8

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 : SATURDAY, 05/03/2016

उत्तर देने का माध्यम
Medium of answering the paper : ENGLISH

प्रश्न पत्र के ऊपर लिखे कोड को लिखें
Write code No. as written on the top of the question paper

Code Number	Set Number
55/1/S	● ② ③ ④

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

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

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

B D H S C A

B = दृष्टिहीन, D = मूक व बधिर, H = शारीरिक रूप से विकलांग, S = स्पास्टिक
C = डिस्लेक्सिक, A = ऑटिस्टिक
B = Visually impaired, D = Hearing Impaired, H = Physically Challanged
S = Spastic, C = Dyslexic, A = Autistic

क्या लेखक – लिपिक उपलब्ध करवाया गया : हाँ / नहीं
Whether writer provided : Yes / No —

यदि दृष्टिहीन है तो उपयोग में लाए गये सॉफ्टवेयर का नाम
If Visually challenged, name of software used : —

*एक खाने में एक अक्षर लिखें। नाम के प्रत्येक भाग के बीच एक खाना रिक्त छोड़ें। 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.

कार्यालय उपयोग के लिए
Space for office use

0409440
042/00390

3

ty, l→ length, A→ Area of cross section

(copper).

an area of Copper wire.

$= \frac{\pi}{3}$

rent and voltage $= \frac{\pi}{3}$.

SECTION-A

1) $R = \frac{\rho l}{A}$ $R \to$ Resistance, $\rho \to$ Resistivity, $l \to$ length, $A \to$ Area of cross section.

(Resistivity of Manganin) > (Resistivity of Copper)

$\rho_{mang} > \rho_{Cu}$

$R = \frac{\rho_{mang}\, l}{A_1}$ — ① $R = \frac{\rho_{Cu}\, l}{A_2}$ — ②

① ÷ ②

$\Rightarrow \left(\frac{\rho_{mang}}{\rho_{Cu}}\right) \times \left(\frac{A_2}{A_1}\right) = 1.$

$\Rightarrow \frac{\rho_{mang}}{\rho_{Cu}} = \frac{A_1}{A_2}$

$\because \rho_{mang} > \rho_{Cu}$, $\therefore A_1 > A_2$

$\therefore$ Area of Manganin wire is greater than area of Copper wire.

2) $\cos\phi = \frac{1}{2} \Rightarrow \phi = \cos^{-1}\left(\frac{1}{2}\right) = 60^\circ = \frac{\pi}{3}$

$\therefore$ phase difference between current and voltage $= \frac{\pi}{3}$.

3) When there exists a time varying electric field alone, there exists a displacement current, but no conduction current
Eg: Between the plates of a capacitor; when it is being charged.

4) P: NOT Gate
Q: OR Gate

5) Relaxation Time (τ): The average time elapsing between two successive collision of electron inside a conductor, under the application of an external electric field is called relaxation time. It is measured in seconds.

SECTION - B

6) The property by which electric field do not exist inside the cavity of a hollow conductor is called electrostatic shielding. This property is used to protect sensitive devices from getting damaged by the external electric field.

$$\lambda = \frac{6.626 \times 10^{-34}\ Js}{\sqrt{2 \times 9.1 \times 10^{-31} kg \times 120 \times 1.6 \times 10^{-19} J}} = \frac{6.626 \times 10^{-34}}{\sqrt{18.2 \times 1.6 \times 120 \times 10^{-50}}}$$

$$\Rightarrow \lambda = \frac{6.626 \times 10^{-34}}{\sqrt{1.82 \times 1.6 \times 1.2 \times 10^{-47}}} = \frac{6.626 \times 10^{-34}}{\sqrt{3.494} \times 10^{-47}}$$

$$\lambda = \frac{6.626 \times 10^{-34} \times 10^{24}}{5.911} = 1.121 \times 10^{-10}\ m$$

$$\therefore \lambda = 1.121 \text{Å}$$

9) (i) Transducer :- Converts one form of energy to other. In a communication system, it helps to convert variables like sound into electrical signals.

