2PUC- CHAPTER 04
MOVING CHARGES AND MAGNETISM

1. The dimensional formula of magnetic flux is

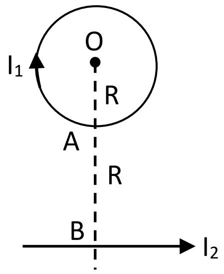
a) $M L^2 T^{-2} A$ b) $M L^{-2} T^2 A^{-1}$ c) $M L^2 T^{-2} A^{-1}$ d) $M L^2 T^{-2} A^{-2}$

(c)

Unit of magnetic flux = $JA^{-1} = [M L^2 T^{-2} A^{-1}]$

2. In the diagram, I_1, I_2 are the strength of the currents in the loop and straight conductors respectively. OA = AB = R. If the net magnetic field at the centre O is zero, then the ratio of the currents in the straight conductor to that in the loop is

a) $1/\pi$
b) $1/2\pi$
c) π
d) 2π



(d)

When net magnetic field at O is zero, then $\frac{\mu_o I_1}{2R} = \frac{\mu_o I_2}{2\pi(2R)}$

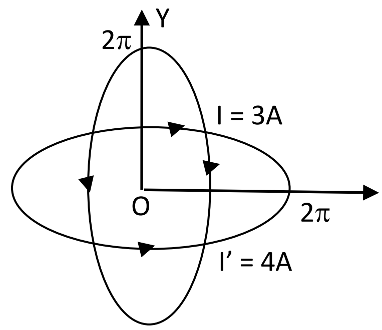
$\frac{I_2}{I_1} = 2\pi$

3. Two concentric coils, each of radius 2π cm are placed at right angles to each other. Currents of 3A and 4A are flowing through the two coils. The resultant magnetic induction at the centre of the coils will be

a) 5×10^{-5} T b) 7×10^{-5} T c) 12×10^{-5} T d) 10^{-5} T

(a)

Field at the centre of the loop is $B = \frac{\mu_o I}{2R}$



where, R is radius given, R = 2 π cm = $2\pi \times 10^{-2}$ m

$B_x = \frac{\mu_0}{2} \frac{I_1}{2\pi \times 10^{-2}}$ where $I_1 = 3$ A

$B_x = \frac{\mu_0}{2} \cdot \frac{3 \times 10^2}{2\pi} = 3 \times 10^{-5}$ T

$B_y = \frac{\mu_0}{2} \cdot \frac{I_2}{2\pi \times 10^{-2}}, I_2 = 4$ A

$B_y = 4 \times 10^{-5}$

$B_{net} = \sqrt{B_x^2 + B_y^2} = \sqrt{(3^2 + 4^2) \times 10^{-10}}$

$B_{net} = 5 \times 10^{-5}$ T

4. The ratio of the magnetic fields at the centre of a circular coil carrying current to that at a point on the axis at a distance half of the radius of the coil from its centre is

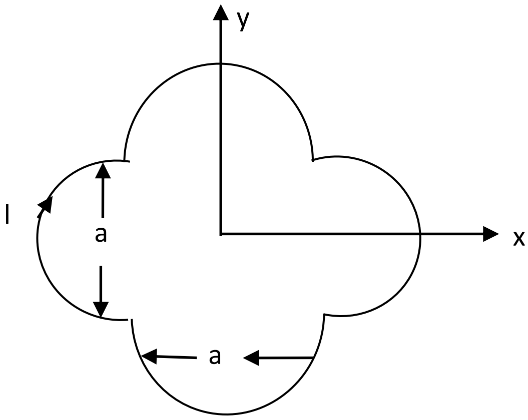
a) $2\sqrt{5} : 8$ b) $5\sqrt{5} : 8$ c) $5\sqrt{5} : 4$ d) $2\sqrt{5} : 4$

(b)

$$\frac{B_c}{B_x} = \frac{(r^2 + x^2)^{3/2}}{r^3} = \frac{\left(r^2 + \frac{r^2}{4}\right)^{3/2}}{r^3} = \frac{\left(\frac{5}{4} r^3\right)^{3/2}}{r^3} = \left(\frac{5}{4}\right)^{3/2} = \frac{5\sqrt{5}}{8}$$

5. A semicircular current loop of diameter 'a' lie in the xy-plane as shown in the figure. The unit vector $\hat{k}$ is out of the plane of the paper. The magnetic moment of the current loop is

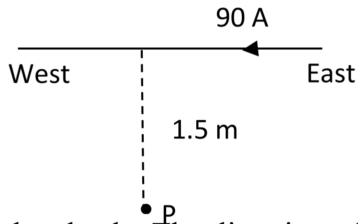
a) $a^2 I\hat{k}$ b) $\left(\frac{\pi}{2}+1\right) a^2 I\hat{k}$ c) $-\left(\frac{\pi}{2}+1\right) a^2 I\hat{k}$ d) $-(2\pi+1)\, a^2 I\hat{k}$



