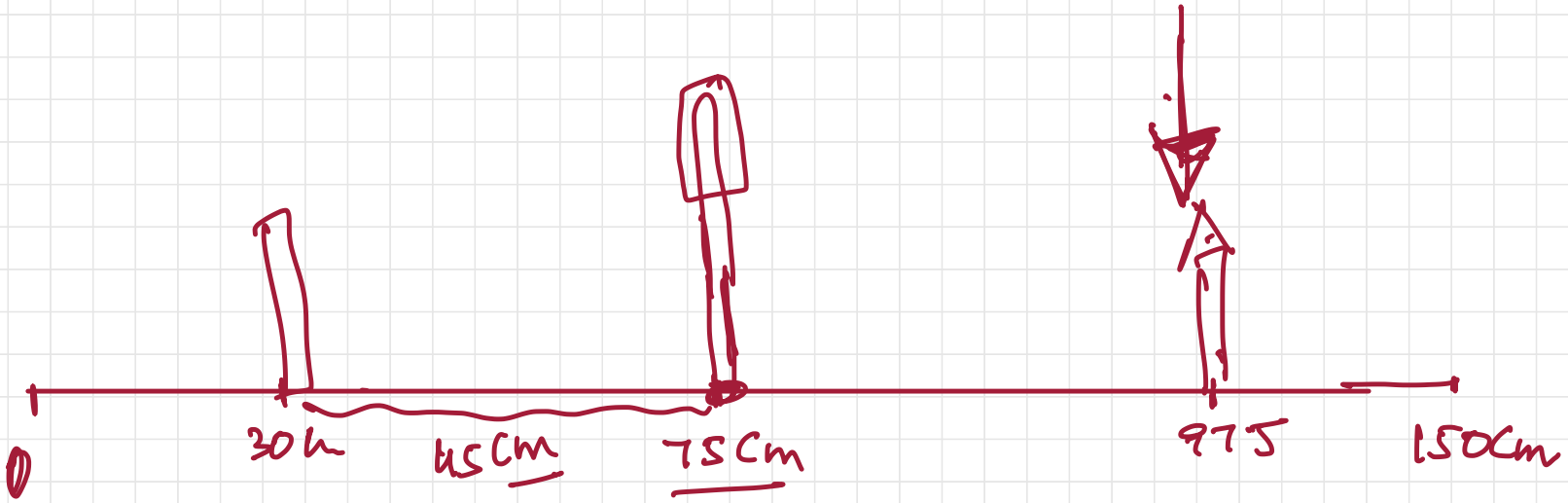


14 cm – 20 cm



$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$

$\frac{1}{15} = \frac{1}{v} - \frac{1}{-45}$

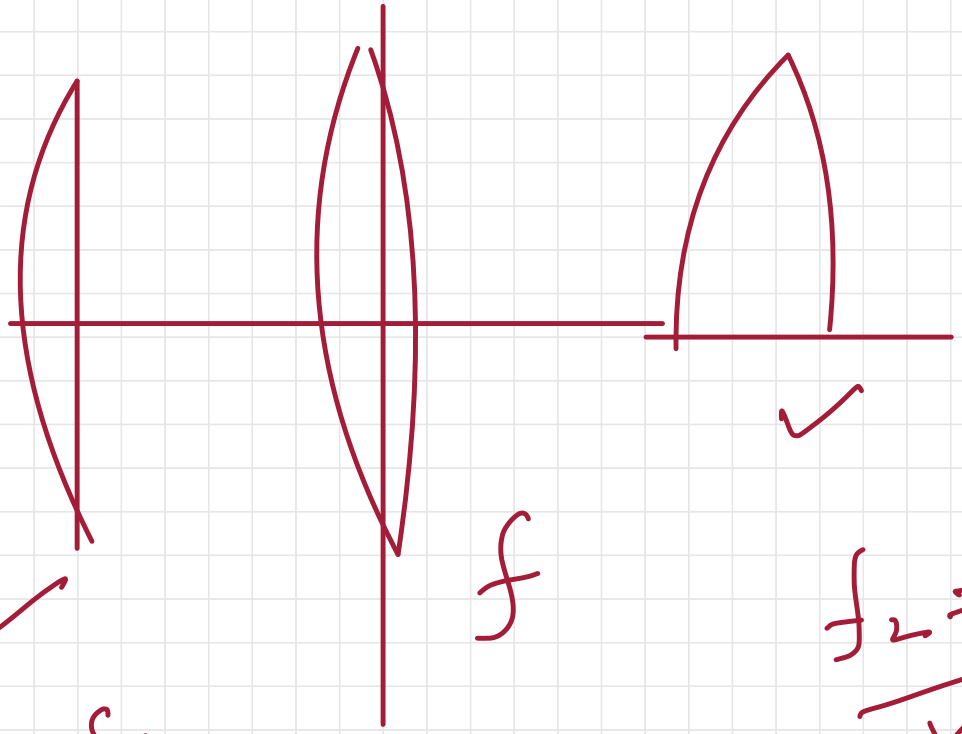
$v = ?$

$75 + 22.5 = 97.5$

$\frac{1}{v} = \frac{1}{15} - \frac{1}{45}$

$\frac{1}{v} = \frac{45 - 15}{15 \times 45}$

$v = \frac{15 \times 45}{30} = 22.5$


f
$f_1 = 2f$
$f_2 = f$

$$\frac{1}{f} = \left(\frac{\mu_g}{\mu_a} - 1\right)\left(\frac{2}{R}\right)$$

$$\frac{1}{f} = \left(\frac{\mu_g}{\mu_w} - 1\right)\left(\frac{2}{R}\right)$$

$$\frac{\mu_g}{\mu_a} > \mu_g/\mu_w$$

$$\frac{1}{f} > \frac{1}{f'}$$

$$f' > f \checkmark$$

$$\frac{1}{f} = (\mu_v - 1)\left(\frac{2}{R}\right)$$

$$\frac{1}{f_R} = (\mu_R - 1)\left(\frac{2}{R}\right)$$

VIBGYOR

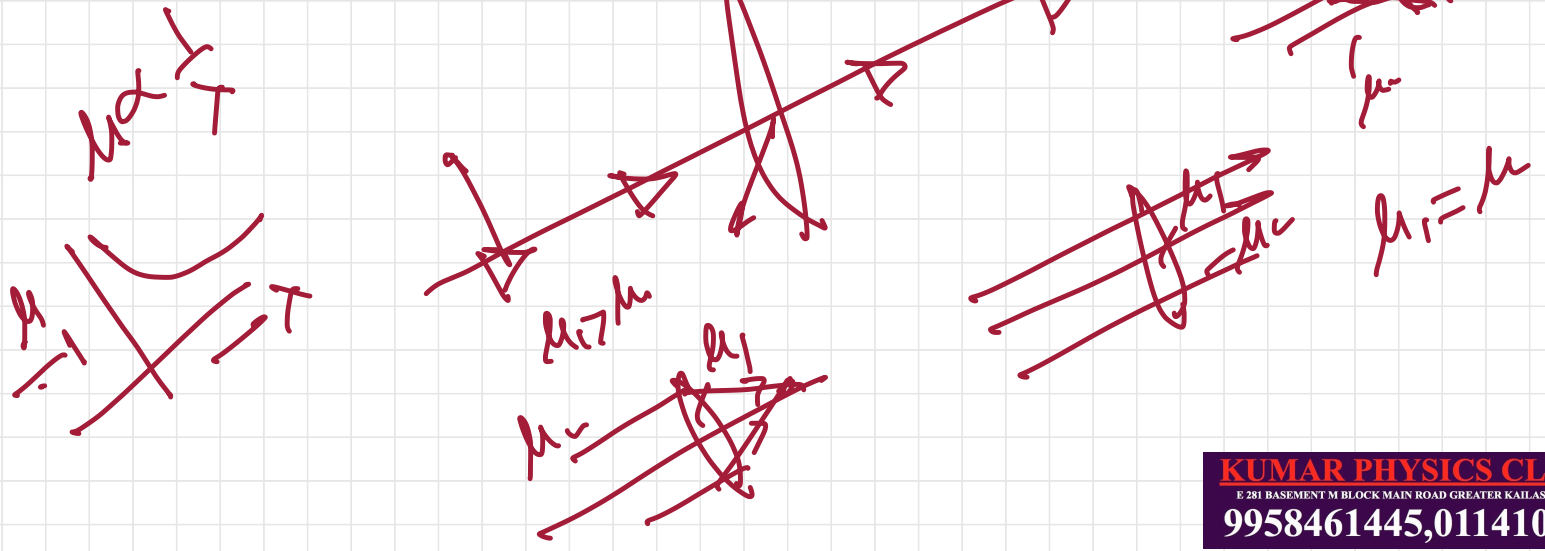
$\lambda_R > \lambda_V$

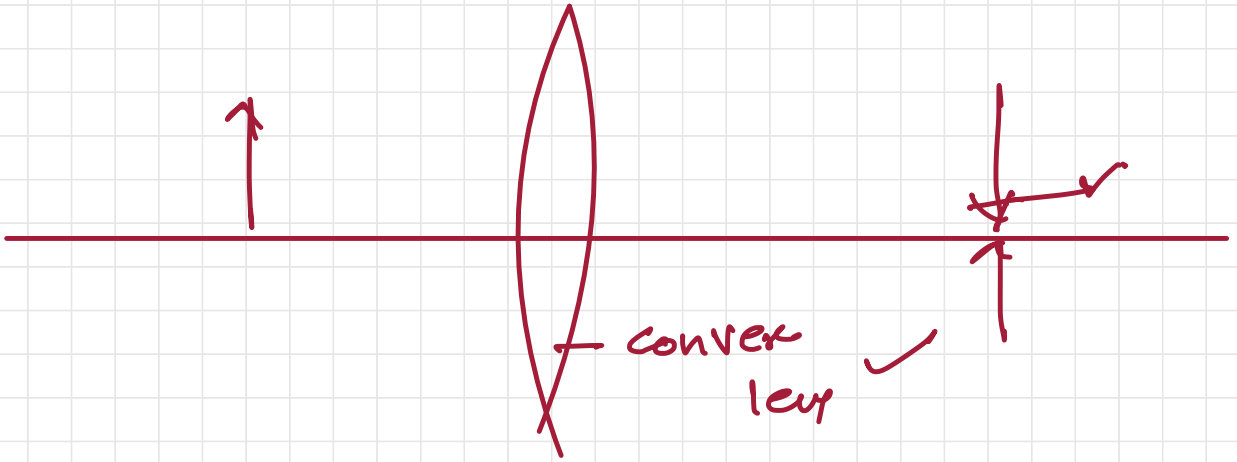
$\mu \propto \frac{1}{\lambda}$

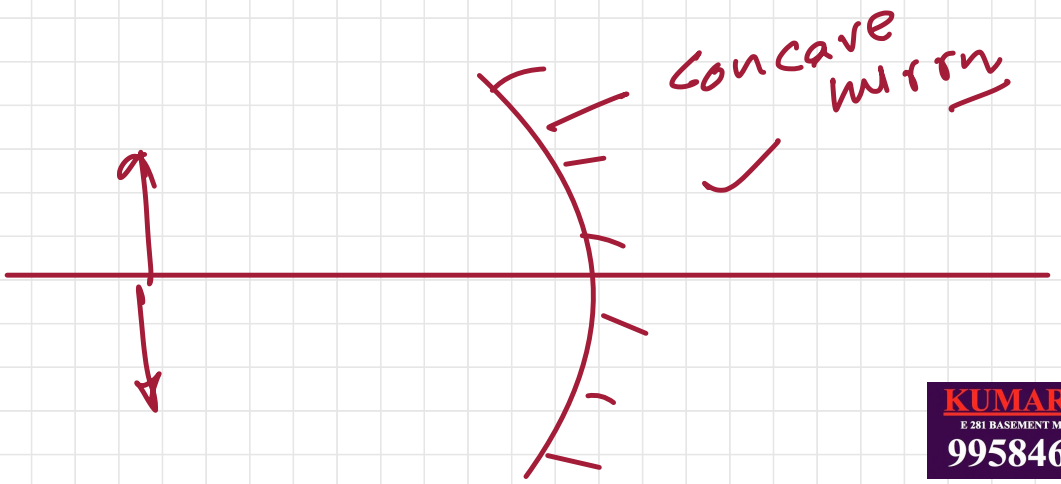
$\mu_V > \mu_R$

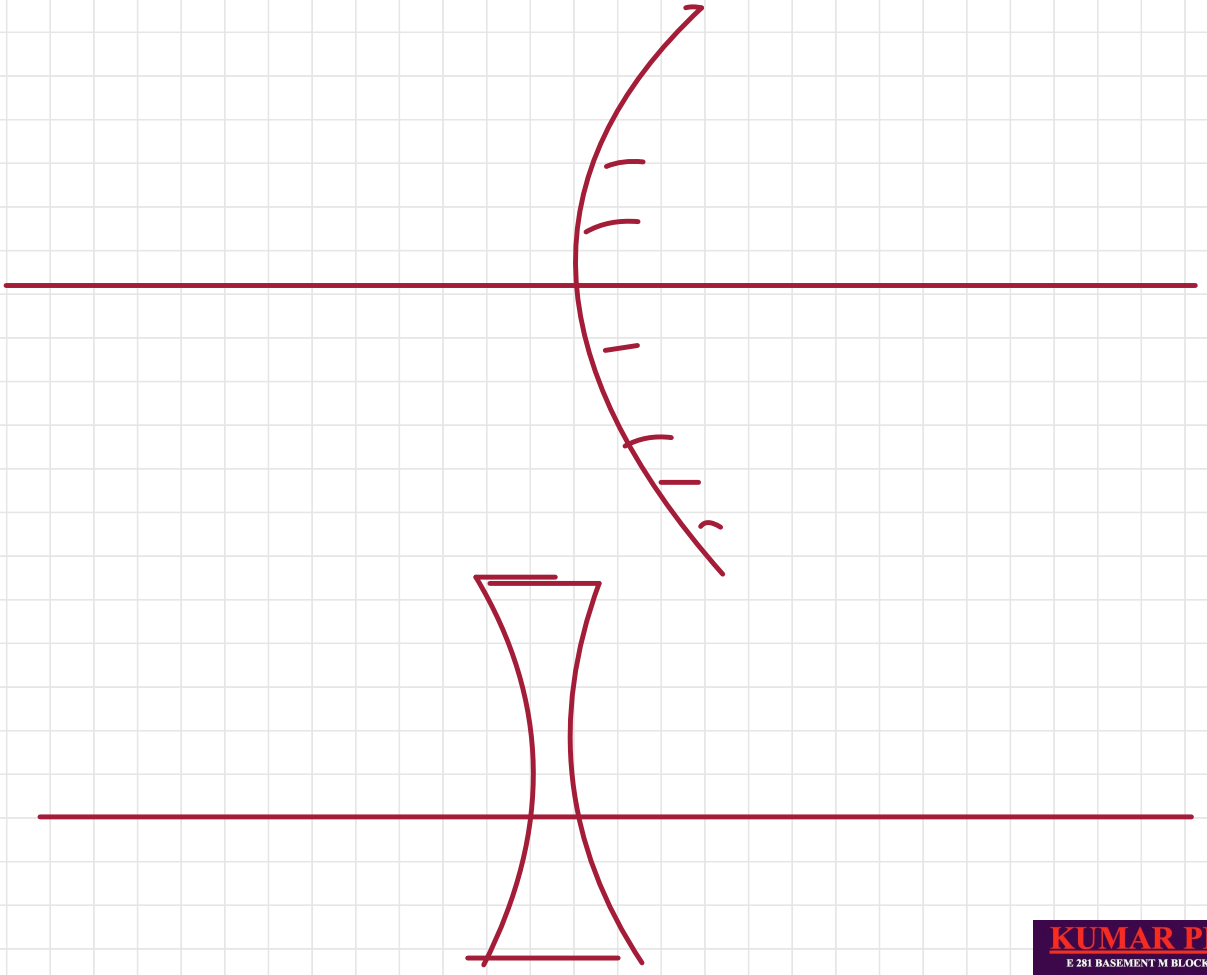
$\frac{1}{f_V} > \frac{1}{f_R}$

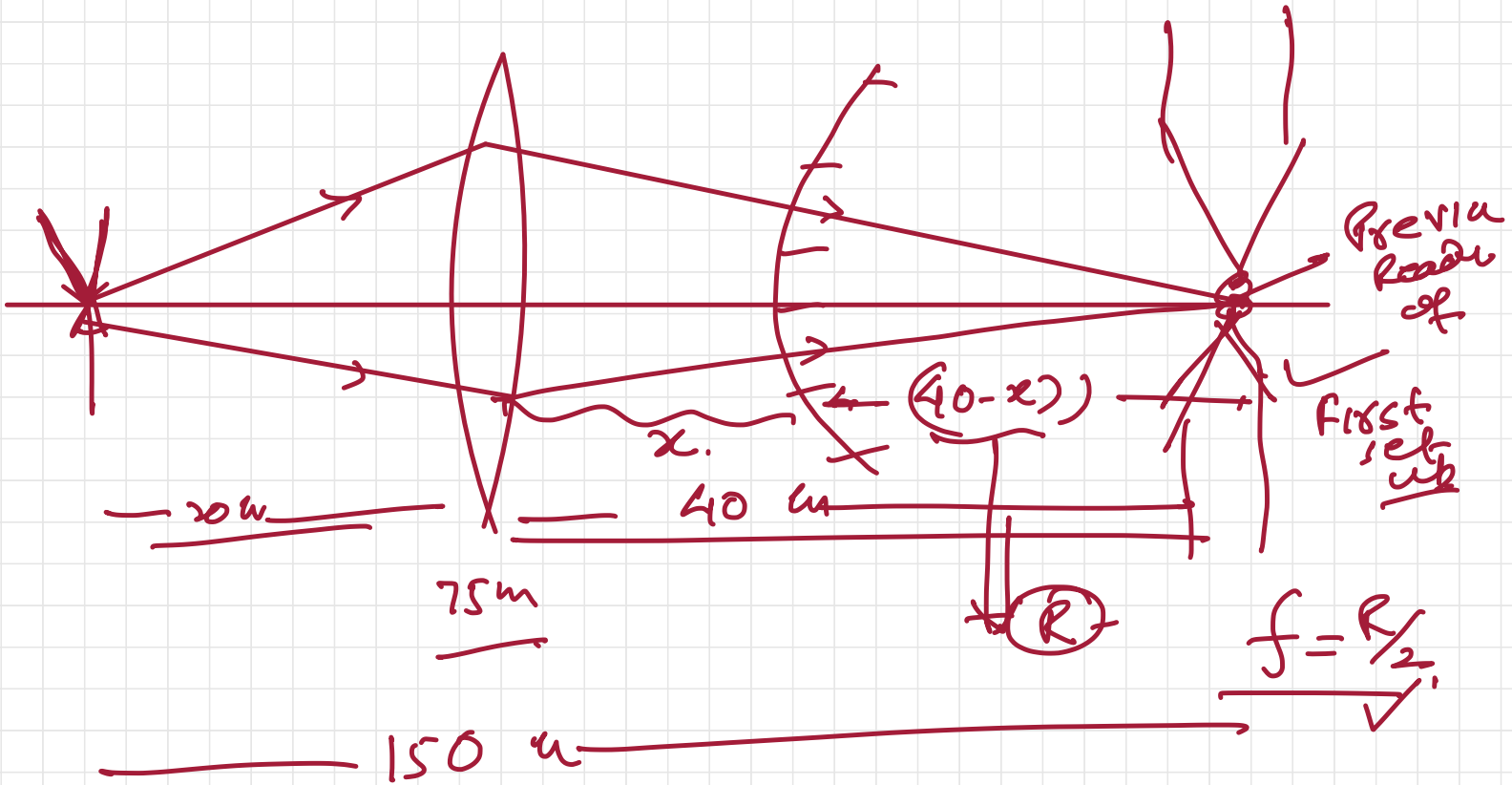
$f_R > f_V$

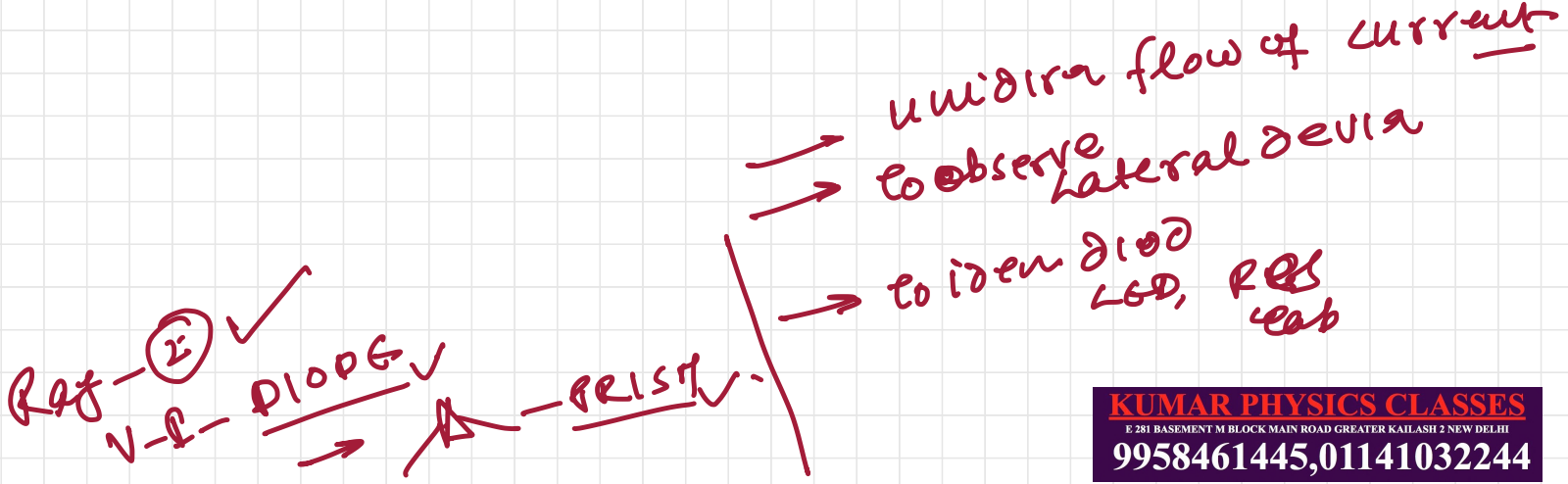


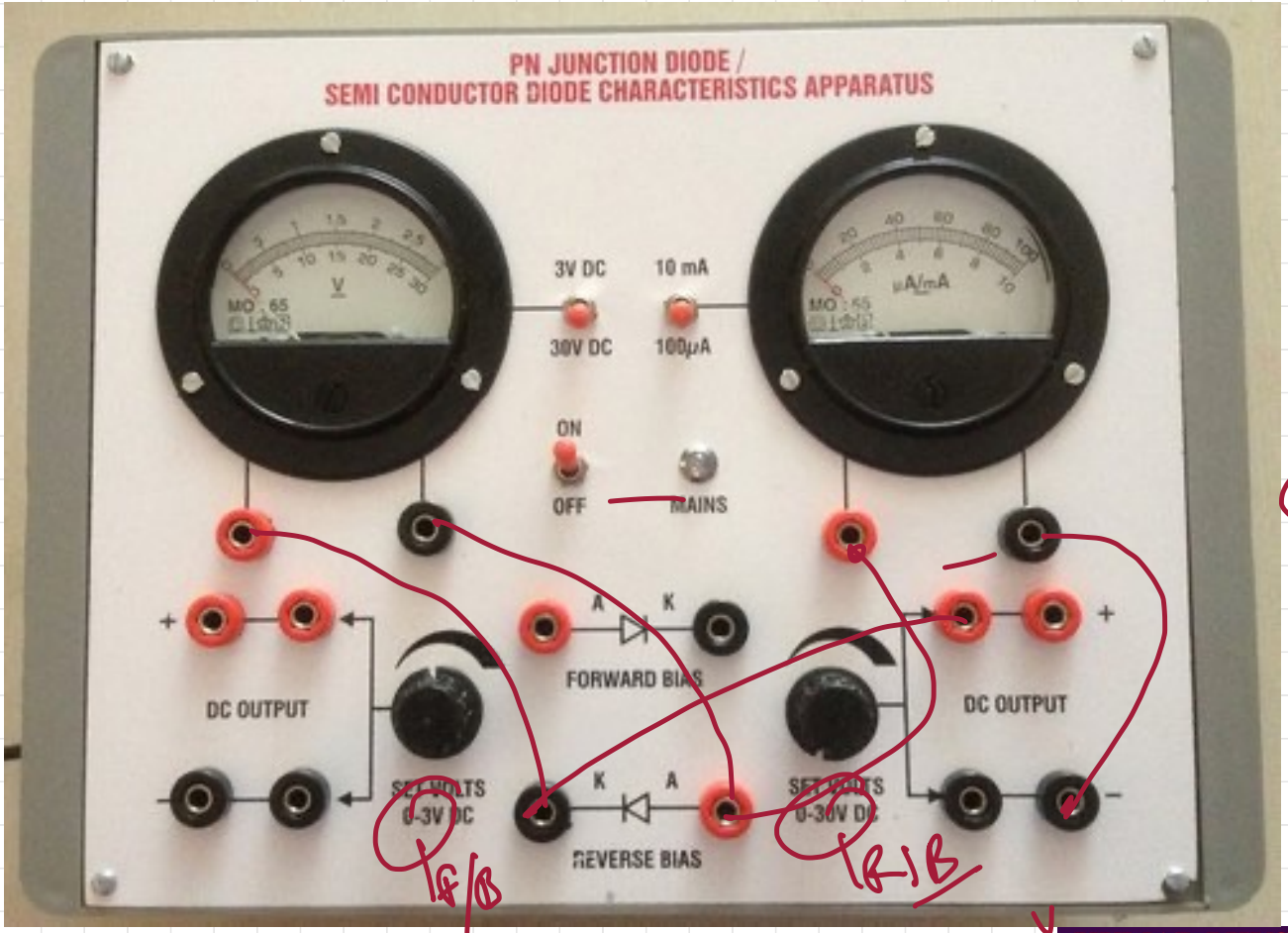


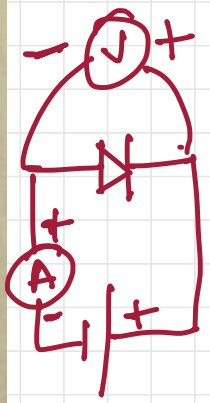


