CHAPTER 19

Magnetism and Matter

1. 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 **[2003]**
   (a) $\frac{1}{2\sqrt{2}}$ (b) $\frac{1}{2}$
   (c) 2 (d) $\frac{1}{4}$
2. A magnetic needle lying parallel to a magnetic field requiers W units of work to turn it through 60^0. The torque needed to maintain the needle in this position will be **[2003]**
   (a) $\sqrt{3}$W (b) W
   (c) $\frac{\sqrt{3}}{2}$W (d) 2W
3. The magnetic lines of force inside a bar magnet **[2003]**
   (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
4. Curie temperature is the temperature above which **[2003]**
   (a) a ferromagnetic material becomes paramagnetic
   (b) a paramagnetic material becomes diamagnetic
   (c) a ferromagnetic material becomes diamagnetic
   (d) a paramagnetic material becomes ferromagnetic
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 2s. The magnet is cut along its length into three equal parts and these parts are then placed on each other with their like poles together. The time period of this combination will be **[2004]**
   (a) $2\sqrt{3}$ s (b) $\frac{2}{3}$s
   (c) 2 s (d) $\frac{2}{\sqrt{3}}$s
6. The materials suitable for making electromagnets should have **[2004]**
   (a) high retentivity and low coercivity
   (b) low retentivity and low coercivity
   (c) high retentivity and high coercivity
   (d) low retentivity and high coercivity
7. A magnetic needle is kept in a non-uniform magnetic field. It experiences **[2005]**
   (a) neither a force nor a torque
   (b) a torque but not a force
   (c) a force but not a torque
   (d) a force and a torque
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 **[2006]**
   (a) attract N_1 and N_2 strongly but repel N_3
   (b) attract N_1 strongly, N_2 weakly and repel N_3 weakly
   (c) attract N_1 strongly, but repel N_2 and N_3 weakly
   (d) attract all three of them

9. Relative permittivity and permeability of a material ε_r and μ_r, respectively. Which of the following values of these quantities are allowed for a diamagnetic material? **[2008]**

(a) $\varepsilon_r = 0.5, \mu_r = 1.5$
(b) $\varepsilon_r = 1.5, \mu_r = 0.5$
(c) $\varepsilon_r = 0.5, \mu_r = 0.5$
(d) $\varepsilon_r = 1.5, \mu_r = 1.5$

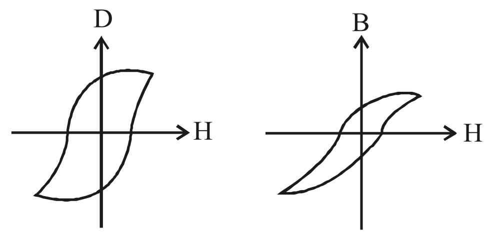
10. Two short bar magnets of length 1 cm each have magnetic moments 1.20 Am^2 and 1.00 Am^2 respectively. They are placed on a horizontal table parallel to each other with their N poles pointing towards the South. They have a common magnetic equator and are separated by a distance of 20.0 cm. The value of the resultant horizontal magnetic induction at the mid-point O of the line joining their centres is close to (Horizontal component of earth.s magnetic induction is 3.6× 10.5Wb/m^2) **[2013]**

(a) 3.6 × 10.5 Wb/m^2
(b) 2.56 × 10.4 Wb/m^2
(c) 3.50 × 10.4 Wb/m^2
(d) 5.80 × 10.4 Wb/m^2

11. The coercivity of a small magnet where the ferromagnet gets demagnetized is 3×10^3 Am^{-1}. The current required to be passed in a solenoid of length 10 cm and number of turns 100, so that the magnet gets demagnetized when inside the solenoid, is: **[2014]**

(a) 30 mA (b) 60 mA
(c) 3 A (d) 6 A

12. Hysteresis loops for two magnetic materials A and B are given below : **[2016]**



(A) (B)

These materials are used to make magnets for elecric generators, transformer core and electromagnet core. Then it is proper to use :

(a) A for transformers and B for electric generators.
(b) B for electromagnets and transformers.
(c) A for electric generators and trasformers.
(d) A for electromagnets and B for electric generators

Answer Key														
1	2	3	4	5	6	7	8	9	10	11	12			
(b)	(a)	(d)	(a)	(b)	(b)	(d)	(b)	(b)	(b)	(c)	(b)			

SOLUTIONS

1. (b) The time period of a rectangular magnet oscillating in earth's magnetic field is given by $T = 2\pi\sqrt{\dfrac{I}{\mu B_H}}$

where I = Moment of inertia of the rectangular magnet

μ = Magnetic moment

B_H = Horizontal component of the earth's magnetic field

Case 1

$$T = 2\pi\sqrt{\frac{I}{\mu B_H}} \quad \text{where} \quad I = \frac{1}{12}M\ell^2$$

