

केन्द्रीय माध्यमिक शिक्षा बोर्ड, दिल्ली  
सीनियर स्कूल सर्टिफिकेट परीक्षा (कक्षा बारहवीं)  
परीक्षार्थी प्रवेश-पत्र के अनुसार भरें

विषय Subject : PHYSICS

विषय कोड Subject Code : 042

परीक्षा का दिन एवं तिथि Day & Date of the Examination : WEDNESDAY, 15.03.2017

उत्तर देने का माध्यम Medium of answering the paper : ENGLISH

प्रश्न पत्र के ऊपर लिखे कोड को दर्शाएँ : Write code No. as written on the top of the question paper : 55/3

Code Number	Set Number
55/3	① ② ③ ④

अतिरिक्त उत्तर-पुस्तिका (ओं) की संख्या No. of supplementary answer -book(s) used : 3

विकलांग व्यक्ति : हाँ / नहीं Person with Disabilities : Yes / No : NO

किसी शारीरिक अक्षमता से प्रभावित हो तो संबंधित वर्ग में ✓ का निशान लगाएँ। If physically challenged, tick the category

B	D	H	S	C	A
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B = दृष्टिहीन, D = मूँछ व वयिर, H = शारीरिक रूप से विकलांग, S = स्पास्टिक  
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क्या लेखन - लिपिक उपलब्ध करवाया गया : हाँ / नहीं Whether writer provided : Yes / No : NO

यदि दृष्टिहीन हैं तो उपयोग में लाए गये सोफ्टवेर का नाम : If Visually challenged, name of software used : NO

\*एक खाने में एक अक्षर लिखें। नाम के प्रत्येक भाग के बीच एक खाना रिक्त छोड़ दें। यदि परीक्षार्थी का नाम 24 अक्षरों से अधिक है, तो केवल नाम के प्रथम 24 अक्षर ही लिखें।

Each letter be written in one box and one box be left blank between each part of the name. In case Candidate's Name exceeds 24 letters, write first 24 letters.

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## Section A

Angle of minimum deviation represented by  $\delta_m$ . The refractive index of the material of the prism is given by

$$n = \frac{\sin [A + \delta_m]}{\sin A}$$

For a small prism, the deviation produced for deviating :  $n = \frac{A + \delta_m}{A}$

$$\therefore \frac{1}{2}$$

$$D = \frac{A + \delta_m}{A}$$

$$DA = A + \delta_m$$

$$\delta_m = nC D - DA$$

$\delta_m$  depends on  $n-1$  for a constant value of  $A$

$$\delta_m = (D-1)A, \text{ now } \frac{1}{\lambda} \propto A.$$

$$\lambda_v < \lambda_s \text{ and so } n_v > n_s$$

Refractive index of the material of the beam is greater for violet. So for violet light,  $(n-1)$  is greater so  $\theta_m$  is greater violet replaced by red,  $(n-1)$  decreases and angle of minimum deviation is also decreased.

The quantum nature of electromagnetic radiation is shown by the phenomenon of photoelectric effect.

3. When current & increasing magnetic flux linked with the two coils also increases. The  $\vec{B}$  due to the current element in 2 is into the plane and 1 is out of the plane. Since flux increases direction of induced current is opp such that the  $\vec{B}$  due to it is opposite to the original flux. So the induced current in the loop 1 is in clockwise direction and 2 is in anticlockwise direction.

4. Electric and magnetic field vectors are perpendicular to the direction of propagation of the wave.

4

The electric field vector is along positive y-axis and the magnetic field is oscillating along the positive z axis. So that  $(E^1 \times B^1) = E B^1$ . The wave is propagating along the +ve x axis.

5

I is same in both

when I constant

The heat produced in ferret

$$H = I^2 R +$$

$$H \propto R$$

$R \propto f$  so  $f$  is higher for nichrome

so  $R$  is higher for nichrome.

More heat is produced in nichrome wire.

### Section-B

6

Making a permanent magnet

Usually steel is used for making the permanent magnet. Because the material used

shows  
residual high resistivity  
high coercivity  
intensity magnetism

for making electromagnets.

Soft iron core is mainly used for making an electromagnet because of the following properties.

high permeability  
less area of the covered by steel loop  
in order to minimize the energy loss  
high resistivity  
low coercivity

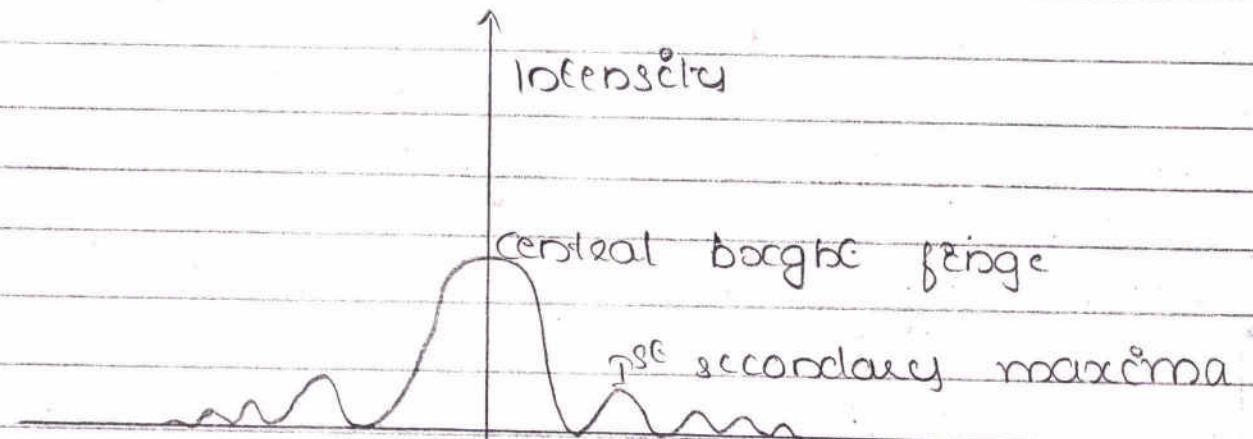
Maximize the relative permeability of the material should be very high in order to permit more magnetic field lines to pass through them

7. Intensity pattern of single slit diffraction

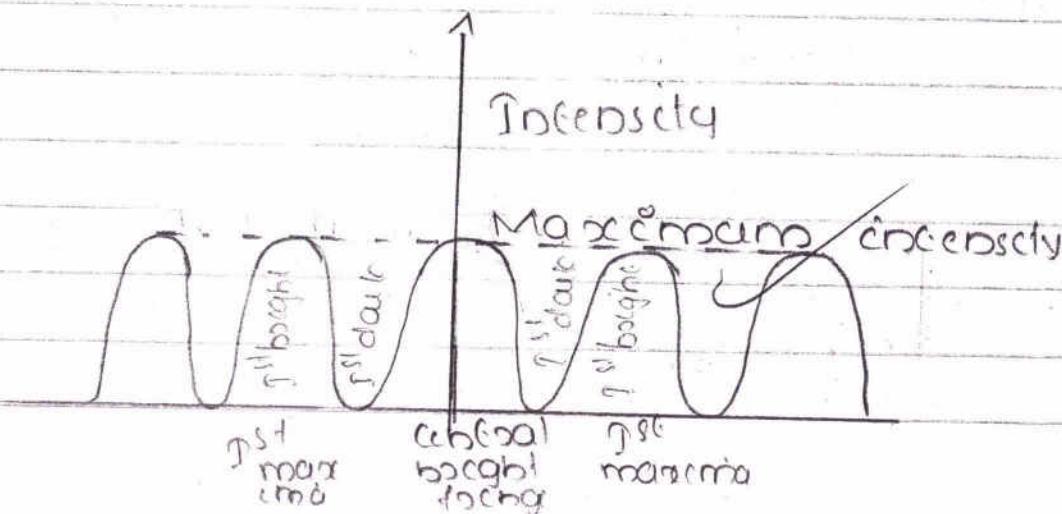
The central bright fringe has the maximum intensity and the intensity decreases as we move on to the either sides of the central



maximum.



Intensity pattern for double slit interference.  
All the bright fringes possess the same intensity



### Inference

All the bright fringes are of equal intensity

All b

All bright fringes are of equal width

Maxima occurs at

$$\theta_n = \frac{n\lambda}{d}$$

Good contrast between bright and dark fringes

### Diffraction

The principal maxima possesses the highest intensity and the intensity decreases as we move on to either sides from the principal maxima

The width of fringe also increases from principal maxima to either sides.

