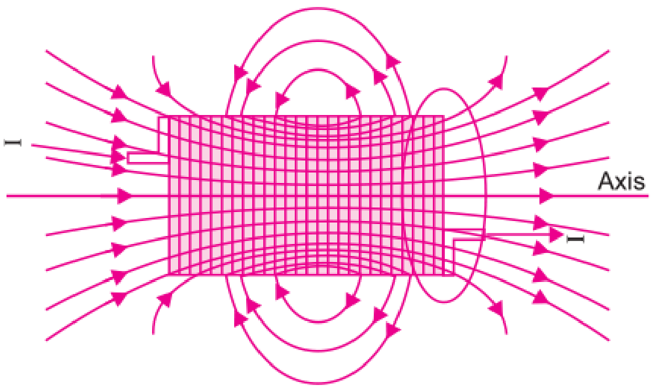
Short Answer Questions –II (PYQ)

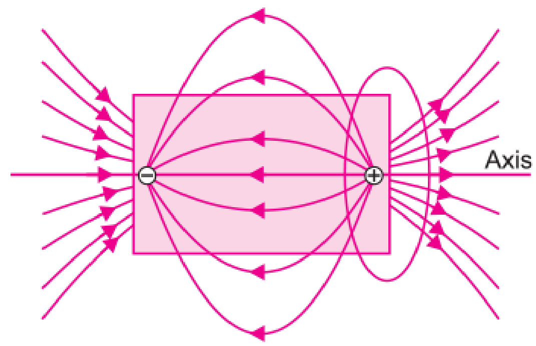
Q. 1. Depict the field-line pattern due to a current carrying solenoid of finite length.

(i) In what way do these lines differ from those due to an electric dipole?

(ii) Why can't two magnetic field lines intersect each other? [CBSE (F) 2009]



Field fines of a current carrying solenoid



Field fines of an electric dipole

Ans. Two magnetic field lines cannot intersect because at the point of intersection, these will be two directions of magnetic field which is impossible.

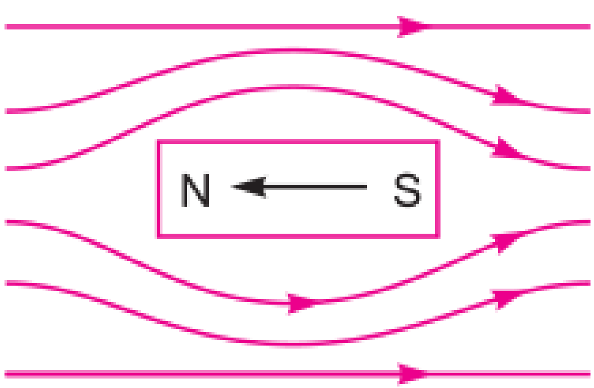
Q. 2. Explain the following:

(i) Why do magnetic field lines form continuous closed loops?

(ii) Why are the field lines repelled (expelled) when a diamagnetic material is placed in an external uniform magnetic field? [CBSE (F) 2011]

Ans. (i) Magnetic lines of force form continuous closed loops because a magnet is always a dipole and as a result, the net magnetic flux of a magnet is always zero.

(ii) When a diamagnetic substance is placed in an external magnetic field, a feeble magnetism is induced in opposite direction. So, magnetic lines of force are repelled.



Q. 3. Answer the following questions.

(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 is it different from Gauss's law in electrostatics and why? [CBSE South 2016]

Ans. (i) Low coercivity and high permeability

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

$$\oint B.\mathrm{ds} = 0$$

Gauss's Law in electrostatics: The net electric flux through any closed surface is $\frac{1}{\varepsilon 0}$ times the net charge.

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

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.