(ii) Repeater: This devices receivs the signal, amplifies it and then again retransmits it. It is used in places where signal strength has become very weak and cannot be transmitted further without energy losses. (information losses)

(10) Energy of ~~photon~~ $= \frac{hc}{\lambda}$, $h \rightarrow$ planck's constant, $c \rightarrow$ speed of light

$\lambda \rightarrow$ wavelength

The potential inside the cavity of a charged conductor is not zero, but, some constant value.

7) Properties of Electromagnetic Waves:

* They are transverse in nature
* They travel with the speed of light ($c = 3 \times 10^8 \text{ ms}^{-1}$)
* They carry momentum.

Proof: When a charged particle is kept in a plane perpendicular to direction of propagation of EM wave, the charged particle gets accelerated from rest and gains some momentum.

In other words, we can say that the electromagnetic wave has transferred its momentum to the chargeal particle.

8) Davison-Germer experiment used the fact that, if electron had a wave nature, then, they could be diffracted by the layers of the Nickel target.

De Broglie wavelength $(\lambda) = \frac{h}{\sqrt{2m(K.E)}}$, $h \rightarrow$ plank's constant
$m \rightarrow$ mass of electron
$K.E \rightarrow$ kinetic energy.

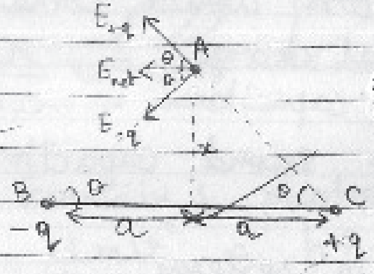
$$E = \frac{12400}{275\times10^{-9}\,m}\,eV\text{Å} = \frac{12400}{2750\,\text{Å}}\,eV\text{Å} = \frac{1.24\times10^{4}}{2.75\times10^{3}}\,eV$$

$$= \frac{4.509\times10^{-1}\times10^{4}}{10^{3}} = 4.509\,eV.$$

$\therefore$ Transition 'B' will result in the emission of photon of wavelength 275 nm.

SECTION-C

11)



Electric field (net) at point A:

Due to Electric field by $+q$ and Electric field by $-q$.

Let 'A' be at a distance of x from the centre of dipole.

$\Rightarrow AB = BC = \sqrt{x^2+a^2}$.

$$E_{+q} = \left(\frac{1}{4\pi\epsilon_0}\right)\frac{q}{(x^2+a^2)}, \quad E_{-q} = \left(\frac{1}{4\pi\epsilon_0}\right)\frac{(-q)}{(x^2+a^2)}$$

We need to add them vectorially, add their 'cos' components

$$E_{net} = \frac{1}{4\pi\epsilon_0}\frac{(q)}{(x^2+a^2)}\left(\frac{a}{\sqrt{x^2+a^2}} + \frac{a}{\sqrt{x^2+a^2}}\right) = \left(\frac{1}{4\pi\epsilon_0}\right)\frac{2aq}{(x^2+a^2)^{3/2}} \text{ along } -\hat{p}.$$

$\Rightarrow E_{net} = \frac{1}{4\pi\epsilon_0} \frac{2|\vec{p}|}{(x^2+a^2)^{3/2}}$ along $-\hat{p}$

when $x \gg a$,

$E_{net} = \left(\frac{1}{4\pi\epsilon_0}\right) \frac{2|\vec{p}|}{x^3}$ along $-\hat{p}$

(2) (a) Both capacitors would come to common potential:

$V_{common} = \frac{\text{Total charge}}{\text{Net capacitance}} = \frac{Q}{C_1C_2}(C_1+C_2)$

$\Rightarrow$ Charge on second capacitor $(Q') = Q\frac{(C_1+C_2)}{C_1}$

(b) Capacitance in series:

$\frac{1}{C_{net}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} \Rightarrow \frac{1}{C_s} = \frac{1}{3} + \frac{1}{3} + \frac{1}{3} = 1 \Rightarrow C_s = 1\ \mu F$