Minima occurs at

$$\theta_n = \frac{(n+1)\lambda}{d}$$

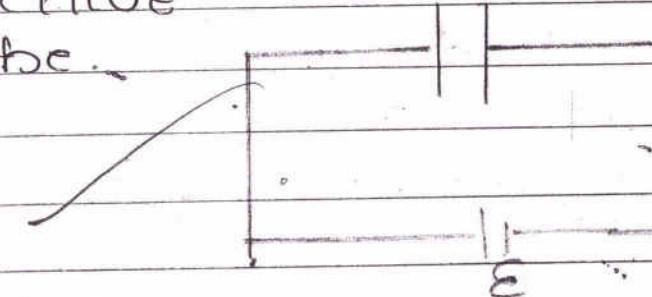
Poor contrast between bright and dark fringes

8

8. A battery always supply a dc current  
 But the capacitive reactance of the capacitor



$$X_C = \frac{1}{C\omega}$$



For d.c

$$f=0$$

$$X_C = \frac{1}{C \times 2\pi f}$$

$$X_C = \frac{1}{0}$$

$$X_C = \infty$$

A capacitor always block dc current if a steady state has a constant value if  $I$  is constant  $f=0$  and current does not flow in a capacitor. However during charging and dc charging current suddenly increases or decreases. If a small emf causes a change in

flux. An emf is induced which causes an induced current. And also during charging and discharging capacitors shows oscillatory properties. So there is a variation in current for an instant of time. It is momentary. It lasts only for a short time. Due to the induced emf, a momentary current is set up.

$$q_0 : E_i = -13.6 \text{ eV}$$

$$E_c = -1.51 \text{ eV}$$

$$E_f = -3.4 \text{ eV}$$

change in energy =  $E_c - E_f = -1.51 \text{ eV} - (-3.4 \text{ eV})$   
~~=  $3.4 \text{ eV} - 1.51 \text{ eV}$~~   
~~=  $\underline{\underline{1.89 \text{ eV}}}$~~

$$h\nu = 1.89 \text{ eV}$$

$$h.c = 1.89 \times 1.6 \times 10^{19} \text{ J}$$

$$\lambda = \frac{hc}{\nu} = \frac{6.636 \times 10^{-34} \times 3 \times 10^8 \text{ m} \cdot \text{s}^{-1} \text{ kg} \cdot \text{m}^{-2} \text{ s}^{-1}}{1.89 \times 1.6 \times 10^{19} \text{ kg} \cdot \text{m}^2 \text{ s}^{-2}}$$

10

$$19.908 \times 10^{-26} \text{ m}$$

$$30.024 \times 10^1 \times 10^{-19}$$

$$6.636$$

$$19.908$$

$$5.189$$

$$1.18$$

$$+1.94$$

$$\frac{11.89}{30.24}$$

$$19.908 \times 10^{-26} \text{ m}$$

$$\times 3.024 \times 10^{-19}$$

$$= 6.58 \times 10^{-7} \text{ m}$$

$$= 6.58 \times 10^{-7} \text{ m}$$

$$302 \text{ nm}$$

It belongs to visible light and hence  
it belongs to Balmer series of Hydrogen  
spectrum

Since 658 nm belongs to 400 nm to  
700 nm.

10. A beam of charged particles move undeflected  
in the presence of crossed electric and magnetic fields when the net force acting on it is  
zero i.e.  $F_m = F_e$   
i.e.  $qVB \sin 90^\circ = qE$

$$VB\sin\theta = E$$

If crossed and the particle moves perpendicular to the both the fields, then  $\theta = 90^\circ$

$$\text{so } VB = E$$

$$V = \frac{E}{B}$$

The particles moving with a speed  $V = \frac{E}{B}$  or  $V = \frac{EB}{B}$  moves undeflected and it can be observed on the screen without any deflection. This principle is used for velocity selector. The particles moving with this velocity can be easily determined.

Section - C

## 12. Self inductance of a coil

When  $\epsilon$ 

$$\epsilon = -L \frac{dI}{dt}$$



$$-L \frac{dI}{dt}$$

mm

Self inductance of a coil or coefficient of self inductance  $L$  is defined as the emf induced across a coil when the current in the coil is changing at the rate of  $1 \text{ A/s}$ .

$$\text{i.e. } |\epsilon| = L \frac{dI}{dt}$$

$$L = \frac{|\epsilon|}{dI/dt}$$

when  $\frac{dI}{dt} = 1 \text{ A/s}$

$$L = \underline{\underline{\epsilon}}$$

It is called as Henry.

Consider the coil of inductance  $L$ . A back-emf  $-\epsilon - L \frac{dI}{dt}$  is set up in the coil against the current

provided by the source. If the current need to be flow through the coil work has to be done against the coil, against the emf  $\epsilon = L \frac{dI}{dt}$

$$\begin{aligned} \text{So } dW &= Pdt \\ &= \epsilon I dt \\ &= L \frac{dI}{dt} \cdot dI + \cancel{xT} \\ &= L dI \times I \end{aligned}$$

$$dW = L dI \times I$$

The total work done is

$$\int_0^{I_0} dW = \int_0^{I_0} L dI \times I = \cancel{L} \int_0^{I_0} I dI$$

$$L \int_0^{I_0} I dI$$

$$L \frac{I_0^2}{2}$$

$$= \frac{1}{2} L I_0^2$$

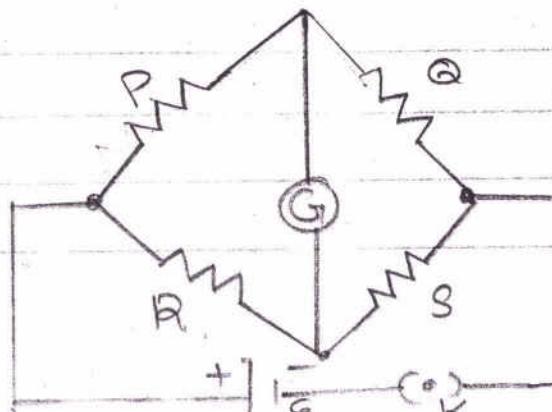
The work done  $\frac{1}{2}LI^2$  is stored as the magnetic potential energy in the circuit.

13. Principle of working of a meter bridge.

The principle is Wheatstone principle. If four resistances P, Q, R and S are connected in the Wheatstone bridge in the following manner, then at balanced condition, if current in the galvanometer is zero, the

$$\frac{P}{Q} = \frac{R}{S}$$

The unknown resistance can be found.



(b)

If AB is taken as 100cm  
In the balanced condition,

$$\frac{R}{s} = \frac{l_1}{100-l_1} \Rightarrow R = \frac{l_1 \times s}{100-l_1}$$

Now s changes to

$$s' = \frac{s \times x}{s+x}$$

$$\text{so } \frac{R}{s'} = \frac{l_2}{100-l_2}$$

$$\text{ie } R \frac{(s+x)}{sx} = \frac{l_2}{100-l_2}$$

$$\text{so } \frac{l_1 s' [s+x]}{(100-l_1) sx} = \frac{l_2}{100-l_2}$$

$$\frac{l_1 [s+x]}{x[100-l_1]} = \frac{l_2}{100-l_2}$$

$$\underline{l_1 s + l_1 x} = \underline{l_2}$$

$$100x - xl_1 \quad 100 - l_2$$

~~$$(l_1 s + l_1 x)(100 - l_2) = l_2(100x - xl_1)$$~~

~~$$100l_1 s - l_1 l_2 s + l_1 x 100 - l_1 l_2 x = l_2 100x - xl_1 l_2$$~~

~~$$x = \frac{100l_1 s - l_1 l_2 s + 100l_1}{100l_2}$$~~

$$100l_1 x - 100l_2 x = l_1 l_2 s - 100l_1 s$$

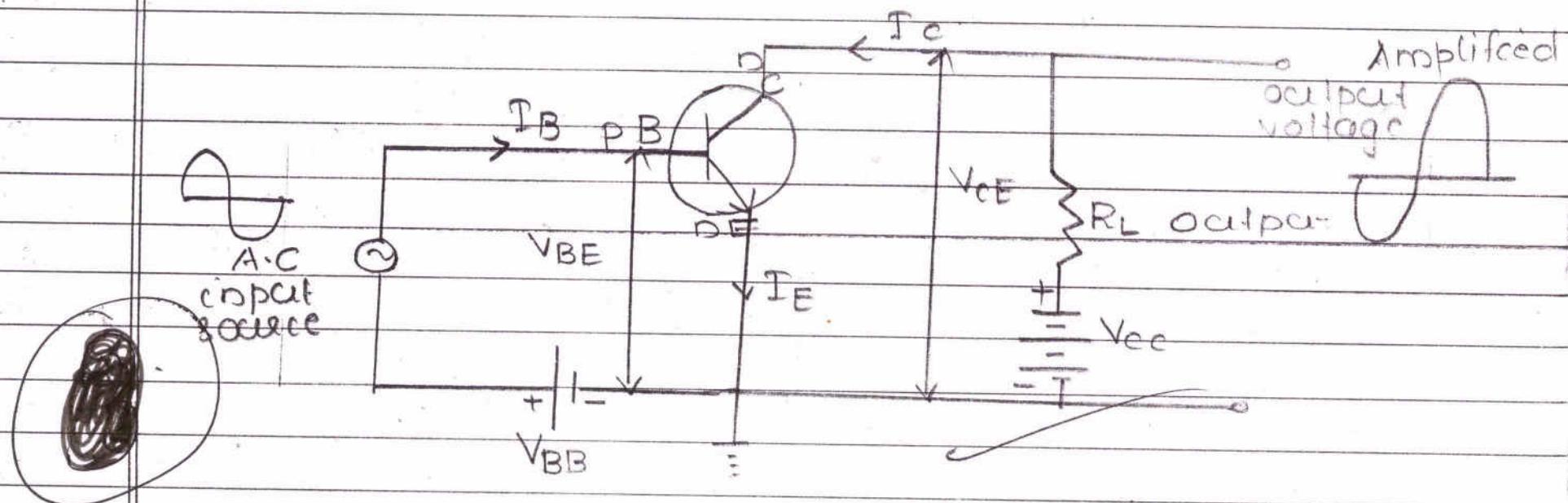
$$x[100l_1 - 100l_2] = l_1 l_2 s - 100l_1 s$$

~~$$x = l_1 l_2 s - 100l_1 s$$~~

~~$$100[l_1 - l_2]$$~~

14. n-p-n transistor amplifier in common emitter configuration.

