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PART - I.

1.	b)	Peacock feather.
2.	a)	decrease by 4 times
3.	d)	Frequency Modulation
4.	d)	All the above
5.	b)	3×10^{-2} C.
6.	b)	γ- rays.
7.	a)	12 cm
8.	a)	R/4
9.	b)	$\sqrt{\frac{2}{3}}$ BIL
10.	a)	Thermionic
11.	d)	337.5 C.
12.	d)	negative

12

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13. d) 0.83

14. d) $r_n \propto n$

15. c) polarisation.

PART - II.

24. $A = 60^\circ$ [equilateral prism]

$D = 40^\circ$

$$n = \frac{\sin\left(\frac{A+D}{2}\right)}{\sin\left(\frac{A}{2}\right)} = \frac{\sin\left(\frac{60^\circ+40^\circ}{2}\right)}{\sin\left(\frac{60^\circ}{2}\right)}$$

$$= \frac{\sin(50^\circ)}{\sin(30^\circ)} = 1.5 \qquad \therefore n = 1.532$$

[$\sin(50^\circ) = 0.766$
$\sin(30^\circ) = 1/2$

0.766×2
1.532

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3. ELECTRICAL RESISTIVITY :

Electrical resistivity is defined as the resistance offered to the current flow by a conductor of unit length having unit area of cross section

$$R = \rho \cdot \left(\frac{l}{A}\right)$$

- It's unit is ohm - metre (Ωm)

- Based on Resistivity, materials are classified into,

1) Conductors
2) semiconductors
3) Insulators.

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22. DISPLACEMENT CURRENT :

Displacement current is the current which comes into play in the region where the electric field (or electric flux) is changing with time

$$i_d = \frac{1}{\varepsilon_0} \frac{d\varphi_E}{dt}.$$

$$i = i_c + i_d$$

$$\oint_l \vec{B} \cdot \vec{dl} = \mu_0 i + \underbrace{\mu_0 \varepsilon_0 \frac{d\varphi_E}{dt}}_{i_d}.$$

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17. DOPING :

The process of adding impurities to the intrinsic semiconductor is called as Doping.

The added impurities are dopants (100 ppm).

2

18. WORK FUNCTION :

2

· The minimum energy required for an electron to escape from the metallic surface (by overcoming the barrier of surface) is called as work function of that metal

· Denoted by φ_0 : unit : electron volt (eV)

4

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17. INCREASING CURRENT SENSITIVITY :

$$I_g = \frac{\theta}{I} = \frac{NAB}{K}$$

the current sensitivity can be increased by

i) Increasing the number of turns (N)

ii) Increasing the magnetic field (B)

iii) Increasing the area of coil (A)

iv) decreasing the couple per unit twist (K).

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PART - III.

29. USES OF POLAROIDS:

- It is used in cameras and goggles to avoid the glare of light
- It is used in taking 3D pictures (Holography)
- It is used to improve the contrast in old oil paintings
- It is used in optical stress analysis
- It is used in the window planes to control the intensity of light
- used in LCD
- Polarised light beam helps to read and write in CD.

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27. LAWS OF PHOTOELECTRIC EFFECT :

i) For a given metallic surface.
It is striken by me.
the emission of electrons takes place if the frequency of the ~~electron~~ light

i) For a given metallic surface, the emission of electrons takes place only if the frequency of incident light is greater than a certain minimum frequency is called as Threshold frequency.

ii) The number of electrons emitted and the saturation current depends on the intensity of the incident light

iii) Maximum kinetic energy of the electrons is independent of the intensity of the incident light

iv) maximum kinetic energy of the electrons are dependent on the frequency of incident light

v) There is no time lag between the incident light and emitted electron (less than 10^{-9} s).

2

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32. $\vec{F}_m = q(\vec{v} \times \vec{B}) = Bqv \sin\theta$

$z = 25\,\Omega$

i) $\vec{F}_m$ (Lorentz force) is directly proportional to the magnetic field $(\vec{B})$

$\sqrt{2500}$

50×50

2500

50×50

2500

ii) $\vec{F}_m$ is directly proportional to the magnitude of the charge (q)

$184 - 42$

30

iii) $\vec{F}_m$ is directly proportional to the velocity of the electron $(\vec{v})$

iv) $\vec{F}_m$ is directly proportional to the $\sin\theta$ between magnetic field $(\vec{B})$ and velocity $(\vec{v})$.

2

v) If the charge q is positive, Lorentz force acts perpendicular (upward) to the magnetic field and velocity.

vi) If the charge q is negative, then the Lorentz force will act on the direction opposite to that of the force acted on a positive charge.

vii) If the velocity $(\vec{v})$ is along the magnetic field $(\vec{B})$, then the Lorentz force acting on it is zero.

