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S. B. ARTS & K. C. P. SCIENCE COLLEGE, VIJAYAPUR

Ist INTERNAL TEST 2022-2023

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Subject/ವಿಷಯ : Physics (DSC) Semester/ಸೆಮಿಸ್ಟರ್ : Ist Exam Seat No / ಪರೀಕ್ಷಾ ಕ್ರಮಾಂಕ : U15KM22S0180

Invigilator's Signature / ಕೊಠಡಿ ಮೇಲ್ವಿಚಾರಕರ ಸಹಿ Signature of Evaluator / ಪರೀಕ್ಷಕರ ಸಹಿ 20/20 Marks obtained/ ಪಡೆದ ಅಂಕಗಳು

05/05

Part - I:

Ans-1) Newton's law of gravitation states that every object in the universe attracts every other object with a force which is directly proportio-nal to the product of their masses of two objects and inversely proport-ional to the square of distance b/w their centers.

1

2

$F \propto m_1 m_2$

$F \propto \frac{1}{r^2}$

$$\boxed{F = \frac{K m_1 m_2}{r^2}}$$

m_1 & m_2 are masses of two objects

r is the distance b/w their centers

Ans-2) The velocity of the satellite to rotate around the earth by overcoming its gravitational force is called as orbital velocity.

2

The expression of orbital velocity for open orbit is:

$h >>>> R$

$\boxed{V_0 = \sqrt{gr}}$

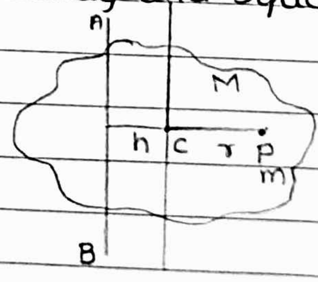
g = acceleration due to gravity

r = radius of satellite

Ans-3) Parallel axis theorem states that the moment of inertia of the axis parallel to the axis passing through the center of rigid body is equal to sum of moment of inertia of the axis passing through the center and product of mass of the rigid body and square of the distance between the two axis.

2

$I_{AB} = I_C + Mh^2$



1

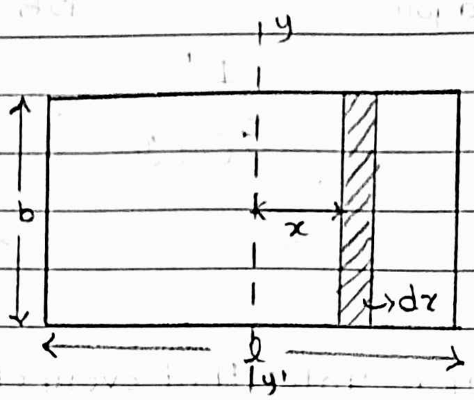
Ans-4) The potential energy stored per unit area of the surface film is called as surface energy.

2

Surface film is the layer between plane (drawn parallel to the free surface of the liquid) and the free surface.

Part - II:

Ans-7) a)



l and b are length and breadth of rectangular lamina.

8

Mass per unit area of the rectangular lamina $= \frac{M}{l \times b}$.

Area of the elementary rectangle $= b \times dx$.

Mass of the elementary rectangle $= \frac{M}{l \times \cancel{b}} \times \cancel{b} \times dx$

$$dm = \frac{M \cdot dx}{l}$$

Moment of Inertia of elementary rectangle, $dI = dm \times x^2$

$$dI = \frac{M}{l} \times x^2 \cdot dx$$

Moment of Inertia of rectangular lamina $\Rightarrow I = \int dI$

$$= \int_{-l/2}^{+l/2} \frac{M}{l} x^2 \cdot dx$$

$$I = \frac{M}{l} \int_{-l/2}^{l/2} x^2 \cdot dx$$

$$I = \frac{M}{l} \left[\frac{x^3}{3}\right]_{-l/2}^{l/2}$$

$$I = \frac{M}{l} \left[\frac{l^3/8}{3} - \left(-\frac{l^3/8}{3}\right)\right]$$

$$I = \frac{M}{l} \left[\frac{l^3}{24} + \frac{l^3}{24}\right]$$

$$I = \frac{M}{l} \left[\frac{2 l^3}{24}\right]$$

$$I = \frac{M}{l} \left[\frac{l^3}{12}\right]$$

$$\boxed{I_{yy'} = \frac{M l^2}{12}} \qquad \boxed{I_{xx'} = \frac{M b^2}{12}}$$

Radius of gyration:

$$K = \sqrt{\frac{I}{M}} \Rightarrow \sqrt{\frac{\cancel{M} l^2}{12 \cancel{M}}}$$

$$\boxed{K = \sqrt{\frac{l^2}{12}}} \text{ (or) } \boxed{K = \sqrt{\frac{b^2}{12}}}$$

b) Diameter of the orbit = 30(Diameter of the Earth's orbit)

Radius of the orbit = 30(Diameter of the Earth's orbit)

$$r_N = 30(r_E)$$

$$\frac{r_N}{r_E} = 30.$$

By Kepler's third law.

