

BYJU'S Study Planner for Board Term I (CBSE Grade 12)

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Subject: Physics

Topic : Magnetism and Matter

Class: Standard XII

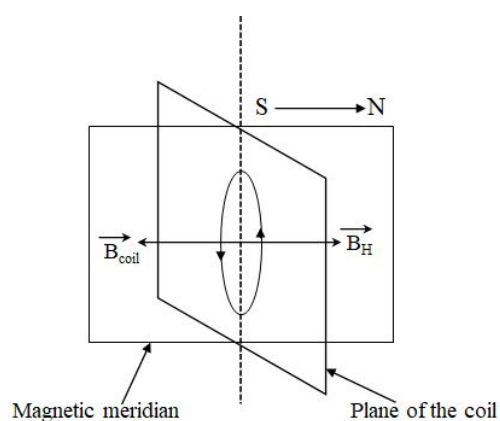
1. A neutral point is obtained at the centre of a vertical circular current carrying coil. The angle between the plane of the coil and the magnetic meridian is

- ☐ A. 0°
- ☐ B. 45°
- ☐ C. 60°
- ☒ D. 90°

The magnetic meridian is along $N - S$ plane, and the earth's magnetic field \vec{B}_H lies along it.

To obtain neutral point at the centre of coil, magnetic field due to current in the coil \vec{B} and \vec{B}_H must cancel each other.

Hence, plane of the coil and magnetic meridian must be perpendicular to each other as shown below.

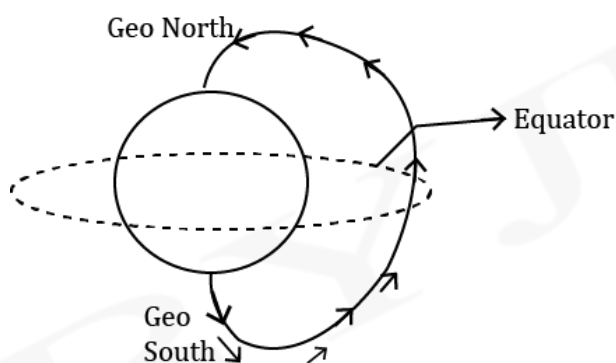


Hence option (D) is the correct answer.

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2. As we go from the magnetic equator towards the geographical south pole, the angle of the dip will become :

- ☒ A. More and more vertically downward and perpendicular to the surface at the magnetic south pole.
- ☒ B. More and more vertically upward and becomes perpendicular to the surface at the magnetic south pole.
- ☒ C. Less and less vertically downward and become horizontal at the magnetic south pole.
- ☒ D. Lesser and lesser vertically upward and become horizontal at the magnetic south pole.



As we move from equator to Geographical south pole (which is near the magnetic north pole), the vertical component of earth's magnetic field increases, and hence, angle of dip goes on increasing.

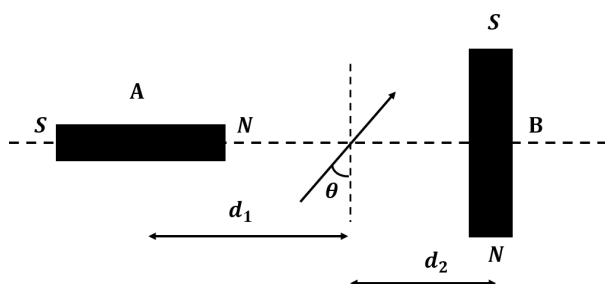
At the two magnetic poles, the magnetic needle rests vertically, such that the angle of dip at two poles is 90° .

On the magnetic equator, the magnetic needle rests horizontally, such that the angle of dip is 0° .

Hence, option (B) is the correct answer.

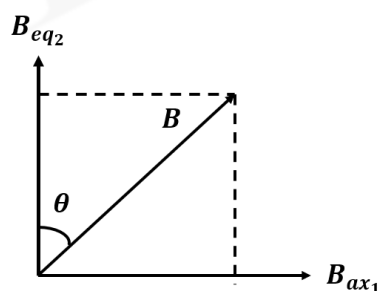
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3. Two short bar magnets A and B are identical and these are arranged as shown in the figure. A magnetic needle is placed between the magnets at point P which gets deflected through an angle θ under the influence of magnets. The ratio of distances d_1 and d_2 will be.



