APPLIED PHYSICS

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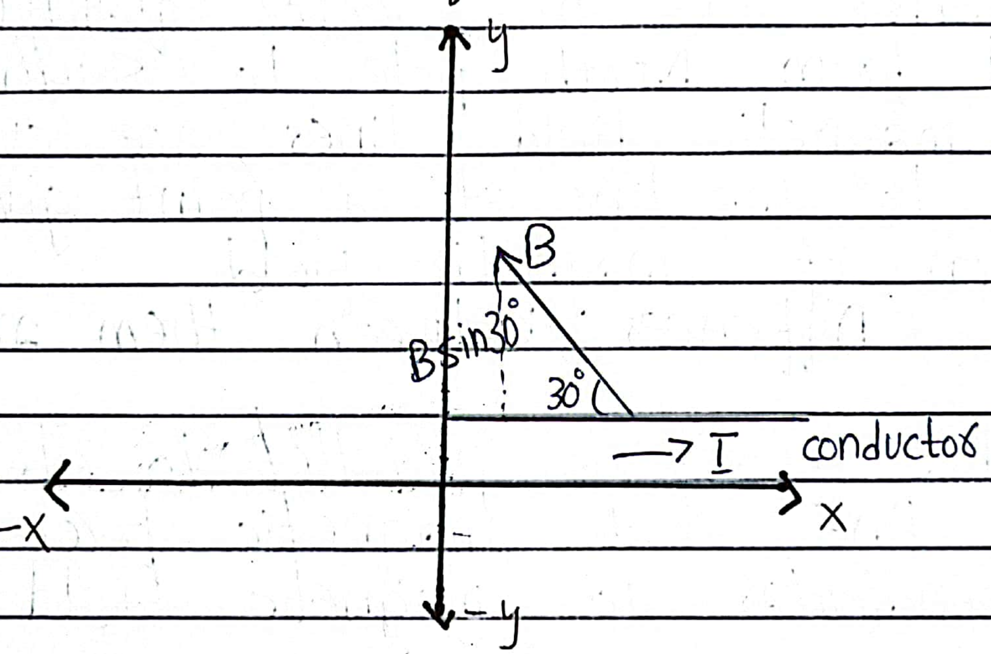
BESE-26C

Assignment

PROBLEM 01:

A straight horizontal wire carries current $I = 30A$, in the direction of positive x-axis. Magnetic field density $= 1.5T$, is directed towards y-axis at an angle of $30°$ with x-axis, find the magnitude of direction of magnetic force on 0.5m section of wire.



Solution:

DATA:

$I = 30A$
$B = 1.5T$
$L = 0.5m$

$$F = (30)(0.5)(1.5)\sin 30\ (A.m.NA^{-1}m^{-1})$$

$$F = 45/4 = 11.25N.$$

Ans) Magnitude of force is 11.3N, in the direction upwards/out of the page using right hand Rule

PROBLEM.02.

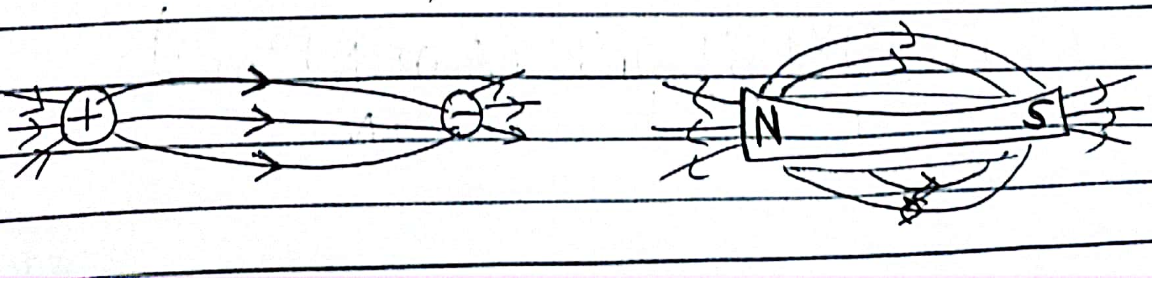
What are magnetic field lines compare and bring out major differences between magnetic and electric field lines

Magnetic field lines represent magnetic field. It is only set up by a moving charge which exerts force on other moving charges. Magnetic field lines do not cross each other and are vector quantity directed from North pole to South. When magnetic field lines are curved, tangent to the line at a point gives direction of magnetic field.

Diffences between them are:

1. Electric force is parrallel to electric field line, but magnetic force is perpendicular to magnetic field line.

2. Magnetic field lines are directed from North to South and viceversa in a closed loop, while electric field lines originate from a charge and terminate at -ve charge.