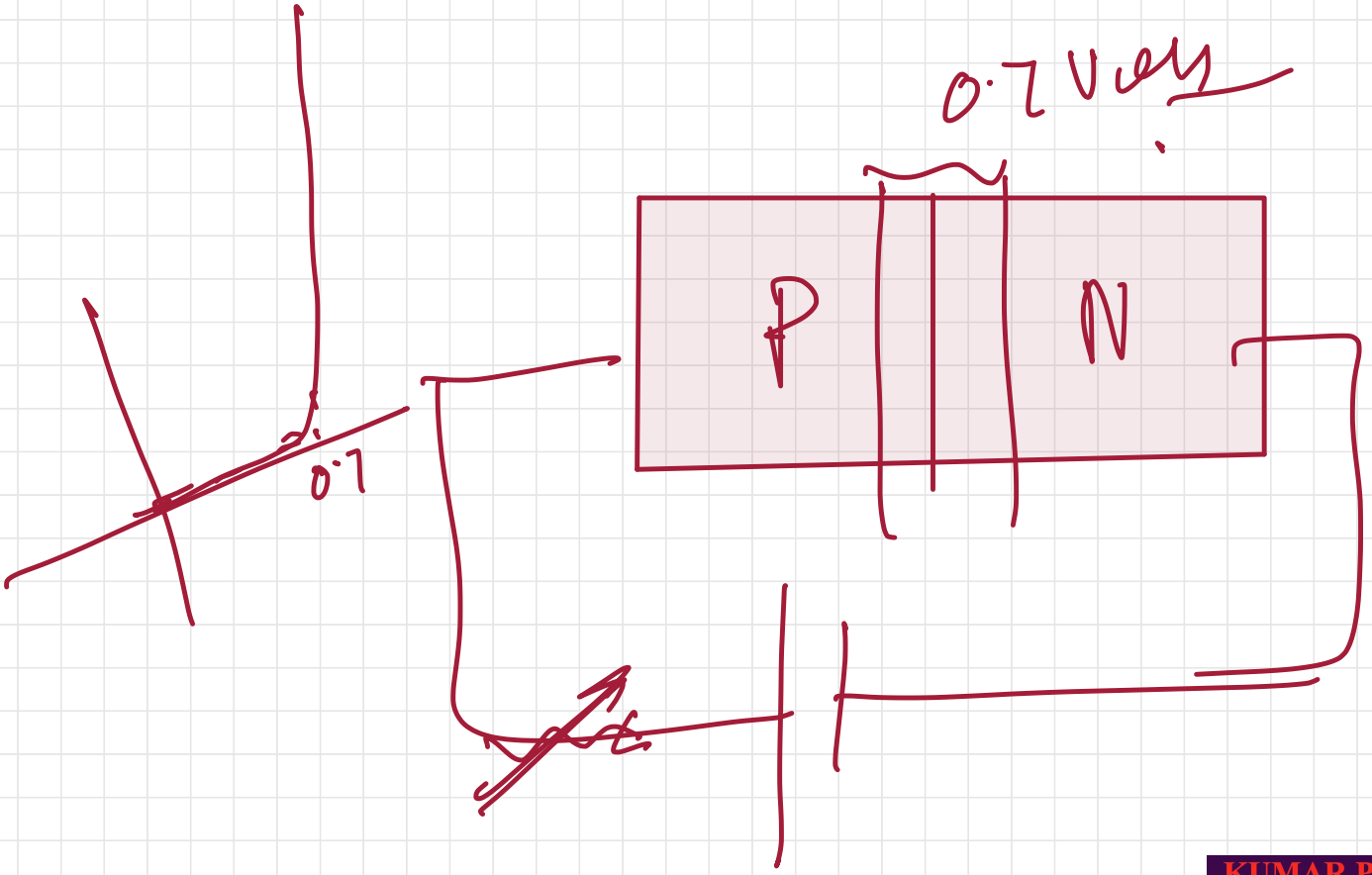


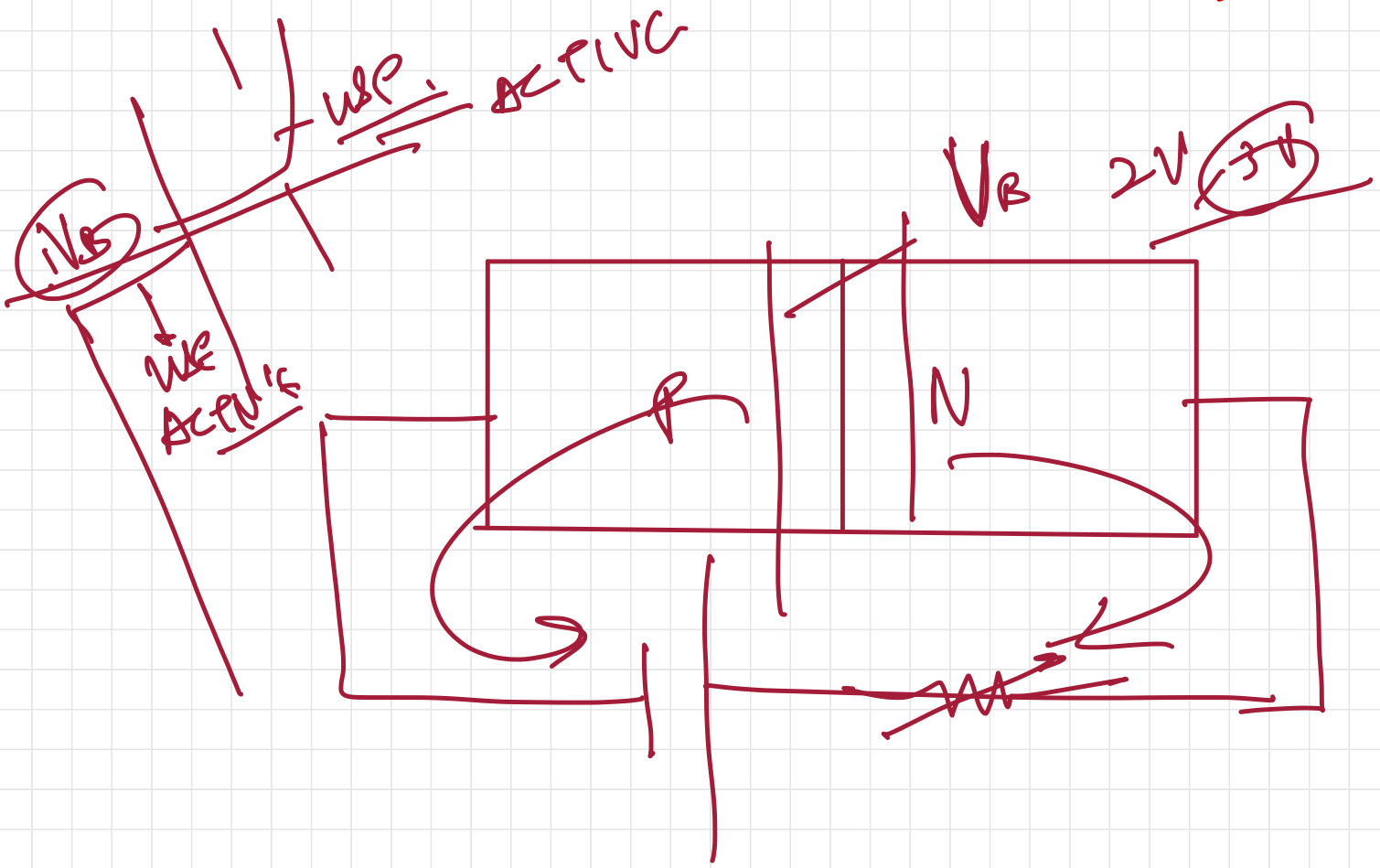


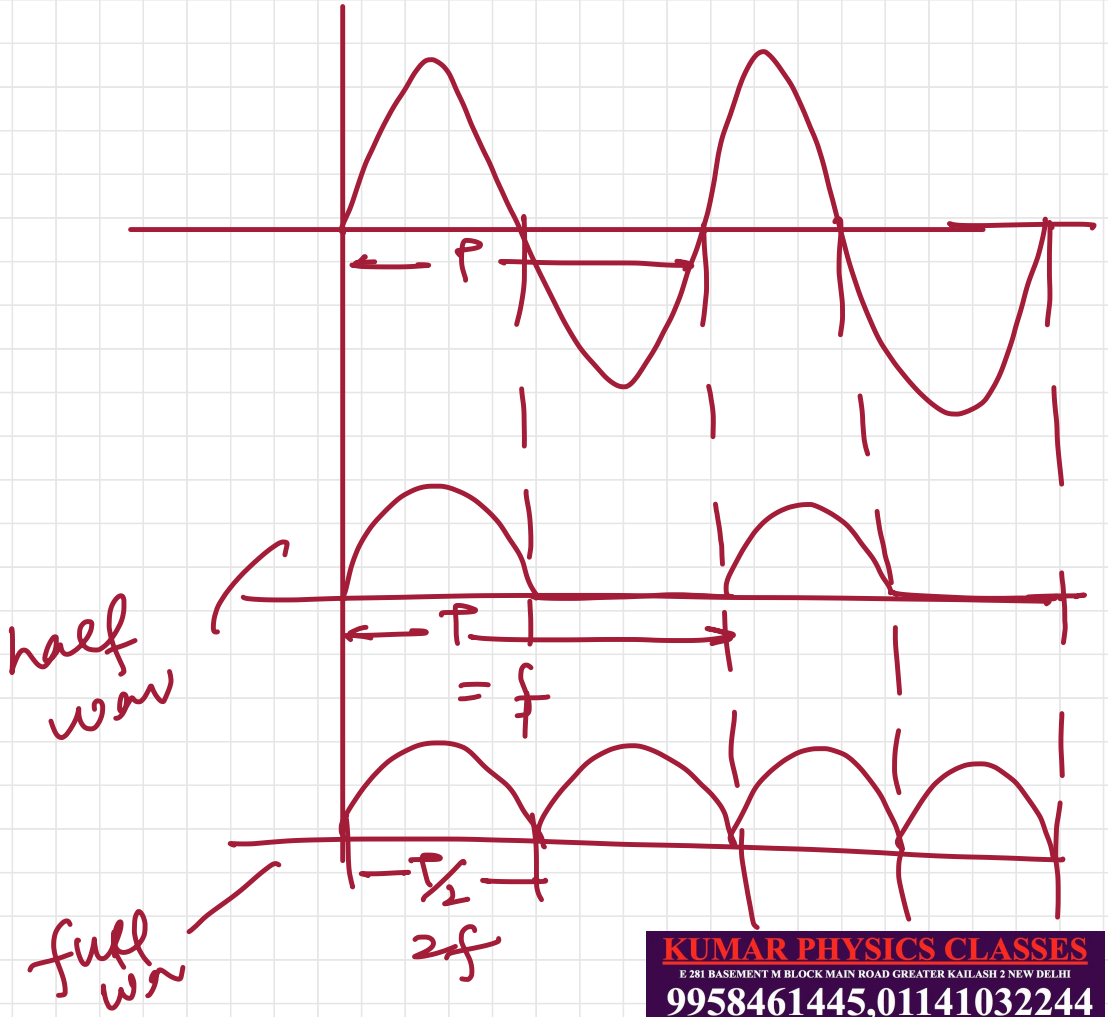












$\delta = (\sqrt{\mu_1} - \sqrt{\mu_2})^2 + 2\sqrt{\mu_1}\sqrt{\mu_2} - A$

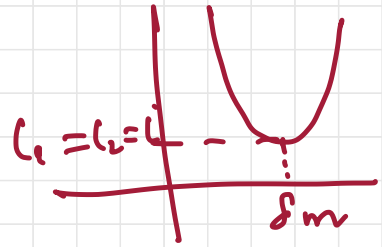
$\delta_m = 2i - A$ ✓

↓ minimum

$\sqrt{\mu_1} = \sqrt{\mu_2}$

$\mu_1 = \mu_2$

$r_1 = r_2$

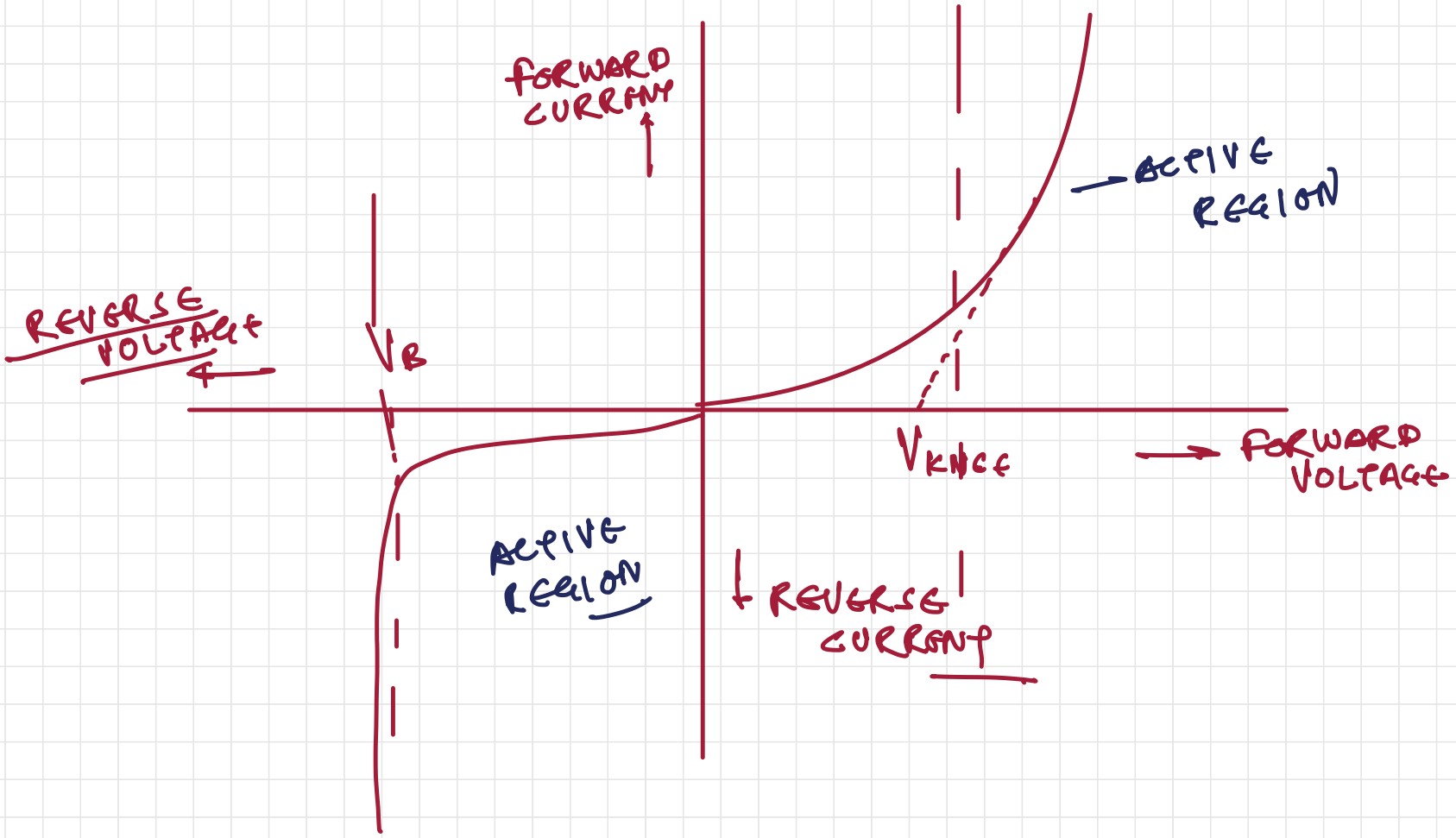


↓ ARROW

$\delta = (\mu_1 - r_1) + (\mu_2 - r_2)$

$= (\mu_1 + \mu_2) - (r_1 + r_2)$

$= (\mu_1 + \mu_2) - A$


FORWARD CURRENT
ACTIVE REGION
REVERSE VOLTAGE
V_B
V_{KNEE}
FORWARD VOLTAGE
ACTIVE REGION
REVERSE CURRENT

Physics Practical viva-voce Questions-

Live Example- **Potentiometer**

(Assuming that the student was assigned the experiment "To determine the internal resistance of a primary cell(which can not be recharged) using potentiometer")

1.Examiner (E): What was the experiment allotted to you?

Students(S): Sir, I was assigned the experiment to determine the internal resistance of a primary cell using potentiometer.

2.E: OK, Tell me the principle of a potentiometer?

S: Sir. The principle of a potentiometer is that the potential drop across any length of a wire of uniform cross section and composition and carrying a constant current is directly proportional to the length.

