Q1. State two characteristic properties of nuclear force.

(i) We know that nuclei consists of tightly packed protons, thus to keep these protons together the nuclear force has to beat the Coulomb repulsion. At short distances nuclear forces is stronger than the Coulomb force, so nuclear forces are the strongest forces in nature.

(ii) The nuclear force does not depend at all on the particle charge, e.g. it is the same for protons and neutrons. Nuclear forces are independent of charge.

Q2. How does the angle of minimum deviation of a glass prism vary, if the incident violet light is replaced with red light?

We know that deviation produced by prism is given by $\delta = A(\mu - 1)$

μ is refractive index of the prism of mean ray(yellow colour).

μ depends of wave length by this formula $\mu = A + \frac{B}{\lambda^2}$

VIBGYOR – Wave length increases from Violet to Red

So Wavelength of Violet is less than Wave length of Red.

Hence Refractive index of Prism for higher for Violet than Red.

So $\delta_{\text{violet}} > \delta_{\text{red}}$ therefore when incident violet is replaced with red light, the angle of minimum deviation of a glass decreases.

Q3. The instantaneous current and voltage of an a.c. circuit are given by

$i = 10\sin 300t \text{ A} \text{ and } v = 200 \sin 300\, t \text{ V}.$

What is the power dissipation in the circuit?

Ans. We know that instantaneous current and voltage is given by $i = i_0 Sin\omega t, V = V_0 Sin\omega t,$

Given

$i = 10Sin300t \text{ and } v = 200Sin300t \text{ V}$

$\therefore\ i_0 = 10 \text{ A and } V_0 = 200 \text{ V}$

$\therefore$ Average power dissipation $= V_0\, i_0$

$= 200 \times 10 = 2000 \text{ W}$

Q4. Why should the spring / suspension wire in a moving coil galvanometer have low torsional constant?

In moving coil galvanometer, we want to measure even small current also hence for small current galvanometer coil should give deflection.

Current $(i)$and deflection (θ) in Moving coil galvanometer is related by

$$i = \frac{c}{nAB}\theta$$

n = Number of turns in the coil, A = Area of the coil, B= magnetic field, c = torsional couple per unit twist,

Hence c is kept Low.

Thus to increase sensitivity moving coil galvanometer has low torsional constant (restoring torque per unit twist).

Q5. Why does the bluish colour predominate in a clear sky?

We know that scattering is wavelength dependent$\left(I\alpha\ \frac{1}{\lambda^4}\right)$. Since blue colour has shorter wavelength hence scatters more and sky appears blue.

Q6. Which orientation of an electric dipole in a uniform electric field would correspond to stable equilibrium?

Torque on an electric dipole in uniform electric field is $\tau = \vec{p} \times \vec{E}$

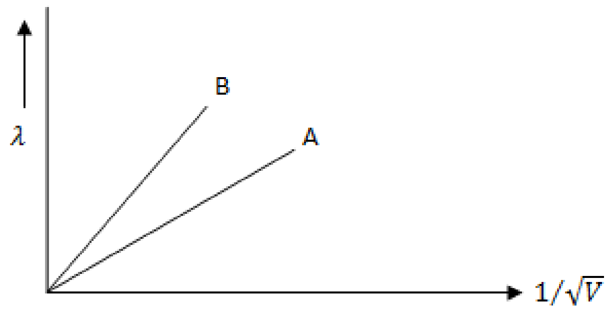
$\vec{p}$ = Electric Dipole Moment

$\vec{E}$ = Electric Field

Cross product is Zero if dipole moment and electric field is in the same direction i.e. parallel.

The dipole is in stable equilibrium when electric dipole is in the direction of electric field.

Q7. Two lines, A and B, in the plot given below show the variation of de-Broglie wavelength, λ versus $1/\sqrt{V}$, where V is the accelerating potential difference, for two particles carrying the same charge. Which one of two represents a particle of smaller mass?



We know that wavelength $\lambda = \frac{h}{\sqrt{2meV}} \Rightarrow \lambda = \frac{h}{\sqrt{m}.\sqrt{2e}} . \frac{1}{\sqrt{V}}$

$\frac{1}{\sqrt{m}} = \frac{\sqrt{2e}}{h} . \left(\frac{\lambda}{1/\sqrt{V}}\right)$

$\therefore \frac{1}{\sqrt{m}} = \frac{\sqrt{2e}}{h} \times (\text{slope of } \lambda \text{ and } \sqrt{V} \text{ graph})$

$\because$ Slope of B $> Slope\ of\ A$

$\frac{1}{\sqrt{m_B}} > \frac{1}{\sqrt{m_A}} \Rightarrow \sqrt{m_B} < \sqrt{m_A}$

$\therefore m_B < m_A$

Therefore, line B represents a particle of smaller mass.

Q8. State the reason, why Ga As is most commonly used in making of a solar cell ?

The absorption coefficient, α, is a property of a material which defines the amount of light absorbed by it. Ga As (Gallium Arsenide) has higher absorption coefficient hence most commonly used in making of a solar cell because it absorbs relatively more energy from the incident solar radiations (photon).

