Magnetism and Matter

Question1

A sample of a ferromagnetic iron in the shape of a cube of side 1.0μ m contains 8.7×10^{28} atoms per cubic metre and the magnetic dipole moment of each iron atom is $93 \times 10^{-24} \mathrm{Am}^2$. Then, the maximum possible magnetic dipole moment (in Am^2) of the sample is nearly

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Options:

A.

8.1×10^{-12}

B.

8.1×10^{-14}

C.

81×10^{-14}

D.

81×10^{-16}

Answer: C

Solution:

Total number of atoms in sample $N =$ Number of atom per cubic metre × Volume of the sample

$$= 8.7 \times 10^{28} \times \left(1 \times 10^{-6}\right)^3$$
$$= 8.7 \times 10^{10} \text{ atoms}$$

Maximum possible dipole moment

$$
\begin{aligned}
M_{\max} = & N \times \text{ magnetic dipole moment of} \\
& \text{each atom} \\
= & 8.7 \times 10^{10} \times 9.3 \times 10^{-24} \\
= & 8.09 \times 10^{-13} = 8.1 \times 10^{-13} \\
& \approx 81 \times 10^{-14} \mathrm{Am}^2
\end{aligned}
$$

Question2

A sample of paramagnetic salt contains 2×10^{24} atomic dipoles each of dipole moment $15 \times 10^{-23} \mathrm{JT}^{-1}$. The sample is placed under homogeneous magnetic field of 0.6 T and cooled to a temperature 4.2 K . The degree of magnetic saturation achived is 20%. Then total dipole moment of the sample for a magnetic field of 0.9 T and a temperature of 2.8 K is

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Options:

A.

$4.5 \mathrm{JT}^{-1}$

B.

$13.5 \mathrm{JT}^{-1}$

C.

$0.64 \mathrm{JT}^{-1}$

D.

$7 \mathrm{JT}^{-1}$

Answer: B

Solution:

We use Curie's law to understand how the magnetism of a paramagnetic material changes with temperature and magnetic field.

According to Curie's law, the magnetisation (M) is directly proportional to the magnetic field (B_0) and inversely proportional to the temperature (T):

$M \propto \frac{B_0}{T}$ or, $M = C \cdot \frac{B_0}{T}$ where C (Curie's constant) stays the same for the same substance.

Curie's constant can be written as: $C = \frac{MT}{B_0}$ where:

- T = temperature in Kelvin
- B_0 = external magnetic field
- M = magnetisation (total dipole moment)

Since C (Curie's constant) is the same for all measurements of the same sample, we can relate two cases as:

$\frac{M_1 T_1}{B_{0_1}} = \frac{M_2 T_2}{B_{0_2}}$ So, $M_2 = M_1 \cdot \frac{T_1}{T_2} \cdot \frac{B_{0_2}}{B_{0_1}}$

Now, let's fill in the given values:

- Number of dipoles $= 2 \times 10^{24}$
- Dipole moment per dipole $= 15 \times 10^{-23}\ \mathrm{JT}^{-1}$

Step 1: Find Initial Total Dipole Moment

Total dipole moment possible (if 100% aligned): $2 \times 10^{24} \times 15 \times 10^{-23} = 3 \times 10^2\ \mathrm{JT}^{-1}$ But, at first, only 20% saturation is achieved: $M_1 = 0.2 \times 3 \times 10^2 = 60\ \mathrm{JT}^{-1}$

Step 2: Use Curie's Law for New Conditions

Magnetic field changes from $B_{0_1} = 0.6\ T$ to $B_{0_2} = 0.9\ T$ and temperature from $T_1 = 4.2\ K$ to $T_2 = 2.8\ K$.

Now, use the formula: $M_2 = M_1 \times \frac{T_1}{T_2} \times \frac{B_{0_2}}{B_{0_1}}$

Substitute the numbers in: $M_2 = 60 \times \frac{4.2}{2.8} \times \frac{0.9}{0.6}$

Calculate step by step:

- $\frac{4.2}{2.8} = 1.5$
- $\frac{0.9}{0.6} = 1.5$

So, $M_2 = 60 \times 1.5 \times 1.5 = 135\ \mathrm{JT}^{-1}$

Question3

The work done in rotating a bar magnet which is initially in the direction of a uniform magnetic field through 45° is W. The additional work to be done to rotate the magnet further through 15° is

Options:

A.