PROBLEM.NO.03

A strip of Cu, thickness 450 μm is placed in a mag. field, having $B = 1.65T$ and perpendicular to field on strip, carrying current $= 15A$. Find voltage.

Formula : $V_H = \frac{IB}{net}$

$t = 450 \times 10^{-6} m$
$B = 1.65\ T$
$I = 15A$
$n = 8.49 \times 10^{28} m^{-3}$
$e = 1.6 \times 10^{-19} C$

$$V_H = \frac{15 \times 1.65 \ (A.T)}{(8.49 \times 10^{28})(1.6 \times 10^{-19})(450 \times 10^{-6}) \ (m^{-3}.C.m)}$$

$\boxed{V_H = 4.05 \times 10^{-6} V}$ Answe.

PROBLEM NO. 04.

State mass action law relating to electron and hole concentrations in case of intrinsic materials. A N-type bar of Si has dopant concentration $= 4.5 \times 10^{16}\, cm^{-3}$. Find concentration.

Mass Action Law:

Due to re-combination rate, number of holes is reduced as compared to intrinsic material.

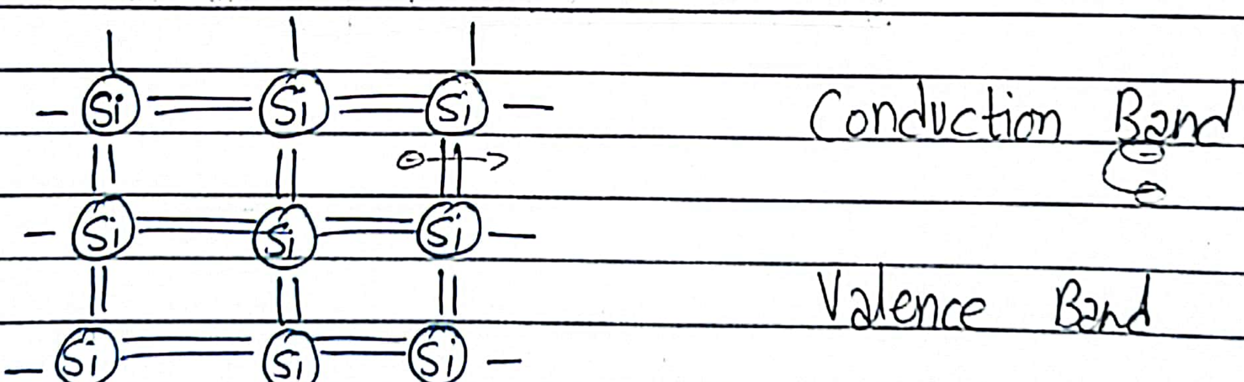
$$n \propto p = n_i^2 = \text{constant}$$

$$n_n = n_{thermal} = n_D \quad (n_{thermal} \text{ is very less } N_D)$$

$$n_n \simeq n_D \quad \text{(Appoximat Majority Carries)}$$

$$P_n \times n_n = (n_i)^2$$

$$P_n = \frac{(n_i)^2}{n_n} \quad \text{(Minority Carrers)}$$



$$n_n \simeq n_D$$

$$n_n = 4.5 \times 10^{+16}\ es\,cm^{-3}$$

$$n_p = \frac{(1.5 \times 10^{10})^2}{4.5 \times 10^{+16}}$$

$$n_p = 5000 \text{ holes } cm^{-3}$$

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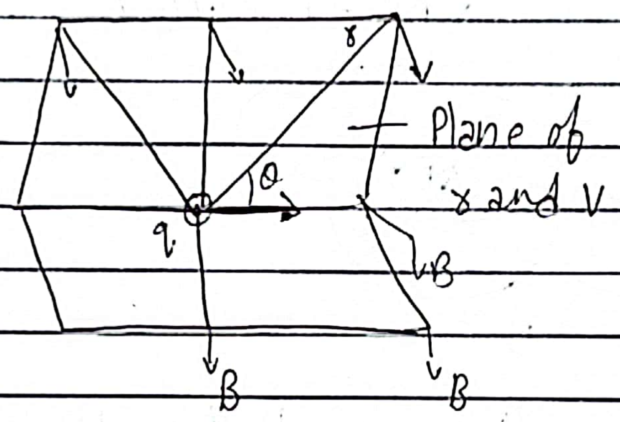
Concentration of majority carriers is 4.5×10^{16} es cm^{-3} and of minority carries is 5×10^{3} es cm^{-3}.

PROBLEM.NO.05.

