SURE SHOT QUESTIONS 2026

Chapter – 05 (Questions)

Magnetism and Matter

➢ Question

1. Depict the behaviour of magnetic field lines in the presence of a diamagnetic material.

2. Relative permeability of a material $\mu_r = 0.5$. Identify the nature of the magnetic material and write its relation to magnetic susceptibility.

3. Write the four important properties of the magnetic field lines due to a bar magnet.

4. The magnetic susceptibility χ of magnesium at 300 K is 1.2×10^5. At what temperature will its magnetic susceptibility become 1.44×10^5?
   Or
   The magnetic susceptibility χ of a given material is – 0.5. identify the magnetic material.

5. 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.

6. A bar magnet of magnetic moment 6 J/T is aligned at 60^0 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).

7. (a) State Gauss' law for magnetism. Explain its significance.
   (b) Write the four important properties of the magnetic field lines due to a bar magnet.

8. Give two points to distinguish between a paramagnetic and a diamagnetic substance.

9. Write the four important properties of the magnetic field lines due to a bar magnet.

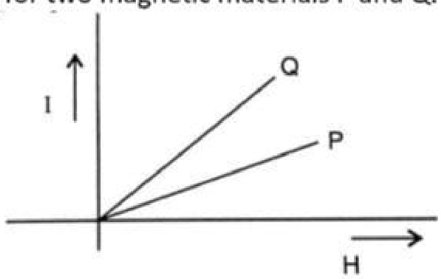
10. A bar magnet of magnetic moment 6 J T^{-1} is aligned at 60^0 with a uniform external magnetic field of 0.44 T. Calculate (a) the work done in turning the magnet to align its magnetic moment (i) normal to the magnetic field, (ii) opposite to the magnetic field, and (b) the torque on the magnet in the final orientation in case (ii).

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.

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

13. In what way is the behaviour of a diamagnetic material different from that of a paramagnetic, when kept in an external magnetic field?

14. The given graphs show the variation of intensity of magnetisation I with strength of applied magnetic field H for two magnetic materials P and Q.



   i. Identify the materials P and Q.
   ii. For a material P, plot the variation of intensity of magnetisation with temperature. Justify, your answer.

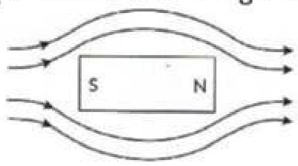
15. Define the terms (i) Magnetisation 'M' (ii) Magnetic Intensity 'H' (iii) Magnetic permeability 'μ' (iv) Magnetic Susceptibility 'χ_m'

16. What is Curie law, Curie temperature & Curie-Weiss law explain.

17. (i) Mention two properties of soft iron due to which it is preferred for making an electromagnet.
(ii) State Gauss's law in magnetism. How it is different from Gauss's law in electrostatics and why?

18. In what way is the behaviour of a diamagnetic material different from that of a paramagnetic, when kept in an external magnetic field?
Soln. A diamagnetic specimen would tend to move towards the region of weaker magnetic field while a paramagnetic specimen would tend to move towards the region of stronger magnetic field.

19. Depict the behaviour of magnetic field lines in the presence of a diamagnetic material.



20. Relative permeability of a material $\mu_r = 0.5$. Identify the nature of the magnetic material and write its relation to magnetic susceptibility.

21. Give two points to distinguish between a paramagnetic and a diamagnetic substance.

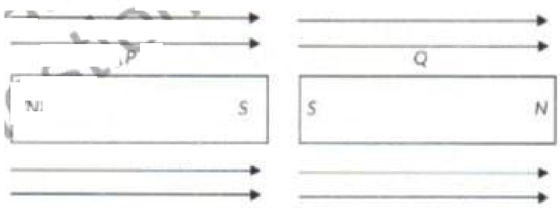
22. Depict the behaviour of magnetic field lines with (i) a diamagnetic material and (ii) a paramagnetic material placed in an external magnetic field. Mention briefly the properties of these materials which explain this distinguishing behaviour.

23. Write three points of differences between paradia- and ferro- magnetic materials giving one example for each.

24. 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.

25. A short bar magnet of magnetic moment $M = 0.3 J T^{-1}$ ispiaced in a uniform external magnetic field of 0.50 T. If the bar is free to rotate in the plane of the field, which orientations would correspond to its (i) stable and (ii) unstable equilibrium? What is the potential energy of the magnet in each case? What is the torque on magnet in each case?