(a)



(b)

We know by using Krichhoff's law

$$V_{CE} = V_{CC} - I_C R_L$$

Voltage gain of an amplifier is defined as the ratio of small change in  $V_{CE}$  to the small change in  $V_{BE}$  i.e.  $A_V = \frac{\Delta V_{CE}}{\Delta V_{BE}}$

To the output circuit

$$V_{CE} = V_{CC} - I_C R_L$$

$$\Delta V_{CC} = 0$$

$$\Delta V_{CE} = 0 - R_L \times \Delta I_C$$

$$\Delta V_{CE} = -R_L \cdot \underline{\Delta I_C}$$

when  $V_i$  is superimposed with  $V_{BE}$

$$V_i + V_{BE} = V_i + I_b (R + R_{in})$$

$$\Delta V_{BE} = \Delta I_b (\underline{\gamma_{in}})$$

$$\Delta V_{BE} = \Delta I_b \cdot \underline{\gamma_{in}}$$

$$\text{so } A_v = \frac{\Delta V_{CE}}{\Delta V_{BE}} = -R_L \cdot \underline{\Delta I_C} = -\frac{\Delta I_C \cdot R_L}{\Delta I_b \cdot \underline{\gamma_{in}}}$$

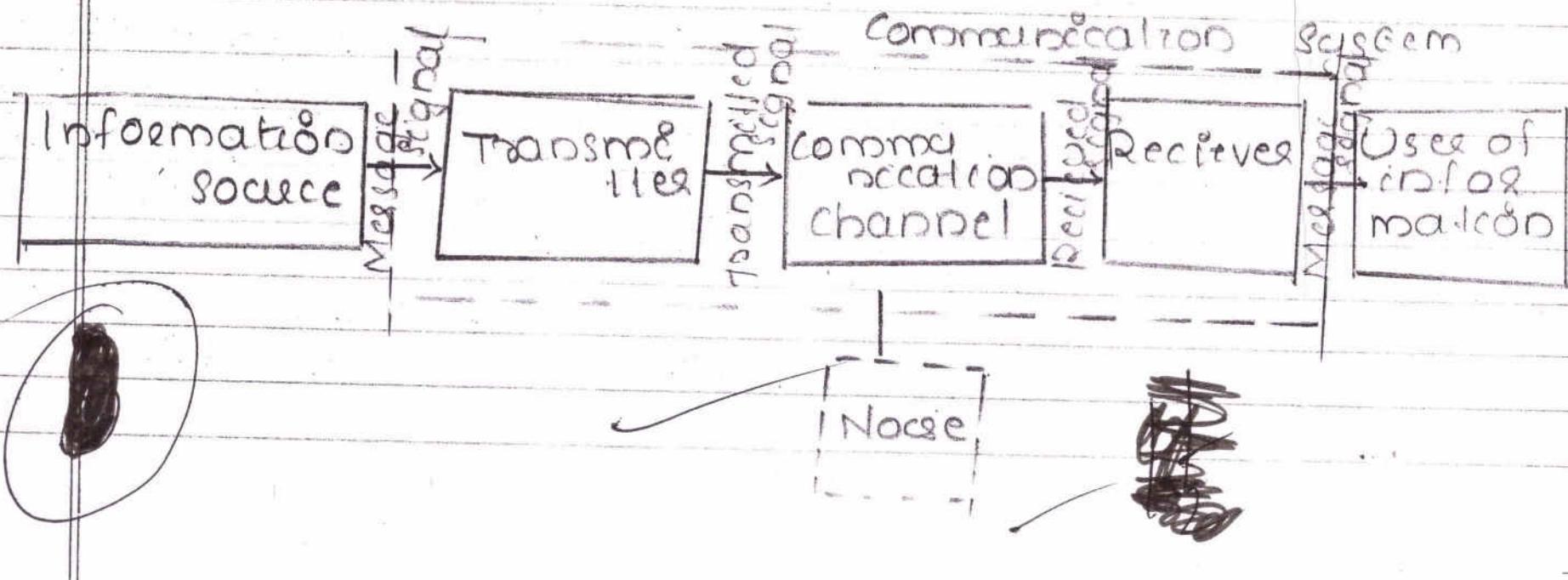
$$= -\beta_{ac} \cdot \underline{\frac{R_L}{\gamma_{in}}}$$

$$A_v = -B_{ac} \cdot \frac{R_L}{Z_{in}}$$

The negative sign shows that the output phase is in opposite phase with the input voltage.

16.

## Communication systems



(a) Transmitter

A transmitter converts the received message signal and transmits it into a suitable form so that it can easily pass through the communication channels transmission medium.

(b) channel

A channel or transmission medium is the physical medium or contact between the transmitter and receiver through which the transmitted message signal reaches the receiver. It can be coaxial cables.

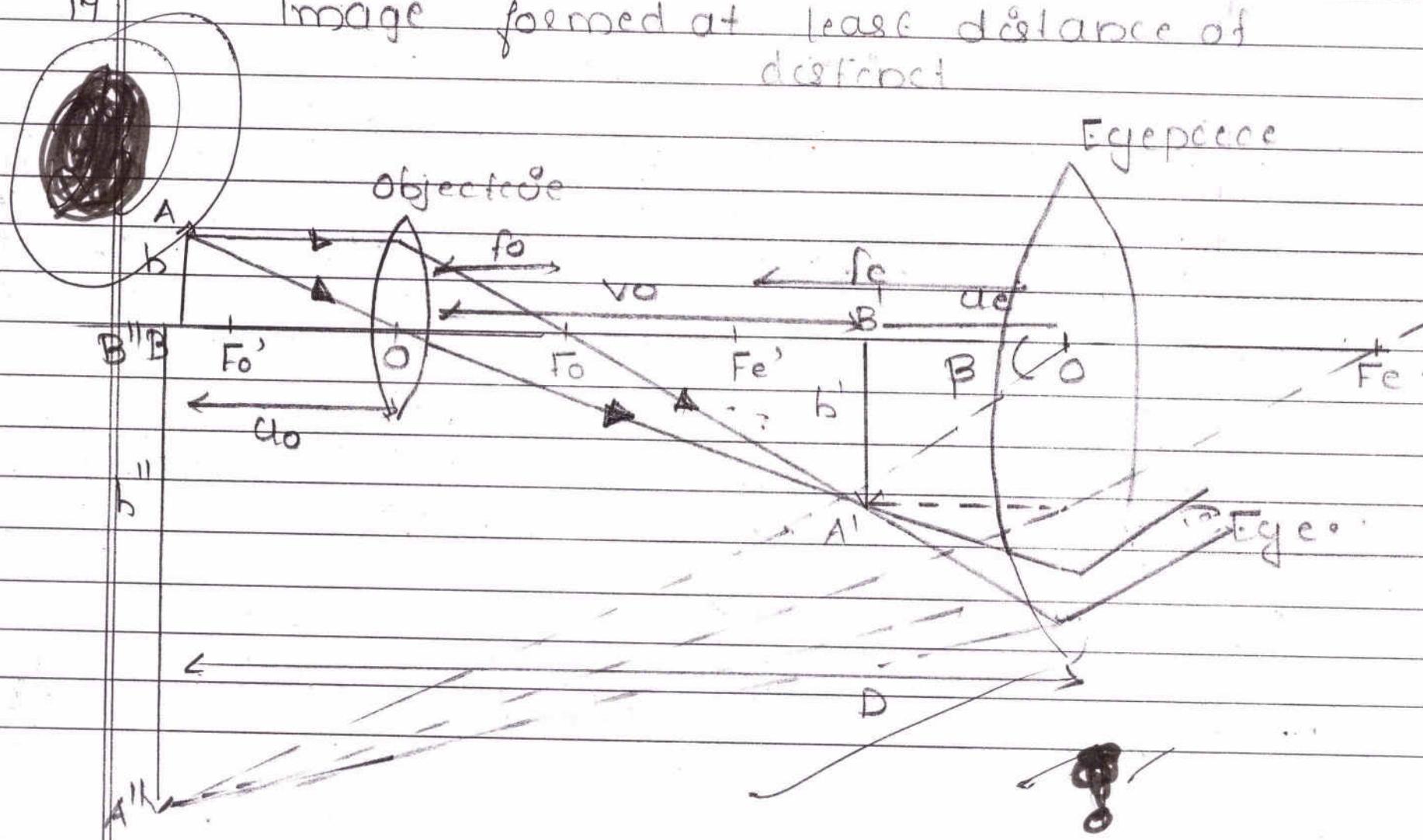
(c) Receiver

A receiver receives the transmitted signal and converts it into the original message signal to be given to the user of information.

