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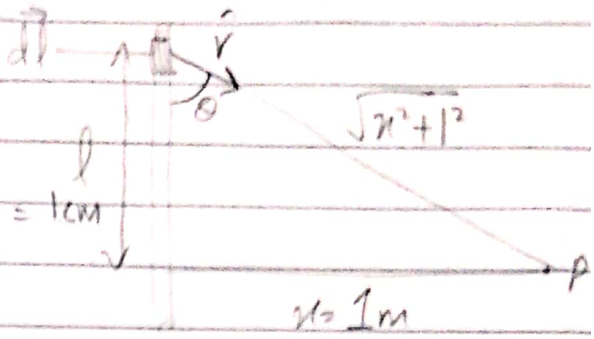
BSSE23058
Section A

Assignment # 4
Applied Physics

Q1



According to Biot-Savart Law.

$$\tan\theta = \frac{x}{l}$$

$$\tan\theta = \frac{1}{1/100}$$

$$\theta = \tan^{-1}\left(\frac{1}{0.01}\right)$$

$$= 89.4^\circ$$

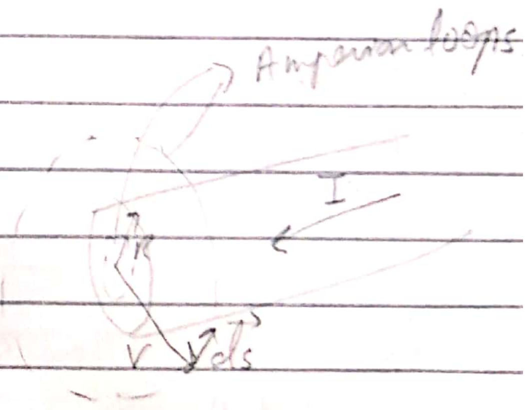
$$B = \int \frac{\mu_0 I}{4\pi} \frac{ds \sin\theta}{r^2}$$

$$= \frac{\mu_0}{4\pi} \frac{I \Delta l \sin\theta}{r^2}$$

$$= \frac{\cancel{4\pi} \times 10^{7}}{\cancel{4\pi}} \times 2 \times \frac{\frac{1}{100} \times \sin(89.4)}{(1)^2}$$

$$\approx 2.0 \times 10^{-9}\, T$$

Q2 a.



According to Ampere's Law
Magnetic field inside the wire.

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

$$I = \underbrace{J}_{\text{charge density}} \times \underbrace{\pi R^2}_{\text{area of wire}}.$$

$\cancel{B = \frac{\mu_0 J \pi R^2}{2\pi R}}$ $2\pi R B = \mu_0 I_{enc}$

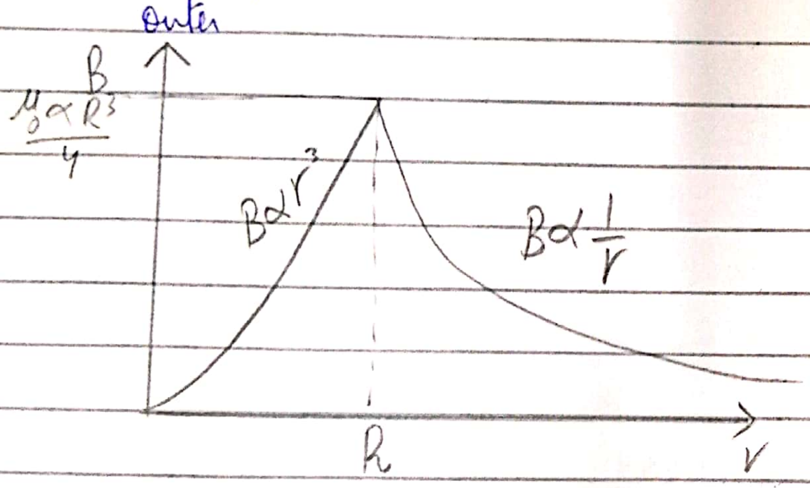
$B = \frac{\mu_0 J R}{2}$ $I_{enc} = J\pi R^2$

$= \frac{I R^2}{r^2}$

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

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

6. B as a function of r.

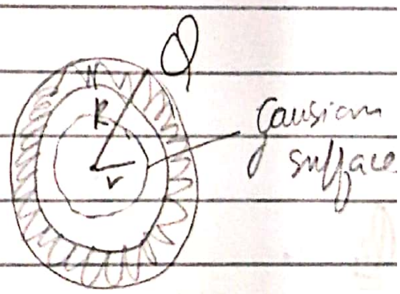


3

1. Inside the hollow sphere.

inside the. $q = 0$ hense, Therefore,

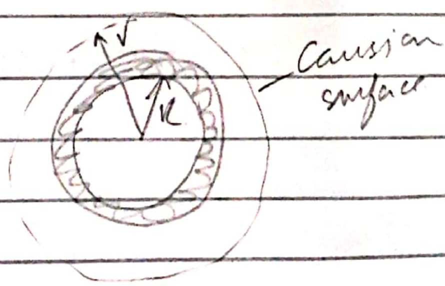
$E = 0$.



