DPP – 1 (Magnetism & Matter)

Video Solution on Website:- https://physicsaholics.com/home/courseDetails/74

Video Solution on YouTube:- https://youtu.be/DLSw1mutOl8

Written Solution on Website:- https://physicsaholics.com/note/notesDetalis/56

Q 1. A magnetic wire of dipole moment $4\pi\ Am^2$ is bent in the form of semicircle. The new magnetic moment is:
(a) $4\pi\ Am^2$ (b) $8\pi\ Am^2$
(c) $4\ Am^2$ (d) $8\ Am^2$

Q 2. A magnet of magnetic moment M and pole strength m is divided in two equal parts, then magnetic moment of each part will be
(a) M (b) M/2
(c) M/4 (d) 2M

Q 3. Magnetic induction due to a short bar magnet on its axial line (at a distance 'r') is inversely proportional to
(a) r^3 (b) $\frac{1}{r^3}$
(c) r^2 (d) $\frac{1}{r^2}$

Q 4. Points A and B are situated along the extended axis of 2 cm long bar magnet at a distance x and 2x cm respectively. From the pole nearer to the points, the ratio of the magnetic field at A and B will be
(a) 4 : 1 exactly (b) 4 : 1 approx.
(c) 8 : 1 exactly (d) 8 : 1 approx.

Q 5. A very long bar magnet (length L) has a pole strength of 10A-m. Find the magnetic field at a point on the axis of the magnet at a distance of 5cm from the north pole of the magnet (L >>> 5cm)
(a) 4×10^{-4} T (b) 8×10^{-4} T
(c) 4×10^{-6} T (d) 8×10^{-8} T

Q 6. Calculate the magnetic field due to a bar magnet 2cm long and having pole strength of 100 A-m at a point 10 cm from each pole on the equatorial line
(a) 2×10^{-2} T (b) 3×10^{-3} T
(c) 2×10^{-4} T (d) 5×10^{-6} T

Q 7. A bar magnet is 0.10 m long and its pole strength is 120 Am. Find magnitude of magnetic field at a point on its axis at a distance 20 cm from its center
(a) 6.8×10^{-5} T (b) 3.4×10^{-4} T
(c) 2.1×10^{-4} T (d) 5.2×10^{-6} T

Q 8. The magnetic potential at a point on the axial line of a bar magnet of dipole moment M is V. What is the magnetic potential due to a bar magnet of dipole moment $\frac{M}{4}$ at the same distant axial point?

(a) 4V (b) 2V
(c) V/2 (d) V/4

Q 9. The pole strength of a bar magnet is 48 ampere-meter and the distance between its poles is 25 cm. The moment of the couple by which it can be placed at an angle of 30^0 with the uniform magnetic intensity of flux density 0.15 Newton/ampere-meter will be

(a) 12 Newton × metre (b) 18 Newton × metre
(c) 0.9 Newton × metre (d) None of the above

Q 10. The work done in rotating a magnet of magnetic moment 2 Am^2 in a magnetic field 5×10^{-3} T from the direction along the magnetic field to opposite direction to the magnetic field, is

(a) zero (b) 2×10^{-2} J
(c) 10^{-2} J (d) 10 J

Q 11. Magnetic moment of bar magnet is M. The magnitude of work done to turn the magnet by 90^0 of magnet in direction of magnetic field B will be

(a) zero (b) $\frac{MB}{2}$
(c) MB (d) $2MB$

Q 12. Find the magnetic field due to a dipole of magnetic moment 1.2 Am^2 at a point 1m away from it in a direction making an angle of 60^0 with the dipole-

(a) $2 \times 10^{-6}T$ (b) $3.2 \times 10^{-6}T$
(c) $4 \times 10^{-7}T$ (d) $1.6 \times 10^{-7}T$

Q 13. The magnitude of magnetic field, due to a dipole of magnetic moment 2.4 Am^2, at a point 200 cm away from it in the direction making an angle of 90^0 with the dipole axis is

