PHYSICS

141. (1)

Resistance per unit length $= \rho = \dfrac{R}{2\pi r}$

Lengths of sections APB and AQB are $r\theta$ and $r(2\pi - \theta)$

Resistances of sections APB and AQB are

$R_1 = \rho r\theta = \dfrac{R}{2\pi r} r\theta = \dfrac{R\theta}{2\pi}$ and

$R_2 = \dfrac{R}{2\pi r} r(2\pi - \theta) = \dfrac{R(2\pi-\theta)}{2\pi}$

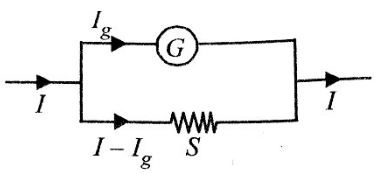
As R_1 and R_2 are in parallel between A and B, their equivalent resistance is

$$R_{eq} = \frac{R_1 R_2}{R_1 + R_2}$$

$$= \frac{\frac{R\theta}{2\pi}\cdot\frac{R(2\pi-\theta)}{2\pi}}{\frac{R\theta}{2\pi}+\frac{R(2\pi-\theta)}{2\pi}}$$

$$= \frac{\frac{R^2\theta(2\pi-\theta)}{4\pi^2}}{\frac{R}{2\pi}[\theta+2\pi-\theta]} = \frac{R(2\pi-\theta)\theta}{4\pi^2}$$

142. (2)



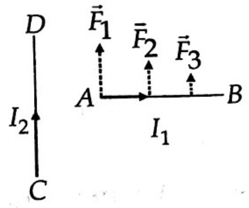
Here, $I_g = \dfrac{I}{10}$

$\Rightarrow I_g G = (I - I_g)S \Rightarrow S = \dfrac{I_g G}{I - I_g}$

Here, $S = 100\ \Omega$ $[\because G = 900\Omega]$

143. (3)

Since the magnetic field, due to current through wire CD at various locations on wire AR is not uniform, therefore, the wire AB, carrying current I_1 is subjected to variable magnetic field due to which, neither the force nor the torque on the wire AB will be zero. As a result of which the wire AB will have both translational and rotational motions.



144. (3)

As velocity, $v = \dfrac{E}{B} = \dfrac{7.7\times10^3}{0.14} = 55\ \text{km s}^{-1}$

145. (2)

When a charged particle enters a magnetic field at a direction perpendicular to the direction of motion, the path of the motion is circular. In circular motion the direction of velocity changes at every point (the magnitude remains constant). Therefore, the tangential momentum will change at every point. But kinetic energy will remain constant as it is given by $\frac{1}{2}mv^2$ and v^2 is the square of the magnitude of velocity which does not change.

146. (1)

Magnetic field at P, B_P = 2 (Magnetic field due to straight wire) + (Magnetic field due to semicircle)

$$B_P = 2\left(\frac{\mu_0 I}{4\pi r}\right) + \frac{\mu_0 I}{4r}$$

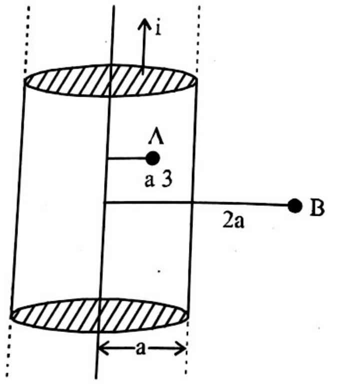
$$\therefore B_P = \frac{\mu_0 I}{2\pi r} + \frac{\mu_0 I}{4r} = \frac{\mu_0 I}{2\pi r}(2+\pi)$$

147. (4)

148. (1)

Let a be the radius of the wire Magnetic field at point A (inside)

$$B_A = \frac{\mu_0 ir}{2\pi a^2} = \frac{\mu_0 i \frac{a}{3}}{2\pi a^2} = \frac{\mu_0 i}{\pi a^2}\frac{a}{6} = \frac{\mu_0 i}{6\pi a}$$



Magnetic field at point B (outside)

$$B_B = \frac{\mu_0 i}{2\pi(2a)}$$

$$\therefore \frac{B_A}{B_B} = \frac{\frac{\mu_0 i}{6\pi a}}{\frac{\mu_0 i}{2\pi(2a)}} = \frac{4}{6} = \frac{2}{3}$$

149. (4)

Let a be the area of the square and r be the radius of circular loop.

$$2\pi r = 4a \Rightarrow r = \left(\frac{2a}{\pi}\right)$$

For square, $M = (I)a^2$

For circular loop, $M_1 = (I)\pi a^2$

$$M_1 = (I)(\pi)\left(\frac{4a^2}{\pi^2}\right) \Rightarrow M_1 = \frac{4Ia^2}{\pi}$$

$$M_1 = \frac{4M}{\pi} \qquad (\because M = Ia^2)$$

150. (2)

From Ampere's circuital law, $\int \vec{B}\cdot\vec{dl} = \mu_0 i$

$$\Rightarrow B \times 2\pi r = \mu_0 i$$

Here i is zero, for r < R, whereas R is the radius

$\therefore B = 0$