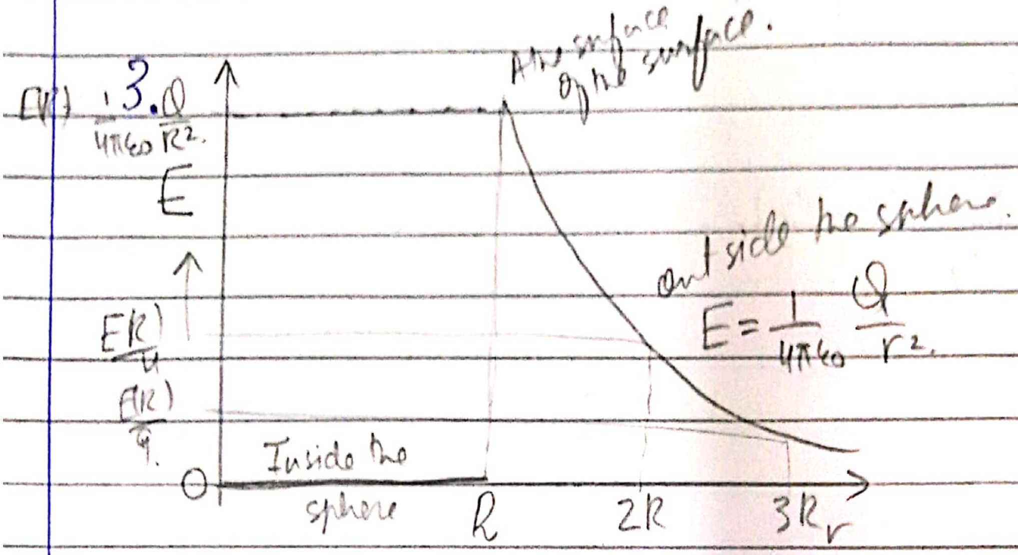
2. Outside the hollow sphere.

$$EA = \frac{q_{enc}}{\varepsilon_0}$$

$$E(4\pi r^2) = \frac{q}{\varepsilon_0}$$



$$E = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}.$$



Q4

a. $emf_{av} = \frac{\Delta\phi}{\Delta t} = \frac{BA\cos\theta}{t}$

$= \frac{0.5 \times 500 \times 4.5\times10^{-3} \times \cos 30}{0.75}$

$= 1.3\ V.$

b. $I = \frac{emf}{R}$

$= \frac{1.3}{6}$

$= 0.217\ A.$

Q5

$$C = 4\pi\varepsilon_0\varepsilon_r \frac{R_1R_2}{R_2-R_1}$$

Capacitance of the upper hemisphere.

$$C_1 = 2\pi\varepsilon_0\varepsilon_r \frac{R_1R_2}{R_2-R_1}$$

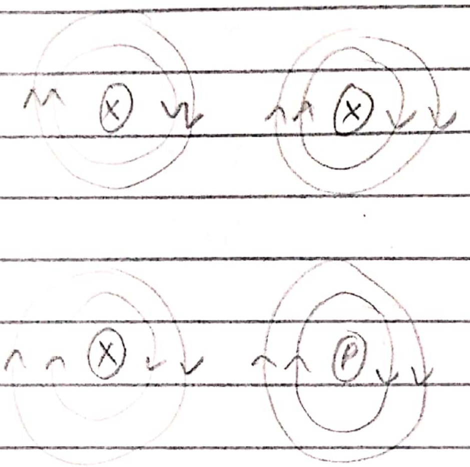
Capacitance of the lower hemisphere.

$$C_2 = \frac{2\pi \varepsilon_0 \varepsilon_2 R_1 R_2}{R_2 - R_1}$$

Total Capacitance.

$$C = C_1 + C_2$$
$$= \frac{2\pi \varepsilon_0 R_1 R_2}{R_2 - R_1} (\varepsilon_1 + \varepsilon_2).$$

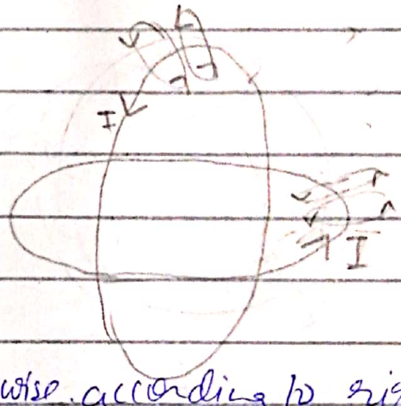
Q6



At point P, the direction of current will be into the page. & magnetic field direction is clockwise.