$\frac{W}{\sqrt{2}}$

B.

$\frac{W}{2}$

C.

$W\sqrt{2}$

D.

2 W

Answer: A

Solution:

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

Initially, $\theta_1 = 0^\circ, \theta_2 = 45^\circ$

$$\begin{aligned}\therefore W_1 &= MB(\cos 0 - \cos 45^\circ)\\ &= MB\left(1 - \frac{1}{\sqrt{2}}\right)\\ &= \left(\frac{\sqrt{2}-1}{\sqrt{2}}\right)MB\end{aligned}$$

Again, $\theta_2 = 45^\circ + 15^\circ = 60^\circ$

$$\begin{aligned}\therefore W_2 &= MB(\cos 45^\circ - \cos 60^\circ)\\ &= MB\left(\frac{1}{\sqrt{2}} - \frac{1}{2}\right)\\ &= MB\left(\frac{\sqrt{2}-1}{2}\right)\end{aligned}$$

$$\therefore \frac{W_2}{W_1} = \frac{MB\left(\frac{\sqrt{2}-1}{2}\right)}{MB\left(\frac{\sqrt{2}-1}{\sqrt{2}}\right)} = \frac{1}{\sqrt{2}}$$

$$\Rightarrow W_2 = \frac{W_1}{\sqrt{2}} = \frac{W}{\sqrt{2}}$$

Question4

Materials suitable for permanent magnets should have

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Options:

A.

Iow retentivity and 'ow coercivity

B.

Iow retentivity ar nigh coercivity

C.

high retentivity and low coercivity

D.

high retentivity and high coercivity

Answer: D

Solution:

Materials suitable for permanent magnets should have high retentivity and high coercivity.

Question5

A short bar magnet of magnetic moment $10^4 \mathrm{JT}^{-1}$ is free to rotate in a horizontal plane. The work done in rotating the magnet slowly from the direction parallel to a horizontal magnetic field of 4×10^{-5} T to a direction 60° to the direction of the field is

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Options:

A.

0.2 J

B.

2.6 J

C.

0.4 J

D.

6.2 J

Answer: A

Solution:

Given data

- Magnetic moment of the bar magnet:

  $M = 10^4 \text{ J T}^{-1}$

- Magnetic field:

  $B = 4 \times 10^{-5} \text{ T}$

- Initial orientation: $\theta_1 = 0^\circ$ (parallel to B)

- Final orientation: $\theta_2 = 60^\circ$

Relevant concept

The **potential energy** of a magnetic dipole in a magnetic field is

$U = -MB\cos\theta$

When the magnet is rotated slowly (quasi-statically), the work done **by an external agent** equals the **change in potential energy** of the system:

$W = U_2 - U_1 = [-MB\cos\theta_2] - [-MB\cos\theta_1]$

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

Substitute the values

$W = (10^4)(4 \times 10^{-5})(\cos 0^\circ - \cos 60^\circ)$

Compute step by step:

$\cos 0^\circ = 1, \quad \cos 60^\circ = \frac{1}{2}$

So,

$W = (10^4)(4 \times 10^{-5})(1 - 0.5)$

$W = (10^4)(4 \times 10^{-5})(0.5)$

$W = (10^4 \times 4 \times 10^{-5} \times 0.5)$

$W = (4 \times 10^{-1} \times 0.5) = 0.2 \text{ J}$

✅ **Final Answer:**

$\boxed{W = 0.2 \text{ J}}$

Correct option: (A) 0.2 J

Question6

A short bar magnet has a magnetic moment of $0.48 \mathrm{JT}^{-1}$. The magnitude of magnetic field at a point at 10 cm distance from the centre of the magnet on its axis is

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Options:

A.