- ☒ A. $\frac{1}{\sqrt[3]{2 \tan \theta}}$
- ☒ B. $\frac{1}{\sqrt[3]{2 \cot \theta}}$
- ☒ C. $\sqrt[3]{2 \cot \theta}$
- ☒ D. $\sqrt[3]{2 \tan \theta}$

Due to both the fields,



$$\tan \theta = \frac{B_{ax_1}}{B_{eq_2}}$$

$$\Rightarrow \tan \theta = \frac{\left(\frac{\mu_0 2M}{4\pi d_1^3} \right)}{\left(\frac{\mu_0 M}{4\pi d_2^3} \right)}$$

$$\Rightarrow \tan \theta = 2 \left(\frac{d_2}{d_1} \right)^3$$

$$\Rightarrow \frac{d_1}{d_2} = (2 \cot \theta)^{1/3}$$

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4. A magnetising field of 5000 A/m produces a magnetic flux of 5×10^{-5} wb in an iron rod is 0.5 cm^2 , then the permeability of the rod will be (in H/m)

☒ A. 2×10^{-4}

☐ B. 1×10^{-3}

☐ C. 4×10^{-6}

☐ D. 3×10^{-5}

$$\begin{array}{l} H = 5000 \text{ A/m} \\ A = 0.5 \text{ cm}^2 \end{array} \quad \left| \quad \begin{array}{l} \phi = 5 \times 10^{-5} \text{ wb} \end{array} \right.$$

(i): $\phi = \vec{B} \cdot \vec{A}$

$$B = \frac{\phi}{A} = \frac{5 \times 10^{-5}}{0.5 \times 10^{-4}} = 1 \text{ T}$$

(ii): $B = \mu H$

$$\mu = \frac{B}{H} = \frac{1}{5000} = 2 \times 10^{-4} \text{ H/m}$$

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5. A magnet is suspended at an angle 60° in an uniform external magnetic field of 5×10^{-4} T. The work done in bringing the magnet in the direction of the magnetic field is (The magnetic moment = 20 Am^2)

☒ A. $-5 \times 10^{-3} \text{ T}$

☐ B. $+5 \times 10^{-3} \text{ T}$

☐ C. $-3 \times 10^{-3} \text{ T}$

☐ D. $+3 \times 10^{-3} \text{ T}$

Workdone by the magnetic field , $W = MB [\cos \theta_1 - \cos \theta_2]$

Here, $\theta_1 = 60^\circ$; $\theta_2 = 0^\circ$

Therefore, $W = 20 \times 5 \times 10^{-4} \times [\cos 60^\circ - \cos 0^\circ]$

$$W = 10^{-2} \times \left[\frac{1}{2} - 1 \right] = -5 \times 10^{-3} \text{ J}$$

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6. Read the two statements carefully to mark the correct option out of the options given below:

Statement -1: The tangent galvanometer can be made more sensitive by increasing the number of turns of its coil.

Statement -2: Current through the galvanometer is proportional to the number of turns of the coil.

- ☒ A. Both the statements are true, and the statement-2 is the correct explanation of statement-1.
- ☒ B. Both statements are true, but the statement-2 is not the correct explanation of the statement-1.
- ☒ C. The statement-1 true but statement-2 is false.
- ☒ D. The statement-1 is false, but statement-2 is true.

Sensitivity of a tangent galvanometer is given by,

$$s = \frac{\theta}{i} \simeq \frac{\tan \theta}{i} = \frac{\mu_0 N}{2aB_H}$$

Here,

$i \rightarrow$ Current passing through the coil

$a \rightarrow$ Radius of the coil

$B_H \rightarrow$ Horizontal component of the magnetic field

$N \rightarrow$ Number of turns of the coil

$\theta \rightarrow$ Angle of deflection

$$\Rightarrow s \propto N$$

So, statement-1 is correct.

Also, the current passing through the coil of a tangent galvanometer is given by,

$$i = \left(\frac{2aB_H}{\mu_0 N} \right) \tan \theta$$

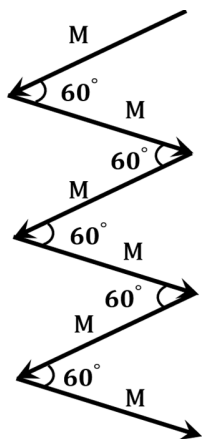
$$\Rightarrow i \propto \frac{1}{N}$$

So, statement-2 is incorrect.

