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5 Magnetism and Matter previously asked

12th Standard

Physics

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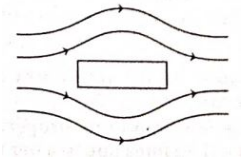
Multiple Choice Question 2 x 1 = 2

1) Which of the following has its permeability less than that different space?

(a) Copper (b) Aluminium (c) Copper chloride (d) Nickel

2) The magnetic field lines near a substance are as shown in the figure. The substance is



(a) Copper (b) Iron (c) Sodium (d) Aluminium

Assertion and reason 1 x 1 = 1

3) **Assertion (A)** Diamagnetic substances exhibit magnetism.
Reason (R) Diamagnetic materials do not have permanent magnetic dipole moment.
(a) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.
(b) Both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
(c) Assertion is true but Reason is false.
(d) Assertion is false but Reason is true

Answer : (a) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.

2 Marks 21 x 2 = 42

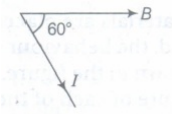
4) If the horizontal and vertical components of the earth's magnetic field are equal at a certain place, what would be the angle of dip at that place?

We know that, tan $\delta = \frac{V}{H}$
where, δ = angle of dip, Hand V are horizontal and vertical components of magnetic field
For V = H
$\therefore \quad \tan\delta = 1 \Rightarrow \delta = \frac{\pi}{4} \text{ or } 45^\circ$

5) Amagnetic needle, free to rotate in a vertical plane orients itself vertically at a certain place on the earth. What are the values of
(i) horizontal component of the earth's magnetic field?
(ii) angle of dip at this place?

(i) The magnetic needle orients itself in vertical plane, it means that there is no component of the earth's magnetic field in horizontal direction, so the horizontal component of the earth's magnetic field is zero.
(ii) The angle of dip is 90°

6) At a place, the horizontal component of earth's magnetic field is B and angle of dip is 60°. What is the value of horizontal component of the earth's magnetic field at equator?



I is the total magnetic field.

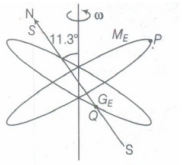
Now, $I\cos 60^\circ = B \Rightarrow I = \frac{B}{\cos 60^\circ} = \frac{B}{1/2} = 2B$

At equator, dip angle is 0°.

∴ BH = I cos 0° = I = 2B.

7) Consider the plane S formed by the dipole axis and the axis of the earth. Let P be point on the magnetic equator in S. Let Q be the point of intersection of the geographical and magnetic equators. Obtain the declination and dip angles at P and Q.

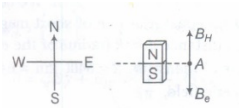
Answer : P is in the plane of S, needle is in North, so the declination is zero.



P is also on the magnetic equator, so the angle of dip is zero, because the value of angle of dip at equator is zero. Q is also on the magnetic equator, so the angle of dip is zero.
As, the earth is tilted on its axis by 113°, thus the declination at Q is 113°.

8) A short bar magnet with its North pole facing North forms a neutral point at A in the horizontal plane. If the magnet is rotated by 90° in the horizontal plane, what is the net magnetic induction at P ?

Answer : Initially,

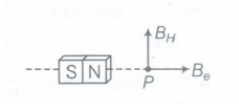


Neutral point obtained on equatorial line such that,

$|B_H| = |B_e|$

where, B_H = horizontal component of the earth's magnetic field and B_e = magnetic field due to a bar magnet on its equatorial line.

Finally,



Now, point P comes to an axial line of the magnet and at P, net magnetic field is given by

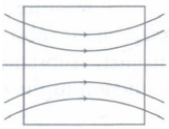
$B = \sqrt{B_a^2 + B_H^2} = \sqrt{(2B_e)^2 + (B_H)^2} \quad [\because B_a = 2B_e]$

$= \sqrt{(2B_H)^2 + B_H^2} \quad [\because |B_e| = |B_H|]$

$= \sqrt{5}\, B_H$

9) Show diagrammatically the behaviour of magnetic field lines in the presence of
(i) paramagnetic and
(ii) diamagnetic substances. How does one explain this distinguishing feature?

