Ravi Maths Tuition

Magnetism and Matter

12th Standard

Physics

Multiple Choice Question 55 x 1 = 55

1) Two magnets have the same length and the same pole strength. But one of the magnets has a small hole at its centre. Then,

(a) both have equal magnetic moment (b) one with hole has small magnetic moment

(c) one with hole has large magnetic moment (d) one with hole loses magnetism through the hole

2) A large magnet is broken into two pieces so that their lengths are in the ratio 2 : 1. The pole strengths of the two pieces will have ratio.

(a) 2: 1 (b) 1: 2 (c) 4: 1 (d) 1: 1

3) The intensity of magnetic field at a point X on the axis of a small magnet is equal to the field intensity at another point Y on equatorial axis. The ratio of distance of X and Y from the centre of the magnet will be

(a) $(2)^{-3}$ (b) $(2)^{-1/3}$ (c) 2^{3} (d) $2^{1/3}$

4) Work done in rotating a bar magnet from 0 to angle 120° is

(a) $\frac{1}{2}$ MB (b) $\frac{3}{2}$ MB (c) MB (d) $\frac{2}{3}$ MB

5) Gauss's law for magnetism is

(a) the net magnetic flux through any closed surface is B. $\triangle$S

(b) the net magnetic flux through any closed surface is E. $\triangle$S

(c) the net magnetic flux through any closed surface is zero (d) Both (a) and (c)

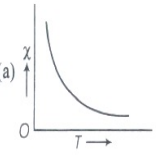
6) At a place angle of dip is 30°. If horizontal component of earth's magnetic field is H, then the total intensity of magnetic field will be

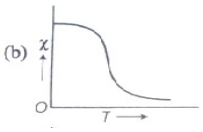
(a) H / 2 (b) 2H / $\sqrt{3}$ (c) H $\sqrt{3/2}$ (d) 2 H

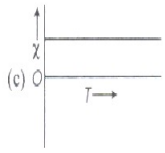
7) The value of angle of dip is zero at the magnetic equator because on it

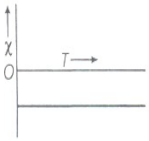
(a) V and Hare equal (b) the values of V and Hare zero (c) the value of V is zero (d) the value ofH is zero

8) The variation of magnetic susceptibility (x) with temperature for a diamagnetic substance is best represented by figure

(a) 

(b) 

(c) 

(d) 

9) The relative permeability of a substance X is slightly less than unity and that of substance Y is slightly more than unity, then

(a) X is paramagnetic and Y is ferromagnetic (b) X is diamagnetic and Y is ferromagnetic

(c) X and Y both are paramagnetic (d) X is diamagnetic and Y is paramagnetic

10) Cutting a bar magnet in half is like cutting a solenoid, such that we get two smaller solenoids with

(a) weaker magnetic properties (b) strong magnetic properties (c) constant magnetic properties

(d) Both (a) and (b)

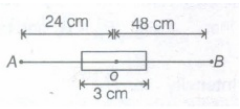
11) In a permanent magnet at room temperature,

(a) magnetic moment of each molecule is zero

(b) the individual molecules have non-zero magnetic moment which are all perfectly aligned

(c) domains are partially aligned (d) domains are all perfectly aligned

12) A bar magnet of length 3 cm has points A and B along axis at a distance of 24 cm and 48 cm on the opposite ends. Ratio of magnetic fields at these points will be



(a) 8 (b) 3 (c) 4 (d) $1/2\sqrt{2}$

13) A short bar magnet placed with its axis at 30° with an external field of 800 G experiences a torque of 0.016 Nm. The magnetic moment of the magnet is

(a) 4 Am^2 (b) 0.5 Am^2 (c) 2 Am^2 (d) 0.40 Am^2

14) The earth's magnetic field at the equator is approximately 0.4 G, the earth's dipole moment is

(a) 1×10^{23} Am^2 (b) 1.05×10^{23} Am^2 (c) 8×10^{22} Am^2 (d) 4×10^2 Am^2

15) At a certain place, horizontal component is $1/\sqrt{3}$ times the vertical component. The angle of dip at this place is

(a) zero (b) $\pi/3$ (c) $\pi/6$ (d) None of these

16) If a diamagnetic substance is brought near the North or the South-pole of a bar magnet, then it is

(a) attracted by the both poles (b) repelled by both the poles

(c) repelled by the North-pole and attracted by the South-pole

(d) attracted by the North-pole and repelled by the South-pole

17) Ferromagnetism show their properties due to

(a) filled inner subshells (b) vacant inner subshells (c) partially filled inner subshells

(d) all the subshells equally filled

18) The relative permeability of a substance is 0.9999. The nature of substance will be

(a) diamagnetic (b) paramagnetic (c) magnetic moment (d) intensity of magnetic field

19) Hysteresis loss is minimised by using

(a) alloy of steel (b) shell type of core (c) thick wire which has low resistance (d) metal

20) To make electromagnet, substance should be of

(a) high permeability and high susceptibility (b) low permeability and high susceptibility

(c) high permeability and low susceptibility (d) low permeability and low susceptibility

21) A toroid of n turns, mean radius R and cross-sectional radius a carries current I. It is placed on a horizontal table taken as x-y plane. Its magnetic moment m.

(a) is non-zero and points in the z-direction by symmetry. (b) points along the axis of the tortoid (m = mΦ).

(c) is zero, otherwise there would be a field falling as $\frac{1}{r^3}$ at large distances outside the toroid.

(d) is pointing radially outwards,

22) The magnetic field of Earth can be modelled by that of a point dipole placed at the centre of the Earth. The dipole axis makes an angle of 11.3° with the axis of Earth. At Mumbai, declination is nearly zero. Then,

(a) the declination varies between 11.3° W to 11.3° E (b) the least declination is 0°.

(c) the plane defined by dipole axis and Earth axis passes through Greenwich

(d) declination averaged over Earth must be always negative.

23) Consider the two idealized systems: (i) a parallel plate capacitor with large plates and small separation and (ii) a long solenoid of length L > > R, radius of cross-section. In (i) E is ideally treated as a constant between plates and zero outside. In (ii) magnetic field is constant inside the solenoid and zero outside. These idealised assumptions, however, contradict fundamental laws as below.