(a) 3×10^{-6}T (b) 3×10^{-7}T
(c) 3×10^{-8}T (d) 0.3×10^{-8}T

Q 14. Two small bar magnets are placed in a line with like poles facing each other at a certain distance d (d >> length of magnets) apart. If the length of each magnet is negligible as compared to d, the force between them will be inversely proportional to

(a) d (b) d^2
(c) d^4 (d) $\frac{1}{d^2}$

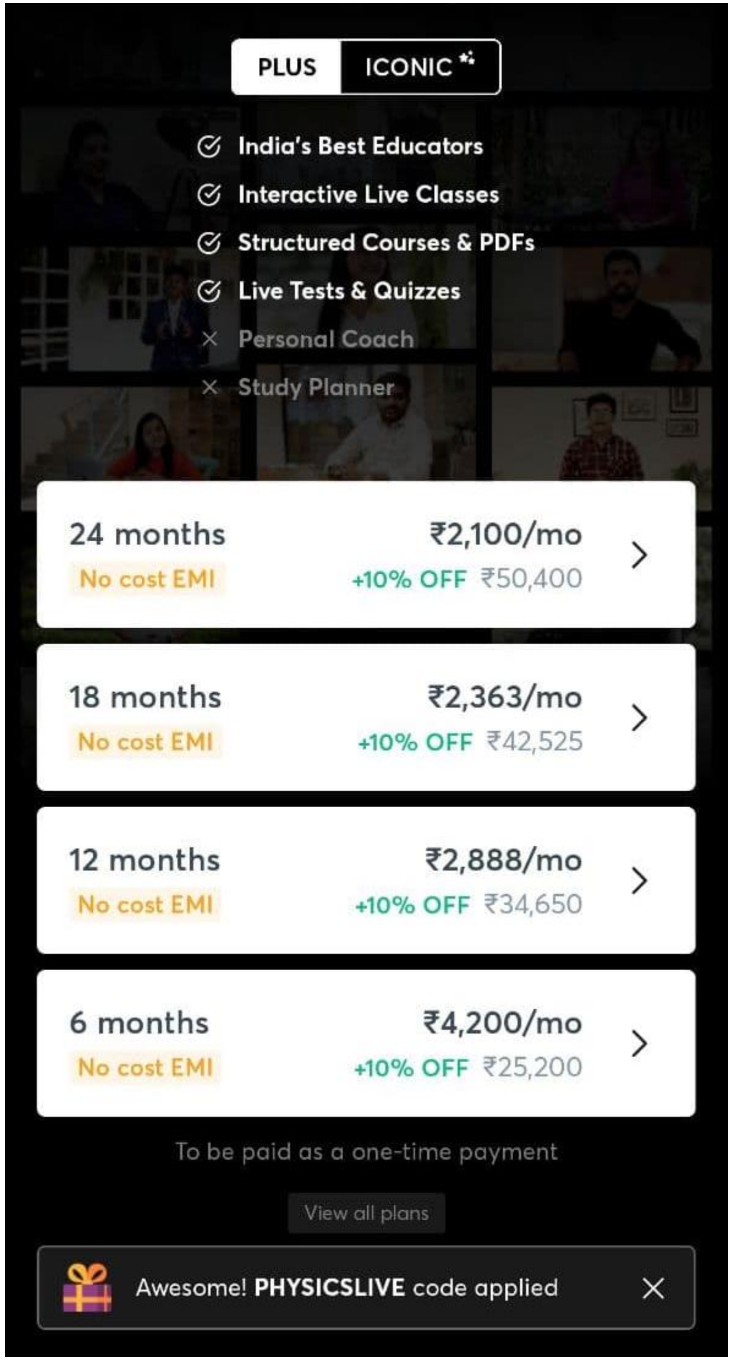
Q 15. A long magnet is cut in two parts in such a way that the ratio of their lengths is 2:1. The ratio of pole strengths of both the section is