Answer :



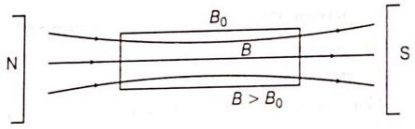
Magnetic permeability of paramagnetic substance is more than air, so it allows more lines to pass through it while permeability of diamagnetic substance is less than air, so it does not allow lines to pass through it. Thus, diamagnetic substances expel magnetic field lines, while paramagnetic substances attract them.

10) Out of the two magnetic materials.A has relative permeability slightly greater than unity while S has less than unity. Identify the nature of the materials A and B. Will their susceptibilities be positive or negative?

Answer : The nature of the material A is paramagnetic and its susceptibility X_m is positive.
The nature of the material B is diamagnetic and its susceptibility X_m is negative.

11) The susceptibility of a magnetic material is 0.9853. Identify the type of magnetic material. Draw the modification of the field pattern on keeping a piece of this material in a uniform magnetic field.

Answer : Given, susceptibility, $X_m = 0.9853$
As the susceptibility of material is positive but small.
∴ The material is paramagnetic in nature. For paramagnetic material, magnetic lines of external magnetic field will pass through the material without much deviation, when it is placed in between magnetic poles.
The modification of the field pattern is shown in the following figure.



12) Out of the following, identify the materials which can be classified as
(i) paramagnetic
(ii) diamagnetic
(a) Aluminium (b) Bismuth
(c) Copper (d) Sodium

Answer : (i) **Paramagnetic substance** Aluminium, sodium
(ii) **Diamagnetic substance** Bismuth, copper, the susceptibility of the diamagnetic materials is small and negative, i.e. $-1 < X_m < 0$, whereas for paramagnetic substance the susceptibility is small and positive, i.e. $0 < X_m < a$, where a is a small number.

13) What is the angle of dip at a place where the horizontal and vertical components of the earth's magnetic field are equal?

Angle of dip is 45°.

14) Which of the following substances are paramagnetic?
Bi, Al, Cu, Ca, Pb and Ni.

Al and Ca.

15) Which of the following substances are diamagnetic?
Bi, Al, Na, Cu, Ca and Ni

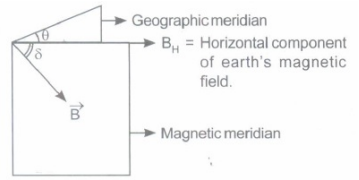
Bi and Cu.

16) What are permanent magnets? Give one example.

Permanent magnets are the materials which retain their ferromagnetic properties for a long time at room temperature, e.g. a bar magnet.

17) Draw a labelled diagram showing the three magnetic elements of earth.

Answer :



Where δ = Angle of dip,
θ = Angle of declination

18) The susceptibility of a magnetic material is -2.6×10^{-5}. Identify the type of magnetic material and state its two properties.

Answer : As the susceptibility is negative (-ve), we conclude that material is diamagnetic.
The following are its two properties:
(i) It has tendency to move from stronger to weaker part of the external magnetic field.
(ii) It gets feebly magnetised in the direction opposite to that of the applied magnetic field.

19) The relative magnetic permeability of a magnetic material is 800. Identify the nature of magnetic material and state its two properties.

Answer : The nature of the magnetic material is ferromagnetic.
The following are its two properties:
(i) It gets strongly magnetised when placed in an external magnetic field.
(ii) It has strong tendency to move from the region of weak magnetic field to strong magnetic field, i.e. it gets strongly attracted to a magnet.

20) Explain the following:
(i) Why do magnetic lines offorce form continuous closed loops?
(ii) Why are the field lines repelled (expelled) when a diamagnetic material is placed in an external uniform magnetic field?

Answer : (i) The net magnetic flux through any closed surface is zero.
(ii) Diamagnetic material gets magnetised in the direction opposite to the direction of external magnetic field

21) Mention the two characteristic properties of the material suitable for making core of a transformer.