26. Two identical bar magnets P and Q are placed in two identical uniform magnetic fields as shown in the figure. Justify that both the magnets are in equilibrium. Which one of these is in stable equilibrium? Give reasons for your answer.



27. The magnetic needle has magnetic moment $6.7 \times 10^{-2}\ A\,m^2$ and moment of inertia $I = 7.5 \times 10^{-6}\ kg\,m^2$. It performs 10 oscillations in 6.70 s. What is the magnitude of the magnetic field?

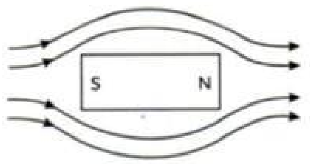
New SURE SHOT QUESTIONS 2026

Chapter – 05 (Solutions)

Magnetism and Matter

➢ Solutions

1. Ans. Behaviour of magnetic field lines when a diamagnetic substance is placed in an external field.



2. Ans. The relative permeability is an intrinsic property of a magnetic material. A related quantity is the magnetic susceptibility, denoted by χ_m.

$\mu_r = 1 + \chi_m [\because \mu_r = 0.5]$

Here, $\mu_r < 1 (\chi_m \, negative)$, so the material is termed as diamagnetic.

3. Soln.

(i) Attractive Property: When a magnetic is dipped into iron filings, it is found that the concentration of iron fillings is maximum at the ends. It means attracting power of the magnet is maximum at two points near the ends and minimum at the centre. The places in a magnet where its attracting power is maximum are known as poles while the place of minimum attracting power is known as the neutral region.

(ii) Directive property: When a magnet is suspended, its length becomes parallel to N-S direction. The pole at the end pointing north is known as north pole while the other pointing south is known as south pole.

(iii) Magnetic poles always exist in pairs i.e., an isolated magnetic pole does not exist.

(iv) Like poles repel each other and unlike poles attract each other.

4. Soln. Given, χ_{mg} at 300 K = 1.2 x 10^5

χ'_{mg} at t temp. = 1.44 x 10^5

$t = ?$

From Curies law,

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

$$\frac{\chi'_{mg}}{\chi_{mg}} = \frac{300}{t}$$

$$\Rightarrow \frac{1.44\times10^5}{1.2\times10^5} = \frac{300}{t}$$

$$t = \frac{300\times1.2}{1.44}$$

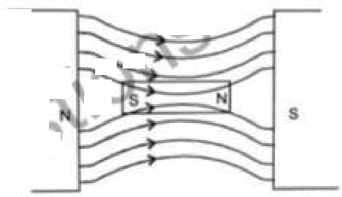
= 250 K

OR

Diamagnetic as $1 < \chi < 0$.

5. Soln. Given, susceptibility, $\chi = 0.9853$.

The material is paramagnetic in nature. If a piece of this material is kept in uniform magnetic field, then field pattern gets modified as follows:



The lines of force tend to pass through the material rather tan the surrounding air.

6. Soln. Given, magnetic momentum,

$m = 6 \, JT^{-1}$

External magnetic field, $B = 0.44T$

$$\theta_1 = 60^0 \Rightarrow \cos\theta_1 = \cos 60^0 = \frac{1}{2}.$$

(a) Work done in turning the magnet normal to the field,

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

(i) Here, $\theta_2 = 90^0$

$$\therefore \quad W = +mB\cos\theta_1$$

$$= 6\times0.44\times\frac{1}{2} = 1.32J$$

(ii) Here $\theta_2 = 180^0$

$$\therefore \quad W = -mB(\cos\theta_2 - \cos\theta_1)$$

$$W = -6\times0.44\left(-1-\frac{1}{2}\right)$$

= 3.96 J

(b) Torque on magnet when moment is aligned opposite to the field,

Torque $= |\vec{m} \times \vec{B}|$

$$\tau = mB\sin\theta$$
$$= 6 \times 0.44 \times \sin 180^0$$
$$= 0 \quad (\because \sin 180^0 = 0)$$

7. Soln. Gauss law for magnetism: It a closed surface is imagined in a magnetic field, the number of lines of force emerging from the surface must be equal to the number entering it. That is, the net magnetic flux out of any closed surface is zero. Gauss law signifies that magnetic monopoles does not exist.

1. In a bar magnet, each lines of force, starts from a north poles and reaches the south pole externally and then goes from south pole to a north pole internally. Thus, magnetic line of force forms a closed loop.
2. No two lines of force will never intersect each other.
3. In a uniform field, the lines are parallel and equidistant from each other.
4. The line of force are crowded near the poles.