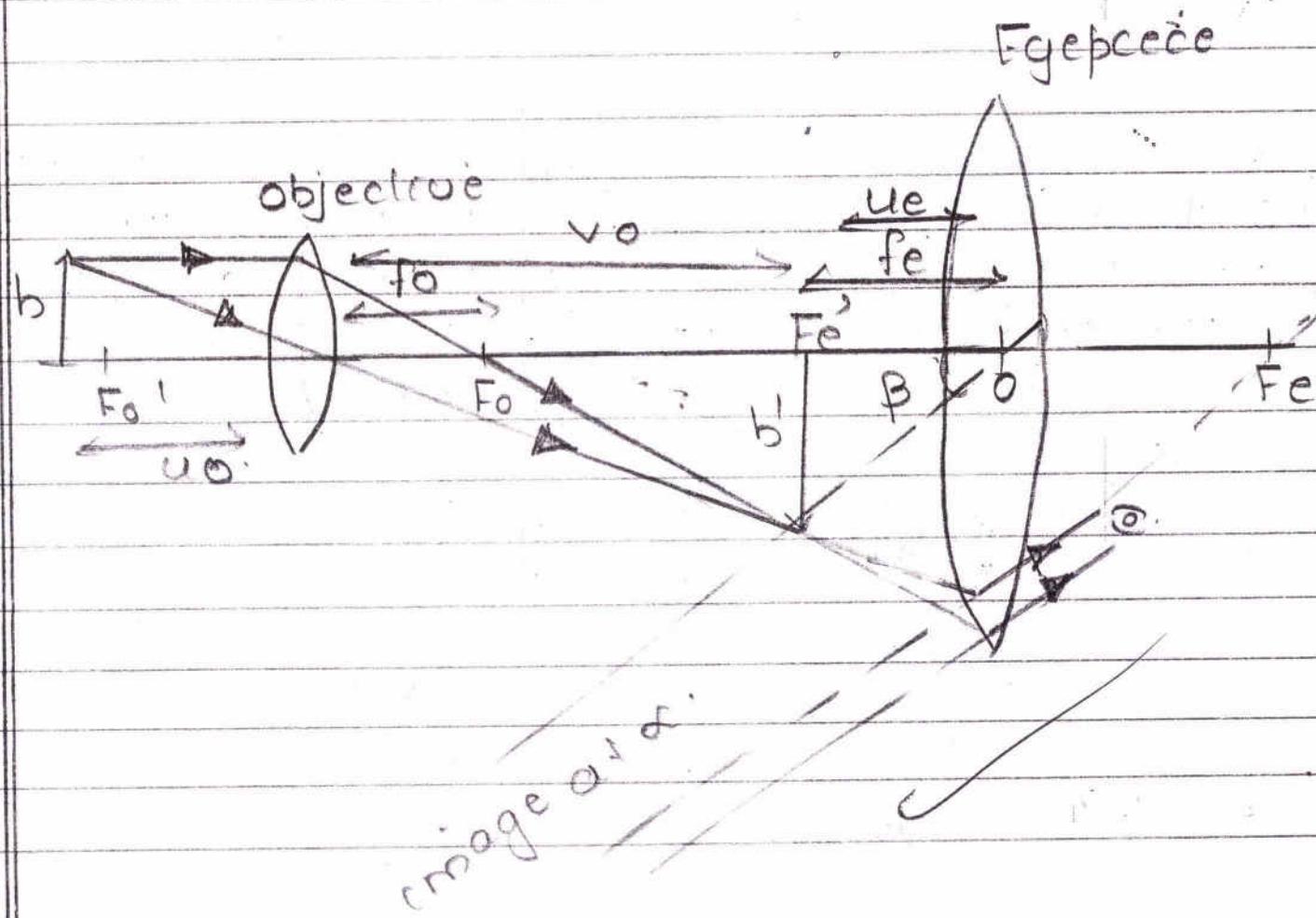
It separates the basic message signal and give it to the user of information.

14

Image formed at least distance of distinct



(b) Image formed at infinity



(b) Focal lengths are

$$L_1 = \frac{1}{3} = 0.33 \text{ cm } 33 \text{ cm}$$

$$L_2 = \frac{1}{6} = 16.66 \text{ cm}$$

$$L_3 = \frac{1}{10} = 10 \text{ cm}$$

The two lenses with short focal lengths are used. So  $L_2$  and  $L_3$  are used.  $L_1$  is used as the eyepiece and  $L_3$  is used as the objective. The objective should have small focal length and aperture as compared to the eyepiece.

(c) The resolving power of a microscope,

$$R.P. = \frac{f}{d} = 1.2 \text{ Msrno}$$

$$R.P. \propto Msrno$$

$$R.P. \propto l$$

The resolving power is inversely proportional to

$R.P. \propto R.c.s.e.a$   
refractive index of  
the material of  
the objective  
lens

the wavelength of light used.

Resolving power of a microscope is defined as the ~~shortest~~ reciprocal of the minimum distance  $d$  between the two objects at which the images of the two objects can be seen distinct when seen through the microscope.

### (22) Biot - Savart Law

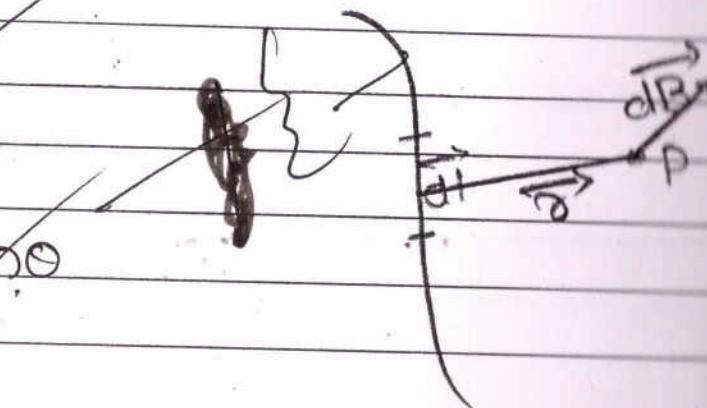
Biot - Savart's Law states that the magnetic field due to a current element  $dI$  at a distance  $r$  from it is given by

$$dB' \propto dB \propto I \quad dB \propto dI \quad dB \propto \text{sin} \theta$$

$$dB \propto \frac{1}{r^2}$$

$$dB \propto \frac{I dL \sin \theta}{r^2}$$

$$dB = \frac{\mu_0 I dL \sin \theta}{4\pi r^2}$$

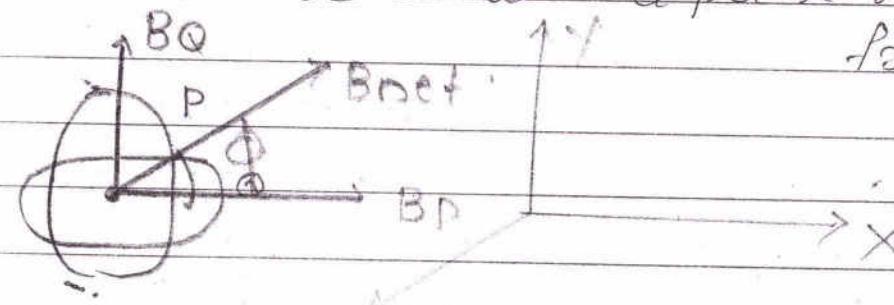


In vector form

$$d\vec{B} = \frac{\mu_0}{4\pi} I \underline{\cancel{r}} (\vec{dr} \times \vec{r})$$

Biot Savart's law gives the magnetic field due to a current element at a particular distance from it.

(b)



The magnetic field due to the coil P at the centre

$$B_p = \frac{\mu_0 I}{2R} = \frac{\mu_0}{2R}$$

$$B_Q = \frac{\mu_0 I}{2R} = \frac{\mu_0 \times \sqrt{3}}{2R} = \frac{\sqrt{3} \mu_0}{2R}$$

$$\begin{aligned} B_{net} &= \sqrt{B_p^2 + B_Q^2} = \sqrt{\frac{\mu_0^2}{4R^2} + \frac{3\mu_0^2}{4R^2}} = \sqrt{\frac{4\mu_0^2}{4R^2}} \\ &= \frac{2\mu_0}{2R} = \frac{\mu_0}{R} \end{aligned}$$

The directions along  $B_{net}$  making  $45^\circ$

- ④  $60^\circ$  with the  $B_p$

$$\tan \phi = \frac{B_Q}{B_p} = \frac{\sqrt{3} M_0}{2R} \times \frac{2R}{M_0} = \frac{\sqrt{3}}{1}$$

$$\phi = 60^\circ$$

*in the plane of the two coils*

$B_{net}$  is making  $60^\circ$  with  $B_p$ , making  $30^\circ$  with  $B_Q$ . If reverse considered making  $30^\circ$  with  $B_Q$  and  $60^\circ$  with  $B_p$ . According to