(a) case (i) contradicts Gauss's law for electrostatic fields.

(b) case (ii) contradicts Gauss's law for magnetic fields. (c) case (i) agrees with $\int E.\,dl = 0.$

(d) case (ii) contradicts $\int \boldsymbol{H}.\,dl = I_{en}$

24) A paramagnetic sample shows a net magnetisation of S Am^{-1} when placed in an external magnetic field of 0.6 T at a temperature of 4 K. When the same sample is placed in an external magnetic field of 0.2 T at a temperature of 16K, the magnetisation will be

(a) $\frac{32}{3}\mathrm{Am}^{-1}$ (b) $\frac{2}{3}\mathrm{Am}^{-1}$ (c) 6 Am^{-1} (d) 2.4 Am^{-1}

25) S is the surface of a lump of magnetic material.

(a) Lines of B are not necessarily continuous across S. (b) Some lines of B must be discontinuous across S.

(c) Lines of H are necessarily continuous across S. (d) Lines of H cannot all be continuous across S.

26) The primary origines of magnetism lies in

(a) Pauli exclusion principle. (b) polar nature of molecules (c) intrinsic spin of electron. (d) None of these

27) A long solenoid has 1000 turns per metre and carries a current of 1 A. It has a soft iron core of μ_r = 1000. The core is heated beyond the Curie temperature, T_c.

(a) The H field in the solenoid is (nearly) unchanged but the B field decreases drastically

(b) The H and B fields in the solenoid are nearly unchanged.

(c) The magnetisation in the core reverses direction. (d) The magnetisation in the core does not diminishes

28) Essential difference between electrostatic shielding by a conducting shell and magnetostatic shielding is due to

(a) electrostatic field lines cannot end on charges and conductors do not have free charges.

(b) lines of B can also end but conductors cannot end them.

(c) lines of B cannot end on any material and perfect shielding is not possible.

(d) shells of high permeability materials cannot be used to divert lines of B from the interior region.

29) Let the magnetic field on earth be modelled by that of a point magnetic dipole at the centre of earth. The angle of dip at a point on the geographical equator

(a) is always zero. (b) can be zero at specific points. (c) cannot be positive or negative (d) is not bounded.

30) A magnetic needle is kept in a non-uniform magnetic field. It experiences

(a) a torque but not a force (b) neither a force nor a torque (c) a force and a torque

(d) a force but not a torque

31) A 25 cm long solenoid has radius 2 ern and 500 total number of turns. It carries a current of 15 A. If it is equivalent to a magnet of the same size and magnetisation $\overline{\mathbf{M}}$, $\mathrm{then}\ |\overline{\mathbf{M}}|\ \mathrm{is}$

(a) $3\pi\mathbf{Am}^{-1}$ (b) $\mathbf{30000}\pi\mathbf{Am}^{-1}$ (c) 300 Am^{-1} (d) 30000 Am^{-1}

32) Three needles N_1, N_2 and N_3 are made of a ferromagnetic, a paramagnetic and a diamagnetic substance respectively. A magnet, when brought close to them, will

(a) attract N_1 strongly, but repel N_2 and N_3 weakly. (b) attract all three of them.

(c) attract N_1 and N_2 strongly but repel N_3 (d) attract N_1 strongly, N_2 weakly and repel N_3 weakly

33) Curie temperature is the temperature above which

(a) a ferromagnetic material becomes paramagnetic. (b) a ferromagnetic material becomes diamagnetic

(c) a paramagnetic material becomes diamagnetic (d) a paramagnetic material becomes ferromagnetic

34) The material suitable for making electromagnets should have

(a) high retentivity and high coercivity (b) low retentivity and low coercivity

(c) high retentivity and low coercivity (d) low retentivity and high coercivity

35) Curie law XT = constant, relating magnetic susceptibility (X) and absolute temperature (T) of magnetic substance is obeyed by

(a) all magnetic substances. (b) paramagnetic substances. (c) diamagnetic substances.

(d) ferromagnetic substances.

36) If M is magnetic moment and B is magnetic field intensity, then the torque is given by

(a) $\overline{\mathbf{M}} \cdot \overline{\mathbf{B}}$ (b) $\frac{|\overline{\mathbf{M}}|}{|\overline{\mathbf{B}}|}$ (c) $\overline{\mathbf{M}} \times \overline{\mathbf{B}}$ (d) MB

37) Angle of dip is 90° at

(a) poles. (b) equator. (c) both at equator and poles. (d) tropic of cancer.

38) Lines of force, due to earth's horizontal magnetic field, are

(a) elliptical (b) curved lines (c) concentric circles (d) parallel and straight

39) If the magnetising field on a ferromagnetic material is increased, its permeability

(a) is decreased (b) is increased (c) is unaffected (d) may be increased or decreased

40) A magnetic needle suspended parallel to a magnetic field requires $\sqrt{3}$ J of work to turn it through 60°. The torque needed to maintain the needle in this position will be

(a) $2\sqrt{3}$ J (b) 3 J (c) $\sqrt{3}$ J (d) $\frac{3}{2}$ J

41) The magnetic susceptibility of an ideal diamagnetic substance is

(a) +1 (b) 0 (c) -1 (d) ∞

42) The best material for the ore of a transformer is

(a) stainless steel (b) mild steel (c) hard steel (d) soft iron

43) Domain formation is the necessary feature of

(a) diamagnetism. (b) Paramagnetism. (c) ferromagnetism (d) all of these.

44) In which type of material the magnetic susceptibility does not depend on temperature

(a) Diamagnetic (b) Paramagnetic (c) Ferromagnetic (d) Ferrite

45) A diamagnetic material in a magnetic field moves

(a) perpendicular to the field (b) from weaker to stronger parts (c) from stronger to weaker parts.

(d) in random direction.

