Chapter–5: Magnetism and Matter

Current loop as a magnetic dipole and its magnetic dipole moment, magnetic dipole moment of a revolving electron, magnetic field intensity due to a magnetic dipole (bar magnet) along its axis and perpendicular to its axis, torque on a magnetic dipole (bar magnet) in a uniform magnetic field; bar magnet as an equivalent solenoid, magnetic field lines; earth's magnetic field and magnetic elements.

Para-, dia- and ferro - magnetic substances, with examples. Electromagnets and factors affecting their strengths, permanent magnets.

PHYSICS CLASS-XII –MAGNETISM & MATTER

301*. Define the term magnetic dipole moment of a current loop. **CBSE (AI)-2008**

[Ans. Magnetic moment of a current loop is defined as the product of current (I) and the area (A) enclosed by the current loop i,e, $M = \mathrm{I}A$

302*. Write the expression for the magnetic moment of a circular coil of area A, carrying current I, in a vector form.

[Ans. $\overrightarrow{M} = NI\,\overrightarrow{A}$ **CBSE (F)-2014,(AI)-2002**

303*. An electron in an atom revolves around the nucleus in an orbit of radius r with frequency ν. Write the expression for the magnetic moment of the electron. **CBSE (F)-2014**

[Ans. $M = \mathrm{I}A = \frac{e}{T}\,\mathrm{X}\,\pi\, r^2 = e\nu\pi\, r^2$

304*. What are S.I. units of pole strength and magnetic moment ? **CBSE (AI)-2003**

[Ans. S.I. unit of pole strength : Ampere-metre

S.I. unit of magnetic moment: Ampere-$metre^2$

305*. What is the direction of magnetic moment ? **CBSE (AIC)-2003**

[Ans. from south to north pole

306*. How does the (i) pole strength and (ii) magnetic moment of each part of a bar magnet is change, if it is cut into two equal pieces transverse to its length ? **CBSE (AI)-2003**

[Ans. **(i)** pole strength (m) will remain same

(ii) magnetic moment(M) will be halved as $M' = m\ \mathrm{X}\ \frac{2l}{2} = M/2$

307*. How does the (i) pole strength and (ii) magnetic moment of each part of a bar magnet is change, if it is cut into two equal pieces along its length ? **CBSE (AI)-2003**

[Ans. **(i)** pole strength (m) will be halved

(ii) magnetic moment(M) will be halved as $M' = \frac{m}{2}\,\mathrm{X}\,2l = M/2$

308*. Why is current loop considered as a magnetic dipole ? **CBSE (AIC)-2001**

[Ans. Like a bar magnet, a current loop possesses magnetic moment (M =NIA) and experiences a torque in magnetic field

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309*. Write two properties of a material suitable for making (a) a permanent magnet, and (b) an electromagnet.

[Ans. **(a) For making permanent magnet :** **CBSE (AI)-2017,2016,(D)-2010,(F)-2009**

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

(b) For making electromagnet :

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

310*. Mention the two characteristic properties of a material suitable for making core of a transformer. **CBSE (AI)-2012**

[Ans. (i) Low coercivity/ Low retentivity (ii) High permeability

311*. What are permanent magnets ? Give one example. **CBSE (D)-2013**

[Ans. Permanent magnets are the materials, which retain their magnetic properties at room temperature for a long time For example : Magnets used in speakers made by steel

312*. Which material is used in making permanent magnets and why ? **CBSE (AI)-2010**

[Ans. **Steel/alnico,** because it has high coercivity and high retentivity

313*. Why do we prefer to use the alloy alnico for making permanent magnets ? **CBSE (AI)-2004**

[Ans. because alnico has high coercivity and high retentivity

314*. Which material is used to make electromagnet and why ? **CBSE (AI)-2010**

[Ans. **Soft iron,** because it has low hysteresis loss/low coercivity and high permeability

315*. Why is soft iron preferred for making the core of a transformer ? **CBSE (AIC)-2010**

