Magnetism and Matter

Question1

The horizontal component of earth's magnetic field at a place is 3.5×10^{-5}T. A very long straight conductor carrying current of √2A in the direction from South east to North West is placed. The force per unit length experienced by the conductor is .... $\times 10^{-6}$N/m.

[30-Jan-2024 Shift 1]

Answer: 35

Solution:

$B_H = 3.5 \times 10^{-5} T$

$F = i\ell B \sin\theta, \quad i = \sqrt{2}A$

$$\frac{F}{\ell} = iB\sin\theta = \sqrt{2} \times 3.5 \times 10^{-5} \times \frac{1}{\sqrt{2}}$$

$= 35 \times 10^{-6} N/m$

Question2

A ceiling fan having 3 blades of length 80cm each is rotating with an angular velocity of 1200rpm. The magnetic field of earth in that region is 0.5G and angle of dip is 30°. The emf induced across the blades is Nπ $\times 10^{-5}$V. The value of N is____

[30-Jan-2024 Shift 1]

Answer: 32

Solution:

$B_v = B \sin 30 = \frac{1}{4} \times 10^{-4}$

$\omega = 2\pi \times f = \frac{2\pi}{60} \times 1200 \text{ rad/ } s$

$\varepsilon = \frac{1}{2} B_V \omega \ell^2$

$= 32\pi \times 10^{-5} \text{V}$

Question3

Certain galvanometers have a fixed core made of non magnetic metallic material. The function of this metallic material is
[8-Apr-2023 shift 1]

Options:

A. To produce large deflecting torque on the coil

B. To bring the coil to rest quickly

C. To oscillate the coil in magnetic field for longer period of time

D. To make the magnetic field radial

Answer: B

Solution:

Solution:
To bring the coil at rest quickly

Question4

Given below are two statements : one is labelled as Assertion A and the other is labelled as Reason R
Assertion A : Electromagnets are made of soft iron.
Reason R : Soft iron has high permeability and low retentivity.
In the light of above, statements, chose the most appropriate answer from the options given below.
[8-Apr-2023 shift 2]

Options:

A. A is correct but R is not correct

B. Both A and R are correct and R is the correct explanation of A

C. Both A and R are correct but R is NOT the correct explanation of A

D. A is not correct but R is correct

Answer: B

Question5

The current required to be passed through a solenoid of 15 cm length and 60 turns in order to demagnetize a bar magnet of magnetic intensity $2.4 \times 10^3 Am^{-1}$ is _______ A.
[10-Apr-2023 shift 1]

Answer: 6

Solution:

$H = 2.4 \times 10^3 A / m$

$H = nI = \frac{N}{\ell} I$

$I = \frac{H\ell}{N} = \frac{2.4 \times 10^3 \times 15 \times 10^{-2}}{60}$

$I = 6A$

Question6

A bar magnet is released from rest along the axis of a very long vertical copper tube. After some time the magnet will
[10-Apr-2023 shift 2]

Options:

A. Oscillate inside the tube

B. Move down with an acceleration greater than g

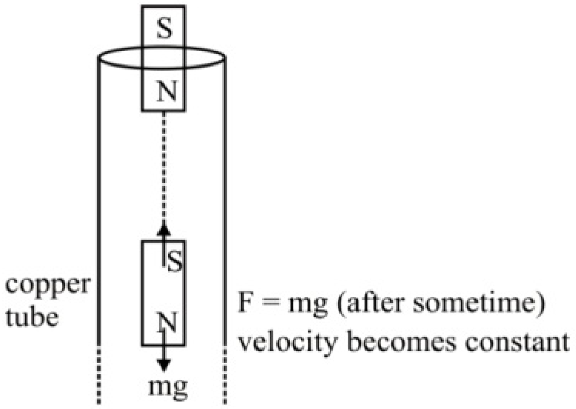
C. Move down with almost constant speed

D. Move down with an acceleration equal to g

Answer: C

Solution:

Solution:
According to lenz's law, the rate of charge of flum produced by bar magnet will be approused by the conducting loops.



Question7

Given below are two statements:
Statement I : For diamagnetic substance, $-1 \leq X < 0$, where X is the magnetic susceptibility.
Statement II : Diamagnetic substances when placed in an external magnetic field, tend to move from stronger to weaker part of the field.
In the light of the above statements, choose the correct answer from the options given below
[10-Apr-2023 shift 2]

Options:

A. Both Statement I and Statement II are false

B. Statement I is incorrect but Statement II is true

C. Both Statement I and Statement II are true

D. Statement I is correct but Statement II is false

Answer: C

Solution:

Solution:
Diamagnetic substances have the property due to which they tends to move away from stronger magnetic field to weaker magnetic field, as their magnetic susceptibility is negative.
Therefore both statements are correct.

Question8

The free space inside a current carrying toroid is filled with a material of susceptibility 2×10^{-2}. The percentage increase in the value of magnetic field inside the toroid will be
[11-Apr-2023 shift 1]

Options:

A. 0.2%

B. 1%

C. 2%

D. 0.1%

Answer: C

Solution:

Solution:
$X = 2 \times 10^{-2}$
$\mu r = 1 + x = 1 + 0.02 = 1.02$
Bo → magnetic field due to magnetic material
B_m→ magnetic field due to magnetic material
$B_m = \mu_r B_0$
$\Delta B = \frac{B_m - B_0}{B_0} \times 100 = \frac{\mu_r B_0 - B_0}{B_0} \times 100$
$\Delta B\% = \frac{(X + 1) - 1}{1} \times 100 = X \times 100$
$\Delta B\% = 2 \times 10^{-2} \times 100 = 2\%$
Ans. Option (3)

Question9

Given below are two statements : one is labelled as Assertion A and the other is labelled as Reason R
Assertion A : A bar magnet dropped through a metallic cylindrical pipe takes more time to come down compared to a non-magnetic bar with same geometry and mass.
Reason R : For the magnetic bar, Eddy currents are produced in the metallic pipe which oppose the motion of the magnetic bar.
In the light of the above statements, choose the correct answer from the options given below
[11-Apr-2023 shift 2]

Options:

A. A is true but R is false

B. Both A and R are true but R is NOT the correct explanation of A

C. A is false but R is true

D. Both A and R are true and R is the correct explanation of A

Answer: D

Solution:

Solution:
Due to Eddy current in the metallic pice which opposes the motion of magnetic bar. So, it takes more time to comes down compared to non-magnetic bar.

Question10

Given below are two statements:
Statements I : The diamagnetic property depends on temperature.
Statements II : The induced magnetic dipole moment in a diamagnetic sample is always opposite to the magnetizing field.
In the light of given statements, choose the correct answer from the options given below.
[12-Apr-2023 shift 1]

Options:

A. Both Statement I and Statement II are true.

B. Both Statement I and Statement II are False.

C. Statement I is correct but Statement II is false.

D. Statement I is incorrect but Statement II is true.

Answer: D

Solution:

Solution:
Diamagnetism do not depends on temperature. So statement-1 is wrong
Statement-1 is given as: Diamagnetic property depends on temperature. Wrong
Statement-2 : in diamagnetic material induced B is apposite to applied magnetic field.

Question11

A compass needle oscillates 20 times per minute at a place where the dip is 30° and 30 times per minute where the dip is 60°. The ratio of total magnetic field due to the earth at two places respectively is $\frac{4}{\sqrt{x}}$. The value of x is
[12-Apr-2023 shift 1]

Answer: 243

Solution:

Period of oscillation $\alpha \frac{1}{\sqrt{B_H}}$

$$T \alpha \frac{1}{\sqrt{B\cos\theta}} \Rightarrow \frac{T_1}{T_2} = \sqrt{\frac{B_2\cos\theta_2}{B_1\cos\theta_1}}$$

$$\Rightarrow \frac{60/20}{60/30} = \sqrt{\frac{B_2}{B_1}\frac{\cos 60^\circ}{\cos 30^\circ}} \Rightarrow \frac{3}{2} = \sqrt{\frac{B_2}{\sqrt{3}B_1}}$$

$$\Rightarrow \frac{9}{4} = \frac{B_2}{\sqrt{3}B_1} \Rightarrow \frac{B_1}{B_2} = \frac{4}{9\sqrt{3}} = \frac{4}{\sqrt{243}}$$

Question12

The soft-iron is a suitable material for making an electromagnet. This is because soft-iron has [24-Jun-2022-Shift-2]

Options:

A. low coercivity and high retentivity.

B. Iow coercivity and low permeability.

C. high permeability and low retentivity.

D. high permeability and high retentivity.

Answer: C

Solution:

Solution:
Electromagnet requires high permeability and Iow retentivity.

Question13

Given below are two statements : Statement I : Susceptibilities of paramagnetic and ferromagnetic substances increase with decrease in temperature. Statement II : Diamagnetism is a result of orbital motions of electrons developing magnetic moments opposite to the applied magnetic field. Choose the correct answer from the options given below : [25-Jun-2022-Shift-2]

Options:

A. Both Statement I and Statement II are true.

B. Both Statement I and Statement II are false.

C. Statement I is true but Statement II is false.

D. Statement I is false but Statement II is true.

Answer: A

Solution:

Statement I is true as susceptibility of ferromagnetic and paramagnetic materials is inversely related to temperature.

Statement II is true as because of orbital motion of electrons the diamagnetic material is able to oppose external magnetic field.