Time period (or) orbital period of Earth ⇒ $T_E = 1$ year.

$$\left(\frac{T_N}{T_E}\right)^2 = \left(\frac{T_N}{r_E}\right)^3$$

$$(T_N)^2 = (30)^3(T_E)^2$$

$$(T_N)^2 = \cancel{3}\,27000(1)^2$$

$$(T_N)^2 = 27000$$

$$T_N = \sqrt{27000}$$

$$T_N = 164.3 \text{ years.}$$

∴ The period of revolution of Neptune round the Sun is 164.3 years//

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II INTERNAL TEST 20 -20

Name / ಹೆಸರು : Aishwarya. H. Roll No./ಕ್ರಮಾಂಕ : 117 Date /ದಿನಾಂಕ : 05-01-2023

Subject/ವಿಷಯ : Physics Semester/ಸೆಮಿಸ್ಟರ್ : I Exam Seat No / ಪರೀಕ್ಷಾ ಕ್ರಮಾಂಕ :

UUCMS NO : U15KM22S0054

Invigilator's Signature / ಕೊಠಡಿ ಮೇಲ್ವಿಚಾರಕರ ಸಹಿ Signature of Evaluator / ಪರೀಕ್ಷಕರ ಸಹಿ Marks obtained/ ಪಡೆದ ಅಂಕಗಳು

20/20

Part - I

1 1) *) Gauss Divergence Theorem :- The Surface integral of the normal compound of a Sector A taken over a closed Surface S is equal to the Volume integral of the divergence of a taken over the Volume V enclosed by the Surface S.

$$\iint A\, ds = \iiint (\operatorname{div} A)\, dv$$

2 *) Stoke's Theorem :- The line integral of a Vector A taken around a closed curved c which bounds a Surface S is equal to the integral of the curl of a taken over S.

$$\int A\, ds = \iint \operatorname{curl} A \cdot ds.$$

2) Scalars : Physical quantities which have magnitude only but not associated with direction or orientation in space are called scalars.

=> Properties of Scalars

i) Law of Association :

2

$$A+B+C = A+(B+C) = (A+B)+C = (A+C)+B$$

and $A\times(B\times C) = (A\times B)\times C = (A\times C)\times B.$

ii) Law of Communication : $A+B = B+A$, $A\times B = B\times A$

iii) Law of distribution : $A\times(B+C) = A\times B + A\times C$

$(A+B)\times C = A\times C + B\times C$

iv) if $A\times B = 0$

1 4) types of elastics constants.

Young's modulus (Y)

Modulus of Rigidity (μ).

2 Bulk modulus (K)

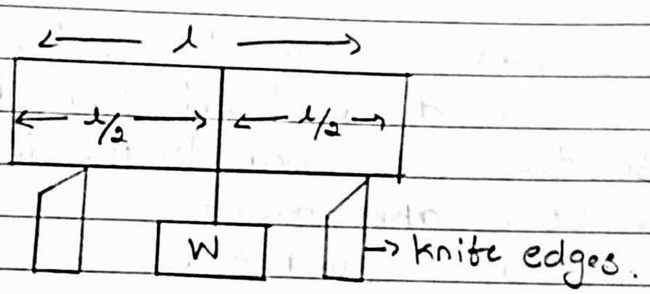
Poisons Ratio

5) Poisson's ratio is the ratio of lateral strain to longitudinal strain.

8) c) Young's modulus is defined as ratio of normal stress to the longitudinal strain.

$$\text{Young's modulus} = \frac{\text{Normal stress}}{\text{longitudinal strain}}$$

$$Y = \frac{F/a}{dl/l} = \frac{Fl}{a.dl}$$



$$\text{Moment of bending Couple} = \text{Force} \times \text{Perpendicular distance}$$

$$= \frac{w}{2} \times \left(\frac{l}{2} - x\right) \quad \text{--- (1)}$$

$$\text{Bending moment (BM)} = \frac{YI_g}{R} \quad \text{--- (2)}$$

Equating eq^n (1) & (2)

$$\frac{w}{2} \times \left(\frac{l}{2} - x\right) = \frac{YI_g}{R}$$

Here $\frac{1}{R} = \frac{d^2y}{dx^2}$

$$YI_g \cdot \frac{d^2y}{dx^2} = \frac{w}{2}\left(\frac{l}{2} - x\right)$$

$$\frac{d^2y}{dx^2} = \frac{w}{2I_g y}\left(\frac{l}{2} - x\right) \quad —③$$

Integrating on both side. w.r.t x

$$\frac{dy}{dx} = \frac{w}{2yI_g}\left(\frac{lx}{2} - \frac{x^2}{2}\right) + C$$

Put $x=0$ & Also $\frac{dy}{dx}$, $C=0$

$$\frac{dy}{dx} = \frac{w}{2yI_g}\left[\frac{lx}{2} - \frac{x^2}{2}\right] + 0$$

$$\frac{dy}{dx} = \frac{w}{2yI_g}\left[\frac{lx}{2} - \frac{x^2}{2}\right] \quad —④$$

integrating eqⁿ ④ b/w terms 0 to $l/2$

$$y = \frac{w}{2yI_g}\left[\frac{l}{2}\frac{x^2}{2} - \frac{x^3}{6}\right]_0^{l/2}$$

