DPP - Daily Practice Problems

Chapter-wise Sheets

Date :   **Start Time :**   **End Time :**

PHYSICS

CP19

SYLLABUS : Magnetism and Matter

Max. Marks : 180   **Marking Scheme :** (+4) for correct & (–1) for incorrect answer   **Time : 60 min.**

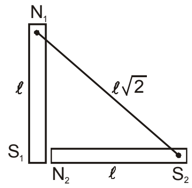
INSTRUCTIONS : This Daily Practice Problem Sheet contains 45 MCQs. For each question only one option is correct. Darken the correct circle/ bubble in the Response Grid provided on each page.

1. Two identical magnetic dipoles of magnetic moments 1.0 A-m^2 each, placed at a separation of 2 m with their axis perpendicular to each other. The resultant magnetic field at point midway between the dipole is

(a) 5×10^{-7} T (b) $\sqrt{5} \times 10^{-7}$ T

(c) 10^{-7} T (d) 2×10^{-7} T

2. Two identical thin bar magnets each of length ℓ and pole strength m are placed at right angles to each other, with north pole of one touching south pole of the other, then the magnetic moment of the system is



(a) $1\,m\ell$ (b) $2\,m\ell$ (c) $\sqrt{2}\,m\ell$ (d) $m\ell/2$

3. 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

4. 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?

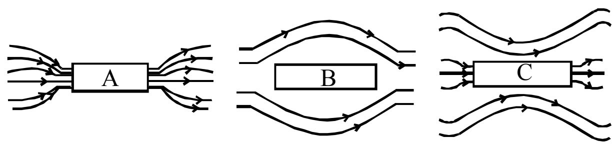
(a) $\varepsilon_r = 0.5, \mu_r = 1.5$ (b) $\varepsilon_r = 1.5, \mu_r = 0.5$

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

5. If the period of oscillation of freely suspended bar magnet in earth's horizontal field H is 4 sec. When another magnet is brought near it, the period of oscillation is reduced to 2s. The magnetic field of second bar magnet is

(a) 4 H (b) 3 H (c) 2 H (d) $\sqrt{3}$ H

6. Three identical bars A, B and C are made of different magnetic materials. When kept in a uniform magnetic field, the field lines around them look as follows:



Make the correspondence of these bars with their material being diamagnetic (D), ferromagnetic (F) and paramagnetic (P):

(a) $A \leftrightarrow D, B \leftrightarrow P, C \leftrightarrow F$
(b) $A \leftrightarrow F, B \leftrightarrow D, C \leftrightarrow P$
(c) $A \leftrightarrow P, B \leftrightarrow F, C \leftrightarrow D$
(d) $A \leftrightarrow F, B \leftrightarrow P, C \leftrightarrow D$

RESPONSE GRID	
	1. ⓐⓑⓒⓓ 2. ⓐⓑⓒⓓ 3. ⓐⓑⓒⓓ 4. ⓐⓑⓒⓓ 5. ⓐⓑⓒⓓ
	6. ⓐⓑⓒⓓ

Space for Rough Work

7. 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

8. A watch glass containing some powdered substance is placed between the pole pieces of a magnet. Deep concavity is observed at the centre. The substance in the watch glass is
(a) iron (b) chromium (c) carbon (d) wood

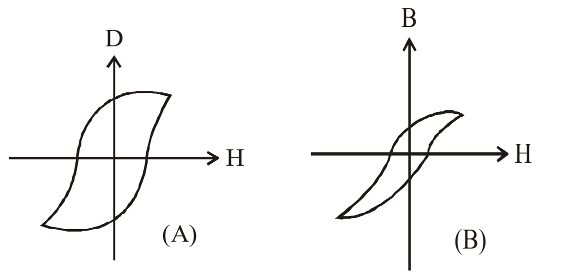
9. A coil in the shape of an equilateral triangle of side l is suspended between the pole pieces of a permanent magnet such that $\vec{B}$ is in the plane of the coil. If due to a current i in the triangle a torque τ acts on it, the side l of the triangle is
(a) $\frac{2}{\sqrt{3}}\left(\frac{\tau}{B.i}\right)^{\frac{1}{2}}$ (b) $2\left(\frac{\tau}{\sqrt{3}B.i}\right)^{\frac{1}{2}}$
(c) $\frac{2}{\sqrt{3}}\left(\frac{\tau}{B.i}\right)$ (d) $\frac{1}{\sqrt{3}}\frac{\tau}{B.i}$