Question14

Given below two statements : One is labelled as Assertion (A) and other is labelled as Reason (R).
Assertion (A) : Non-polar materials do not have any permanent dipole moment.
Reason (R): When a non-polar material is placed in an electric field, the centre of the positive charge distribution of it's individual atom or molecule coincides with the centre of the negative charge distribution.
In the light of above statements, choose the most appropriate answer from the options given below.
[26-Jun-2022-Shift-1]

Options:

A. Both (A) and (R) are correct and (R) is the correct explanation of (A).

B. Both (A) and (R) are correct and (R) is not the correct explanation of (A).

C. (A) is correct but (R) is not correct.

D. (A) is not correct but (R) is correct.

Answer: C

Solution:

Solution:
Non-polar bonds do not have any net dipole moment and are generally formed in compound where there is presence of symmetry.
When non polar material placed in electric field, due to redistribution of charges dipole is formed.
So, (R) is incorrect.

Question15

The susceptibility of a paramagnetic material is 99 . The permeability of the material in Wb/A-m, is :
[Permeability of free space $\mu_0 = 4\pi \times 10^{-7}$ Wb / A − m]
[27-Jun-2022-Shift-1]

Options:

A. $4\pi \times 10^{-7}$

B. $4\pi \times 10^{-4}$

C. $4\pi \times 10^{-5}$

D. $4\pi \times 10^{-6}$

Answer: C

Solution:

$\mu_r = x + 1$
$= 99 + 1 = 100$
$\Rightarrow \mu = \mu_r \mu_0 = 100 \times 4\mu \times 10^{-7}\,\text{Wb / Am}$
$= 4\mu \times 10^{-5}\,\text{Wb / Am}$

Question16

The space inside a straight current carrying solenoid is filled with a magnetic material having magnetic susceptibility equal to 1.2×10^{-5}. What is fractional increase in the magnetic field inside solenoid with respect to air as medium inside the solenoid?
[28-Jun-2022-Shift-2]

Options:

A. 1.2×10^{-5}

B. 1.2×10^{-3}

C. 1.8×10^{-3}

D. 2.4×10^{-5}

Answer: A

Solution:

$\vec{B}' = \mu_0(1 + X)ni$ (in the material)
$\vec{B}' = \mu_0 ni$ (without material)
So fractional increase is
$\frac{B' - B}{B} = X = 1.2 \times 10^{-5}$

Question17

At a certain place the angle of dip is 30° and the horizontal component of earth's magnetic field is 0.5G. The earth's total magnetic field (in G), at that certain place, is :
[29-Jun-2022-Shift-1]

Options:

A. $\frac{1}{\sqrt{3}}$

B. $\frac{1}{2}$

C. $\sqrt{3}$

D. 1

Answer: A

Solution:

Solution:

$B_H = B\cos\theta$

$\therefore B = \frac{B_H}{\cos\theta} = \frac{0.5G}{\cos 30^{\circ}} \Rightarrow \frac{G}{\sqrt{3}}$

Question18

An electron with energy 0.1keV moves at right angle to the earth's magnetic field of $1 \times 10^{-4} Wbm^{-}$
2. The frequency of revolution of the electron will be
(Take mass of electron $= 9.0 \times 10^{-31} kg$)
[25-Jul-2022-Shift-2]

Options:

A. $1.6 \times 10^{5} Hz$

B. $5.6 \times 10^{5} Hz$

C. $2.8 \times 10^{6} Hz$

D. $1.8 \times 10^{6} Hz$

Answer: C

Solution:

$T = \frac{2\pi m}{Bq}$

$\Rightarrow$ Frequency $f = \frac{Bq}{2\pi m}$

$= \frac{10^{-4} \times 1.6 \times 10^{-19}}{2\pi \times 9 \times 10^{-31}}$

$\simeq 2.8 \times 10^{6} Hz$

Question19

In a coil of resistance 8Ω, the magnetic flux due to an external magnetic field varies with time as $\varphi = \frac{2}{3}(9 - t^{2})$. The value of total heat produced in the coil, till the flux becomes zero, will be _________ J .

[26-Jul-2022-Shift-2]

Answer: 2

Solution:

Solution:

$\varphi = \frac{2}{3}(9 - t^2) = 0$

$t = 3\,\text{sec}$

$e = \frac{-d\varphi}{dt} = -\frac{2}{3}(0 - 2t) = \frac{4t}{3}$

Heat produced in $3\,\text{sec} = \int \frac{e^2}{r} dt = \int_0^3 \frac{16t^2}{9 \times 8} dt = 2J$

Question20

A magnet hung at 45° with magnetic meridian makes an angle of 60° with the horizontal. The actual value of the angle of dip is - [27-Jul-2022-Shift-1]

Options:

A. $\tan^{-1}\left(\sqrt{\frac{3}{2}}\right)$

B. $\tan^{-1}(\sqrt{6})$

C. $\tan^{-1}\left(\sqrt{\frac{2}{3}}\right)$

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

Answer: A

Solution:

$\tan\theta' = \frac{\tan\theta}{\cos\alpha}$

$\theta' = 60^\circ$

$\alpha = 45^\circ$

$\sqrt{3} = \frac{\tan\theta}{\frac{1}{\sqrt{2}}}$

$\tan\theta = \sqrt{\frac{3}{2}}$

$\theta = \tan^{-1}\sqrt{\frac{3}{2}}$

Question21

The magnetic field at the center of current carrying circular loop is B_1. The magnetic field at a distance of $\sqrt{3}$ times radius of the given circular loop from the center on its axis is B_2. The value of B_1 / B_2 will be [28-Jul-2022-Shift-2]

Options:

A. 9 : 4

B. 12 : $\sqrt{5}$

C. 8 : 1

D. 5 : $\sqrt{3}$

Answer: C

Solution:

$$B_1 = \frac{\mu_0 i}{2R}$$

$$B_2 = \frac{\mu_0 i R^2}{2(R^2 + x^2)^{\frac{3}{2}}}$$

$$\Rightarrow \frac{B_1}{B_2} = \frac{1}{R^3}(R^2 + x^2)^{\frac{3}{2}}$$

$$= \frac{1}{R^3}(8R^3)$$

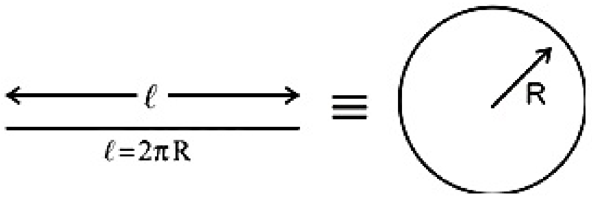
$$= 8$$

Question22

A wire of length 314 cm carrying current of 14A is bent to form a circle. The magnetic moment of the coil is _______ $A - m^2$. [Given .π = 3.14] [29-Jul-2022-Shift-1]

Answer: 11

Solution:



$\frac{314}{100} = 2\pi R \ \ R = 0.5m$

Magnetic Moment = IA

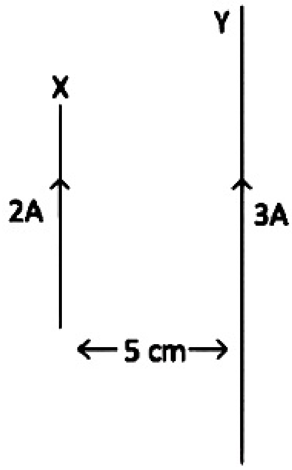
$= 14 \times \pi R^2$

$= 14 \times (3.14) \times \frac{1}{4}$

$= 10.99 \approx 11.00$

Question23

A wire X of length $50\,cm$ carrying a current of $2A$ is placed parallel to a long wire Y of length $5m$. The wire Y carries a current of $3A$. The distance between two wires is $5\,cm$ and currents flow in the same direction. The force acting on the wire Y is



[29-Jul-2022-Shift-2]

Options:

A. 1.2×10^{-5}N directed towards wire X.

B. 1.2×10^{-4}N directed away from wire X.

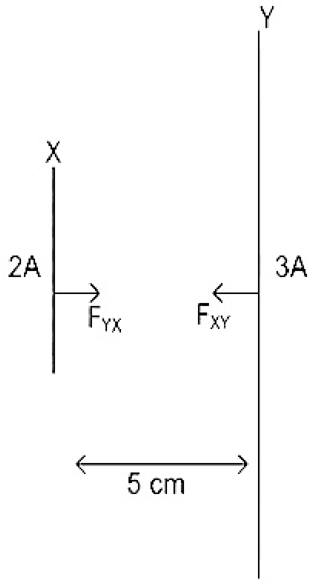
C. 1.2×10^{-4}N directed towards wire X

D. 2.4×10^{-5}N directed towards wire X.

Answer: A

Solution:

Solution:



Length of wire Y is very high compared to length of wire X. So we can assume length of wire Y is infinite compare to wire X.
Magnetic field due to wire y from $5\,cm$ from wire towards wire X is,
$B = \frac{\mu_0 I_1}{2\pi d} = \frac{\mu_0 \times 3}{2\pi \times 0.05}$
And direction of B is outward.
Now force on wire X due to wire Y,
$F_{YX} = I_2 Bl$
$= 2 \times \frac{\mu_0 \times 3}{2\pi \times 0.05} \times 0.5$
$= 1.2 \times 10^{-5} N$
Current flowing in both the wire in same direction so both wire will attract each other with equal force.
$\therefore F_{YX} = F_{XY}$
$\therefore F_{XY} = 1.2 \times 10^{-5} N$, attractive force towards wire X.