M field of a point charge q, moving with velocity v, is $B = (qv\sin\theta)/r^2$, find magnetic field due to an element of current. How can it represent Biot-Savart law



There is a small element of a current carrying conductor, this will have small quantity of charge $dq = nAq\,dl$

$$\text{Magnetic field is } \frac{K' dq\, v \sin\theta}{r^2}$$

$$dB = \frac{K'(JA\,dl \sin\theta)}{r^2}$$

$$= \frac{K' I\, dl \sin\theta}{r^2}$$

$$\int dB = K' \int \frac{I\, dl \sin\theta}{r^2}$$

$$\boxed{B = K' \int \frac{I\, dl \sin\theta}{r^2}} \quad \text{Biot-Savart Law}$$

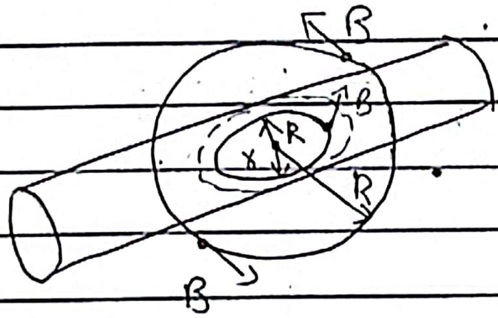
PROBLEM. NO. 06.

Using Ampere's Circuital law, find magnetic field due to a long conductor carrying current I.

A cylinderical conductor of radius R carries current I. The current is uniformly distributed over the cross-sectional area.

From ampere's law, we know that,

$$\oint \vec{B} \cdot \vec{dl} = \mu_0 I$$



From outside the conductor, the current (ampere loop) will be a circle of radius r, where r < R

$$B \times 2\pi r = \mu_0 I$$

$$\boxed{B = \frac{\mu_0 I}{2\pi r}}$$

PROBLEM. 7.

Define potential and potential energy ......

Electric Potential.

The potential is the amount of work or energy needed to move a unit of electric charge from a reference point to the specific point in an electric field.

Potential Energy.

Electric potential energy is the energy that is needed to move a charge against electric field.

Numerical Solution:

$r = d = 12\ cm = 12 \times 10^{-2}\ m$

$\lambda = 4\ \mu C\ cm^{-1} = 4 \times 10^{-6}\ C / 10^{-2}\ m$

$R = 4\ cm = 4 \times 10^{-2}\ m$

Formula:

$$V = \frac{\lambda}{2\pi\varepsilon_0} \ln \frac{R}{r}$$

$$V = \frac{(4 \times 10^{-6}\ C)/10^{-2}\ m}{2\pi (8.85 \times 10^{-12}\ C^2 N^{-1} m^{-2})} \ln \left(\frac{4 \times 10^{-2}\ m}{12 \times 10^{-2}\ m} \right)$$

$$V = -7.9 \times 10^{6}\ V$$

$\boxed{V = -7.9\ MV}$ Answer

PROBLEM.NO.08 :

Find capacitance of a parralel plate.....

Solution.

Capacitance of a parraal plate capacitor having rectangular plate:

Consider two parallel conductivity plates, seperated by vaccum, each carries a charge Q.
let the conducting plate A have Area "A" and seperated by distance 'd'.
By Gauss's Law, magnitude of electric field between the two parraal plates is given by

$$E = \sigma/\varepsilon_0 = Q/\varepsilon_0 A$$

E field brings uniformity of a parallel plate

$$E = V_{ab}/d \Rightarrow V_{ab} = Ed = Qd/\varepsilon_0 A$$

Putting all this together;

$$C = \frac{Q}{V_{ab}} = \varepsilon_0 \frac{A}{d}$$

Capacitance of a parallel-plate capacitor:

Using line integral the Potential Difference is

~~Vab~~ $V_{ab} = \Delta V = \int_a^b E\,dr, \; E = kQ/r^2$

$$\Delta V = kQ \int_a^b r^{-2}\,dr$$

$$\Delta V = kQ \left| \frac{1}{a} - \frac{1}{b} \right|$$

Capactance will be,

$$C = Q/\Delta V = (ab)/k\,(b-a)$$

$$C = 4\pi\varepsilon_0\,(ab)/b-a)$$

where $b-a$ is seperation b/w plates.

The capacitance of the geometry of capacitor and material b/w plates:

$$C = \varepsilon_0 \frac{A}{d}$$

From here, Capacitance is function only of geometry and what material fill the space between plates

From $Q = CV$, adding charge increases potential.

$\Rightarrow$ Areas increase, so will the C of the plates. While increasing seperation will decrease Capacitance