(a) In the ratio of 1 : 1 (b) In the ratio of 2 : 1
(c) In the ratio of 1 : 2 (d) In the ratio of 4 : 1

Q 16. A magnet of magnetic moment $50\,\hat{\imath}\ Am^2$ is placed along the x-axis in a magnetic field $\vec{B} = (0.5\,\hat{\imath} + 3.0\,\hat{\jmath})$T. The torque acting on the magnet is
(a) $175\,\hat{k}$ N-m
(b) $150\,\hat{k}$ N-m
(c) $75\,\hat{k}$ N-m
(d) $25\,\hat{k}$ N-m

Answer Key

Q.1 d	Q.2 b	Q.3 a	Q.4 d	Q.5 a
Q.6 c	Q.7 b	Q.8 d	Q.9 c	Q.10 b
Q.11 c	Q.12 d	Q.13 c	Q.14 c	Q.15 a
Q.16 b				



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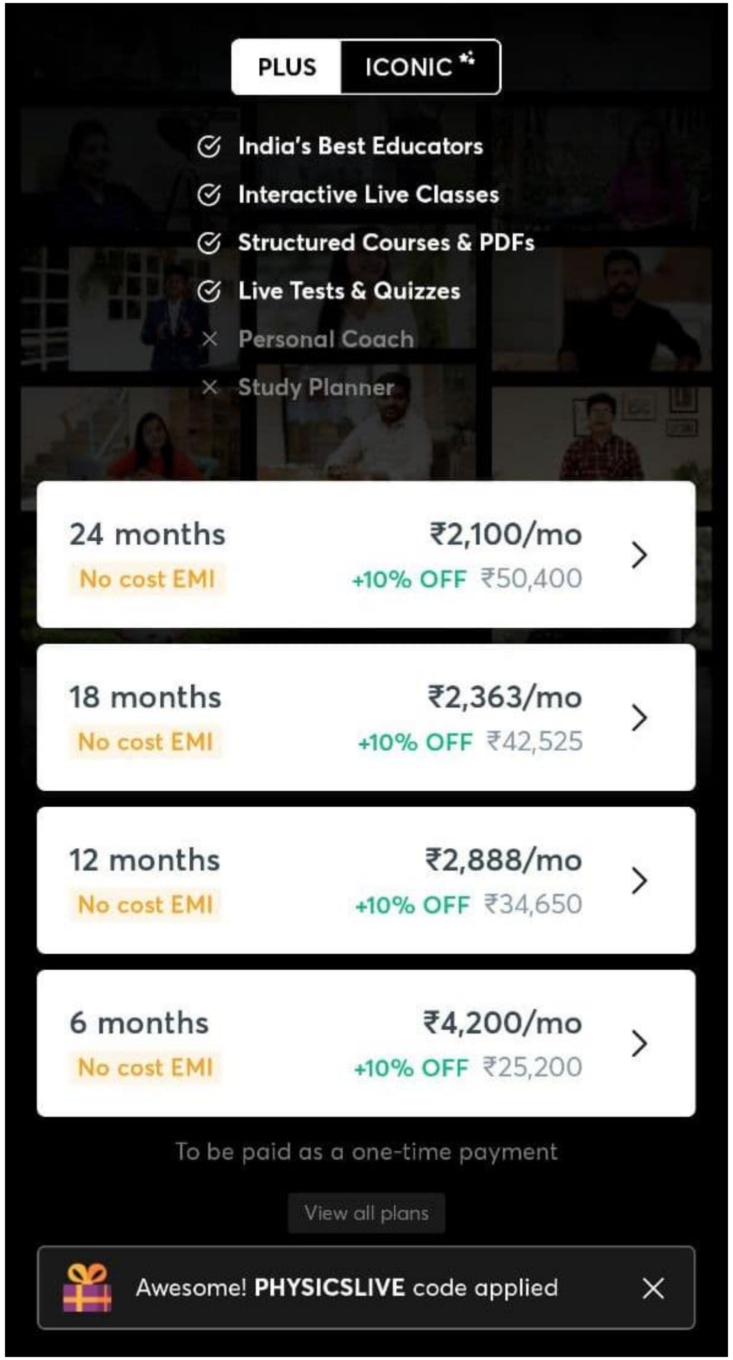