Question24

The vertical component of the earth's magnetic field is $6 \times 10^{-5} T$ at any place where the angle of dip is 37°. The earth's resultant magnetic field at that place will be (Given $\tan 37^{\circ} = \frac{3}{4}$)
[29-Jul-2022-Shift-2]

Options:

A. $8 \times 10^{-5} T$

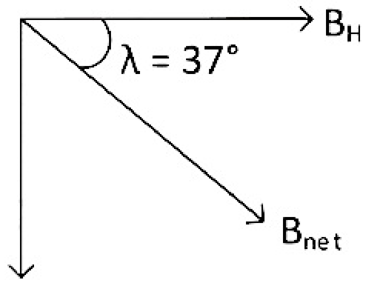
B. $6 \times 10^{-5} T$

C. $5 \times 10^{-4} T$

D. $1 \times 10^{-4} T$

Answer: D

Solution:



$\therefore \sin 37^\circ = \frac{B_v}{B_{net}}$

$\Rightarrow B_v = B_{net} \sin 37^\circ$

$\Rightarrow B_{net} = \frac{B_v}{\sin 37^\circ}$

$= \frac{6 \times 10^{-5}}{\frac{3}{5}}$

$= 10 \times 10^{-5} T$

$= 1 \times 10^{-4} T$

Question25

In a ferromagnetic material, below the Curie temperature, a domain is defined as
[25 Feb 2021 Shift 2]

Options:

A. a macroscopic region with zero magnetisation

B. a macroscopic region with saturation magnetisation

C. a macroscopic region with randomly oriented magnetic dipoles

D. a macroscopic region with consecutive magnetic dipoles oriented in opposite direction

Answer: B

Solution:

Solution:
Since, in ferromagnetic material, with increase in temperature susceptibility decreases,
∴ Ferromagnetic material below Curie temperature will show saturation magnetisation.
Hence, option (b) is the correct i.e. domain is defined as a macroscopic region with saturation magnetisation.

Question26

Which of the following statements are correct?
A. Electric monopoles do not exist, whereas magnetic monopoles exist.
B. Magnetic field lines due to a solenoid at its ends and outside cannot be completely straight and confined.
C. Magnetic field lines are completely confined within a toroid.
D. Magnetic field lines inside a bar magnet are not parallel.
E. $\chi = -1$ is the condition for a perfect diamagnetic material, where χ is

its magnetic susceptibility.
Choose the correct answer from the options given below.
[18 Mar 2021 Shift 2]

Options:

A. C and E

B. B and D

C. A and B

D. B and C

Answer: A

Solution:

Solution:
Statement (A) Magnetic monopoles do not exist, they always exist in pairs as South and North poles but electric monopoles exist. So, statement A is incorrect.
Statement (B) In solenoid have a both ends, so magnetic field lines cannot be confined. Inside the solenoids, the magnetic field lines are parallel to the length of the conductor. So, statement B is incorrect.
Statement (C) In toroid has no ends. It is closed loop conductor, so the magnetic field lines are completely confined. So, the statement C is correct.
Statement (D) Inside the bar magnet, the magnetic field lines are parallel. So, the statement D is incorrect.
Statement (E) Magnetic susceptibility of the diamagnetic material is -1. So, the statement E is correct.
Hence, the correct statements are C and E .

Question27

A bar magnet of length 14cm is placed in the magnetic meridian with its North pole pointing towards the geographic North pole A neutral point is obtained at a distance of 18cm from the centre of the magnet. If $B_H = 0.4G$, then the magnetic moment of the magnet is ($1G = 10^{-4}T$)
[16 Mar 2021 Shift 1]

Options:

A. $2.88 \times 10^3 J\,T^{-1}$

B. $2.88 \times 10^2 J\,T^{-1}$

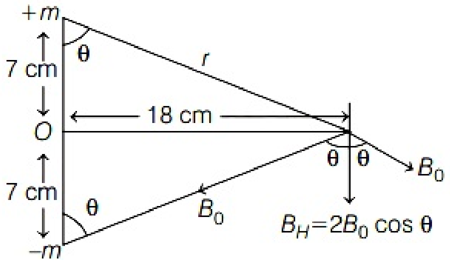
C. $2.88 J\,T^{-1}$

D. $28.8 J\,T^{-1}$

Answer: C

Solution:

Solution:
The given situation can be shown as below



From the above figure, it is clear that the neutral point will lie on equatorial plane.

$B_0 = \frac{\mu_0 m}{4\pi} \frac{1}{r^2}$

$B_H = 2B_0 \cos\theta$

$\Rightarrow 0.4 \times 10^{-4} = \frac{2\mu_0 m}{4\pi r^2} \cdot \frac{7 \times 10^{-2}}{r}$ $(\because B_H = 0.4G = 0.4 \times 10^{-4} T)$

$\left[\because \cos\theta = \frac{7}{r} \text{ and } r = (7^2 + 18^2)^{1/2}\right]$

$\Rightarrow 0.4 \times 10^{-4} = 2 \times 10^{-7} \times \frac{m \times 7}{(7^2 + 18^2)^{3/2}} \times 10^4$

$\Rightarrow m = \frac{4 \times 10^{-2} \times (373)^{3/2}}{14}$ ...(i)

$\because$ Magnetic moment, $M = m \times 2l = m \times \frac{14}{100}$ ...(ii)

From Eqs. (i) & (ii), we get

$M = \frac{4 \times 10^{-2} \times (373)^{3/2}}{14} \times \frac{14}{100}$

$= 4 \times 10^{-4} \times 7203.82 = 2.88 J/T$

Question28

A solenoid of 1000 turns per metre has a core with relative permeability 500 . Insulated windings of the solenoid carry an electric current of 5A. The magnetic flux density produced by the solenoid is (Permeability of free space $= 4\pi \times 10^{-7} H/m$) [17 Mar 2021 Shift 1]

Options:

A. πT

B. $2 \times 10^{-3} \pi T$

C. $\frac{\pi}{5} T$

D. $10^{-4} \pi T$

Answer: A

Solution:

Solution:

Given, number of turns per unit length, $n = 1000$

Relative magnetic permeability, $\mu_t = 500$

Current flowing through solenoid, $I = 5A$

Magnetic permeability of free space,

$\mu_0 = 4\pi \times 10^{-7} H/m$

We know that, magnetic field inside the solenoid can be given as

$B = \mu n I$ ....(i)

where, $\mu =$ permeability of medium.

As $\mu = \mu_r \mu_0$...(ii)

From Eqs. (i) and (ii), we get

$\therefore\ B = \mu_r \mu_0 n I$

$= 500 \times 4\pi \times 10^{-7} \times 1000 \times 5$

$= 100\pi \times 10^{-7} \times 10^{5}$

$= \pi T$

Question29

In a uniform magnetic field, the magnetic needle has a magnetic moment $9.85 \times 10^{-2} A / m^2$ and moment of inertia $5 \times 10^{-6} kgm^2$. If it performs 10 complete oscillations in 5 seconds then themagnitude of the magnetic field is _______ mT [Take π^2 as 9.85] [27 Jul 2021 Shift 1]

Answer: 8

Solution:

Solution:

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

$B = 80 \times 10^{-4} = 8mT$

Question30

Choose the correct option : [22 Jul 2021 Shift 2]

Options:

A. True dip is not mathematically related to apparent dip.

B. True dip is less than apparent dip.

C. True dip is always greater than the apparent dip.

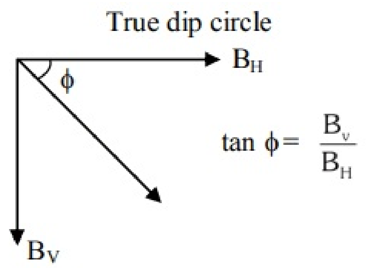
D. True dip is always equal to apparent dip.

Answer: B

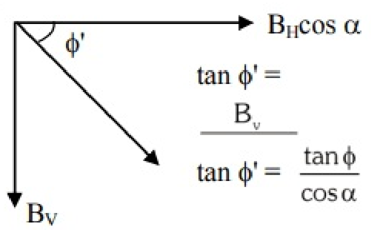
Solution:

Solution:

If apparent dip circle is at an angle α with true dip circle then



Apparent dip circle



As $\cos\alpha < 1$
Hence true dip (ϕ) is less than apparent dip(ϕ')

Question31

At an angle of 30° to the magnetic meridian, the apparent dip is 45°. Find the true dip:
[20 Jul 2021 Shift 2]

Options:

A. $\tan^{-1}\sqrt{3}$

B. $\tan^{-1}\frac{1}{\sqrt{3}}$

C. $\tan^{-1}\frac{2}{\sqrt{3}}$

D. $\tan^{-1}\frac{\sqrt{3}}{2}$

Answer: D

Solution:

Solution:
A $\tan\delta = \tan\delta'\cos\theta$
$= \tan 45^\circ \cos 30^\circ$
$\tan\delta = 1 \times \frac{\sqrt{3}}{2}$
$\delta = \tan^{-1}\left(\frac{\sqrt{3}}{2}\right)$

Question32

Statement I : The ferromagnetic property depends on temperature. At high temperature, ferromagnet becomes paramagnet.
Statement II : At high temperature, the domain wall area of a

ferromagnetic substance increases.
In the light of the above statements, choose the most appropriate answer from the options given below :
[22 Jul 2021 Shift 2]

Options:

A. Statement I is true but Statement II is false

B. Both Statement I and Statement II are true

C. Both Statement I and Statement II are false

D. Statement I is false but Statement II is true

Answer: A

Solution:

Solution:
As temperature increases, domains disintegrate so ferromagnetism decreases and above curie temperature it become paramagnet.