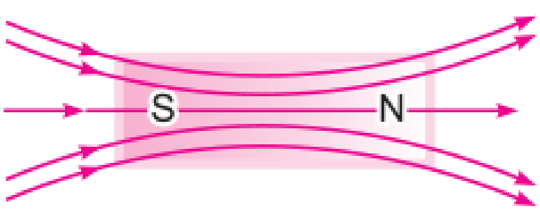
Q. 4. Show diagrammatically the behaviour of magnetic field lines in the presence of (i) paramagnetic and (ii) diamagnetic substances. How does one explain this distinguishing feature? [CBSE (AI) 2014]

OR

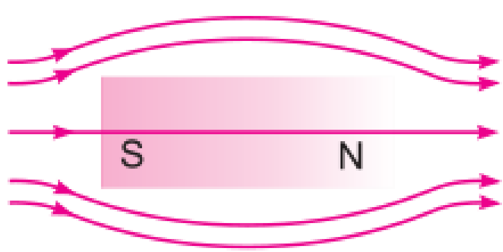
Draw the magnetic field lines distinguishing between diamagnetic and paramagnetic materials.

Give a simple explanation to account for the difference in the magnetic behaviour of these materials. [CBSE Bhubaneshwar 2015, Central 2016]

Ans.



Paramagnetic substance



Diamagnetic substance

A paramagnetic material tends to move from weaker field to stronger field regions of the magnetic field. So, the number of lines of magnetic field increases when passing through it. Magnetic dipole moments are induced in the direction of magnetic field. Paramagnetic materials has a small positive susceptibility.

A diamagnetic material tends to move from stronger field to weaker field region of the magnetic field. So, the number of lines of magnetic field passing through it decreases. Magnetic dipole moments are induced in the opposite direction of the applied magnetic field. Diamagnetic materials has a negative susceptibility in the range ($-1 \le x < 0$).

Q. 5. Answer the following questions.

(i) What happens when a diamagnetic substance is placed in a varying magnetic field?

(ii) Name the properties of a magnetic material that make it suitable for making (a) a permanent magnet and (b) a core of an electromagnet. [CBSE (F) 2009]

Ans. (i) A diamagnetic substance is attracted towards a region of weaker magnetic field.

(ii) (a) Permanent magnets are made of steel which is characterised by **high retentivity** and **high coercivity.**

(b) Electro magnets are made of soft iron which is characterised by **high retentivity** and **low coercivity.**

Q. 6. In what way is Gauss's law in magnetism different from that used in electrostatics? Explain briefly.

The Earth's magnetic field at the Equator is approximately 0.4 G. Estimate the Earth's magnetic dipole moment. Given: Radius of the Earth = 6400 km. [CBSE Patna 2015]

Ans. As we know that

Isolated positive or negative charge exists freely. So, Gauss's law states that

$$\oint \vec{E} \, . \, d\vec{S} = \frac{1}{\varepsilon_0} [q]$$

Isolated magnetic poles do not exist. So, Gauss's law states that

$$\oint \vec{B} \, . \, \overrightarrow{dS} = 0$$

Magnetic field intensity at the equator is

$$B = \frac{\mu_0}{4\pi} \cdot \frac{m}{R^3} = 10^{-7} \frac{m}{R^3}$$

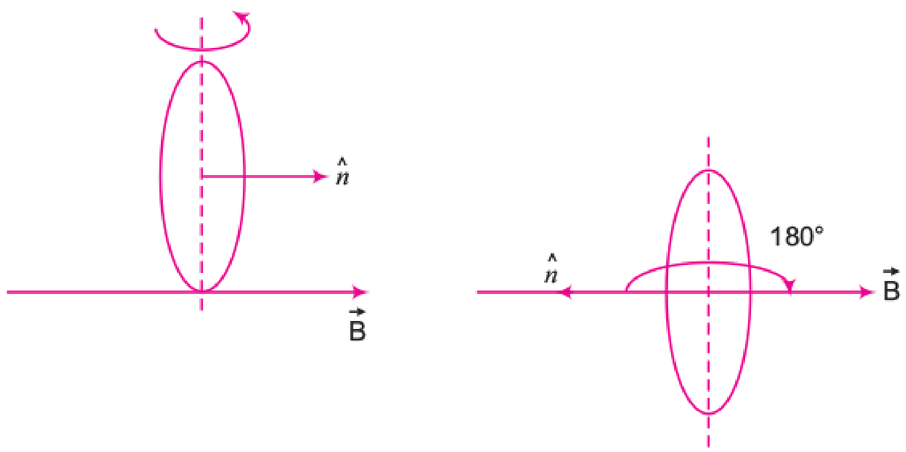
$$\therefore \quad m = 10^7 \cdot B|R|^3$$