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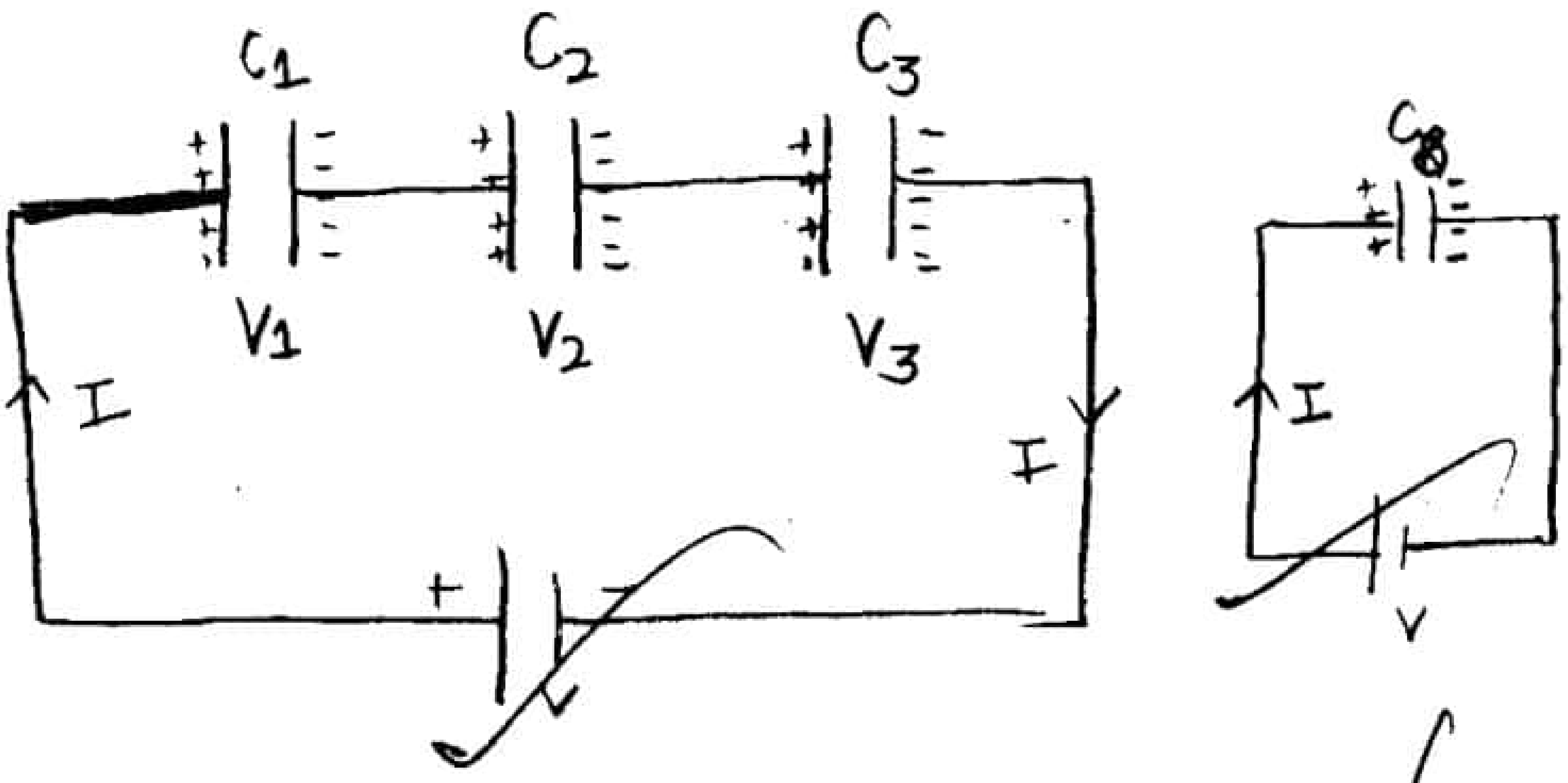
30.



- consider three capacitors C_1, C_2, C_3 connected in series.

- In series connection,

1) Current through all the resistors are same. [charge Q same].

2) Potential difference across the capacitors vary.

Let V_1, V_2, V_3 be the potential difference across C_1, C_2 and C_3.

$V = V_1 + V_2 + V_3$

We know, ~~C = Q V~~ $Q = CV \Rightarrow V = \frac{Q}{C}$

$\Rightarrow$

$V_1 = \frac{Q}{C_1}$; $V_2 = \frac{Q}{C_2}$; $V_3 = \frac{Q}{C_3}$.

$V_1 + V_2 + V_3 = \frac{Q}{C_1} + \frac{Q}{C_2} + \frac{Q}{C_3} = Q\left[\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}\right] \Rightarrow (1)$

For a equivalent capacitor C_s.

$V_s = \frac{Q}{C_s}$. $\Rightarrow (2)$

From (1) & (2)

$\Rightarrow \frac{Q}{C_s} = Q\left[\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}\right]$

$\Rightarrow \frac{1}{C_s} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$.