3.E: Good. What is internal resistance?

S: The resistance offered by the electrodes and electrolyte of a cell is called internal resistance.

4.E: What are the factors affecting internal resistance?

S: Sir. The internal resistance of a cell depends on the nature of electrodes and electrolyte, the temperature of electrolyte, the area of electrodes, the concentration of electrolyte and the distance between electrodes.

5.E: Good; how does the internal resistance change if we increase the area of electrodes?

S: Sir, the internal resistance will decrease if we increase the area of electrodes.

6.E: What will happen to internal resistance if we increase the temperature?

S: The internal resistance of the cell will decrease with increase in temperature.

7.E: How does the Resistance of a conductor vary with temperature?

S: For a conductor the resistance increases with increase in temperature due the decrease in relaxation time.

8.E: Oh! What is relaxation time?

S: The average time interval between two successive collisions of electrons is called relaxation time.

9.E: Why does the relaxation time decrease with an increase in temperature?

S: Sir, as temperature increases, the collisions become more frequent and therefore the average time interval between collisions decreases.

10.E: Define potential gradient of a potentiometer?

S: The potential drop per unit length of the potentiometer wire is called potential gradient.

11.E: How does the sensitivity of a potentiometer vary with potential gradient?

S: The sensitivity of the potentiometer decreases with an increase in potential gradient.

12.E: Can you explain why?

S: As the potential gradient increases, greater potential difference is obtained for a small change in length of the wire. Or the length of the potentiometer for a given change in potential will be less. The potentiometer is more sensitive if we get a considerably larger change in length for a given change in potential. Therefore, with an increase in potential gradient, the sensitivity decreases.

13.E: OK can we draw any amount of current from a primary cell? What limits the value of current drawn?

No, we can not draw any amount of current from a cell. The internal resistance of the cell limits the maximum value

14.E: what are the defects of primary cell?

S ;Local action and Polarisation

15.E; What is role of CuSO4 in Daniel cell?

S: it act as depolariser

16.E; then what is depolariser in Leclanche cell?

S: MnO_2

17.E:Why in primary circuit we should not use a primary cell?

S: It cannot provide steady current through wire for long time

18.E;Which potentiometer would you select 4 wire or 10 wire?

S: 10 wire because it is more sensitive and having less potential gradient.

19.E What are characteristics of wire of potentiometer?

S: Uniform area, high resistivity, low temperature coefficient

20.E; OK you are really good student last question . it is generally said, the electric current should not pass through potentiometer wire for long time ,Why?

S; sir this will heat up the potentiometer wire and it will change its resistance. potential gradient will change

Live Example--- **SEMICONDUCTOR PRACTICAL**

Suppose you are assigned P-N Junction

1.E: What are you doing?

S; Sir I am finding relation between current and voltage for P-N junction in forward and reverse bias

2.E: OK, what is P-N junction?

S; P-N junction is a semiconductor device in which a P type semiconductor is joined with N type semiconductor

3.E: What is depletion layer?