0.96 gauss

B.

0.48 gauss

C.

1.92 gauss

D.

1.44 gauss

Answer: A

Solution:

$$B=\frac{\mu_0}{4\pi}\cdot\frac{2M}{r^3}=10^{-7}\times\frac{2\times 0.48}{(0.1)^3}$$
$$=0.96\times 10^{-4}\ \mathrm{T}=0.96\ \text{Gauss}$$

Question7

A short bar magnet is placed in a uniform magnetic field of 2 T such that the axis of the magnet makes an angle of 45° with the direction of the magnetic field. If the torque acting on the magnet is $0.36\sqrt{2}\ \mathrm{N-m}$, then the moment of the magnet is

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Options:

A.

$0.54\mathrm{JT}^{-1}$

B.

$0.18\mathrm{JT}^{-1}$

C.

$0.72\mathrm{JT}^{-1}$

D.

$0.36\mathrm{JT}^{-1}$

Answer: D

Solution:

Torque on bar magnet,

$$\tau=MB\sin\theta$$
$$\Rightarrow\quad M=\frac{\tau}{B\sin\theta}=\frac{0.36\sqrt{2}}{2\sin 45^{\circ}}$$
$$=\frac{0.36\sqrt{2}}{2\times\frac{1}{\sqrt{2}}}=\frac{0.36\sqrt{2}}{\sqrt{2}}=0.36\ \mathrm{J/T}$$

Question8

The relation between μ and H for a specimen of iron is $\mu=\left[\frac{1.4}{H}+12\times10^{-4}\right]\mathrm{Hm}^{-1}$. The value of H which produces flux density of 1 T will be ($\mu=$ magnetic permeability, $H=$ magnetic intensity)

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Options:

A. $250\mathrm{Am}^{-1}$

B. $500\mathrm{Am}^{-1}$

C. $750\mathrm{Am}^{-1}$

D. $10^3\mathrm{Am}^{-1}$

Answer: B

Solution:

To find the value of H that produces a flux density of 1 T, we are given:

$\mu=\left[\frac{0.4}{H}+12\times10^{-4}\right]$ H/m

We also know the relationship between B and μH:

$B=\mu H$

Given $B=1$ T, substitute into the equation:

$\mu=\frac{0.4}{H}+12\times10^{-4}$

Multiply both sides by H:

$\mu H=0.4+12\times10^{-4}H$

Since $B=\mu H=1$ T, substitute the expression for μH:

$1=0.4+12\times10^{-4}H$

Rearrange to solve for H:

$1-0.4=12\times10^{-4}H$

$0.6=12\times10^{-4}H$

$H=\frac{0.6}{12\times10^{-4}}$

$H = \frac{6000}{12}$

$H = 500 \text{ A/m}$

Thus, the value of H is 500 Am^{-1}.

Question9

At a place the horizontal component of earth's magnetic field 3×10^{-5} T and the magnetic declination is 30°. A compass needle of magnetic moment $18 \mathrm{Am}^2$ pointing towards geographic north at this place experiences a torque of

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Options:

A. $36 \times 10^{-5} \mathrm{Nm}$

B. $18 \times 10^{-5} \mathrm{Nm}$

C. $54 \times 10^{-5} \mathrm{Nm}$

D. $27 \times 10^{-5} \mathrm{Nm}$

Answer: D

Solution:

To calculate the torque experienced by a compass needle due to the Earth's magnetic field, we use the following information:

The **angle of declination** is $\alpha = 30^{\circ}$.

The **magnetic moment** of the compass is $M = 18 \text{ Am}^2$.

The **magnetic field** is $B = 3 \times 10^{-5}$ T.

The formula to calculate torque (τ) is:

$\tau = MB \sin \theta$

where θ is the angle between the magnetic moment and the magnetic field, which in this case is the angle of declination, 30°. Substituting the given values into the formula:

$\tau = 18 \times 3 \times 10^{-5} \times \sin 30^{\circ}$

Since $\sin 30^{\circ} = \frac{1}{2}$, the calculation becomes:

$\tau = 18 \times 3 \times 10^{-5} \times \frac{1}{2}$

$\tau = 27 \times 10^{-5}\,\mathrm{Nm}$

Therefore, the torque experienced by the compass needle is $27 \times 10^{-5}\,\mathrm{Nm}$.