(c)

$\vec{M}$ = I × Area vector = $-I \times \left[a^2 + \frac{\pi a^2}{4 \times 2} \times 4\right]\hat{k} = -I \times a^2\left[\frac{\pi}{2}+1\right]\hat{k}$

6. A horizontal overhead power line carries a current of 90 A in east to west direction. What are the magnitude and direction of the magnetic field due to the current 1.5 m below the line?
a) 1.2×10^{-5} T, perpendicularly outward to the plane of paper
b) 1.6×10^{-5} T, perpendicularly outward to the plane of paper
c) 1.2×10^{-5} perpendicularly inward to the plane of paper
d) 1.6×10^{-5} T, perpendicularly inward to the plane of paper
(a)



Given, I = 90 A and r = 1.5 m

The magnitude of magnetic field $B = \frac{\mu_0}{4\pi} \cdot \frac{2I}{r}$

$= \frac{10^{-7} \times 2 \times 90}{1.5} = 1.2 \times 10^{-5}$ T

The direction of magnetic field is given by Maxwell's right hand rule. The direction of magnetic field at point P due to the flowing current is perpendicularly outwards to the plane of paper

7. A proton and an α-particle enter a uniform magnetic field perpendicular with the same speed. If proton takes 25μs to make 5 revolutions, then the periodic time for the α-particle would be
a) 50 μs b) 25 μs c) 10 μs d) 5 μs
(c)

$T = \frac{2\pi m}{Bq}$ or $T \propto \frac{m}{q}$

$\frac{T_\alpha}{T_P} = \frac{4m}{2q} \times \frac{q}{m} = 2$

Or $T_\alpha = 2\left[\frac{25}{5}\right]\mu s = 10\mu s$

8. A long solenoid has 800 turns per metre length of solenoid. A current of 1.6 A flows through it. The magnetic induction at the end of the solenoid on its axis is approximately
a) 16×10^{-4} T b) 8×10^{-4} T c) 32×10^{-4} T d) 4×10^{-4} T
(b)

Magnetic field at the end of solenoid $B = \frac{\mu_0 ni}{2} = \frac{4\pi \times 10^{-7} \times 800 \times 1.6}{2} = 8 \times 10^{-4}$ tesla

9. A long straight, solid metal wire of radius 2 mm carries a current uniformly distributed over its circular cross-section. The magnetic field induction at a distance 2 mm from its axis is B. Then, the magnetic field induction at distance 1 mm from the axis will be

a) B b) B/2 c) 2B d) B

(b)

At a point inside the metal wire carrying current, magnetic field induction $B \propto r$

$\therefore \quad B' = \frac{B}{2}$

10. A beam of protons is moving parallel to a beam of electrons in opposite directions. Both the beams will

a) repel each other b) come closer c) not be deflected d) either (a) or (b)

(b)

There will be an electrostatic force of attraction between beam of protons and beam of electrons and there will be magnetic force of attraction due to currents by virtue of motion of protons and electrons in the opposite directions.

11. An electron is moving along positive x-axis. To get it moving in an anticlockwise circular path in x-y plane, a magnetic field applied should be along

a) +ve y-axis b) +ve z-axis

c) -ve y-axis d) -ve z-axis

(b)

Use FLHR for negative charge

12. A deuteron of kinetic energy 50 keV is describing a circular orbit of radius 0.5 m, in a plane perpendicular to magnetic field B. The kinetic energy of proton that describes a circular orbit of radius 0.5 m in the same plane with the same magnetic field B, is

a) 200 keV b) 50 keV c) 100 keV d) 25 keV

(c)

As, $r = \frac{\sqrt{2mE}}{Bq} = \frac{\sqrt{2m_1E_1}}{Bq}$

$E \propto \frac{1}{m}$ when r, q and B are same

$$E_p = \frac{m_dE_d}{m_p} = \frac{(2m_1)}{m_1} \text{ x } 50 \text{ keV} = 100 \text{ keV}$$

13. A proton, a deuteron and an α- particle enter a magnetic field perpendicular to field with same velocity. What is the ratio of the radii of circular paths?

a) 1 : 2 : 2 b) 2 : 1 : 1 c) 1 : 1: 2 d) 1 : 2 : 1

(a)

As, $r = \frac{mv}{Bq}$ or $r \propto \frac{m}{q}$ for the same value of v and B

$\therefore \quad r_p : r_d : r_\alpha = \frac{m_p}{q_p} : \frac{m_d}{q_d} : \frac{m_\alpha}{q_\alpha} = \frac{m}{e} : \frac{2m}{e} : \frac{4m}{2e} = 1:2:2$

