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Final Term Examination

Subject Name: Applied Physics
Class: BS SE-1, CS-1
Instructor: M Khalid Hamid
Total Marks: 50

Q.1 (a) How to calculate the magnetic force on current carrying wire?

The **force** on an individual charge moving at the drift velocity v_d is given by $F = qv_dB \sin \theta$. Taking B to be uniform over a length of **wire** l and zero elsewhere, the total **magnetic force** on the **wire** is then $F = (qv_dB \sin \theta)(N)$, where N is the number of charge carriers in the section of **wire** of length l.

EXAMPLE

Calculate the force on the wire shown in Figure 1, given $B = 1.50$ T, $l = 5.00$ cm, and $I = 20.0$ A.
Strategy
The force can be found with the given information by using F=IlBsinθF=IlBsin θ and noting that the angle θ between I and B is 90º, so that $\sin \theta = 1$.
Solution
Entering the given values into $F = IlB \sin \theta$ yields

$$F = IlB \sin \theta = (20.0 \text{ A})(0.0500 \text{ m})(1.50 \text{ T})(1).$$

The units for tesla are 1 T=NA·m1 T=NA·m; thus,

$$F = 1.50 \text{ N}.$$

Discussion
This large magnetic field creates a significant force on a small length of wire.

Q.1 (b) What is the difference between Resistance and Resistivity?

Sl. No.	Differentiating Property	Resistance	Resistivity
1	Definition	Resistance is the physical property of a substance because of which it opposes 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 inversely 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	ρ
4	Formula	$R = V/I$ or, $R = \rho(L/A)$ V = Voltage, I = Current, ρ = Resistivity	$\rho = (R \times A)/L$ R = Resistance, L= Length, A = Cross-sectional area
5	SI Units	The SI unit of resistance is Ohms	The 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 measurement is used as a quality control test for calcareous soil.

Q. 2(a) What is the difference between reflection and refraction?

Difference between Reflection and Refraction	
Reflection	Refraction
This phenomenon usually occurs in mirrors.	This phenomenon usually occurs in Lenses.
Reflection can simply be defined as the reflection of light when it strikes the medium on a plane.	Refraction can be defined as the process of the shift of light when it passes through a medium leading to the bending of light.
The light entering the medium returns to the same direction.	The light entering the medium travels from one medium to another.
Considering the light waves, they bounce from the plane and change direction.	The light waves pass through the surface while simultaneously change from medium to medium.
The angle of incidence of the light is equal to the angle of reflection.	The angle of incidence is not equal to the angle of reflection.

Q.2 (b) Explain the difference among angle of incident, angle of reflection and angle of refraction with the help of formulae and a single diagram?

Angle Of Incidence

In optics, angle of incidence can be defined as the angle between a ray incident on a surface and the line perpendicular to the surface at the point of incidence (called as normal). To understand the angle of incidence, we have to first look into the concept of reflection of light. We all know that when a ray of light hits a polished surface like a mirror, it is reflected back.

Angle Of Incidence Formula

The angle of incidence is equal to the reflected angle through the law of reflection. The angle of incidence and the angle of reflection is always equal, and they are both on the same plane along with the normal.

The relationship between the angle of incidence and angle of refraction:

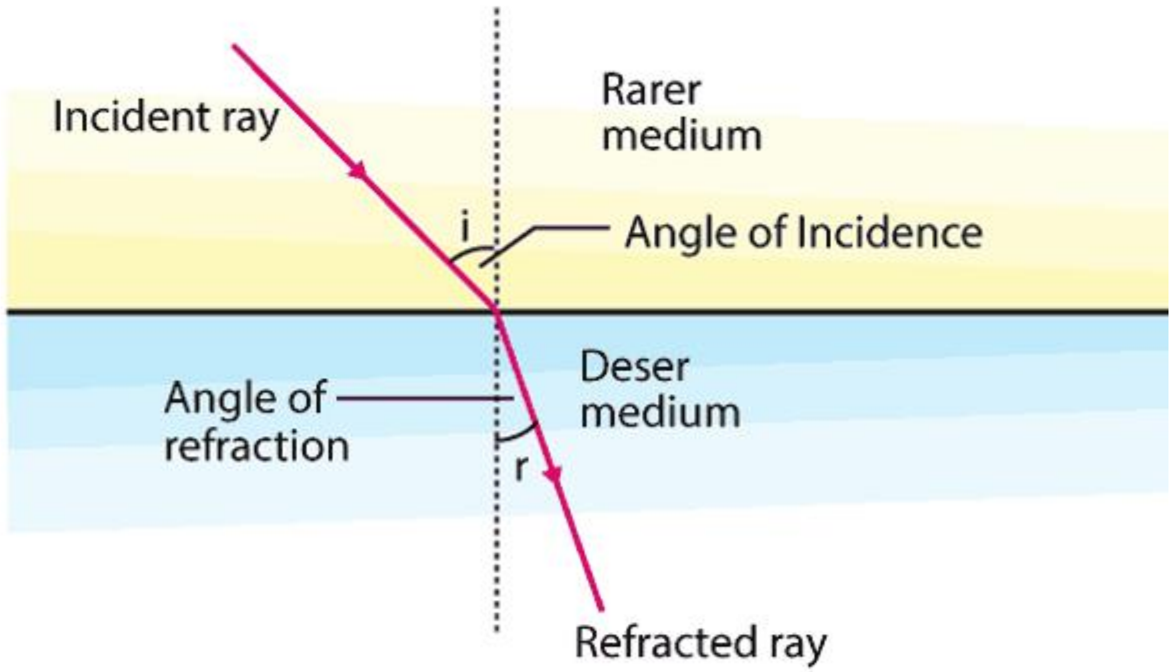
When light passes from one medium to another with different densities, its path gets deviated. This phenomenon is called the refraction of light. Like a reflection, there are similar components in refraction too. They are:

Incident ray

Refracted ray

Normal

Point of incidence

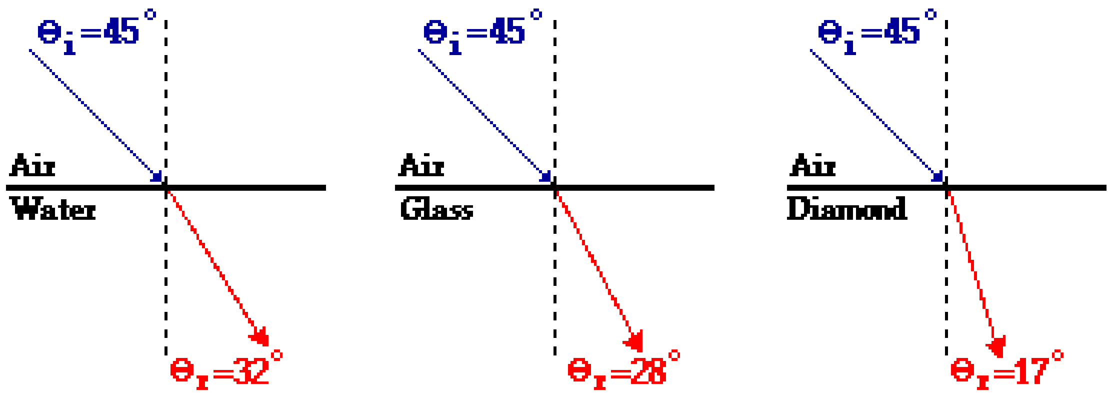


Angle of Incidence and Angle of Refraction

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

The relationship between the angle of incidence and angle of refraction is explained by Snell's law, which states that the ratio of the sine of the angle of refraction and the sine of the angle of incidence is always constant and equivalent to the ratio of phase velocities of the two mediums it is passing through.

Angle of Refraction Diagram:



Q.3 (a) Find the difference between electric potential energy and electric potential?

Electric potential:

Ans: Electric potential (V) is the property of points in space. Electric potential can be defined in several ways:

The value of the electric potential at a point in space numerically gives the amount of work that needs to be done to bring a unit positive charge from infinity to that point.

A charge qq is said to have a potential energy of VqVq if it is at a point in space which has a potential of VV.

For example, if you place a charge qq at a point, space nearby will have a non-zero value of potential. The electric potential at a point due to a charge at a distance rr from it is given by:

V=kqrV=kqr

Electric Potential Energy:

Electric potential energy (U) is the property of a system. Two charges in the vicinity of each other are said to have potential energy.

The electric potential energy associated with two charges separated by a distance rr is given by:

U=kq1q2r

Q.3 (b) How to find the potential difference between any two points in the electric field lines?

Electric Potential Difference:

The electric potential at a particular point in space is the work done in moving a positive charge from infinity to that point. The electric potential at infinity is defined as zero. It is related to the electric potential energy in that electric potential is the electric potential energy per unit charge.

So, if a four coulomb charge has 4,000 Joules of electric potential energy due to its position in an electric field that would mean that the electric potential at that point in the field is 1,000 Joules per coulomb - each coulomb has a thousand Joules of electric potential energy. Whereas electric potential energy is specific to a particular charge, electric potential is defined only by a position inside a field. This makes it a much more useful quantity.

To understand how a point can have potential at all, think about dropping a mass in a gravitational field. If you drop a ball, it falls to the ground. This is because it had gravitational potential energy relative to the ground, and this energy was released when you let go of the ball. Gravitational potential (instead of electric potential) would be the energy per unit mass (instead of energy per unit charge), and would describe the point in space where you let go of the ball.