$$= 10^7 \times 0.4 \times 10^{-4} \times (6400 \times 10^3)^3$$

$$= 1.1 \times 10^{23} \text{ Am}^2$$

Q. 7. A circular coil of radius 10 cm, 500 turns and resistance 200 W is placed with its plane perpendicular to the horizontal component of the Earth's magnetic field. It is rotated about its vertical diameter through 180° in 0.25 s. Estimate the magnitudes of the emf and current induced in the coil. (Horizontal component of the Earth's magnetic field at the place is 3.0 × 10^{-5} T) [CBSE (F) 2015]

Ans.



Initial magnetic flux, φi = NBA

= 500 × 3 × 10^{-5} × π (0.1)2

= 15 π × 10^{-5} Wb

On turning by 180°

Final flux, φf = – NBA = – 15 π × 10^{-5} Wb

Magnitude of induced emf, $e = -\frac{d\varphi}{dt}$

$$= \frac{2 \times 15\pi \times 10^{-5}}{0.25} = 120\pi \times 10^{-5} \text{ volt}$$

$$= 376.8 \times 10^{-5} = 0.038 \text{ volt}$$

Induced current, $I = \frac{\varepsilon}{R} = \frac{0.038}{200} = 19_{10^{-5}}$

Short Answer Questions –II (OIQ)

Q. 1. What are permanent magnets? What is an efficient way of preparing a permanent magnet? Write two characteristic properties of materials which are required to select them for making permanent magnets.

Ans. Permanent Magnets: The magnets prepared from ferromagnetic materials which retain their magnetic properties for a long time are called permanent magnets.

An efficient way to make a permanent magnet is to place a ferromagnetic rod in a solenoid and pass a current. The magnetic field of the solenoid magnetises the rod.

The materials used for permanent magnet must have the following characteristic properties:

(i) High retentivity so that the magnet may cause strong magnetic field.

(ii) High coercivity so that the magnetisation is not wiped out by strong external fields, mechanical ill-treatment and temperature changes. The loss due to hysteresis is immaterial because the magnet in this case is never put to cyclic changes.

Q. 2. Distinguish between diamagnetic and ferromagnetic materials in respect of their (i) intensity of magnetisation (ii) behaviour in non-uniform magnetic field and (iii) susceptibility.

Ans.

S. No.	S. No.	S. No.	Ferromagnetic
(i)	Intensity of magnetisation	Negative and very small	Positive and very large

(i)	Behaviour in non-uniform magnetic field	Attracted towards a region of weaker magnetic field	Attracted towards a region of stronger magnetic field.
(iii)	Susceptibility	Negative and small 0<χ<∈∈ small quantity.	Positive and large χ of the order of hundreds & thousands.

Q. 3. The horizontal component of earth's magnetic field at a given place is 0.4 × 10^{-4} Wb/m^2 and angle of dip is 30°. Calculate the value of (i) Vertical component (ii) Total intensity of earth's magnetic field.

Ans.

i. Given $H = 0.4 \times 10^{-4}$ Wb/m^2, $\theta = 30^\circ$

$$\tan\theta = \frac{V}{H} \Rightarrow \text{vertical component } V = H \tan\theta = 0.4 \times 10^{-4} \times \tan 30^\circ$$

$$= \frac{0.4\times10^{-4}}{\sqrt{3}} = 0.23 \times 10^{-4}\,\text{Wb}/m^2$$

ii. Total intensity of earth's magnetic field

$$B_e = \sqrt{H^2 + V^2} = \sqrt{(0.4\times10^{-4})^2 + \left(\frac{0.4\times10^{-4}}{\sqrt{3}}\right)^2} = 0.46 \times 10^{-4}\,\text{Wb}/m^2$$

Q. 4. The magnetic properties of the different materials A, B and C are shown in the following table:

Material	Permeability	Susceptibility	Temperature dependence of susceptibility
A	Low positive	Small but negative	Independent of temperature
B	High	Very high 1	Susceptibility decreases with temperature
C	Greater than 1	Small but positive	Decreases with temperature

Which of the above three materials should be used for making an electromagnet and why?