Written Solution

DPP-1 Magnetism- Bar Magnets & its Magnetic field, Magnet in Magnetic field

By Physicsaholics Team

Solution: 1

Let length of wire = L

& Pole strength = m

so; initially dipole moment

$M = mL = 4\pi$ —(1)

Now wire is bent in semicircle

so;

$\pi r = L$

$r = \frac{L}{\pi}$

$d = 2r = \frac{2L}{\pi}$

so; New Dipole moment

$M' = m(d) = m\left(\frac{2L}{\pi}\right)$

$M' = \frac{2}{\pi}(mL)$

$M' = \frac{2}{\pi}M$

$M' = \frac{2}{\pi}(4\pi)$

$M' = 8\ Am^2$ Ans.

Ans. d

Solution: 2

Case-1

If magnet is cutted along its axis

$M = ml$

$M' = \frac{m}{2} l$

$M' = \frac{ml}{2}$

$M' = \frac{M}{2}$ Ans

Case-2

When magnet is cutted perpendicular to its axis

$M = mL$

$M' = m\left(\frac{L}{2}\right)$

$M' = \frac{mL}{2}$

$M' = \frac{M}{2}$ Ans

Ans. b

Solution: 3

magnetic field on axial line

$$B = \frac{\mu_0}{4\pi} \frac{2M}{r^3}$$

$$\Rightarrow \boxed{B \propto \frac{1}{r^3}}$$

$\therefore$ B is inversely proportional to r^3.

Ans. a

Solution: 4

$$B \propto \frac{1}{r^3}$$

$$\frac{B_1}{B_2} = \left(\frac{r_2}{r_1}\right)^3 = \left(\frac{2x}{x}\right)^3 = \left(\frac{2}{1}\right)^3$$

$$\frac{B_1}{B_2} = \frac{8}{1} \text{ approx.}$$

Because we have taken assumption that $x >>> d$ to derive formula of magnetic field intensity

$$B = \frac{\mu_0}{4\pi}\frac{2M}{x^3}$$

Ans. d

Solution: 5

Pole strength; $m = 10\ Am^2$

$r = 5\,cm$

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

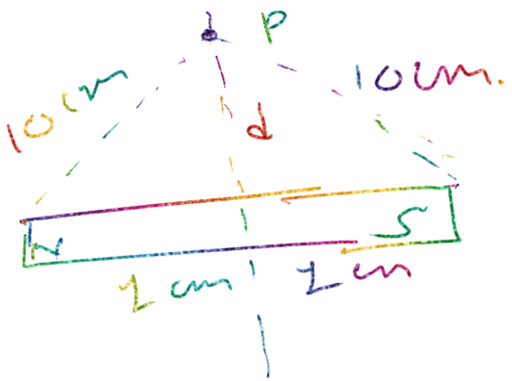
$$B = 10^{-7} \times \frac{10}{(5\times10^{-2})^2} = 10^{-7} \times \frac{10}{25\times10^{-4}}$$

$$B = \frac{1}{25}\times10^{-2} = \frac{100}{25}\times10^{-4}$$

$$\boxed{B = 4\times10^{-4}\,T}$$ Ans.

