13. MAGNETISM

HOMEWORK SOLUTION

1. Given :

moment (M) = $4\ Am^2$

Magnetic length ($2l$) = 5 cm = 0.05 m

To Find :

Pole strength (m) = ?

Solution :

Magnetic moment (M) = $m \times 2l$

Now, Pole strength (m) = $\frac{M}{2l}$

$= \frac{4}{0.05}$

= 80 Am

2. Given :

no. of turns (n) = 100

Current (I) = 0.1 A

Area of coil = $50\ cm^2$ = $50 \times (10^{-2}m)^2$ = $50 \times 10^{-4}\ m^2$ = $0.005\ m^2$

To Find :

Magnetic moment (M) = ?

Solution :

Magnetic moment (M) = nIA

$= 100 \times 0.1 \times 0.005$

$= 0.05\ Am^2$

3. Given :

Rectangular coil,

Length (l) = 8 cm = 0.08 m

Breadth = 5 cm = 0.05 m

No. of turns (A) = 200

Current (I) = 2 A

To Find :

Magnetic moment of coil (M) = ?

Solution :

M = nIA

We have, for rectangular coil,

Area = $l \times b$

$= 0.08 \times 0.05$

$= 0.004\ m^2$

$\therefore$ M $= 200 \times 2 \times 0.004$

$= 1.6\ Am^2$

4. Given :

Couple = Torque

$= \tau = 3 \times 10^{-4}$ Nm

Magnetic induction (B) = $3 \times 10^{-5}\ Wb/m^2$,

$\theta = 90^0$

To Find :

Magnetic moment (M) = ?

Solution :

$\tau = MB \sin \theta$

$3 \times 10^{-4} = 3 \times 10^{-5} \times B \sin (90)$

$\therefore B = \frac{3\times10^{-4}}{3\times10^{-5}}$

$B = 10\ Am^2$

5. Given :

Magnetic moment = $7.5\ Am^2$

Torque (τ) = 1.5×10^{-4} Nm

$\theta = 30^0$

To Find :

Magnetic induction of field (B) = ?

Solution :

$\tau = mB \sin \theta$

$1.5 \times 10^{-4} = 7.5 \times B \times \sin 30$

$\therefore B = \frac{1.5\times10^{-9}}{7.5\times0.5}$

$B = 4 \times 10^{-5}$ T

6. Given :

Vertical component of earth's magnetic field (B_V) = 2×10^{-5} T

Horizontal component of earth's magentic field (B_H) = 3.464×10^{-5} T

To Find :

i) Angle of dip (δ)

ii) Earth's magnetic field (Resultant)

Solution :

$$\tan\delta = \frac{B_V}{B_H}$$

$$\tan\delta = \left[\frac{2\times10^{-5}}{3.464\times10^{-5}}\right]$$

$$\delta = \tan^{-1}[0.577] = 29.980 \approx 30^0$$

$\therefore$ Earths magnetic field (B)

$$= \sqrt{B_V{}^2 + B_H{}^2}$$

$$= \sqrt{\left(2\times10^{-5}\right)^2 + \left(3.464\times10^{-5}\right)^2}$$

$$= 3.99 \times 10^{-5} \approx 4 \times 10^{-5}\ T$$

7. Given :

Magnetic length ($2l$) = 10 cm = 0.1 m

Equator pt. Dist. from centre = 12 cm

Pole strength (m) = 10 Am

To Find :

B_{eq} = ?

Solution :

Q Point is along the equator of magnet

$$B_{eq} = \frac{\mu_0}{4\pi}\frac{M}{\left(r^2+l^2\right)^{\frac{3}{2}}}$$

But $\left(r^2+l^2\right)^{\frac{3}{2}} = 2197$

At m = $m \times 2l$ = 10×0.1 = 1 Am^2

$$\therefore B_{eq} = \frac{4\pi\times10^{-7}}{4\pi}\left[\frac{1}{2197}\right] = 4.55 \times 10^{-5}\ T$$

8. Given :

$2l$ = 6 cm

μ_0 = $4\pi \times 10^{-7}$ Wb/Am

B = 5×10^{-4} Wb/m²

To Find :

M = ?

Solution :

r = l + 2 cm = 3 + 2 = 5 cm = 0.5 m

$$B_{axis} = \frac{\mu_0}{4\pi}\frac{2M}{r^3}$$

$$\therefore M = \frac{B_{axis}\times4\pi\times r^3}{2\mu_0}$$

$$= \frac{5\times10^{-4}\times4\pi\times(0.5)^3}{2\times4\pi\times10^{-7}}$$

$$= 312.5 \times 10^{-3} = 0.3125\ Am^2$$

9. Given :

B_{eq} = 1.481×10^{-6} Wb/m²

r = 30 cm = 0.3 m

To Find :

M = ?

Solution :

$$B_{eq} = \frac{\mu_0}{4\pi}\frac{M}{r^3}$$

$$1.481 \times 10^{-6} = \frac{4\pi \times 10^{-3}}{4\pi} \times \frac{M}{0.3}$$

$$M = \frac{1.481 \times 10^{-6} \times 0.3}{10^{-3}}$$

$$M = 0.44 \text{ Am}^2$$

10. Given :

B_{axis} = 10×10^{-4} T

r = 20 cm = 0.2 m

To Find :

M = ?

Solution :

$$B_{axis} = \frac{\mu_0}{4\pi} \times \frac{2M}{r^3}$$

$$10 \times 10^{-4} = \frac{10 \times 10^{-4} \times (0.2)^3}{10^{-7} \times 2}$$

$$M = \frac{8 \times 10^{-3} \times 10^{-3}}{10^{-3} \times 2}$$

$$M = 4 \times 10^1$$

$$M = 40 \text{ Am}^2$$

11. Given :

M = 0.5 Am^2

d = 20 cm

μ_0 = $4\pi \times 10^{-7}$ Wb/Am

To Find :

B_{axis} = ?

B_{eq} = ?

Solution :

For short dipole at axis,

$$B_{axis} = \frac{\mu_0}{4\pi} \frac{2M}{r^3}$$

$$= \frac{4\pi \times 10^{-7} \times 2 \times 0.5}{4\pi \times (20 \times 10^{-5})^3}$$

$$= 12.5 \times 10^{-6} \text{ T}$$

For short dipole at equation,

$$B_{eq} = \frac{\mu_0}{4\pi} \frac{M}{r^3}$$

$$= \frac{4\pi \times 10^{-7} \times 0.5}{4\pi \times (20 \times 10^{-2})^3}$$

$$= 6.25 \times 10^{-6} \text{ T}$$

12. Solution :

Magnetic induction for short dipole at axis

$$B_{axis} = 2\left(\frac{\mu_0}{4\pi} \frac{M}{r^3}\right) \quad \text{...(i)}$$

Magnetic induction for short dipole at equator

$$B_{eq} = \left(\frac{\mu_0}{4\pi} \frac{M}{r^3}\right) \quad \text{...(ii)}$$

Dividing (ii) by (i)

$$\frac{B_{axis}}{B_{eq}} = 2$$

$$\therefore \quad B_{axis} = 2B_{eq}$$