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

PHYSICS

042

SATURDAY, 05/03/2016

ENGLISH

Code Number	Set Number
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ty, l → length, A → Area of Cross section.

pper).

an area of Copper wire.

$= \frac{\pi}{}$

sent^3 and voltage $= \frac{\pi}{3}$.

SECTION-A

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

(Resistivity of Manganin) > (Resistivity of Copper)

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

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

① ÷ ②

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

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

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

∴ Area of Manganin wire is greater than area of Copper wire.

2) 

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

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

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

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

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

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

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

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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 receives 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 loss)

(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.

2) Properties of Electromagnetic Waves:
* They are transverse in nature
* They travel with the speed of light ($c = 3 \times 10^8\ ms^{-1}$)
* 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 transfered its momentum to the charged particle.

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

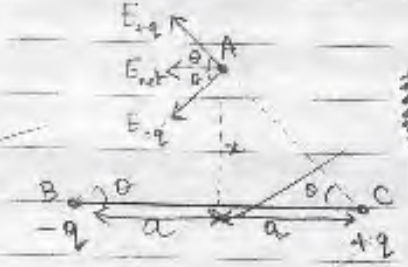
De Broglie wavelength (λ) $= \frac{h}{\sqrt{2m(K.E)}}$, h → plank's constant
m → mass of electron
K.E → kinetic energy

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

$$= \frac{4.509\times10^{4}}{10^{4}} = 4.509\ eV.$$

∴ Transition 'B' will result in the emission of photon of wavelength 275 nm.

(i)



SECTION-C

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

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

12) (a) Both capacitors would come to common potential

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

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

(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

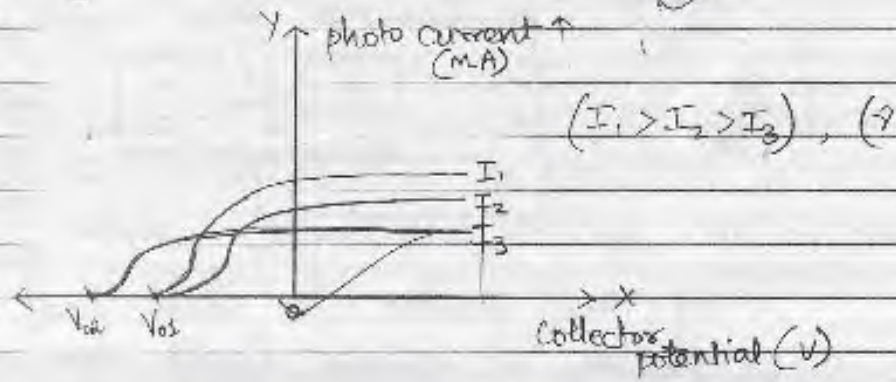
$C_{net} = C_1 + C_2 + C_3 \Rightarrow C_p = 3+3+3 = 9 \Rightarrow C_p = 9\ \mu F$

Ratio of energies $= \frac{1}{2} C_s V^2 : \frac{1}{2} C_p V^2 = 1:9$

$\therefore$ 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 $I_3(\nu_1)$ greater than that of I_1, I_2 (ν))

(c) Einstein's photoelectric equation:

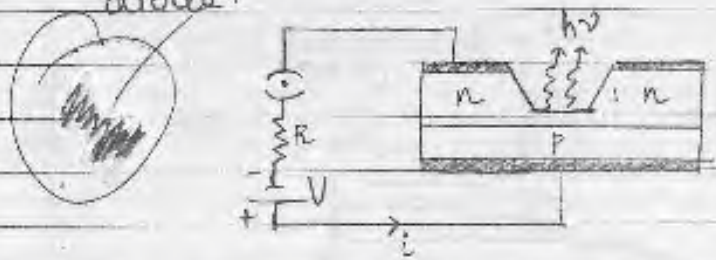
$$\frac{1}{2}mv_{max}^2 = h\nu - h\nu_0$$

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, $V_{o_2} > V_{o_1}$

14) (i) LED (light emitting diode) is a forward biased p-n junction diode.