Question10

If the vertical component of the earth's magnetic field is 0.45 G at a location and angle of dip is 60°, then magnetic field of earth in that location is

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Options:

A. 0.26 G

B. 0.52 G

C. 0.3 G

D. 0.7 G

Answer: B

Solution:

Given the vertical component of the Earth's magnetic field as $B_V = 0.45\,\mathrm{G}$ and the angle of dip $\delta = 60^{\circ}$, we can determine the Earth's magnetic field at this location.

Calculate the Horizontal Component (B_H):

The formula for the angle of dip is:

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

Given $\delta = 60^{\circ}$, we find that:

$B_H = \frac{B_V}{\tan 60^{\circ}} = \frac{0.45}{\sqrt{3}} \approx 0.26\,\mathrm{G}$

Calculate the Earth's Magnetic Field (B_e):

The Earth's total magnetic field can be found using the horizontal component and the angle of dip:

$\cos \delta = \frac{B_H}{B_e}$

With $\cos 60^{\circ} = 0.5$, we have:

$$B_e = \frac{B_H}{\cos 60^\circ} = \frac{0.26}{0.5} = 0.52\,\mathrm{G}$$

Thus, the magnetic field of Earth at this location is $0.52\,\mathrm{G}$.

Question11

At a place where the magnitude of the earth's magnetic field is 4×10^{-5} T, a short bar magnet is placed with its axis perpendicular to the earth's magnetic field direction. If the resultant magnetic field at a point at a distance of 40 cm from the centre of the magnet on the normal bisector of the magnet is inclined at 45° with the earth's field, then the magnele moment of the magnet is

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Options:

A. $38.4\mathrm{Am}^2$

B. $51.2\mathrm{Am}^2$

C. $12.8\mathrm{Am}^2$

D. $25.6\mathrm{Am}^3$

Answer: D

Solution:

Given:

Earth's magnetic field, $B_e = 4 \times 10^{-5}\,\mathrm{T}$

Distance from the magnet, $r = 0.4\,\mathrm{m}$

The magnetic field due to a short bar magnet at a point on its normal bisector is given by:

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

For a 45° angle of inclination of the resultant magnetic field with Earth's field, we have:

$B_m = B_e$

Substituting the values, we get:

$4 \times 10^{-5} = \frac{\mu_0}{4\pi} \frac{M}{(0.4)^3}$

This simplifies to:

$4 \times 10^{-5} = \frac{10^{-7} \times M}{(0.4)^3}$

Solving for M, the magnetic moment:

$M = 2.56 \times 10^1$

Therefore, the magnetic moment of the magnet is:

$M = 25.6 \, \text{Am}^2$

Question12

Any magnetic material loses its magnetic property when it is

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Options:

A. dipped in water

B. dipped in sand

C. attached to an iron piece

D. heated to high temperature

Answer: D

Solution:

The correct answer is Option D: heated to high temperature.

Here's why:

Magnetic materials (especially ferromagnetic ones like iron) have a special temperature called the Curie temperature.

When heated above this Curie temperature, the thermal agitation disrupts the alignment of the magnetic domains.

As a result, the material loses its permanent magnetic properties.

Thus, heating the material to a high temperature causes it to lose its magnetism.

Question13

The domain in ferromagnetic material is in the form of a cube of side 2μ m. Number of atoms in that domain is 9×10^{10} and each atom has a dipole movement of $9 \times 10^{-24} \mathrm{Am}^2$. The magnetisation of the domain is (approximately).