10. A compass needle whose magnetic moment is 60 Am^2, is directed towards geographical north at any place experiencing moment of force of 1.2×10^{-3} Nm. At that place the horizontal component of earth field is 40 micro W/m^2. What is the value of dip angle at that place?
(a) 30° (b) 60° (c) 45° (d) 15°

11. The materials suitable for making electromagnets should have
(a) high retentivity and low coercivity
(b) low retentivity and low coercivity
(c) high retentivity and high coercivity
(d) low retentivity and high coercivity

12. 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
(a) $2\sqrt{3}$ s (b) $\frac{2}{3}$s (c) 2 s (d) $\frac{2}{\sqrt{3}}$s

13. Hysteresis loops for two magnetic materials A and B are given below :



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.

14. Which of the following is responsible for the earth's magnetic field?
(a) Convective currents in earth's core.
(b) Diversive current in earth's core.
(c) Rotational motion of earth.
(d) Translational motion of earth.

15. In a vibration megnetometer, the time period of a bar magnet oscillating in horizontal component of earth's magnetic field is 2 sec. When a magnet is brought near and parallel to it, the time period reduces to 1 sec. The ratio H/F of the horizontal component H and the field F due to magnet will be
(a) 3 (b) 1/3 (c) $\sqrt{3}$ (d) $1/\sqrt{3}$

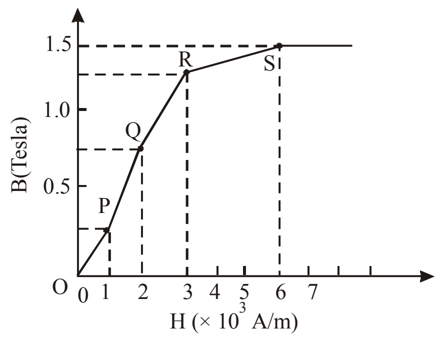
16. Let V and H be the vertical and horizontal components of earth's magnetic field at any point on earth. Near the north pole
(a) V>>H (b) V<<H (c) V=H (d) V=H=0

17. A thin circular wire carrying a current I has a magnetic moment M. The shape of the wire is changed to a square and it carries the same current. It will have a magnetic moment
(a) M (b) $\frac{4}{\pi^2}M$ (c) $\frac{4}{\pi}M$ (d) $\frac{\pi}{4}M$

18. A bar magnet of magnetic moment M is placed at right angles to a magnetic induction B. If a force F is experienced by each pole of the magnet, the length of the magnet will be
(a) F/MB (b) MB/F (c) BF/M (d) MF/B

19. If the susceptibility of dia, para and ferro magnetic materials are χ_d, χ_p, χ_f respectively, then
(a) $\chi_d < \chi_p < \chi_f$ (b) $\chi_d < \chi_f < \chi_p$
(c) $\chi_f < \chi_d < \chi_p$ (d) $\chi_f < \chi_p < \chi_d$

20. The basic magnetization curve for a ferromagnetic material is shown in figure. Then, the value of relative permeability is highest for the point



(a) P (b) Q (c) R (d) S

RESPONSE GRID				
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12. ⓐⓑⓒⓓ	13. ⓐⓑⓒⓓ	14. ⓐⓑⓒⓓ	15. ⓐⓑⓒⓓ	16. ⓐⓑⓒⓓ
17. ⓐⓑⓒⓓ	18. ⓐⓑⓒⓓ	19. ⓐⓑⓒⓓ	20. ⓐⓑⓒⓓ	

Space for Rough Work

21. A magnetic needle suspended by a silk thread is vibrating in the earth's magnetic field. if the temperature of the needle is increased by 700ºC, then
(a) time period decreases
(b) time period increases
(c) time period remains unchanged
(d) the needle stops vibrating

22. Torques τ_1 and τ_2 are required for a magnetic needle to remain perpendicular to the magnetic fields at two different places. The magnetic fields at those places are B_1 and B_2 respectively; then ratio $\frac{B_1}{B_2}$ is
(a) $\frac{\tau_2}{\tau_1}$ (b) $\frac{\tau_1}{\tau_2}$
(c) $\frac{\tau_1+\tau_2}{\tau_1-\tau_2}$ (d) $\frac{\tau_1-\tau_2}{\tau_1+\tau_2}$