Q7

$$B = \frac{\mu_0 I}{2r}$$
$$= \frac{4\pi \times 10^{-7} \times 10}{2 \times 0.2}$$
$$= 3.14 \times 10^{-5}$$



Direction of magnetic field is clockwise according to right hand rule.

Q8

within the smaller solenoid.

$$EA = \frac{q_{inside}}{\varepsilon_0}.$$

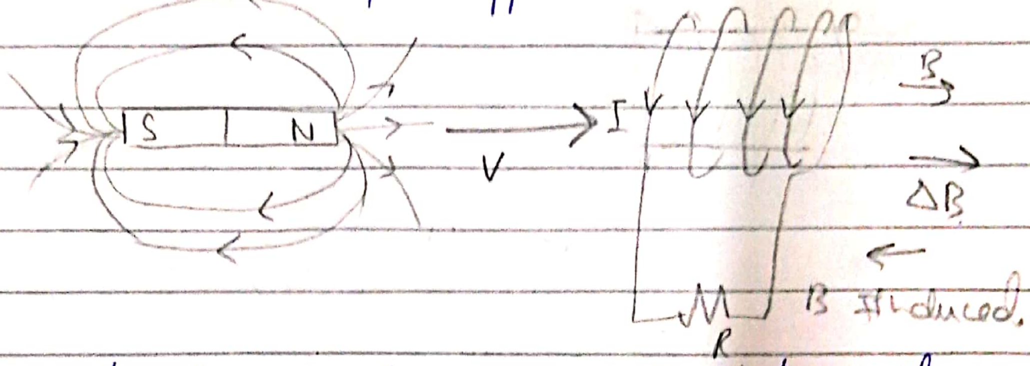
$$B = \mu_0 n I.$$

Between the two solenoids is the same

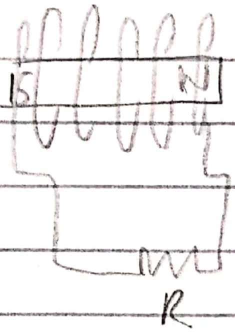
$$B = \mu_0 n I.$$

magnetic field doesn't depend on Radius.

Q9 a. When the north pole approaches the coil.

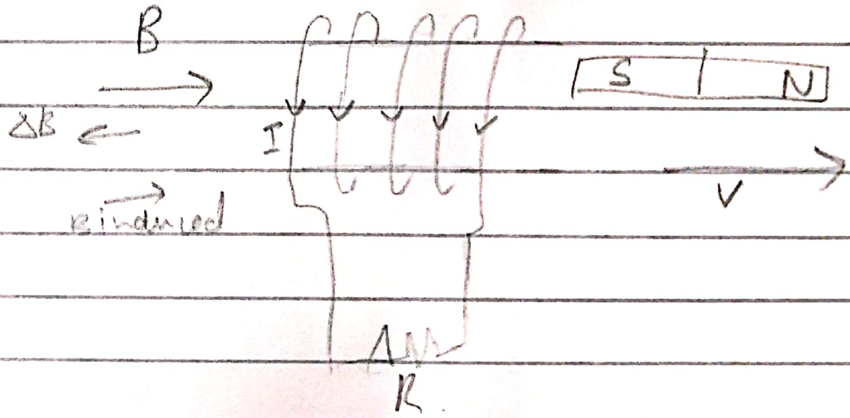


b. When the magnet is centered in the coil



If the magnet is stationary, no current in induced in the resistor.

c. When the south pole leaves the right side of the coil.



Q_{10}

$$A = \frac{200}{(100)^2} = 0.02\ m^2$$

$$A = \frac{100}{(100)^2} = 0.01 m^2.$$

$$\Delta\phi = 0.3 \times (0.02 - 0.01)$$

$$BA. = 0.003\ Tm^2.$$

$$emf = \frac{\Delta\phi}{\Delta t}$$

$$= \frac{0.003}{0.02}$$

$$= 0.15V.$$

$$V = IR$$

$$I = \frac{V}{R}$$

$$= \frac{0.15}{15} = 0.01A$$

Current direction is clockwise.

B is inside the page.