OR

Why is the core of an electromagnet made of ferromagnetic materials ? **CBSE (D)-2010**

[Ans. Because soft iron (ferromagnetic materials) has low hysteresis loss/low retentivity and high permeability

316*. Which material is used for making the core of a moving coil galvanometer and why ? **CBSE (DC)-2006**

[Ans. **Soft iron,** because it has low hysteresis loss/low retentivity and high permeability

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317*. Name the three elements of Earth's magnetic field. **CBSE (F)-2011**

[Ans. Elements of Earth's magnetic field :

(i) Magnetic declination (θ)

(ii) Angle of dip or magnetic inclination (δ)

(iii) Horizontal component of earth's magnetic field (B_H)

318* What is the angle of dip at equator ? **CBSE (AIC)-2010**

[Ans. zero **(**0^0**)**

319*. What is the angle of dip at magnetic poles ? **CBSE (AIC)-2001**

[Ans. 90^0

320*. How does angle of dip varies from equator to poles ? **CBSE (F)-2009,2003**

[Ans. angle of dip increases from zero to 90^0 on moving from equator to poles

321*. Where on the surface of Earth is the angle of dip zero ? **CBSE (AI)-2011**

[Ans. At equator

322*. Where on the surface of Earth is the angle of dip 90^0 ? **CBSE (AI)-2011**

[Ans. At poles

323*. Where on the Earth's surface is the value of angle of dip (i) minim um (ii) maximum ? **CBSE (D)-2003**

[Ans. (i) at equator $(\delta = 0^0)$ (ii) At poles $(\delta = 90^0)$

324*. Where on the surface of Earth is the vertical component of Earth' s magnetic field zero ? **CBSE (AI)-2011,2003,(F)-2010**

[Ans. At equator

Reason : At equator, $\delta = 0^0 \Rightarrow B_V = B_e \sin\delta = B_e \sin 0 = 0$

325*. What will be the value of the horizontal component of the Earth's magnetic field at the Earth's geometric pole ?

[Ans. Zero

Reason : At poles $\delta = 90^0$, $\Rightarrow B_H = B_e \cos\delta = B_e \cos 90^0 = 0$

326*. A small magnet is pivoted to move freely in the magnetic meridian. At what place on the surface of the earth will the magnet be vertical ? **CBSE (F)-2012**

[Ans. At poles

327*. A magnetic needle, free to rotate in a vertical plane, orients itself vertically at a certain place on the earth. What are the values of (i) angle of dip at this place, and (ii) horizontal component of earth's magnetic field **CBSE (F)-2012**

[Ans. (i) 90^0 (ii) $B_H = B_e \cos\delta = B_e \cos 90^0 = 0$

328* The horizontal component of earth's magnetic field at a place is B_H and the angle of dip is 60^0. What is the value of vertical component of earth's magnetic field at equator ? **CBSE (D)-2012**

[Ans. Zero, Reason : at equator, $\delta = 0$, so $B_V = B_H \tan\theta = B_H \tan 0 = 0$

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

[Ans. As $B_V = B_H \Rightarrow \tan\delta = \frac{B_V}{B_H} = 1 \Rightarrow \delta = 45^0$ **CBSE (F)-2012,(AI)-2011**

330*. Horizontal component of earth's magnetic field at a place is $\sqrt{3}$ times the vertical component. What is the value of angle of dip at this place ? **CBSE (DC)-2007**

[Ans. As $B_H = \sqrt{3}\, B_V \Rightarrow \tan\delta = \frac{B_V}{B_H} = 1/\sqrt{3} \Rightarrow \delta = 30^0$

331*. The vertical component of earth's magnetic field at a place is $\sqrt{3}$ times the horizontal component. What is the value of angle of dip at this place ? **CBSE (D)-2006**

[Ans. As $B_V = \sqrt{3}\, B_H \Rightarrow \tan\delta = \frac{B_V}{B_H} = \sqrt{3} \Rightarrow \delta = 60^0$

