Magnetism and Matter

Disclaimer: Physics

Date: 06/09/2022

Subject: Physics

Topic : Magnetic Field Lines & its Properties

Class: Standard XII

Time: 00:20 hrs

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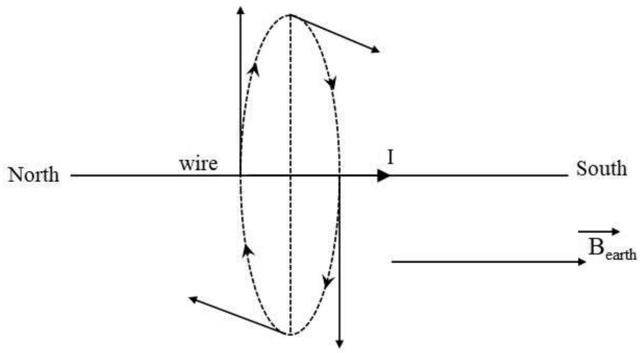
1. An electric cable is laid out horizontally and is carrying current from north to south, at the magnetic equator. The position of the null point from the cable is :

   A. Vertically upward

   B. Vertically downward

   C. Eastward

   D. Null point cannot be achieved



The magnetic field line around the straight wire is shown above. The direction of magnetic field at a point, will be along the tangent drawn to the field line, at that point.

At the magnetic equator, the earth's magnetic field is directed horizontally, from south to north.

Since, the magnetic field of earth is always perpendicular to the field of the wire, for the given configuration, there is no point where they both can cancel each other. So, the neutral point will not be obtained for any position.

The direction of magnetic field due to the wire is vertical, while due to earth is from south to north.

Hence, option (D) is the correct answer.

Magnetism and Matter

2. 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. $\frac{1}{\cos\ x}$ (correct)

B. $\frac{1}{\sin\ x}$

C. $\frac{1}{\tan\ x}$

D. $\cos x$

Here,
$\theta \rightarrow$Actual dip

$\theta' \rightarrow$ Apparent dip

$x \rightarrow$ Angle of plane with respect to the magnetic meridian.

Then, $\tan\theta = \frac{B_V}{B_H} \quad \ldots\ldots(1)$

$\tan\theta' = \frac{B_V}{B_H \cos x} \quad \ldots\ldots(2)$

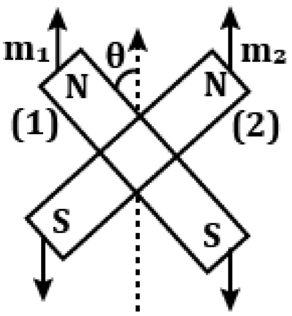
Dividing equation (1) and (2) we have,

$\Rightarrow \frac{\tan\ \theta'}{\tan\ \theta} = \frac{1}{\cos\ x}$

Hence, option (A) is the correct answer.

Magnetism and Matter

3. Two magnets of equal masses are joined at right angles to each other as shown in the diagram. Magnet-1 has a magnetic moment three times that of magnet-2. This arrangement is pivoted so that it is free to rotate in the horizontal plane. Under equilibrium, what angle will the magent-1 subtend with the magnetic meridian?



A. $\tan^{-1}\left(\frac{1}{2}\right)$

B. $\tan^{-1}\left(\frac{1}{3}\right)$ ✔

C. $\tan^{-1}(1)$

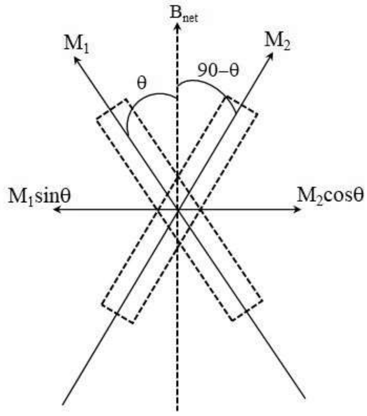
D. 0

Magnetism and Matter

Let M_1 and M_2 be the magnetic moments of the two magnets. Then,

$M_1 = 3\ M_2$

Also, B_{net} is in the direction of magnetic meridian.



Components of M_1 and M_2, in the direction perpendicular to magnetic meridian, must be cancelled.

From the diagram,

$\Rightarrow M_1 \sin\theta = M_2 \cos\theta$

$\tan\theta = \dfrac{M_2}{M_1} = \dfrac{1}{3}$

$\therefore\ \theta = \tan^{-1}\left(\dfrac{1}{3}\right)$

Hence, option (B) is the correct answer.

4. At a place, the earth's horizontal component of magnetic field is $0.36 \times 10^{-4}\ \mathrm{weber/m^2}$. If the angle of dip at that place is 60°, then the vertical component of earth's magnetic field at that place in $\mathrm{weber/m^2}$ will be approximately

A. 0.12×10^{-4}

B. 0.24×10^{-4}

C. 0.40×10^{-4}

D. 0.62×10^{-4}

We know that the angle of dip can be expressed as,

$$\tan\delta = \frac{B_V}{B_H}$$

$$\therefore B_V = B_H \tan\delta$$

$$B_V = 0.36 \times 10^{-4} \times \tan 60^\circ$$

$$B_V = 0.62 \times 10^{-4}\ \mathrm{Wb/m^2}$$

Hence, option (D) is the correct answer.

Magnetism and Matter

5. A domain in a magnet is in the form of a cube of side length $1\ \mu\text{m}$. If it contains 8×10^{10} atoms and each atomic dipole has a dipole moment of $9 \times 10^{-24}\text{A-m}^2$ and all of this dipoles are aligned in the same direction, then the magnetisation of the domain is:

- ✔ **A.** $7.2 \times 10^5\ \text{Am}^{-1}$
- ✖ **B.** $7.2 \times 10^3\ \text{Am}^{-1}$
- ✖ **C.** $3,6 \times 10^5\ \text{Am}^{-1}$
- ✖ **D.** $1.8 \times 10^3\ \text{Am}^{-1}$

We know that magnetisation is given by,

$$I = \frac{M_{net}}{\text{volume}}$$

Here,

$$M_{net} = 8 \times 10^{10} \times 9 \times 10^{-24}\ \text{A-m}^2$$

$$M_{net} = 72 \times 10^{-14}\ \text{A-m}^2$$

Volume of the cube,

$$V = (10^{-6})^3 = 10^{-18}\ \text{m}^3$$

$$\therefore I = \frac{72 \times 10^{-14}}{10^{-18}} = 7.2 \times 10^5\ \text{Am}^{-1}$$

Hence, option (A) is the correct answer.