Ans. a

Solution: 6



$$d = \sqrt{10^2 - 1^2} = \sqrt{99}\ \text{cm}$$

$$B = \frac{\mu_0}{4\pi}\frac{M}{d^3} = 10^{-7} \times \frac{(2\times10^{2})\times(100)}{(\sqrt{99}\times10^{-2})^3}$$

$$B = 10^{-7} \times \frac{2}{(99)^{3/2}\times10^{-6}} = \frac{2}{(99)^{3/2}} \times 10^{-1}$$

$$= 2\times10^{-3}\times10^{-1} = 2\times10^{-4}$$

$$\boxed{B = 2\times10^{-4}\ T}$$ Ans.

Ans. c

Solution: 7

on axial point

$$B = \frac{\mu_0}{4\pi} \frac{2Mr}{(r^2 - l^2)^2}$$; given $L = 0.1\,m$, $l = L/2 = 0.05\,m$, $m = 120\,Am$, $r = 20\,cm = 0.2\,m$

$$= 10^{-7} \times \frac{2 \times (120 \times 0.1) \times 0.2}{((0.2)^2 - (0.05)^2)^2}$$

$$= 10^{-7} \times \frac{24 \times 0.2}{(4 \times 10^{-2} - 25 \times 10^{-4})^2} = \frac{10^{-7} \times 48 \times 10^{-1}}{(3.75 \times 10^{-2})^2}$$

$$B = 10^{-4} \times 3.4$$

$$\boxed{B = 3.4 \times 10^{-4}\ T}$$ Ans

Ans. b

Solution: 8

Magnetic potential

$$V = \frac{\mu_0}{4\pi}\frac{M\cos\theta}{r^2}$$

For axial point; $\theta = 0$

$\cos\theta = 1$

$$\therefore V = \frac{\mu_0}{4\pi}\frac{M}{r^2}$$

$$V \propto M$$

$$\frac{V_1}{V_2} = \frac{M_1}{M_2}$$

$$\Rightarrow \frac{V_1}{V_2} = \frac{M_1}{M_2}$$

$$\Rightarrow \frac{V}{V_2} = \frac{M}{M/4} = 4$$

$$V_2 = V/4 \quad \text{Ans.}$$

Ans. d

Solution: 9

$\tau = MB\sin\theta$

$M = md = 48 \times 25 \times 10^{-2}$

$M = 12\ Am^2$

given; $B = 0.15\ N/A\cdot m$

$\theta = 30^\circ$

$\tau = MB\sin\theta = 12 \times 0.15 \times \sin 30^\circ$

$= 12 \times 0.15 \times \frac{1}{2} = 6 \times 0.15$

$= 0.90$

$\tau = 0.9\ Nm$ Ans.