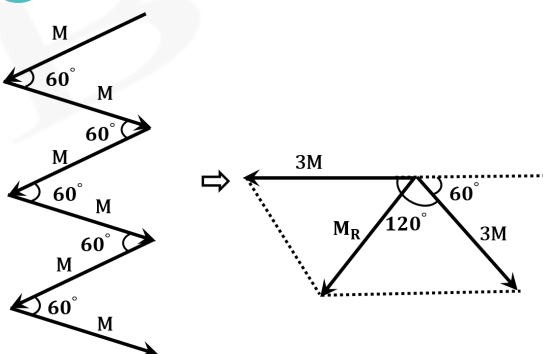
Hence, option (C) is correct.

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7. The resultant magnetic moment of the following arrangement is-



- ☒ A. $6M$
- ☒ B. $4M$
- ☒ C. $3M$
- ☒ D. $2M$



The resultant magnetic moment is,

$$M_R = \sqrt{M_1^2 + M_2^2 + 2M_1M_2 \cos \theta}$$

Here, $M_1 = 3M$; $M_2 = 3M$; $\theta = 120^\circ$

$$M_R = \sqrt{(3M)^2 + (3M)^2 + 2(3M)(3M) \cos 120^\circ}$$

$$= 3M \sqrt{2 + 2 \left(-\frac{1}{2} \right)}$$

$$\therefore M_R = 3M$$

Hence, (C) is the correct answer.

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8. A bar magnet of length 10 cm and pole strength 2 Am makes an angle 60° with a uniform magnetic field of induction $B = 50 \text{ T}$. The couple acting on it is-

☐ A. $20\sqrt{3} \text{ Nm}$

☐ B. $10\sqrt{3} \text{ Nm}$

☐ C. $\sqrt{3} \text{ Nm}$

☒ D. $5\sqrt{3} \text{ Nm}$

Given, $2l = 10 \text{ cm}$; $m = 2 \text{ Am}$

$B = 50 \text{ T}$; $\theta = 60^\circ$

Torque acting on the dipole is,

$$\tau = MB \sin \theta \quad [\because M = m(2l)]$$

$$= m(2l)B \sin \theta$$

$$= 2 \times 10 \times 10^{-2} \times 50 \times \left(\frac{\sqrt{3}}{2} \right)$$

$$= 5\sqrt{3} \text{ Nm}$$

Hence, (D) is the correct answer.

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9. The magnetic susceptibility of a rod is 499. The absolute permeability of vacuum is $\mu_0 = 4\pi \times 10^{-7} \text{ Hm}^{-1}$. The absolute permeability of the material of the rod is-

- ☒ A. $4\pi \times 10^{-4} \text{ Hm}^{-1}$
- ☒ B. $3\pi \times 10^{-4} \text{ Hm}^{-1}$
- ☒ C. $2\pi \times 10^{-4} \text{ Hm}^{-1}$
- ☒ D. $\pi \times 10^{-4} \text{ Hm}^{-1}$

Given, $\chi = 499$; $\mu_0 = 4\pi \times 10^{-7}$

The absolute permeability of the material of the rod is,

$$\begin{aligned}\mu &= \mu_0(1 + \chi) \\ &= 4\pi \times 10^{-7}(500) \\ &= 2\pi \times 10^{-4} \text{ Hm}^{-1}\end{aligned}$$

Hence, (C) is the correct answer.

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10. A short bar magnet placed with its axis at 30° with a uniform external magnetic field of 0.16 T , experiences a torque of 0.032 Nm . If the bar magnet is free to rotate, its potential energy when it is in stable and unstable equilibrium are-

- ☐ A. 0.032 J ; -0.032 J
- ☐ B. 0.064 J ; -0.128 J
- ☐ C. -0.032 J ; 0.032 J
- ☒ D. -0.064 J ; 0.064 J

Given,

$$B = 0.16 \text{ T} ; \tau = 0.032 \text{ Nm} ; \theta = 30^\circ$$

$$\text{As , } \tau = MB \sin \theta = 0.032$$

$$\Rightarrow M = \frac{\tau}{B \sin \theta} = \frac{0.032}{0.16 \times \sin 30^\circ} = 0.4$$

For stable equilibrium, $\theta = 0^\circ$

$$\text{P.E} = -MB \cos \theta = -(0.4 \times 0.16 \times 1) = -0.064 \text{ J}$$