23. A bar magnet has a length 8 cm. The magnetic field at a point at a distance 3 cm from the centre in the broad side-on position is found to be $4\times10^{-6}\ T$. The pole strength of the magnet is.
(a) 6×10^{-5} Am (b) 5×10^{-5} Am
(c) 2×10^{-4} Am (d) 3×10^{-4} Am

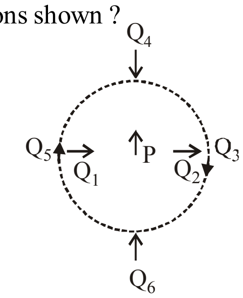
24. A vibration magnetometer consists of two identical bar magnets placed one over the other such that they are perpendicular and bisect each other. The time period of oscillation in a horizontal magnetic field is $2^{5/4}$ seconds. One of the magnets is removed and if the other magnet oscillates in the same field, then the time period in seconds is
(a) $2^{1/4}$ (b) $2^{1/2}$ (c) 2 (d) $2^{3/4}$

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

26. 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 at this place is (tan 37° = 3/4)
(a) 7×10^{-5} T (b) 6×10^{-5} T
(c) 5×10^{-5} T (d) 10^{-4} T

27. 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 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

28. The figure shows the various positions (labelled by subscripts) of small magnetised needles P and Q. The arrows show the direction of their magnetic moment. Which configuration corresponds to the lowest potential energy among all the configurations shown ?

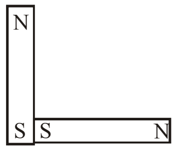


(a) PQ_3
(b) PQ_4
(c) PQ_5
(d) PQ_6

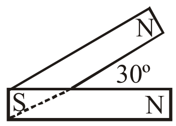
29. A dip needle lies initially in the magnetic meridian when it shows an angle of dip θ at a place. The dip circle is rotated through an angle x in the horizontal plane and then it shows an angle of dip θ′.
Then $\frac{\tan\theta'}{\tan\theta}$ is
(a) $\frac{1}{\cos x}$ (b) $\frac{1}{\sin x}$ (c) $\frac{1}{\tan x}$ (d) cos x

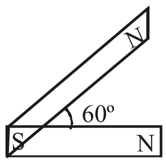
30. Two tangent galvanometers having coils of the same radius are connected in series. A current flowing in them produces deflections of 60º and 45º respectively. The ratio of the number of turns in the coils is
(a) 4/3 (b) $\frac{\sqrt{3}+1}{1}$ (c) $\frac{\sqrt{3}+1}{\sqrt{3}-1}$ (d) $\frac{\sqrt{3}}{1}$

31. Following figures show the arrangement of bar magnets in different configurations. Each magnet has magnet ic dipole moment $\vec{m}$. Which configuration has highest net magnetic dipole moment?

(a) 

(b) 

(c) 

(d) 

32. A compass needle which is allowed to move in a horizontal plane is taken to a geomagnetic pole. It :
(a) will become rigid showing no movement
(b) will stay in any position
(c) will stay in north-south direction only
(d) will stay in east-west direction only

33. If a magnetic dipole of moment *M* situated in the direction of a magnetic field *B* is rotated by 180°, then the amount of work done is
(a) MB (b) 2MB (c) $\frac{MB}{\sqrt{2}}$ (d) 0

RESPONSE GRID					
	21. ⓐⓑⓒⓓ	22. ⓐⓑⓒⓓ	23. ⓐⓑⓒⓓ	24. ⓐⓑⓒⓓ	25. ⓐⓑⓒⓓ
	26. ⓐⓑⓒⓓ	27. ⓐⓑⓒⓓ	28. ⓐⓑⓒⓓ	29. ⓐⓑⓒⓓ	30. ⓐⓑⓒⓓ
	31. ⓐⓑⓒⓓ	32. ⓐⓑⓒⓓ	33. ⓐⓑⓒⓓ		