46) At a certain place on earth, $\boldsymbol{B_H = \frac{1}{\sqrt{3}} B_V}$ angle of dip at this place is

(a) 60° (b) 30° (c) 45° (d) 90°

47) The universal property among all substances is

(a) diamagnetism. (b) paramagnetism. (c) ferromagnetism. (d) all of these

48) At a point on the right bisector of a magnetic dipole, the magnetic

(a) potential varies as $\frac{1}{r^2}$ (b) potential is zero at aU points on the right bisector. (c) field varies as r^3

(d) field is perpendicular to the axis of dipole

49) A magnet of dipole moment M is aligned in equilibrium position in a magnetic field of intensity B. The work done to rotate it through an angle θ with the magnetic field is

(a) MB sin θ (b) MB cos θ (c) MB (1 - cos θ) (d) MB(l - sin θ)

50) A magnet can be completely demagnetised by

(a) breaking the magnet into small pieces (b) heating it slightly (c) dropping it into ice cold water

(d) a reverse field of appropriate strength

51) If a ferromagnetic material is inserted in a current carrying solenoid, the magnetic field of solenoid

(a) largely increases (b) slightly increases. (c) largely decreases (d) slightly decreases

52) An electron of charge e moves in a circular orbit of radius r around orbital motion of the electron is

(a) $\pi \text{ ver}^{2}$ (b) $\frac{\pi v r^2}{e}$ (c) $\frac{\pi v e}{r}$ (d) $\frac{\pi e r^2}{v}$

53) The magnetic lines of force inside a bar magnet

(a) are from north-pole to south-pole of the magnet (b) do not exist.

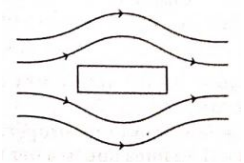
(c) depend upon the area of cross-section of the bar magnet.

(d) are from south-pole to north-pole of the magnet

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

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

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



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

Fill up / 1 Marks 10 x 1 = 10

56) Gauss's law in magnetism indicates that magnetic _____ do not exist.

57) Magnetic dipole moment associated with an electron due ro its orbital motion in first orbit of H-atom is known as _____.

58) Magnetic lines of force form closed loop. They converge at _____ pole and diverge at _____ pole.

59) Angle between the geographical meridian and magnetic meridian at the given place is known as _____.

60) Angle made by the earth's total magnetic field with the horizontal direction is known as _____.

61) S.I.unit of magnetic dipole moment is _____.

62) Magnetic moment developed per unit volume of a material when placed in a magnetising field is known as _____.

63) The value of the reverse magnetising field required to make the residual magnetism of a sample equal to zero is called _____.

64) Ratio of the intensity of magnet isation (M) induced to the magnetising field intensity (H) is known as _____.

65) Substances which when placed in a magnetising field get strongly magnetised in the direction of the magnetising field is known as _____.

Assertion and reason 11 x 1 = 11

66) **Assertion (A) :** Magnetic moment of an atom is due to both, the orbital motion and spin motion of every electron.
Reason (R) : A charged particle produces a magnetic field.
Codes:
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is NOT the correct explanation of A
(c) A is true but R is false
(d) A is false and R is also false

67) **Assertion (A) :** The earth's magnetic field is due to iron present in its core.
Reason (R) : At a low temperature magnet losses its magnetic property or magnetism.
Codes:
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is NOT the correct explanation of A
(c) A is true but R is false
(d) A is false and R is also false

68) **Assertion (A) :** The ends of a magnet suspended freely point out always along north south.
Reason (R) : Earth behaves as a huge magnet.
Codes:
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is NOT the correct explanation of A
(c) A is true but R is false
(d) A is false and R is also false

69) **Assertion (A) :** A compass needle when placed on the magnetic north pole of the earth rotates in vertical direction.
Reason (R) : The earth has only horizontal component of its magnetic field at the north poles
Codes:
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is NOT the correct explanation of A
(c) A is true but R is false
(d) A is false and R is also false

70) **Assertion (A)** : At neutral point, a compass needle point out in any arbitrary direction.
Reason (R) : Magnetic field of earth is balanced by field due to magnets at the neutral points
Codes:
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is NOT the correct explanation of A
(c) A is true but R is false
(d) A is false and R is also false

71) **Assertion (A)** : Magnetic moment is measured in joule/tesla or amp m^2.
Reason (R) : Joule/tesla is equivalent to amp m^2.
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but Ris NOT the correct explanation of A
(c) A is true but R is false
(d) A is false and R is also false

72) **Assertion (A)** : Earth's magnetic field does not affect the working of a moving coil galvanometer.
Reason (R) : The earth's magnetic field is < luiteweak as compared to magnetic field produced in the moving coil galvanometer.
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but Ris NOT the correct explanation of A
(c) A is true but R is false
(d) A is false and R is also false

73) **Assertion (A) :** Aclinic lines on the magnetic map represents lines of equal dip.
Reason (R) : When the horizontal and vertical components of the earth's magnetic field are equal, the angle of dip is 60°.
Codes:
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is NOT the correct explanation of A
(c) A is true but R is false
(d) A is false and R is also false

74) **Assertion (A)** : The true geographic north direction is found by using a compass needle.
Reason (R) : The magnetic meridian of the earth is along the axis of rotation of the earth.
Codes:
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is NOT the correct explanation of A
(c) A is true but R is false
(d) A is false and R is also false

75) **Assertion (A) :** There is only one neutral points on a horizontal board when a magnet is held vertically on the board.
Reason (R) : At the neutral point the net magnetic field due to the magnetic and magnetic field of the earth is zero.
Codes:
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is NOT the correct explanation of A
(c) A is true but R is false
(d) A is false and R is also false

76) **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

2 Marks 92 x 2 = 184

77) A short bar magnet placed with its axis at 30º with a uniform external magnetic field of 0.25 T experiences a torque of magnitude equal to 4.5 x 10^{-2} J. What is the magnitude of magnetic moment of the magnet?

78) If the solenoid in Exercise 5.5 is free to turn about the vertical direction and a uniform horizontal magnetic field of 0.25 T is applied, what is the magnitude of torque on the solenoid when its axis makes an angle of 30° with the direction of applied field?

79) What is the magnitude of the equatorial and axial fields due to a bar magnet of length 5.0 cm at a distance of 50 cm from its mid-point? The magnetic moment of the bar magnet is 0.40 A m^2, the same as in.

80) In the magnetic meridian of a certain place, the horizontal component of the earth's magnetic field is 0.26G and the dip angle is 60º. What is the magnetic field of the earth at this location?

