[APPLIED PHYSICS]

[Final Exam Paper]

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FINAL EXAM ASSIGMENT

Q1: A slit of width α is illuminated by white light.

a. For what value of α will the first minimum for red light of wavelength λ = 650 nm appear at θ = 15°?

b. 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?

a) For what value of α will the first minimum for red light of wavelength λ = 650 nm appear at θ = 15°?

Q1. A slit of width d is illuminated by white light.

(a) For what value of d will the first minimum of for red light of wavelength $\lambda = 650$ nm appear at $\theta = 15°$?

Ans. Diffraction occurs separately for each wavelength in the range of wavelengths passing through the slit, with the locations of the minima for each wavelength given ($d \sin\theta = m\lambda$).

CALCULATION:-

When we set $m = 1$ (for the first minimum) and substitute the given values of θ and λ, yields.

$$d = \frac{m\lambda}{\sin\theta} = \frac{(1)(650\,nm)}{\sin 15°}$$

$$= 2511\,nm \approx 2.5\,\mu m. \quad \text{(Ans)}$$

b) 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?

b) 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?

Ans:- The first side maximum for any wave length is about halfway between the first and second minima for that wavelength.

CALCULATION:-

Those first and second minima can be located with setting m = 1 and m = 2, respectively. Thus, the first side maximum can be located approximately by setting m = 1.5. Then becomes

$$d \sin \theta = 1.5\lambda'$$

Solving for λ' and substituting known data yield

$$\lambda' = \frac{d \sin \theta}{1.5} = \frac{(2511\ nm)(\sin 15^\circ)}{1.5}$$

$$= 430\ nm. \quad (Ans)$$

Q2:

a. What is the difference between reflection and refraction?
b. Explain the difference among angle of incident, angle of reflection and angle of refraction with the help of formulae and a single diagram?

a) What is the difference between reflection and refraction?

Q2

(a). What is the difference between reflection and refraction?

Ans:- DIFFERENCE BETWEEN REFLECTION AND REFRACTION:-

The phenomenon of a light beam rebounding after hitting a surface is called reflaction. To put it simply, the mirror images are what are called reflection generally. The light beam that hits the surface is called incident ray. The light beam that leaves the surface is called the reflected ray.

There's another phenomenon called refraction. Here, the light changes direction, or 'bends' as it passes through the boundary between these two media. The images that are witnessed through the glass/see-through objects are a result of refraction.

The angle of incidence and angle of reflection are the same in the case of reflection. For example, when a ray of light strikes a horizontal surface at a 45 degree angle (angle of incidence), it always rebounds at the same 45 degree angle (angle of reflection). These angles are the same even when multiple rays hit the surface and bounce back. For example a flat mirror produces an image that is upright, and of the same size as the object that is being reflects. The length between the image and object from the mirror also remains the same. This type of reflection is called specular reflection. While most of the objects reflect light in all direction in a microscopic level, the irregularities on the objects surface will determine the specific rate of reflection. When the light passes through a rough surface, the reflection also happens in different directions. This is called diffuse reflection.

However in the case of refraction, these angles are not the same. Different media participate in the refraction. thus making this angle unequal. In reflection, the incident and reflected rays pass through the same medium. Reflection is found in mirrors while lenses uses refraction.

SUMMARY:-

1) The phenomenon of a light beam rebounding after hitting a surface is called reflection while the bouncing back of light from its normal path is termed refraction.

2) The angle of incidence and angle of reflection are the same in the case of reflection. These angles are not the same in refraction.

3) Reflection is found in mirrors while lenses uses refraction.

4) In reflection, the light returns to the same medium while in refraction the light travels from one medium to another medium.

b) Explain the difference among angle of incident, angle of reflection and angle of refraction with the help of formulae and a single diagram?

b) ANGLE OF INCIDENT:-

The incident ray and reflected ray form two angles at the point of incidence.

1) The angle formed between the normal and the incident ray at the point of incidence is called the angle of incidence.

2) ~~The~~ Similarly, the angle of formed between the normal and the reflected ray at the point of incidence is called the angle of reflection.

ANGLE OF INCIDENT FORMULA:-

$$\frac{\sin \theta_2}{\sin \theta_1} = \frac{v_2}{v_1} = \frac{n_1}{n_2}$$

*ANGLE OF REFLECTION:-

The angle between a reflected ray and the normal drawn at the point of incidence to a reflecting surface.