Space for Rough Work

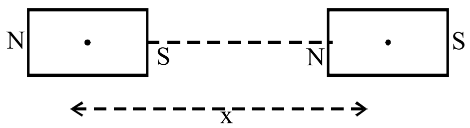
34. A bar magnet is oscillating in the earth's magnetic field with a period T. What happens to its period of motion, if its mass is quadrupled
(a) motion remains simple harmonic with new period = T/2
(b) motion remains simple harmonic with new period = 2 T
(c) motion remains simple harmonic with new period = 4T
(d) motion remains simple harmonic and the period stays nearly constant

35. 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 of the earth will be nearly of the order of:
(a) 10^{23} Am^2 (b) 10^{20} Am^2 (c) 10^{16} Am^2 (d) 10^{10} Am^2

36. The relative permeability of a medium is 0.075. What is its magnetic susceptibility?
(a) 0.925 (b) –0.925 (c) 1.075 (d) –1.075

37. A dip circle is so set that its needle moves freely in the magnetic meridian. In this position, the angle of dip is 40º. Now the dip circle is rotated so that the plane in which the needle moves makes an angle of 30º with the magnetic meridian. In this position, the needle will dip by an angle
(a) 40º (b) 30º (c) more than 40º (d) less than 40º

38. The mid points of two small magnetic dipoles of length d in end-on positions, are separated by a distance x, (x > > d). The force between them is proportional to x^{-n} where n is:



(a) 1 (b) 2 (c) 3 (d) 4

39. At a temperatur of 30°C, the susceptibility of a ferromagnetic material is found to be χ. Its susceptibility at 333°C is
(a) χ (b) 0.5χ (c) 2χ (d) 11.1χ

40. The susceptibility of annealed iron at saturation is 5500. Find the permeability of annealed iron at saturation.
(a) 6.9×10^{-3} (b) 5.1×10^{-2} (c) 5×10^{2} (d) 3.2×10^{-5}

41. A short magnet oscillates in an oscillation magnetometer with a time period of 0.10s where the earth's horizontal magnetic field is 24 μT. A downward current of 18 A is established in a vertical wire placed 20 cm east of the magnet. Find the new time period.
(a) 0.076 s (b) 0.5 s (c) 0.1 s (d) 0.2 s

42. A permanent magnet in the shape of a thin cylinder of length 10 cm has magnetisation (M) = 10^{6} A m^{-1}. Its magnetization current I_M is
(a) 10^5 A (b) 10^6 A (c) 10^7 A (d) 10^8 A

43. The earth's magnetic field lines resemble that of a dipole at the centre of the earth. If the magnetic moment of this dipole is close to 8×10^{22} Am^2, the value of earth's magnetic field near the equator is close to (radius of the earth = 6.4×10^{6} m)
(a) 0.6 Gauss (b) 1.2 Gauss
(c) 1.8 Gauss (d) 0.32 Gauss

44. 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:
(a) 30 mA (b) 60 mA (c) 3 A (d) 6 A

45. A thin bar magnet of length 2 ℓ and breadth 2 b pole strength m and magnetic moment M is divided into four equal parts with length and breadth of each part being half of original magnet.
Then, the magnetic moment of each part is
(a) M/4 (b) M (c) M/2 (d) 2 M

RESPONSE GRID					
	34. ⓐⓑⓒⓓ	35. ⓐⓑⓒⓓ	36. ⓐⓑⓒⓓ	37. ⓐⓑⓒⓓ	38. ⓐⓑⓒⓓ
	39. ⓐⓑⓒⓓ	40. ⓐⓑⓒⓓ	41. ⓐⓑⓒⓓ	42. ⓐⓑⓒⓓ	43. ⓐⓑⓒⓓ
	44. ⓐⓑⓒⓓ	45. ⓐⓑⓒⓓ			

DAILY PRACTICE PROBLEM DPP CHAPTERWISE CP19 - PHYSICS			
Total Questions	45	Total Marks	180
Attempted		Correct	
Incorrect		Net Score	
Cut-off Score	50	Qualifying Score	70
Success Gap = Net Score – Qualifying Score			
Net Score = (Correct × 4) – (Incorrect × 1)			

Space for Rough Work

1. **(b)** As the axes are perpendicular, mid point lies on axial line of one magnet and on equatorial line of other magnet.

