
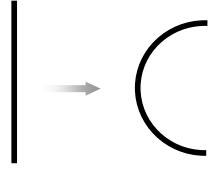
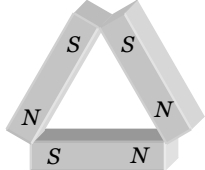


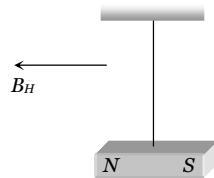
Magnetism

 Self Evaluation Test - 22

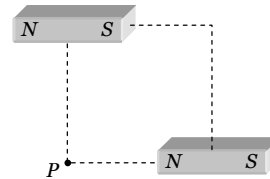
1. A compass needle whose magnetic moment is $60 \text{ amp} \times \text{m}^2$ pointing geographical north at a certain place, where the horizontal component of earth's magnetic field is $40 \mu \text{ Wb/m}^2$, experiences a torque $1.2 \times 10^{-3} \text{ N} \times \text{m}$. What is the declination at this place [EAMCET (Engg.) 1996]
- (a) 30° (b) 45°
(c) 60° (d) 25°
2. The distance between the poles of a horse shoe magnet is 0.1 m and its pole strength is 0.01 amp-m . The induction of magnetic field at a point midway between the poles will be
- (a) $2 \times 10^{-5} \text{ T}$ (b) $4 \times 10^{-6} \text{ T}$
(c) $8 \times 10^{-7} \text{ T}$ (d) Zero
- 
3. Due to a small magnet intensity at a distance x in the end on position is 9 Gauss. What will be the intensity at a distance $\frac{x}{2}$ on broad side on position
- (a) 9 Gauss (b) 4 Gauss
(c) 36 Gauss (d) 4.5 Gauss
4. The magnetic moment produced in a substance of 1 gm is $6 \times 10^{-7} \text{ ampere} - \text{metre}^2$. If its density is 5 gm/cm^3 , then the intensity of magnetisation in A/m will be
- (a) 8.3×10^6 (b) 3.0
(c) 1.2×10^{-7} (d) 3×10^{-6}
5. The needle of a deflection galvanometer shows a deflection of 60° due to a short bar magnet at a certain distance in $\tan A$ position. If the distance is doubled, the deflection is
- (a) $\sin^{-1}\left(\frac{\sqrt{3}}{8}\right)$ (b) $\cos^{-1}\left(\frac{\sqrt{3}}{8}\right)$
(c) $\tan^{-1}\left(\frac{\sqrt{3}}{8}\right)$ (d) $\cot^{-1}\left(\frac{\sqrt{3}}{8}\right)$
6. The area of hysteresis loop of a material is equivalent to 250 joule. When 10 kg material is magnetised by an alternating field of 50 Hz then energy lost in one hour will be if the density of material is 7.5 gm/cm^3
- (a) $6 \times 10^4 \text{ J}$ (b) $6 \times 10^4 \text{ erg}$
(c) $3 \times 10^2 \text{ J}$ (d) $3 \times 10^2 \text{ erg}$
7. A magnetised wire of moment M is bent into an arc of a circle subtending an angle of 60° at the centre; then the new magnetic moment is
- (a) $(2M/\pi)$ (b) (M/π)
(c) $(3\sqrt{3}M/\pi)$ (d) $(3M/\pi)$
- 
8. A tangent galvanometer shows a deflection 45° when 10 mA current pass through it. If the horizontal component of the earth's field is $3.6 \times 10^{-5} \text{ T}$ and radius of the coil is 10 cm. The number of turns in the coil is
- (a) 5700 turns (b) 57 turns
(c) 570 turns (d) 5.7 turns
9. A magnet is parallel to a uniform magnetic field. If it is rotated by 60° , the work done is 0.8 J. How much work is done in moving it 30° further
- (a) $0.8 \times 10^7 \text{ ergs}$ (b) 0.4 J
(c) 8 J (d) 0.8 ergs
10. Susceptibility of Mg at 300 K is 1.2×10^{-5} . The temperature at which susceptibility will be 1.8×10^{-5} is [Roorkee 1996]
- (a) 450 K (b) 200 K
(c) 375 K (d) None of these
11. Three identical bar magnets each of magnetic moment M are placed in the form of an equilateral triangle as shown. The net magnetic moment of the system is
- (a) Zero (b) $2M$
(c) $M\sqrt{3}$ (d) $\frac{3M}{2}$
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12. A magnetic needle is placed on a cork floating in a still lake in the northern hemisphere. Does the needle together with the cork move towards the north of the lake
- (a) Yes (b) No
(c) May be or may not be move (d) Nothing can be said

