DPP - Daily Practice Problems

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

PHYSICS

CP19

SYLLABUS : Magnetism and Matter

Max. Marks : 120 **Marking Scheme :** (+4) for correct & (–1) for incorrect answer **Time : 60 min.**

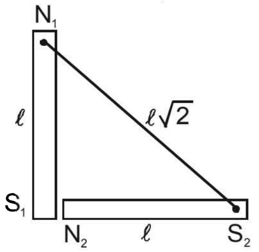
INSTRUCTIONS : This Daily Practice Problem Sheet contains 30 MCQ's. For each question only one option is correct. Darken the correct circle/ bubble in the Response Grid provided on each page.

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. 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) $\varepsilon_r = 1.5$, $\mu_r = 1.5$

4. 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

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

5. 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) $\frac{1}{\sqrt{3}}\frac{\tau}{B.i}$

6. 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°

7. 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

8. 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

9. A magnetic dipole is under the influence of two magnetic fields The angle between the field directions is 60° and one of the fields has a magnitude of 1.2×10^{-2} T. If the dipole comes to stable equilibrium at an angle of 15° with this field, what is the magnitude of other field ?

(a) 4.4×10^{-3} tesla (b) 5.2×10^{-3} tesla

(c) 3.4×10^{-3} tesla (d) 7.8×10^{-3} tesla

10. A bar magnet 8 cms long is placed in the magnetic merdian with the N-pole pointing towards geographical north. Two netural points separated by a distance of 6 cms are obtained on the equatorial axis of the magnet. If horizontal component of earth's field = 3.2×10^{-5} T, then pole strength of magnet is

(a) 5 ab-amp × cm (b) 10 ab-amp × cm

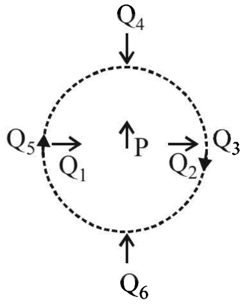
(c) 2.5 ab-amp × cm (d) 20 ab-amp × cm

11. 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) $\chi_f < \chi_p < \chi_d$

12. 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

13. 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

14. 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

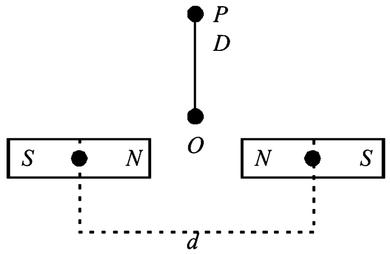
(c) 5×10^{-5} T (d) 10^{-4} T

RESPONSE GRID					
	5. ⓐⓑⓒⓓ	6. ⓐⓑⓒⓓ	7. ⓐⓑⓒⓓ	8. ⓐⓑⓒⓓ	9. ⓐⓑⓒⓓ
	10. ⓐⓑⓒⓓ	11. ⓐⓑⓒⓓ	12. ⓐⓑⓒⓓ	13. ⓐⓑⓒⓓ	14. ⓐⓑⓒⓓ

15. 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

16. 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) $2^{3/4}$

17. Two identical bar magnets are fixed with their centres at a distance d apart. A stationary charge Q is placed at P in between the gap of the two magnets at a distance D from the centre O as shown in the Figure



The force on the charge Q is
(a) directed perpendicular to the plane of paper
(b) zero
(c) directed along OP
(d) directed along PO

18. 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} A m^2 (b) 10^{20} A m^2
(c) 10^{16} A m^2 (d) 10^{10} A m^2

19. Which of the following is not correct about relative magnetic permeability (μ_r)?
(a) It is a dimensionless pure ratio.
(b) For vacuum medium its value is one.
(c) For ferromagnetic materials $\mu_r >> 1$
(d) For paramagnetic materials $\mu_r < 1$.

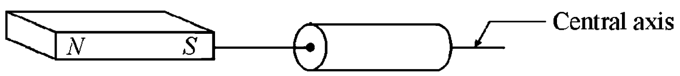
20. A bar magnet of moment of inertia 9×10^{-5} kg m^2 placed in a vibration magnetometer and oscillating in a uniform magnetic field $16\pi^2 \times 10^{-5}$T makes 20 oscillations in 15 s. The magnetic moment of the bar magnet is
(a) 3 Am^2 (b) 2 Am^2 (c) 5 Am^2 (d) 4 Am^2

21. Two short bar magnets P and Q are arranged such that their centres are on the X-axis and are separated by a large distance. The magnetic axes of P and Q are along X and Y axes respectively. At a point R, midway between their centres, if B is the magnitude of induction due to Q, the magnitude of total induction at R due to the both magnets is
(a) 3B (b) $\sqrt{5}$B (c) $\frac{\sqrt{5}}{2}$B (d) B

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

23. 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

24. Imagine rolling a sheet of paper into a cylinder and placing a bar magnet near its end as shown in figure. What can you say about the sign of $\vec{B}.d\vec{A}$ for every area $d\vec{A}$ on the surface?