332*. At a place the horizontal component of magnetic field is B and angle of dip is 60^0. What is the value of horizontal component of the Earth's magnetic field at equator ? **CBSE (D)-2017**

[Ans. Given : In first case, $B_H = B$, $\delta = 60^0$,

$$B_H = B_e \cos\delta \Rightarrow B_e = \frac{B_H}{\cos\delta} = \frac{B}{\cos 60^0} = \frac{B}{1/2} = 2\,B$$

In second case, at equator, $\delta = 0^0 \Rightarrow B_H = B_e \cos\delta = 2\,B \cos 0^0 = 2\,B$

333*. Which of the following substances are diamagnetic ? **CBSE (D)-2013,(AIC)-2009**

Bi, Al, Na, Cu, Ca and Ni

[Ans. Bi and Cu both are diamagnetic substances

334*. Which of the following substances are paramagnetic ? **CBSE (D)-2013**

$Bi, Al, Cu, Ca\ Pb$ and Ni

[Ans. Al is a paramagnetic substance

335*. Define the term intensity of magnetization. **CBSE (AIC)-2006**

[Ans. Intensity of magnetization : It is defined as the magnetic moment per unit volume of the material when placed in a magnetizing field

$$I = \frac{M}{V}$$

336*. Define the term magnetic susceptibility. **CBSE (AIC)-2006**

[Ans. Magnetic susceptibility(χ_m)**:** It is defined as the ratio of intensity of magnetization (I) to the magnetizing field intensity (H)

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

337*. What do you mean by the statement that "Susceptibility of Iron is more than that of copper" ? **CBSE (AIC)-2003**

[Ans. It means that iron can be magnetized more easily than copper

338*. Why do magnetic lines of force prefer to pass through ferromagnetic materials (e.g., Iron) than through air ?

[Ans. It is because magnetic permeability & susceptibility of ferromagnetic materials is very high than that of air

339*. What happens when a diamagnetic substance is placed in a varying magnetic field ? **CBSE (F)-2009**

[Ans. Diamagnetic substance tends to move from stronger to the weaker parts of the varying magnetic field

340*. What is the characteristic property of a diamagnetic material ? **CBSE (F)-2010**

[Ans. When a diamagnetic material is placed in an extern al magnetic field, it acquires a slight magnetism in a direction opposite to that of the magnetic field

341*. What is Curie point ? **CBSE (AIC)-2001**

[Ans. Curie Point : It is the temperature above which a ferromagnetic substance becomes paramagnetic

342*. State Curie law. **CBSE (AIC)-2001**

[Ans. Curie Law : The susceptibility of a paramagnetic material is inversely proportional to the absolute temperature

i,e, $\chi_m = \frac{C}{T}$

343*. The permeability of a magnetic material is 0.9983. Name the type of magnetic material it represents.

[Ans. As $\mu < 1$, so the given material is diamagnetic **CBSE (D)-2011**

344*. The susceptibility of a magnetic material is $-4.2 \text{ X } 10^{-6}$. Name the type of magnetic material it represents.

[Ans. As susceptibility is negative, so the given material is diamagnetic **CBSE (D)-2011**

345*. The susceptibility of a magnetic material is $1.9 \text{ X } 10^{-5}$. Name the type of magnetic material it represents.

[Ans. As susceptibility is positive, so the given material is Paramagnetic **CBSE (D)-2011**

346*. How does the intensity of magnetization of a paramagnetic material vary with increasing applied magnetic field ?