S: It is a thin region around the junction which is free from holes and electrons

4.E: Good, can you explain me how we can join two semiconductor, is there any specific way?

S: Yes sir we have various ways by which we can join P type semiconductor with N type such as grown junction diode ,fuse junction diode.

5.E: What is ideal junction diode?

S: Ideal junction diode is that which conduct only in forward bias

6.E; Good, Tell me why it is so that current is flowing so easily in forward bias where as not so easily in reverse bias?

S; sir in forward bias depletion region is thin so resistance is low hence current flow due to majority carrier where as in reverse bias depletion region is thick so resistance is so high hence no current flow due to majority carrier current only flow due to minority carrier

7.E; Is P-N junction is ohmic device?

S; No it is non ohmic devices; current is not vary linearly with potential.

8.E; What is knee voltage?

S; Sir knee voltage is that below which graph in forward bias is non –linear or non ohmic and above which it is linear or ohmic.

9.E; Which elements are used as intrinsic semiconductor?

S; Si and Ge are used as semiconductor. It is because it has four electrons in its valance shell and form covalent bond

10.E: carbon also has four electrons in valance shell then why it is not used as semiconductor?

S; Electricity can conduct through carbon, but carbon does have a significant resistance, and much of the electrical energy will be lost as heat energy when it passes through carbon and it forms diamond crystal structure so when we add impurity atoms it will not make any significant change...+

Carbon is not used as semiconductor it has 4 valence electrons in it valence shell but the energy gap is very small it will conduct electricity even at room temperature ,the size of carbon is very small . It depends upon the structure of carbon. In case of germanium and silicon they have d orbits in the outer shell and they have greater mobility.

11.E: Tell me various types of P-N junctions?

S: P-N junction is also called diode, such as photo diode, light emitting diode, tunnel diode, Zener diode, varactor diode etc

12.E:What is value of the potential barrier of a silicon and germanium?

S; 0.7V and 0.3 V

13.E: What is difference between P-N diode and Zener Diode?

S: Zener is highly dopped and work in reverse bias

14. What is Zener breakdown?

S; When a very high reverse voltage is applied across a semiconductor diode, a large amount of current flows through it. This effect is called Zener breakdown.

15.What is charge on P type or N type semiconductor?

S: it is charge less

16. What is donor impurity?

S: The pentavalent impurity atoms like Sb, As

17. What is acceptor impurity?

S: The trivalent impurity like B, Al

18. What is dopping?

S: Addition of impurity to pure semiconductor

19.How does conductivity of semiconductor varies with temperature?

S; The conductivity of the semiconductor increases with time

20.Why a large electric current flows, the semiconductor gets damaged?

S: It is because it gets heated

21. What are two important process involved in the formation of a P-N junction?

S; Diffusion and Drift , when a PN junction is formed due to concentration gradient , the holes diffuse from P side to N side and electron diffuse from N side to P side . the drift of charge carriers occurs due to electric field due to built in potential barrier an electric field directed from n region to p region is developed across the junction. This field causes motion of electron on p side to n side and motion of holes on n side to p side thus a drift current start which is opposite to diffusion current.

Electricity Practice Questions for CBSE

1.What is value of resistance for ideal voltmeter and ammeter?

S; It is infinity for voltmeter and 0 for ammeter

2.Define electric potential?

Amount of work done to move a unit charge from infinity to any point in the electric field of given charge

3.Why is an ammeter connected in series in a circuit?

Ammeter has very low resistance, hence to measure the amount of current flowing through the circuit; it must pass through the ammeter hence it is connected in series

4.Why is a voltmeter connected in parallel in a circuit?

Voltmeter posse's very high resistance, to find potential across given resistance, minimum current must pass through the voltmeter and maximum through the resistance

5.State the law that governs the strength of the current passing through a metallic conductor when a p.d is applied across its end. Illustrate this law graphically?

Ohm's law is the law. It provide linear relation between current and voltage

6.State the law which governs the amount of heat produced in a metallic conductor when current is passed through it for a given time. Express this law mathematically?

Joules heating effect is the law which provide heat produced according to it

$H=I2Rt$

7.Define resistance. What are the factors on which it depends?

Obstruction posses by the conductor in the flow of current is called resistance, it depends on length, area, temperature, nature of material

8.A copper wire of resistivity P is stretched to reduce its diameter to half its previous value. What is the new resistivity?

Resistivity is independent of dimension so it will remain P (no change)

9.Define the S I unit of electric current and potential difference?

Current =Ampere, Potential difference = Volt

10.What is expression for equivalent resistance when we connect them in series?

R= R+R+R...

B. in parallel combination

11. What is an electric fuse? Explain its function?

To prevent circuit from excess current, we have electric fuse which consist of high resistance and low melting point it will melt when high current flows through it.

12. What do you mean by a shunt?

It is a small value of resistance which is connected in parallel with the galvanometer

13. Can we increase or decrease range of ammeter?

We can increase by the range by connecting suitable resistance in parallel

14. Write the advantages of connecting electrical appliances in parallel and disadvantages of connecting them in series in a household circuit?

15. Why is tungsten used almost exclusively for making the filaments of electric lamps?

16. A piece of wire is redrawn by pulling it until its length is doubled .Compare the new resistance with the original value.

17. An electric geyser has rating 2000 w, 220 v marked on it. What should be the minimum rating in whole number of a fuse wire that may be required for safe use with the geyser?

18. Three resistors each of resistance 10 ohm are connected, in turn, to obtain a. minimum resistance b. Maximum resistance. Compute?

a) The effective resistance in each case

b) The ratio of minimum to maximum resistance so obtained.

19. Two resistors of resistance 2 ohms and 4 ohms are, in turn connected?

a) In series

b) In parallel to a given battery for same interval.

20.Compute the ratio of the total quantity of heat produced in the combination in the two cases.

Extra Questions----

19. Two metallic wires A and B are connected in parallel. Wire A has length L and radius R wire B has a length 2L and radius 2r. Compute the ratio of the total resistance of parallel combination and resistance of wire A.

20. In a house three bulb of 100w each are lighted for 4 hours daily and six tube lights of 20w each are lighted for 5 hours daily and a refrigerator of 400w is worked for 10 hours daily for a month of 30 days. Calculate the electricity bill if the cost of one unit is Rs 4.00.

21. Three resistors of 4ohms, 6ohms and 12 ohms are connected in parallel. The combination of above resistors is connected in series to a resistance of 2 ohms and then to a battery of 6 volts. Draw a circuit diagram and calculate

a) Current in main circuit

b) Current flowing through each of the resistors in parallel

c) P.d and the power used by the 2 ohm resistor.

22. Two lamps, one rated 100 W at 220 V and the other 60W at 220 V, are connected in Parallel to a 220 volt supply. What current is drawn from the supply line?

Viva help for Optics Experiments

1. Define refractive index?

It is defined as ratio of velocity of light in rarer medium to velocity in denser medium

2. What is the least value of refractive index possible?

One

3. What can you infer if someone says that he has a medium of refractive index less than one?

Through that medium light travel faster than its speed through vacuum

4. Define focus?

The point on the principal axis at which the parallel rays after reflection/refraction converge or appear to converge

5. Define pole of a spherical mirror?

The center of curved and reflecting surface of a spherical mirror

6. Define optic centre?

It is the geometrical center of the lens.A ray of light passing through this point does not suffer any deviation.

7. What is the type of lens in an air bubble formed inside water?

Convex lens

8. Is your eye is a lens?

It is convex lens

9. What is the focal length of a lens?

The distance between the principal focus and the optical center of a lens is called as the focal length of the lens

10How will you distinguish between a plane mirror, concave mirror and a convex mirror without feeling its surface with your hand?

11.What is linear magnification of plane mirror,concave mirror,and convex mirror?

It is 1 for plane more than 1 for concave and less than 1 for convex

12What are the differences between convex lens and concave lens?

Concave lens has diverging property and convex converging

Concave is thin at the middle whereas convex thick

13.What is dispersion?

The phenomenon of splitting of white light into its constituent colours on passing through a glass prism is called dispersion of light.

14.Why a glass slab does not produce dispersion whereas a prism does?

Since a rectangular glass slab is equivalent to two similar prisms placed with their base inverted.the dispersion and deviation produced by the two prisms are equal but in opposite direction so net deviation and dispersion are zero+`

15.Define refractive angle of the prism?

It is angle between two refracting surfaces

16.What is parallax?

It may be defined as the relative shift between the two objects placed at different distances from the eye when eye is moved to and fro.

17.What is index correction?

It is difference between observed distance and actual distance because of sharpe edges of needle

18.How is parallax removed?

By making two objects coincident

19.What are the practical uses of a concave mirror?

In tourches,search lights,reflector,reflecting telescope,shaving mirror,solar appliances,solar cooker

Concave mirror is used:

i) in torches, search lights etc. as reflector,

ii) In reflecting telescopes,

iii) As a shaving mirror,

iiii) In solar appliances such as solar cooker etc.

20.In which situation ,a convex lens behaves as a concave lens?

When a convex lens is placed in a medium of refractive index greater than that of the material of the lens

21.Why the reflectors used in search lights are paraboloidal and not concave?

22.Distinguish real image and virtual image?

Image which can be obtained on screen is real which cant is virtual

23.Why mirrors are silvered on the back surface?

24.Why a convex mirror is preferred as the rear view mirror of vehicles?