Parallel combination

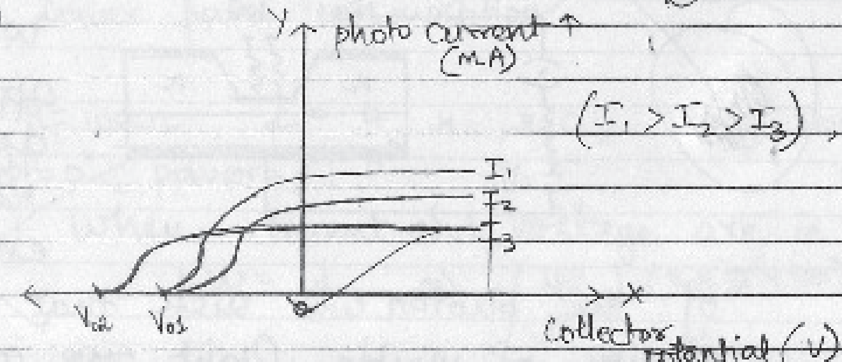
$C_{net} = C_1 + C_2 + C_3 \Rightarrow C_p = 3+3+3 = 9 \Rightarrow C_p = 9\ \mu F$

Ratio of energies $= \frac{1}{2}C_sV^2 : \frac{1}{2}C_pV^2 = 1:9$ ($\because$ voltage is same)

$\therefore$ Ratio of energies in series & parallel $= 1:9$

13) (a) Intensity of Radiation refers to the number of photons striking the metal surface per unit time.

(b)



$(I_1 > I_2 > I_3)$, $(\nu_1 = \nu_2)$, (frequency of I_3 (ν_1) greater than that of I_1, I_2 (ν))

(c) Einstein's photoelectric equation:

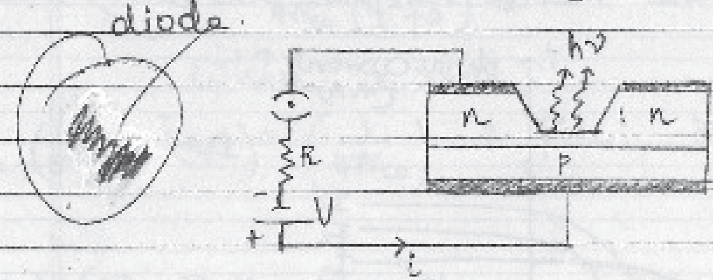
$$\frac{1}{2}mv^2_{max} = h\nu - h\nu_0$$

Since the intensity of $I_1 > I_2 > I_3$, the photocurrent due the intensities will also be in the same order.

Greater the frequency of the photon, greater will be the energy of electron emitted and thus, greater is its stopping potential.

In this case, $\nu_1 > \nu$. So, $V_{02} > V_{01}$

14) (i) LED (Light emitting diode) is a forward biased pn juncti[on] diode



when a suitable potential i[s] applied, electron-hole pairs [are] generated immediately which releases a photon of the energy released. If the wav[elength] of the photon is such that it lies in the wavelength region of visible light, we can actually see the colou[r] emitted. This is kept in mind and the potential is applied as such.

(ii) Compound Semiconductors are used for making LED because, the band gap of semiconductor used, must [be] such that the photon emitted, must have an energy nearly that of the visible light ($\simeq 1.8$ eV). But such h[igh] band gaps are not found in elemental semiconductors ($Si: 0.72$ eV, $Ge: 1.1$ eV). So, compound semiconductors such as GaAs are used for making LED.

(iii) Advantages of LED:

* High life and Ruggedness
* Lower power consumption.

15) $R = 100\,\Omega$, $L = \frac{4}{\pi^2}$ H, C, $V_{rms} = 200$ V, $f = 50$ Hz, $C = ?$, $Z = ?$

$\phi = 0°$, power = ?

When current and voltage are in phase,

$$L\omega = \frac{1}{C\omega} \Rightarrow \left(\frac{4}{\cancel{\pi^2}}\right)(2 \times \cancel{\pi} \times 50) = \frac{1}{C(2\cancel{\pi} \times 50)}$$

$$\Rightarrow 8 \times 50 \times 100 = \frac{1}{C} \Rightarrow 4 \times 10^4 = \frac{1}{C} \Rightarrow C = \frac{10^{-4}}{4}$$

$$\therefore C = 2.5 \times 10^{-5}\ F = 25\,\mu F$$

$$Z = \sqrt{R^2 + \left(L\omega - \frac{1}{C\omega}\right)^2} = \sqrt{R^2} = R \quad \left(\because L\omega = \frac{1}{C\omega}\right)$$

$\therefore Z = 100\,\Omega$

$i_{rms} = \frac{200}{100} = 2$ A.

