Question1

If B_V and B_H are respectively the vertical and horizontal components of the Earth's magnetic field at a place where the angle of dip is $60°$, then the total magnetic field at that place is

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Options:

A.

$\sqrt{3}B_H$

B.

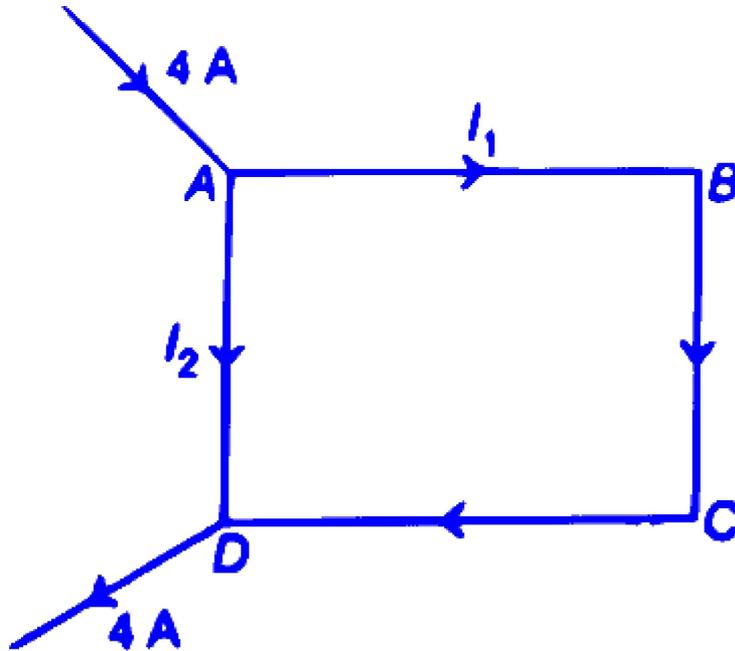$\sqrt{3}B_v$

C.

$\frac{2}{\sqrt{3}}B_v$

D.

$\frac{\sqrt{3}}{2}B_H$

Answer: C

Solution:

$$B_H = B \cos 60°$$
$$B_H = \frac{B}{2}$$
$$B_V = B \sin 60°$$
$$B_V = \frac{\sqrt{3}}{2} B \Rightarrow B = \frac{2}{\sqrt{3}} B_V$$

Question2

If the magnetic susceptibility of a substance is 0.6 , then the ratio of permeability of the substance and permeability of free space is

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Options:

A.

6 : 5

B.

7 : 4

C.

8 : 5

D.

3 : 5

Answer: C

Solution:

Given:

Magnetic susceptibility $\chi = 0.6$

We need the ratio $\dfrac{\mu}{\mu_0}$, where

μ = permeability of the substance

μ_0 = permeability of free space

Relation between μ and χ:

$\mu = \mu_0(1 + \chi)$

Substitute the value:

$\dfrac{\mu}{\mu_0} = 1 + \chi = 1 + 0.6 = 1.6$

$\dfrac{\mu}{\mu_0} = \dfrac{1.6}{1} = \dfrac{8}{5}$

✅ **Final Answer:**

$$\boxed{\dfrac{\mu}{\mu_0} = \dfrac{8}{5}}$$

Option (C) $\rightarrow 8 : 5$

Question3

The magnetising field which produces a magnetic flux of 22×10^{-6} Wb in a metal bar of area of cross-section 2×10^{-5} m^2 is (susceptibility of the metal $= 699$)

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Options:

A. $2500 \mathrm{Am}^{-1}$

B. $1250 \mathrm{Am}^{-1}$

C. $3750 \mathrm{Am}^{-1}$

D. $5000 \mathrm{Am}^{-1}$

Answer: B

Solution:

Given,

Magnetic flux, $\phi = 22 \times 10^{-6}\,\mathrm{Wb}$

Cross-sectional area, $A = 2 \times 10^{-5}\,\mathrm{m}^2$

Magnetic susceptibility of the metal, $\chi = 699$

We now that,

$\phi = B \cdot A$

$B = \dfrac{\phi}{A} = \dfrac{22 \times 10^{-6}}{2 \times 10^{-5}}$

$B = 1.1\,\mathrm{T}$

Relation between magnetic field and magnetizing field is given by,

$B = \mu_0(H + M)$

where, $H = $ magnetising field, $\mu_0 = $ permeability of free space and $M = $ magnetisation of the material but, $M = \chi H$