25.What is the principle on which the working of a simple microscope is based?

26.Define power of a lens?

It is ability of a lens to converge beam of light towards its principal axis

27.Define angle of deviation?

It is angle between incident ray and emergent ray

28.What are the factors on which the lateral displacement produced by a glass slab depends?

29.Which type of lens has negative power?

Concave

30.which lens is called as diverging lens?

Concave

31.What are the applications of total internal reflection?

32.What is angle of minimum deviation?

It is the angle at which angle of incidence becomes equal to angle of emergence so that the ray of light will be parallel to the base of the prism

33.What are the factors on which the deviation produced by a prism depends ?

34.What is the cause of dispersion?

Different color travel with different velocity when passes through the prism

35.Does refractive index depends on wavelength?

Yes the refractive index depends on the wavelength of light inversely proportional

36.What happens to prism if it is placed in water?

It will remain unchanged

36 Why travelling microscope is called so?

Travelling microscope is called so because it can be moved in horizontal and vertical directions to take measurements while seeing the magnified image of the object under study. It can be used to determine the diameter of capillary tube, to determine the refractive index of the material of a glass slab by measuring real depth and apparent depth etc.

37. When water is filled on the concave mirror ,then how will it behave ?

It will behave as a plano-convex lens

38.What type of eye-piece is used in a travelling microscope?

Ramsden's eye piece

39. What is role of lycopodium powder on the upper surface of glass slab while determine refractive index by travelling microscope?

So that we can focus over the surface of glass slab

40.What is SI unit of refractive index ?

It has no unit

Half Deflection Method

1. What are you doing?

I am finding resistance of a galvanometer by half deflection method and its figure of merit.

2. What is moving coil galvanometer?

It is a devices used to detect the direction as well as magnitude of the electric current.

3. What is principle of moving coil galvanometer?

Current carrying coil placed in a magnetic field experience torque.

4. What is figure of merit?

Amount of electric current required to produce one scale deflection in the galvanometer

5. Define the current sensitivity?

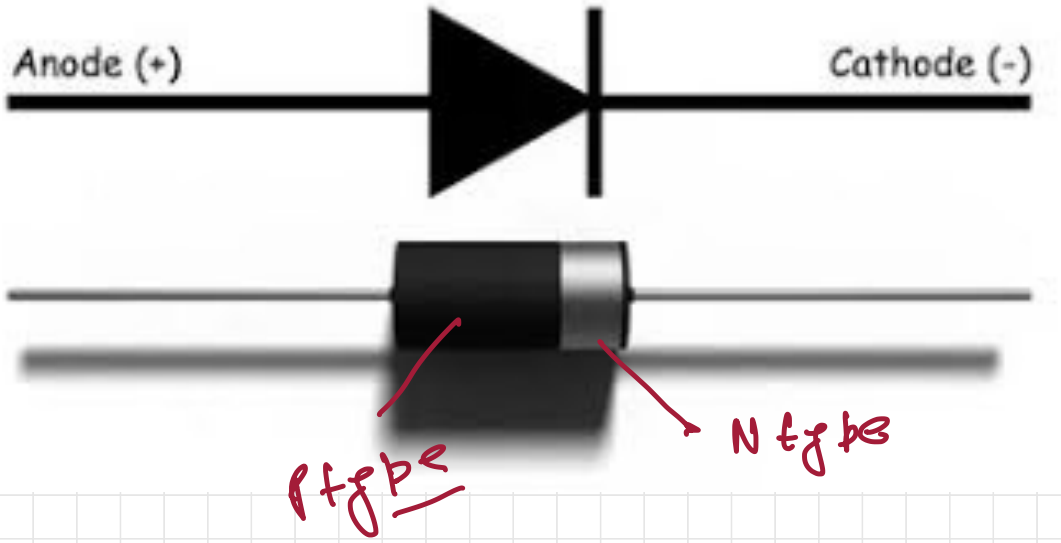
The deflection produce per unit current through it

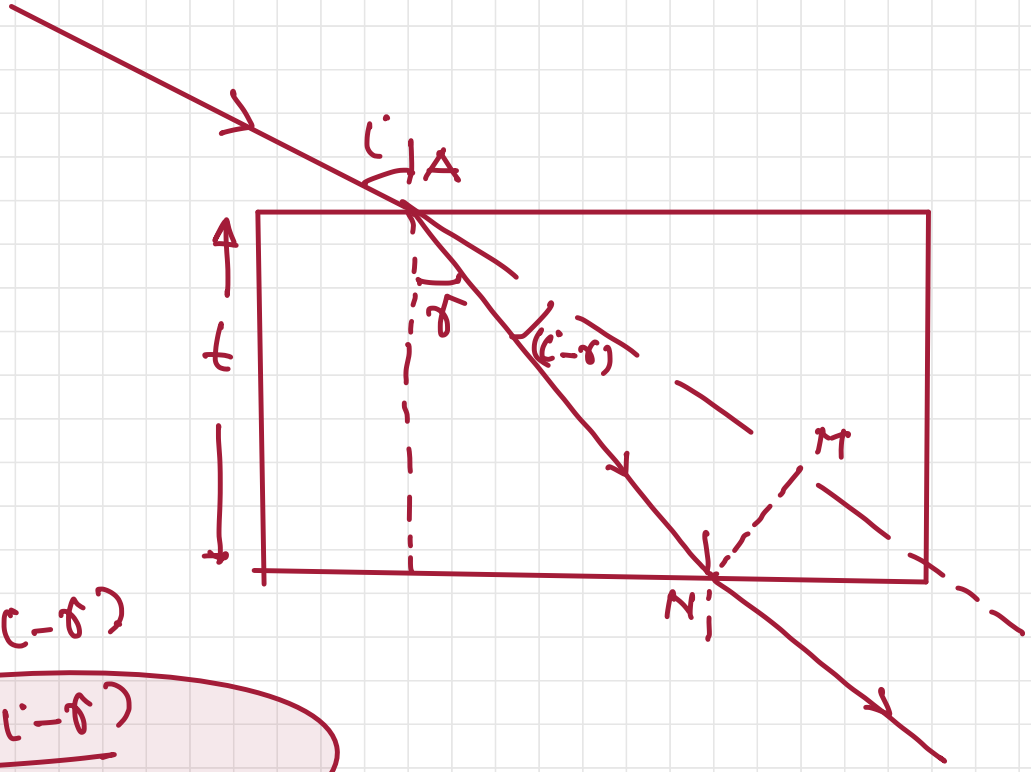
6. What is the nature of the magnetic field in moving coil galvanometer?

It is radial magnetic field.

7. Out of galvanometer voltmeter and ammeter which one has maximum and minimum resistance ?

Ammeter is having minimum and voltmeter maximum in fact ideal ammeter is having zero and voltmeter is having infinite resistance