*ANGLE OF REFLECTION FORMULA:-

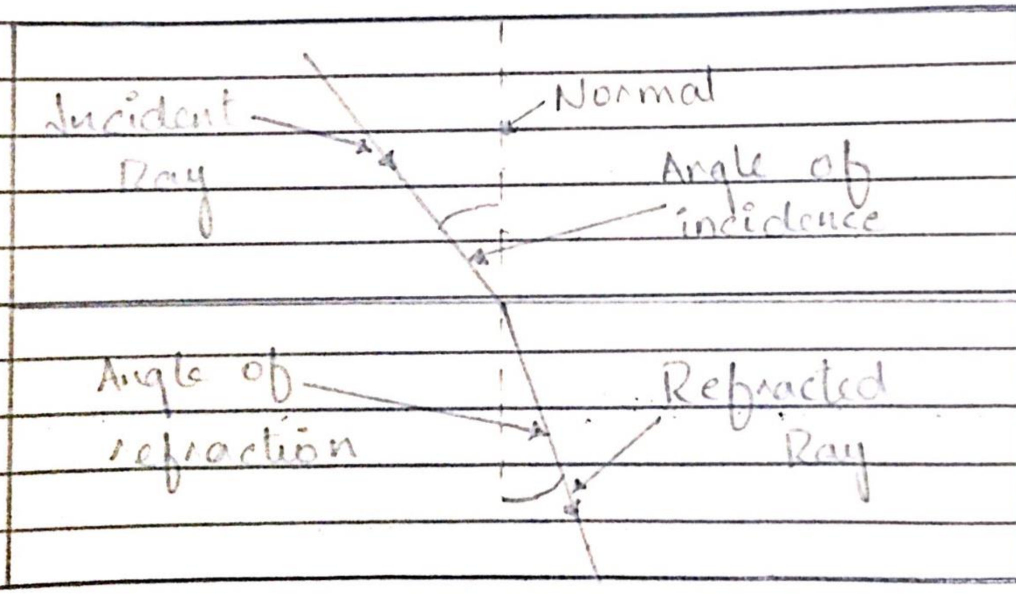
$$\theta_r = \theta_i$$

*ANGLE OF REFRACTION:-

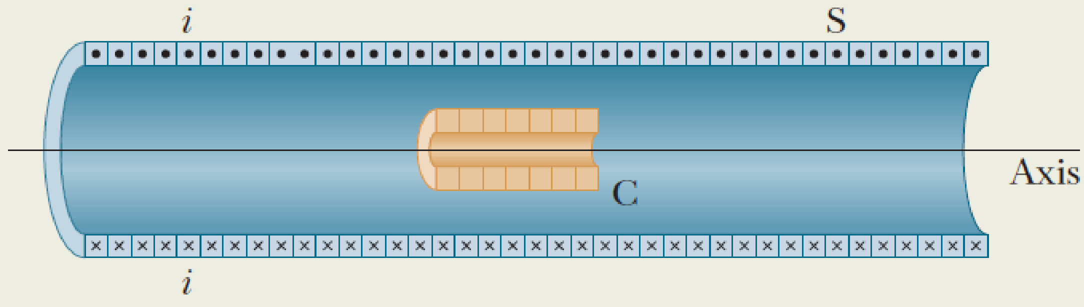
The angle between a refracted ray and the normal drawn at the point of incidence to the interface at which refraction occurs.

ANGLE OF REFRACTION FORMULA:-

$$\frac{\sin i}{\sin r} = \text{constant} = \mu$$



Q3: The long solenoid S shown (in cross section) in the following diagram has 220 turns/cm and carries a current *i* = 1.5 A; its diameter D is 3.2 cm. At its center we place a 130-turn closely packed coil C of diameter d = 2.1 cm. The current in the solenoid is reduced to zero at a steady rate in 25 ms. What is the magnitude of the emf that is induced in coil C while the current in the solenoid is changing?



A coil C is located inside a solenoid S, which carries current *i*.

Q3.

The long solenoid S shown (in cross section) above has 220 turns/cm and diameter D = 3.2 cm; it carries a current i = 1.5 A. At its center we place a 130-turn closely packed coil C of diameter d = 2.1 cm. The current in the solenoid is reduced to zero at a steady rate in t = 25 ms. What is the magnitude of the emf that is induced in coil C while the current in the solenoid is changing?

Solution:-

coil C is in the region of magnetic field of S :

$$B = \mu_0 i n$$

There is a flux through each loop of coil C: $\Phi_1 = BA = (\mu_0 i n)(\pi d^2/4)$

The net flux through coil C: $\Phi = N\Phi_1$; $N = 130$

Flux is decreasing: $\frac{d\Phi}{dt} = NA\frac{dB}{dt} = NA\frac{B_f - B_i}{t} = -NAB/t$

Induced emf $\mathcal{E}$: $\mathcal{E} = -\frac{d\Phi}{dt} = NAB/t = 75\,mV$.

Ans

Q4:

a. How to calculate the magnetic force on current carrying wire?
b. A straight, horizontal length of copper wire has a current i = 28 A through it. What are the magnitude and direction of the minimum magnetic field B needed to suspend the wire, that is, balance the gravitational force on it? The linear density (mass per unit length) of the wire is 46.6 g/m.