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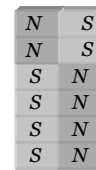
- 13.** The magnet of vibration magnetometer is heated so as to reduce its magnetic moment by 36%. By doing this the periodic time of the magnetometer will
- (a) Increases by 36% (b) Increases by 25%
 (c) Decreases by 25% (d) Decreases by 64%
- 14.** The ratio of magnetic moments of two bar magnet is 13 : 5. These magnets are held together in a vibration magnetometer are allowed to oscillate in earth's magnetic field with like poles together 15 oscillation per minute are made. What will be the frequency of oscillation of system if unlike poles are together
- (a) 10 oscillations/min (b) 15 oscillations/min
 (c) 12 oscillations/min (d) $\frac{75}{13}$ oscillations/min
- 15.** A magnet is suspended horizontally in the earth's magnetic field. When it is displaced and then released it oscillates in a horizontal plane with a period T . If a piece of wood of the same moment of inertia (about the axis of rotation) as the magnet is attached to the magnet what would the new period of oscillation of the system become
- (a) $\frac{T}{3}$
 (b) $\frac{T}{2}$
 (c) $\frac{T}{\sqrt{2}}$
 (d) $T\sqrt{2}$



- 16.** Two short magnets of magnetic moment 1000 Am^2 are placed as shown at the corners of a square of side 10 cm . The net magnetic induction at P is



- (a) 0.1 T (b) 0.2 T
 (c) 0.3 T (d) 0.4 T
- 17.** The length of a magnet is large compared to its width and breadth. The time period of its oscillation in a vibration magnetometer is T . The magnet is cut along its length into six parts and these parts are then placed together as shown in the figure. The time period of this combination will be
- (a) T
 (b) $\frac{T}{\sqrt{3}}$
 (c) $\frac{T}{2\sqrt{3}}$
 (d) Zero

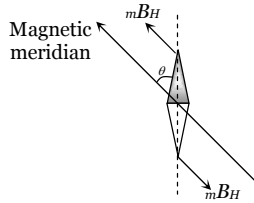


AS Answers and Solutions

(SET -22)

1. (a) As the compass needle is free to rotate in a horizontal plane and points along the magnetic meridian,

so when it is pointing along the geographic meridian, it will experience a torque due to the horizontal component of earth's magnetic field i.e.
 $\tau = MB_H \sin \theta$



where $\theta =$ angle between geographical and magnetic meridians called angle of declination

So, $\sin \theta = \frac{1.2 \times 10^{-3}}{60 \times 40 \times 10^{-6}} = \frac{1}{2} \Rightarrow \theta = 30^\circ$

2. (c) Net magnetic field at mid point P , $B = B_N + B_S$

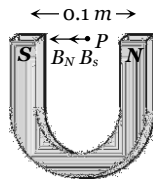
where $B_N =$ magnetic field due to N - pole

$B_S =$ magnetic field due to S - pole

$$B_N = B_S = \frac{\mu_0 m}{4\pi r^2}$$

$$= 10^{-7} \times \frac{0.01}{\left(\frac{0.1}{2}\right)^2} = 4 \times 10^{-7} T$$

$\therefore B_{net} = 8 \times 10^{-7} T.$



3. (c) In C.G.S. $B_{axial} = 9 = \frac{2M}{x^3}$ (i)

$$B_{equatorial} = \frac{M}{\left(\frac{x}{2}\right)^3} = \frac{8M}{x^3}$$
(ii)

From equation (i) and (ii) $B_{equatorial} = 36$ Gauss.

4. (b) $I = \frac{M}{V} = \frac{M}{\text{mass/density}}$,
 given mass = $1gm = 10^{-3} kg$,
 and

density = $5gm/cm^3 = \frac{5 \times 10^{-3} kg}{(10^{-2})^3 m^3} = 5 \times 10^3 kg/m^3$

Hence $I = \frac{6 \times 10^{-7} \times 5 \times 10^3}{10^{-3}} = 3$

5. (c) For short bar magnet in tan A-position

$$\frac{\mu_0 2M}{4\pi d^3} = H \tan \theta$$
(i)

When distance is doubled, then new deflection θ' is given by

$$\frac{\mu_0 2M}{4\pi (2d)^3} = H \tan \theta'$$
(ii)

$$\therefore \frac{\tan \theta'}{\tan \theta} = \frac{1}{8} \Rightarrow \tan \theta' = \frac{\tan \theta}{8} = \frac{\tan 60^\circ}{8} = \frac{\sqrt{3}}{8}$$

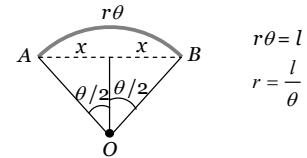
$$\Rightarrow \theta' = \tan^{-1} \left(\frac{\sqrt{3}}{8} \right)$$

6. (a) $E = nAVt = nA \frac{m}{d} t = \frac{50 \times 250 \times 10 \times 3600}{7.5 \times 10^3} = 6 \times 10^4 J$

7. (d) From figure

$$\sin \frac{\theta}{2} = \frac{x}{r}$$

$$\Rightarrow x = r \sin \frac{\theta}{2}$$



Hence new magnetic moment

$$M' = m(2x) = m.2r \sin \frac{\theta}{2}$$

$$= m. \frac{2l}{\theta} \sin \frac{\theta}{2} = \frac{2ml \sin \theta / 2}{\theta} = \frac{2M \sin(\pi/6)}{\pi/3} = \frac{3M}{\pi}$$