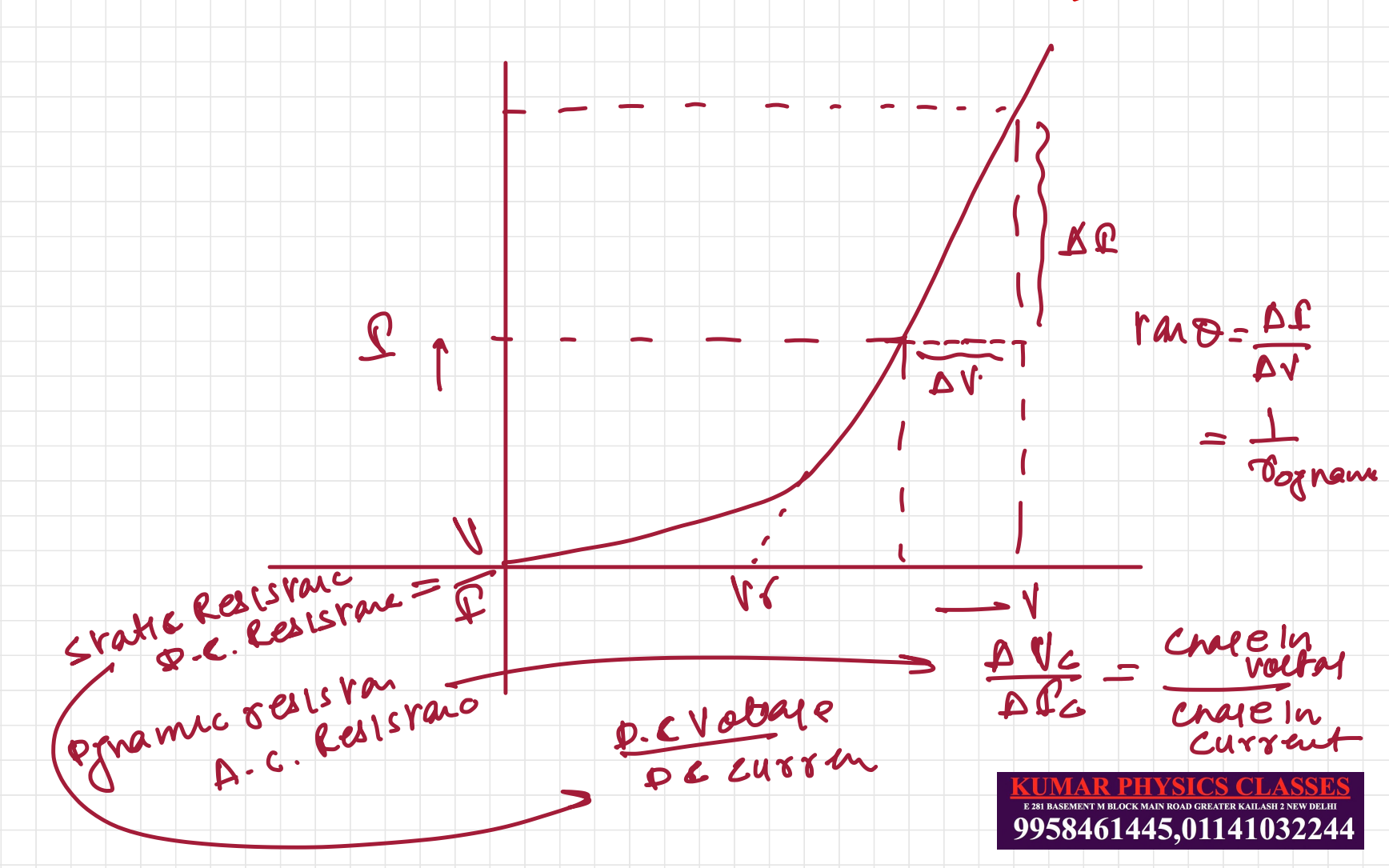
$$\sin(i-r) = \frac{MN}{AN}$$

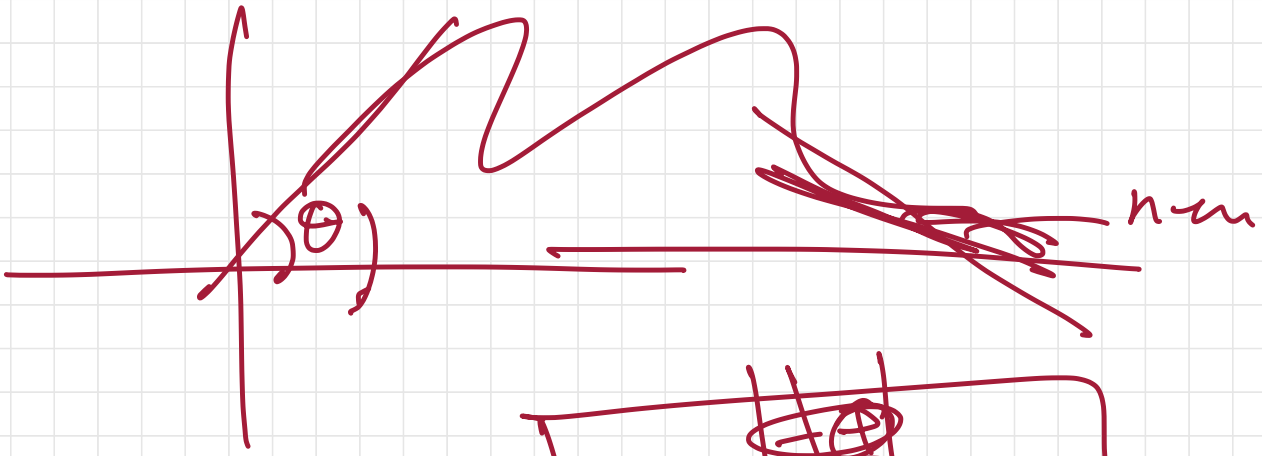
$$\cos r = \frac{t}{AN}$$

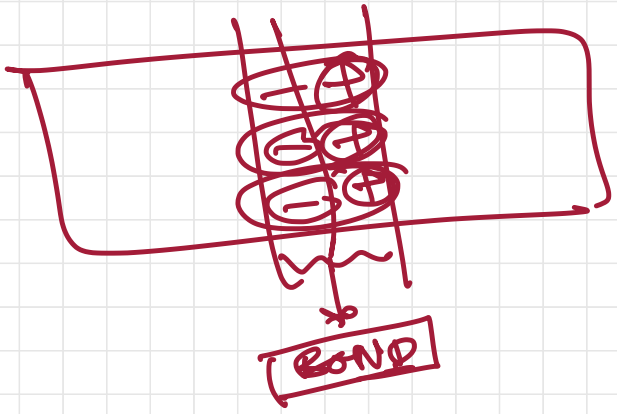
$$AN = \frac{t}{\cos r}$$

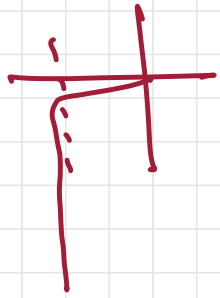
$$MN = AN \sin(i-r)$$

$$MN = \frac{t \sin(i-r)}{\cos r}$$

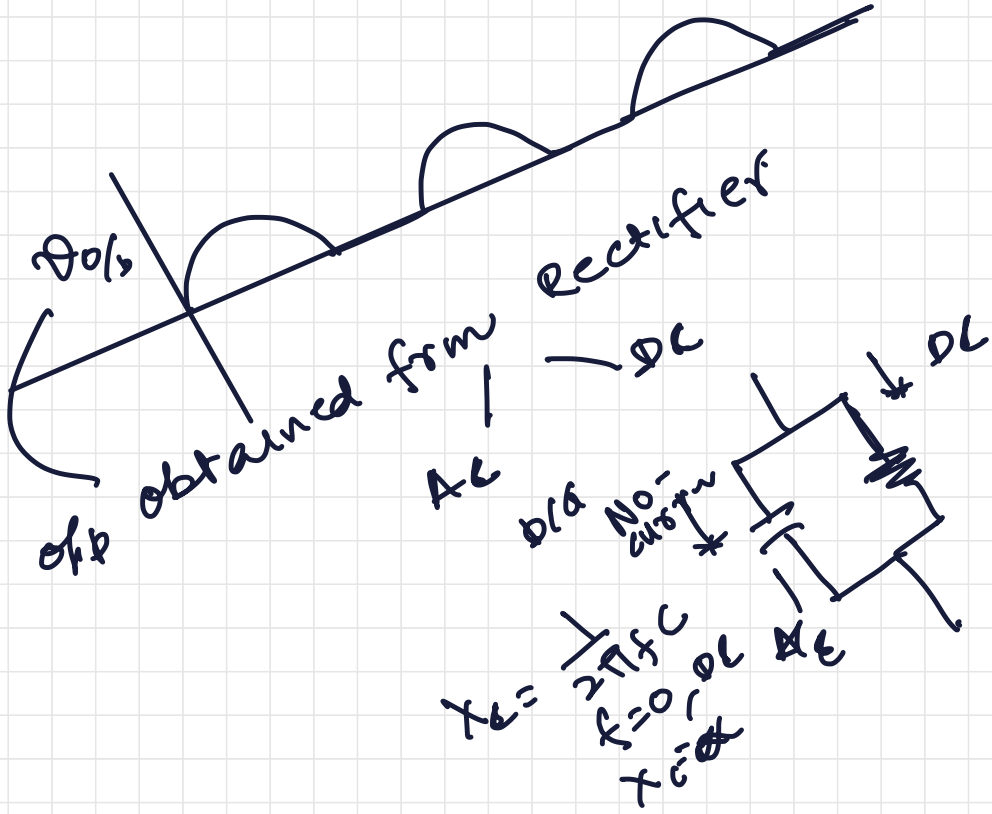


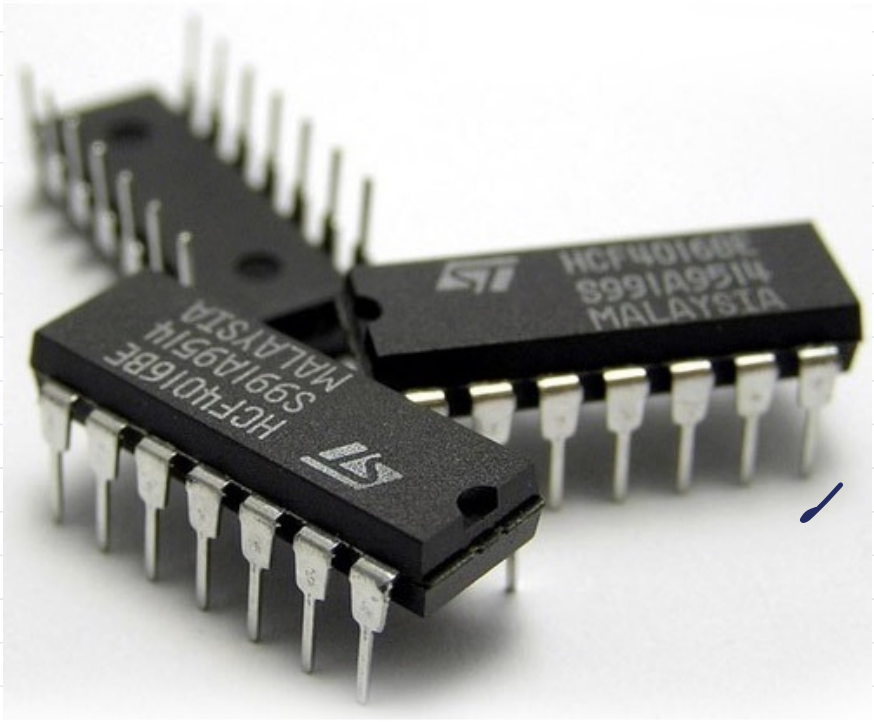






search the value of potential.





combination of different circuit in to one chip

IC / Integrated circuit

LED
Light emitting diode.