8. Ans. .

S.No.	Paramagnetic substances	Diamagnetic substances
1.	A paramagnetic substance is feebly attracted by a magnet,	A diamagnetic substance is feebly repelled by a magnet.
2.	For a paramagnetic substance, the intensity of magnetisation has a small positive value.	For a diamagnetic substance, the intensity of magnetization hasa small negative value.

9. Ans. Properties of magnets:

(i) Attractive property: When a magnet is dipped into iron filings, it is found that the concentration of iron fillings is maximum at the ends. It means attracting power of the magnet is maximum at two points near the ends and minimum at the centre. The places in a magnet where at attracting power is maximum are known as poles while the place of minimum attracting power is known as the neutral region.

(ii) Directive property: When a magnet is suspended, its length becomes parallel to N – S direction. The pole at the end pointing north is known as north pole while the other pointing south is known as south pole.

(iii) Magnetic pole always exist in pairs i.e., an isolated magnetic pole does not exist.

(iv) Like poles repel each other and unlike poles attract each other.

10. Ans. Here, $m = 6JT^{-1}, \theta_1 = 60^0, B = 0.44T$

(a) Work done in turning the magnet,

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

(i) When the bar magnet is turned normal to the magnetic field, the final angle made by the axis of the bar magnet with the magnetic field is, $\theta_2 = 90^0$ and $\theta_1 = 60^0$.

$\therefore W = -6 \times 0.44(\cos 90^0 - \cos 60^0)$

$= -6 \times 0.44\left(0 - \frac{1}{2}\right) = 1.32J$

(ii) When the bar magnet is turned opposite to the magnetic field, the final angle made by the axis of the bar magnet with the magnetic field is $\theta_2 = 180^0$ and

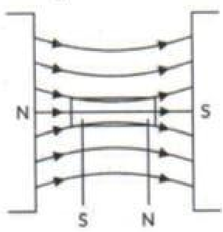
$\theta_1 = 60^0$

$\therefore W = -6 \times 0.44(\cos 180^0 - \cos 60^0)$

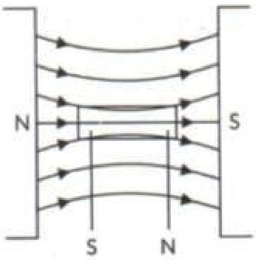
$= -6 \times 0.44\left(-1 - \frac{1}{2}\right) = 3.96J$

$\tau = mB\sin\theta = mB\sin 180^0 = 0$

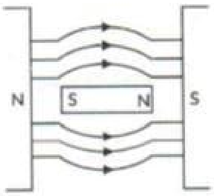
11. Ans. As χ = 0.9853, so material is paramagnetic. The behaviour of magnetic field lines in the presence of a paramagnetic substance is shown.



12. Ans. (i) The behaviour of magnetic field lines in the presence of a paramagnetic substance is shown:



(ii) The behaviour of magnetic field lines in the presence of a diamagnetic substance is shown:

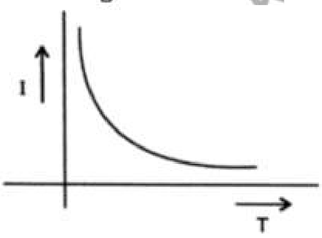


This distinguishing feature is because of the difference in their relative permeabilities. The relative permeability of the diamagnetic substance is negative; so, the magnetic lines of force do not prefer passing through the substance. The relative permeability of a paramagnetic substance is greater than 1; so, the magnetic lines of force prefer passing through the substance.

13. Ans. A diamagnetic specimen would tend to move towards the region of weaker magnetic field while a paramagnetic specimen would tend to move towards the region of stronger magnetic field.

14. Soln. (i) P – Paramagnetic material

(ii) Q – Ferromagnetic material



In paramagnetic materials, I decreases with temperature as, $I \propto \frac{H}{T}$, where, H is the magnetising field.