For unstable equilibrium, $\theta = 180^\circ$

$$\text{P.E} = -MB \cos \theta = -(0.4 \times 0.16 \times (-1)) = 0.064 \text{ J}$$

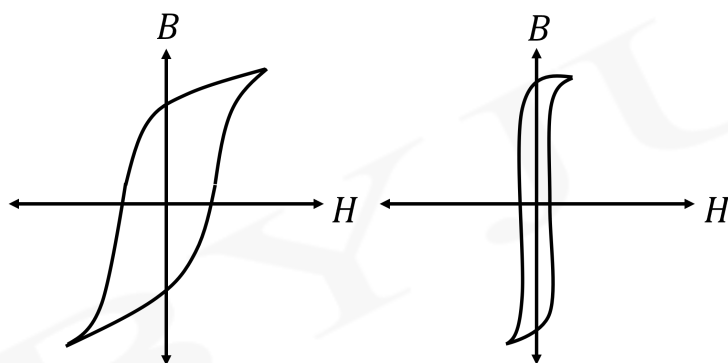
Hence, (D) is the correct answer.

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11. Choose the incorrect statement about the magnetic properties of soft iron and steel

- ☒ A. Retentivity of soft iron is more than retentivity of steel
- ☒ B. Coercivity of soft iron is less than coercivity of steel
- ☒ C. Area of $B - H$ loop in soft iron is smaller than the area of $B - H$ loop for steel
- ☒ D. Area of $B - H$ loop in soft iron is greater than the area of $B - H$ loop for steel

The hysteresis loop for both steel and soft iron is shown below:



Hysteresis curve of steel Hysteresis curve of soft iron

From the figure, it is evident that the area of $B - H$ loop in case of steel is greater than that of the soft iron.

Also, retentivity of soft iron is greater than the retentivity of steel.

However, the coercivity of steel is greater than that of the soft iron.

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12. Assertion (A) : Electromagnets are made of soft iron.

Reason (R) : Coercivity of soft iron is small.

- ☒ **A.** Both (A) and (R) are true, (R) is the correct explanation of (A)
- ☐ **B.** Both (A) and (R) are true, (R) is not the correct explanation of (A)
- ☐ **C.** (A) is true but (R) is false.
- ☐ **D.** (A) is false but (R) is true.

The soft iron is preferred in making electromagnets because of its low coercivity and high retentivity.

Hence, (A) is the correct answer.

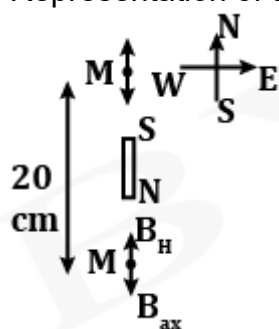
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13. A short bar magnet of moment 4 Am^2 is placed in the magnetic meridian with its south-pole pointing geographic north. The distance between two null points is found to be 20 cm.

(i) The value of horizontal component of the earth's magnetic field at the place is

- ☐ A. $4 \times 10^{-4} \text{ T}$
- ☐ B. $6 \times 10^{-4} \text{ T}$
- ☒ C. $8 \times 10^{-4} \text{ T}$
- ☐ D. $10 \times 10^{-4} \text{ T}$

Representation of the data given in the question is given in the figure below:



$$M = 4 \text{ Am}^2 ; d = 10 \text{ cm}$$

At null point : $B_{ax} = B_H$

$$\therefore \frac{\mu_0 2M}{4\pi d^3} = B_H$$

Substituting the data gives,

$$\frac{4\pi \times 10^{-7}}{4\pi} \times \frac{2 \times 4}{10^{-3}} = B_H$$

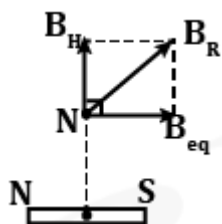
$$\Rightarrow B_H = 8 \times 10^{-4} \text{ T}$$

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14. A short bar magnet of moment 4 Am^2 is placed in the magnetic meridian with its south-pole pointing geographic north. The distance between two null points is found to be 20 cm.

(ii) If the magnet is turned through 90° , the resultant field at the location of the null point will be.