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Options:

A. $10 \times 10^4 \mathrm{Am}^{-1}$

B. $8 \times 10^4 \mathrm{Am}^{-1}$

C. $12 \times 10^4 \mathrm{Am}^{-1}$

D. $9 \times 10^4 \mathrm{Am}^{-1}$

Answer: D

Solution:

To calculate the magnetization of a ferromagnetic material domain, follow these steps:

Determine the Volume of the Domain:

The domain is a cube with each side measuring 2 μm. First, convert this measurement to meters:

$2\,\mu\mathrm{m} = 2 \times 10^{-6}\,\mathrm{m}$

Therefore, the volume V of the cube is:

$V = (2 \times 10^{-6})^3 = 8 \times 10^{-18}\,\mathrm{m}^3$

Use Given Values:

Number of atoms in the domain, $N = 9 \times 10^{10}$.

Dipole moment of each atom, $M = 9 \times 10^{-24}\,\mathrm{Am}^2$.

Calculate the Total Dipole Moment:

The total dipole moment M' for all the atoms is given by:

$M' = N \times M = 9 \times 10^{10} \times 9 \times 10^{-24} = 81 \times 10^{-14}\,\mathrm{Am}^2$

Find the Magnetization:

Magnetization Magnetization is the total dipole moment M' divided by the volume V:

Magnetization $= \frac{M'}{V} = \frac{81\times10^{-14}}{8\times10^{-18}} = 9\times10^4\ \mathrm{Am}^{-1}$

Thus, the magnetization of the domain is approximately $9\times10^4\ \mathrm{Am}^{-1}$.

Question14

A magnet suspended in a uniform magnetic field is heated, so as to reduce its magnetic moment by 19%. By doing this, the time period of the magnet approximately

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Options:

A. increse by 11%

B. decrease by 19%

C. increases by 19%

D. decreases by 4%

Answer: A

Solution:

We know that the time period for an oscillating magnet is given by:

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

where:

M is the magnetic moment,

I is the moment of inertia, and

B_H is the horizontal component of the Earth's magnetic field.

Given that the magnetic moment decreases by 19%, we can express the initial magnetic moment as $M_1 = m$ and the reduced magnetic moment as:

$M_2 = m - \frac{19\times m}{100} = 0.81m$

From the equation for the time period, we derive:

$\frac{T_1}{T_2} = \sqrt{\frac{M_2}{M_1}}$

Substituting the values we have:

$\frac{T_1}{T_2} = \sqrt{\frac{0.81m}{m}} = \sqrt{0.81} = \frac{9}{10}$

Rearranging gives:

$T_2 = \frac{10}{9}T_1$

This implies:

$T_2 = 1.11T_1$

So, the new time period T_2 is $T_1 + 0.11T_1$, which indicates that:

The time period increases by 11%.

Question15

Two short magnets of equal dipole moments M are fastened perpendicularly at their centres. The magnitude of the magnetic field at a distance d from the centre on the bisector of the right angle is(μ_0 = Permeability of free space)

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Options:

A. $\frac{\mu_0}{4\pi} \frac{2\sqrt{2}M}{d^3}$

B. $\frac{\mu_0}{4\pi} \frac{5M}{d^3}$

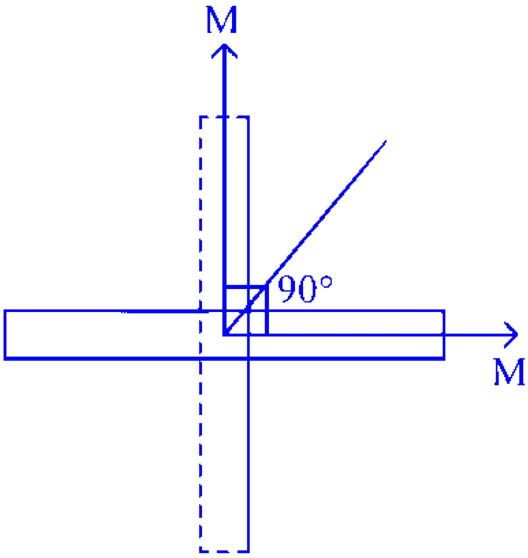
C. $\frac{\mu_0}{4\pi} \frac{2M}{d^3}$

D. $\frac{\mu_0}{4\pi} \frac{10M}{d^3}$

Answer: A

Solution:

When two short magnets of equal dipole moments M are fastened perpendicularly at their centres. Then their resultant dipole moment is given as



$$M' = \sqrt{M_1^2 + M_2^2 + 2M_1M_2\cos\theta}$$
$$= \sqrt{M^2 + M^2 + 2MM\cos 90^\circ}$$
$$\Rightarrow M' = M\sqrt{2} \quad .... \text{(i)}$$

The magnitude of the magnetic field at a distance d from the centre on the bisector i.e at a distance d on the axial position of dipole,

$$B = \frac{\mu_0}{4\pi} \cdot \frac{2M'}{d^3}$$
$$= \frac{\mu_0}{4\pi} \cdot \frac{2\sqrt{2}M}{d^3} \quad \text{[from Eq. (i)]}$$

Question16

A steel wire of length l and magnetic moment M is bent into a semicircular arc of radius R. The new magnetic moment is

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Options:

A. M

B. $\frac{2RM}{\pi l}$

C. $\frac{2M}{\pi}$

D. $\frac{2\pi RM}{1}$

Answer: C

Solution:

Length of steel wire $= l$

Magnetic moment, $M = ml \quad .... \text{(i)}$

Where, m is pole strength when steel wire is bent into semicircular wire, then

$$l = \pi R$$
$$\Rightarrow \quad R = \frac{l}{\pi}$$

$\therefore$ length of wire $=$ diameter

$$\Rightarrow \quad l' = 2R = \frac{2l}{\pi}$$
$$\Rightarrow \quad l' = \frac{2l}{\pi}$$

New magnetic dipole moment,

$$M' = ml'$$
$$= m\frac{2l}{\pi} = \frac{2}{\pi}(ml) = \frac{2M}{\pi}$$

Question17

A magnetic needle free to rotate in a vertical plane parallel to the magnetic meridian has its north tip pointing down at 30° with the horizontal. The horizontal component of the earth's magnetic field at the place is 0.3 G . Then the magnitude of the earth's magnetic field at the location is

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Options:

A. $\frac{\sqrt{3}}{5}G$

B. $\sqrt{3}$G

C. $\frac{20}{\sqrt{3}}$G

D. $\frac{2}{\sqrt{3}}$G

Answer: A

Solution:

Given:

$B_H = 0.3\text{G}$

Angle of dip:

$\delta = 30^\circ$

We know the relationship between the horizontal component and the total magnetic field:

$B_H = B\cos\delta$

Solving for B:

$$\begin{aligned}
\Rightarrow B &= \frac{B_H}{\cos\delta} \\
&= \frac{0.3}{\cos 30^\circ} \\
&= \frac{0.3}{\sqrt{3}/2} \\
&= 2 \times \frac{0.3}{\sqrt{3}} \\
&= \frac{0.6}{\sqrt{3}} \\
&= \frac{2}{10} \times \frac{3}{\sqrt{3}} \\
&= \frac{1}{5}\sqrt{3} \\
&= \frac{\sqrt{3}}{5}\text{G}
\end{aligned}$$

Question18

A compass needle oscillates 20 times per minute at a place where the dip is 45° and the magnetic field is B_1. The same needle oscillates 30 times per minute at a place where the dip is 30° and magnetic field is B_2. Then, $B_1 : B_2$ is

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Options:

A. $9\sqrt{3} : 4\sqrt{2}$

B. $4\sqrt{2} : 9\sqrt{3}$

C. $3\sqrt{3} : 2\sqrt{2}$

D. $2\sqrt{2} : 3\sqrt{3}$

Answer: D

Solution:

When compass needle oscillates 20 times per minute, then its time period,

$T_1 = \frac{1}{f} = \frac{1}{\left(\frac{20}{60}\right)} = 3 \text{ s}$

Angle of dip, $\delta_1 = 45^\circ$

When the same oscillates 30 times per min then, its time period.