Putting value in Eq. (i), we get

$B = \mu_0(H + \chi H) = \mu_0 H(1 + \chi)$

$1.1 = 4\pi \times 10^{-7} \times H(1 + 699)$

$H = \dfrac{1.1 \times 10^7}{4\pi \times 700}$

$H = 0.01250 \times 10^5$

$H = 1250\,\mathrm{A/m}$

Question4

A short bar magnet placed in a uniform magnetic field making an angle with the field experiences a torque.If the angle made by the magnet with field is changed from $30°$ to $45°$, the torque on the magnet

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Options:

A. increases by 50%

B. decreases by 50%

C. decreases by 41.4%

D. increases by 41.4%

Answer: D

Solution:

When a short bar magnet is placed in a uniform magnetic field at an angle $θ$, it experiences a torque. The formula for the torque $τ$ is given by:

$\tau = MB \sin \theta$

where M is the dipole moment and B is the magnetic field strength.

Case 1: When the angle $\theta = 30°$,

$\tau_1 = MB \sin 30° = \frac{MB}{2}$

Case 2: When the angle $\theta = 45°$,

$\tau_2 = MB \sin 45° = \frac{MB}{\sqrt{2}}$

The change in torque is given by:

$\tau_2 - \tau_1 = \frac{MB}{\sqrt{2}} - \frac{MB}{2}$

Since $\tau_2 - \tau_1$ is positive, the torque increases. The percentage increase can be calculated as follows:

$\frac{\tau_2 - \tau_1}{\tau_1} \times 100$

$= \frac{MB(2-\sqrt{2})}{2\sqrt{2} \times MB} \times 100$

$= 41.4\%$

Thus, the torque on the magnet increases by 41.4%.

Question5

If a bar magnet of moment $10^{-4} Am^2$ is kept in a uniform magnetic field of 12×10^{-3} T such that it makes angle of $30°$ with the direction of magnetic field, then the torque acting on the magnet is

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Options:

A. $6 \times 10^{-7} N - m$

B. $6 \times 10^{-5} N - m$

C. $12 \times 10^{-7} N - m$

D. $12 \times 10^{-5} N - m$

Answer: A

Solution:

Torque $= MB \sin \theta$

$= 10^{-4} \times 12 \times 10^{-3} \times \sin 30°$

$= 10^{-4} \times 12 \times 10^{-3} \times \dfrac{1}{2}$

$= 6 \times 10^{-7} N - m$

Question6

The most exotic diamagnetic materials are

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Options:

A. superconductors

B. semiconductors

C. conductors

D. resistors

Answer: A

Solution:

Semiconductor exhibit diamagnetic properties, particularly when they are in their pure form. In the context of exotic materials, semiconductors can indeed be considered as such, especially when their diamagnetic properties are studied in detail.

Question7

The magnetic susceptibility of ferromagnetic materials is

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Options:

A. < 0

B. > 1

C. 1

D. 0

Answer: B

Solution:

Magnetic susceptibility is a measure of how much a material becomes magnetized in the presence of an external magnetic field.

The formula for magnetic susceptibility is given by:

$$\chi = \frac{M}{H} = \frac{\text{Magnetization (M)}}{\text{Magnetic field intensity (H)}}$$

Ferromagnetic materials are substances that can be highly magnetized when exposed to a magnetic field. As a result, the magnetic susceptibility of ferromagnetic materials is significantly greater than 1.

Question8

A bar magnet has coercivity $4 \times 10^3 \mathrm{Am}^{-1}$. It is placed inside a solenoid of 12 cm length and 60 turns. The current that should be passed through the solenoid to demagnetise, the bar magnet is

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Options:

A. 2 A

B. 4 A

C. 6 A

D. 8 A

Answer: D

Solution:

To solve this, we first recall that the magnetic field intensity inside a solenoid is given by:

$$H = \frac{NI}{l}$$

where:

• N is the number of turns (60 turns),

• I is the current in amperes, and

• l is the length of the solenoid in meters (12 cm = 0.12 m).

The bar magnet has a coercivity of $4 \times 10^3 \, \mathrm{A/m}$, which means to demagnetize the magnet, the solenoid needs to produce an opposing field of this magnitude.

Now, set the solenoid's field equal to the coercivity:

$$4 \times 10^3 = \frac{60 \times I}{0.12}$$

Now, solve for I:
Multiply both sides by 0 12:

$4 \times 10^3 \times 0.12 = 60I$

Compute the left side:

$480 = 60I$

Divide both sides by 60:

$I = \frac{480}{60} = 8 \, \text{A}$

Thus, the current that should be passed through the solenoid to demagnetize the bar magnet is 8 A.

The correct answer is:

Option D: 8 A.