- ☐ A. $2\sqrt{5} \times 10^{-4} \text{ T}$
- ☒ B. $4\sqrt{5} \times 10^{-4} \text{ T}$
- ☐ C. $3\sqrt{5} \times 10^{-4} \text{ T}$
- ☐ D. $8\sqrt{5} \times 10^{-4} \text{ T}$



$$B_R = \sqrt{B_H^2 + B_{eq}^2} = \sqrt{B_H^2 + \left(\frac{B_H}{2}\right)^2}$$

$$\Rightarrow B_R = \sqrt{B_H^2 + \left(\frac{B_H}{2}\right)^2} = B_H \sqrt{1 + \frac{1}{4}}$$

$$\Rightarrow B_R = \frac{\sqrt{5}}{2} B_H$$

Substituting the value gives,

$$B_R = \frac{\sqrt{5}}{2} \times 8 \times 10^{-4} = 4\sqrt{5} \times 10^{-4} \text{ T}$$

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15. Assertion (*A*) : Magnetic moment of an atom is due to both, the orbital motion and spin motion of every electron.

Reason (*R*) : A charged particle at rest produces a magnetic field.

- ☒ A. Both (*A*) and (*R*) are true, (*R*) is the correct explanation of (*A*)
- ☒ B. Both (*A*) and (*R*) are true, (*R*) is not the correct explanation of (*A*)
- ☒ C. (*A*) is true but (*R*) is false.
- ☒ D. (*A*) is false but (*R*) is true.

As we know, current loop has magnetic moment, here the moving electrons behaves as current loops. Thus, the magnetic moment associated with electron motion is,

$$\mu = IA = q \left(\frac{v}{2\pi r} \right) \times \pi r^2 = \frac{evr}{2} \quad [\because q = e]$$

$$\because L = mvr \Rightarrow vr = \frac{L}{m}$$

$$\Rightarrow \mu = \frac{eL}{2m}$$

It is also possible that, magnetic moment due to spin motion of electrons.

But a charged particle at rest will not produce the magnetic field. It will only produce electric field.

Hence, (*C*) is the correct answer.

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16. Assertion (*A*) : The poles of a magnet cannot be separated by breaking into two pieces.

Reason (*R*) : The magnetic moment will be reduced to half when a magnet is broken into two equal pieces.

- ☒ A. Both (*A*) and (*R*) are true, (*R*) is the correct explanation of (*A*)
- ☒ B. Both (*A*) and (*R*) are true, (*R*) is not the correct explanation of (*A*)
- ☒ C. (*A*) is true but (*R*) is false.
- ☒ D. (*A*) is false but (*R*) is true.

As we know, every atom of a magnet acts as a dipole. So poles cannot be separated.

As we know, magnetic moment is,

$$M = m(2l)$$

Where, m = Pole strength

$(2l)$ = Length of the magnet

When a magnet is cut into equal pieces perpendicular to its axis, its pole strength remains the same but its length becomes half the initial length i.e.,

$$m' = m ; (2l)' = \frac{2l}{2}$$

Thus new magnetic moment of each piece is,

$$M' = m'(2l)' = ml$$

Hence, the new magnetic moment of each piece is, half of its initial magnetic moment.

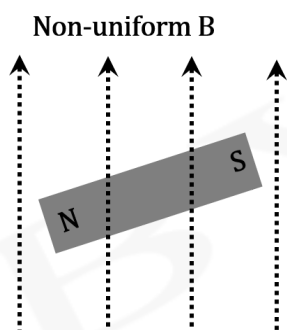
Hence, (*B*) is the correct answer.

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17. Assertion (A) : When a magnet is placed in a non-uniform magnetic field , it experiences both translatory and rotatory motion.

Reason (R) : The poles of the bar magnet experiences resultant force and torque.

- ☒ A. Both (A) and (R) are true, (R) is the correct explanation of (A)
- ☐ B. Both (A) and (R) are true, (R) is not the correct explanation of (A)
- ☐ C. (A) is true but (R) is false.
- ☐ D. (A) is false but (R) is true.



When a magnet is placed in a non-uniform magnetic field, it experiences non-zero net force and net torque.

Due to non-zero net force, it will have translatory motion. Due to non-zero net torque, it will have rotatory motion.

Hence, (A) is the correct answer.