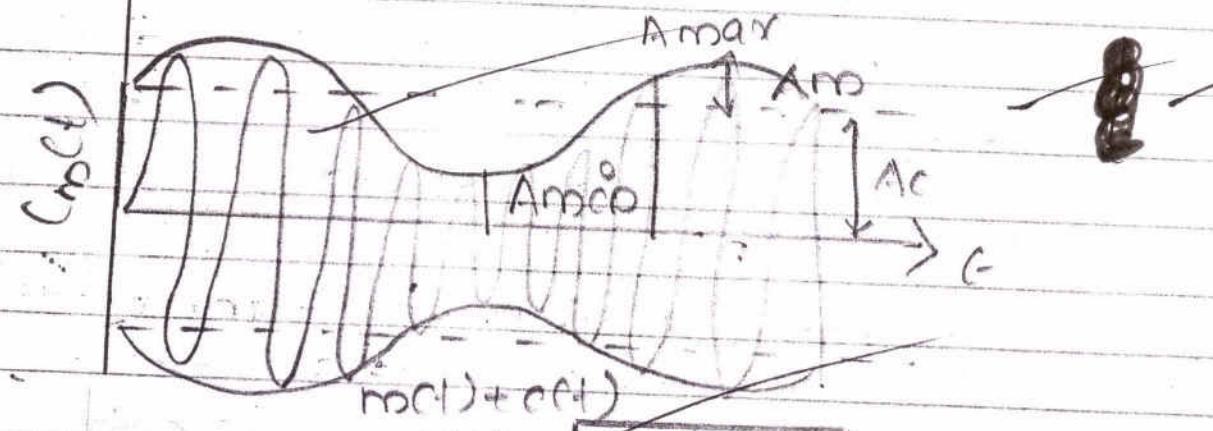
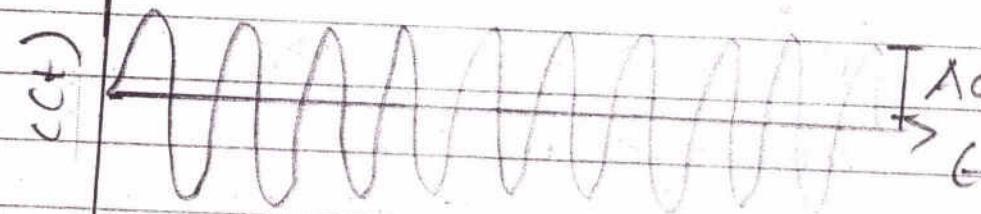
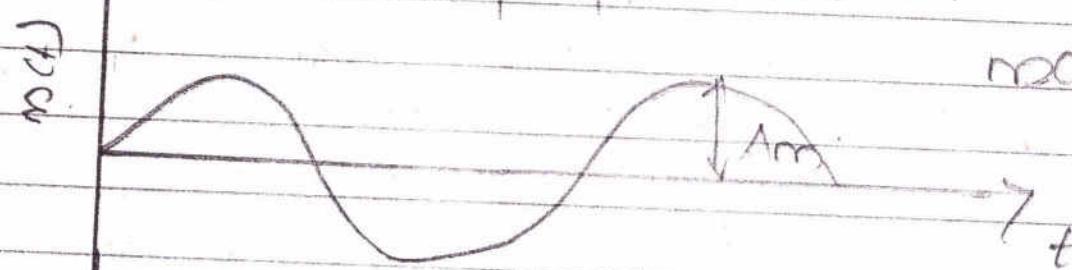
- 20) Amplitude modulation is achieved by superimposing a low frequency message signal with a high frequency carrier wave of frequency  $f_c$ .

In amplitude modulation, the amplitude of a high frequency carrier wave is varied in accordance with the instantaneous values of low frequency message signal.

(a)

# Superposition of

$mct(t)$  and  
 $cct(t)$



$$\overrightarrow{mct} \oplus \overrightarrow{x(t)} \uparrow cct$$

Square Law Device

$y(t)$

$$= B > cct(t) + C \dot{c}^{\infty} cct(t)$$

Bandpass AM  
wave  
filter  
demodulator  
L.D.  
D.C.

(b)  ~~$f_c + f_m$~~ 

$$f_c + f_m = 640 \text{ kHz}$$

$$f_c - f_m = 60 \text{ kHz}$$

$$f_c + f_m = 660 \text{ kHz} \quad \text{--- } ①$$

$$f_c - f_m = 640 \text{ kHz} \quad \text{--- } ②$$

Adding ① and ②

$$2f_c = 1300 \text{ kHz}$$

$$f_c = \frac{1300}{2} = 650 \text{ kHz}$$

Carrier  
signal

$$f_c + f_m = 660 \text{ kHz}$$

$$f_m = 50 \text{ kHz}$$

Modulating  
signal frequency

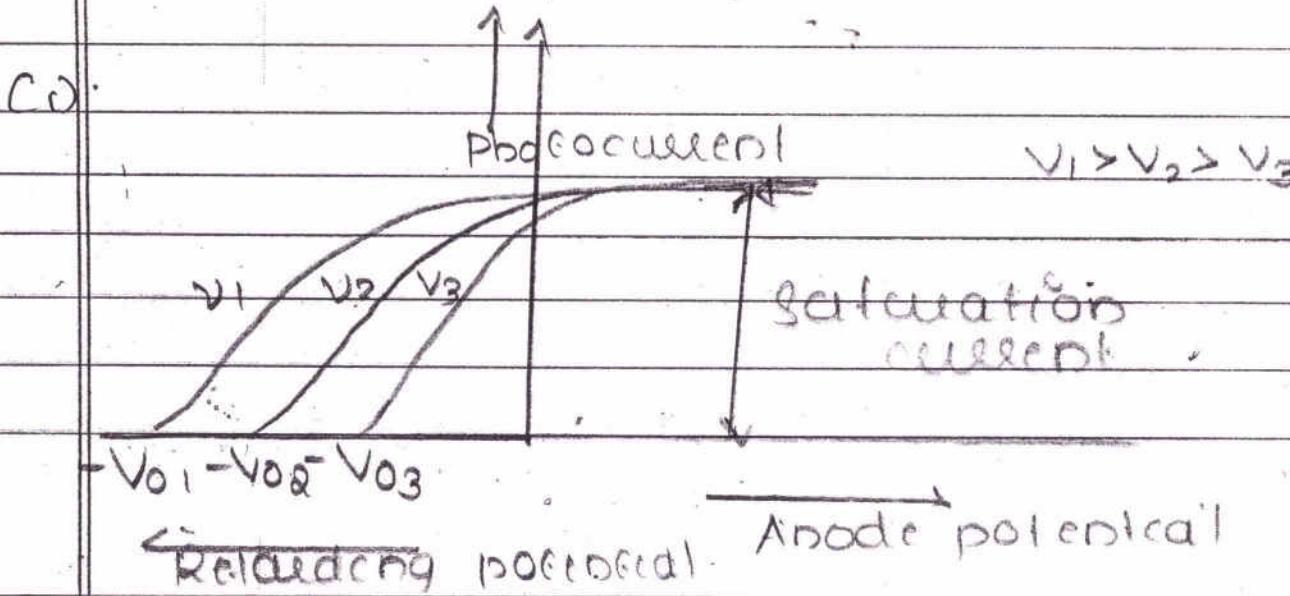
$$f_c + f_m - (f_c - f_m) = \text{Bandwidth}$$

$$= 660 \text{ kHz} - 640 \text{ kHz}$$

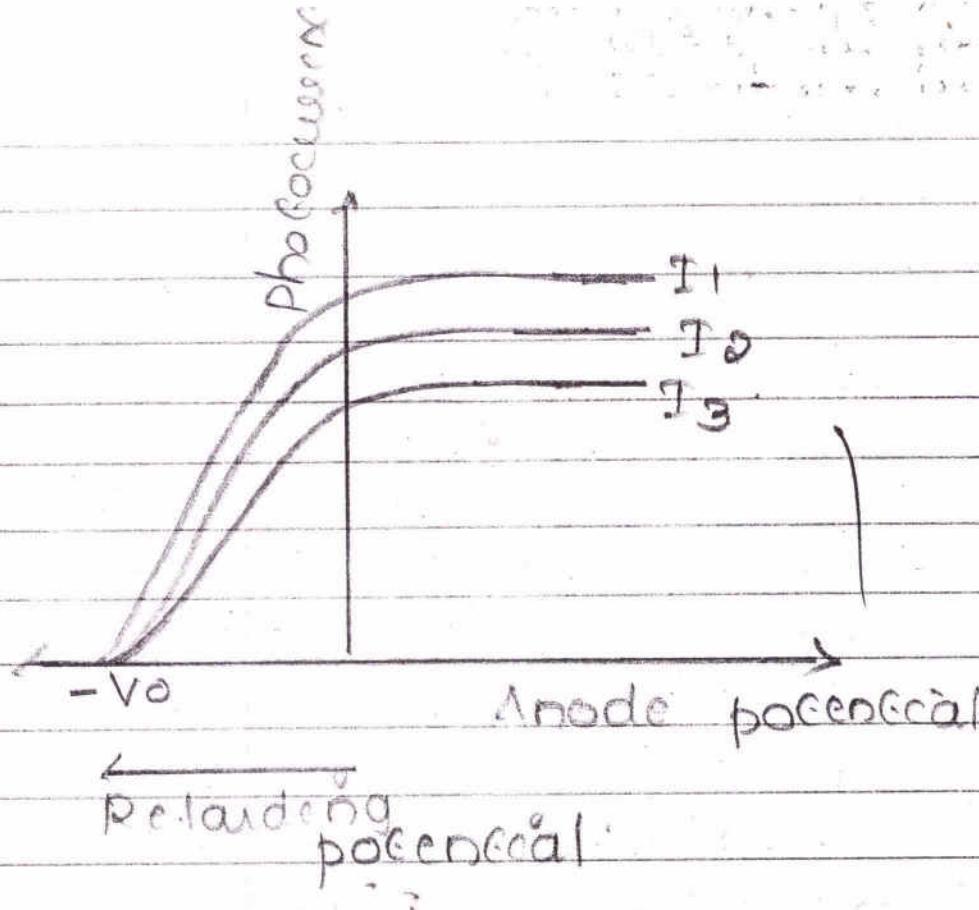
$$\underline{\underline{20 \text{ kHz}}}$$

- 18<sup>a</sup> The cascade x is collector plate potential or  
 Anode potential. On the other side, it is retarding potential.