Characteristic Properties
(i) Resistance should be less.
(ii) Torsional constant should be less

22) The permeability of a magnetic material is 0.9983. Name the type of magnetic materials it represents.

Diamagnetic.

23) The magnetic susceptibility of χ of a given material is -0.5. Identify the magnetic material.

Answer : Substances having (small) negative value (-0.5) of magnetic susceptibility χ_m are diamagnetic.

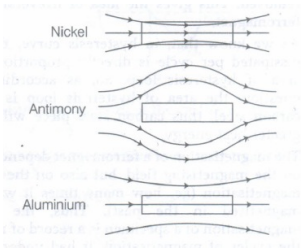
24) Write any two points of difference between a diamagnetic and a paramagnetic substance.

Answer : Diamagnetic substances:
1. When a diamagnetic substance is kept in a magnetizing field, then the magnetic field lines will be repelled by the diamagnetic substances.
2. The susceptibility of diamagnetic substance is negative.
Paramagnetic substance:
1. When a paramagnetic substance is kept in an external magnetic field the field lines pass through the paramagnetic substances.
2. The susceptibility of paramagnetic substance is positive.

3 Marks 8 x 3 = 24

25) Three identical specimens of a magnetic material, nickel, antimony, aluminium are kept in a uniform magnetic field. Draw the modification in the field lines in each case. Justify your answer.

Answer :



The modification in the field lines shown in the figure are as such because
(i) nickel is a ferromagnetic substance.
(ii) antimony is a diamagnetic substance.
(iii) aluminium is a paramagnetic substance.

26) A bar magnet of magnetic moment 6 J/T is aligned at 60° with a uniform external magnetic field of 0.44 T.
Calculate (a) the work done in turning the magnet to align its magnetic moment
(i) normal to the magnetic field,
(ii) opposite to the magnetic field, and (b) the torque on the magnet in the final orientation in case (ii).

Answer : (a) Given, magnetic moment, M = 6J/T

Aligned angle, θ_1 = 60°

External magnetic field, B = 0.44 T

(i) When the bar magnet is align normal to the magnetic field, i.e. θ_2 = 90°

∴ Amount of work done in turning the magnet,

W = - MB (cos θ_2 - cos θ_1)

- 6 x 0.44 (cos 90° - cos 60°)

$= +6 \times 0.44 \times \frac{1}{2} \quad (\because \cos 90^\circ = 0 \text{ and } \cos 60^\circ = 1/2)$

= 1.32 J

(ii) When the bar magnet align opposite to the magnetic field, i.e. θ_2= 180°

∴ W = - MB (cos 180° - cos 60°)

$= -6 \times 0.44 \left(-1 - \frac{1}{2}\right) (\because \cos 180^\circ = -1)$

$= 6 \times 0.44 \times \frac{3}{2} = 3.96 \text{ J}$

(b) We know that, torque

τ = M x B = MBsinθ

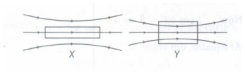
For case (ii), θ = 180°

∴ τ = MBsin 180° (∴ sin 180° = 0)

= 0

∴ Amount of torque is zero for case (ii).

27) When two materials are placed in an external magnetic field, the behaviour of magnetic field lines is as shown in the figure. Identify the magnetic nature of each of these two materials.



Answer : (i) Material X is paramagnetic substance. When a specimen of a paramagnetic substance is placed in a magnetising field, the lines of force prefer to pass through the specimen rather than through air. Thus, magnetic induction inside the sample is more than the magnetic intensity.

(ii) Material Y is ferromagnetic substance. These are the substances in which a strong magnetism is produced in the same direction as the applied magnetic field, these are strongly attracted by a magnet, exhibits highly concentrated lines of force.

28) If the bar magnet in Q.14 is turned around by 180°, where will the new null points be located?

Answer : When a bar magnet is turned by 180°, then the null points are obtained on the equatorial line.