14. A proton and an α particle enter perpendicular to a uniform magnetic field with same velocity. Frequency of revolution of α particle will be X times that of proton. X is

a) 4 b) 2 c) $\frac{1}{2}$ d) $\frac{1}{4}$

(c)

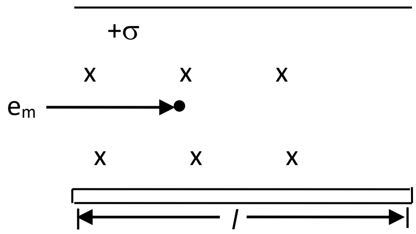
$f = \frac{Bq}{2\pi m}$

$f \propto (q/m) \propto$ (specific charge)

Specific charge of α-particle = ½ $\times$ specific charge of proton

$f_\alpha = \frac{1}{2} f_p$

15. An electron moves straight inside a charged parallel plate capacitor of uniform surface charge density σ. A magnetic field B exist between plates of the capacitor. Neglecting gravity, the time of straight line motion of the electron in the capacitor is



a) $\frac{\sigma}{\varepsilon_0 lB}$ b) $\frac{\varepsilon_0 lB}{\sigma}$ c) $\frac{\sigma}{\varepsilon_0 B}$ d) $\frac{\varepsilon_0 B}{\sigma}$

(b)

The electric field $E = \frac{\sigma}{\varepsilon_0}$

The net force acting on the electron is zero because it moves with constant velocity

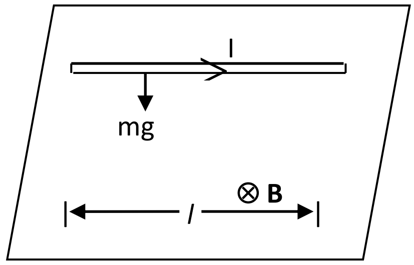
$F_{net} = F_e + F_m = 0$

$\Rightarrow$ $|F_e| = |F_m|$ or eE = evB

Or $v = \frac{E}{B} = \frac{\sigma}{\varepsilon_o B}$

$\therefore$ The time of motion inside the capacitor $t = \frac{\ell}{v} = \frac{\varepsilon_o \ell B}{\sigma}$

16. A straight wire of mass 200g and length 1.5 cm carries a current of 2 A. It is suspended in mid air by a uniform horizontal magnetic field B. The magnitude of the magnetic field is
($g = 10\ ms^{-2}$)



a) 0.33 T

b) 0.67 T

c) 0.165 T

d) 1.34 T

(b)

Applying Fleming's rule, we find that upward force of magnitude $I\ell B$ acts.
For mid-air suspension this must be balanced by the force due to gravity

$\therefore$ $mg = IlB \Rightarrow B = \frac{mg}{I\ell}$

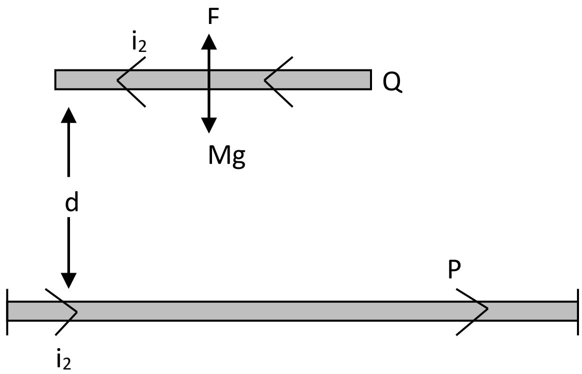
Given, m = 200g = 0.2 kg, g = 10 m/s^2, I = 2A, ℓ = 1.5 m

we have, $B = \frac{0.2 \times 10}{2 \times 1.5} = 0.67\ T$

17. A long horizontal wire P carries a current of 50 A. It is rigidly fixed. Another fine wire Q is placed directly above and parallel to P. The weight of wire Q is 0.075 Nm^{-1} and carries a current of 25 A. Find the position of wire Q from P so that wire Q remains suspended.

a) $\frac{1}{2} \times 10^{-2}$ m b) $\frac{1}{3} \times 10^{-2}$ m c) $\frac{1}{4} \times 10^{-2}$ m d) $\frac{1}{5} \times 10^{-2}$ m

(b)



As force per unit length between two parallel current carrying wires separated by a distance d is given by $\frac{F}{L} = \frac{\mu_o}{4\pi}\frac{2i_1i_2}{d}$ and is repulsive if the current in the wires are in opposite direction

