Short Answer Questions – I (PYQ)

Q. 1. The susceptibility of a magnetic material is 2.6×10^{-5}. Identify the type of magnetic material and state its two properties. [CBSE Delhi 2012]

Ans. The material having positive and small susceptibility is paramagnetic material. Properties

(i) They have tendency to move from a region of weak magnetic field to strong magnetic field, i.e., they get weakly attracted to a magnet.

(ii) When a paramagnetic material is placed in an external field the field lines get concentrated inside the material, and the field inside is enhanced.

Q. 2. The susceptibility of a magnetic material is -2.6×10^{-5}. Identify the type of magnetic material and state its two properties. [CBSE Delhi 2012]

Ans. The magnetic material having negative susceptibility is diamagnetic in nature. Two properties:

(i) This material has + ve but low relative permeability.

(ii) They have the tendency to move from stronger to weaker part of the external magnetic field.

Q. 3. 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 at to be 0.4 G. Determine the magnitude of the earth's magnetic field at the place. [CBSE Delhi 2011]

Ans. Angle of dip, θ = 60°

H = 0.4 G = 0.4 × 10–4 T

If Be is earth's magnetic field, then

$$H = B_e \cos\theta. \Rightarrow \quad B_e = \frac{H}{\cos\ \theta} = \frac{0.4\times10^{-4}T}{\cos\ 60^\circ} = \frac{0.4\times10^{-4}T}{0.5} = 0.8 \times 10^{-4}\ T = 0.8\ G$$

Q. 4. A compass needle, free to turn in a vertical plane orients itself with its axis vertical at a certain place on the earth. Find out the values of (i) horizontal component of earth's magnetic field and (ii) angle of dip at the place.
[CBSE Delhi 2013]

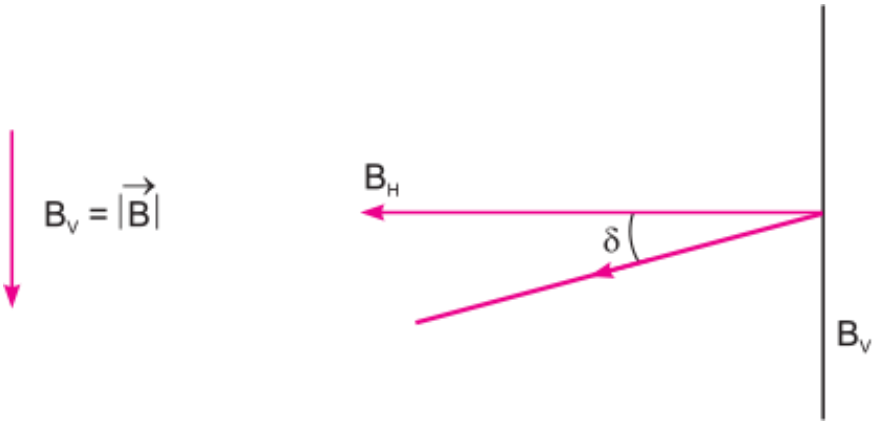
Ans. If compass needle orients itself with its axis vertical at a place, then

i. $B_H = 0$ because $B_V = |B|$

ii. $\tan \delta = \frac{B_V}{B_H} = \infty$

$\Rightarrow$ Angle of dip $\delta = 90°$,

Concept: It is possible only on magnetic north or south poles.



Q. 5. A magnetised needle of magnetic moment 4.8×10^{-2} J T–1 is placed at 30° with the direction of uniform magnetic field of magnitude 3×10^{-2} T. Calculate the torque acting on the needle. [CBSE (F) 2012]

Ans. We have, $\tau = MB \sin \theta$

Where $\tau \rightarrow$ torque acting on magnetic needle

M $\rightarrow$ Magnetic moment

B $\rightarrow$ Magnetic field strength

Then $\tau = 4.8 \times 10^{-2} \times 3 \times 10^{-2} \sin 30°$

$= 4.8 \times 10^{-2} \times 3 \times 10^{-2} \times \frac{1}{2}$

$= 7.2 \times 10^{-4}$ Nm

Q. 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. [CBSE Delhi 2017]

Ans. Here, $B_H = B$ and $\delta = 60°$

We know that

$B_H = B_E \cos \delta$

$B = B_E \cos 60° \quad \Rightarrow \quad B_E = 2B$

At equator δ = 0°

∴ $B_H = 2B \cos 0° = 2B$

Q. 7. Write two properties of a material suitable for making (a) a permanent magnet, and (b) an electromagnet. [CBSE (AI) 2017]

Ans. (a) Two properties of material used for making permanent magnets are

(i) High coercivity
(ii) High retentivity
(iii) High permeability

(b) Two properties of material used for making electromagnets are

(i) High permeability
(ii) Low coercivity
(iii) Low retentivity

Short Answer Questions-I (OIQ)