50, magnetic field on the equatorial line at a distance g' is given by

$B' = \frac{\mu_0}{4\pi} \cdot \frac{M}{d'^3}$

This magnetic field is equal to the horizontal component of the earth's magnetic field

$B' = \frac{\mu_0}{4\pi} \cdot \frac{M}{d'^3} = H$ .....(i)

As we know that,

Magnetic field, $B_1 = \frac{\mu_0}{4\pi} \cdot \frac{2M}{d^3} = H$ .....(ii)

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

$\frac{\mu_0}{4\pi} \cdot \frac{M}{d'^3} = \frac{\mu_0}{4\pi} \cdot \frac{2M}{d^3}$

or $\frac{1}{d'^3} = \frac{2}{d^3}$

or $d'^3 = \frac{d^3}{2} = \frac{(14)^3}{2} \quad [\because d = 14 \text{ cm}]$

or $d' = \frac{14}{(2)^{1/3}} = 11.1 \text{ cm}$

Thus, the null points are located on the equatorial line at a distance of 11.1 cm.

29) A short bar magnet of magnetic moment 0.9 J/T is placed with its axis at 30° to a uniform magnetic field. It experiences a torque of 0.063 J.

(i) Calculate the magnitude of the magnetic field.

(ii) In which orientation will the bar magnet be in stable equilibrium in the magnetic field.

Answer : (i) We know that $\tau = MB\sin\theta$

Magnitude of the magnetic field is calculated as

$B = \frac{\tau}{M\sin\theta} = \frac{0.063}{0.9\times\sin 30^\circ} = 0.14\ \mathrm{T}$

(ii) When the magnetic moment vector and the magnetic field vectors are in the same direction,

i.e. θ = 0°

It's so because this configuration corresponds to a minimum energy.

U = -MB

30) A short bar magnet of magnetic moment 0.5 J/T is placed with its axis at 30° to a uniform magnetic field of 0.1 T. Calculate

(i) the magnitude of the torque experienced, and

(ii) the direction on which it acts

Answer : Given: $M = 0.5\ \mathrm{J/T}, B = 3\times10^{-2}\ \mathrm{T}, \theta = 30^\circ$

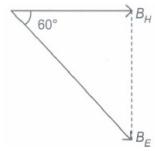
(i) Torque acting on the needle,

τ = MB sin 8 = 0.5 x 0.1 x sin 30° = 2.5 x 10^{-2} Nm

(ii) The direction of the torque is perpendicular to the plane containing the vectors $\vec{M}$ and $\vec{B}$

31) A magnetic needle free to rotate in a vertical plane parallel to the magnetic meridian has its north tip down at 60° with the horizontal. The horizontal component of the earth's magnetic field at the place is known to be 0.4 G. Determine the magnitude of the earth's magnetic field at the place.

Answer : Given: $B_H = 0.4\mathrm{G}$



$\because\ B_H = B_E\cos 60^\circ$

$\therefore\ B_E = \frac{0.4}{\cos 60^\circ}\quad \left(\because \cos 60^\circ = \frac{1}{2}\right)$

B_E = 0.4 x 2 = 0.8 G

32) Write three points of differences between para-, dia- and ferro-magnetic materials, giving one example for each.

Answer :

Paramagnetic Materials	**Diamagnetic Materials**	**Ferromagnetic materials**
1. These are materials in which each individual atom has a not nonzero magnetic moment its own.	1. These are materials in which the individual atoms possess no net magnetic moment of their own.	1. These are the materials in which the individual atoms have a net non-zero magnetic moment.
2. Magnetic susceptibility is low and positive.	2. Magnetic susceptibility is low and negative.	2. Magnetic susceptibility is high and positive.
3. In presence of nonuniform magnetic field, it weakly attracts and tend to move from weaker parts of field to stronger parts.	3. In presence of nonuniform magnetic field, it repels and tend to move from stronger parts of field to weaker parts.	3. In presence of nonuniform magnetic field, it strongly attracts and easily move from weaker part of field to stronger parts.
5. Example: Aluminum.	5. Example: Copper.	5. Example: Iron