8 –

$$y = \frac{w}{2yI_g}\left[\frac{ll^2}{16} - \frac{l^3}{48}\right]$$

$$y = \frac{w}{2yI_g}\left[\frac{l^3}{16} - \frac{l^3}{48}\right]$$

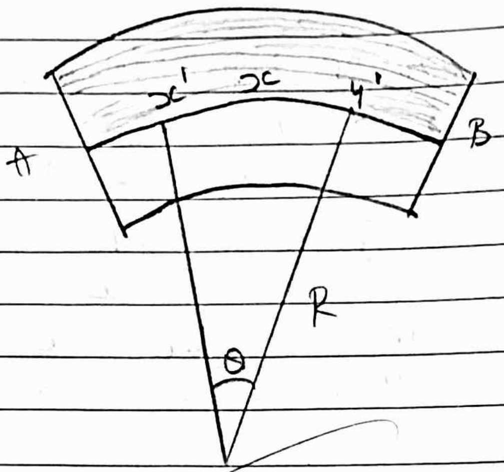
$$y = \frac{w}{2yI_g}\left[\frac{2l^3}{48}\right]$$

$$\boxed{y = \frac{wl^3}{48yI_g}}$$

l = length of bending beam.

I_g = Gyration of moment of inertia.

d)



Let beam AB be fixed at A and loaded at B as shown in figure

This arc subtending angle θ to O.
Let R be the radius of curvature of this part of the neutral axis

Let x' y' be an element at a distance x from the neutral axis.

AB = Neutral axis.

$xy = R\theta$

$x'y' = (R+x)\theta$

The original length $= R\theta$

Change in length $= x'y' - xy$

$= (R+x)\theta - R\theta$

$= x\theta$

Now

$$\text{Strain} = \frac{\text{Change in length}}{\text{Original length}}$$

$$\frac{x\theta}{R\theta}$$

$$\text{Strain} = \frac{x}{R}$$

Hence the strain is proportional to the distance from the neutral axis.

Now consider a small area δa at distance x.

Young's modulus $Y = \frac{\text{Stress}}{\text{Strain}}$

$\therefore$ Stress $= Y \times$ Strain

$$\frac{F}{\delta a} = Y \times \frac{x}{R}$$

The force F on area δa $= \frac{Y \times x}{R} \times \delta a$

$\therefore$ The force F on area δa $= \frac{Y \times x}{R} \times \delta a$.

Then, the moment of this force = force $\times$ distance

$$= \frac{Y \times x}{R} \times \delta a \times x$$

4

$$= \frac{Y \times x^2}{R} \delta a$$

Then the total moment of force.

$$= \Sigma \frac{Yx^2}{R} \delta a$$

$$= \frac{Y}{R} \Sigma x^2 \delta a.$$

Gyration of moment of Inertia I_g

$$I_g = \Sigma x^2 \delta a$$

$$I_g = ak^2$$

where a - area of the surface.

k - radius of gyration.

$\therefore$ The moment of forces $= \frac{Y}{R} \cdot ak^2$

$$= \frac{Y \, I_g}{R}$$

$\therefore$ The bending moment M of beam is

$$\boxed{M = \frac{Y \, I_g}{R}}$$

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I INTERNAL TEST 20 -20

Name / ಹೆಸರು : Anjana G. patil Roll No./ಕ್ರಮಾಂಕ : 162 Date /ದಿನಾಂಕ : 10-7-2023

Subject/ವಿಷಯ : physics Semester/ಸೆಮಿಸ್ಟರ್ : BSc 2nd Exam Seat No / ಪರೀಕ್ಷಾ ಕ್ರಮಾಂಕ : U15KM22S0213

Invigilator's Signature / ಕೊಠಡಿ ಮೇಲ್ವಿಚಾರಕರ ಸಹಿ Signature of Evaluator / ಪರೀಕ್ಷಕರ ಸಹಿ 30/30 Marks obtained/ ಪಡೆದ ಅಂಕಗಳು 15/15

Q.No I

~~a) Coulomb's Law :- The force~~

a) * Coulomb's Law

It states that the force of attraction between two point charges is directly proportional to the product of the magnitude of charges and inversly proportional to the square of the distance between their centers.

$$C = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}$$

* Gauss Law

It states that the total electric flux (ϕ) of a closed surface in a free space is equal to the $1/\varepsilon_0$ times of Net charge enclosed by the surface.

b) properties of Electric field lines

* Electric field lines are origante from positive charge and terminate from negative charge.
* Electric field lines do not form a loop.
* Tangent at any point is give the direction of Electric field at that point.
* Two or more field lines ~~do not form a loop~~. cannot intersect each other.
* Electric field lines are always higher potential to the lower potential.
* The number of field lines are originate / terminate are perpendicular unit area is proportional to the magnitude of the electric field.
* The number of fields lines originate from positive charge is proportional to the magnitude of charge.

* Electric field lines are originate and terminate is directly proportional to surface of conductor

It produced the

c) Kirchoff's Current law

It states that in any network in a conductor, is algebraic sum of current at a point is zero.

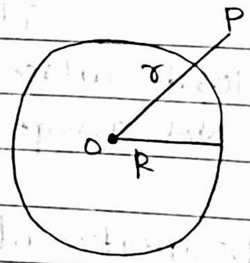
2

or

The algebraic sum of leaving the junction is equal to the entering junction.