$$\therefore\ B_1 = \frac{\mu_0}{4\pi}\frac{2M}{d^3} = \frac{10^{-7}\times 2\times 1}{1^3} = 2\times 10^{-7}$$

$$\text{and } B_2 = \frac{\mu_0}{4\pi}\frac{M}{d^3} = 10^{-7}$$

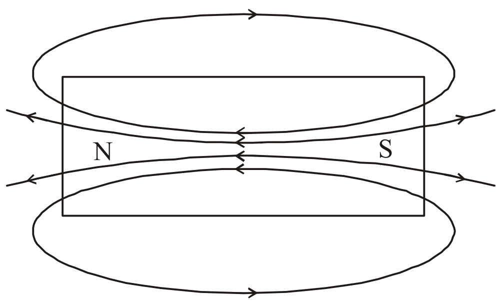
$$\therefore \text{Resultant field} = \sqrt{B_1^2 + B_2^2} = \sqrt{5}\times 10^{-7}\,T$$

2. **(c)** Initial magnetic moment of each magnet = m × ℓ.
As is clear from Fig., S_1 and N_2 neutralize each other.
Effective distance between

N_1 and $S_2 = \sqrt{\ell^2 + \ell^2} = \ell\sqrt{2}$

$\therefore\ M' = m\ell\sqrt{2}$.

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



4. **(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.

5. **(a)** The time period of oscillation of a freely suspended magnet is given by

$$T = 2\pi\sqrt{\frac{I}{MH}}$$

$$\text{Thus, } \frac{T}{T'} = \frac{2\pi\sqrt{\frac{I}{MH}}}{2\pi\sqrt{\frac{I}{MH'}}}$$

Given, T = 4 sec, T' = 2 sec,

$$\text{So, } \frac{4}{2} = \sqrt{\frac{H'}{H}}$$

$$\text{or } \sqrt{\frac{H'}{H}} = 2$$

or H' = 4H

6. **(b)** Diamagnetic materials are repelled in an external magnetic field.
Bar *B* represents diamagnetic materials.

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

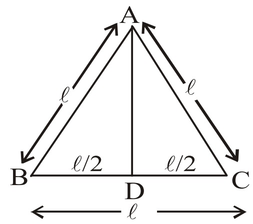
8. **(a)** Iron is ferromagnetic.

9. **(b)** $\tau = MB\sin\theta$

$\tau = iAB\sin 90^\circ$

$$\therefore\ A = \frac{\tau}{iB}$$

Also, A = 1/2 (BC) (AD)



$$\text{But } \frac{1}{2}(BC)(AD) = \frac{1}{2}(l)\sqrt{l^2 - \left(\frac{l}{2}\right)^2} = \frac{\sqrt{3}}{4}l^2$$

$$\Rightarrow\ \frac{\sqrt{3}}{4}(l)^2 = \frac{\tau}{Bi}$$

$$\therefore\ l = 2\left(\frac{\tau}{\sqrt{3}\,B.i}\right)^{\frac{1}{2}}$$

10. **(a)** $M = 60\,Am^2$

$\vec{\tau} = 1.2\times 10^{-3}$ Nm, $B_H = 40\times 10^{-6}\ Wb/m^2$

$\vec{\tau} = \vec{M}\times\vec{B}_H \Rightarrow \tau = MB_H\sin\theta$

$\Rightarrow 1.2\times 10^{-3} = 60\times 40\times 10^{-6}\sin\theta$

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

$\Rightarrow \theta = 30^\circ$

11. **(b)** Electro magnet should be amenable to magnetisation and demagnetization.
∴ retentivity and coercivity should be low.

12. **(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

$$\text{M.I. } (I') = \frac{1}{12}\left(\frac{m}{3}\right)\left(\frac{\ell}{3}\right)^2\times 3 = \frac{I}{9}$$

We have, Magnetic moment (*M*)
= Pole strength (*m*) × ℓ
∴ New magnetic moment,

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

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

13. **(b)** Graph [A] is for material used for making permanent magnets (high coercivity)
Graph [B] is for making electromagnets and transformers.

14. (a) The earth's core is hot and molten. Hence, convective current in earth's core is responsible for it's magnetic field.