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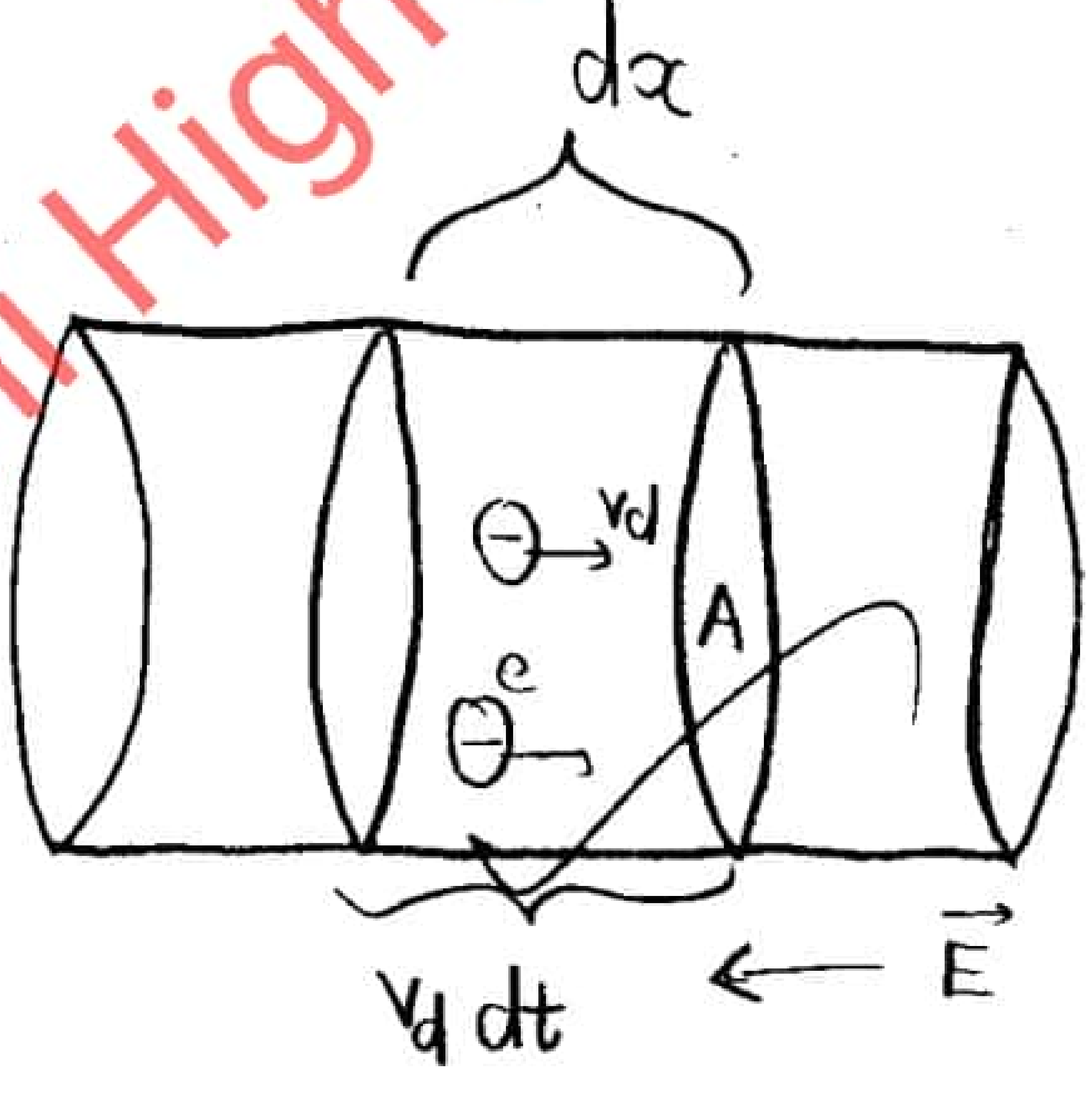
· The equivalent capacitance in series is given by the sum of the reciprocal of the ~~re~~ capacitance and it will be always less than the individual capacitance.

26.
3



· consider a conductor of area of cross section A

· Let electric field be applied to

the conductor from left to right.

- let n be the no. of electrons per unit volume.

- The electrons move with drift velocity v_d opposite to the direction of $\vec{E}$.

- The drift velocity of the electrons travelling a distance dx in a time dt.

$$\Rightarrow v_d = \frac{dx}{dt}.$$

$$dx = v_d\, dt.$$

The ~~electrons~~ available in the volume of length dx

$$= A\,dx \times n.$$

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$= A dx \times n$

$= A (v_d\, dt)\, n.$

Total charge element in length dx

$dQ = e \times (n A v_d) dt$

$dQ = neAv_d\, dt$

We know : $I = \frac{dQ}{dt}$

$I = \frac{neAv_d\, dt}{dt}$

$\Rightarrow I = neAv_d$

In vector form, $\vec{I} = neA\vec{v_d}$

This is the relation between current and drift velocity

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Given : $R = 30\,\Omega$, $X_L = 184\,\Omega$, $X_C = 144\,\Omega$

33. i) $Z = \sqrt{R^2 + (X_L - X_C)^2}$

$184 - 144 = 40$

$Z = \sqrt{900 + 1600}$

$Z = \sqrt{2500}$

$Z = 50\,\Omega$

ii) $\tan\phi = \frac{X_L - X_C}{R}$

$\tan\phi = \frac{40}{30}$

$3 \overline{)4} = 1.33$

$\phi = \tan^{-1}\left(\frac{4}{3}\right)$

$\Rightarrow \phi = 53.1^\circ$ (or) $\phi \simeq 52.1^\circ$

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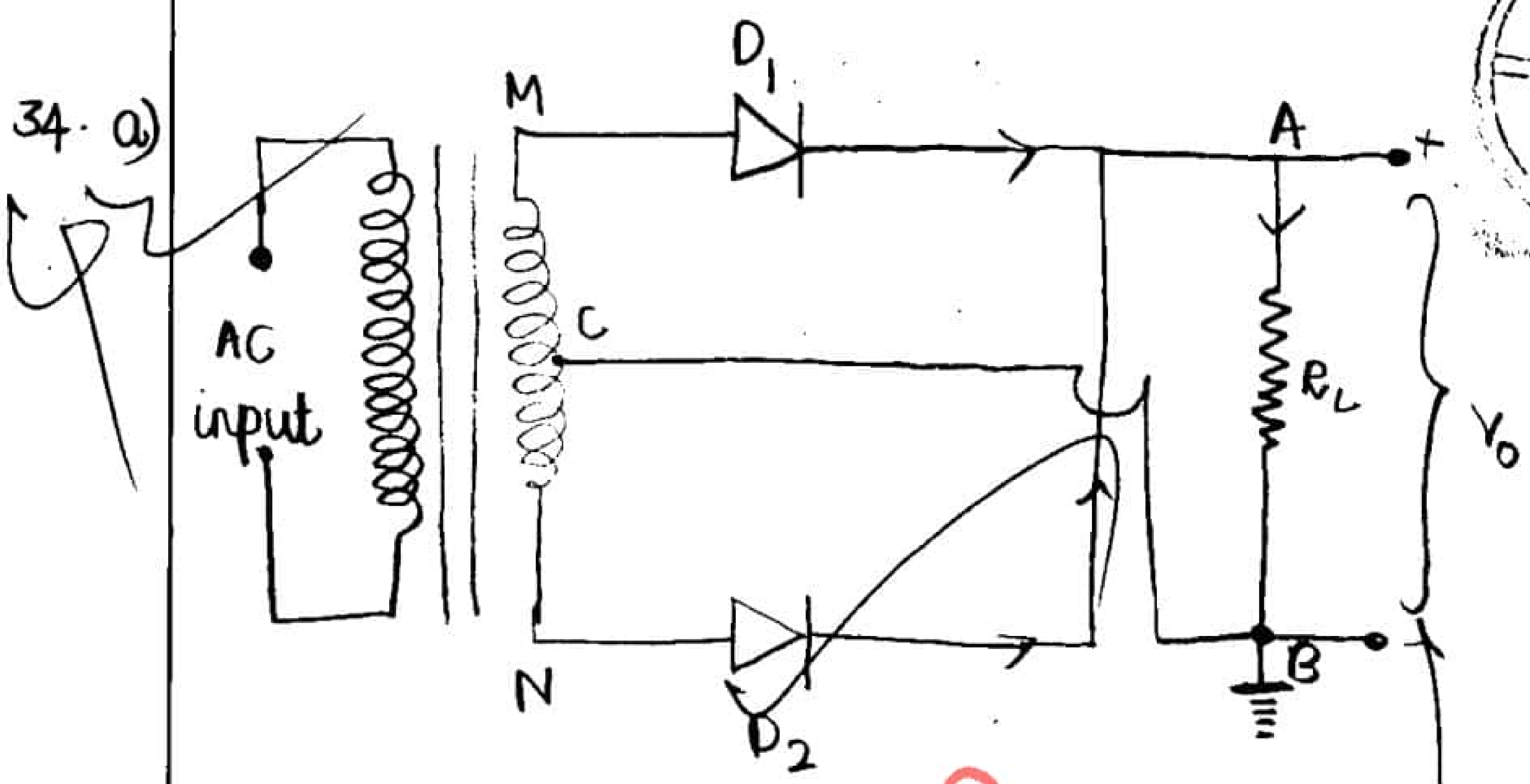
PART - IV