15. Soln. *The magnetic moment developed per unit volume of a material when placed in a magnetising field is called intensity of magnetisation or simply magnetisation.* Thus

$$\vec{M} = \frac{\vec{m}}{V}$$

If I_M is the surface magnetisation current set up in a solenoid of cross-sectional area A and having n turns per unit length, then magnetic moment developed per unit length of the solenoid is $nI_M A$. Therefore, magnetic moment developed per unit volume or the magnetisation $\vec{M}$ is given by

$$M = \frac{m}{V} = \frac{nI_M A}{A} = nI_M$$

Hence $B_M = \mu_0 n I_M = \mu_0 M$

Again, consider a bar of magnetic material having cross-sectional area a and length $2l$. Its volume is

$$V = a \times 2l$$

$$\therefore M = \frac{m}{V} = \frac{q_m \times 2l}{a \times 2l} = \frac{q_m}{a}$$

Hence *intensity of magnetisation may also be defined as the pole strength developed per unit cross-sectional area of a material.*

Magnetising field intensity. The ability of magnetising field to magnetise a material medium is expressed by a vector $\vec{H}$, called *magnetising field intensity* or magnetic intensity. *Its magnitude may be defined as the number of ampere – turns (nI) flowing round the unit length of the solenoid required to produce the given magnetising field.* Thus

$$H = nI$$

$$\therefore B_0 = \mu_0 nI = \mu_0 H or H = \frac{B_0}{\mu_0}$$

Magnetic Permeability. Permeability is the measure of the extent to which a material can be penetrated or permeated by a magnetic field. *The magnetic permeability of a material may be defined as the ratio of its magnetic induction B to the magnetic intensity H.*

$$\mu = \frac{B}{H}$$

Clearly, SI unit of μ

$$= \frac{tesla}{amperemetre^{-1}}$$

$$= teslametreampere^{-1} or TmA^{-1}$$

$\therefore$ Dimensions of $\mu = [MLT^{-2} A^{-2}]$.

Magnetic susceptibility. Magnetic susceptibility measures the ability of a substance to take up magnetisation when placed in a magnetic field. *It is defined as the ratio of the intensity of magnetisation M to the magnetising field intensity H.* It is denoted by χ_m. Thus, $\chi_m = \frac{M}{H}$

As magnetic susceptibility is the ratio of two quantities having the same units (Am^{-1}), so it has no units.

16. Soln. Curie's law. From experiments, it is found that the intensity of magnetisation (M) of a paramagnetic material is

(i) Directly proportional to the magnetising field intensity H, because the latter tends to align the atomic dipole moments.

(ii) Inversely proportional to the absolute temperature T, because the latter tends to oppose the alignment of the atomic dipole moments.

Therefore at low H/T values, we have

$$M \propto \frac{H}{T}$$

Or $M = C.\frac{H}{T}$

Or $\frac{M}{H} = \frac{C}{T} or \chi_m = \frac{C}{T}$

Here C is curie constant and χ_m is the susceptibility of the material. The above relation is called *Curie's law.* This law states that far away saturation, the susceptibility of a paramagnetic material is inversely proportional to the absolute temperature.

Temperature at which a ferromagnetic substance becomes paramagnetic is called curie temperature of Curie point T_C.

Above the curle point i.e., the paramagnetic phase, susceptibility varies with temperature as

$$\chi_m = \frac{C}{T-T_C} \qquad (T > T_C)$$

Where C is a constant. This is modified Curie's law for a ferromagnetic material above the Curie temperature. It is also known as Curie – Weiss law. This law states that the susceptibility of a ferromagnetic substance above its Curie temperature is inversely proportional to the excess of temperature above the Curie temperature.

17. Soln. (i) Low coercivity and high permeability

(ii) Gauss's law in magnetism: The net magnetic flux through any closed surface is zero.

$$\oint B.ds = 0$$

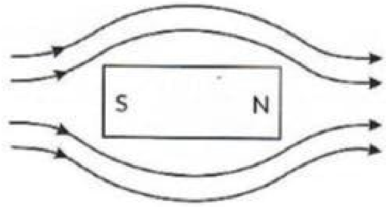
Gauss's Law in electrostatics: The net electric flux through any closed surface is $\frac{1}{\varepsilon_0}$times the net charge.

$$\oint E.ds = \frac{q}{\varepsilon_0}$$

The difference between the Gauss's law of magnetism and that for electrostatic is a reflection of the fact that magnetic monopole do not exist i.e., magnetic poles always exist in pairs.

18. Soln. A diamagnetic specimen would tend to move towards the region of weaker magnetic field while a paramagnetic specimen would tend to move towards the region of stronger magnetic field.

19. Soln. Behaviour of magnetic field lines when a diamagnetic substance is placed in an external field.



20. Soln. The relative permeability is an intrinsic property of a magnetic material. A related quantity is the magnetic susceptibility, denoted by χ_m.

$\mu_r = 1 + \chi_m \qquad [\because \mu_r = 0.5]$

Here, $\mu_r < 1$ (χ_m negative), so the material is termed as diamagnetic.