[Ans. for small magnetic field, intensity of magnetization increases with magnetic field $(I \propto B)$ **CBSE (AIC)-2006**
but at strong magnetic field, intensity of magnetization gets saturated and becomes independent of B

347*. How does the intensity of magnetization of a paramagnetic sample vary with temperature ? **BSE (AI)-2001**

[Ans. Intensity of magnetization decreases with increase in temperature $I \propto \frac{1}{T}$

Reason : on increasing the temperature, tendency to disrupt the alignment of atomic dipoles increases

348*. Why does the magnetization of a paramagnetic sample increase on cooling ? **CBSE (AIC)-2006**

[Ans. Intensity of magnetization increases with decrease in temperature $I \propto \frac{1}{T}$

Reason : on decreasing the temperature, tendency to disrupt the alignment of atomic dipoles decreases

349*. How does the magnetization of a diamagnetic material change on cooling ? **CBSE (AIC)-2006**

[Ans. No effect, because magnetism of a diamagnetic material does not depend on temperature

350*. Why is diamagnetism independent of temperature ? **CBSE (AIC)-2001**

[Ans. The induced dipole moment in a diamagnetic material is always opposite to the magnetizing field. It does not depend on the internal motion of atoms

351*. State Gauss's law in magnetism. How is it different from Gauss's law in electrostatics and why ?**CBSE (AI)-2016**

[Ans. Gauss's law in magnetism : The net magnetic flux through a closed surface is zero

i,e, $\phi_B = \oint \vec{B}.\vec{ds} = 0$

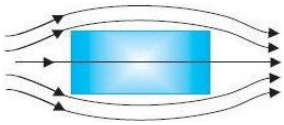
Gauss's law in electrostatics : The net electric flux through any closed surface is $\frac{1}{\varepsilon_0}$ times the net charge enclosed

i,e, $\phi_E = \oint \vec{E}.\vec{ds} = \frac{q}{\varepsilon_0}$

It indicates that mono pole does not exists/ magnetic poles always exists as unlike pairs of equal strengths

352*. 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.

[Ans. **CBSE (DC)-2017,(F)-2016,(AI)-2015,2014**



(i) Diamagnetic

(ii) Paramagnetic

Explanation : When a diamagnetic material is placed in an external magnetic field, atoms acquire net magnetic moment opposite to field, and material acquires a slight magnetism in the opposite direction of field. Hence, magnetic field lines are repelled or expelled.

When a paramagnetic material is placed in an external magnetic field, atomic magnets align themselves along the field direction and material acquires a slight magnetism in the direction of field. Hence, magnetic field lines are attracted

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353*. In what way is the behaviour of a diamagnetic material different from that of a paramagnetic, when kept in an external magnetic field. **CBSE (AI)-2016**

[Ans. Behaviour of a diamagnetic and paramagnetic material in an external magnetic field

Diamagnetic	Paramagnetic
1. A diamagnetic specimen is repelled by a magnet	1. A paramagnetic specimen is attracted by a magnet
2. A diamagnetic specimen would move towards the weaker region of the magnetic field	2. A paramagnetic specimen would move towards the stronger region of the magnetic field
3. A diagrammatic rod aligned perpendicular to the magnetic field	3. A paramagnetic rod aligned along the magnetic field

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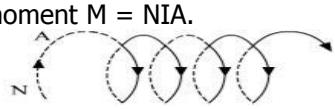
354*. The Earth's magnetic field at the Equator is approximately 0.4 G. Estimate the Earth's magnetic dipole moment. (Given : Radius of the Earth = 6400 km) **CBSE (AI)-2015**

[Ans. $B = \frac{\mu_0}{4\pi}\frac{M}{R^3} = 10^{-7}\,\mathrm{X}\,\frac{M}{R^3}$

$\Rightarrow \quad M = \frac{0.4\,\mathrm{X}\,10^{-4}\,\mathrm{X}\,(6400\,X\,10^3)^3}{10^{-7}} = 1.1\,\mathrm{X}\,10^{23}\ Am^2$

355* An observer to the left of a solenoid of N turns each of cross section area A observes that a steady current I in it flows in the clockwise direction. Depict the magnetic field lines due to the solenoid specifying its polarity and show that it acts as a bar magnet of magnetic moment M = NIA. **CBSE (D)-2015**



[Ans. The solenoid contains N loops, each carrying a current I. Therefore, each loop acts as a magnetic dipole having dipole moment **m** = I**A**. The magnetic moments of all loops are aligned along the same direction. Hence, net magnetic moment equals M= N1**A**