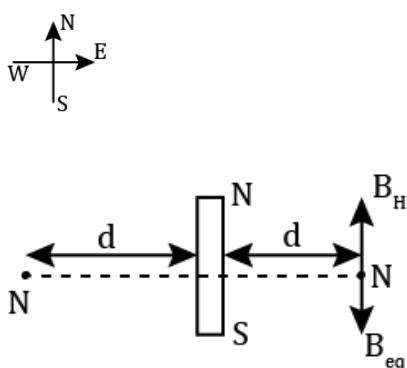
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18. A short bar magnet of moment 4 Am^2 is placed in the magnetic meridian with its south-pole pointing geographic north. The distance between two null points is found to be 20 cm.

(iii) If the same magnet is placed with its north pole pointing geographic north, then the distance between the null points (use $4^{\frac{1}{3}} = 1.59$).

- ☐ A. 1.59 m
- ☒ B. 0.159 m
- ☐ C. 15.59 m
- ☐ D. 0.0159 m

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At null points, $B_H = B_{eq} \dots\dots\dots (1)$

Where,

B_H = Horizontal component of earth's field

B_{eq} = Equatorial field due to a bar magnet

$$B_{eq} = \frac{\mu_0 M}{4\pi d^3} \dots\dots\dots (2) \quad [\because B_H = 8 \times 10^{-4} \text{ T}]$$

From (1) and (2) we get,

$$\Rightarrow 8 \times 10^{-4} = \frac{4\pi \times 10^{-7}}{4\pi} \times \frac{4}{d^3}$$

$$\Rightarrow d^3 = \frac{1}{2} \times 10^{-3}$$

$$\Rightarrow d = \left(\frac{1}{2}\right)^{\frac{1}{3}} \times 10^{-1} \text{ m} = \frac{1}{10 \times (2)^{\frac{1}{3}}} \text{ m}$$

The separation between the two null points D is given by,

$$D = 2d = \frac{2}{10 \times (2)^{\frac{1}{3}}} = \frac{4^{\frac{1}{3}}}{10}$$

$$\therefore D = \frac{1.59}{10} = 0.159 \text{ m}$$

Hence, (B) is the correct answer.

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19. The poles of a horse-shoe magnet each of pole strength 2 Am are at 4 cm apart.

(i) The magnetic moment of the horse-shoe magnet is (in Am^2)

- ☒ A. 0.04
- ☒ B. 0.06
- ☒ C. 0.08
- ☒ D. 0.02

Given, $m = 2 \text{ Am}$; $2l = 4 \text{ cm} = 4 \times 10^{-2} \text{ m}$

The magnetic moment is given by,

$$M = m(2l)$$

$$\begin{aligned} M &= 2 \times 4 \times 10^{-2} \\ &= 8 \times 10^{-2} \text{ Am}^2 \quad (\text{or}) \end{aligned}$$

$$M = 0.08 \text{ Am}^2$$

Hence, (C) is the correct answer.

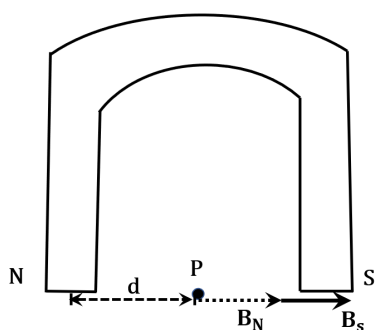
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20. The poles of a horse-shoe magnet each of pole strength 2 Am are at 4 cm apart.

(ii) The magnetic induction at the mid point between the poles is (in T)

- ☒ A. 10^{-3}
- ☐ B. 0.125×10^{-3}
- ☐ C. 0.5×10^{-3}
- ☐ D. 0.25×10^{-3}

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As we can at the mid, field due to both N and S directed along the same direction,

The net field at the mid-point P is,

$$B_{net} = B_N + B_S$$

At the equatorial point $B_H = B_s$

$$B_{net} = 2B_N$$

$$= 2 \times \frac{\mu_0}{4\pi} \left(\frac{m}{d^2} \right)$$

$$= 2 \times \left[\frac{4\pi \times 10^{-7}}{4\pi} \times \frac{2}{(2 \times 10^{-2})^2} \right]$$

$$\left[\because d = \frac{4}{2} = 2 \text{ cm} = 2 \times 10^{-2} \text{ m} \right]$$

$$= \frac{2 \times 10^{-7} \times 2}{4 \times 10^{-4}}$$

$$\therefore B_{net} = 10^{-3} \text{ T}$$

Hence, (A) is the correct answer.