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

(ii) Compound Semiconductors are used for making LEDs because, the band gap of semiconductor used must such that the photon emitted, must have an energy nearly that of the visible light ($\simeq$ 1.8 eV). But such 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,

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

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

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

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

$\therefore Z = 100\ \Omega$

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

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

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

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

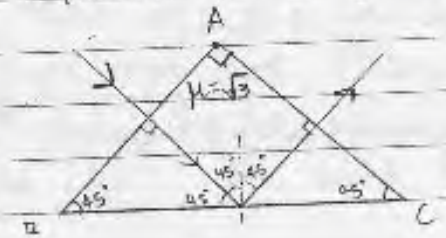
$$\sqrt{3}\sin\left(\frac{A}{2}\right) = 2\sin\left(\frac{A}{2}\right)\cos\left(\frac{A}{2}\right)$$

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

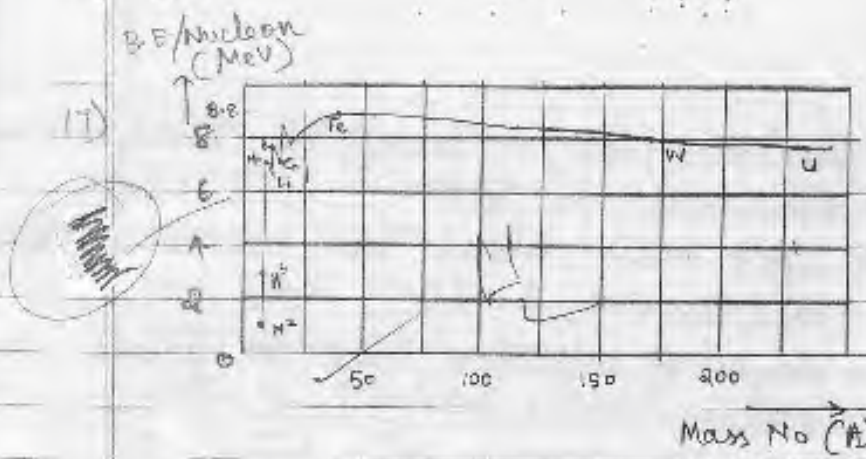
$\therefore$ Angle of prism = 60°

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

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



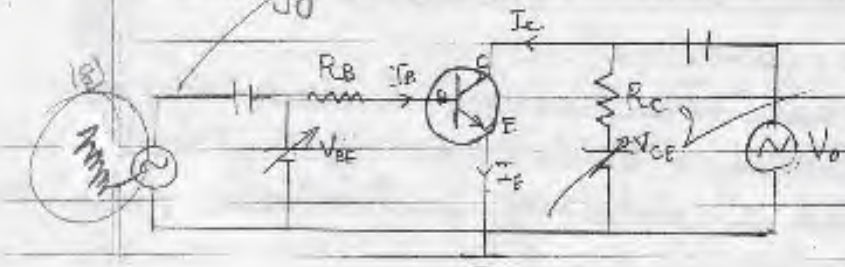
17)



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)



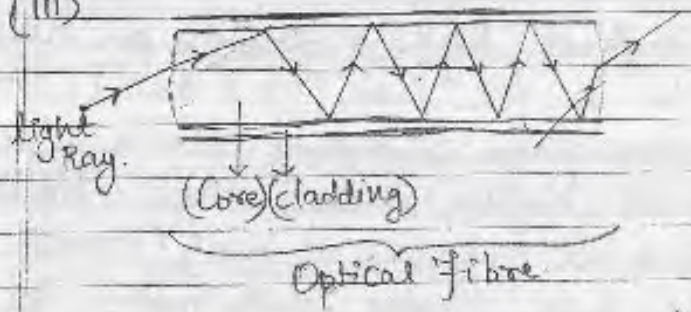
Current gain $(\beta_{ac}) = \left(\frac{\Delta I_C}{\Delta I_B}\right)_{V_{CE}}$