(a) Positive
(b) Negative
(c) No sign
(d) Can be positive or negative

RESPONSE GRID					
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	20. ⓐⓑⓒⓓ	21. ⓐⓑⓒⓓ	22. ⓐⓑⓒⓓ	23. ⓐⓑⓒⓓ	24. ⓐⓑⓒⓓ

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

(a) 2W (b) W (c) $\frac{W}{\sqrt{2}}$ (d) $\sqrt{3}W$

26. 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

27. 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 resultand 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^{-5} Wb/m^2)

(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

28. 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

29. 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) $\frac{1}{4}$

30. Which of the following statements is incorrect about hysteresis ?

(a) This effect is common to all ferromagnetic substances

(b) The hysteresis loop area is proportional to the thermal energy developed per unit volume of the material

(c) The hysteresis loop area is independent of the thermal energy developed per unit volume of the material

(d) The shape of the hysteresis loop is characteristic of the material

RESPONSE GRID	25. ⓐⓑⓒⓓ 26. ⓐⓑⓒⓓ 27. ⓐⓑⓒⓓ 28. ⓐⓑⓒⓓ 29. ⓐⓑⓒⓓ 30. ⓐⓑⓒⓓ

DAILY PRACTICE PROBLEM DPP CHAPTERWISE CP19 - PHYSICS			
Total Questions	30	Total Marks	120
Attempted		Correct	
Incorrect		Net Score	
Cut-off Score	45	Qualifying Score	60
Success Gap = Net Score – Qualifying Score			
Net Score = (Correct × 4) – (Incorrect × 1)			

DAILY PRACTICE PROBLEMS

PHYSICS SOLUTIONS

DPP/CP19

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

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

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

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

2. **(c)** Initial magnetic moment of each magnet = $m \times \ell$.

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. **(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.

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

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

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

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

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

or $\sqrt{\dfrac{H'}{H}} = 2$

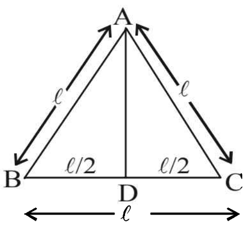
or $H' = 4H$

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

$\tau = iAB\sin 90°$

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

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



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

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

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

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

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

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

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

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

$\Rightarrow \theta = 30°$

7. **(b)** Electro magnet should be amenable to magnetisation and demagnetization

$\therefore$ retentivity and coercivity should be low.

8. **(b)** $T = 2\pi\sqrt{\dfrac{I}{M\times B}} = 2\pi\sqrt{\dfrac{I}{MB}}$ where $I = \dfrac{1}{12}m\ell^2$

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

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

We have, Magnetic moment (M)

= Pole strength (m) $\times\ \ell$

$\therefore$ New magnetic moment,

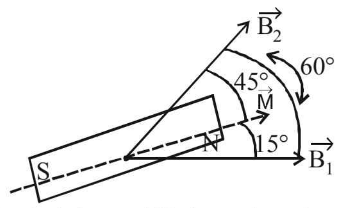
$M' = m\times\left(\dfrac{\ell}{3}\right)\times 3 = m\ell = M$

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

9. **(a)** Given that : $B_1 = 1.2\times 10^{-2}$ T, orientation of dipole with the field B_1, $\theta_1 = 15°$

Hence, orientation of dipole with B_2,

$\theta_2 = 60° - 15° = 45°$ (figure)



As the dipole is in equilibrium, therefore, the torque on the dipole due to the two fields must be equal and opposite. If M be the magnetic dipole moment of the dipole, then

$\tau_1 = \tau_2$ or $MB_1\sin\theta_1 = MB_2\sin\theta_2$

or, $B_2 = \dfrac{B_1\sin\theta_1}{\sin\theta_2} = \dfrac{1.2\times 10^{-2}\sin 15°}{\sin 45°}$

$= \dfrac{1.2\times 10^{-2}\times 0.2588}{0.7071} = 4.4\times 10^{-3}$ Tesla

10. **(a)** Here, $2\ell = 8\,\text{cm}$, $\ell = 4\,\text{cm}$, $d = \frac{6}{2} = 3\,\text{cm}$.

At neutral point,

$$H = B = \frac{\mu_0}{4\pi}\frac{M}{(d^2+\ell^2)^{3/2}}$$

$$= 10^{-7}\frac{M}{(5\times10^{-2})^3} = \frac{M}{1250}$$

$$\therefore\ M = 1250\,H = 1250\times3.2\times10^{-5}\ \text{Am}^2$$

$$m = \frac{M}{2\ell} = \frac{1250\times3.2\times10^{-5}}{8\times10^{-2}}\text{A m.}$$

$$= 0.5\ \text{Am} = 0.5\times\frac{1}{10}\text{ab amp}\times100\ \text{cm}$$

$$= 5\ \text{ab-amp cm.}$$

11. **(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 $10^5)$

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

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

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

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

$V = 6\times10^{-5}\,\text{T}$

$H = \frac{4}{3}\times6\times10^{-5}\,\text{T} = 8\times10^{-5}\,\text{T}$

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

$= 10\times10^{-5} = 10^{-4}\text{T}.$

15. **(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.