Q.No 2

a) Consider a solid sphere Centre at o.



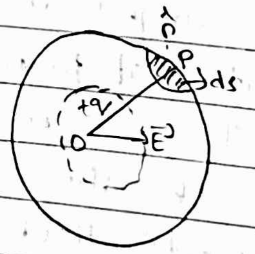
$$E = \frac{q\,4/3\pi R^3}{3\varepsilon_0} \rightarrow (i)$$

8

$$E = \frac{q\,q\,4/3\pi R^3}{3\varepsilon_0 R^2} \rightarrow (ii)$$

i) Charge outside the solid sphere

Consider outside the solid sphere Centre at o and ds be the magnification of charge.



then.

According to Gauss law

$$\phi = \oint \vec{E}\, d\vec{s}$$

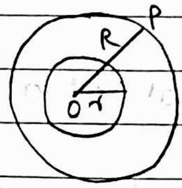
$$\phi = \oint E\, ds \cos\theta$$

$$\oint \vec{E}\,d\vec{s}\cos\theta = 2\times\pi R l$$

$$2\times 4\pi R l\, x = \frac{\cancel{A}\, q\,4\pi\cancel{\varepsilon_0} R^2}{3\varepsilon_0}$$

$$E = \frac{qR^2}{3\varepsilon_0 R^2}$$

b) Centre of Solid sphere



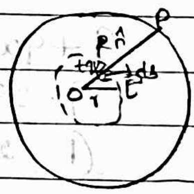
Consider a solid sphere at centre O and originate from P

According to gauss law

$$E = \frac{q\,4/3\,\pi R^2}{3\varepsilon_0} = \frac{q\,4/3\,\pi R}{3\varepsilon_0}$$

$$E = \frac{qr}{3\varepsilon_0}$$

c) ~~Out~~ inside the solid sphere



consider inside the solid sphere at centre O.

According to Gauss law

$$E = \frac{q\,4/3\,\pi\,\cancel{\varepsilon_0} R^2}{3\varepsilon_0 k}$$

$$\therefore\quad E = \frac{q\,2r}{2\pi\varepsilon_0 R}$$ //

b) $q_1 = +q$

$q_2 = -3q$

$d = 1m$

$V = ?$

4) potential difference $\frac{1}{4\pi\varepsilon_0}\left(\frac{+q}{q x}\right) = \left(\frac{-3q}{q - q x}\right)$

$$\frac{1}{4\pi\varepsilon_0}\left(\frac{q}{x}\right) + \frac{-3q}{1-x}$$

$$\frac{1}{4\pi\varepsilon_0}\ \frac{(q(1-x) - 3qx}{x(1-x)}$$

$$q - qx - 3qx$$

$$q - 4qx$$

$$(1-4x) = 0$$

$$4x = 1$$

$$x = \frac{1}{4}$$

0.2

Axial of a point A = 0.2

At point B obn Axil of the potential

$$\text{potential difference} = \left(\frac{q}{qx}\right)\left(\frac{-3q}{(q-qx)}\right)$$

$$\frac{q(1-x) + 3qx}{x(1-x)}$$

$$q + qx - 3qx$$

$$q - 2qx$$

$$(1-2x) = 0$$

$$2x - 1 = 0$$

$$x = \frac{1}{2} = 0.5$$

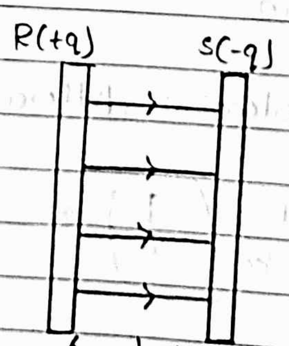
Axial of a point B = 0.5

At ~~0.2 an~~ point A(0.2) and point B(0.5) on its axis is the potential zero.

Q.NO 3)

a) parallel plate capacitor

8



Consider a parallel plate capacitor P and S are separated by a distance d. and +q be the charge density of a Plate R and −q be the charge density of a plat S.

parallel plate capacitor $V = \frac{\sigma}{\varepsilon_0} d \rightarrow (i)$

$$\text{But } \sigma = \frac{q}{A} d$$

$$V = \frac{q}{\varepsilon_0 A} d$$

Bu

According to capacitance of parallel plate capacitor

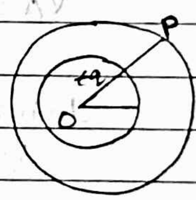
$$C = \frac{q}{\varepsilon A} d$$

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

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

Capacitance of spherical capacitor

Consider a capacitance of spherical capacitor at centre O.



the potential difference V_A & V_B.