34. a)



- In a full wave rectifier both the positive and negative half cycles of AC are rectified and converted to DC.

- A full wave rectifier consits of

i) Transformer

ii) Diodes D_1 and D_2

iii) Central tap transformer.

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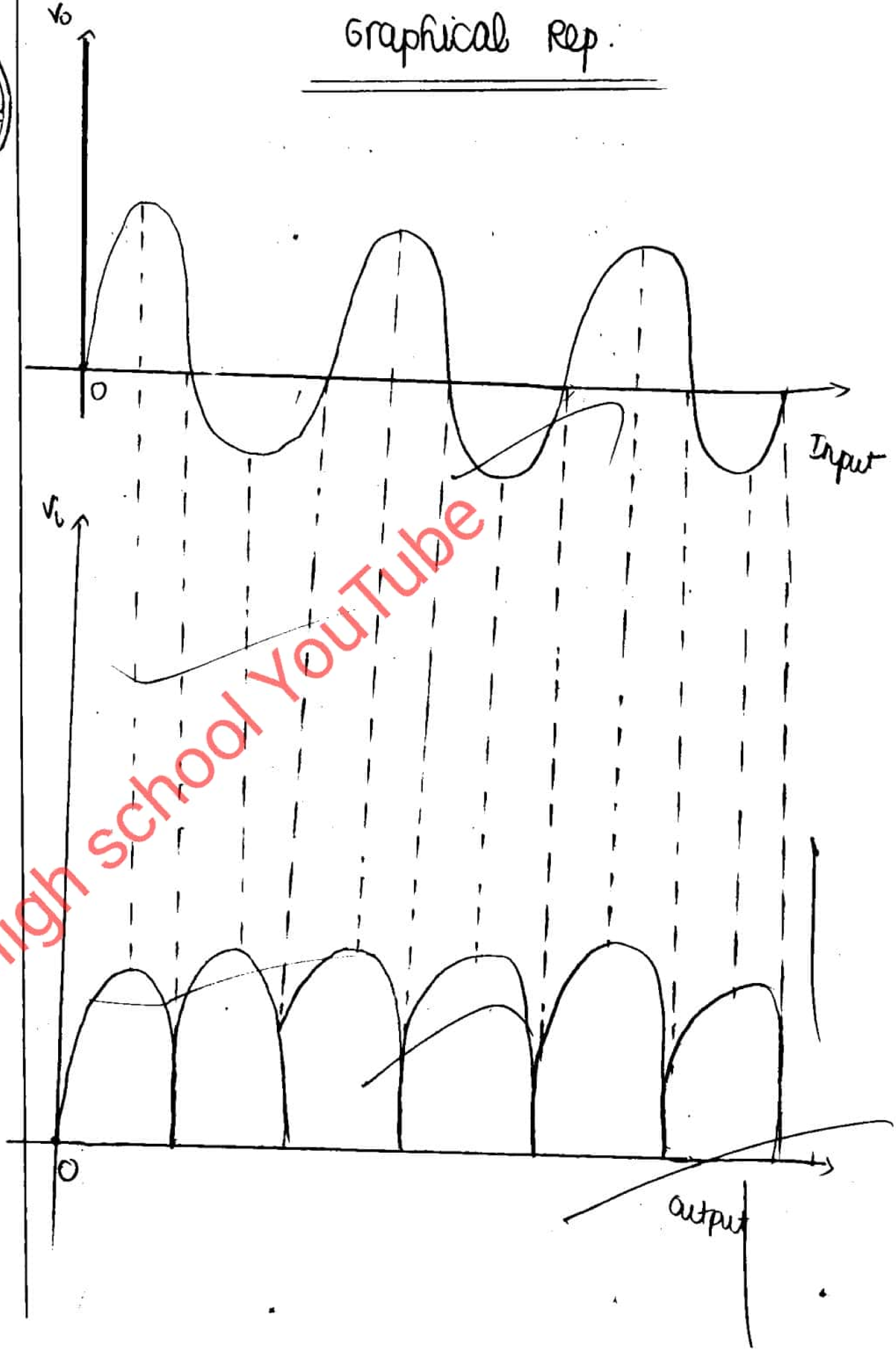
Graphical Rep.