16. **(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, $T = 2\pi\sqrt{\frac{I}{M\,B_H}}$

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

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

17. **(b)** Force on a charged particle is given by $F = qvB$. Here $v = 0$ and also resultant B is zero.

$\therefore$ Force = 0

18. **(a)** Given, $B = 4\times10^{-5}\,\text{T}$

$R_E = 6.4\times10^6\,\text{m}$

Dipole moment of the earth M = ?

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

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

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

19. **(d)** Relative magnetic permeability

$$\mu_r = \frac{\text{magnetic permeability of material }(\mu)}{\text{permeability of free space }(\mu_0)}$$

For paramagnetic materials $\mu_r > 1$.

20. **(d)** Given, $I = 9\times10^{-5}\,\text{kg m}^2$, $B = 16\pi^2\times10^{-5}\,\text{T}$

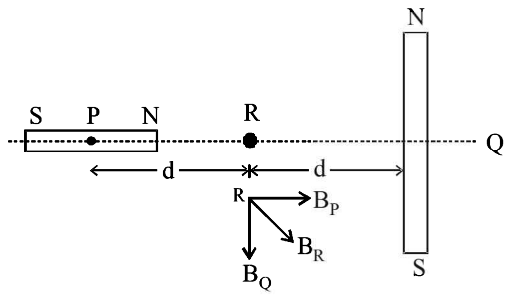
$T = \frac{15}{20} = \frac{3}{4}\text{s}$

In a vibration magnetometer

Time period, $T = 2\pi\sqrt{\frac{I}{MB}}$ or $M = \frac{4\pi^2 I}{BT^2}$

$$M = \frac{4\pi^2\times9\times10^{-5}}{16\pi^2\times10^{-5}\times\left(\frac{3}{4}\right)^2} = 4\ \text{A m}^2$$

21. **(b)**



$$B_R = \sqrt{B_P^2+B_Q^2} = \sqrt{\left(\frac{\mu_0}{4\pi}\frac{2M}{d^3}\right)^2+\left(\frac{\mu_0}{4\pi}\frac{M}{d^3}\right)^2}$$

$$= \sqrt{5}\frac{\mu_0}{4\pi}\frac{M}{d^3} = \sqrt{5}\,B,\ \left\{B_Q = \frac{\mu_0}{4\pi}\frac{M}{d^3} = B\right\}$$

22. **(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. $\delta < 40°$.

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

24. **(b)** The field is entering into the surface so flux is negative.

25. **(d)** Work done, $W = MB(\cos\theta_1 - \cos\theta_2)$

Here $\theta_1 = 0°, \theta_2 = 60°$

$\therefore \quad W = MB\left[1 - \frac{1}{2}\right] = \frac{MB}{2}$ ...(i)

Torque, $\tau = MB\sin\theta = MB\sin 60°$

$= \frac{MB\sqrt{3}}{2} = \sqrt{3}W$ (Using eq. (i))

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

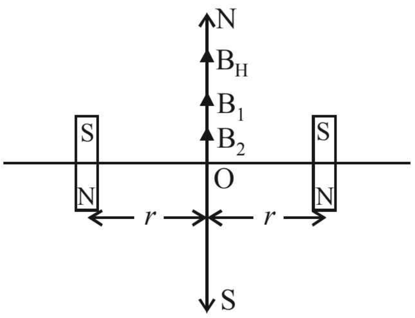
$d = R_e = 6.4 \times 10^6 m$

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

$= \frac{4\pi \times 10^{-7}}{4\pi} \times \frac{2 \times 8 \times 10^{22}}{(6.4 \times 10^6)^3}$

$\cong 0.6$ Gauss

27. **(b)** Given: $M_1 = 1.20\,Am^2$



$M_2 = 1.00\,Am^2$

$r = \frac{20}{2} cm = 0.1\text{m}$

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

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

$= \frac{10^{-7}(1.2+1)}{(0.1)^3} + 3.6 \times 10^{-5}$

$= 2.56 \times 10^{-4}\ \text{Wb/m}^2$

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

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

(Where n = number of turns per unit length)

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

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

$\Rightarrow i = 3A$

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

where I = Moment of inertia of the rectangular magnet

μ = Magnetic moment

B_H = Horizontal component of the earth's magnetic field

Case 1

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

Case 2

Magnet is cut into two identical pieces such that each piece has half the original length. Then

$T' = 2\pi\sqrt{\frac{I'}{\mu' B_H}}$

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

$\therefore \frac{T'}{T} = \sqrt{\frac{I'}{\mu'} \times \frac{\mu}{I}}$

$= \sqrt{\frac{I/8}{\mu/2} \times \frac{\mu}{I}} = \sqrt{\frac{1}{4}} = \frac{1}{2}$

30. **(c)** The net energy dissipated per unit volume of the material during a complete cycle of magnetisation is equal to area of B.H curve.