Question33

The magnetic susceptibility of a material of a rod is 499. Permeability in vacuum is $4\pi \times 10^{-7} H / m$. Absolute permeability of the material of the rod is :
[20 Jul 2021 Shift 2]

Options:

A. $4\pi \times 10^{-4} H / m$

B. $2\pi \times 10^{-4} H / m$

C. $3\pi \times 10^{-4} H / m$

D. $\pi \times 10^{-4} H / m$

Answer: B

Solution:

Solution:
$\mu = \mu_0(1 + x_m)$
$= 4\pi \times 10^{-7} \times 500$
$= 2\pi \times 10^{-4} H / m$

Question34

A long solenoid with 1000 turns/m has a core material with relative

permeability 500 and volume $10^3 cm^3$. If the core material is replaced by another material having relative permeability of 750 with same volume maintaining same current of 0.75A in the solenoid, the fractional change in the magnetic moment of the core would be approximately $\left(\frac{\chi}{499}\right)$. Find the value of χ.

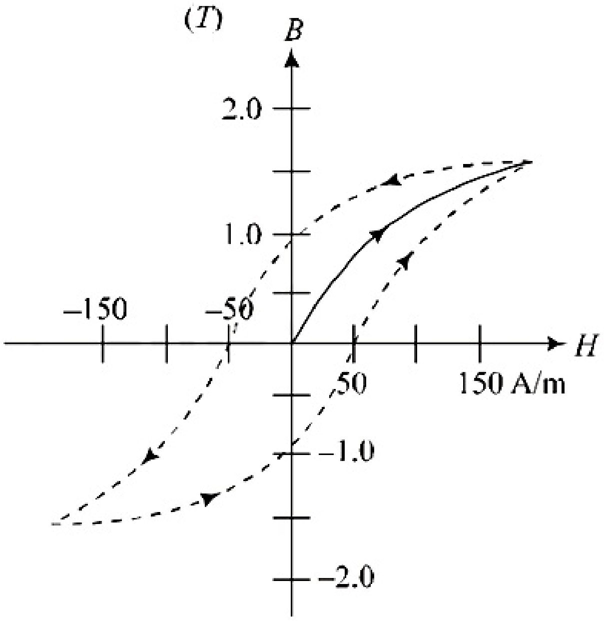
[31 Aug 2021 Shift 2]

Answer: 250

Solution:

Given, number of turns, $n = 1000 m^{-1}$
Electric current, i = 0.75 A
Relative permeability of 1st material
$\mu_1 = 500$
Relative permeability of 2nd material
$\mu_2 = 750$
we know that $\mu_r = 1 + \chi \Rightarrow \chi$
$= \mu_r - 1$
For 1st and 2nd material,
$\chi_1 = \chi_1 - 1 = 500 - 1 = 499$
and $\chi_2 = \mu_2 - 1 = 750 - 1 = 749$
Now, magnetic intensity, M = ni
Let M_1 and M_2 be the magnetisation and m_1 and m_2 be the magnetic moments of material 1st and 2nd.
Using, $\frac{I_1}{M} = \chi_1$ ...(i)
and $\frac{I_2}{M} = \chi_2$ ...(ii)
Dividing Eqs. (i) and (ii),
$\frac{I_1}{I_2} = \frac{\chi_1}{\chi_2}$ ...(iii)
We also know that,
$\text{Magnetisation} = \frac{\text{Dipole moment in core material}}{\text{Volume}}$
i.e $I = \frac{m}{V}$
$\frac{I_1}{I_2} = \frac{m_1}{m_2}$ ...(iv)
From Eqs. (iii) and (iv), we get
$\frac{m_1}{m_2} = \frac{\chi_1}{\chi_2} = \frac{499}{749}$
Hence, fraction change in magnetic moment,
$\frac{\Delta m}{m_1} = \frac{m_2 - m_1}{m_1} = \left(\frac{m_2}{m_1} - 1\right)$
$= \left(\frac{749}{499} - 1\right) = \frac{250}{499}$
Thus, value of χ is 250.

Question35



The figure gives experimentally measured B vs. H variation in a ferromagnetic material. The retentivity, co- ercivity and saturation, respectively, of the material are:
[7 Jan. 2020 II]

Options:

A. 1.5 T, 50 A/m and 1.0 T

B. 1.5 T, 50 A/m and 1.0 T

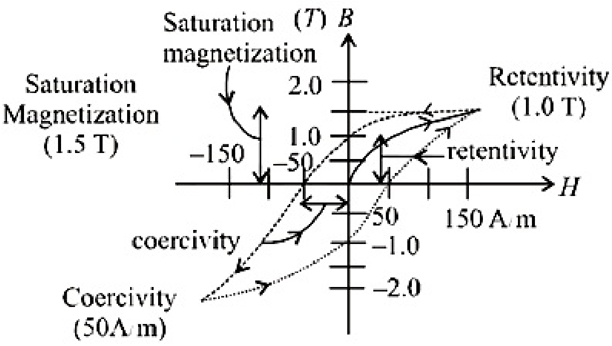
C. 150 A/m, 1.0 T and 1.5 T

D. 1.0 T, 50 A/m and 1.5 T

Answer: D

Solution:

Solution:



Question36

A small bar magnet placed with its axis at 30° with an external field of 0.06T experiences a torque of 0.018N m. The minimum work required to rotate it from its stable to unstable equilibrium position is:
[Sep. 04, 2020 (I)]

Options:

A. $6.4 \times 10^{-2} J$

B. $9.2 \times 10^{-3} J$

C. $7.2 \times 10^{-2} J$

D. $11.7 \times 10^{-3} J$

Answer: C

Solution:

Solution:
Here, $\theta = 30°$, $\tau = 0.018 N - m$, $B = 0.06 T$
Torque on a bar magnet :
$\tau = M B \sin\theta$
$0.018 = M \times 0.06 \times \sin 30°$
$\Rightarrow 0.018 = M \times 0.06 \times \frac{1}{2} \Rightarrow M = 0.6 A - m^2$
Position of stable equilibrium ($\theta = 0°$)
Position of unstable equilibrium ($\theta = 180°$)
Minimum work required to rotate bar magnet from stable to unstable equilibrium
$\Delta U = U_f - U_i = -M B \cos 180° - (-M B \cos 0°)$
$W = 2 M B = 2 \times 0.6 \times 0.06$
$\therefore W = 7.2 \times 10^{-2} J$

Question37

A circular coil has moment of inertia $0.8 kgm^2$ around any diameter and is carrying current to produce a magnetic moment of $20 Am^2$. The coil is kept initially in a vertical position and it can rotate freely around a horizontal diameter. When a uniform magnetic field of $4T$ is applied along the vertical, it starts rotating around its horizontal diameter. The angular speed the coil acquires after rotating by 60° will be: [Sep. 04, 2020 (II)]

Options:

A. $10 rad\ s^{-1}$

B. $10\pi rad\ s^{-1}$

C. $20\pi rad\ s^{-1}$

D. $20 rad\ s^{-1}$

Answer: A

Solution:

Solution:
Given,
Moment of inertia of circular coil, $I = 0.8 kgm^2$
Magnetic moment of circular coil, $M = 20 Am^2$
Rotational kinetic energy of circular coil,

$KE = \frac{1}{2} I \omega^2$

Here, $\omega =$ angular speed of coil

Potential energy of bar magnet $= -MB\cos\phi$

From energy conservation

$\frac{1}{2} I \omega^2 = U_{in} - U_f = -MB\cos 60° - (-MB)$

$\Rightarrow \frac{MB}{2} = \frac{1}{2} I \omega^2$

$\Rightarrow \frac{20 \times 4}{2} = \frac{1}{2}(0.8)\omega^2$

$\Rightarrow 100 = \omega^2 \Rightarrow \omega = 10 \text{rad}$

Question38

An iron rod of volume $10^{-3} m^3$ and relative permeability 1000 is placed as core in a solenoid with 10 turns/cm. If a current of 0.5A is passed through the solenoid, then the magnetic moment of the rod will be : [Sep. 05, 2020 (II)]

Options:

A. $50 \times 10^2 Am^2$

B. $5 \times 10^2 Am^2$

C. $500 \times 10^2 Am^2$

D. $0.5 \times 10^2 Am^2$

Answer: B

Solution:

Solution:

Given,

Volume of iron rod, $V = 10^{-3} m^3$

Relative permeability, $\mu_r = 1000$

Number of turns per unit length, $n = 10$

Magnetic moment of an iron core solenoid,

$M = (\mu_r - 1) \times N iA$

$\Rightarrow M = (\mu_r - 1) \times N i \frac{V}{l} \Rightarrow M = (\mu_r - 1) \times \frac{N}{l} iV$

$\Rightarrow M = 999 \times \frac{10}{10^{-2}} \times 0.5 \times 10^{-3} = 499.5 \approx 500$