- b) The point A represents stopping potential or cut off potential. The maximum negative potential at which the photocurrent becomes zero.



(cd)



15(a) Heat per second  $\propto \frac{V^2}{R}$

Initially  $H_1 = \frac{V_1^2}{R}$  The R is fixed.

Then  $H_2 = q H_1 = q \frac{V_2^2}{R} = 8 \cdot \frac{V_2^2}{R} = \frac{(3V_1)^2}{R}$

The potential difference is increased by a factor of 3.

$$(b) V = \mathcal{E} - I\gamma$$

$$\text{Total current} = \frac{\text{Total emf}}{\text{Total resistance}}$$

$$= \frac{12}{6}$$

$$= 2A$$

$$= \frac{12}{8} = 2A$$

The ammeter reading is 2A

The voltmeter reading is  $V = \mathcal{E} - I\gamma$

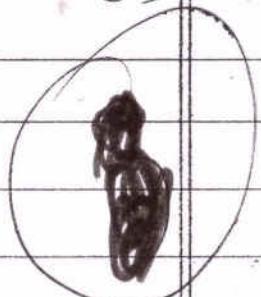
$$= 12 - 2 \times 2$$

$$= 12 - 4$$

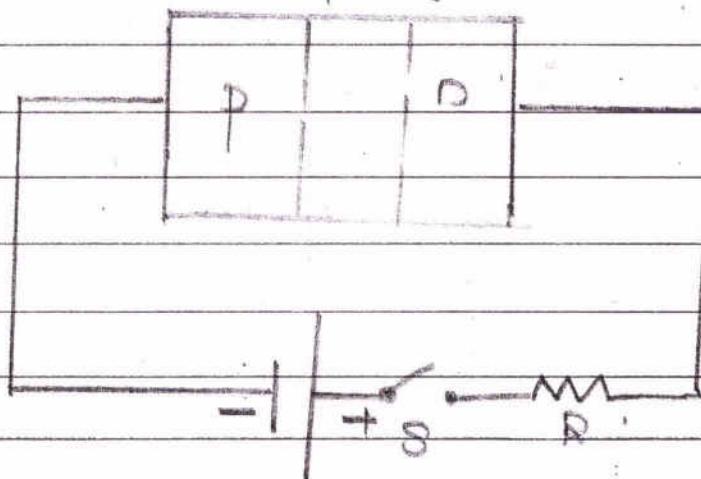
$$= 8V$$

Q1.

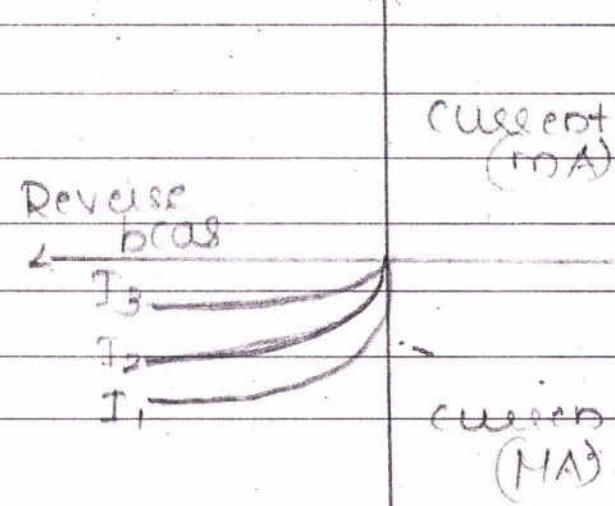
(b) Photodiode



~~Kondensator~~



2017



$$I_1 > I_2 > I_3$$

{ अपना अनुक्रमांक इस उत्तर-पुस्तिका  
पर न लिखें

Please do not write your

Roll Number on this Answer-Book

अतिरिक्त उत्तर-पुस्तिका (ओं) की संख्या.....  
Supplementary Answer-Book(s) No.....

In photodiode, the p-n junction diode is reverse biased. The bias voltage is kept below the reverse breakdown voltage. When the photons are incident on the p-n junction diode the electron hole pairs are generated. electrons move towards the n side and holes move towards the p-side under the influence of an external electric field directed from n to p. A potential difference is set up across the junction and the photocurrent begins to flow through the current. The photocurrent is directly proportional to the intensity.

(a)

When it is heated, the temperature increases, the resistivity decreases. The resistance of the circuit decreases. So more current tends to flow. In order to keep the current value as

congans the resistance R should be increased

so R is increased to keep the ammeter reading as constant.

19.

Initially;



$$C_A^o = \frac{\epsilon_0 A}{d} = c \cdot V_0$$

$$C_B^o = \frac{\epsilon_0 A}{d} = c \cdot V_0$$

Later

$$C_A = K C_A^o = Kc$$

$$C_B = Kc$$

Total electrostatic energy

Before dielectric

$$\text{Q} \frac{1}{2} C_A V_A^2 + \frac{1}{2} C_B V_B^2$$

$$\frac{1}{2} L C V^2 + \frac{1}{2} C V^2$$

$$x 2 \times \frac{1}{2} C V^2 = \underline{\underline{C V^2}}$$

After across A

$$\frac{1}{2} L C_A V^2$$

$$\frac{1}{2} L K C X V^2 = K \times \frac{1}{2} C V^2$$

across B  $\frac{1}{2} C_B V_{\text{new}}^2$

$$\frac{1}{2} C_B \times \frac{V_0^2}{K^2} = \frac{1}{2} L K C \times \frac{V_0^2}{K^2}$$

$$\frac{1}{2} C V^2 = \frac{1}{2} C V^2$$

Total energy

$$\text{after insertion} = KCV^2 + \frac{CV^2}{2K}$$

$$\cancel{\frac{CV^2}{2} \left[ K + \frac{1}{K} \right]}$$

$$\checkmark \frac{CV^2}{2} \left[ \frac{K^2 + 1}{K} \right]$$

$$\text{Ratio is } \frac{CV^2 \times 2K}{CV^2(K^2 + 1)}$$

$$= \frac{2K}{K^2 + 1}$$

## Section-D

23. (a) The constellation at Chernobyl was a nuclear reactor. In a nuclear reactor, nuclear fission or nuclear reaction takes place. Large amount of energy is released by this process. The large amount of energy may cause any sort of explosion. The neutrons are produced in the process and are also used. Some penetrating radiations are emitted by this process.

(b) The bonding energies on the both sides of reaction and products are different. In this process, a heavier nucleus disintegrates into two lighter nuclei with higher bonding energy. These nuclei are stable as compared to the original. So a large amount of energy is

~~is released. The change in binding energy is released as the energy.~~

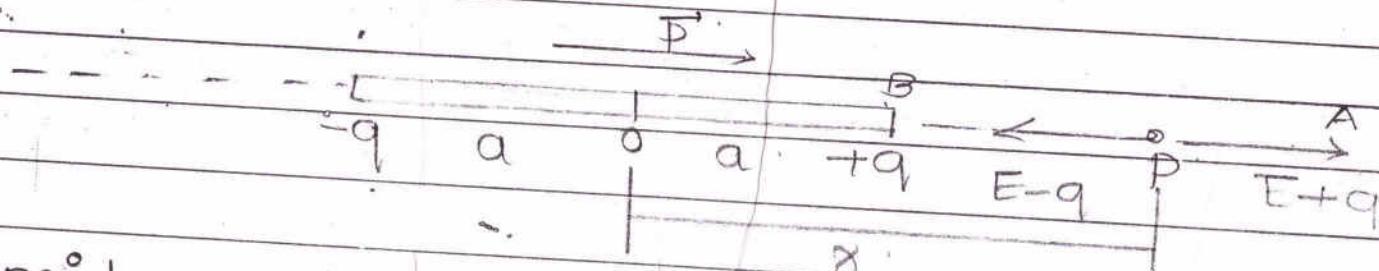
In nuclear fission, the two lighter nuclei combine together to form a heavier nuclei. Here binding energy is decreased increased and a large amount of energy is released.