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- With the help of the central tap transformer, each of the diodes rectify the both cycles to DC.

During Positive half cycle:

i) During the positive half cycle,

- The terminal M becomes positive and terminal N becomes negative
- The diode D_1 becomes forward biased
- It starts to conduct
- The diode D_2 becomes reverse biased.

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- The Diode D_1 ~~and D_2~~ conducts electricity along the path MD_1ABC.

During Negative half cycle :

i) The terminal N becomes positive and terminal M becomes negative.

ii) The Diode D_2 is forward biased

iii) It starts to conduct

iv) The Diode D_1 is reverse biased

v) The Diode D_2 conducts the electricity along the path ND_2ABC.

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- During both positive and negative half cycles, the direction of current through the load resistor R_L is same.

- Even though they are rectified they are still in pulsating nature and this can be corrected using the filter circuits

- Efficiency is the ratio of output DC to input AC

- The efficiency of Full wave Rectifier is 41.2%.

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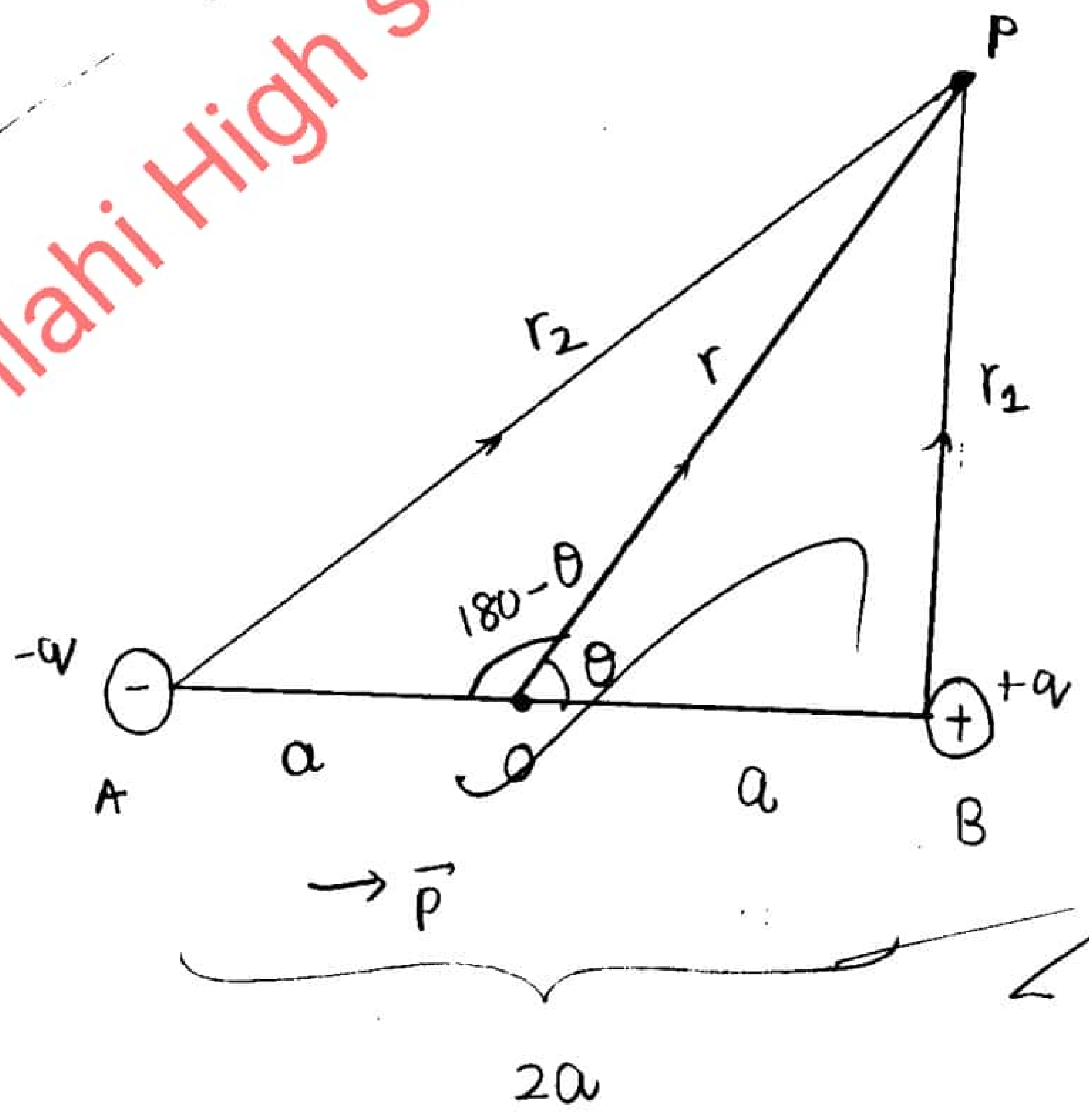
- It is more efficient ~~than~~ the half wave rectifier.

35. a)



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- Consider a dipole AB, with centre O, and the distance between them is 2a.

- Its dipole moment be $\vec{p}$.

- Let us consider a point P at a distance r from centre O.