Question39

A paramagnetic sample shows a net magnetisation of 6 A/m when it is placed in an external magnetic field of 0.4 T at a temperature of 4 K. When the sample is placed in an external magnetic field of 0.3 T at a temperature of 24 K, then the magnetisation will be : [Sep. 04, 2020 (II)]

Options:

A. 1 A/m

B. 4 A/m

C. 2.25 A/m

D. 0.75 A/m

Answer: D

Solution:

Solution:
For paramagnetic material. According to curies law

$\chi \propto \frac{1}{T}$

For two temperatures T_1 and T_2

$\chi_1 T_1 = \chi_2 T_2$

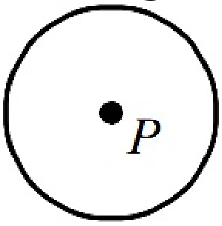
But $\chi = \frac{I}{B}$

$\therefore \frac{I_1}{B_1} T_1 = \frac{I_2}{B_2} T_2$

$\Rightarrow \frac{6}{0.4} \times 4 = \frac{I_2}{0.3} \times 24 \Rightarrow I_2 = \frac{0.3}{0.4} = 0.75 A/m$

Question40

A perfectly diamagnetic sphere has a small spherical cavity at its centre, which is filled with a paramagnetic substance. The whole system is placed in a uniform magnetic field $\vec{B}$. Then the field inside the paramagnetic substance is :



[Sep. 03, 2020 (II)]

Options:

A. $\vec{B}$

B. zero

C. much large than $|\vec{B}|$ and parallel to $\vec{B}$

D. much large than $|\vec{B}|$ but opposite to $\vec{B}$

Answer: B

Solution:

Solution:
When magnetic field is applied to a diamagnetic substance, it produces magnetic field in opposite direction so net

magnetic field inside the cavity of sphere will be zero. So, field inside the paramagnetic substance kept inside the cavity is zero.

Question41

Magnetic materials used for making permanent magnets (P) and magnets in a transformer (T) have different properties of the following, which property best matches for the type of magnet required?
[Sep. 02, 2020 (I)]

Options:

A. T : Large retentivity, small coercivity

B. P : Small retentivity, large coercivity

C. T : Large retentivity, large coercivity

D. P : Large retentivity, large coercivity

Answer: D

Solution:

Solution:
Permanent magnets (P) are made of materials with large retentivity and large coercivity. Transformer cores (T) are made of materials with low retentivity and low coercivity.

Question42

A ring is hung on a nail. It can oscillate, without slipping or sliding (i) in its plane with a time period T_1 and, (ii) back and forth in a direction perpendicular to its plane, with a period T_2 . The ratio $\frac{T_1}{T_2}$ will be :
[Sep. 05, 2020 (II)]

Options:

A. $\frac{2}{\sqrt{3}}$

B. $\frac{2}{3}$

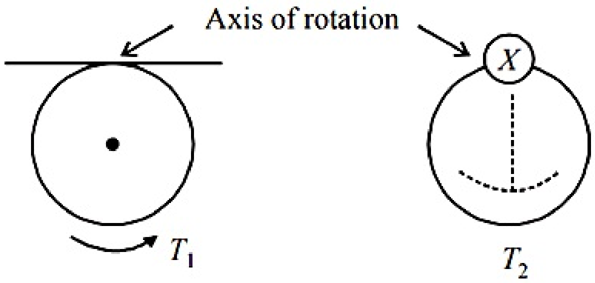
C. $\frac{3}{\sqrt{2}}$

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

Answer: A

Solution:

Let I_1 and I_2 be the moment of inertia in first and second case respectively.
$I_1 = 2MR^2$
$I_2 = MR^2 + \frac{MR^2}{2} = \frac{3}{2}MR^2$



Time period, $T = 2\pi\sqrt{\frac{I}{mgd}}$
$T \propto I$
$\therefore \frac{T_1}{T_2} = \sqrt{\frac{I_1}{I_2}} = \sqrt{\frac{2MR^2}{\frac{3}{2}MR^2}} = \frac{2}{\sqrt{3}}$

Question43

A magnet of total magnetic moment $10^{-2}\hat{i}$ A − m^2 is placed in a time varying magnetic field,$B\hat{i}(\cos\omega t)$ where B = 1 Tesla and $\omega = 0.125$rad / s. The work done for reversing the direction of the magnetic moment at t = 1 second, is: [10 Jan. 2019 I]

Options:

A. 0.01 J

B. 0.007 J

C. 0.028 J

D. 0.014 J

Answer: C

Solution:

Solution:
Work done, $W = 2m \cdot B$
$= 2 \times 10^{-2} \times 1\cos(0.125)$
$= 0.02J$

Question44

A paramagnetic material has 10^{28} atoms /m^3. Its magnetic susceptibility at temperature 350K is 2.8×10^{-4}. Its susceptibility at 300K is: [12 Jan. 2019 II]

Options:

A. 3.267×10^{-4}

B. 3.672×10^{-4}

C. 3.726×10^{-4}

D. 2.672×10^{-4}

Answer: A

Solution:

Solution:
According to Curie law for paramagnetic substance,

$$\chi \propto \frac{1}{T_C} \Rightarrow \frac{\chi_1}{\chi_2} = \frac{T_{C_2}}{T_{C_1}}$$

$$\frac{2.8 \times 10^{-4}}{\chi_2} = \frac{300}{350}$$

$$\chi_2 = \frac{2.8 \times 350 \times 10^{-4}}{300} = 3.266 \times 10^{-4}$$

Question45

A paramagnetic substance in the form of a cube with sides 1cm has a magnetic dipole moment of 20×10^{-6}J / T when a magnetic intensity of 60×10^{3}A / m is applied. Its magnetic susceptibility is: [11 Jan. 2019 II]

Options:

A. 3.3×10^{-2}

B. 4.3×10^{-2}

C. 2.3×10^{-2}

D. 3.3×10^{-4}

Answer: D

Solution:

Solution:
Magnetic susceptibility,

$$\chi = \frac{I}{H}$$

where, $I = \frac{\text{Magnetic moment}}{\text{Volume}} = \frac{20 \times 10^{-6}}{10^{-6}} = 20\text{N} / \text{m}^2$

Now, $\chi = \frac{20}{60 \times 10^3} = \frac{1}{3} \times 10^{-3} = 3.3 \times 10^{-4}$

Question46

At some location on earth the horizontal component of earth's magnetic field is 18×10^{-6}T . At this location, magnetic needle of length 0.12m and pole strength 1.8 Am is suspended from its mid-point using a thread, it makes 45° angle with horizontal in equilibrium. To keep this needle horizontal, the vertical force that should be applied at one of its ends is:
[10 Jan. 2019 II]

Options:

A. 3.6×10^{-5}N

B. 1.8×10^{-5}N

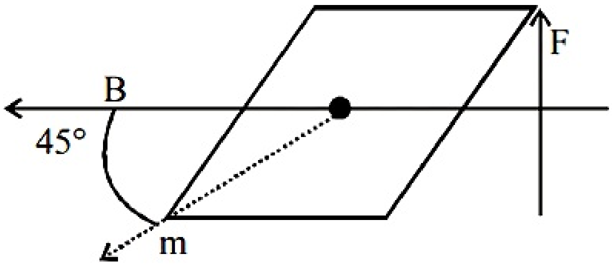
C. 1.3×10^{-5}N

D. 6.5×10^{-5}N

Answer: D

Solution:

Solution:
using, $M B \sin\theta = F l \ \text{Sin}\,\theta(\tau)$



$M B \sin 45° = F \frac{l}{2} \sin 45°$
$F = 2M B = 2 \times 1.8 \times 18 \times 10^{-6} = 6.5 \times 10^{-5}$N

Question47

A bar magnet is demagnetized by inserthing it inside a solenoid of length 0.2 m, 100 turns, and carrying a current of 5.2 A. The coercivity of the bar magnet is:
[9 Jan. 2019 I]

Options:

A. 285 A/m

B. 2600 A/m

C. 520 A/m

D. 1200 A/m

Answer: B

Solution:

Solution:

Corecivity, $H = \frac{B}{\mu_0}$ and $B = \mu_0 ni \left(n = \frac{N}{l} \right)$

or, $H = \frac{N}{l} i = \frac{100}{0.2} \times 5.2 = 2600 A / m$

Question48

A hoop and a solid cylinder of same mass and radius are made of a permanent magnetic material with their magnetic moment parallel to their respective axes. But the magnetic moment of hoop is twice of solid cylinder. They are placed in a uniform magnetic field in such a manner that their magnetic moments make a small angle with the field. If the oscillation periods of hoop and cylinder are T_h and T_c respectively, then:
[10 Jan. 2019 II]

Options:

A. $T_h = T_c$

B. $T_h = 2T_c$

C. $T_h = 1.5T$

D. $T_h = 0.5T_c$

Answer: A

Solution:

Solution:
Using, time /oscillation period,

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

Where, M = magnetic moment, I moment of inertia and B = magnetic field

$T_h = 2\pi \sqrt{\frac{mR^2}{(2MB)}}$

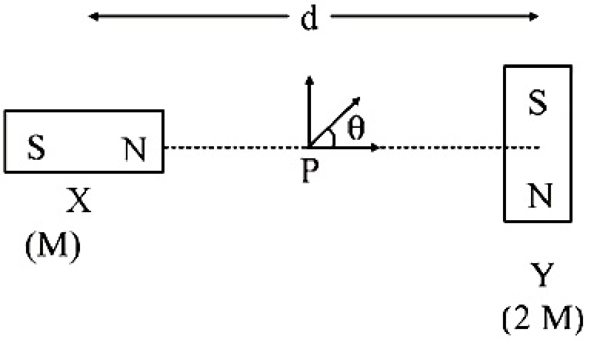
$T_c = 2\pi \sqrt{\frac{1/2 mR^2}{MB}}$

Clearly, $T_h = T_c$

Question49

Two magnetic dipoles X and Y are placed at a separation d, with their axes perpendicular to each other. The dipole moment of Y is twice that

of X . A particle of charge q is passing through their midpoint P, at angle θ = 45° with the horizontal line, as shown in figure. What would be the magnitude of force on the particle at that instant? (d is much larger than the dimensions of the dipole)



[8 April 2019 II]

Options:

A. $\left(\frac{\mu_0}{4\pi}\right)\frac{M}{(d\ /\ 2)^3} \times qv$

B. 0

C. $\sqrt{2}\left(\frac{\mu_0}{4\pi}\right)\frac{M}{(d\ /\ 2)^3} \times qv$

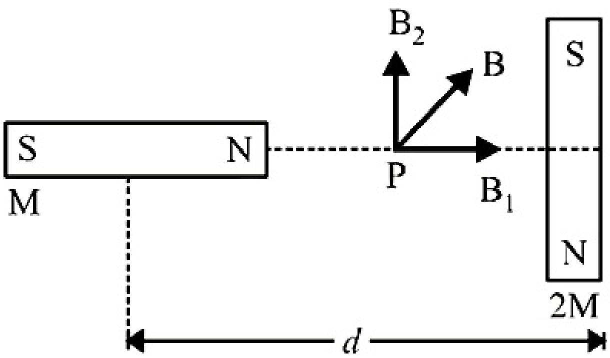
D. $\left(\frac{\mu_0}{4\pi}\right)\frac{2M}{(d\ /\ 2)^3} \times qv$

Answer: B

Solution:

Solution:

$B_1 = \frac{\mu_0}{4\pi}\frac{2K}{(d\ /\ 2)^3}$



and $B_2 = \frac{\mu_0}{4\pi}\frac{2M}{(d\ /\ 2)^3}$

$\therefore \tan\theta = \frac{B_2}{B_1} = \frac{\frac{\mu_0}{4\pi}\frac{2M}{(d\ /\ 2)^3}}{\frac{\mu_0}{4\pi}\frac{2M}{(d\ /\ 2)^3}} = 1$

or $\theta = 45°$

The resultant field is 45° from B_1. The angle between $\vec{B}$ and $\vec{v}$ zero, so force on the particle is zero.

Question50

A magnetic compass needle oscillates 30 times per minute at a place where the dip is 45° , and 40 times per minute where the dip is 30° . If B_1 and B_2 are respectively the total magnetic field due to the earth and the two places, then the ratio B_1 / B_2 is best given by :
[12 April 2019 I]

Options:

A. 1.8

B. 0.46

C. 3.6

D. 2.2

Answer: B

Solution:

Solution:

We have, $T = 2\pi\sqrt{\frac{I}{M B_x}}$

$\therefore \frac{T_1^2}{T_2^2} = \frac{Bx_2}{Bx_1}$

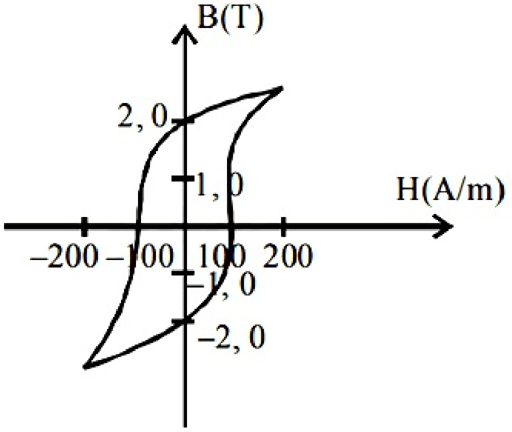
or $\left(\frac{2}{1.5}\right)^2 = \frac{B_2 \cos 45°}{B_1 \cos 30°} = \frac{B_2 \times 2}{\sqrt{2} \times B_1 \times \sqrt{3}}$

$\left(\frac{4}{3}\right)^2 = \frac{B_2}{B_1} \times \frac{2}{\sqrt{6}}$

$\therefore \frac{B_1}{B_2} = \frac{9}{8\sqrt{6}} = 0.46$

Question51

The B-H curve for a ferromagnet is shown in the figure. The ferromagnet is placed inside a long solenoid with 1000 turns/cm.. The current that should be passed in the solenoid to demagnetise the ferromagnet completely is:



[Online April 15, 2018]

Options:

A. 2 mA

B. 1 mA

C. 40 μA

D. 20 μA

Answer: B

Solution:

Solution:
Given Number of turns,
$n = 1000 \text{ turns / cm} = 1000 \times 100 \text{ turns / m}$
Coercivity of ferromagnet, $H = 100 A / m$
Current to demagnetise the ferromagnet, $I = ?$
Using, $H = nI$
or, $100 = 10^5 \times I$
$\therefore I = \frac{100}{10^5} = 1mA$

Question52

A magnetic dipole in a constant magnetic field has :
[Online April 8, 2017]

Options:

A. maximum potential energy when the torque is maximum

B. zero potential energy when the torque is minimum.

C. zero potential energy when the torque is maximum.

D. minimum potential energy when the torque is maximum.

Answer: C

Solution:

Solution:
Potential energy of dipole,
$U = -pE \cos\theta$
Torque experienced by dipole
$\tau = pE \sin\theta$
Torque will be maximum (τ_{max}) when $\theta = 90°$ then potential energy $U = 0$

Question53

A magnetic needle of magnetic moment $6.7 \times 10^{-2} Am^2$ and moment of inertia $7.5 \times 10^{-6} kgm^2$ is performing simple harmonic oscillations in a magnetic field of 0.01 T. Time taken for 10 complete oscillations is :

[2017]

Options:

A. 6.98 s

B. 8.76 s

C. 6.65 s

D. 8. 89 s

Answer: C

Solution:

Solution:
Given : Magnetic moment, $M = 6.7 \times 10^{-2} Am^2$
Magnetic field, $B = 0.01T$
Moment of inertia, $I = 7.5 \times 10^{-6} K\,gm^2$
Using, $T = 2\pi\sqrt{\frac{I}{M\,B}}$
$= 2\pi\sqrt{\frac{7.5 \times 10^{-6}}{6.7 \times 10^{-2} \times 0.01}} = \frac{2\pi}{10} \times 1.06s$
Time taken for 10 complete oscillations
$t = 10T = 2\pi \times 1.06$
$= 6.6568 \approx 6.65s$

Question54

A magnetic dipole is acted upon by two magnetic fields which are inclined to each other at an angle of 75°. One of the fields has a magnitude of 15 mT. The dipole attains stable equilibrium at an angle of 30° with this field. The magntidue of the other field (in mT) is close to :
[Online April 9, 2016]

Options:

A. 1

B. 11

C. 36

D. 1060

Answer: B

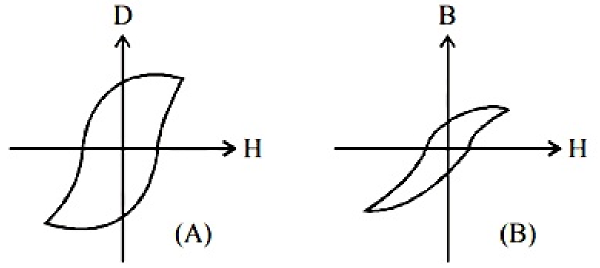
Solution:

Solution:
We know that, magnetic dipole moment
$M = N\,iA\cos\theta$ i.e., $M \propto \cos\theta$
When two magnetic fields are inclined at an angle of 75° the equilibrium will be at 30°, so
$\cos\theta = \cos(75° - 30°) = \cos 45° = \frac{1}{\sqrt{2}}$

$\frac{x}{\sqrt{2}} = \frac{15}{2} \therefore x \approx 11$

Question55

Hysteresis loops for two magnetic materials A and B are given below :



These materials are used to make magnets for electric generators, transformer core and electromagnet core. Then it is proper to use : [2016]

Options:

A. A for transformers and B for electric generators.

B. B for electromagnets and transformers.

C. A for electric generators and trasformers.

D. A for electromagnets and B for electric generators.

Answer: B

Solution:

Solution:
Graph [A] is for material used for making permanent magnets (high coercivity) Graph [B] is for making electromagnets and transformers.

Question56

A fighter plane of length 20m, wing span (distance from tip of one wing to the tip of the other wing) of 15m and height 5m is lying towards east over Delhi. Its speed is $240ms^{-1}$. The earth's magnetic field over Delhi is $5\times 10^{-5}T$ with the declination angle ~0° and dip of θ such that $\sin\theta = \frac{2}{3}$. If the voltage developed is V_B between the lower and upper side of the plane and V_W between the tips of the wings then V_B and V_W are close to : [Online April 10, 2016]

Options:

A. V_B = 40mV ; V_W = 135 mV with left side of pilot at higher voltage

B. V_B = 45mV ; V_W = 120 mV with right side of pilot at higher voltage

C. $V_B = 40mV$; $V_W = 135$ mV with right side of pilot at higher voltage

D. $V_B = 45mV$; $V_W = 120$ mV with left side of pilot at higher voltage

Answer: D

Solution:

Solution:
$V_B = V B_H l = 240 \times 5 \times 10^{-5} \cos(\theta) \times 5 = 44.7mv$
By right hand rule, the charge moves to the left of pilot.