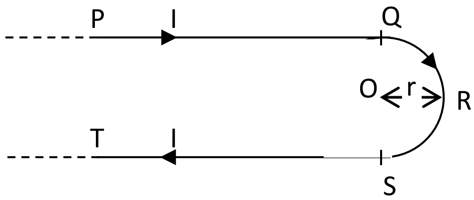
So, in order that wire Q may remain suspended, the force F on it must be repulsive and equal to its weight

$$\frac{F}{L} = \frac{Mg}{L}$$

Or $\frac{\mu_0}{4\pi}\frac{2i_1i_2}{d} = \frac{Mg}{L}$

Or $d = 10^{-7} x \frac{2x50x25}{0.075} = \frac{1}{3}x10^{-2}m$

18. A long wire is bent into the shape PQRST as shown in the figure with QRS being a semi circle with centre O and radius r



A current of I ampere flows through it in the direction shown. Then the net magnetic induction at the point O of the figure in vacuum is

a) $\mu_o I\left[\frac{1}{2\pi r} + \frac{1}{4r}\right]$ b) $\mu_o I\left[\frac{1}{2\pi r} - \frac{1}{4r}\right]$ c) $\mu_o \frac{I}{4r}$ d) $\frac{\mu_o I}{\pi r}$

(a)

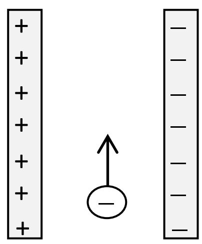
$B = \frac{\mu_o I}{4r} + \frac{\mu_o I}{4\pi r} + \frac{\mu_o I}{4\pi r} = \mu_o I\left(\frac{1}{2\pi r} + \frac{1}{4r}\right)$

19. A potential difference of 600 V is applied across the plates of a parallel plate capacitor, plates being separated by 3 mm. An electron projected vertically parallel to the plates with a velocity of 2×10^6 ms^{-1} moves undeflected. The magnitude of the magnetic field in the region between the condenser plates is

a) 0.1T b) 0.2 T

c) 2×10^6 T d) 600 T

(a)



$$B = \frac{E}{v} = \frac{600V}{3X10^{-3}m} X \frac{1}{2X10^{6}ms^{-1}} = 10^{-1} T = 0.1T$$

20. A voltmeter has resistance of 2000 Ω and it can measure upto 2 V. If we want to increase its range by 8 V, then required resistance in series will be

a) 4000 Ω   b) 6000 Ω   c) 7000 Ω   d) 8000 Ω

(d)

As, $i_g = \frac{2}{2000} = \frac{1}{1000}$ A;

Now for new range, V = 8V + 2V = 10 V

$$\therefore \quad R = \frac{V}{i_g} - G = \frac{10}{\left(\frac{1}{1000}\right)} - 2000 = 8000\ \Omega$$

Shortcut: R = G(n-1) = 2000(5 - 1) = 8000 Ω; n = 10/2 = 5

21. A galvanometer of resistance 20 Ω shows deflection of 10 divisions, when a current of 1 mA is passed through it. If a shunt of 4 Ω is connected and there are 50 divisions on the scale, the range of the galvanometer is

a) 1 A   b) 3 A   c) 10 mA   d) 30 mA

(d)

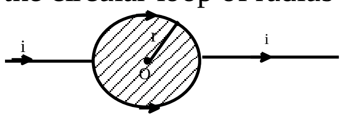
Here, $i_g = \frac{1mA}{10} \times 50 = 5$ mA; i =?; S = 4 Ω; G = 20 Ω

As, $S = \frac{i_g G}{i - i_g}$

So, $4 = \frac{(5 \times 10^{-3}) \times 20}{i - 5 \times 10^{-3}}$

On solving, $i = 30 \times 10^{-3} = 30$ mA

22. A straight conductor carrying a direct current i is split into circular loop as shown in figure. Then the magnetic induction at the centre of the circular loop of radius r is



a) 0   b) ∞   c) $\frac{\mu_0 i}{2\pi r}$ d) $\frac{\mu_0 i}{2r}$

(a)

The magnetic field at the centre O due to current through upper side of semicircular current loop is equal and opposite to that due to lower side of semicircular current loop.

23. A coil of area A is kept perpendicular in a magnetic field B. If coil is rotated by 180°, change in magnetic flux will be

a) BA   b) zero   c) 2BA   d) 4BA

(c)

$$\Delta\phi = \phi_2 - \phi_1 = BA\cos 180^0 - BA\cos 0^0 = -2BA$$

24. The magnetic force acting on a moving charge is

a) parallel to velocity $\vec{V}$ b) perpendicular to magnetic field $\vec{B}$ only

c) perpendicular to $\vec{V}$ and $\vec{B}$ d) perpendicular to $\vec{V}$ and parallel to $\vec{B}$

(c)