Eo potential difference for $V_A = \left[\frac{q}{4\pi\varepsilon_0 a}\right] - \left[\frac{-q}{4\pi\varepsilon_0 b}\right]$

$$V_A = \frac{q}{4\pi\varepsilon_0 ab} \left[\frac{1}{a} - \frac{1}{b}\right] \qquad V_A = \frac{q}{4\pi\varepsilon_0}\left[\frac{1}{a} - \frac{1}{b}\right]$$

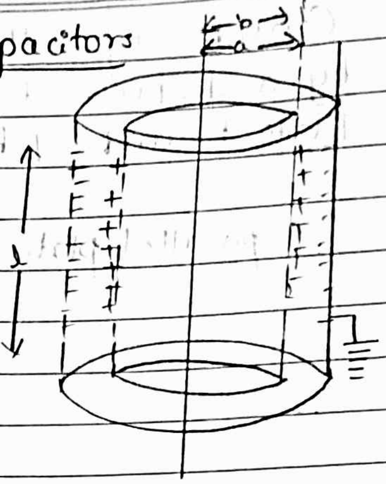
$$V_A = \frac{q(b-a)}{4\pi\varepsilon_0 ab}$$

V_A as taken as infinite and V_B taken as zero

$$\therefore V = \frac{q(b-a)}{4\pi\varepsilon_0 ab} //$$

* Capacitance of cylindrical capacitors

Consider a capacitance of cylindrical capacitors. at the distance l.



The potential difference V_A + V_B
at ~~V_A~~ $= \left[\frac{q}{4\pi\varepsilon_0}\right.$

~~V_A~~ = According to cylindrical capacitors.

$$C = \frac{q}{V}$$

According to gauss theorem

$$\phi = \oint \vec{E}\cdot d\vec{x}$$

$$\oint ds \cos\theta.$$

$$\oint ds \cos\theta = 2\pi r l$$

from $V_A = \left[\frac{q}{4\pi\varepsilon_0 a}\right]\left[\frac{-q}{4\pi\varepsilon_0 b}\right]$

$$V_A = \frac{q}{4\pi\varepsilon_0} \cancel{V_A} = \left[\frac{1}{a} - \frac{1}{b}\right]$$

$$V_A = \frac{q(b-a)}{4\pi\varepsilon_0 ab}\cdot\frac{1}{r}$$

Integrate the eqn.

$$V_A = \int_a^b \vec{E}\cdot d\vec{r} = \int_a^b \frac{b-a}{4\pi\varepsilon_0 ab}\frac{1}{r}$$

$$= \frac{q}{4\pi\varepsilon_0 R}\left[\frac{1}{r}\right]_a^b$$

$$= \frac{q}{4\pi\varepsilon_0 R}\log\frac{b}{a}$$

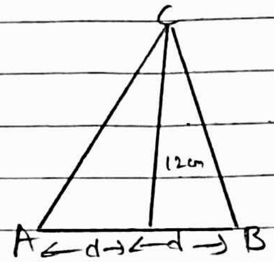
$$\frac{4\pi\varepsilon_0 R}{\log b/a}$$

$$\frac{4\pi\varepsilon_0 R}{2.303\log b/a}$$ //

b) $q_1 = 10\mu C$

$q_2 = -10\mu C$

$d = 10\,cm$



from AB = BP. $\sqrt{(5)^2+(12)^2}$

$= 13\,cm.$

Electric Field $= \dfrac{4\pi\varepsilon_0}{r}$

$\dfrac{4 \times 10 \times 10^{-6}}{13}$

$= 5.1 \times 10^{6}\, \cancel{\phi} C$

$\cancel{8} \times E_A \cos\theta + E_A j \cos\theta = AB.$

$5 \times 5.1 \times 10^{-6} \cancel{\times} \dfrac{5}{13} = 4.1 \times 10^{-6}\ NC^{-1}$ //

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II nd INTERNAL TEST 2022 -2023

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Subject/ವಿಷಯ : Physics Semester/ಸೆಮಿಸ್ಟರ್ : II nd Exam Seat No / ಪರೀಕ್ಷೆ ಸ್ಥಳಾಂಕ : U15KM22S0180

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15/15

I.

Ans-c) • Significance of div.B :

1) Monopoles doesn't exist.
2) Magnetic field lines are continuous.
3) Number of magnetic field lines leaving the object are equal to number of magnetic field lines entering the object.
4) Magnetic field lines doesn't depend on direction.

• Significance of curl.B :

1) Even for the steady current, curl of B isn't zero.
2) Magnetic field lines are spherical in nature for steady current.
3) Magnetic field lines form the loop.

Ans-d) Types of magnetic materials :

1) Diamagnetic materials.
2) Paramagnetic materials.
3) Ferromagnetic materials.
4) Ferrimagnetic materials.
5) Antiferromagnetic materials.

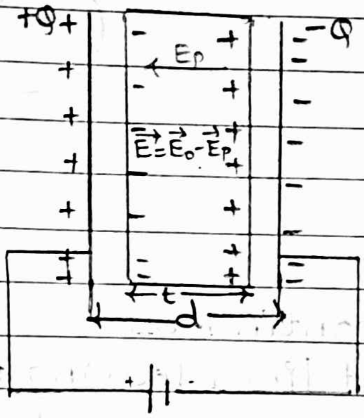
Ans-e) The energy stored in a magnetic field,

$$\boxed{U_B = \frac{1}{2} L I^2}$$

U_B = Energy stored
L = inductance of the coil
I = current through the coil.

Q. No. II.

a) Capacitance of parallel plate capacitor – (in dielectric presence)



Here we have considered a parallel plate capacitor.
d = distance b/w two plates
t = thickness of the dielectric inserted.
Ep = polarised electric field

$$C_0 = \frac{A\varepsilon_0}{d} \rightarrow (1)$$

$$E = E_0 - E_p \rightarrow (2)$$

W.K.T, $V = Ed$.

dielectric const.