$\therefore$ Power $= 200 \times 2 \times \cos 0 = 400$ W.

16) (i) $\mu = \sqrt{3}$, $\delta_m = A$, $A = ?$

$$\mu = \frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\left(A/2\right)} \Rightarrow \sqrt{3} = \frac{\sin(A)}{\sin\left(\frac{A}{2}\right)}$$

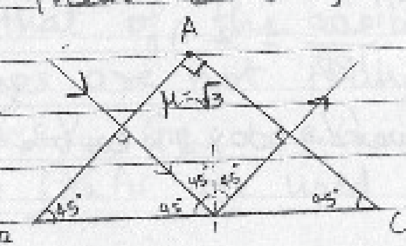
$$\Rightarrow \sqrt{3}\ \cancel{\sin\left(\frac{A}{2}\right)} = 2\,\cancel{\sin\left(\frac{A}{2}\right)} \cos\left(\frac{A}{2}\right)$$

$$\Rightarrow \cos\left(\frac{A}{2}\right) = \frac{\sqrt{3}}{2} \Rightarrow \frac{A}{2} = 30^\circ \Rightarrow A = 60^\circ$$

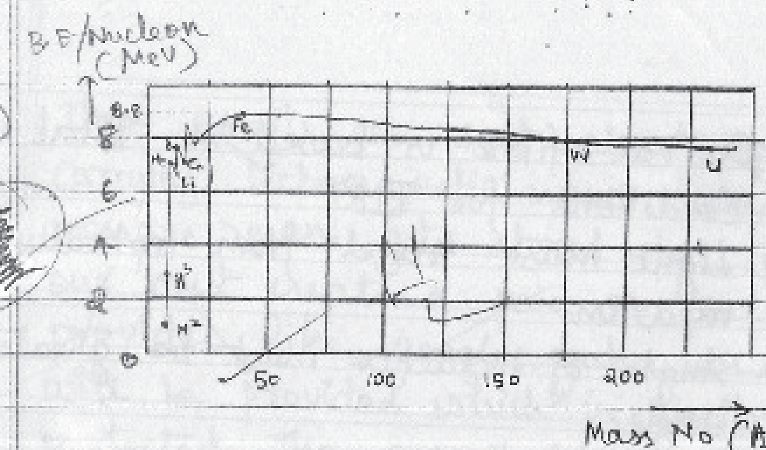
$\therefore$ Angle of prism $= 60^\circ$

(ii) $\mu = \frac{1}{\sin i_c} \Rightarrow i_c = \sin^{-1}\left(\frac{1}{\mu}\right) = \sin^{-1}\left(\frac{1}{\sqrt{3}}\right) = \sin^{-1}(0.5773) \simeq 35.3$

If angle of incidence inside the prism is greater than 35.3°, TIR (Total internal reflection occu



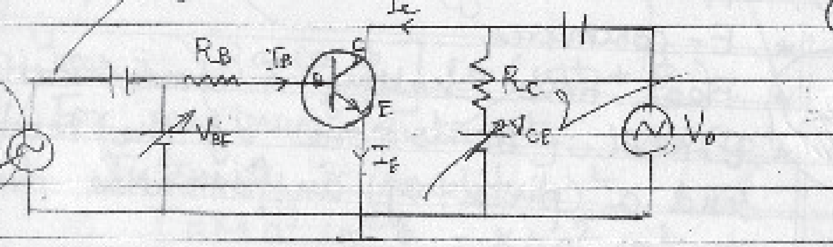
(17)



Approximate constancy of the Binding energy per nucleon from A: 30 to 170 is explained by the fact that Nuclear force is a short ranged force.

The highest binding energy per nucleon as seen from the graph is for iron (8.8 MeV). All elements try to attain this as this is highly stable (less energy). So, the initial state has higher energy than final state. Energy is conserved as there is release of heat. (Greater B.E/Nucleon ⇒ Greater stability) So, in both fission and fusion, as they attain more stability, energy is released.