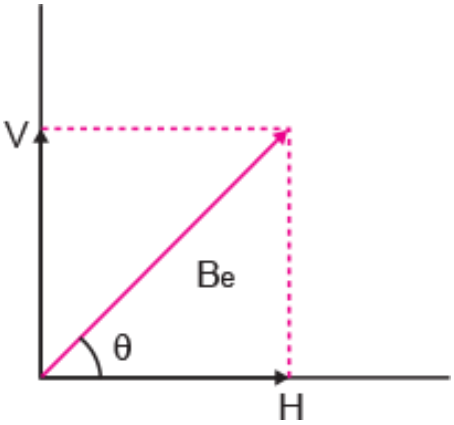
Q. 1. Define the term magnetic inclination. Deduce the relation connecting the horizontal component and inclination with the help of a diagram.

Ans. Magnetic Inclination: It is the angle made by resultant magnetic field of earth with the horizontal. It is also called angle of dip.

Relation, suppose $\underset{Be}{\rightarrow}$ is earth's net magnetic field, θ is angle of dip. Resolving $\underset{Be}{\rightarrow}$ along horizontal and vertical directions; the horizontal component is H and vertical component is V. From fig. $\cos\theta = \frac{H}{B_e}$

∴ $H = B_e \cos\theta$

This is the required relation.



Q. 2. Define magnetic susceptibility of a material. Name two elements, one having positive susceptibility and the other having negative susceptibility. What does negative susceptibility signify?

Ans. Magnetic susceptibility: Refer to Basic Concepts Point 5 (iv).

Iron has positive susceptibility while **copper** has negative susceptibility.

Negative susceptibility of a substance signifies that the substance will be repelled by a strong magnet or opposite feeble magnetism induced in the substance. Such a substance is called diamagnetic.

Q. 3. Answer the following questions:

If χ-stands for the magnetic susceptibility of a given material, identity the class of materials for which (i) $-1 \geq \chi < 0$ (ii) $0 < \chi < \varepsilon$ 0 (ε is a small positive number).

(1) Write the range of relative magnetic permeability of these materials.

(2) Draw the pattern of the magnetic field lines when these materials are placed on an strong magnetic field.

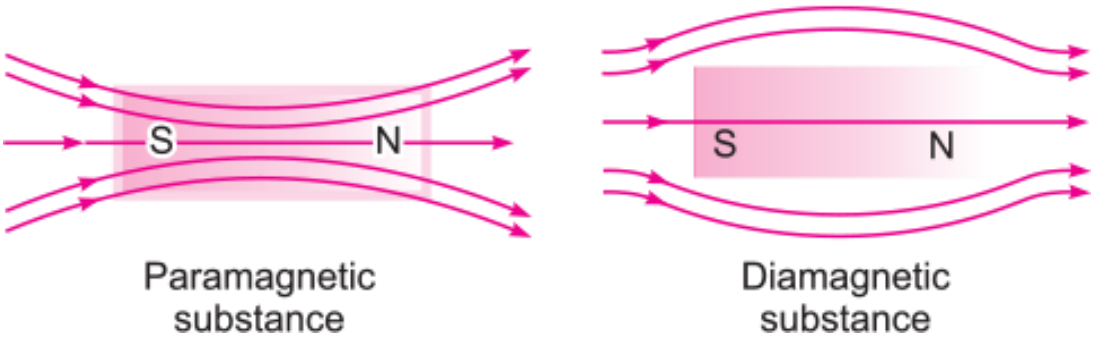
Ans. (1) Material is diamagnetic (ii) Material is paramagnetic.

$$\mu_r = 1 + \chi$$

(i) Range of relative magnetic permeability for diamagnetic is $0 \leq \mu_r < 1$.

(ii) Range of relative magnetic permeability for paramagnetic is $1 < \mu_r < 1 + \varepsilon$.

(2)



(i) **(ii)**

Q. 4. Write any three characteristics, a ferromagnetic substance should possess if it is to be used to make a permanent magnet. Give one example of such a material.

Ans. Characteristics for permanent magnet

(i) High permeability

(ii) High retentivity

(iii) High coercivity

Example: steel.

Q. 5. What is Curie law in magnetism?

Ans. Curie law. It states that the magnetic susceptibility of a paramagnetic material is inversely proportional to absolute temperature

$$\therefore \quad \chi \propto \frac{1}{T} = \frac{C}{T} \quad \text{where } C \text{ is Curie constant.}$$

Q. 6. When a compass needle be placed at magnetic north pole, how would it behave? If a dip needle be placed at the place, how would it behave?

Ans. Compass needle stays in horizontal north-south direction. At poles horizontal component H= 0; therefore there will be no effect of earth's field on magnetic north pole and it can stay in any direction; on the other hand a dip needle points along the resultant magnetic field and at poles the resultant field is vertical; hence the needle becomes vertical.