15. (b) $T \propto \frac{1}{\sqrt{H}} \Rightarrow \frac{T_1}{T_2} = \sqrt{\frac{H_2}{H_1}} \Rightarrow \frac{2}{1} = \sqrt{\frac{H+F}{H}}$

$\Rightarrow F = 3H \; or \; \frac{H}{F} = \frac{1}{3}$

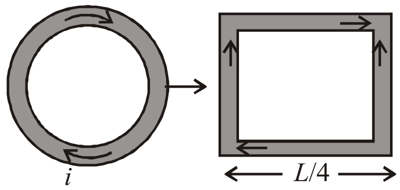
16. (a) $H = B\cos\theta, \quad V = B\sin\theta$
Here B = earth's magnetic field
θ = angle of dip = 90° at north pole
$\Rightarrow H = B\cos 90° = 0$
$V = B\sin 90° = B$
$\Rightarrow V >> H$

17. (d) Initially for circular coil $L = 2\pi r$ and $M = i \times \pi r^2$

$= i \times \pi\left(\frac{L}{2\pi}\right)^2 = \frac{iL^2}{4\pi}$ ...(i)

Finally for square coil side $a = \frac{L}{4}$ and

$M' = i \times \left(\frac{L}{4}\right)^2 = \frac{iL^2}{16}$ ...(ii)



Solving equation (i) and (ii) $M' = \frac{\pi M}{4}$

18. (b) $FL = MB$ (= Torque) $\Rightarrow L = \frac{MB}{F}$

19. (a) $\chi_d < \chi_p < \chi_f$
For diamagnetic substance χ_d is small and negative (10^{-5})
For paramagnetic substances χ_p is small and positive (10^{-3} to 10^{-5})
For ferromagnetic substanes χ_f is very large (10^3 to 10^5)

20. (b) $B = \mu_0\mu_r H \Rightarrow \mu_r \propto \frac{B}{H}$ = slope of B-H curve

According to the given graph, slope of the graph is highest at point Q.

21. (d) On increasing the temperature by 700ºC, the magnetic needle is demagnetised. Therefore, the needle stops vibrating.

22. (b) $\tau = MB\sin\theta \qquad (\theta = 90°)$

$\tau = MB \Rightarrow \frac{B_1}{B_2} = \frac{\tau_1}{\tau_2}$ (since magnetic moment is same)

23. (a) Magnetic field due to a bar magnet in the broad-side on position is given by

$$B = \frac{\mu_0}{4\pi}\frac{M}{\left[r^2 + \frac{\ell^2}{4}\right]^{3/2}} \; ; M = m\ell.$$

After substituting the values and simplifying we get
$B = 6 \times 1^{-5}$ A-m

24. (c) Initially magnetic moment of system

$M_1 = \sqrt{M^2 + M^2} = \sqrt{2}M$ and moment of inertia
$I_1 = I + I = 2I.$
Finally when one of the magnet is removed then
$M_2 = M$ and $I_2 = I$

So, $T = 2\pi\sqrt{\frac{I}{M\,B_H}}$

$\frac{T_1}{T_2} = \sqrt{\frac{I_1}{I_2} \times \frac{M_2}{M_1}} = \sqrt{\frac{2I}{I} \times \frac{M}{\sqrt{2}M}}$

$\Rightarrow T_2 = \frac{2^{5/4}}{2^{1/4}} = 2\,\text{sec}$

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

26. (d) $\tan\delta = \frac{V}{H} = \frac{3}{4} \quad \left[\because \tan 37° = \frac{3}{4}\right]$

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

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

$H = \frac{4}{3} \times 6 \times 10^{-5}\,T = 8 \times 10^{-5}\,T$

$\therefore \; B_{total} = \sqrt{V^2 + H^2} = \sqrt{(36+64)} \times 10^{-5}$

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

27. (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.

28. (d) PQ_6 corresponds to the lowest potential energy among all the configurations shown.

29. (a) $\tan\theta = \frac{V}{H}, \tan\theta' = \frac{V}{H\cos x}; \; \frac{\tan\theta'}{\tan\theta} = \frac{1}{\cos x}$

30. (d) In series, same current flows through two tangent galvanometers.

31. (c) Net magnetic dipole moment = $2\,M\cos\frac{\theta}{2}$

As value of $\cos\frac{\theta}{2}$ is maximum in case (c) hence net magnetic dipole moment is maximum for option (c).

32. **(b)** Since magnetic field is in vertical direction and needle is free to totate in horizontal plane only so magnetic force cannot rotate the needle in horizontal plane so needle can stay in any position.