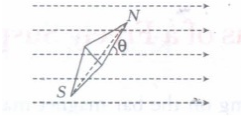
81) Consider a short magnetic dipole of magnetic length 20 cm. Find its geometric length.

82) A thin bar magnet of length 4L is bent at the mid-point, so that the angle between them is 60°. Find the new length of the bar magnet.

83) A magnetic wire of dipole moment 4π A-m^2 is bent in the form of semicircle. Find the new magnetic moment.

84) A bar magnet when suspended horizontally and perpendicular to the earth's magnetic field experiences a torque of 3 x 10^{-4} N-m. What is the magnetic moment of the magnet? Horizontal component of earth's magnetic field at that place is 0.4 x 10^{-4} T.

85) A magnetic needle is free to oscillate in a uniform magnetic field as shown in figure. The magnetic moment of magnetic needle is 7.2 A - m^2 and moment of inertia I = 6.5 x 10^{-6} kq - m^2. The number of oscillations performed in 5s is 10. Calculate the magnitude of magnetic field.

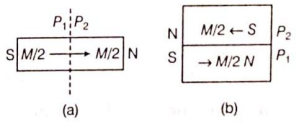


86) On what factors does the pole strength of a magnet depend?

87) What is Coulomb's law of magnetic force?

88) Define magnetic dipole moment. Also, write its SI unit.

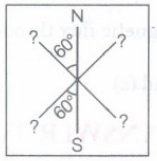
89) A bar magnet is cut into two equal parts as shown in the Fig. (a). One part is now kept over the other such that, the P_2 is above P_1 as shown in the Fig. (b).
If M is the magnetic moment of the original magnet, what would be the magnetic moment of new combination of magnets so formed?



90) A coil of N turns and radius R carries a current I. It is unwound and rewound to make a square coil of side a having same number of turns N. Keeping the current I same, find the ratio of the magnetic moments of the square coil and the circular coil.

91) Why do magnetic lines of force form continuous closed loops?

92) Three identical bar magnets are rivetted together at centre in the same plane as shown in the figure. This system is placed at rest in a slowly varying magnetic field. It is found that the system of magnets does not show any motion. The North-South poles of one magnet is shown in the figure. Determine the poles of the remaining two.



93) What happens to a bar magnet if it is cut into two pieces
(i) transverse to its length?
(ii) along its length?

94) State whether the given statement is correct or incorrect and explain it. "The magnetic field lines of a magnet form continuous closed loops unlike electric field lines."

95) A circular coil of closely wound N turns and radius r carries a current I. Write the expressions for the following:
(i) The magnetic field at its centre.
(ii) The magnetic moment of this coil

96) Two bar magnets having same geometry with magnetic moments M and 2M are placed in such a way that their similar poles are on the same side, then its time period of oscillation is T_1 Now, if the polarity of one of the magnets is reversed, then time period of oscillation is T_2, then find the relation between T_1 and T_2.

97) Suppose we want to verify the analogy between electrostatic and magneto static by an explicit experiment. Consider the motion of
(i) electric dipole p in an electrostatic field E and
(ii) magnetic dipole M in a magnetic field B.
Write down a set of conditions on E, B, p, M, so that the two motions are verified to be identical. (Assume identical initial conditions).

98) Answer the following
(i) Is it possibe to have a magnetic field configuration with three poles?
(ii) If magnetic monopoles existed, how would Gauss's law of magnetism be modified?

99) A short bar magnet has a magnetic moment of 0.48 J / T. Give the direction and magnitude of the magnetic field produced by the magnet at a distance of 10 cm from the centre of the magnet on
(i) the axis,
(ii) the equatorial lines (normal bisector) of the magnet.

100) The electron in a H - atom circles around the proton with a speed of 2.18×10^6 ms^{-1} in an orbit of radius 5.3×10^{-11} m.
Calculate
(i) the equivalent current
(ii) magnetic field produced at the proton.
Given, charge on electron is 1.6×10^{-19} C and
$\mu_0 = 4\pi \times 10^{-7}\ \mathrm{T\ mA^{-1}}$

101) If two magnets having magnetic moments M and M $\sqrt{3}$ are joined to form a cross (i.e. x). The combination is suspended freely in a uniform magnetic field. In equilibrium position, the magnet having magnetic moment M makes an angle θ with the field. Calculate the value of θ.

102) Where on the surface of the earth is the vertical component of the earth's magnetic field zero?

103) 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?

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

105) 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?

106) 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?

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

108) 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.

109) The horizontal component of the earth's magnetic field at a place is $\sqrt{3}$ times its vertical component here. Find the value of the angle of dip at that place. What is the ratio of the horizontal component to the total magnetic field of the earth at that place?

110) 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 ?

111) From molecular view point, discuss the temperature dependence of susceptibility for diamagnetism, paramagnetism and ferromagnetism.

112) 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?

113) 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?

114) A ball of superconducting matesial is dipped in liquid nitrogen and placed near a bar magnet.
(i) In which direction will it move?
(ii) What will be the direction of its magnetic moment?

115) Explain quantitatively the order of magnitude difference between the diamagnetic susceptibility of $\mathrm{N}_2\left(\sim 5 \times 10^{-9}\right)$ (at STP) and $\mathrm{Cu}\left(\sim 10^{-5}\right)$

116) A proton has spin and magnetic moment just like an electron. Why then its effect is neglected in magnetism of materials?

117) (i) How does a diamagnetic material behave when it is cooled at very low temperature?
(ii) Why does a paramagnetic sample display greater magnetisation when cooled? Explain.

118) 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.

119) An aeroplane is flying horizontally from west to east with a velocity of 900 km/h, Calculate the potential difference developed between the ends of its wings having a span of 20 m. The horizontal component of the earth's magnetic field is 5 x 10^{-4} T and the angle of dip is 30°.

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

121) Earth's core contains iron. Is it a source of the earth's magnetism?

122) What is the basic difference between magnetic and electric field lines?

123) In a submarine, a compass becomes ineffective. Why?

124) Why is diamagnetism almost independent of temperature?

125) If a toroid uses bismuth for its core, will the field in the core be (slightly) greater or (slightly) less than when the core is empty?