Q. 7. What is the value of magnetic field within a hollow sphere made of ferromagnetic substance? Hence explain magneto static shielding.

Ans. The magnetic field within, hollow sphere of ferromagnetic substance is zero. Magneto static shielding means to shield any specimen from magnetic effects by placing it within a hollow region of a ferromagnetic substance.

Q. 8. Horizontal component of earth's magnetic field at a place is $\sqrt{3}$ times its vertical component. What is the value of angle of dip at that place?

Ans.

$$\text{Given } H = \sqrt{3}V \Rightarrow \tan\theta = \frac{V}{H} = \frac{1}{\sqrt{3}}$$

$$\Rightarrow \quad \text{Angle of dip, } \theta = \tan^{-1}\left(\frac{1}{\sqrt{3}}\right) = 30^\circ$$

Q. 9. From molecular view point, discuss the temperature dependence of susceptibility for diamagnetism, Para magnetism and ferromagnetism.
[NCERT Exemplar]

Ans. Diamagnetism is due to orbital motion of electrons developing magnetic moments opposite to applied field and hence is not much affected by temperature.

Paramagnetic and ferromagnetism is due to alignments of atomic magnetic moments in the direction of the applied field. As temperature increases, this alignment is disturbed and hence susceptibilities of both decrease as temperature increases.

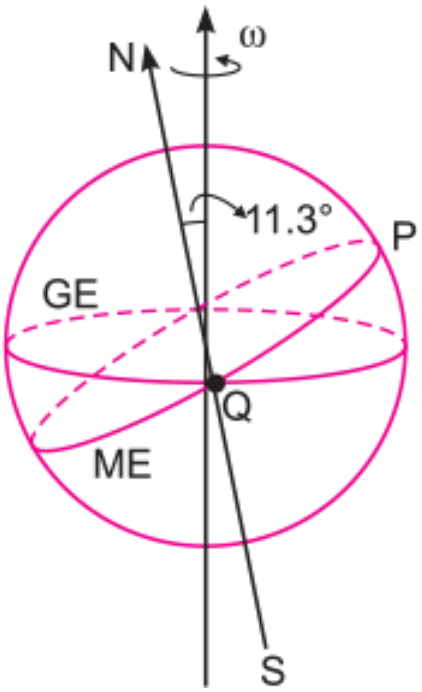
Q. 10.Consider the plane S formed by the dipole axis and the axis of earth. Let P be point on the magnetic equator and in S. Let Q be the point of intersection of the geographical and magnetic equators. Obtain the declination and dip angles at P and Q.
[NCERT Exemplar]

Ans. In following figure:

(i) P is in S (needle will point both north) Declination = 0P is also on magnetic equator.∴ Dip = 0

(ii) Q is on magnetic equator.∴ Dip = 0

But declination = 11.3.

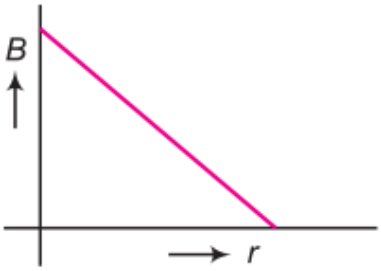


Q. 11. What is the basic difference between the atom and molecule of a diamagnetic and a paramagnetic material? Why are elements with even atomic number more likely to be diamagnetic?

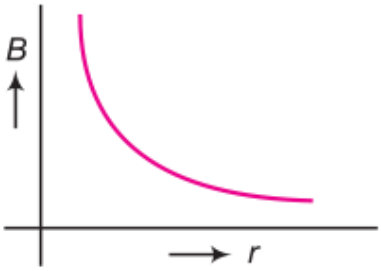
Ans. Atoms/molecules of a diamagnetic substance contain even number of electrons and these electrons from the pairs of opposite spin; while the atoms/molecules of a paramagnetic substance have excess of electrons spinning in the same direction.

The elements with even atomic number Z has even number of electrons in its atoms/molecules, so they are more likely to form electrons pairs of opposite spin and hence more likely to be diamagnetic.

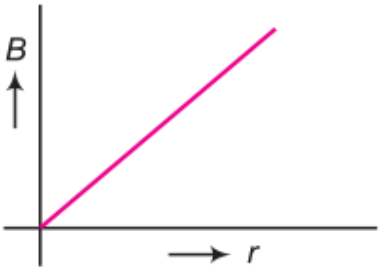
Q. 12. Three students represent the variation of magnetic field B with distance r for a straight infinity long current carrying conductor as



Student 1



Student 2



Student 3

Which of the three students has drawn the graph correctly and why?

Ans. For a straight infinitely long current carrying conductor, the magnetic field is given by the relation

$$\overrightarrow{B} = \frac{\mu_0 I}{2\pi r}$$

Thus, $B \propto \frac{1}{r}$ and the graph between B and r will be a rectangular hyperbola. Thus, student 2 has drawn the graph correctly.