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

(ii) Conditions for TIR:

* Light must travel from optically denser to optically rare 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

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 $\propto$ (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: $4ka^2$

∴ Intensity due maxima is four times intensity due to

Moreover, generally, maximum intensity: $4I_0\cos^2\left(\frac{\phi}{2}\right) \Rightarrow I_{max}$

Constructive interference:

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

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

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

Destructive interference:

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

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

22) (i) * High permeability

* Low resistivity

(ii) Gauss law in magnetism: $\oint \vec{B} \cdot d\vec{s} = 0$

It is 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.

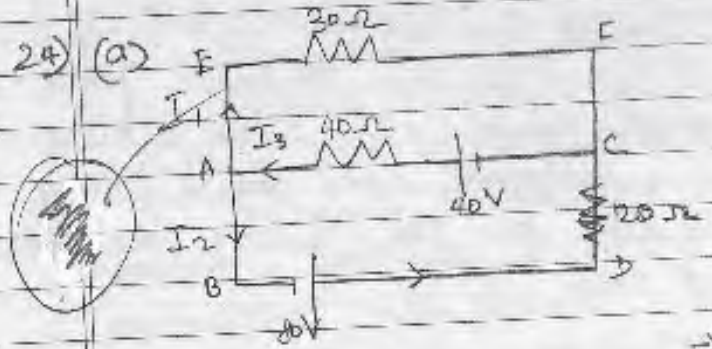
SECTION-D

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)

$-6I_3 + 18 - 3I_2 = 0$

$-7I_3 + 4 + 3I_2 = 0$

$-13I_3 = -22$

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

$\therefore I_3 = 22$ A

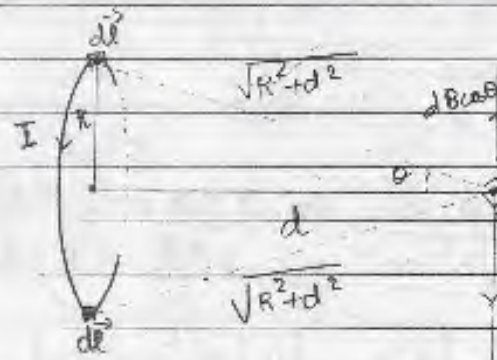
(b) Meter bridge works on the principle of wheatstone bridge. When the Ratio of resistances in the adjacent arms are equal, no current flows through the galvanometer and the bridge is said to be balanced.

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

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

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

$$\Rightarrow B\sin\theta \text{ (Horizontal component)} = \frac{\mu_0 i}{4\pi} \left(\frac{1}{(R^2+d^2)^{3/2}}\right)^2 \frac{R^2}{R^2+d^2} \int_0^{2\pi R} dl$$

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

$$\Rightarrow \frac{B\cdot R}{\sqrt{R^2+d^2}} = \frac{\mu_0 i}{2\cancel{4\pi}} \frac{\cancel{2\pi} R^{\cancel{3}\,2}}{(R^2+d^2)^{3/2}} \Rightarrow B = \frac{\mu_0 i R^2}{4(R^2+d^2)}$$

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

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

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

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

$\therefore B_1 : B_2 = 8 : 1$

26) (i)

$n_2 > n_1$

We can see that

$i = \alpha + \gamma$

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

$\Rightarrow i = \frac{DN}{ND} + \frac{DN}{NC}$ — (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)

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

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

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

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

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 wavelength of a light increases, the refractive index decreases.

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

$\Rightarrow \frac{1}{f}$ 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) $y_1 = a\cos\omega t$, $y_2 = a\cos(\omega t + \phi)$

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

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

Repeat

P. V. Ramana Murthy