Let's imagine we have two parallel plates: one with a positive charge and one with a negative charge. In electromagnetism, we use a positive charge to define electric fields. So we'll focus on what happens to a positive charge inside the plates. If you release a positive charge on the negative plate, it won't go anywhere because opposites attract. But, if you release it on the positive plate, it will follow the field lines and 'fall' to the negative plate. So when we talk about electric fields, we say that the field lines point in the direction of decreasing electric potential.

And now, finally, that brings us to electric potential difference. Electric potential difference is the difference in electric potential between two points in space. That's really all it is. It is also measured in Joules per coulomb, but this is usually shortened to a different unit: volts. The electric potential difference between two sides of a battery is what makes electricity flow around a circuit. A 12V battery.

Q.4 (a) Differences between Forward and Reverse Bias

The forward bias reduces the strength of the potential barrier due to which the current easily move across the junction whereas reverse bias strengthens the potential barrier and obstruct the flow of charge carrier.

In forward biasing the positive terminal of the battery is connected to the p-region and the negative terminal is connected to the n-type material while in reverse bias the positive terminal of the supply is connected to the n- type material and the negative terminal is connected to the p-type material of the device.

The forward bias set up the electric field across the potential which reduces the strength of the potential barrier whereas the reverse bias increases the strength of the potential barrier.

Note -The potential barrier is the layer between the PN junction diode which restrict the movement of electrons across the junction.

In forward biasing the voltage of the anode is greater than the cathode whereas in reverse bias the voltage of the cathode is greater than the anode.

The forward bias has large forward current while the reverse bias has very small forward current.

Note – The current in the diode when flow in the forward direction is called forward current.

The depletion layer of the diode is very thin in forward biasing and thick in reverse bias.

Note – The depletion layer is the region around the junction in which the free charge carriers are depleted.

The Forward bias decreases the resistance of the diode whereas the reversed bias increases the resistance of the diode.

In forward biasing the current is easily flowing through the circuit whereas reverse bias does not allow the current to flow through it.

In forward biasing the magnitude of the current depends on the forward voltage whereas in reverse bias the magnitude of the current is very small or negligible.

In forward biasing the device operates as a conductor whereas in reverse bias the device act as an insulator.

The forward voltage of the silicon diode is 0.7 volts, and the forward voltage of the germanium is 0.3 volts.

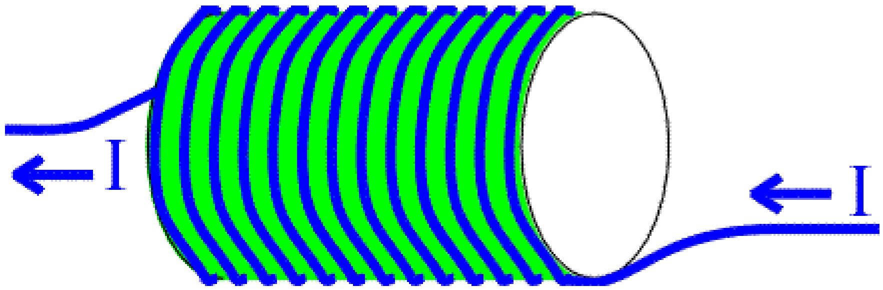
Q.4 (b) How reverse breakdown occur in a diode?

“Break down” of a diode occurs during its reverse biased condition. We all know, under reverse bias the positive terminal of battery is connected to n side and the negative terminal of battery is connected to p side. As a result, electrons will be drawn towards the terminal of n side and holes will be draw towards terminal of p side. At this condition electron hole recombination will not happen and hence minority carrier movement is absent. This is the reason a diode is not conducting under reverse bias condition.

If we keep on increasing the applied reverse voltage, the depletion width will increase accordingly. At a point which we can call as “breakdown point”, the diode will get damaged. At this point, the diode behave more like a shorted wire and hence current flows through it easily. The internal resistance of diode at this stage is approximately near zero. According to Ohms Law, V = I/R and since resistance is very low, current increases many folds with voltage. This is the reason we get a perpendicular line shoot in VI characteristics of reverse bias.