- (ii) Asha is very caring. Very sensitive, handles Physics very carefully, have much and deep knowledge. She is practical and kindhearted. She is generous and wise.

26 a)



### Secton-E



Consider a dipole having dipole moment  $P$ . Electric field due to  $-q$  at the point  $P$  is along  $PB$ .

$$E = \frac{1}{4\pi\epsilon_0} \frac{q}{(x+a)^2} \text{ along } PB$$

Electric field due to  $+q$  at the point  $P$  is along  $PA$ .

$$E = \frac{1}{4\pi\epsilon_0} \frac{q}{(x-a)^2} \text{ along } PA$$

The net electric field

$$= E_q - E_{-q}$$

$$= \frac{1}{4\pi\epsilon_0} \frac{q}{(r-a)^2} - \frac{1}{4\pi\epsilon_0} \frac{q}{(r+a)^2}$$

$$\frac{q}{4\pi\epsilon_0} \left[ \frac{1}{(r-a)^2} - \frac{1}{(r+a)^2} \right]$$

$$\frac{q}{4\pi\epsilon_0} \left[ \frac{(r+a)^2 - (r-a)^2}{(r^2 - a^2)^2} \right]$$

$$\frac{q}{4\pi\epsilon_0} \frac{4ra^2}{(r^2 - a^2)^2}$$

$$\frac{qa^2}{4\pi\epsilon_0 (r^2 - a^2)^2}$$

& P along PA.

0902

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Electric field at point P is

$$E = \frac{1}{4\pi\epsilon_0} \frac{2P\alpha}{(6^2 - a^2)^2} \text{ in the direction of } \vec{P}$$

$$\vec{E} = \frac{1}{4\pi\epsilon_0} \frac{2\vec{P}\alpha}{(6^2 - a^2)^2}$$

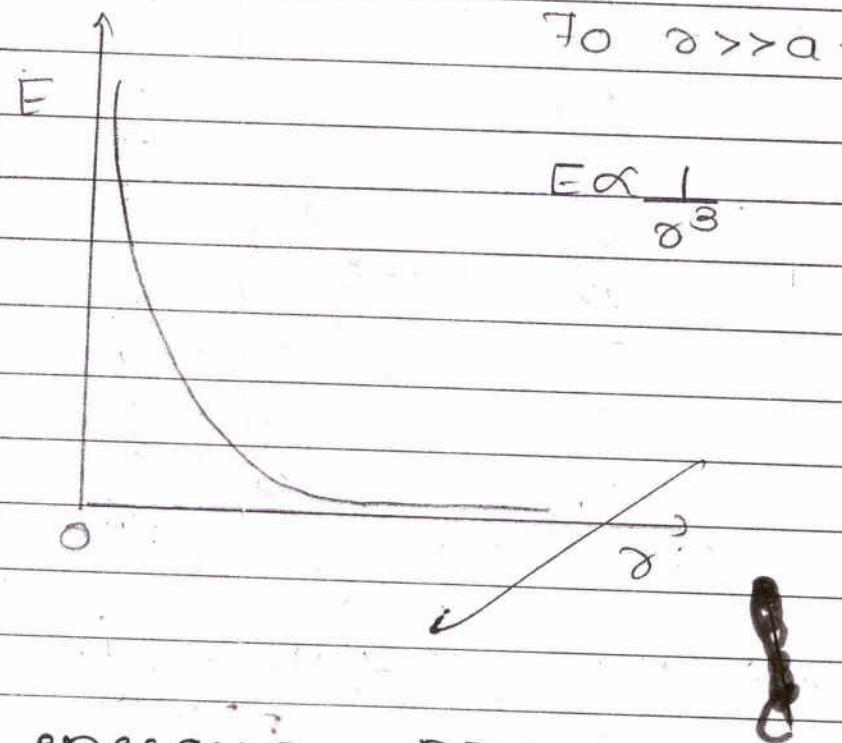
Qb) For  $\alpha \gg a$

$$E = \frac{1}{4\pi\epsilon_0} \frac{2P\alpha}{a^4}$$

~~$$= \frac{1}{4\pi\epsilon_0} \frac{2P}{a^3}$$~~

$$E \propto \frac{1}{a^3}$$

2



c) When  $\theta = 0$

$$\text{energy} = -PE$$

$$\text{Torque} = 0$$

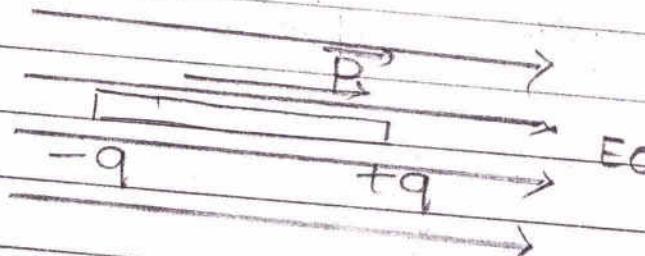
If it's stable equilibrium

When dipole is in stable equilibrium

potential  
energy

$$P \cdot E = -PE$$

$$\text{Torque} = 0$$



The dipole is placed parallel to the electric field.

In unstable equilibrium

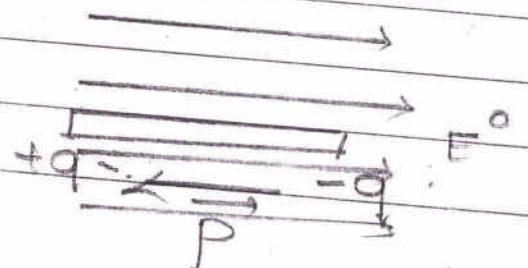
$$\theta = 180^\circ$$

$$\mathbf{P} \cdot \mathbf{E} = -PE \cos 180^\circ$$

$$= -PE \times -1$$

$$= PE$$

Potential energy is maximum



The dipole is placed antiparallel to the field  
Torque

$$\tau = p \times E$$

$$PESCO$$

$$\text{In I}^{\text{st}} \text{ case } \tau = PESCO$$

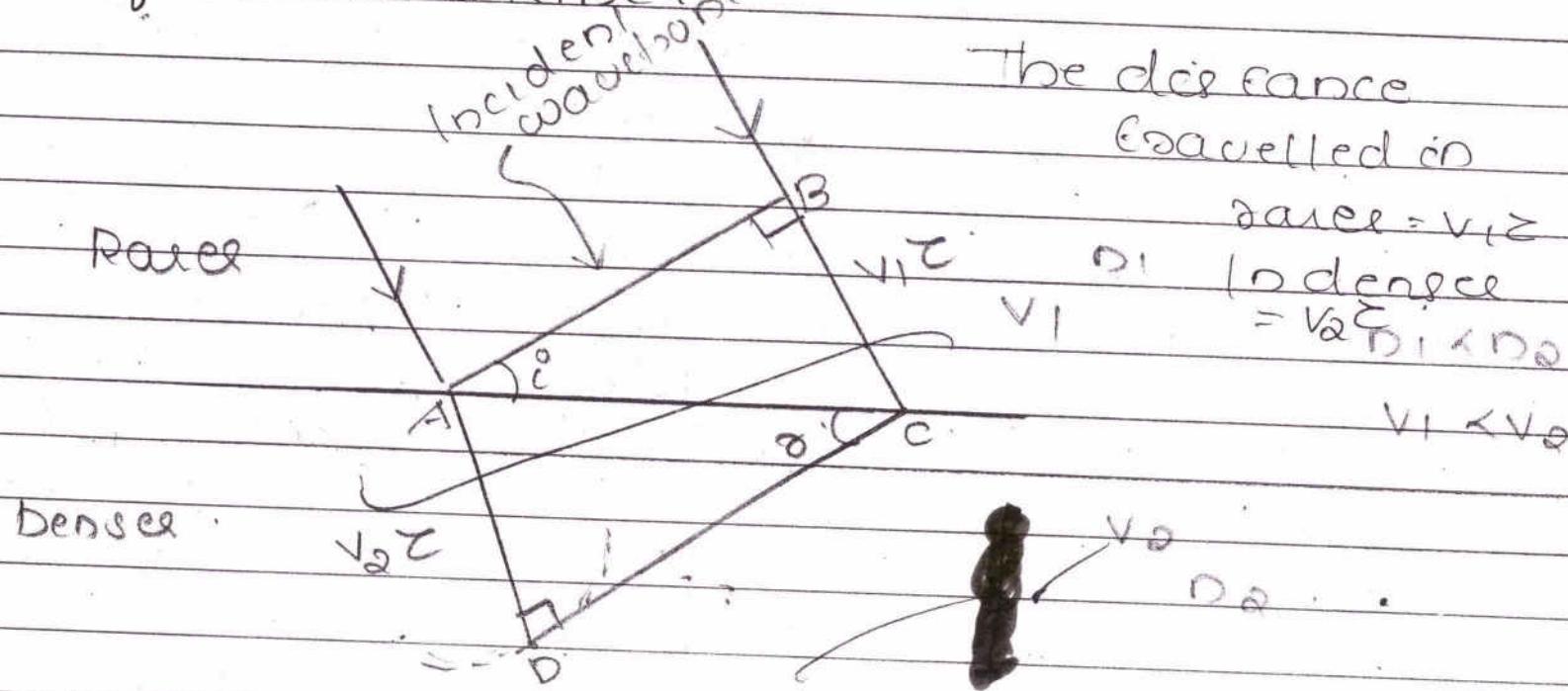
$$\text{In II}^{\text{nd}} \text{ case } \tau = \underline{\underline{PESCO}}_{180^\circ}$$

25(a) Waveszone: Waveszone is a surface having the locus of all points vibrating in the same phase. Waveszone is a surface of constant phase. The rays are always perpendicular to the waveszone.

