17 Magnetism

1. A magnetic needle lying parallel to a magnetic field requires W units of work to turn it through 60°. The torque needed to maintain the needle in this position will be

(a) $\sqrt{3}W$ (b) W

(c) $\left(\frac{\sqrt{3}}{2}\right)W$ (d) $2W$.

(2003)

2. The magnetic lines of force inside a bar magnet

(a) are from north-pole to south-pole of the magnet

(b) do not exist

(c) depend upon the area of cross-section of the bar magnet

(d) are from south-pole to north-pole of the magnet.

(2003)

3. Curie temperature is the temperature above which

(a) a ferromagnetic material becomes paramagnetic

(b) a paramagnetic material becomes diamagnetic

(c) a ferromagnetic material becomes diamagnetic

(d) a paramagnetic material becomes ferromagnetic.

(2003)

4. A thin rectangular magnet suspended freely has a period of oscillation equal to T. Now it is broken into two equal halves (each having half of the original length) and one piece is made to oscillate freely in the same field. If its period of oscillation is T', the ratio $\frac{T'}{T}$ is

(a) $\frac{1}{2\sqrt{2}}$ (b) $\frac{1}{2}$

(c) 2 (d) $\frac{1}{4}$.

(2003)

5. The length of a magnet is large compared to its width and breadth. The time period of its oscillation in a vibration magnetometer is 2 s. The magnet is cut along its length into three equal parts and three parts are then placed on each other with their like poles together. The time period of this combination will be

(a) 2 s (b) $\frac{2}{3}$ s

(c) $(2\sqrt{3})$ s (d) $\left(\frac{2}{\sqrt{3}}\right)$ s

(2004)

6. The materials suitable for making electromagnets should have

(a) high retentivity and high coercivity

(b) low retentivity and low coercivity

(c) high retentivity and low coercivity

(d) low retentivity and high coercivity.

(2004)

7. A magnetic needle is kept in a non-uniform magnetic field. It experiences

(a) a force and a torque

(b) a force but not a torque

(c) a torque but not a force

(d) neither a force nor a torque

(2005)

8. Needles N_1, N_2 and N_3 are made of a ferromagnetic,

a paramagnetic and a diamagnetic substance respectively. A magnet when brought close to them will

(a) attract all three of them

(b) attract N_1 and N_2 strongly but repel N_3

(c) attract N_1 strongly, N_2 weakly and repel N_3 weakly

(d) attract N_1 strongly, but repel N_2 and N_3 weakly.

(2006)

9. Relative permittivity and permeability of a material are ε_r and μ_r, respectively. Which of the following values of these quantities are allowed for a diamagnetic mateiral?

(a) $\varepsilon_r = 1.5, \mu_r = 1.5$

(b) $\varepsilon_r = 0.5, \mu_r = 1.5$

(c) $\varepsilon_r = 1.5, \mu_r = 0.5$

(d) $\varepsilon_r = 0.5, \mu_r = 0.5$

(2008)

Answer Key

1.	(a)	**2.**	(d)	**3.**	(a)	**4.**	(b)	**5.**	(b)	**6.**	(b)
7.	(a)	**8.**	(c)	**9.**	(c)						

EXPLANATIONS

1. **(a) :** $W = -MB(\cos\theta_2 - \cos\theta_1)$

$= -MB(\cos 60° - \cos 0) = \frac{MB}{2}$

$\therefore \quad MB = 2W$ .....(i)

Torque $= MB \sin 60° = (2W)\sin 60°$

$= \frac{2W \times \sqrt{3}}{2} = \sqrt{3}\,W.$

2. **(d) :** The magnetic lines of force inside a bar magnet are from south pole to north pole of magnet.

3. **(a) :** A ferromagnetic material becomes paramagnetic above Curie temperature.

4. **(b) :** For an oscillating magnet, $T = 2\pi\sqrt{\frac{I}{MB}}$

where $I = ml^2/12$, $M = xl$, x = pole strength

When the magnet is divided into 2 equal parts, the magnetic dipole moment

$M' =$ Pole strength $\times$ length $= \frac{x \times l}{2} = \frac{M}{2}$ .....(i)

$I' = \frac{\text{Mass} \times (\text{length})^2}{12}$

$= \frac{(m/2)(l/2)^2}{12} = \frac{ml^2}{12 \times 8} = \frac{I}{8}$ .....(ii)

$\therefore$ Time period $T' = 2\pi\sqrt{\frac{I'}{M'B}}$

$\therefore \quad \frac{T'}{T} = \sqrt{\frac{I'}{M'} \times \frac{M}{I}} = \sqrt{\frac{I'}{I} \times \frac{M}{M'}}$ .....(iii)

$\therefore \quad \frac{T'}{T} = \sqrt{\frac{1}{8} \times \frac{2}{1}} = \frac{1}{2}.$

5. **(b) :** For a vibrating magnet, $T = 2\pi\sqrt{\frac{I}{MB}}$

where $I = ml^2/12$, $M = xl$, x = pole strength of magnet

$I' = \left(\frac{m}{3}\right)\left(\frac{l}{3}\right)^2 \times \frac{3}{12} = \frac{ml^2}{9 \times 12} = \frac{I}{9}$

(For three pieces together)

$M' = (x)\left(\frac{l}{3}\right) \times 3 = xl = M$

(For three pieces together)

$\therefore \quad T' = 2\pi\sqrt{\frac{I'}{M'B}} = 2\pi\sqrt{\frac{I/9}{MB}}$

$= \frac{1}{3} \times 2\pi\sqrt{\frac{I}{MB}} = \frac{T}{3}$

$\therefore \quad T' = \frac{T}{3} = \frac{2}{3}\text{sec}.$

6. **(b) :** Materials of low retentivity and low coercivity are suitable for making electromagnets.

7. **(a) :** A force and a torque act on a magnetic needle kept in a non-uniform magnetic field.

8. **(c) :** Magnet will attract N_1 strongly, N_2 weakly and repel N_3 weakly.

9. **(c) :** The values of relative permeability of diamagnetic materials are slightly less than 1 and ε_r is quite high. According to the table given, one takes

$\varepsilon_r = 1.5$ and $\mu_r = 0.5$. Then the choice (c) is correct.