F is perpendicular to both B and v

25. Inside a cyclotron, a charged particle is subjected to both an electric field and a magnetic field. It gains kinetic energy due to

a) only the electric field   b) only the magnetic field

c) both the fields   d) none of the fields

(a)

26. Current sensitivity of a pointer galvanometer is independent of

a) number of turns of the coil b) magnetic field applied
c) resistance of the coil d) area of the coil

(c)

27. Two particles X and Y having equal charges, after being accelerated through the same potential difference, enter a region of uniform magnetic field and describe circular paths of radii R_1 and R_2 respectively. The ratio of the mass of X to that of Y is

a) $\left(\frac{R_1}{R_2}\right)^{\frac{1}{2}}$ b) $\frac{R_2}{R_1}$ c) $\left(\frac{R_1}{R_2}\right)^2$ d) $\frac{R_1}{R_2}$

(c)

$$R = \frac{mv}{qB} = \frac{\sqrt{2mK}}{qB} = \frac{\sqrt{2mqV}}{qB} = \sqrt{\frac{2mV}{qB^2}}$$

$$R_1^2 = \left(\frac{2m_1V}{qB^2}\right);\ R_2^2 = \left(\frac{2m_2V}{qB^2}\right)$$

$$\frac{m_1}{m_2} = \left(\frac{R_1^2}{R_2^2}\right)$$

28. A uniform electric field and a uniform magnetic field are produced, pointing in the same direction. An electron is projected with its velocity pointing in the same direction, then

a) the electron will turn to its right
b) the electron will turn to its left
c) the electron velocity will increase in magnitude
d) the electron velocity will decrease in magnitude

(d)

Since electron is projected with its velocity pointing in the direction of $\vec{E}$ and $\vec{B}$, force on it due to magnetic field is zero but electron's motion will be retarded due to electric field.

Since $\vec{F}_{magnetic} = q\vec{v} \times \vec{B}$ and

$\vec{F}_{electric} = q\vec{E}x - e\vec{E} = m\vec{a}$

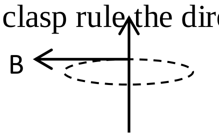
$$\vec{a} = \frac{-e\vec{E}}{m}$$

29. A current carrying conductor carries current in the upward direction. At a point towards the North of the conductor the magnetic lines of force are directed towards

a) North b) South c) East d) West

(d)

Using right hand clasp rule the direction of magnetic field at a point towards north is in the direction of west



30. Two concentric circular coils, each having 10 turns with radii 0.2m and 0.4m carry currents 0.2A and 0.3A respectively in opposite direction. Magnetic field at the centre is

a) (2/3) μ_o b) (5/4) μ_o c) (1/4) μ_o d) (1/6) μ_o

(b)

$$B = \frac{\mu_o nI}{2r}$$

$$B_1 = \frac{\mu_o}{2}\left(\frac{10 \times 0.2}{0.2}\right) = 5\mu_o$$

$$B_2 = \frac{\mu_o}{2}\left(\frac{10 \times 0.3}{0.4}\right) = \frac{15}{4}\mu_o$$

$$B = B_1 - B_2 = \frac{5}{4}\mu_o$$

31. Two long parallel wires placed 0.08 m apart carry currents 3A and 5A in the same direction. The distance from the conductor carrying larger current where the resultant magnetic field is zero is

a) 0.03 m b) 0.05 m c) 0.12 m d) 0.2 m

(b)

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

$B_1 = B_2$

$\frac{3}{0.08 - x} = \frac{5}{x}$

$3x = 0.4 - 5x$

$8x = 0.4$

$x = 0.05$ m

32. When a charged particle moves perpendicular to a uniform magnetic field, then

a) its momentum changes total energy is same.

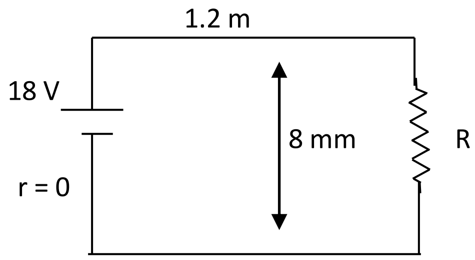
b) both momentum and total energy remain the same

c) both momentum and its total energy will change

d) total energy changes but momentum remains same

(a)

33.