- Potential at point P due to +q,

$$V_1 = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q}{r_1}$$

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- Potential at point P due to $-q$

$$V_2 = -\frac{1}{4\pi\varepsilon_0}\frac{q}{r_2}$$

$$V_1 + V_2 = \frac{1}{4\pi\varepsilon_0} \cdot q\left[\frac{1}{r_1} - \frac{1}{r_2}\right]$$

In Δ BOP, applying cosine law,

$$r_1^2 = r^2 + a^2 - 2ra\cos\theta$$

$$r_1^2 = r^2\left[1 + \frac{a^2}{r^2} - \frac{2a}{r}\cos\theta\right]$$

The term $\frac{a^2}{r^2}$ can be neglected as $a \ll r$,

$$\Rightarrow r_1^2 = r^2\left[1 - \frac{2a}{r}\cos\theta\right]$$

$$r_1 = r\left[1 - \frac{2a}{r}\cos\theta\right]^{1/2}$$

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$$\frac{1}{r_1} = \frac{1}{r}\left[1 - \frac{2a}{r}\cos\theta\right]^{-1/2}$$

Applying Binomial theorem. $\left(\frac{a}{r} << 1\right)$

$$\frac{1}{r_1} = \frac{1}{r}\left[1 + \frac{a}{r}\cos\theta\right].$$

Applying cosine law in ΔAOP

$$r_2^2 = r^2 + a^2 - 2ra\cos(180-\theta)$$

$$r_2^2 = r^2 + a^2 + 2ra\cos\theta$$

$$(\because \cos(180-\theta) = -\cos\theta).$$

$$\Rightarrow r_2^2 = r^2\left[1 + \frac{a^2}{r^2} + \frac{2a}{r}\cos\theta\right]$$

The term $\frac{a^2}{r^2}$ can be neglected as $a << r$.

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$$r_2^2 = r^2 \left[1 + \frac{2a}{r}\cos\theta\right]$$

$$r_2 = r\left[1 + \frac{2a}{r}\cos\theta\right]^{1/2}$$

$$\frac{1}{r_2} = \frac{1}{r}\left[1 + \frac{2a}{r}\cos\theta\right]^{-1/2}$$

Applying Binomial theorem,

$$\frac{1}{r_2} = \frac{1}{r}\left[1 - \frac{a}{r}\cos\theta\right]$$

Sub $\frac{1}{r_1}$ & $\frac{1}{r_2}$

$$\Rightarrow V = \frac{1}{4\pi\varepsilon_0} \cdot q \left[\frac{1}{r}\left[\cancel{1} + \frac{a}{r}\cos\theta - \cancel{1} + \frac{a}{r}\cos\theta\right]\right]$$

$$V = \frac{1}{4\pi\varepsilon_0} \cdot q\left[\frac{1}{r}\,\frac{2a}{r}\cos\theta\right]$$

$$V = \frac{1}{4\pi\varepsilon_0} \cdot \frac{(\overset{p}{2aq})\cos\theta}{r^2}$$

$(\because 2aq \cos\theta = \vec{p}\cdot\hat{r})$

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$$V = \frac{1}{4\pi\varepsilon_0} \cdot \frac{p\cos\theta}{r^2}$$

$$V = \frac{1}{4\pi\varepsilon_0} \cdot \frac{\vec{p}\cdot\hat{r}}{r^2} \quad (\because \vec{p}\cdot\hat{r} = p\cos\theta)$$

CASES :

i) If the point P is placed on the side of +q, $\theta = 0°$

$$\Rightarrow V = \frac{1}{4\pi\varepsilon_0} \cdot \frac{p}{r^2}$$

ii) If the point p is placed on the side of -q, $\theta = 180°$

$$\Rightarrow V = -\frac{1}{4\pi\varepsilon_0} \cdot \frac{p}{r^2}$$

iii) If the point p is placed at equatorial, $\theta = 90° \Rightarrow V = 0$.

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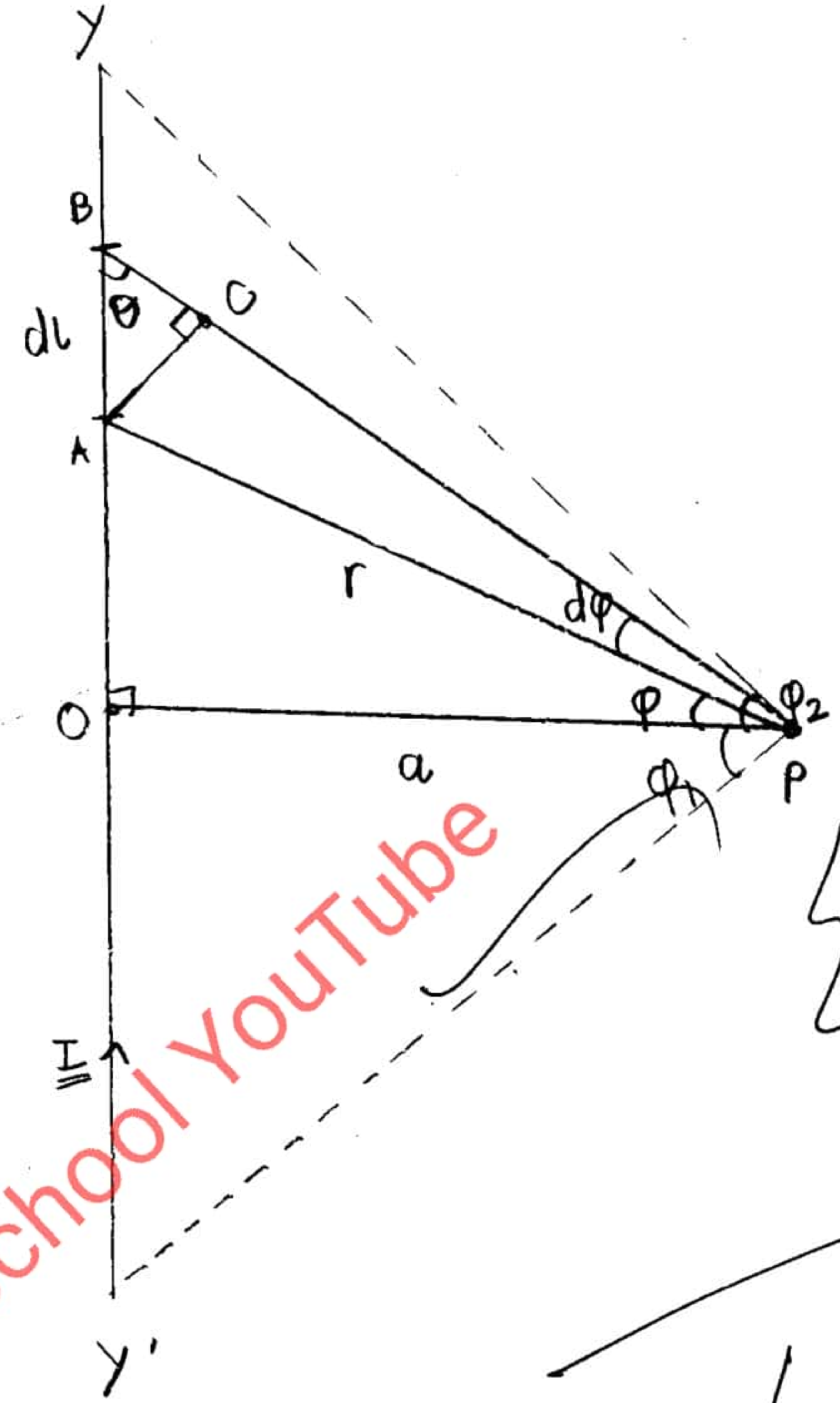
36. (a)