Laygren's principle:

Each point on the waveszone is a source of secondary disturbance and the wavelets emanating from all the points spread out in all directions with the speed of the wave.

When we draw a common tangent to all these spheres, we obtain the new position of the wavefront at a time  $t$ .



$$\text{In } \triangle ABC, \frac{\sin i}{\sin \alpha} = \frac{BC}{AC} = \frac{v_1 c}{v_2 c} \quad \text{--- ①}$$

$$\text{In } \triangle ADC, \frac{\sin \alpha}{\sin \gamma} = \frac{AD}{AC} = \frac{v_2 c}{v_1 c} \quad \text{--- ②}$$

$$\text{①} \rightarrow \frac{\sin i}{\sin \alpha} = \frac{v_1 c \times AC}{v_2 c \times AC} = \frac{v_1}{v_2} = \frac{n_2}{n_1}$$

6

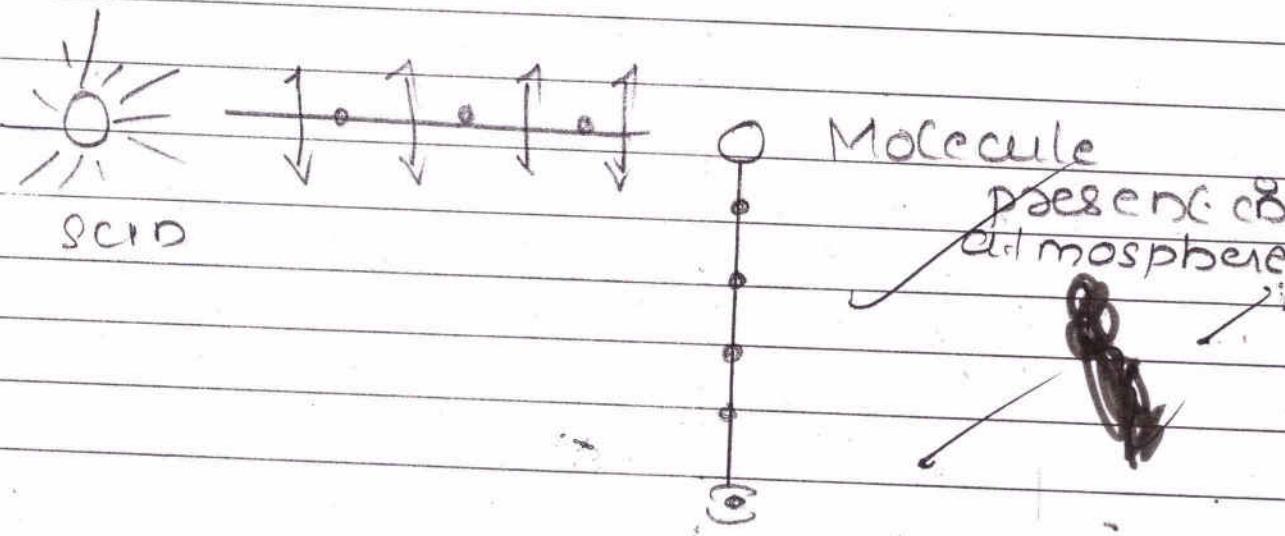
$$\frac{\sin i}{\sin r} = \frac{n_2}{n_1} = \frac{V_1}{V_2}$$

$$\frac{\sin i}{\sin r} = n_{21}$$

This is Snell's law.

Also the refracted ray makes the reflected ray and the normal at the point of incidence which are perpendicular to incident wave along reflected wave along and separating surface all lie on the same plane.

(b)



The sublight coming from the Sun is unpolarised, it concerns vibrations in perpendicular and parallel directions. The electrons which are present in the scattering molecule only allows the vibration parallel to the double headed arrow to radiate energy towards the observer. The perpendicular components are absorbed.

According to Brewster's law

$$\tan i_p = N$$

$$1.5 = \tan i_p$$

~~$$\tan i_p = 1.5$$~~

$$(P = \tan^{-1}(1.5))$$

$$n_g = 1.5$$

Q4. Consider a coil rotating in a uniform magnetic field. The flux associated with the coil

$$\Phi = NB \cos \theta$$

The emf induced due to the flux change.

$$-E = -\frac{d\Phi}{dt} = -\frac{d}{dt}(NB \cos \theta)$$

$$-NBA \frac{d(\cos\theta)}{dt}$$

But the coil consists of  $N$  turns and also  
 $\theta$  is a function of time  $\omega t$

$$\text{so } \epsilon = -NBA \frac{d(\cos\omega t)}{dt}$$

$$= NBA \times -Scn\omega t \times \omega$$

$$= NBA \omega \sin\omega t$$

$$\Rightarrow \epsilon_{\text{oscillant}}$$

$\epsilon = \epsilon_{\text{oscillant}}$  where  $\epsilon_0$  is the  
 maximum induced voltage or peak voltage

$$\epsilon_0 = NBA\omega$$

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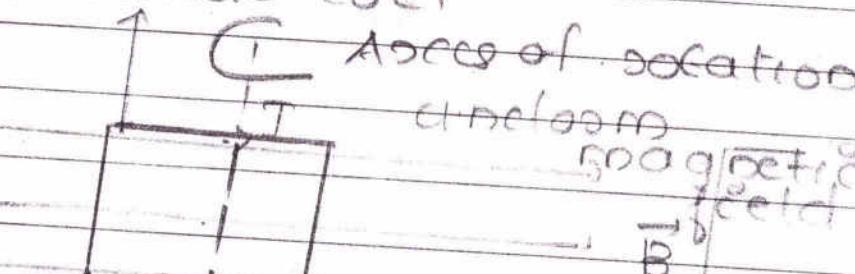
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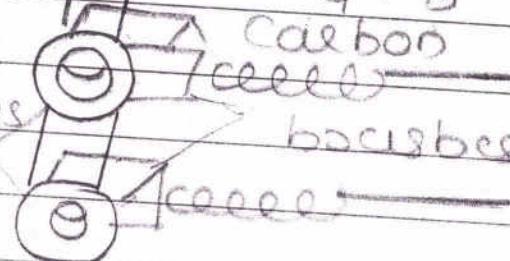
Ammeter coil



$$\phi = B A \cos \theta$$

$$\theta = \omega t$$

Slit  
screws



Output  
Alternating  
voltage

2

cb) The rod is moving perpendicular to the magnetic field

so

$$\epsilon = Blv$$

$$= 0.3 \times 10^4 \text{ Wb m}^{-2} \times 10 \text{ m} \times 5 \text{ ms}^{-1}$$

$$= 0.3 \times 10^4 \times 10 \times 5 \text{ V}$$

$$= 1.5 \times 10^3 \text{ V}$$

Section - C

11)

ii) Ca)

$$\lambda = 589 \text{ nm}$$

$$= 589 \times 10^{-9} \text{ m}$$

The frequency of the reflected light is same as that of the incident light so  $v = \frac{c}{\lambda}$

$$v = \frac{3 \times 10^8}{589 \times 10^{-9}} = \frac{3 \times 10^8}{0.589 \times 10^{-6}} = \frac{3 \times 10^{14}}{0.589} \text{ Hz}$$

$$= \frac{3 \times 10^{14} \text{ Hz}}{0.589} = 5.09 \times 10^{14} \text{ Hz}$$

Wavelength  $\lambda$

$$\lambda' = \frac{\lambda}{M}$$

$$= \frac{589 \times 10^{-9} \text{ m}}{1.33}$$

$$= \frac{5.89 \times 10^{-7} \text{ m}}{1.33} = 4.43 \times 10^{-7} \text{ m}$$

Speed is

$$\frac{C}{V} = M$$

$$\text{So } V = \frac{C}{M} = \frac{3 \times 10^8 \text{ m/s}}{1.33} = 2.25 \times 10^8 \text{ m/s}$$

$$(b) n = 1.55$$

$$R_1 = R \quad R_2 = -R$$

$$f = 20 \text{ cm}$$

4

According to lens-maker's formula

$$\frac{1}{f} = (n_2 - 1) \left[ \frac{1}{R_1} - \frac{1}{R_2} \right]$$

$$\frac{1}{0.2} = (1.55 - 1) \left[ \frac{1}{R_1} + \frac{1}{R_2} \right]$$

$$\frac{1}{0.2} = 0.55 \times \frac{2}{R}$$

$$\frac{1}{0.2} = \frac{1.1}{R}$$

$$R = 0.1 \times 0.2 \\ = 0.2 \text{ m}$$

$$= \underline{\underline{20 \text{ cm}}}$$

