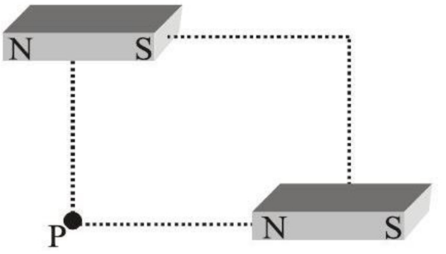
Magnetism and Matter

1. A bar magnet is demagnetized by inserting it inside a solenoid of length 0.2 m, 100 turns, and carrying a current of 5.2 A. The coercivity (in A/m) of the bar magnet is:
2. A magnet of total magnetic moment $10^{-2}\hat{\imath}$ A $-$ m^2 is placed in a time varying magnetic field, B$\hat{\imath}$(cos ωt) where B $= 1$ Tesla and $\omega = 0.125$rad/s. The work done (in joule) for reversing the direction of the magnetic moment at $t = 1$ second, is:
3. At some location on earth the horizontal component of earth's magnetic field is 18×10^{-6} T. At this location, magnetic needle of length 0.12 m and pole strength 1.8 Am is suspended from its mid-point using a thread, it makes 45° angle with horizontal in equilibrium. To keep this needle horizontal, the vertical force (in N) that should be applied at one of its ends is:
4. A paramagnetic substance in the form of a cube with sides 1 cm has a magnetic dipole moment of 20×10^{-6} J/T when a magnetic intensity of 60×10^3 A/m is applied. Its magnetic susceptibility is:
5. A paramagnetic material has 10^{28} atoms /m^3. Its magnetic susceptibility at temperature 350 K is 2.8×10^{-4}. Its susceptibility at 300 K is:
6. If the dipole moment of magnet is 0.4amp $-$ m^2 and the force acting on each pole in a uniform magnetic field of induction 3.2×10^{-5}Weber/m^2 is 5.12×10^{-5} N, the distance (in cm) between the poles of the magnet is
7. Two short bar magnets of magnetic moments 1000Am^2 are placed as shown at the corners of a square of side 10 cm. The net magnetic induction (in Tesla) at P is



8. The magnetic field of earth at the equator is approximately 4×10^{-5} T. The radius of earth is 6.4×10^6 m. Then the dipole moment (in A-m ^{2}) of the earth will be nearly of the order of
9. The angle of dip at a place is 37° and the vertical component of the earth's magnetic field is 6×10^{-5} T. The earth's magnetic field (in Tesla) at this place is (tan 37° $= 3/4$)
10. If relative permeability of iron is 2000. Its absolute permeability in S.I. unit is
11. The susceptibility of annealed iron at saturation is 5500. Find the absolute permeability (in SI unit) of annealed iron at saturation.
12. A magnetising field of 2×10^3 A m^{-1} produces a magnetic flux density of 8π T in an iron rod. The relative permeability of the rod will be
13. Two tangent galvanometers having coils of the same radius are connected in series. A current flowing in them produces deflections of 60° and 45° respectively. The ratio of the number of turns in the coils is
14. Two short magnets with their axes horizontal and perpendicular to the magnetic maridian are placed with their centres 40 cm east and 50 cm west of magnetic needle. If the needle remains undeflected, the ratio of their magnetic moments $M_1 : M_2$ is
15. A certain amount of current when flowing in a properly set tangent galvanometer, produces a deflection of 45°. If the current be reduced by a factor of $\sqrt{3}$, the deflection (in degree) would decrease by

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SOLUTIONS

1. **(2600)** Corecivity, $H=\frac{B}{\mu_0}$ and $B=\mu_0 ni\left(n=\frac{N}{\ell}\right)$

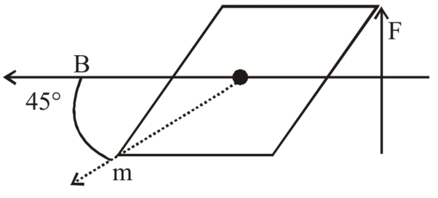
or, $H=\frac{N}{\ell}i=\frac{100}{0.2}\times 5.2=2600\,A/m$