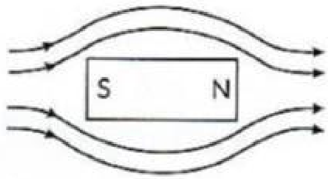
21. Soln.

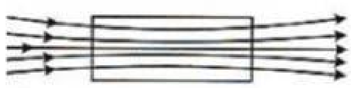
S.No.	Paramagnetic substance	Diamagnetic substance
1.	A paramagnetic substance is feebly attracted by a magnet.	A diamagnetic substance is feebly repelled by a magnet.
2.	For a paramagnetic substance, the intensity of magnetisation has a small positive value.	For a diamagnetic substance, the intensity of magnetisation has a small negative value.

22. Soln.

(i) Behaviour of magnetic field lines when a diamagnetic substance is placed in an external field.

(ii) Behaviour of magnetic field lines when a paramagnetic substance is placed in an external field.



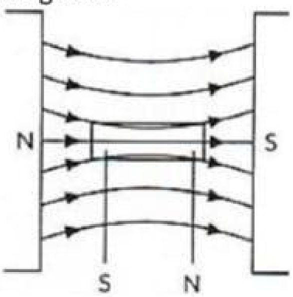


Atoms/molecules of a diamagnetic substance contain even number of electrons and these electrons form the pair of opposite spin; while the atoms/molecules of a paramagnetic substance have excess of electrons spinning in the same direction.

23. Soln.

S.No.	Paramagnetic	Diamagnetic	Ferromagnetic
1.	Substances are feebly attracted by the magnet. Na, K, Mg, Mn, Al, Cr, Sn and liquid oxygen are paramagnetic.	Substances are feebly repelled by the magnet. Bi, Cu, Ag, Hg, Pb, water, hydrogen He, Ne, etc., are diamagnetic.	Substances are strongly attracted by the magnet. Fe, Co, Ni and their alloys are ferromagnetic.
2.	χ_m is small, positive and varies inversely with temperature, i.e., $\chi_m \propto (1/T)$.	Susceptibility χ_m is small, negative and temperature independent.	χ_m is very large, positive and temperature dependent.
3.	μ_r is slightly greater than unity, i.e., $\mu > \mu_0$	Relative permeability μ_r is slightly lesser than unity, i.e., $\mu < \mu_0$	μ_r is much greater than unity, i.e., $\mu >> \mu_0$.

24. Soln. As $\chi = 0.9853$, so material is paramagnetic.



The behaviour of magnetic field lines in the presence of a paramagnetic substance is shown:

25. Soln. (i) For $\theta = 0^0$ between $\vec{M}$ and $\vec{B}$, dipole is in stable equilibrium.

(ii) For $\theta = 180^0$ between $\vec{M}$ and $\vec{B}$, dipole is in unstable equilibrium.

Potential energy, $U = -\vec{M}.\vec{B}$

At $\theta = 0^0, U_i = -MB\cos 0^0 = -MB$

$= -0.30 \times 0.50 = -0.15J$

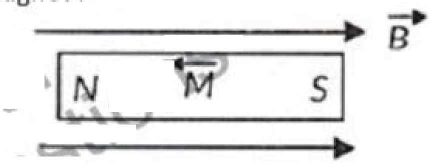
At $\theta = 180^0, U_f = -MB\cos 180^0 = MB = +0.15J$

Torque on magnet is $\tau = MB\sin\theta$

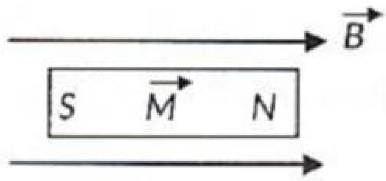
At $\theta = 0^0, \tau = MB\sin 0^0 = 0$

At $\theta = 180^0, \tau = MB\sin 180^0 = 0$

26. Soln. $\theta_1 = 180^0$ between $\vec{M}$ and $\vec{B}$ of bar magnet P



Whereas $\theta_2 = 0^0$ between $\vec{M}$ and $\vec{B}$ of bar magnet Q



So, force and toque on both the magnets due to magnetic field is zero, and the hence both are in equilibrium.

But $U = -MB\cos\theta$

i.e., Potential energy possessed by P is +MB, whereas by Q is -MB. So magnet Q with less potential energy is in stable equilibrium.

27. Soln.

$T = 2\pi \times \sqrt{\frac{I}{MB}}, 0.67 = 2\pi\sqrt{\frac{7.5\times10^{-6}}{6.7\times10^{-2}(B)}}$

$B = 0.01T$