126) One cannot write the proportionality B = μH for the ferromagnets. Comment.

127) "Alkali halides are diamagnetic rather than paramagnetic." Explain why?

128) What is the net magnetic moment of two identical magnets each of magnetic moment mo inclined at 60° with each other?

129) A wire of length L is bent in the form of a circle of radius R and carries current I. What is its magnetic moment?

130) A bar magnet of length 0.1m and a pole strength 10^{-4} A-m is placed in a magnetic field of 30 Wb / m^2 at an angle 30°. Determine the couple acting on it.

131) Which orientation of a magnetic dipole in a uniform magnetic field will correspond to its stable equilibrium?

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

133) How does the (i) pole strength and (ii) magnetic moment of each part of a bar magnet change if it is cut into two equal pieces along its length?

134) Magnetic field lines can be entirely confined within the core of a toroid, but not within a straight solenoid. Why?

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

136) 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) horizontal component of earth's magnetic field, and
(ii) angle of dip at this placed?

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

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

139) The susceptibility of a magnetic material is - 4.2 x 10^{-6}. Name the type of magnetic material it represents.

140) What are permanent magnets? Give one example.

141) (i) Name the three elements of the earth's magnetic field.
(ii) Where on the surface of the earth is the vertical component of the earth's magnetic field zero?

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

143) State Curie's law. How does the susceptibility and the relative permeability of paramagnetic substances vary with the temperature?

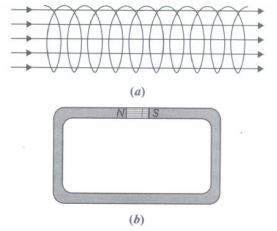
144) Give two points to distinguish between a paramagnetic and a diamagnetic substances.

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

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

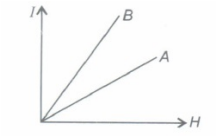
147) Explain the following:
(i) Why do magnetic lines offorce form continuous closed loops?
(ii) Why are the field lines repelled (expelled) when a diamagnetic material is placed in an external uniform magnetic field?

148) The diagrams given in the figure (a) and (b) show magnetic field lines (thick lines in the figure) wrongly. Point out what is wrong with them. Some of them may describe electrostatic field lines correctly. Point out which ones.



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

150) The following figure shows the variation of intensity of magnetisation versus the applied magnetic field intensity, H, for two magnetic materials A and B:
(a) Identify the materials A and B.
(b) Why does the material B, have a larger susceptibility than A, for a given field at constant temperature?



151) The hysteresis curves used for making transformer cores and telephone diaphragms must be narrow. Why? What should other property be possessed by these materials?

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

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

154) What is the characteristic property of a diamagnetic material?

155) Why should the material used for making permanent magnets have high coercivity?

156) 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?

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

158) The susceptibility of a magnetic material is 1.9 x 10^{-5}. Name the type of magnetic materials it represents.

159) Steel is preferred for making permanent magnets, whereas soft iron is preferred for making electromagnets. Give one reason.

160) What is the value of the horizontal component of the earth's magnetic field at magnetic poles?

161) What is the apparent angle of dip in a direction perpendicular to the magnetic meridian?

162) Define the terms 'magnetic dip' and 'magnetic declination' with the help of relevant diagrams.

163) Define the terms magnetic inclination and horizontal component of Earth's magnetic field at a place. Establish the relationship between the two with the help of a diagram.

164) Why does a paramagnetic substance display greater magnetisation for the same magnetising field when cooled? How does a diamagnetic substance respond to similar temperature changes?

165) State Gauss's law in magnetism and compare it with Gauss's law in electrostatics.

166) Do the diamagnetic substances have resultant magnetic moment in an atom in the absence of external magnetic field?

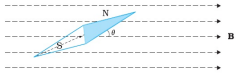
167) The magnetic susceptibility of χ of a given material is -0.5. Identify the magnetic material.

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

3 Marks 44 x 3 = 132

169) A closely wound solenoid of 800 turns and area of cross section 2.5×10^{-4} m^2 carries a current of 3.0 A. Explain the sense in which the solenoid acts like a bar magnet. What is its associated magnetic moment?

170) In Fig. the magnetic needle has magnetic moment 6.7×10^{-2} Am^2 and moment of inertia G = 7.5×10^{-6} kg m^2. It performs 10 complete oscillations in 6.7s. What is the magnitude of the magnetic field?



171) The earth's magnetic field at the equator is approximately 0.4 G. Estimate the earth's dipole moment.

172) A magnetic needle free to rotate in a vertical plane parallel to the magnetic meridian has its north tip pointing down at 22º with the horizontal. The horizontal component of the earth's magnetic field at the place is known to be 0.35 G. Determine the magnitude of the earth's magnetic field at the place.

173) At a certain location in Africa, a compass points 12º west of the geographic north. The north tip of the magnetic needle of a dip circle placed in the plane of magnetic meridian points 60º above the horizontal. The horizontal component of the earth's field is measured to be 0.16 G. Specify the direction and magnitude of the earth's field at the location.

174) A magnetic dipole is under the influence of two magnetic fields. The angle between the field directions is 60º, and one of the fields has a magnitude of 1.2×10^{-2} T. If the dipole comes to stable equilibrium at an angle of 15º with this field, what is the magnitude of the other field?

175) Two poles one of which is 5 times as strong as the other, exert on each other a force equal to 0.8×10^{-3} kg-wt, when placed 10 cm apart in air. Find the strength of each pole.

176) Two identical magnets with a length 100 cm are arranged freely with their like poles facing in a vertical glass tube. The upper magnet hangs in air above the lower one so that the distance between the nearest poles of the magnet is 3 mm. If the pole strength of the pole of these magnets is 6.64 A-m, then determine the force between the two magnets.

177) The length of a magnetised steel wire is l and its magnetic moment is M. It is bent into the shape of L with two sides equal. What will be the new magnetic moment?

178) What is the magnitude of the axial fields due to a bar magnet of length 5 cm at a distance of 50 cm from its mid-point? The magnetic moment of the bar magnet is 0.40 A -m^2.