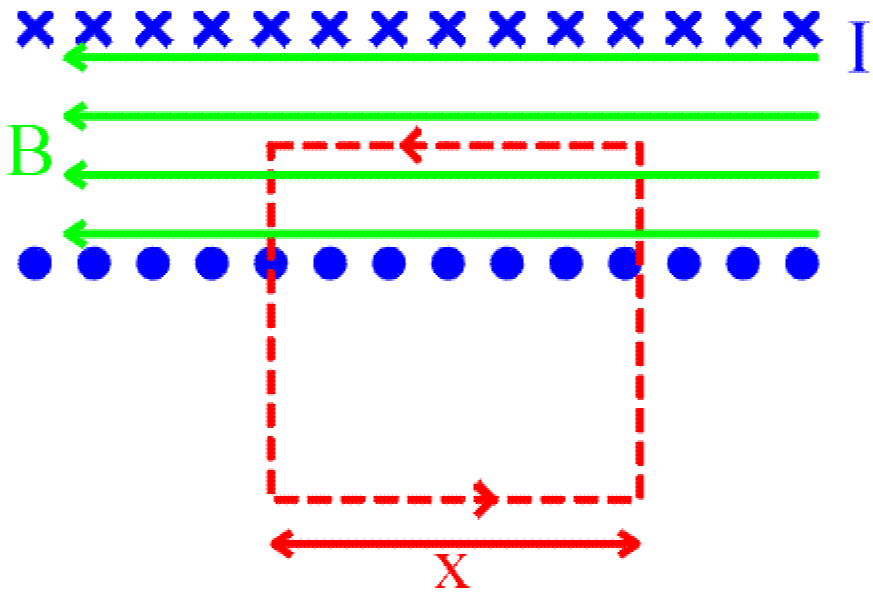
Q.5 (a) Magnetic field of a solenoid

A solenoid is a coil of wire designed to create a strong magnetic field inside the coil. By wrapping the same wire many times around a cylinder, the magnetic field due to the wires can become quite strong. The number of turns N refers to the number of loops the solenoid has. More loops will bring about a stronger magnetic field. The formula for the field inside the solenoid is



B = m0 I N / L

This formula can be accepted on faith; or it can be derived using Ampere's law as follows. Look at a cross section of the solenoid.



The blue crosses represent the current traveling into the page, while the blue dots represent the currents coming out of the page. Ampere's law (left) for the red path can be written as.

$$\sum_i B_i \, \Delta L_i \cos\theta_i = \mu_0 I \quad \Rightarrow \quad B \cdot x = \mu_0 \left(\frac{N}{L} x \right) I$$

Where the number of loops enclose by the path is (N/L)x. Only the upper portion of the path contributed to the sum because the magnetic field is zero outside, and because the vertical paths are perpendicular to the magnetic field. By dividing x out of both sides of the last equation, one finds:

$$B = \mu_0 \left(\frac{N}{L}\right) I$$

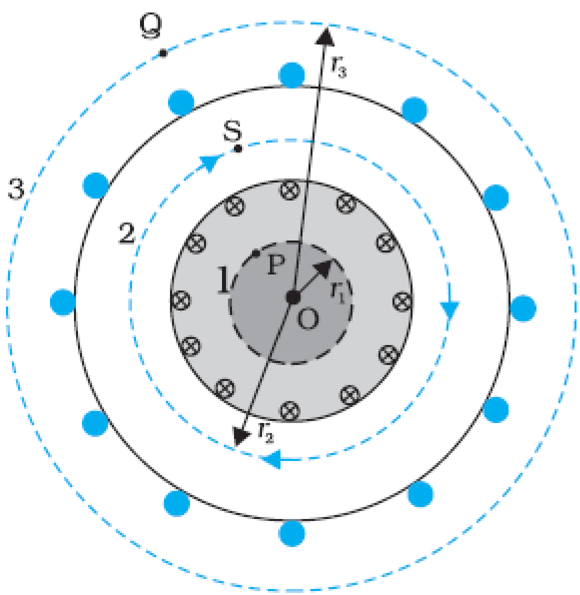
The magnetic field inside a solenoid is proportional to both the applied current and the number of turns per unit length. There is no dependence on the diameter of the solenoid, and the field strength doesn't depend on the position inside the solenoid, i.e., the field inside is constant.

Q.5 (b) What is the difference between reflection and refraction?

TOROID

If a solenoid is bent in a circular shape and the ends are joined, we get a toroid. Alternatively, one can start with a no conducting ring and wind a conducting wire closely on it. The magnetic field in such a toroid can be obtained using Ampere's Law.

mAGNETIC FIELD of a TOROID



The magnetic field in the open space inside (point P) and exterior to the toroid (point Q) is zero. The field B inside the toroid is constant in magnitude for the ideal toroid of closely wound turns.The direction of the magnetic field inside is clockwise as per the right-hand thumb rule for circular loops. Three circular Amperian loops 1, 2 and 3 are shown by dashed lines.
By symmetry, the magnetic field should be tangential to each of them and constant in magnitude for a given loop.
Example: The number of turns per unit length in a toroid is 103 and current flowing in it is 4π1 ampere, then the magnetic induction produced in it, is :
Magnetic field in a toroid B=μ0ni

Given $n=103$ and $I = 4\pi 1A$

We know that $\mu 0=4\pi\times 10-7T/A$

$B=4\pi\times 10-7\times 103\times 4\pi 1=10-4T$