8. (c) $K = \frac{2rB_H}{\mu_0 n}$

or $n = \frac{2rB_H}{\mu_0 K} = \frac{2 \times 0.1 \times 3.6 \times 10^{-5}}{4\pi \times 10^{-7} \times 10 \times 10^{-3}} = \frac{1.8 \times 10^3}{3.14} = 570$

9. (a) $W = MB(\cos \theta_1 - \cos \theta_2)$

When the magnet is rotated from 0° to 60° , then work done is $0.8 J$

$$0.8 = MB(\cos 0^\circ - \cos 60^\circ) = \frac{MB}{2}$$

$$\Rightarrow MB = 1.6 N - m$$

In order to rotate the magnet through an angle of 30° , i.e., from 60° to 90° , the work done is

$$W' = MB(\cos 60^\circ - \cos 90^\circ) = MB \left(\frac{1}{2} - 0 \right)$$

$$= \frac{MB}{2} = \frac{1.6}{2} = 0.8 J = 0.8 \times 10^7 \text{ ergs}$$

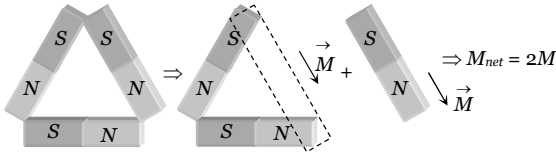
10. (b) $\chi \propto \frac{1}{T}$

$$\therefore \chi_1 T_1 = \chi_2 T_2$$

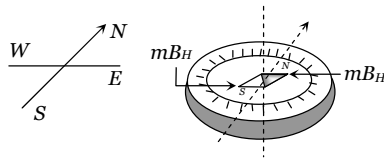
Hence $T_2 = \frac{1.2 \times 10^{-5} \times 300}{1.8 \times 10^{-5}} = 200 K$

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11. (b) The resultant magnetic moment can be calculated as follows.



12. (b) Magnetic needle is a dipole which is in earth's uniform magnetic field and as a dipole in a uniform field does not experience any net force but may experience a couple as shown in figure, so the needle together with the cork will not translate *i.e.* move towards the north of the lake, but will rotate and set itself parallel to the field with its north pole pointing north.



13. (b) $T = 2\pi\sqrt{\frac{I}{MB_H}} \Rightarrow T \propto \frac{1}{\sqrt{M}} \Rightarrow \frac{T_1}{T_2} = \sqrt{\frac{M_2}{M_1}}$

If $M_1 = 100$ then $M_2 = (100 - 36) = 64$

So $\frac{T_1}{T_2} = \sqrt{\frac{64}{100}} = \frac{8}{10} \Rightarrow T_2 = \frac{10}{8}T_1 = 1.25 T_1$

So % increase in time period = 25%

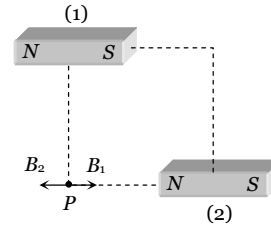
14. (a) $\frac{M_1}{M_2} = \frac{v_s^2 + v_d^2}{v_s^2 - v_d^2} \Rightarrow \frac{13}{5} = \frac{(15)^2 + v_d^2}{(15)^2 - v_d^2}$

$\Rightarrow v_d = 10$ oscillations/min

15. (d) Due to wood moment of inertia of the system becomes twice but there is no change in magnetic moment of the system.

Hence by using $T = 2\pi\sqrt{\frac{I}{MB_H}} \Rightarrow T \propto \sqrt{I} \Rightarrow T' = \sqrt{2} T$

16. (a) Point P lies on equatorial line of magnet (1) and axial line of magnet (2) as shown



$B_1 = \frac{\mu_0}{4\pi} \cdot \frac{M}{d^3} = 10^{-7} \times \frac{1000}{(0.1)^3} = 0.1 T$

$B_2 = \frac{\mu_0}{4\pi} \cdot \frac{2M}{d^3} = 10^{-7} \times \frac{2 \times 1000}{(0.1)^3} = 0.2 T$

$\therefore B_{net} = B_2 - B_1 = 0.1 T$

17. (c) $T = 2\pi\sqrt{\frac{I}{MH}}$; MI of each part = $\frac{I}{6^3}$

and magnetic moment of each part = $\frac{M}{6}$

so net MI of system = $\frac{I}{6^3} \times 6 = \frac{I}{6^2}$

and net magnetic moment = $\frac{4M}{6} - \frac{2M}{6} = \frac{M}{3}$

\therefore time period of the system

$T' = 2\pi\sqrt{\frac{I/36}{(M/3)H}} = \frac{1}{2\sqrt{3}} 2\pi\sqrt{\frac{I}{MH}} = \frac{T}{2\sqrt{3}}$