$K = \frac{E_0}{E}$

$E = \frac{E_0}{K}$

$$V = E_0(d-t) + E(t).$$

$$V = E_0(d-t) + \frac{E_0 t}{K}$$

$$V = E_0\left(d - t + \frac{t}{K}\right)$$

$E_0 = \frac{\sigma}{\varepsilon_0}$

$E_0 = \frac{Q}{A\varepsilon_0}$

$$V = \frac{Q}{A\varepsilon_0}\left(d - t + \frac{t}{K}\right) \rightarrow (3)$$

W.K.T, $Q = CV$

$$C = \frac{Q}{V} \rightarrow (4)$$

put (3) in (4)

$$C = \frac{\cancel{Q}}{\frac{\cancel{Q}}{A\varepsilon_0}\left(d - t + \frac{t}{K}\right)}$$

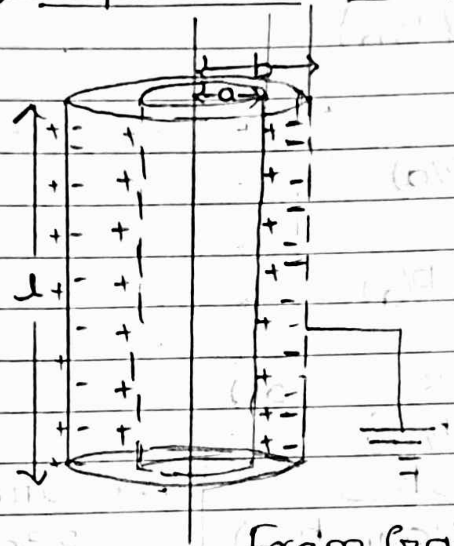
$$C = \frac{A\varepsilon_0}{\left(d - t + \frac{t}{K}\right)} \Rightarrow \frac{A\varepsilon_0}{d\left(1 - \frac{t}{d} + \frac{t}{dK}\right)}$$

$\rightarrow$

$$C = \frac{C_0}{1 - \frac{t}{d} + \frac{t}{dK}}$$

$$\star \quad \boxed{C = \frac{C_0}{1 - \frac{t}{d}\left(1 - \frac{1}{K}\right)}}$$

b) Capacitance of Cylindrical capacitor - (in dielectric presence)



Here we have considered a cylinder and have inserted the dielectric in it.

a = radius of inner cylinder

b = radius of outer cylinder

l = length of cylinder

From Gauss law.

W.K.T, $\oint_S E \cdot ds = \phi$ and $\phi = \frac{q}{\varepsilon_0}$

$$\frac{q}{K\varepsilon_0} = \oint_S E \cdot ds \cos\theta \qquad \theta = 0^\circ, \cos\theta = 1$$

$$\frac{q}{K\varepsilon_0} = \oint E \cdot ds.$$

$$\frac{\lambda l}{K\varepsilon_0} = E \oint ds$$

$$\frac{\lambda l}{K\varepsilon_0} = E \cdot 2\pi r l.$$

$$E = \frac{\lambda \cancel{l}}{2\pi\varepsilon_0 r \cancel{l} K} \Rightarrow E = \frac{\lambda}{2\pi\varepsilon_0 r K} \longrightarrow (1)$$

$$V = \oint_a^b E \cdot dr \Rightarrow V = \int_a^b \frac{\lambda}{2\pi\varepsilon_0 r K} \cdot dr$$

$$V = \frac{\lambda}{2\pi\varepsilon_0 K} \int_a^b \frac{1}{r} \cdot dr \longrightarrow$$

$$V = \frac{\lambda}{2\pi\varepsilon_0 K} \log_e r \Big|_a^b$$

$$V = \frac{\lambda}{2\pi\varepsilon_0 K} \left(\log_e b - \log_e a\right)$$

$$V = \frac{\lambda}{2\pi\varepsilon_0 K} \log_e(b/a) \longrightarrow ②$$

W.K.T $\Rightarrow q = CV \Rightarrow C = q/V \longrightarrow ③$ put ② in ③

$$C = \frac{q}{\frac{\lambda}{2\pi\varepsilon_0 K} \log_e(b/a)}$$

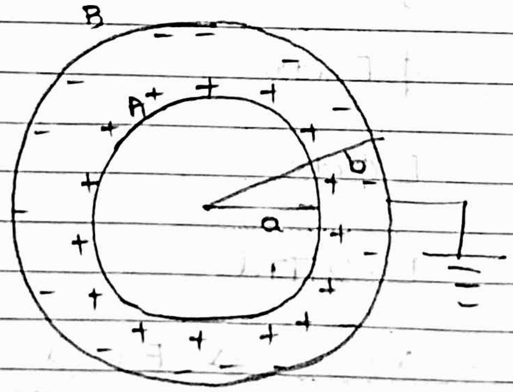
$$C = \frac{q\, 2\pi\varepsilon_0 K}{\lambda \log_e(b/a)}$$

$$C = \frac{\cancel{q}\, 2\pi\varepsilon_0 K}{\frac{\cancel{q}}{l} \log_e(b/a)}$$

$$C = \frac{2\pi\varepsilon_0 l K}{\log_e(b/a)} \quad \text{(or)}$$

* $\boxed{C = \frac{2\pi\varepsilon_0 l K}{2.303 \log_{10}(b/a)}}$ $\Rightarrow C = \frac{2\pi K \varepsilon_0 l}{2.303 \log_{10}(b/a)}$

c) Spherical Capacitor's Capacitance: (in dielectric presence)



Here we have conside-red a spherical - capacitor and have inserted a dielectric

a = radius of inner sphere (A)

b = radius of outer sphere (B).

