Applied Physics

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Final Term Paper (Online)

Subject Name: **Applied Physics**
Class: **BS CS-1**
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Question # 1

A slit of width a is illuminated by white light.

ⓐ For what value of a will the first minimum for red light of $\lambda = 650nm$ be at $\theta = 15^\circ$?

ⓑ What is the wavelength λ' of the light whose first side diffraction maximum is at 15°, thus coinciding with the first minimum for the red light?

Solution:- Part(a)

ⓐ At the first minimum, m=1 in equation [$a \sin\theta = m\lambda$, for $m = 1, 2, 3 \ldots$]. Solving for a, we then find

$a = m\lambda / \sin\theta$

$= (1)(650nm)/(\sin 15^\circ)$

$= 2511 \text{ nm}$

$= 2.5 \, \mu m$

Therefore, the value of a the first minimum for red light of $\lambda = 650$ nm be at $\theta = 15^\circ$ would be $2.5 \, \mu m$. For the incident light to flare out that much ($\pm 15^\circ$) the slit has to be very fine indeed, amounting to about four times the wavelength. Note that a fine human hair may be about $100 \mu m$ in diameter.

Q-① Part (b)

ⓑ This maximum is about halfway between the first and second minima produced with wavelength λ'. we can find it without too much error by putting $m = 1.5$ in equation [$a \sin\theta = m\lambda$, for $m = 1,2,3,\ldots$], obtaining
$a \sin\theta = 1.5\lambda'$
Solving for λ' and substituting known data give

$$\lambda' = a \sin\theta / 1.5$$
$$= (2511 \text{ nm})(\sin 15^\circ)/1.5$$
$$= 430 \text{ nm}$$

From the above observation we conclude that, the wavelength λ' of the light whose first side diffraction maximum is at 15° would be 430 nm. Light of this wavelength is violet. the first side maximum for light of wavelength 430 nm will always coincide with the first minimum for light of wavelength 650 nm, ~~so~~ no matter what the slit width. If the slit is relatively narrow, the angle θ at which this overlap occurs will be relatively large, and conversely.

Question. 2. (A)

what is the difference between reflection and refraction?

Reflection and refraction are two different properties of light. The basic difference between reflection and refraction is that Reflection of light is process in which light bounces back on striking the surface, while refraction of light is the process in which light changes its direction as it passes from one medium to another medium.

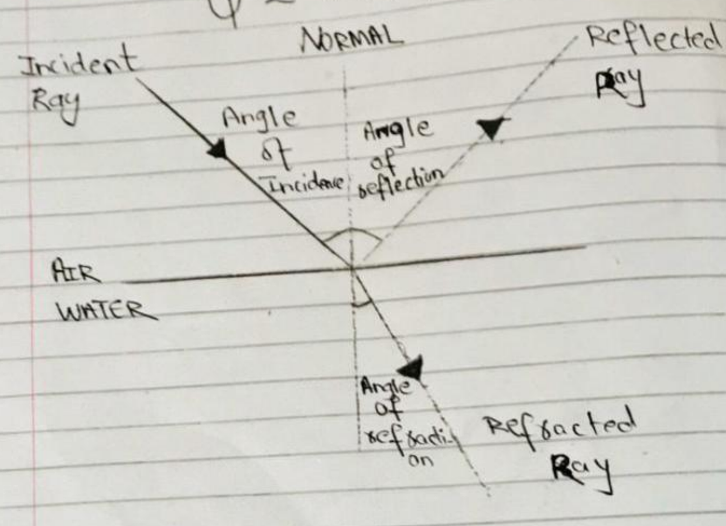
Reflection	Refraction
① This phenomenon usually accurs in mirrors.	① This phenomenon usually accurs in lenses.
② Reflection can simply be defined as the reflection of light when it strikes the medium on a plane.	② Refraction can be defined as the process of shift of light when it passes through a medium leading to the bending of light.
③ The light entering the medium returns back in the same direction	③ The light entering the medium travels from one medium to another.
④ ~~cond~~ considering the light waves, they bounce from the plane and change direction.	④ The light wave pass through the surface while simultaneosly changes from medium to medium.

Q2 - PART (B)

Where θ_i ("theta") ⇒ angle of incidence
θ_r ("theta") ⇒ angle of refraction
n_i ⇒ index of refraction of the incident medium
n_r ⇒ index of refraction of the refractive medium.