2. **(0.02)** Work done, W = 2 m·B

$= 2\times 10^{-2}\times 1\cos(0.125)$

$= 0.02\,J$

3. **(6.5×10^{-5})** using, $MB\sin\theta = F\,\ell\,\sin\theta\ (\tau)$



$MB\sin 45° = F\frac{\ell}{2}\sin 45°$

$F=2MB=2\times 1.8\times 18\times 10^{-6}=6.5\times 10^{-5}N$

4. **(3.3×10^{-4})** Magnetic susceptibility,

$\chi=\frac{I}{H}$

where, $I=\frac{\text{Magnetic moment}}{\text{Volume}}=\frac{20\times 10^{-6}}{10^{-6}}$

$=20\,N/m^2$

Now, $\chi=\frac{20}{60\times 10^3}=\frac{1}{3}\times 10^{-3}=3.3\times 10^{-4}$

5. **(3.266×10^{-4})** According to Curie law for paramagnetic substance,

$\chi\ \alpha\ \frac{1}{T_C}$

$\frac{\chi_1}{\chi_2}=\frac{T_{C_2}}{T_{C_1}}$

$\frac{2.8\times 10^{-4}}{\chi_2}=\frac{300}{350}$

$\chi_2=\frac{2.8\times 350\times 10^{-4}}{300}$

$=3.266\times 10^{-4}$

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6. **(25)**

7. **(0.1)**

8. **(10^{23})** Given, $B = 4 \times 10^{-5}$ T

$R_E = 6.4 \times 10^6$ m

Dipole moment of the earth M = ?

$$B = \frac{\mu_0}{4\pi}\frac{M}{d^3}$$

$$4\times10^{-5} = \frac{4\pi\times10^{-7}\times M}{4\pi\times\left(6.4\times10^6\right)^3}$$

$\therefore$ $M \cong 10^{23}\ Am^2$

9. **(10^{-4})** $\tan\theta = \frac{V}{H} = \frac{3}{4}$ $\left[\because \tan 37^\circ = \frac{3}{4}\right]$

$\therefore$ $V = \frac{3}{4}H$

$V = 6 \times 10^{-5}$ T

$H = \frac{4}{3}\times 6\times10^{-5}\,T = 8\times10^{-5}\,T$

$\therefore$ $B_{total} = \sqrt{V^2 + H^2} = \sqrt{(36+64)}\times10^{-5}$

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

10. **($8\pi \times 10^{-4}$)** $\mu = \mu_0\mu_r = (4\pi \times 10^{-7}) \times 2000 = 8\pi \times 10^{-4}$ S.I. unit

11. **(6.9×10^{-3})** We know that $\mu_r = 1 + \chi$

$= 1 + 5500 = 5501$

$\therefore$ $\mu = \mu_r\mu_0 = (5501) \times (4\pi \times 10^{-7})$

$= 6.9 \times 10^{-3}$

12. **(10^4)** Here, $H = 2 \times 10^3$ A m^{-1}, $B = 8\pi$ T, $\mu_0 = 4\pi \times 10^7$

Since $\mu_r = \frac{\mu}{\mu_0} = \frac{\mu H}{\mu_0 H} = \frac{B}{\mu_0 H}$

$$= \frac{8\pi}{4\pi\times10^{-7}\times2\times10^3} = 10^4$$

13. **($\sqrt{3}$)** In the first galvanometer

$i_1 = K_1\tan\theta_1 = K_1\tan60^\circ = K_1\sqrt{3}$

In the second galvanometes,

$i_2 = K_2\tan\theta_2 = K_2\tan45^\circ = K_2$

In series $i_1 = i_2 \Rightarrow K_1\sqrt{3} = K_2$

$$\Rightarrow \frac{K_1}{K_2} = \frac{1}{\sqrt{3}}$$

But, $K \alpha \frac{1}{n} \Rightarrow \frac{K_1}{K_2} = \frac{n_2}{n_1}$ $\quad \therefore \frac{n_1}{n_2} = \frac{\sqrt{3}}{1}$

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14. **(0.51)** For null deflection, $\frac{M_1}{M_2}=\left(\frac{d_1}{d_2}\right)^3=\left(\frac{40}{50}\right)^3=\frac{64}{125}$

15. **(15)** In tangent galvanometer, $I \propto \tan\theta$

$$\frac{I_1}{I_2}=\frac{\tan\theta_1}{\tan\theta_2} \quad \Rightarrow \frac{I_1}{I_2/\sqrt{3}}=\frac{\tan 45}{\tan\theta_2}$$

$\theta_2 = 30^o$

so, deflection will decrease by $45^o - 30^o = 15^o$

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