(18)



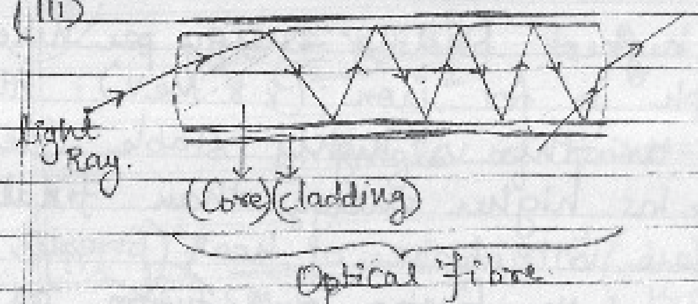
Current gain $(\beta_{ac}) = \left(\frac{\Delta I_C}{\Delta I_B}\right)_{V_{CE}}$

19) (i) Optical fibre is based on Total internal reflection

(ii) Conditions for TIR:

* Light must travel from optically denser to optically rarer medium.
* Angle of incidence must be greater than the critical angle.

(iii)



The refractive index of core is greater than that of cladding which facilitates TIR

20) Applications of Internet:

* E-commerce
* Real time chatting & communication.
* E-mail :- It is one of the modern & fastest technique to send a piece of information from one person to another

These emails are sent almost instantaneously as the information carrying electromagnetic waves travel at the speed of light. The message even gets stored for later reference. To send an E-mail, one must create a paid or free account in an e-mail service provider like google, yahoo or hotmail. Then, an e-mail-id will be provided which is similar to an identity and is password protected. The e-mail id consists of 2 parts. The part before the @ part contains the user name / account name, while the part after @ contains domain name.

Eg: xyz@gmail.com

Here xyz is account name and gmail.com is domain name

21) $y_1 = a\cos\omega t$, $y_2 = a\cos(\omega t + \phi)$

$y_{net} = y_1 + y_2 = a\left(\cos\omega t + \cos(\omega t+\phi)\right) = a\left(2\cos\left(\frac{2\omega t+\phi}{2}\right)\cos\left(\frac{\phi}{2}\right)\right)$

$y_{net} = \left[2a\cos\frac{\phi}{2}\right]\cos\left(\omega t + \frac{\phi}{2}\right)$

For maximum Intensity, $\cos\left(\omega t + \frac{\phi}{2}\right) = 1$ (maximum value) $\left(\omega t = -\frac{\phi}{2}\right)$

Intensity $\propto (\text{Amplitude})^2$

$\Rightarrow I = K4a^2\cos^2\frac{\phi}{2} = K4a^2\cos^2\omega t$ $\Rightarrow$ Intensity = 4 times $Ka^2\cos^2\omega t$

Intensity due to the wave 1: Ka^2

Intensity due to the wave 2: Ka^2

Intensity due to interference: $4Ka^2$

$\therefore$ Intensity due maxima is four times intensity due to each

More over, generally, maximum intensity: $4I_0\left[\cos^2\left(\frac{\phi}{2}\right)\right] \Rightarrow I_{max} = 4I_0$

Constructive interference:

For maximum: $\cos\left(\omega t + \frac{\phi}{2}\right) = 1 \Rightarrow \omega t + \frac{\phi}{2} = 2\pi n$

$\Rightarrow \frac{\phi}{2} = 2n\pi - \omega t$

$\Rightarrow \phi = 4n\pi - 2\omega t$

Destructive interference:

For minimum: $\cos\left(\omega t + \frac{\phi}{2}\right) = 0 \Rightarrow \omega t + \frac{\phi}{2} = \left(\frac{2n+1}{2}\right)\pi$

$\Rightarrow \frac{\phi}{2} = \left(\frac{2n+1}{2}\right)\pi - \omega t$

22 (i) * High permeability

* Low retentivity

(ii) Gauss law in magnetism: $\oint \vec{B} \cdot d\vec{s} = 0$.
It stt that the magnetic field lines inside a closed surface is always zero i.e, lines entering it always leave it.
This is different from Gauss Law in electrostatics : $\oint \vec{E} \cdot d\vec{s} = \frac{q}{\epsilon_0}$.
This is due to the reason that magnetic monopoles do not exist.