Force per unit length between long parallel wires in the circuit is 3.6×10^{-3} Nm^{-1}. Resistance of the circuit is

a) 3 Ω b) 1.5 Ω c) 4.5 Ω d) 6 Ω

(b)

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

$3.6 \times 10^{-3} = \frac{2 \times 10^{-7} I^2}{8 \times 10^{-3}}$

I = 12 A

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

$12 = \frac{18}{R}$

R = 1.5 Ω

34. Magnetic field at the centre of a circular loop carrying current of area A is B. The magnetic moment of the loop will be

a) $\frac{BA^2}{\mu_0 \pi}$ b) $\frac{BA^{3/2}}{\mu_0 \pi}$ c) $\frac{BA^{3/2}}{\mu_0 \pi^{1/2}}$ d) $\frac{2BA^{3/2}}{\mu_0 \pi^{1/2}}$

(d)

$B = \frac{\mu_0}{4\pi}\frac{2\pi I}{r} = \frac{\mu_0 I}{2r}$ or $I = \frac{2Br}{\mu_0}$;

Also $A = \pi r^2$ or $r = \left(\frac{A}{\pi}\right)^{1/2}$

Magnetic moment, $M = IA = \frac{2Br}{\mu_0} A = \frac{2BA}{\mu_0} \times \left(\frac{A}{\pi}\right)^{1/2} = \frac{2BA^{3/2}}{\mu_0 \pi^{1/2}}$

35. Currents of 10 A and 2 A are passed through two parallel wires A and B respectively in opposite directions. If the wire A is infinitely long and the length of the wire B is 2 metre, the force on the conductor B, which is situated at 10 cm distance from A will be

a) 8×10^{-5} N   b) 4×10^{-5} N   c) $8\pi \times 10^{-7}$ N   d) $4\pi \times 10^{-7}$ N

(a)

$F = \frac{\mu_o}{4\pi} \frac{2I_1I_2}{r} \ell = 10^{-7} \times 2 \times \frac{10 \times 2}{10 \times 10^{-2}} \times 2\text{ N} = 8 \times 10^{-5}\text{ N}$

36. A uniform magnetic field acts at right angles to the direction of motion of electrons. As a result, the electron moves in a circular path of radius 2 cm. If the speed of the electron is doubled, the radius of the circular path will be

a) 2.0 cm   b) 0.5 cm   c) 4.0 cm   d) 1.0 cm

(c)

$F = evB = \frac{mv^2}{r}$

$r = \frac{mv}{eB}$; $v \to 2v$, $r \to 2r$

Hence radius becomes 4 cm.

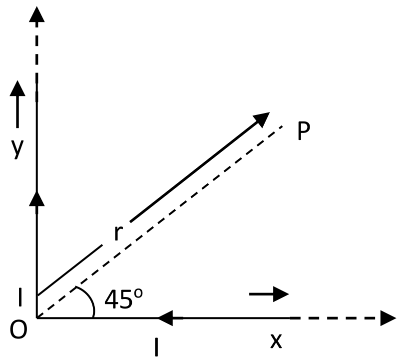
37. Current I flows through a long conducting wire bent at right angles as shown in figure. The magnetic field at a point P on the right bisector of the angle XOY at a distance r from O is

a) $\frac{\mu_o I}{\pi r}$

b) $\frac{2\mu_o I}{\pi r}$

c) $\frac{\mu_o I}{4\pi r}\left(\sqrt{2}+1\right)$

d) $\frac{\mu_o}{4\pi}\frac{2I}{r}\left(\sqrt{2}+1\right)$



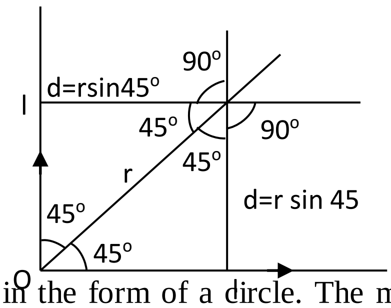
(d)

$B = \frac{\mu_o}{4\pi}\frac{I}{d}$ $(\sin\theta_1 + \sin\theta_2)$

Here $d = r\sin 45^o = \frac{r}{\sqrt{2}}$

$B = 2 \times \frac{\mu_o}{4\pi}\frac{I}{\left(\frac{r}{\sqrt{2}}\right)}[\sin 45^o + \sin 90^o]$

$= 2\sqrt{2}\frac{\mu_o}{4\pi}\frac{I}{r}\left[\frac{1}{\sqrt{2}}+1\right] = \frac{\mu_o}{2\pi}\frac{I}{r}\left[\sqrt{2}+1\right] = \frac{\mu_o}{4\pi}\frac{2I}{r}\left(\sqrt{2}+1\right)$



38. A wire of length L m carrying a current 'i' ampere is bent in the form of a dircle. The magnitude of magnetic moment is

a) $\frac{iL^2}{4\pi}$ b) $\frac{iL^2}{2\pi}$ c) $4\pi^2 L^2 i$ d) $\pi L^2 i$

(a)

Magnetic moment, $P_m = iA = i\pi r^2$ where $2\pi r = L$

$r = \frac{L}{2\pi}$

$P_m = i\pi\left(\frac{L}{2\pi}\right)^2 = \frac{iL^2}{4\pi}$

39. A proton, a deuteron and an α-particle accelerated through the same potential difference enter a region of uniform magnetic field, moving at right angles to B. What is the ratio of their K.E.?