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

Q4

a)

CALCULATE:-

All the conduction electron in this section of wire will draft past plan xx in a Time $t = L/v$. Thus in that Time a change given by

$$q = it = i\frac{L}{v_d}$$

will pass through

$$F_B = qv_d B \sin\theta = \frac{iL}{v_d} v_d B \sin 90^\circ$$

$$F_B = iLB$$

$$\vec{F_B} = i\vec{L} \times \vec{B} \quad \text{force on current}$$

$$F_B = iLB \sin\theta$$

$$dF_B = i\,d\vec{L} \times B$$

We ~~have~~ can find the resultant force on a given arrangment of current by integrating over the arrangment.

b) A straight, horizontal length of copper wire has a current i = 28 A through it. What are the magnitude and direction of the minimum magnetic field B needed to suspend the wire, that is, balance the gravitational force on it? The linear density (mass per unit length) of the wire is 46.6 g/m.

b)

~~The~~

SOLUTION:-

The magnitude of $\vec{F_B}$ is $F_B = iLB \sin \theta$. Because we want $\vec{F_B}$ to balance $\vec{F_g}$, we want.

$$iLB \sin \theta = mg,$$

where mg is the magnitude of $\vec{F_g}$ and m is the mass of the wire.

FORMULA:-

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

putting values

$$B = \frac{(46.6 \times 10^{-3} \text{kg/m})(9.9 \text{m/s}^2)}{28 \text{A}}$$

$B = 1.6 \times 10^{-2}$ T Ans.

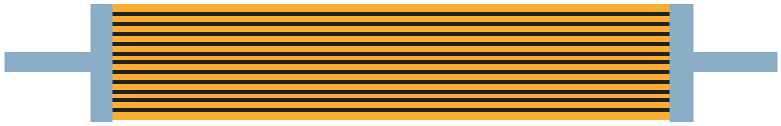
Q5:

a. What is the difference between Resistance and Resistivity?

b. A rectangular block of iron has dimensions 1.2 cm x 1.2 cm x 15 cm. A potential difference is to be applied to the block between parallel sides and in such a way that those sides are equipotential surfaces as shown in the following diagram. What is the resistance of the block if the two parallel sides are

(1) the square ends (with dimensions 1.2 cm x 1.2 cm)

(2) two rectangular sides (with dimensions 1.2 cm x 15 cm)?



a) What is the difference between Resistance and Resistivity?

Q5

a) Difference between Resistance and Resistivity.

Ans) RESISTANCE:-*

1) Resistance is the physical property of a substance because of which it opposes the flow of current i.e. electrons.

2) Resistance is directly proportional to the length and temperature while it is inversely proportional to the cross-sectional area of the material.

3) Its symbol is R.

4) The formula for resistance is $R = V/I$ or, $R = \rho(L/A)$ where V = voltage, I = current, ρ = Resistivity.

5) The SI unit of resistance is Ohms.

6) The property of resistance is used in several places like heaters, fuses, sensors, etc.

RESISTIVITY:-

1) Resistivity is the physical property of a particular substance which is having particular dimensions.

2) Resistivity is only proportional to the nature and temperature of the particular material.

3) Its symbol is ρ.

4) The formula for resistivity is $\rho = (R \times A)/L$ where R = Resistance, L = Length, A = Cross sectional area.

5) The SI unit of resistivity is Ohm's meter.

6) Electrical resistivity measurement is used as a quality control test for calcareous soil.

b) A rectangular block of iron has dimensions 1.2 cm x 1.2 cm x 15 cm. A potential difference is to be applied to the block between parallel sides and in such a way that those sides are equipotential surfaces as shown in the following diagram. What is the resistance of the block if the two parallel sides are

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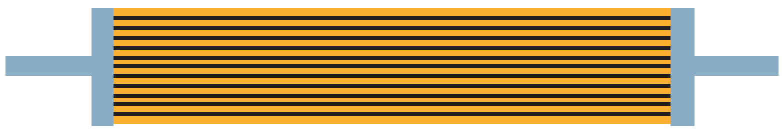

b)

CALCULATION:

For arrangement 1, we have $L = 15\,cm = 0.15\,m$ and

$$A = (1.2\,cm)^2 = 1.44 \times 10^{-4}\,m^2.$$

$$R = \frac{\rho L}{A} = \frac{(9.68 \times 10^{-8}\,\Omega \cdot m)(0.15\,m)}{1.44 \times 10^{-4}\,m^2}$$

$$= 1.0 \times 10^{-4}\,\Omega = 100\,\mu\Omega. \quad \text{Ans}$$

Similarly, for arrangement 2, with distance $L = 1.2\,cm$ and area $A = (1.2\,cm)(15\,cm)$, we obtain

$$R = \frac{\rho L}{A} = \frac{(9.68 \times 10^{-8}\,\Omega \cdot m)(1.2 \times 10^{-2}\,m)}{1.80 \times 10^{-3}\,m^2}$$

$$= 6.5 \times 10^{-7}\,\Omega = 0.65\,\mu\Omega. \quad \text{Ans.}$$