33. **(b)** Work done in rotating the magnetic dipole from position $\theta_1 = 0°$ to $\theta_2 = 180°$

$\because W = MB(\cos\theta_1 - \cos\theta_2)$

$\therefore W = MB(\cos 0° - \cos 180°) = 2MB$

34. **(b)** The time period of a bar magnet in a magnetic field is given by.

$$T = 2\pi\sqrt{\frac{I}{MB}};$$

Here, I = moment of inertia $\propto m$, M = moment of magnet, B = magnetic field.

$T \propto \sqrt{I} \propto \sqrt{m}$; so, T becomes twice as mass becomes four times

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

$R_E = 6.4 \times 10^6$ m

Dipole moment of the earth M = ?

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

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

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

36. **(b)** From $\mu_r = 1 + \chi_m$;

Magnetic suscaptibility, $\chi_m = \mu_r - 1$

$\chi_m = 0.075 - 1 = -0.925.$

37. **(d)** $\delta_1 = 40°, \delta_2 = 30°, \delta = ?$

$$\cot\delta = \sqrt{\cot^2\delta_1 + \cot^2\delta_2} = \sqrt{\cot^2 40° + \cot^2 30°}$$

$$\cot\delta = \sqrt{1.19^2 + 3} = 2.1$$

$\therefore$ $\delta = 25°$ i.e. $\delta < 40°$.

38. **(d)** In magnetic dipole

Force $\propto \frac{1}{r^4}$

In the given question,

Force $\propto x^{-n}$

Hence, n = 4

39. **(b)** According to Curie's law, $\chi_m = \frac{\mu_0 C}{T}$

where C is Curie constant, T = temperature

$$\therefore \chi_m \alpha \frac{1}{T}$$

$$\frac{\chi_{m_1}}{\chi_{m_2}} = \frac{T_2}{T_1} = \frac{273+333}{273+30} = \frac{606}{303} = 2$$

$$\therefore \chi_{m_2} = \chi_{m_1}/2 = 0.5\chi_{m_1} = 0.5\chi. \left(\because \chi_{m_1} = \chi\right)$$

40. **(a)** We know that $\mu_r = 1 + x$

$= 1 + 5500 = 5501$

$\therefore$ $\mu = \mu_r\mu_0 = (5501)\times(4\pi\times10^{-7})$

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

41. **(a)** We know that $T_1 = 2\pi\sqrt{\frac{T}{MB_{H_1}}}$ ...(i)

Where $B_{H_1} = 24\times10^{-6}$ T

The magnetic field produced by, wire

$$B = \frac{\mu_0}{2\pi}\cdot\frac{i}{r}$$

$$= (2\times10^{-7})\times\frac{(18)}{0.20}$$

$$= 1.8\times10^{-6}\text{ T}$$

Now $B_{H_2} = B_{H_1} + B = 42 \times 10^{-6}$ T

$T_2 = 2\pi\sqrt{\frac{I}{MBH_2}}$ ...(ii)

Using equations (i) and (ii), and substituting the values, we get

$T_2 = 0.076$ s

42. **(a)** As $BI = \mu_0 MI_M = \mu_0(I + I_M)$

Here, $I = 0$

Then $\mu_0 MI = \mu_0(I_M)$

$\Rightarrow$ I_M = MI = 10^5 A

43. **(a)** Given $M = 8 \times 10^{22}$ Am^2

$d = R_e = 6.4 \times 10^6$m

Earth's magnetic field, $B = \frac{\mu_0}{4\pi}\cdot\frac{2M}{d^3}$

$$= \frac{4\pi\times10^{-7}}{4\pi}\times\frac{2\times8\times10^{22}}{(6.4\times10^6)^3}$$

$\simeq 0.6$ Gauss

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

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

(Where n = number of turns per unit length)

$\Rightarrow \frac{B}{\mu_0} = \frac{Ni}{L}$

$\Rightarrow 3\times10^3 = \frac{100i}{10\times10^{-2}}$

$\Rightarrow i = 3$A

45. **(a)** As length of each part also becomes half, therefore magnetic moment M = pole strength × length

$\Rightarrow \frac{1}{2}\times\frac{1}{2} = \frac{1}{4}$th i.e. M/4.