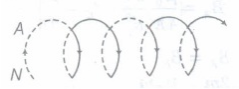
179) Determine the magnitude of the equatorial fields due to a bar magnet of length 6 cm at a distance of 60 cm from its mid-point. The magnetic moment of the bar magnet is 0.60 A - m^2.

180) An electron in a hydrogen atom is moving with a speed of 2.3×10^6 ms^{-1} in an orbit of radius 0.53 $\overset{o}{A}$. A Calculate the magnetic moment of the revolving electron.

181) A straight solenoid of length 50 cm has 1000 turns per metre and a mean cross-sectional area of 2×10^{-4} m^2. It is placed with its axis at 30°, with a uniform magnetic field of 0.32 T. Find the torque acting on the solenoid when a current of 2 A is passed through it.

182) A circular coil of 100 turns and have an effective radius of 5 cm carries a current of 0.1 A. How much work is required to turn it in an external magnetic field of 1.5 Wb / m^2 through 180° about an axis perpendicular to the magnetic field? The plane of the coil is initially perpendicular to the magnetic field.

183) 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.



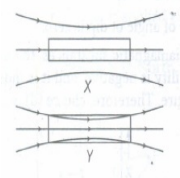
184) A uniform conducting wire of length 12 a and resistance R is wound up as a current carrying coil in the shape of
(i) an equilateral triangle of side a,
(ii) a square of sides a and
(iii) a regular hexagon of side a. The coil is connected to a voltage source V_o. Find the magnetic moment of the coils in each case.

185) Verify the Gauss' law for magnetic field of a point dipole of dipole moment M at the origin for the surface which is a sphere of radius R.

186) Assume the dipole model for the earth's magnetic field B which is given by B_V = vertical component of magnetic field $= \frac{\mu_0}{4\pi} \cdot \frac{2M\cos\theta}{r^3}$ and B_H = horizontal component of magnetic field $= \frac{\mu_0}{4\pi} \cdot \frac{M\sin\theta}{r^3}$
Find the loci of points for which
(i) IBI is minimum,
(ii) dip angle is zero and
(iii) dip angle is ± 45°.

187) 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.

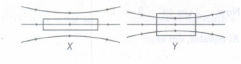
188) (i) How does angle of dip change as line goes from magnetic pole to magnetic equator of the earth?



(ii) Auniform magnetic field gets modified as shown in the figure below, when two specimens X and Y are placed in it. Identify whether specimens X and Yare diamagnetic, paramagnetic or ferromagnetic.

189) 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).

190) 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.



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

192) Draw a plot showing the variation of intensity of magnetisation with the applied magnetic field intensity for bismuth. Under what condition does a diamagnetic material exhibit perfect conductivity and perfect diamagnetism?

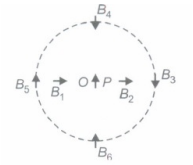
193) A short bar magnet of magnetic moment 0.1J/T is placed with its axis perpendicular to the horizontal component of the earth's magnetic field of strength 0.4 x 10^{-4}T. Calculate the position of points on
(i) its axis and
(ii) its normal bisector.
Where does the resultant field make an angle of 45° with the earth's field?

194) The vertical component of the earth's magnetic field at a place is $0.24\sqrt{3}$ x 10^{-4} T. Find out the value of horizontal component of the earth's magnetic field, if angle of dip at that place is 30°.

195) The magnetic field B and the magnetic intensity H in a material are found to be 1.6 T and 1000 Am^{-1}, respectively. Determine the relative permeability μ_r and the susceptibility X_m of the material.

196) Deduce the expression for the magnetic dipole moment of an electron orbiting around the central nucleus.

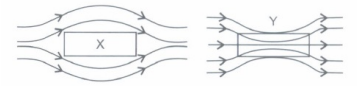
197) The given figure shows a small magnetised needle P placed at a point O. The arrow shows the direction of its magnetic moment. The other arrows show different positions (and orientations of the magnetic moment) of another identical magentised needle B.



(a) In which configuration the system is not in equilibrium?
(b) In which configuration is the system in (i) stable, and (ii) unstable equilibrium?
(c) Which configuration corresponds to the lowest potential energy among all the configurations shown?

198) Two identical thin bar magnets, each of length L and pole strength In are placed at right angles to each other, with the north pole of one touching the south pole of the other. Find the magnetic moment of the system.

199) (i) How does angle of dip change as one goes from magnetic pole to magnetic equator of the earth?
(ii) A uniform magnetic field gets modified as shown below when two specimens X and Y are placed in it. Identify whether specimens X and Y are diamagnetic, paramagnetic or ferromagnetic.



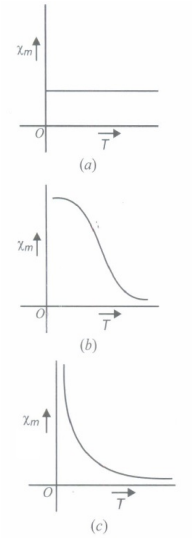
(iii) How is the magnetic permeability of specimen X different from that of specimen Y?

200) How will you judge as to which of the two given similar magnets is stronger without using a third magnet?

201) What are hard and soft magnetic materials? Give one example of each.

202) Write two properties of superconductor magnets. Where do they find their application?

203) Three curves are shown in the figures. Indicate what magnetic substance they represent.



204) 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.

205) 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

206) A coil of 200 turns has a cross-sectional area 900 mm^2. It carries a current of 2 ampere. The plane of the coil is perpendicular to a uniform magnetic field of 0.5 T. Calculate
(i) the magnetic moment of the coil and
(ii) the torque acting on the coil

207) A magnetic compass needle of magnetic moment 60 Am^2 is placed at a place. The needle points towards the geographical north. Using the data given below, find the value of declination at that place. Horizontal component of earth's magnetic field = 40 x 10^{-6} Wb m^{-2} and torque experienced by the needle = 1.2 x 10^{-3} Nm.

208) 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.

209) An iron rod of 0.5 cm^2 area of cross-section is subjected to a magnetising field of 1,200 Am^{-1}. If susceptibility of iron is 599, calculate
(i) μ
(ii) E, and
(iii) Φ (magnetic flux) produced.