$T_2 = \frac{1}{f_2} = \frac{1}{30/60} = 2 \text{ s}$

and angle of dip, $\delta_2 = 30^\circ$

we know that, time period of compass needle

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

where, $I =$ moment of inertia $B_H =$ horizontal component of Earth's magnetic field.

$$\Rightarrow \quad T \propto \frac{1}{\sqrt{B_H}}$$

$$\Rightarrow \quad T \propto \frac{1}{\sqrt{B\cos\delta}} \Rightarrow \frac{T_2}{T_1} = \sqrt{\frac{B_1\cos\delta_1}{B_2\cos\delta_2}}$$

$$= \sqrt{\frac{B_1\cos 45^\circ}{B_2\cos 30^\circ}} = \sqrt{\frac{B_1}{B_2}} = \sqrt{\frac{\frac{1}{\sqrt{2}}}{\frac{\sqrt{3}}{2}}} = \sqrt{\frac{2}{\sqrt{6}}} \cdot \sqrt{\frac{B_1}{B_2}}$$

$$\Rightarrow \quad \frac{T_2^2}{T_1^2}=\frac{2}{\sqrt{6}} \cdot \frac{B_1}{B_2} \Rightarrow \frac{2^2}{3^2}=\frac{2}{\sqrt{6}} \frac{B_1}{B_2}$$

$$\Rightarrow \quad \frac{4}{9}=\frac{2}{\sqrt{6}} \frac{B_1}{B_2} \Rightarrow \frac{B_1}{B_2}=\frac{2 \sqrt{6}}{9}$$

$$\Rightarrow \quad \frac{B_1}{B_2}=\frac{2 \sqrt{2}}{3 \sqrt{3}} \Rightarrow B_1: B_2=2 \sqrt{2}: 3 \sqrt{3}$$

Question19

A paramagnetic sample showing a net magnetisation of $0.8 \mathrm{~A} \mathrm{~m}^{-1}$, when placed in an external magnetic field of strength $0.8 \mathrm{~T}$, at a temperature $5 \mathrm{~K}$. If the temperature is raised to $20 \mathrm{~K}$, then the magnetisation becomes

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Options:

A. $0.8 \mathrm{~A} \mathrm{~m}^{-1}$

B. $0.2 \mathrm{~A} \mathrm{~m}^{-1}$

C. $0.1 \mathrm{~A} \mathrm{~m}^{-1}$

D. $0.4 \mathrm{~A} \mathrm{~m}^{-1}$

Answer: B

Solution:

Given,

Initial magnetisation, $m_1=0.8 \mathrm{~Am}^{-1}$

Magnetic field strength, $B=0.8 \mathrm{~T}$

Initial temperature, $T_1=5 \mathrm{~K}$

Final temperature, $T_2=20 \mathrm{~K}$

Let, final magnetisation be m_2.

Since, $m=C B / T$

where, C is Curie's temperature.

$$\Rightarrow \quad m \propto \frac{1}{T}$$
$$\therefore \quad \frac{m_1}{m_2} = \frac{T_2}{T_1}$$
$$\Rightarrow \quad m_2 = \frac{m_1 T_1}{T_2} = \frac{0.8 \times 5}{20} = 0.2 \text{ Am}^{-1}$$

Question20

The plane of a dip circle is set in the geographic meridian and the apparent dip is δ_1. It is then set in a vertical plane perpendicular to the geographic meridian. The apparent dip angle is δ_2. The declination θ at the place is

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Options:

A. $\tan^{-1}(\tan_1 \tan_2)$

B. $\tan^{-1}(\tan\delta_1 + \tan\delta_2)$

C. $\tan^{-1}\left(\frac{\tan\delta_1}{\tan\delta_2}\right)$

D. $\tan^{-1}(\tan\delta_1 - \tan\delta_2)$

Answer: C

Solution:

Given, first apparent dip $= \delta_1$

Second apparent dip $= \delta_2$

Declination $= \theta$

$$\text{As we know that, } \tan\theta = \frac{\tan_1}{\tan_2}$$
$$\therefore \quad \theta = \tan^{-1}\left(\frac{\tan\delta_1}{\tan\delta_2}\right)$$