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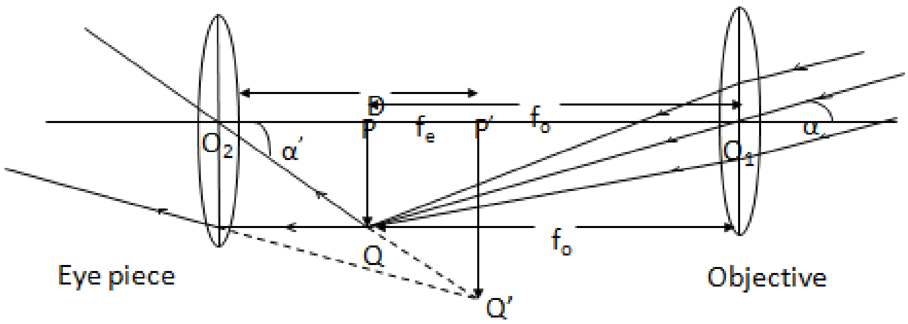
Q9. Draw a labeled ray diagram of an astronomical telescope in the near point position. Write the expression for its magnifying power.



To find magnifying power (M_d): $O_1P = f_o, O_2P = u < f_e, O_2P' = D$

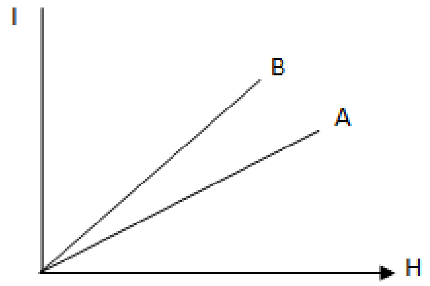
$$\therefore \frac{1}{f_e} = \frac{1}{u} + \frac{1}{-D}$$

$$or \ \frac{1}{u} = \frac{D + f_e}{Df_e}$$

For distinct vision $M_d = \frac{\alpha'}{\alpha} = \frac{\tan \alpha'}{\tan \alpha} = \frac{PQ/O_2P}{PQ/O_1P} = \frac{O_1P}{O_2P} = \frac{f_o}{u}$

$$M_d = f_o\left[\frac{1}{f_e} + \frac{1}{D}\right] = \frac{f_o}{f_e}\left[1 + \frac{f_e}{D}\right]$$

Q10. The following figure shows the variation of intensity of magnetization versus the applied magnetic field intensity, H, for two magnetic materials A and B:



(a) Identify the materials A and B.
(b) Why does the material B, have a larger susceptibility than A, for a given field at constant temperature?

Answer:

(a) Material A is diamagnetic whereas material B is paramagnetic.
(b) Since paramagnetic substances have a tendency to pull in magnetic field lines when placed in a magnetic field.

Q11. Two metallic wires of the same material have the same length but cross-sectional area is in the ratio 1:2. They are connected (I) in series and (II) in parallel. Compare the drift velocities of electrons in the two wires in both the cases (I) and (II).

Given

$$\mathrm{A_1 : A_2 = 1 : 2} \Rightarrow \frac{A_1}{A_2} = \frac{1}{2}$$

(I) When two wires are connected in series, the current in both wires A and B will be the same.

$\therefore \mathrm{I_A = I_B}$

$ne\,A_1\,v_{d1} = ne\,A_2 v_{d2}$

$\therefore \frac{\mathrm{v_{d1}}}{\mathrm{v_{d2}}} = \frac{\mathrm{A_2}}{\mathrm{A_1}}$

$\therefore \frac{\mathrm{v_{d1}}}{\mathrm{v_{d2}}} = \frac{2}{1} \Rightarrow \mathrm{v_{d1} : v_{d2} = 2 : 1}$

(II) When two wires are connected in parallel, then the potential difference across the wire A and B will be same

$\mathrm{V_A = V_B}$ $\quad [\because \mathrm{V = IR}]$

$$\Rightarrow\ V = ne\,A\,v_d.\rho\,\frac{l}{A}$$

$$\therefore V = ne\,\rho l\,v_d$$

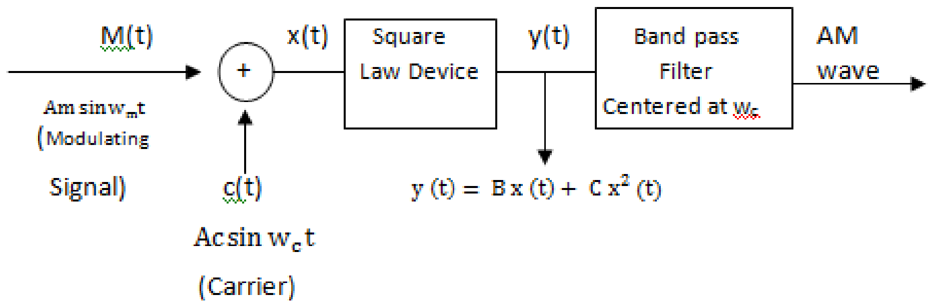
$$\therefore\ ne\,\rho l\,v_{d1} = ne\,\rho l\,v_{d2}$$

$$\text{or,}\ \ v_{d1} = v_{d2}$$

$$\therefore\ \frac{v_{d1}}{v_{d2}} = \frac{1}{1} \Rightarrow v_{d1} : v_{d2} = 1 : 1$$

Q12. Draw a block diagram of a simple amplitude modulation. Explain briefly how amplitude modulation is achieved?

Ans. Block diagram to produce AM wave is



In this method the modulating signal $Am\,sin\,w_m t$ is added to the carrier signal $Ac\,sin\,w_c t$ to produce the signal x (t). This signal $x(t) = Am\,sin\,w_m t + Ac\,sin\,w_c t$ is passed through a *square law device* which produces an output.

$$y\,(t) = B\,x\,(t) + C\,x^2\,(t)$$

Where, B and C are constants.

This signal is passed through a *band pass filter* which rejects dc. The output of the band pass filter is therefore, an AM wave.