Case 2

Magnet is cut into two identical pieces such that each piece has half the original length. Then $T' = 2\pi\sqrt{\dfrac{I'}{\mu' B_H}}$

$$\text{where } I' = \frac{1}{12}\left(\frac{M}{2}\right)\left(\frac{\ell}{2}\right)^2 = \frac{I}{8} \text{ and } \mu' = \frac{\mu}{2}$$

$$\therefore \frac{T'}{T} = \sqrt{\frac{I'}{\mu'} \times \frac{\mu}{I}} = \sqrt{\frac{I/8}{\mu/2} \times \frac{\mu}{I}} = \sqrt{\frac{1}{4}} = \frac{1}{2}$$

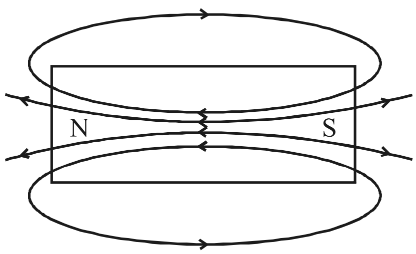
2. (a) $W = MB(\cos\theta_1 - \cos\theta_2)$

$= MB(\cos 0° - \cos 60°)$

$= MB(1 - \frac{1}{2}) = \frac{MB}{2}$

$\therefore \ \tau = MB \sin\theta = MB \sin 60° = \sqrt{3}\frac{MB}{2} = \sqrt{3}W$

3. (d) As shown in the figure, the magnetic lines of force are directed from south to north inside a bar magnet.



4. (a) The temperature above which a ferromagnetic substance becomes paramagnetic is called Curie's temperature.

5. (b) $T = 2\pi\sqrt{\frac{I}{M \times B}} = 2\pi\sqrt{\frac{I}{MB}}$ where

$I = \frac{1}{12}m\ell^2$

When the magnet is cut into three pieces the pole strength will remain the same and

M.I. $(I') = \frac{1}{12}\left(\frac{m}{3}\right)\left(\frac{\ell}{3}\right) \times 3 = \frac{I}{9}$

We have, Magnetic moment (M)
= Pole strength (m) × ℓ

$\therefore$ New magnetic moment,

$M' = m \times \left(\frac{\ell}{3}\right) \times 3 = m\ell = M$

$\therefore \ T' = \frac{T}{\sqrt{9}} = \frac{2}{3}s$.

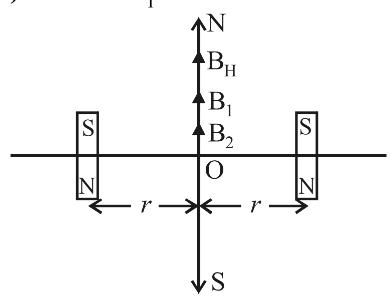
6. (b) Electromagnet should be amenable to magnetisation & demagnetization.
$\therefore$ retentivity should be low & coercivity should be low.

7. (d) A magnetic needle kept in non uniform agnetic field experience a force and torque due to unequal forces acting on poles.

8. (b) Ferromagnetic substance has magnetic domains whereas paramagnetic substances have magnetic dipoles which get attracted to a magnetic field. Diamagnetic substances do not have magnetic dipole but in the presence of external magnetic field due to their orbital motion of electrons these substances are repelled.

9. (b) For a diamagnetic material, the value of μ_r is less than one. For any material, the value of $\in_r$ is always greater than 1.
Solving we get, $B = 5 \times 10^{-8}$ tesla

10. (b) Given : $M_1 = 1.20\ Am^2$



$M_2 = 1.00\ Am^2$; $r = \frac{20}{2}cm = 0.1$ m

$B_{net} = B_1 + B_2 + B_H$

$B_{net} = \frac{\mu_0}{4\pi}\frac{(M_1 + M_2)}{r^3} + B_H$

$= \frac{10^{-7}(1.2+1)}{(0.1)^3} + 3.6 \times 10^{-5} = 2.56 \times 10^{-4}$ wb/m^2

11. (c) Magnetic field in solenoid $B = \mu_0 n$ i

$\Rightarrow \ \frac{B}{\mu_0} = ni$

(Where n = number of turns per unit length)

$\Rightarrow \ \frac{B}{\mu_0} = \frac{Ni}{L} \Rightarrow 3 \times 10^3 = \frac{100i}{10 \times 10^{-2}}$

$\Rightarrow \ i = 3$A

12. (b) Graph [A] is for material used for making permanent magnets (high coercivity)

Graph [B] is for making electromagnets and transformers.