The potential of inner sphere;

$$V_A = \frac{q}{4\pi\varepsilon_0 K a} + \left(\frac{-q}{4\pi\varepsilon_0 K b}\right)$$

$$V_A = \frac{q}{4\pi\varepsilon_0 K a} - \frac{q}{4\pi\varepsilon_0 K b}$$

$$V_A = \frac{q}{4\pi\varepsilon_0 K}\left(\frac{1}{a} - \frac{1}{b}\right)$$

$$V_A = \frac{q}{4\pi\varepsilon_0 K}\left(\frac{b-a}{ab}\right) \longrightarrow (1)$$

$$V_B = 0 \longrightarrow (2)$$

Net potential; $V = V_A - V_B \longrightarrow (3)$

put (1) & (2) in (3)

$$V = \frac{q}{4\pi\varepsilon_0 K}\left(\frac{b-a}{ab}\right) \longrightarrow (4)$$

W.K.T, $q = CV \Rightarrow C = \frac{q}{V} \longrightarrow (5)$

put (4) in (5)

$$C = \frac{q}{\frac{q}{4\pi\varepsilon_0 K}\left(\frac{b-a}{ab}\right)}$$

$$\star \boxed{C = \frac{4\pi\varepsilon_0 K ab}{b-a}}$$

b) $C = 400 \times 10^{-12}\,F$

$d = 2 \times 10^{-3}\,m$

i) $V = 1500\,V$

$$U = \frac{1}{2}CV^2$$

$$U = \frac{1}{2} \times 400 \times 10^{-12} \times (1500)^2$$

$$U = 2 \times 10^{-10} \times 2250000$$

$$U = 2 \times 225 \times 10^{-6}$$

$$U = 450 \times 10^{-6}$$

$$U = 4.5 \times 10^{-4}\,J.$$

ii) $q = CV$, $q' = C'V'$

If d is doubled

C is halued.

$$C' = \frac{C}{2} = \frac{400 \times 10^{-12}}{2}$$

$$C' = 200 \times 10^{-12}\ F.$$

$q = q'$ (Given)

$$CV = C'V'$$

$$400 \times \cancel{10^{-12}} \times 1500 = 200 \times \cancel{10^{-12}} \times V'$$

$$V' = 2\cancel{00} \times 1500$$

$$V' = 3000\ V. //$$

iii) $U = U_2 - U_1$

$$U = \frac{1}{2} C'V'^2 - \frac{1}{2} CV^2$$

$$U = \frac{1}{2} \times 200 \times 10^{-12} \times (3000)^2 - 4.5 \times 10^{-4}$$

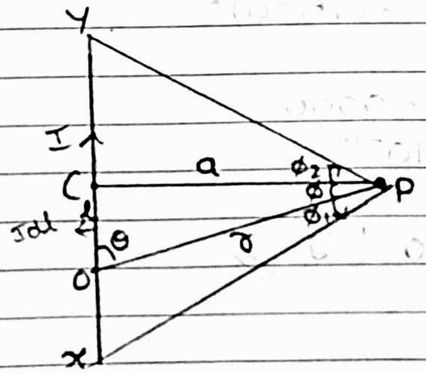
$$U = 9 \times 10^{-4} - 4.5 \times 10^{-4}$$

$$U = 4.5 \times 10^{-4}\ J. //$$

Q.No.III

Ans-a) Biot-Savart's law states that the magnetic field due to the current carrying wire at a distant point is directly proportional to the current in the coil, length of the coil and inversely proportional to the square of the distance b/w the point and wire.

i)



We have considered a current carrying wire and a point P.

$CO = l$

$CP = a$

$OP = r$

By Biot-Sivart's law.

$$dB = \frac{\mu_0}{4\pi} \frac{I\,dl \sin\theta}{r^2} \longrightarrow (1)$$

Here, $\theta + \phi + 90^\circ = 180^\circ$

$$\theta + \phi = \cancel{18}\ 90^\circ$$

$$\cancel{\phi = 90 - \theta}$$

$$\theta = 90^\circ - \phi$$

$$\sin\theta = \sin(90^\circ - \phi)$$

$$\sin\theta = \cos\phi \longrightarrow (2)$$

$$\cos\phi = \frac{a}{r} \Rightarrow r = \frac{a}{\cos\phi} \longrightarrow (3)$$

$$\tan\phi = \frac{l}{a} \Rightarrow l = a\tan\phi$$

$$\Rightarrow dl = a\sec^2\phi \cdot d\phi \longrightarrow (4)$$

put (2), (3), (4) in (1)

$$dB = \frac{\mu_0}{4\pi} \frac{I a \sec^2\phi\, d\phi \cdot \cos\phi}{\frac{a^2}{\cos^2\phi}}$$

$$dB = \frac{\mu_0}{4\pi} \frac{I \cancel{a} \frac{1}{\cancel{\cos^2\phi}} \cdot d\phi \cdot \cos\phi}{\frac{\cancel{a^2}}{\cancel{\cos^2\phi}}}$$

$$dB = \frac{\mu_0 I \cos\phi \cdot d\phi}{4\pi a}$$

$$B = \int dB = \int_{-\phi_1}^{\phi_2} \frac{\mu_0}{4\pi} \frac{I\cos\phi \cdot d\phi}{a}$$