Ans. c

Solution: 10

$$W = \Delta U$$

$$W = MB\cos 0^\circ - MB\cos 180^\circ$$

$$W = MB - MB(-1) = MB + MB = 2MB$$

$$W = 2 \times 2 \times 5 \times 10^{-3}$$

$$W = 2 \times 10^{-2}\ \text{T}$$

Ans

Ans. b

Solution: 11

$$W = \Delta U$$

$$U = -MB\cos\theta$$

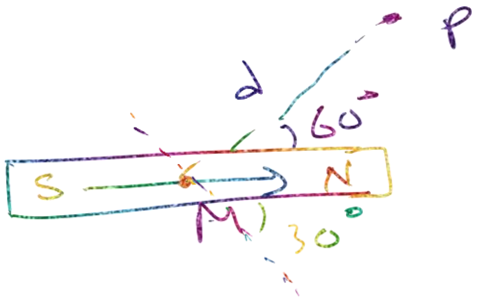
$$W = MB(\cos\theta_1 - \cos\theta_2)$$

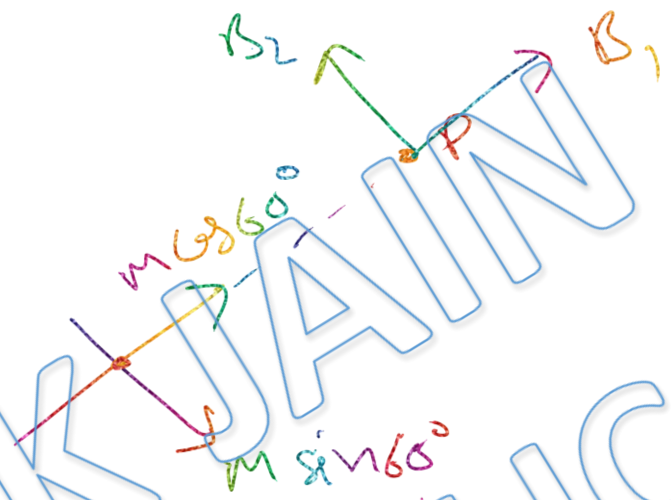
$$= MB(\cos 0^\circ - \cos 90^\circ) = MB(1 - 0)$$

$$\boxed{W = MB}$$ Ans.

Ans. c

Solution: 12





$$B_1 = \frac{\mu_0}{4\pi}\frac{2(M\cos 60^\circ)}{d^3} = \frac{\mu_0}{4\pi}\times\frac{2(1.2)(1/2)}{(1)^3} = 10^{-7}\times 1.2$$

$$B_2 = \frac{\mu_0}{4\pi}\frac{M\sin 60^\circ}{d^3} = \frac{\mu_0}{4\pi}\times\frac{(1.2)\left(\frac{\sqrt{3}}{2}\right)}{(1)^3} = 10^{-7}\times 0.6\sqrt{3}$$

$$B = \sqrt{B_1^2 + B_2^2} = 10^{-7}\sqrt{(1.2)^2 + (0.6\sqrt{3})^2}$$

$$B = 10^{-7}\times(1.58) \Rightarrow \boxed{B \simeq 1.6\times 10^{-7}\ T}$$ Ans.

or

$$B = \frac{\mu_0}{4\pi}\frac{M}{d^3}\sqrt{1+3\cos^2\theta}$$

$$B = 10^{-7}\times\frac{1.2}{(1)^3}\sqrt{1+3\cos^2 60^\circ}$$

$$B = 10^{-7}\times 1.2\times\sqrt{1+3\times\frac{1}{4}}$$

$$\boxed{B = 1.6\times 10^{-7}\ T}$$ Ans.

Ans. d

Solution: 13

at equitorial point

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

so,

$$B = \frac{\mu_0}{4\pi} \times \frac{2.4}{(200\times10^{-2})^3}$$

$$= 10^{-7} \times \frac{2.4}{(2)^3} = 10^{-7} \times \frac{2.4}{8}$$

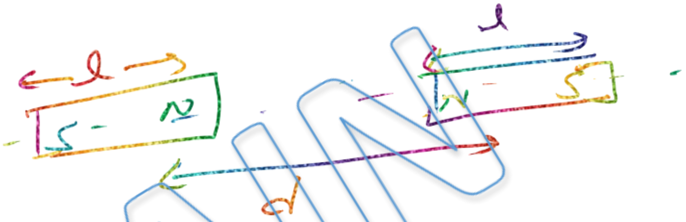
$$B = 0.3 \times 10^{-7}\ T$$

$$\boxed{B = 3\times10^{-8}\ T}$$ Ans.

Ans. c

Solution: 14

∵ Force between two magnets (when; $d >> l$)



$$F = \frac{\mu_0}{4\pi} \frac{6 M_1 M_2}{d^4}$$

$\Rightarrow$ $F \propto \frac{1}{d^4}$ Ans.

Ans. c

Solution: 15

Pole strength doesn't depend upon the length.

Ans. a

Solution: 16

$$\vec{\tau} = \vec{M} \times \vec{B} = (50\hat{j}) \times (0.5\hat{i} + 3.0\hat{j})\,T$$

$$= 0 + (50 \times 3)\hat{k}$$

$$\boxed{\vec{\tau} = 150\hat{k}\ N\text{-}m}$$ Ans.

Ans. b

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