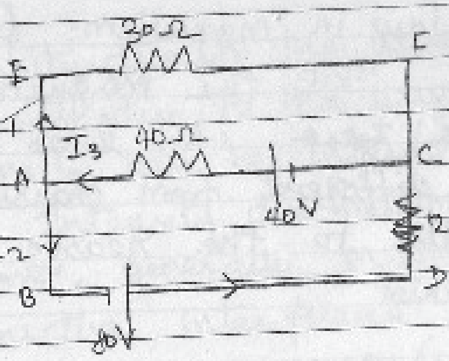
SECTION-D

23) (a) Hari was very attentive and careful. He used his presence of mind

(b) Current flows only when there exists a difference in potential. This happens when we touch the wire remaining on ground. But bird is in air and touches the wire.

(c) It is set to a very high voltage, to minimize the power loss during transmission. When voltage becomes high, at high resistance power loss will be less.

24) (a)



Current in AC arm=?

Let it be I_3.

$I_1 + I_2 = I_3$ —— ①

In loop ABDC,

$-40I_3 + 80 - 20I_2 + 40 = 0$

$\Rightarrow -2I_3 + 6 - I_2 = 0$ —— ②

In loop AEFC,

$-30I_1 + 40 - 40I_3 = 0$

$\Rightarrow -3I_1 - 4I_3 + 4 = 0$ —— ③

Put $I_1 = I_3 - I_2$

$\Rightarrow$ ②: $-2I_3 + 6 - I_2 = 0$

$\Rightarrow$ ③: $-3(I_3 - I_2) - 4I_3 + 4 = 0 \Rightarrow -3I_3 + 3I_2 - 4I_3 + 4 = 0$

$\Rightarrow -7I_3 + 3I_2 + 4 = 0$ —— ④

$-6I_3 + 18 - \cancel{3I_2} = 0$

$-7I_3 + 4 + \cancel{3I_2} = 0$

$-13I_3 = -22$

$\Rightarrow I_3 = \frac{22}{13}$ A

$\therefore I_0 = 22$ A

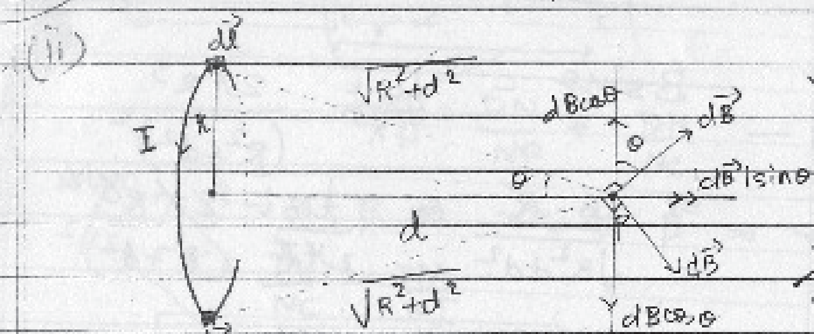
(b) Meter bridge works on the principle of wheatstone bridge. When the Ratio of resistances in the adjacent arms are equal, no current flows through the galvanometer and the bridge is said to be balanced.

The metal strips are used because, they must not contribute to the resistance. When they are thick, their resistances will be low hence minimi-ging their contribution.

25) (i) Biot-savart Law: (vector form).

$$d\vec{B} = \frac{\mu_0}{4\pi} \frac{i\,(d\vec{l} \times \vec{r})}{r^3}$$

(ii)



We know that at the point 'P', the vertical components of the magnetic field gets cancelled.