This relationship between the angles of incidence and refraction and the indices of refraction of the two media is known as Snell's Law. Snell's law applies to the refraction of light in any situation, regardless of what the two media are. Angle of incidence is the angle between the normal at the interface and incident ray. Angle of refraction is defined as the angle between the normal at the interface and refracted ray. Angles can be measured by any unit, but here, degrees are used. Let us first have a glance of laws of refraction

Q-2 PART (B)



Question # 3

Solution:-

The Initial flux through Solenoid C is

$$\Phi_{Bi} = BA_c = \mu_0 i n_s A_c = \pi \mu_0 i n_s r_c^2$$

Now we can write

$$\frac{d\Phi_B}{dt} = \frac{\Delta \Phi_B}{\Delta t} = \frac{\Phi_{Bf} - \Phi_{Bi}}{\Delta t}$$

$$= \frac{0 - \pi \mu_0 i n_s r_c^2}{\Delta t} = -\frac{\pi \mu_0 i n_s r_c^2}{\Delta t}$$

Substituting gives

$$\frac{d\Phi_B}{dt} = -\frac{\pi (4\pi \times 10^{-7}\ T\cdot m/A)(1.5\ A)}{25\ ms}$$

$$\times \left(22000\ \frac{turn}{m}\right)(0.0105\ m)^2$$

$$= -5.76 \times 10^{-4}\ V.$$

The magnitude of the induced emf is then

$$\mathcal{E} = N\left|\frac{d\Phi_B}{dt}\right| = (130)(5.76 \times 10^{-4}\ V)$$

$$= 75\ mV.$$

Q4 (a) How to calculate the magnetic force on current carrying wire?

Ans:-

So the magnetic field exerts a force on current carrying wire in a direction given by the "Right hand Rule".

Deriving an expersion for magnitude force:

Force on drift velocity (v_d) is given by:-

$$F = q v_d B \sin\theta$$

B = uniform over a length of wire.

Total magnetic force on the wire

$$\Rightarrow F = (q v_d B \sin\theta)(N)$$

where N is the number of charge carriers in the section of wire of length (L).

Now $N = nV$

n = number of charge carriers per unit volume.

V = volume of wire in the field

→ Note

$V = Al$

where

A = cross-sectional area of the wire.

$F = (nqAv_d)\, LB\sin\theta$

Because $nqAv_d = I$

$F = IL\,B\sin\theta$ (equation for magnetic force on a wire).

if we divide both sides of this expression by l, we find that magnetic force per unit length of wire in uniform field is :-

$\frac{F}{L} = IB\sin\theta$ (Direction given by RHR)

Q4(b)

$i = 28A$

Linear density $= 46.6 g/m$

Find magnitude and direction of minimum magnetic field.

magnitude of $\vec{F_B}$ is $F_B = iLB \sin\theta$

Because we want $\vec{F_B}$ to balance F_g

So we want

$$iLB \sin\theta = mg$$

Since we want minimal field magnitude for $\vec{F_B}$ to balance F_g.

we maximize $\sin\theta$.

So By placing θ as $90°$

$$\sin 90 = 1$$

$$B = \frac{mg}{iL\sin\theta} = \frac{(m/L)g}{i}$$

$$B = \frac{(46.6\times10^{-3})(9.8)}{(28A)}$$ $$B = 1.6\times10^{-2} T.$$

Question. 5 (A)

Difference Between Resistance and Resistivity

S.No.	Differentiating Property	Resistance	Resistivity
1	Definition	Resistance is the physical property of a substance, of which it, because opposses the flow of current i.e. electrons.	Resistivity is the physical property of a particular substance which is having particular dimensions
2	Proportionality	Resistance is directly proportional to the length and temperature while it is inversly proportional to the cross-sectional area of the material.	Resistivity is only proportional to the nature and temperature of the particular material.
3	Symbol	R	P
4	Formula	R= V/I or R= P(L/A) V=voltage, I= current P= resistivity	P= (R×A)/L R=Resistance L= Length A= cross-sectional area
5	SI Units	The SI unit of resistance is "Ohms".	SI unit of resistivity is "Ohms-meter"
6	Applications	The property of resistance is used in several places like heaters, fuses, sensors etc.	Electrical resistivity measurment is used as a quality control test for calcareous soil.

Q5(b)

i) Soln

Cross-sectional area of rectangular block is square:-

$S = 1.2 \times 1.2 \ cm^3 = 1.44 \times 10^{-4} m^2$

L is 5cm so $L = 0.15m$

so $R = (9.6 \times 10^{-8}) \left(\frac{0.15}{1.44 \times 10^{-4}} \right)$

$R = 1 \times 10^{-4} \ \Omega$

ii) Soln

Cross-sectional area for rectangular block is rectangular:-

$S = 1.2 \times 15 cm^2 = 1.8 \times 10^{-3} m^2$

$L = 1.2 cm = 0.012 m$

$R = (9.6 \times 10^{-8}) \left(0.012 / 1.8 \times 10^{-3} \right)$

$R = 6.4 \times 10^{-7} \ \Omega.$

END