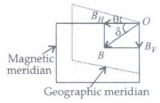
210) Define the term magnetic permeability of a magnetic material. Write any two characteristics of a magnetic substance if it is to be used to make a permanent magnet. Give an example of such a material.

211) How does the behaviour of ferromagnetic substances change when they get heated up? Hence, define the Curie temperature (T_c)Write an expression for susceptibility of ferromagnetic materials for temperature T (> T_c).

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

Case Study Questions 8 x 4 = 32

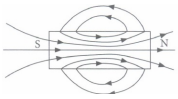
213) The earth's magnetic field at a point on its surface is usually characterised by three quantities: (a) declination (b) inclination or dip and (c) horizontal component of the field. These are known as the elements of the earth's magnetic field. At a place, angle between geographic meridian and magnetic meridian is defined as magnetic declination, whereas angle made by the earth's magnetic field with the horizontal in magnetic meridian is known as magnetic dip.



(i) In a certain place, the horizontal component of magnetic field is $\frac{1}{\sqrt{3}}$ times the vertical component. The angle of dip at this place is
(a) zero $(b)\ \pi/3$ $(c)\ \pi/2$ $(d)\ \pi/6$
(ii) The angle between the true geographic north and the north shown by a compass needle is called as
(a) inclination **(b) magnetic declination**
(c) angle of meridian **(d) magnetic pole**
(iii) The angles of dip at the poles and the equator respectively are
(a) 30°,60° **(b) 0°,90°** **(c) 45°,90°** **(d) 90°,0°**
(iv) A compass needle which is allowed to move in a horizontal plane is taken to a geomagnetic pole. It
(a) will become rigid showing no movement
(b) will stay in any position
(c) will stay in north-south direction only
(d) will stay in east-west direction only.
(v) Select the correct statement from the following
(a) The magnetic dip is zero at the centre of the earth
(b) Magnetic dip decreases as we move away from the equator towards the magnetic pole
(c) Magnetic dip increases as we move away from the equator towards the magnetic pole
(d) Magnetic dip does not vary-from place to place.

214) By analogy to Gauss's law of electrostatics, we can write Gauss's law of magnetism as $\oint \vec{B} \cdot d\vec{s} = \mu_0 m_{\text{inside}}$ where $\oint \vec{B} \cdot d\vec{s}$ is the magnetic flux and m_{inside} is the net pole strength inside the closed surface.

We do not have an isolated magnetic pole in nature. At least none has been found to exist till date. The smallest unit of the source of magnetic field is a magnetic dipole where the net magnetic pole is zero. Hence, the net magnetic pole enclosed by any closed surface is always zero. Correspondingly, the flux of the magnetic field through any closed surface is zero.



(I) Consider the two idealised systems

(i) a parallel plate capacitor with large plates and small separation and

(ii) a long solenoid oflength L > > R, radius of cross-section.

In (i) $\vec{E}$ is ideally treated as a constant between plates and zero outside. In (ii) magnetic field is constant inside the solenoid and zerq outside. These idealised assumptions, however, contradict fundamental laws as below

(a) case (i) contradicts Gauss's law for electrostatic fields

(b)case (ii) contradicts Gauss's aw for magnetic fields

(c) case (i) agrees with $\oint \vec{E} \cdot \overrightarrow{dl} = 0$.

(d) case (ii) contradicts $\oint \vec{H} \cdot \overrightarrow{dl} = I_{en}$

(ii) The net magnetic flux through any closed surface, kept in a magnetic field is

(a) zero $(\text{b})\ \frac{\mu_0}{4\pi}$ $(\text{c})\ 4\pi\mu_0$ $(\text{d})\ \frac{4\mu_0}{\pi}$

(iii) A closed surface S encloses a magnetic dipole of magnetic moment 2ml. The magnetic flux emerging from the surface is

$(\text{a})\ \mu_0 m$ **(b) zero** $(\text{c})\ 2\mu_0 m$ $(\text{d})\ \frac{2m}{\mu_0}$

(iv) Which of the following is not a consequence of Gauss's law?

(a) The magnetic poles always exist as unlike pairs of equal strength.

(b) If several magnetic lines of force enter in a closed surface, then an equal number of lines of force must leave that surface

(c) There are abundant sources or sinks of the magnetic field inside a closed surface

(d) Isolated magnetic poles do not exist

(v) The surface integral of a magnetic field over a surface

(a) is proportional to mass enclosed **(b) is proportional to charge enclosed**

(c) is zero **(d) equal to its magnetic flux through that surface.**

215) When the atomic dipoles are aligned partially or fully, there is a net magnetic moment in the direction of the field in any small volume of the material. The actual magnetic field inside material placed in magnetic field is the sum of the applied magnetic field and the magnetic field due to magnetisation. This field is called magnetic intensity (H).

$H = \frac{B}{\mu_0} - M$

where M is the magnetisation of the material, llo is the permittivity of vacuum and B is the total magnetic field. The measure that tells us how a magnetic material responds to an external field is given by a dimensionless quantity is appropriately called the magnetic susceptibility: for a certain class of magnetic materials, intensity of magnetisation is directly proportional to the magnetic intensity.

(i) Magnetization of a sample is

(a) volume of sample per unit magnetic moment **(b) net magnetic moment per unit volume**

(c) ratio of magnetic moment and pole strength **(d) ratio of pole strength to magnetic moment**

(ii) Identify the wrongly matched quantity and unit pair.

(a) Pole strength **Am**

(b) Magnetic susceptibility **dimensionless number**

(c) Intensity of magnetisation **A m^{-1}**

(d) Magnetic permeability **Henry m**

(iii) A bar magnet has length- 3 cm, cross-sectional area 2 cm^2 and magnetic moment 3 A m^2. The intensity of magnetisation of bar magnet is

$(a)\ 2 \times 10^5\ \mathrm{A/m}$ $(b)\ 3 \times 10^5\ \mathrm{A/m}$

$(c)\ 4 \times 10^5\ \mathrm{A/m}$ $(d)\ 5 \times 10^5\ \mathrm{A/m}$

(iv) A solenoid has core of a material with relative permeability 500 and its windings carry a current of 1 A. The number of turns of the solenoid is 500 per metre. The magnetization of the material is nearly

$(a)\ 2.5 \times 10^3 \mathrm{Am}^{-1}$ $(b)\ 2.5 \times 10^5\ \mathrm{A\ m}^{-1}$

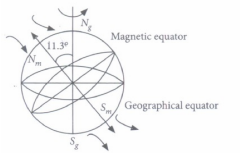
$(c)\ 2.0 \times 10^3\ \mathrm{A\ m}^{-1}$ $(d)\ 2.0 \times 10^5\ \mathrm{A\ m}^{-1}$

(v) The relative permeability of iron is 6000. Its magnetic susceptibility is

(a) 5999 **(b) 6001**

(c) 6000 x 10^{-7} **(d) 6000 x 10^7**

216) The magnetic field lines of the earth resemble that of a hypothetical magnetic dipole located at the centre of the earth. The axis of the dipole is presently tilted by approximately 11.3° with respect to the axis of rotation of the earth.