~~We~~ must find the horizontal components.

$$dB = \frac{\mu_0 i \, dl \sin\theta}{4\pi \left(\sqrt{R^2+d^2}\right)^2}$$

$$\Rightarrow dB \sin\theta = \frac{\mu_0 i \sin^2\theta}{4\pi (R^2+d^2)} \, dl$$

$$\Rightarrow B\sin\theta = \frac{\mu_0 i}{4\pi}\left(\frac{1}{R^2+d^2}\right)\frac{R^2}{R^2+d^2}\int_0^{2\pi R} dl$$

(Horizontal component)

$$B\sin\theta = \frac{\mu_0 i}{4\pi} \; \frac{2\pi R^3}{(R^2+d^2)^2}$$

$$\Rightarrow \frac{B \cdot R}{\sqrt{R^2+d^2}} = \frac{\mu_0 i}{2 \cdot \cancel{2\pi}} \; \frac{\cancel{2\pi} R^{\cancel{3}\,2}}{(R^2+d^2)^2} \Rightarrow B = \frac{\mu_0 i R^2}{2(R^2+d^2)^{3/2}}$$

$$\therefore \boxed{B = \frac{\mu_0 i R^2}{2(R^2+d^2)^{3/2}}}$$

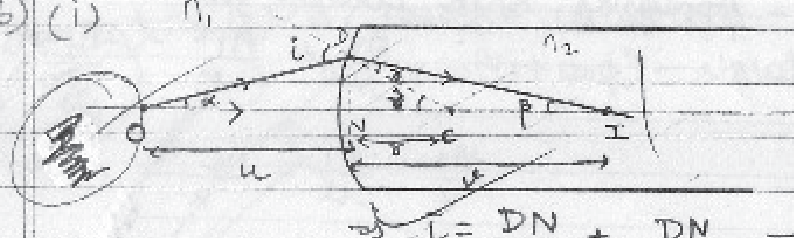
(iii) At centre of coil: $d = 0 \Rightarrow B_1 = \frac{\mu_0 i R^2}{2R^3} = \frac{\mu_0 i}{2R}$.

At $R\sqrt{3} = d \Rightarrow B_2 = \frac{\mu_0 i R^2}{2(R^2 + 3R^2)^{3/2}} = \frac{\mu_0 i R^2}{2(4R^2)^{3/2}} = \frac{\mu_0 i R^2}{2(2R)^3} = \frac{\mu_0 i R^2}{2 \cdot 8 R^3}$

$= \frac{\mu_0 i}{16 R}$.

$\therefore B_1 : B_2 = 8 : 1$

26) (i)



$n_2 > n_1$

We can see that

$i = \alpha + \gamma$

$\Rightarrow i \simeq \tan\alpha + \tan\gamma$ (small angles)

$\Rightarrow i = \frac{DN}{NO} + \frac{DN}{NC}$ — ①

Also, $\gamma = r + \beta \Rightarrow r = \gamma - \beta \Rightarrow r \simeq \tan\gamma - \tan\beta$ (small angles)

$\Rightarrow r = \frac{DN}{NC} - \frac{DN}{NI}$

We know that $n_1 \sin i = n_2 \sin r$ (Snell's Law)

$\Rightarrow n_1 i \simeq n_2 r$ ($\because$ small angles)

$$\Rightarrow n_1\left(\frac{DN}{NO} + \frac{DN}{NC}\right) = n_2\left(\frac{DN}{NC} - \frac{DN}{NI}\right)$$

$$\Rightarrow \frac{n_1}{NO} + \frac{n_1}{NC} = \frac{n_2}{NC} - \frac{n_2}{NI}$$

$$\Rightarrow \frac{n_1}{NO} + \frac{n_2}{NI} = \frac{n_2 - n_1}{NC}$$

Applying sign conventions.

$$\frac{n_2}{V} + \frac{n_1}{(-u)} = \frac{n_2 - n_1}{R}$$

$$\therefore \frac{n_2}{V} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$$

(ii) when the wavelenth of a light increases, the refractive index decreases.

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

$$\Rightarrow \frac{1}{f} \text{ decreases}$$

$\therefore f$ increases on increasing wavelength.

(iii) when convex lens is immersed in water, its focal length increases.

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

Relative refractive index 'μ' decreases $\Rightarrow \frac{1}{f}$ decreases

$\therefore$ 'f' increases.

21) $y_1 = a\cos\omega t$; $y_2 = a\cos(\omega t + \phi)$

$y_1 + y_2 = a(\cos\omega t + \cos\omega t\cos\phi - \sin\omega t\sin\phi)$

$= a\{\cos\omega t(1+\cos\phi) - \sin\omega t\sin\phi)$

Repel

P.V. Ramanamoorthy

E.06086/2004.