a) 2 : 1 : 1   b) 2 : 2 : 1   c) 1 : 2 : 1   d) 1 : 1 : 2

(d)

$qv = \frac{1}{2}mv^2 = (KE)$

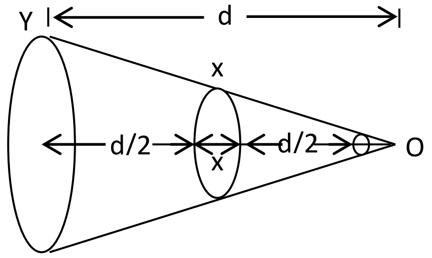
$(KE)_{proton} = eV$

$(KE)_{deutron} = eV$

$(KE)_{\alpha} = 2\ eV$

Ratio is 1 : 1 : 2

40. Two circular coils X and Y having equal number of turns and carry equal currents in the same sense and subtend same solid angle at point O. If the smaller coil X is midway between O and Y, then if we represent the magnetic induction due to bigger coil Y at O as B_Y and that due to smaller coil X at O as B_X, then

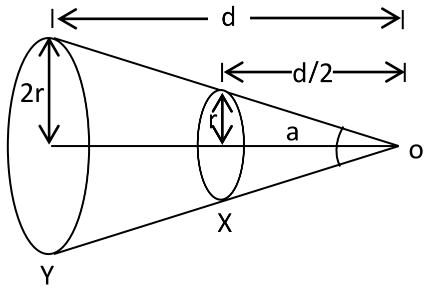


a) $\frac{B_y}{B_x} = 1$ b) $\frac{B_y}{B_x} = 2$

c) $\frac{B_y}{B_x} = \frac{1}{2}$ d) $\frac{B_y}{B_x} = \frac{1}{4}$

(c)

Let n be number of turns in each coil



$$B_y = \frac{\mu_o}{4\pi}\frac{n2\pi(2r)^2}{[(2r)^2 + (d)^2]^{\frac{3}{2}}}$$

$$B_x = \frac{\mu_o}{4\pi}\frac{n2\pi I r^2}{\left[r^2 + \left(\frac{d}{2}\right)^2\right]^{\frac{3}{2}}}$$

$$\frac{B_y}{B_x} = \frac{4}{[4r^2 + d^2]^{\frac{3}{2}}} \times \left[\frac{4r^2 + d^2}{4}\right]^{\frac{3}{2}} = \frac{4}{[4]^{3/2}} = \frac{4}{8} = \frac{1}{2}$$

41. A charged particle of charge q and mass m is shot into a uniform magnetic field. The frequency of revolution of the particle

a) is proportional to the specific charge $\frac{q}{m}$ of the particle.

b) depends on angle θ.

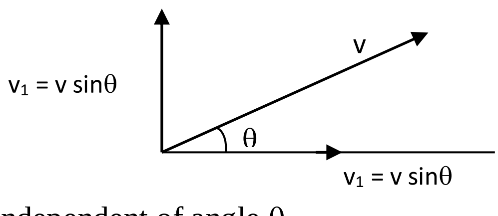
c) is proportional to $\frac{m}{q}$ of the particle.

d) is inversely proportional to the value of B.

(a)

$qv_1 B = \frac{mv_{\perp}^2}{r}$

$r = \frac{mv_1}{qB}$; $T = \frac{2\pi r}{v_{\perp}}$



$T = \frac{2\pi m v_{\perp}}{qBv_{\perp}} = \frac{2\pi m}{qB}$

Frequency $f = \frac{1}{T} = \frac{qB}{2\pi m} \propto \left(\frac{q}{m}\right)$ and is independent of angle θ.

42. Identify the incorrect statement

a) The magnetic torque on the current carrying coil of a suspended coil galvanometer is independent of the orientation of the coil.

b) The magnetic field inside a current carrying conductor is zero.

c) Magnetic field at all points on some line due to current element can be zero.

d) The magnetic force on a moving charged particle does no work.

(b)

Magnetic field inside a current carrying conductor is not zero.