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- consider an infinitely long straight YY' with a current I flowing through it

- To calculate the magnetic field at point P at a distance a from the centre O. let us consider a line element dl of AB in the conductor.

- The magnetic field at a ~~point~~ P,

$$\Rightarrow \vec{dB} = \cancel{\frac{1}{4\pi\varepsilon_0}} \frac{\mu_0}{4\pi} \frac{I\, dl \sin\theta}{\cancel{r^2}} \hat{n}$$

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Here $\hat{n}$ is the unit vector pointing perpendicular to the plane of paper.

- By using geometry, we construct a a line $AC \perp BP$.

In ΔABC, $\sin\theta = \frac{AC}{dl}$

$$dl = \frac{AC}{\sin\theta}$$

$$AC = dl \sin\theta.$$

- Let the angle between AP & PC be $d\varphi$

$$\sin(d\varphi) = \frac{AC}{r}$$

$\sin(d\varphi) \simeq d\varphi$ ($\because$ the angle is very small.)

$\Rightarrow AC = r\,d\phi$

Sub $r\,d\phi$ in place of $dl \sin\theta$

$$\Rightarrow \vec{dB} = \frac{\mu_0}{4\pi} \cdot \frac{I\,r\,d\phi}{r^2}\,\hat{n}$$

$$\vec{dB} = \frac{\mu_0}{4\pi} \cdot \frac{I\,d\phi}{r}\,\hat{n}$$

In Δ OPA,

$$\cos\phi = \frac{a}{r}$$

$$\Rightarrow r = \frac{a}{\cos\phi}$$

$$\Rightarrow \vec{dB} = \frac{\mu_0}{4\pi}\,\frac{I\,d\phi}{\frac{a}{\cos\phi}}\,\hat{n}$$

$$\Rightarrow \vec{dB} = \frac{\mu_0}{4\pi} \cdot \frac{I\cos\phi\,d\phi}{a}\,\hat{n}$$

$$\vec{dB} = \frac{\mu_0 I}{4\pi} \cos\varphi \, d\varphi \, \hat{n}$$

$$\vec{B} = \int_{-\varphi_1}^{\varphi_2} d\vec{B} = \int_{-\varphi_1}^{\varphi_2} \frac{\mu_0 I}{4\pi a} \cos\varphi \, d\varphi \, \hat{n}$$

$$= \frac{\mu_0 I}{4\pi a} \int_{-\varphi_1}^{\varphi_2} \cos\varphi \, d\varphi \, \hat{n}$$

$$= \frac{\mu_0 I}{4\pi a} [\sin\varphi]_{-\varphi_1}^{\varphi_2} \hat{n}$$

$$\Rightarrow \vec{B} = \frac{\mu_0 I}{4\pi a} [\sin\varphi_1 + \sin\varphi_2] \hat{n}$$

For a infinitely long straight conductors,

$\varphi_1 = \varphi_2 = 90$

$$\Rightarrow \vec{B} = \frac{\mu_0 I}{4\pi a} \cdot 2 \, \hat{n} = \boxed{\frac{\mu_0 I}{2\pi a}} \hat{n}.$$

37. b). When a white light is split into its constituent colours (violet to Red) it forms a spectrum.

- The patterns of colour is arranged in definite patterns. This is called as spectrum.
- The spectrum consists of different wavelength and frequencies of different colour.

EMISSION ~~TYP~~ SPECTRUM :

- When a source of self luminous is taken, we get emission spectrum.
- Each source has characteristic emission spectrum.
- Types of emission spectrum :

i) Continous emission spectrum / (Continous spectrum)
ii) Line emission spectrum (line spectrum)
iii) Band emission spectrum (Band spectrum).

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CONTINUOUS SPECTRUM :

- When the light from the incandescent source (self luminous) is taken we get ~~line~~ continous emission spectrum. This continous spectrum has all the possible colours of different wavelength and frequencies. This spectrum is also produced by hot bodies.

Eg : Spectrum from carbon arc, incandescent solids etc...,

LINE SPECTRUM :

- When a hot gas is passed through the prism (simplest spectroscope), the spectrum obtained is line spectrum. The line emission spectrum has sharp lines of definite wavelength and frequency. Such spectrum are due to the excited atoms of elements. Such spectrum is the characteristic of each atom. and different atoms produce different line spectrum.

