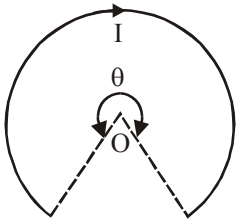
18 Moving Charges and Magnetism

Diagram Based Questions :

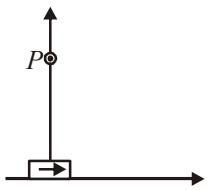
1. A current of I ampere flows in a wire forming a circular arc of radius r metres subtending an angle θ at the centre as shown. The magnetic field at the centre O in tesla is



(a) $\frac{\mu_0 I\theta}{4\pi r}$ (b) $\frac{\mu_0 I\theta}{2\pi r}$

(c) $\frac{\mu_0 I\theta}{2r}$ (d) $\frac{\mu_0 I\theta}{4r}$

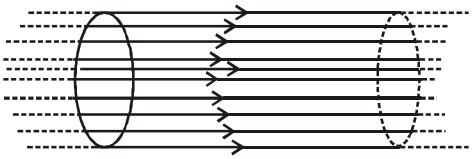
2. An element of $0.05\,\hat{i}$ *m* is placed at the origin as shown in figure which carries a large current of 10 A. distance of 1 m in perpendicular direction. The value of magnetic field is



(a) 4.5×10^{-8} T (b) 5.5×10^{-8} T

(c) 5.0×10^{-8} T (d) 7.5×10^{-8} T

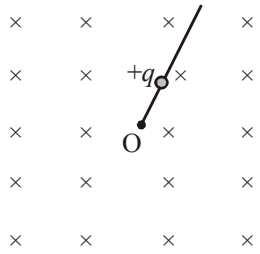
3. The figure shows *n* (*n* being an even number) wires placed along the surface of a cylinder of radius *r*. Each wire carries current *i* in the same direction. The net magnetic field on the axis of the cylinder is



(a) $\mu_0 ni$ (b) $\frac{\mu_0 ni}{2\pi r}$

(c) zero (d) $\frac{\mu_0 ni}{4\pi r}$

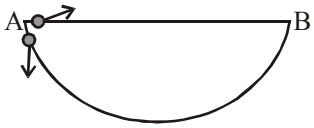
4. The figure shows a thin rod pivoted at point O and rotating clockwise in the plane of paper with constant angular velocity *w*. A bead having charge + *q* can slide freely on the rod as the rod rotates.



Which of the following statements is incorrect ?

(a) Magnetic moment of current loop generated by the bead increases.
(b) Angular momentum of the bead increases.
(c) Torque on current loop generated is zero.
(d) Potentential energy of current loop generated decreases.

5. The figure shows a closed loop bent in the form of a semi-circle. One bead having charge +*q* slides from *A* to *B* along the diameter in uniform motion and other bead having the same charge slides along the arc from *A* to *B* in uniform circular motion. Both take some time to travel from *A* to *B*. When both the beads are at the mid-point of their journey, then the forces exerted by lower bead and upper bead are respectively



(a) gravitational and magnetic
(b) magnetic and electric
(c) electric and gravitational
(d) gravitational and electric.

Solution

1. **(a)** $B = \frac{\mu_0 I}{2r} \times \frac{\theta}{2\pi} = \frac{\mu_0 I\theta}{4\pi r}$

2. **(c)** $dB = \frac{\mu_0}{4\pi} \frac{IdI \sin\theta}{r^2}$

Here, $dI = \Delta x = 0.05\ m$, $I = 10\ A$, $r = 1\ m$
$\sin\theta = \sin 90° = 1$,

$$\therefore dB = 10^{-7} \times \frac{10 \times 0.05 \times 1}{(1)^2}$$

$= 0.50 \times 10^{-7} = 5.0 \times 10^{-8}$ T

3. **(c)** Since n is an even number, we can assume the wires in pairs such that the two wires forming a pair is placed diametrically opposite to each other on the surface of cylinder. The fields produced on the axis by them are equal and opposite and can get cancelled with each other.

4. **(d)** Since P.E. $= -\vec{m} \cdot \vec{B} = -mB\cos 0°$

$\therefore$ P.E. $= -mB$

Since $\vec{m}$ increases in magnitude, therefore P.E. decreases.

5. **(d)** Obviously gravitational and electric force is there as both the particle have mass and charge. Since both charges are in motion so they constitute currents which generate magnetic fields around them and thus exert magnetic force on each other.