Question57

A 25cm long solenoid has radius 2cm and 500 total number of turns. It carries a current of 15A. If it is equivalent to a magnet of the same size and magnetization $\vec{M}$ (magnetic moment/volume), then $|\vec{M}|$ is :
[Online April 10, 2015]

Options:

A. $30000\pi Am^{-1}$

B. $3\pi Am^{-1}$

C. $30000Am^{-1}$

D. $300Am^{-1}$

Answer: C

Solution:

Solution:
$\vec{M}$ (mag. moment / volume) $= \frac{N iA}{Al}$
$= \frac{N i}{l} = \frac{(500)15}{25 \times 10^{-2}} = 30000Am^{-1}$

Question58

A short bar magnet is placed in the magnetic meridian of the earth with north pole pointing north. Neutral points are found at a distance of 30 cm from the magnet on the East – West line, drawn through the middle point of the magnet. The magnetic moment of the magnet in Am^2 is close to: (Given $\frac{\mu_0}{4\pi} = 10^{-7}$ in SI units and B_H = Horizontal component of earth's magnetic field $= 3.6 \times 10^{-5}$ tesla)
[Online April 11, 2015]

Options:

A. 14.6

B. 19.4

C. 9.7

D. 4.9

Answer: C

Solution:

Solution:
Here, $r = 30cm = 0.3cm$
we know $\frac{\mu_0 M}{4\pi r^3} = B_H = 3.6 \times 10^{-5}$
$\Rightarrow M = \frac{3.6 \times 10^{-5}}{10^{-7}}(0.3)^3$
Hence, $M = 9.7Am^2$

Question59

The coercivity of a small magnet where the ferromagnet gets demagnetized is $3 \times 10^3 Am^{-1}$. ´ The current required to be passed in a solenoid of length 10 cm and number of turns 100, so that the magnet gets demagnetized when inside the solenoid, is: [2014]

Options:

A. 30 mA

B. 60 mA

C. 3 A

D. 6 A

Answer: C

Solution:

Solution:
Magnetic field in solenoid $B = \mu_0 ni$
$\Rightarrow \frac{B}{\mu_0} = ni$ (Where $n =$ number of turns per unit length)
$\Rightarrow \frac{B}{\mu_0} = \frac{N i}{L} \Rightarrow 3 \times 10^3 = \frac{100i}{10 \times 10^{-2}}$
$\Rightarrow i = 3A$

Question60

An example of a perfect diamagnet is a superconductor. This implies that when a superconductor is put in a magnetic field of intensity B, the magnetic field B_s inside the superconductor will be such that:
[Online April 19, 2014]

Options:

A. $B_s = -B$

B. $B_s = 0$

C. $B_s = B$

D. $B_S < B$ but $Bs \neq 0$

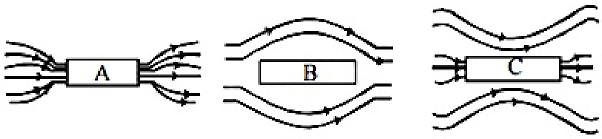
Answer: B

Solution:

Solution:
Magnetic field inside the superconductor is zero.
Diamagnetic substances are repelled in external magnetic field.

Question61

Three identical bars A, B and C are made of different magnetic materials. When kept in a uniform magnetic field, the field lines around them look as follows:



Make the correspondence of these bars with their material being diamagnetic (D), ferromagnetic (F) and paramagnetic (P):
[Online April 11, 2014]

Options:

A. A ↔ D, B ↔ P,C ↔ F

B. A ↔ F, B ↔ D,C ↔ P

C. A ↔ P, B ↔ F,C ↔ D

D. A ↔ F, B ↔ P,C ↔ D

Answer: B

Solution:

Diamagnetic materials are repelled in an external magnetic field.
$\vec{B}$ represents diamagnetic materials.

Question62

The magnetic field of earth at the equator is approximately 4×10^{-5}T . The radius of earth is 6.4 times 10^6 m. Then the dipole moment of the earth will be nearly of the order of:
[Online April 9, 2014]

Options:

A. 10^{23}Am^2

B. 10^{20}Am^2

C. 10^{16}Am^2

D. 10^{10}Am^2

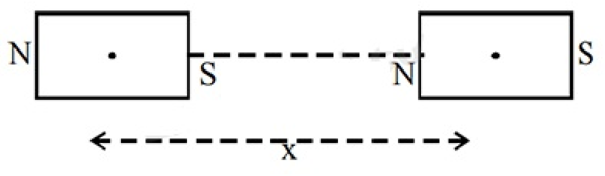
Answer: A

Solution:

Solution:
Given, $B = 4 \times 10^{-5}\text{T}$
$R_E = 6.4 \times 10^6\text{m}$
Dipole moment of the earth M = ?
$B = \frac{\mu_0}{4\pi}\frac{M}{d^3}$
$4 \times 10^{-5} = \frac{4\pi \times 10^{-7} \times M}{4\pi \times (6.4 \times 10^6)^3}$
$\therefore M \cong 10^{23}\text{Am}^2$

Question63

The mid points of two small magnetic dipoles of length d in end-on positions, are separated by a distance x, (x > > d). The force between them is proportional to x^{-n} where n is:



[Online April 9, 2014]

Options:

A. 1

B. 2

C. 3

D. 4

Answer: D

Solution:

In magnetic dipole
Force $\propto \frac{1}{r^4}$
In the given question,
Force $\propto x^{-n}$
Hence, $n = 4$

Question64

Two short bar magnets of length 1cm each have magnetic moments $1.20 Am^2$ and $1.00 Am^2$ respectively. They are placed on a horizontal table parallel to each other with their N poles pointing towards the South. They have a common magnetic equator and are separated by a distance of 20.0cm. The value of the resultant horizontal magnetic induction at the mid-point O of the line joining their centres is close to (Horizontal component of earth's magnetic induction is $3.6 \times 10.5 Wb/m^2$)
[2013]

Options:

A. $3.6 \times 10.5 Wb/m^2$

B. $2.56 \times 10.4 Wb/m^2$

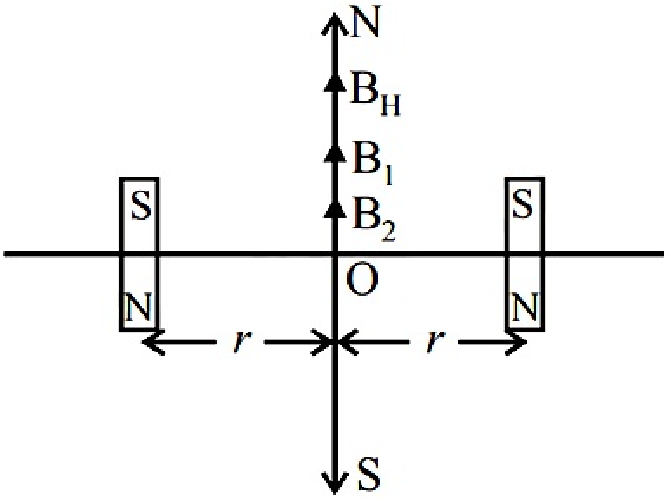
C. $3.50 \times 10.4 Wb/m^2$

D. $5.80 \times 10.4 Wb/m^2$

Answer: B

Solution:

Given : $M_1 = 1.20 Am^2$



$M_2 = 1.00 Am^2$; $r = \frac{20}{2} cm = 0.1 m$
$B_{net} = B_1 + B_2 + B_H$

$$B_{net} = \frac{\mu_0}{4\pi}\frac{(M_1 + M_2)}{r^3} + B_H$$
$$= \frac{10^{-7}(1.2+1)}{(0.1)^3} + 3.6 \times 10^{-5} = 2.56 \times 10^{-4} wb / m^2$$

Question65

The earth's magnetic field lines resemble that of a dipole at the centre of the earth. If the magnetic moment of this dipole is close to $8 \times 10^{22} Am^2$, the value of earth's magnetic field near the equator is close to (radius of the earth $= 6.4 \times 10^6$ m)
[Online April 25, 2013]

Options:

A. 0.6 Gauss

B. 1.2 Gauss

C. 1.8 Gauss

D. 0.32 Gauss

Answer: A

Solution:

Solution:
Given $M = 8 \times 10^{22} Am^2$
$d = R_e = 6.4 \times 10^6 m$

Earth's magnetic field, $B = \frac{\mu_0}{4\pi} \cdot \frac{2M}{d^3}$

$$= \frac{4\pi \times 10^{-7}}{4\pi} \times \frac{2 \times 8 \times 10^{22}}{(6.4 \times 10^6)^3} \cong 0.6 \text{ Gauss}$$

Question66

A bar magnet of length 6cm has a magnetic moment of $4 J T^{-1}$. Find the strength of magnetic field at a distance of 200cm from the centre of the magnet along its equatorial line.
[Online May 7, 2012]

Options:

A. 4×10^{-8} tesla

B. 3.5×10^{-8} tesla

C. 5×10^{-8} tesla

D. 3×10^{-8} tesla

Answer: C

Solution:

Solution:
Along the equatorial line, magnetic field strength
$B = \frac{\mu_0}{4\pi}\frac{M}{(r^2 + l^2)^{3/2}}$
Given: $M = 4J\,T^{-1}$
$r = 200cm = 2m$
$l = \frac{6cm}{2} = 3cm = 3 \times 10^{-2}m$
$\therefore B = \frac{4\pi \times 10^{-7}}{4\pi} \times \frac{4}{[2^2 + (3 \times 10^{-2})^2]^{3/2}}$
Solving we get, $B = 5 \times 10^{-8}$ tesla

Question67

A thin circular disc of radius R is uniformly charged with density σ > 0 per unit area. The disc rotates about its axis with a uniform angular speed ω. The magnetic moment of the disc is [2011 RS]

Options:

A. $\pi R^4 \sigma\omega$

B. $\frac{\pi R^4}{2}\sigma\omega$

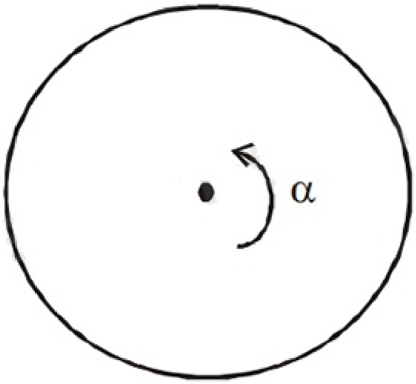
C. $\frac{\pi R^4}{4}\sigma\omega$

D. $2\pi R^4 \sigma\omega$

Answer: C

Solution:

Solution:
$\frac{q}{2m} = \frac{\text{Magnetic dipole moment}}{\text{Angular momentum}}$



∴ Magnetic dipole moment (M)
$M = \frac{q}{2m} . \left(\frac{mR^2}{2}\right) . \omega = \frac{1}{4}\sigma . \pi R^4 \omega$

Question68

Relative permittivity and permeability of a material ε_r and μ_r, respectively. Which of the following values of these quantities are allowed for a diamagnetic material? [2008]

Options:

A. $\varepsilon_r = 0.5$, $\mu_r = 1.5$

B. $\varepsilon_r = 1.5$, $\mu_r = 0.5$

C. $\varepsilon_r = 0.5$, $\mu_r = 0.5$

D. $\varepsilon_r = 1.5$, $\mu_r = 1.5$

Answer: B

Solution:

Solution:
For a diamagnetic material, the value of μ_r is slightly less than one. For any material, the value of ε_r is always greater than 1

Question69

Needles N_1, N_2 and N_3 are made of a ferromagnetic, a paramagnetic and a diamagnetic substance respectively. A magnet when brought close to them will [2006]

Options:

A. attract N_1 and N_2 strongly but repel N_3

B. attract N_1 strongly, N_2 weakly and repel N_3 weakly

C. attract N_1 strongly, but repel N_2 and N_3 weakly

D. attract all three of them

Answer: B

Solution:

Solution:
Ferromagnetic substance has magnetic domains whereas paramagnetic substances have magnetic dipoles which get attracted to a magnetic field. Ferromagnetic material magnetised strongly in the direction of magnetism field, Hence, N_1 will be attracted paramagnetic substance attract weekly in the direction of field. Hence, N_2 will weakly attracted. Diamagnetic substances do not have magnetic dipole but in the presence of external magnetic field due to their orbital motion of electrons these substances are repelled. Hence, N_3 will be repelled.

Question70

The materials suitable for making electromagnets should have
[2006]

Options:

A. high retentivity and low coercivity

B. low retentivity and low coercivity

C. high retentivity and high coercivity

D. low retentivity and high coercivity

Answer: B

Solution:

Solution:
Electromagnet should be amenable to magnetisation & demagnetization.
Materials suitable for making electromagnets should have low retentivity and low coercivity should be low.

Question71

A magnetic needle is kept in a non-uniform magnetic field. It experiences
[2005]

Options:

A. neither a force nor a torque

B. a torque but not a force

C. a force but not a torque

D. a force and a torque

Answer: D

Solution:

Solution:
A magnetic needle kept in non uniform magnetic field experience a force and torque due to unequal forces acting on poles.

Question72

The length of a magnet is large compared to its width and breadth. The time period of its oscillation in a vibration magnetometer is 2s. The

magnet is cut along its length into three equal parts and these parts are then placed on each other with their like poles together. The time period of this combination will be
[2004]

Options:

A. $2\sqrt{3}$ s

B. $\frac{2}{3}$s

C. 2s

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

Answer: B

Solution:

Solution:
Initially, time period of magnet
$T = 2\pi\sqrt{\frac{I}{MB}} = 2s$ where $I = \frac{1}{12}ml^2$
When the magnet is cut into three pieces the pole strength will remain the same and
Moment of inertia of each part,
$(I') = \frac{1}{12}\left(\frac{m}{3}\right)\left(\frac{l}{3}\right) \times 3 = \frac{I}{9}$
We have, Magnetic moment (M)
= Pole strength $(m) \times l$
∴ New magnetic moment,
$M' = m \times \left(\frac{l}{3}\right) \times 3 = ml = M$
New time period, $T = 2\pi\sqrt{\frac{I'}{M'B}}$
$= 2\pi\sqrt{\frac{I}{9MB}} \quad \Rightarrow T' = \frac{T}{\sqrt{9}} = \frac{2}{3}s$

Question73

A magnetic needle lying parallel to a magnetic field requires W units of work to turn it through 60° . The torque needed to maintain the needle in this position will be
[2003]

Options:

A. $\sqrt{3}W$

B. W

C. $\frac{\sqrt{3}}{2}W$

D. 2W

Answer: A

Solution:

Solution:
Workdone to turn a magnetic needle from angle θ_1 to θ_2 is given by
$W = MB(\cos\theta_1 - \cos\theta_2)$
$\therefore W = MB(\cos 0° - \cos 60°)$
$= MB\left(1 - \frac{1}{2}\right) = \frac{MB}{2}$
$\therefore$ Torque, $\tau = MB\sin\theta = MB\sin 60° = \sqrt{3}\frac{MB}{2} = \sqrt{3}W$

Question74

The magnetic lines of force inside a bar magnet [2003]

Options:

A. are from north-pole to south-pole of the magnet

B. do not exist

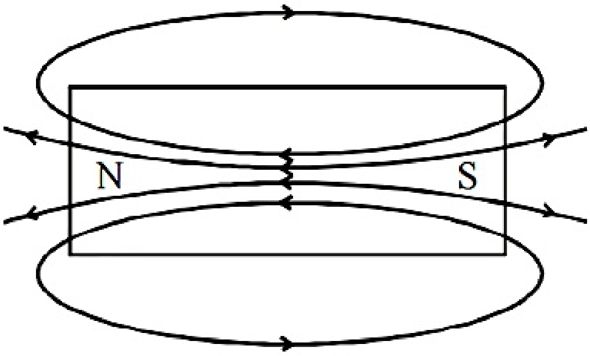
C. depend upon the area of cross-section of the bar magnet

D. are from south-pole to north-pole of the Magnet

Answer: D

Solution:

Solution:
The magnet if field lines of bar magnet form closed lines. As shown in the figure, the magnetic lines of force are directed from south to north inside a bar magnet. Outside the bar magnet magnetic field lines directed from north to south pole.



Question75

A thin rectangular magnet suspended freely has a period of oscillation equal to T. Now it is broken into two equal halves (each having half of the original length) and one piece is made to oscillate freely in the same field. If its period of oscillation is T', the ratio $\frac{T'}{T}$ is [2003]

Options:

A. $\frac{1}{2\sqrt{2}}$

B. $\frac{1}{2}$

C. 2

D. $\frac{1}{4}$

Answer: B

Solution:

Solution:

The time period of a rectangular magnet oscillating in earth's magnetic field is given by $T = 2\pi\sqrt{\frac{I}{MB_H}}$

where I = Moment of inertia of the rectangular magnet
M = Magnetic moment
B_H = Horizontal component of the earth's magnetic field Initially, the time period of the magnet

$T = 2\pi\sqrt{\frac{I}{MB_H}}$ where $I = \frac{1}{12}Ml^2$

Case 2

Magnet is cut into two identical pieces such that eac piece has half the original length.

Then $T' = 2\pi\sqrt{\frac{I'}{M'B_H}}$

Moment of inertia of each part

$I' = \frac{1}{12}\left(\frac{M}{2}\right)\left(\frac{l}{2}\right)^2 = \frac{I}{8}$ and $M' = \frac{M}{2}$

$\therefore \frac{T'}{T} = \sqrt{\frac{I'}{M} \times \frac{M}{I}} = \sqrt{\frac{I/8}{M/2} \times \frac{M}{I}} = \sqrt{\frac{1}{4}} = \frac{1}{2}$

Question76

Curie temperature is the temperature above which [2003]

Options:

A. a ferromagnetic material becomes paramagnetic

B. a paramagnetic material becomes diamagnetic

C. a ferromagnetic material becomes diamagnetic

D. a paramagnetic material becomes ferromagnetic

Answer: A

Solution:

The temperature above which a ferromagnetic substance becomes paramagnetic is called Curie's temperature.