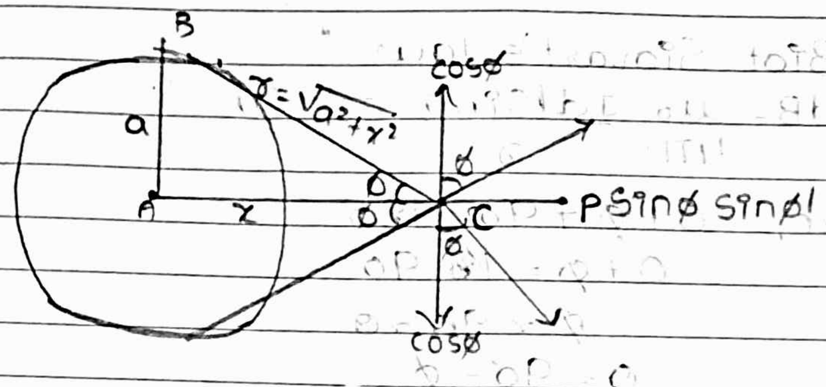
$$B = \frac{\mu_0 I}{4\pi a} \left(\sin\phi\right)_{-\phi_1}^{\phi_2}$$

$$\star \quad \boxed{B = \frac{\mu_0 I}{4\pi a}\left(\sin\phi_2 + \sin\phi_1\right)}$$

- When, P is at centre, $B = \frac{\mu_0 I}{2\pi a}$ $\quad \left[\phi_1 = \phi_2 = 90^\circ\right]$

When, P is near X, $B = \frac{\mu_0 I}{4\pi a}$ $\quad \left[\begin{array}{l}\phi_2 = 90^\circ \\ \phi_1 = 0^\circ\end{array}\right]$

ii)



$AB = a$

$AO = x$

$BO = r = \sqrt{a^2+x^2}$

We have considered a circular loop.

By biot-siovart law,

$$dB = \frac{\mu_0}{4\pi} \frac{Idl\sin\theta}{r^2} \longrightarrow (1)$$

$$dB = \frac{\mu_0}{4\pi} \frac{Idl}{(\sqrt{a^2+x^2})^2}$$

$$dB = \frac{\mu_0}{4\pi} \frac{Idl}{a^2+x^2} \longrightarrow (2) \qquad \sin\phi = \frac{a}{\sqrt{a^2+x^2}}$$

$$B = \oint dB\sin\phi$$

$$B = \int \frac{\mu_0}{4\pi} \frac{Idl}{a^2+x^2} \frac{a}{\sqrt{a^2+x^2}}$$

$$B = \int \frac{\mu_0}{4\pi} \frac{Idl\,a}{(a^2+x^2)^{3/2}}$$

$$B = \frac{\mu_0 I a}{\cancel{4}_2\cancel{\pi}(a^2+x^2)^{3/2}} \cdot \cancel{2}\cancel{\pi}a$$

$$* \boxed{B = \frac{\mu_0 I a^2}{2\pi(a^2+x^2)^{3/2}}}$$

- When, P in centre;

$$B = \frac{\mu_0 I a^2}{2\pi a^3}$$

$$B = \frac{\mu_0 I}{2\pi a}$$

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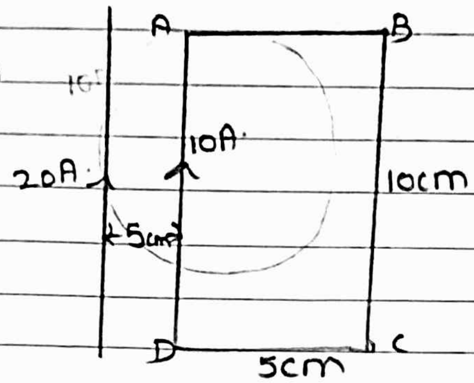
b)



$I_1 = 20A$, $a = 5\times10^{-2}m$
$I_2 = 10A$
$BC = 10\times10^{-2}m$
$DC = 5\times10^{-2}m.$

$$F_1 = \frac{\mu_0 I_1 I_2}{2\pi a} \times \text{length of } AD.$$

$$F_1 = \frac{\cancel{4}^{2}\cancel{\pi}\times10^{-7}\times20\times10}{\cancel{2\pi}\times5\times10^{-2}} \times 10\times10^{-2}$$

$$F_1 = \frac{4\times10^{-5}\times10^{-1}}{5\times10^{-2}}$$

$$F_1 = 0.8\times10^{-4}\,J. \Rightarrow$$

lly, $F_2 = 0.4\times10^{-4}\,J$

Net force, $F = F_1 - F_2$
$F = 0.8\times10^{-4} - 0.4\times10^{-4}$
$F = 0.4\times10^{-4}\,J$ //