43. The deflection of a portable galvanometer falls from 50 divisions to 1 division when a shunt of 1.0 Ω is connected to it. The resistance of the galvanometer is

a) 49 Ω b) 4.9 Ω c) 50 Ω d) 100 Ω

(a)

$I \propto \theta$

$\frac{I_g}{I} = \frac{50}{1}$

$\frac{S}{G+S} = 50$

$\frac{1}{G+1} = 50$

G = 49 Ω

44. If only 2% of the main current is to be passed through a Galvanometer of resistance G, the resistance of shunt should be

a) G/50 b) G/49 c) 50G d) 49G

(b)

$S = \frac{I_g G}{I - I_g} = \frac{0.02IG}{I - 0.02I} = \left(\frac{0.02}{0.98}\right)G = \frac{G}{49}$

45. An ammeter has a resistance of 0.1 Ω. It can read upto 5 A. To convert this into voltmeter to read 100 V, the resistance to be used is

a) 19.9 Ω in series b) 19.9 Ω in parallel c) 199 Ω in series d) 0.19 Ω in parallel

(a)

$R = \frac{V}{I_g} - G = \frac{100}{5} - 0.1$ = 19.9 Ω in series

46. A voltmeter can read up to V volt. When the series resistance used in the voltmeter is doubled, range of voltmeter is

a) V b) 2V c) less than 2V d) more than 2V

(c)

$R = \frac{V}{I_g} - G$

$\Rightarrow R < \frac{V}{I_g}$

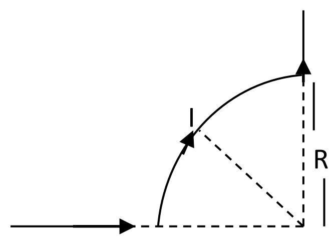
∴ When R is doubled then range of the voltmeter will be less than 2V

47. A current carrying conductor is bent into a quarter of a circle of radius R as shown. The magnetic field at the centre O is

a) $\frac{\mu_o I}{8R}$ Inwards b) $\frac{\mu_o I}{8R}$ Outwards

c) $\frac{\mu_o I}{4R}$ Inwards d) $\frac{\mu_o I}{4R}$ Outwards

(a)



Magnetic field at the centre O due to straight conductor is zero.

Magnetic field due to one turn of a circular coil carrying current is $B = \frac{\mu_o I}{2R}$

Magnetic field due to ¼ of a turn of a circular coil carrying current is $B = \frac{\mu_o I}{8R}$ inwards

48. If an electron and a proton are projected in a uniform magnetic field at right angle to the direction of the field, with the same kinetic energy then

a) the proton trajectory will be less curved than that of electron

b) both the trajectories will be straight

c) both the trajectories will be equally curved

d) the electron trajectory will be less curved than that of proton.

(a)

Radius of curvature is directly proportional to square root of mass of the particle (for same KE)

$r_e < r_p$

Therefore the proton trajectory will be less curved than that of electron

49. When a galvanometer of resistance 50Ω is connected in series to a battery of 3V and a resistance of 2950Ω, a full scale deflection of 30 divisions is obtained in it. In order to reduce the deflection to 20 division, the resistance in series with galvanometer required is

a) 6050Ω b) 4450Ω c) 5050Ω d) 5550Ω

(b)

Total initial resistance = G + R = $50\Omega + 2950\Omega = 3000\Omega$

Current, $I = \dfrac{3\,\text{volt}}{3000\ \Omega} = 1\times10^{-3} A = 1mA$

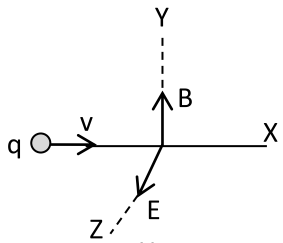
If the deflection has to be reduced to 20 divisions, then current, $I = \dfrac{1mA}{30}\times 20 = \dfrac{2}{3}mA$.

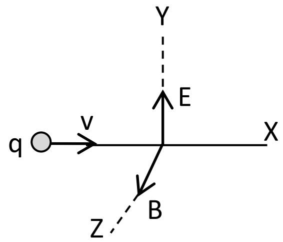
Let $'x'$ be the effective resistance of the circuit, then

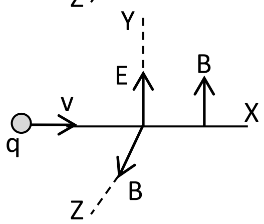
$3V = 3000\Omega \times 1mA = x\Omega \times \dfrac{2}{3}mA$ or $x = 3000\times 1\times \dfrac{3}{2} = 4500\Omega$

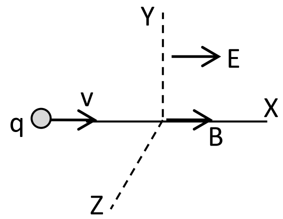
$\therefore$ Resistance to be added = $(4500\Omega - 50\Omega) = 4450\Omega$.

50. A particle of charge q and mass m is moving along the x-axis with a velocity v and enters a region of electric field E and magnetic field B as shown in figures below. For which figure the net force on the charge may be zero?

a)


b)


c)


d)


(b)

The charge will not experience any force if $|\vec{F}_e| = |\vec{F}_m|$. This condition is satisfied in option (b) only