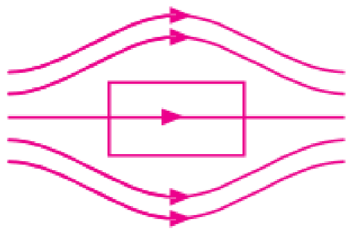
Ans. The material to be used for making an electromagnet should have high permerability and low retentivity. Moreover, less energy should be utilised for magnetisation of the material.

Thus, material B should be used for making the core of an electromagnet.

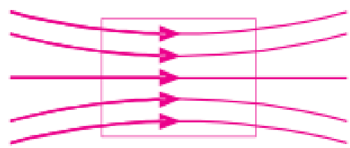
Q. 5. Draw diagrams to depict the behaviour of magnetic field lines near a 'bar' of:

(i) Copper (ii) Aluminium (iii) Mercury, cooled to a very low temperature (4.2K

Ans. (i) Copper is diamagnetic. **(ii)** Aluminium is paramagnetic.

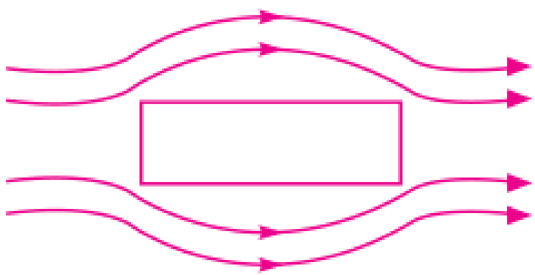


Magnetic field lines near copper bar



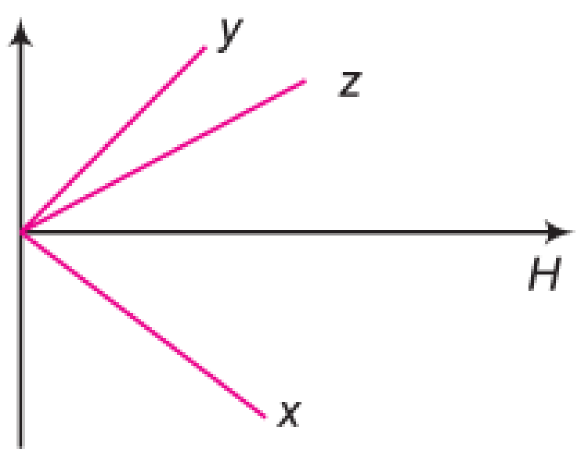
Magnetic field lines near aluminium bar

(iii) Mercury cooled to low temperature (4.2 K) is a super conductor. It behaves as a perfect diamagnetic, so no lines of force passes through it.



Mercury cooled to 4.2 K behaves as a diamagnet

Q. 6. The variation of intensity of magnetisation I and the applied magnetic field intensity H for three magnetic materials X, Y and Z are as shown in the given graphs.



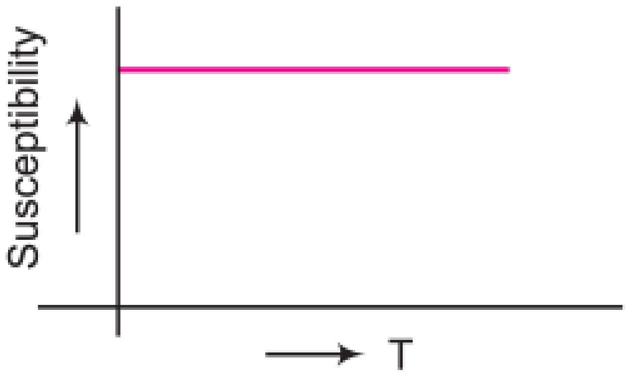
(i) Identify the materials X, Y and Z.

(ii) Show graphically the variation of susceptibility with temperature for X.

(iii) Put of Y and Z, which of the material will you prefer for making transformer cores and why?

Ans. (i) X — diamagnetic, Z — paramagnetic, Y — ferromagnetic

(ii) For X



(iii) Y will be preferred to be used in the transformer core because it has high permeability and low hysteresis loss.