Eg: spectrum of atomic hydrogen, helium etc...,

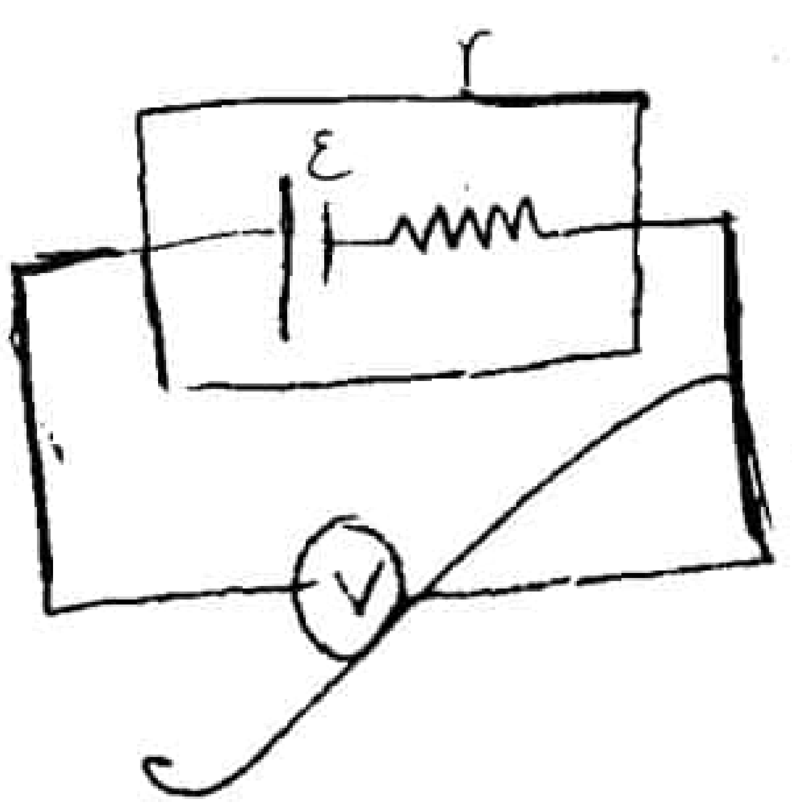
BAND SPECTRUM:

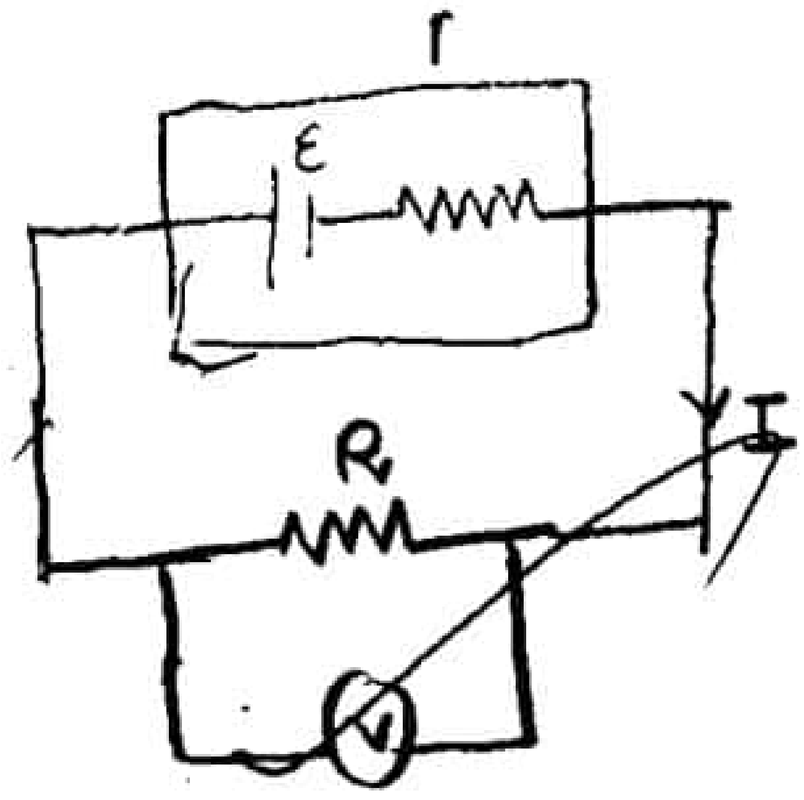
Band spectrum consists of group of definite lines which are grouped into bands and they have dark space inbetween them.

- They fade out from one end to other end.
- They are exhibited by the excited molecules
- They are the characteristics of molecules and used to study the structure of molecules.

Eg: spectrum obtained from ammonia gas etc...,

38. b)





- The voltmeter is used to measure the potential difference.

- When the voltmeter is connected to a cell, and without any external resistance shows the emf of the cell.

- If the external resistance (R) is added, then the voltmeter reads a value V which is less than the emf [current I established in the circuit]

- The potential drop across the resistor R,

$\Rightarrow V = IR \Rightarrow$ (1)

- The ~~emf~~ pot. diff of the cell.

$V = \varepsilon - Ir$ (Ir is the internal resistance.

$Ir = \varepsilon - V \Rightarrow$ (2)

$Ir =$

$Ir = \varepsilon - V$

$IR = V$

Dividing eqn. ⓐ & ②

$$\Rightarrow \frac{Ir}{IR} = \frac{\varepsilon - V}{V}$$

$$\frac{r}{R} = \frac{\varepsilon - V}{V}$$

$$r = \left[\frac{\varepsilon - V}{V}\right] R$$

This is the internal resistance of the cell, which opposes the current through the cell.

$$P = I\varepsilon$$

$$P = I(V + Ir)$$

$$P = I(IR + Ir)$$

$$P = I^2R + I^2r.$$

A freshly prep. battery has low internal resistance and increases with aging.

Hence we can find the power using int. resistance.

Prepared By

M.Abbas Manthiri

B sc,B.ed,M.A,M.Phil

B.T Assistant

Cell : 8940968432

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