The pole near the geographic North pole of the earth is called the North magnetic pole and the pole near the geographic South pole is called South magnetic pole.

(i) The strength of the earth's magnetic field varies from place to place on the earth's surface, its value being of the order of

(a) 10^5 T **(b) 10^{-6}T** **(c) 10^{-5} T** **(d) 10^8 T**

(ii) A bar magnet is placed North-South with its North-pole due North. The points of zero magnetic field will be in which direction from centre of magnet?

(a) North-South **(b) East-West**

(c) North-East and South-West **(d) None of these.**

(iii) The value of angle of dip is zero at the magnetic equator because on it

(a) V and H are equal **(b) the values of Vand H zero**

(c) the value of V is zero **(d) the value of H is zero .**

(iv) The angle of dip at a certain place, where the horizontal and vertical components of the earth's magnetic field are equal, is

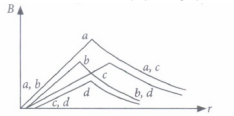
(a) 30° **(b) 90°** **(c) 60°** **(d) 45°**

(v) At a place, angle of dip is 30°. If horizontal component of earth's magnetic field is H, then the total intensity of magnetic field will be

(a) $\frac{H}{2}$ $(b)\ \frac{2H}{\sqrt{3}}$ $(c)\ H\sqrt{\frac{3}{2}}$ **(d) 2H**

217) The field of a hollow wire with constant current is homageneous

Curves in the graph shown give, as functions of radius distance r, the magnitude B of the magnetic field inside and outside four long wires a, b, c and d, carrying currents that are uniformly distributed across the cross sections of the wires. Overlapping portions of the plots are indicated by double labels.



(i) Which wire has the greatest magnitude of the magnetic field on the surface?

(a) a **(b) b** **(c) c** **(d) d**

(ii) The current density in a wire a is

(a) greater than in wire c

(b) less than in wire

(c) equal to that in wire c

(d) not comparable to that of in wire c due to lack of information

(iii) Which wire has the greatest radius?

(a) a **(b) b** **(c) c** **(d) d**

(iv) A direct current I flows along the length of an infinitely long straight thin walled pipe, then the magnetic field is

(a) uniform throughout the pipe but not zero

(b) zero only along the axis of the pipe

(c) zero at any point inside the pipe

(d) maximum at the centre and minimum at the edges

(v) In a coaxial, straight cable, the central conductor and the outer conductor carry equal currents in opposite direction. The magnetic field is zero

(a) outside the cable	**(b) inside the inner conductor**
(c) inside the outer conductor	**(d) in between the two conductor.**

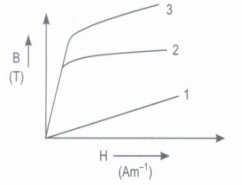
218) In small fields, ferromagnetic materials typically have much larger susceptibility, and therefore larger permeability, than paramagnetic materials. Ferromagnetism results because of spontaneous, self-aligning, cooperative interaction among relatively large number of iron atoms in regions called domains. As a result of molecular interactions the molecular magnetic moments in each domain are aligned parallel to one another. In other words, each domain is spontaneously magnetized to saturation even in the absence of any external magnetic field. The directions of magnetization in different domains are random, so that the resultant magnetization is zero and the specimen is unmagnetized.

(i) If above specimen is placed inside a solenoid; and slowly the magnetic intensity H (=ni) is increased from zero.

(a) What changes will occur in specimen on increasing H?

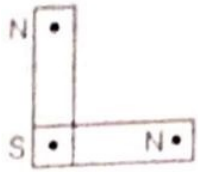
(b) Write the formula of magnetic flux density $(\vec{\mathbf{B}})$ for the specimen inside current carrying solenoid.

(c) Graphs of $\mathbf{B}, \mu_0\mathbf{H}$ and $\mu_0\mathbf{I}$ as a function of H are drawn. Identify which of the above physical quantities are contributing curves 1,2 and 3.



(ii) Why saturation of paramagnetic substances can be attained only at low temperatures?

219) A magnetic dipole is an arrangement of two magnetic poles of equal and opposite strengths, + m and - m separated by a small distance. The positive pole strength is north pole and the negative pole strength is south pole. A magnetic dipole is characterised by its magnetic dipole moment, M = m (2l), where 2l is the distance between two poles. It is similar to electric dipole moment in electrostatics.
(i) A bar magnet use dipole moment M. When it is bent to form a semicircular arc, then find its dipole moment.
(ii) The arrangement of two bar magnets each of dipole moment M is shown in figure.



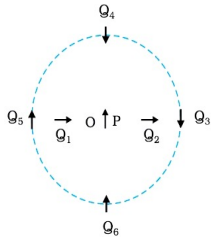
What will be the resultant dipole moment?
(iii) What is the direction of magnetic moment of a magnetic dipole?
(iv) How is the magnetic pole is different from a charge?

220) There are several magnetic materials like diamagnetic materials, paramagnetic materials and ferromagnetic materials.When a diamagnetic material is placed in a magnetising, field, then it gets feebly magnetised in a direction opposite to the magnetising field. It is weakly repelled by magnetic field. The field (B) inside the diamagnetic material is less than magnetising field (H).
A paramagnetic material is weakly attracted by the magnetic field. The field (B) inside the paramagnetic material is slighly greater than the magnetising field. A ferromagnetic material is aparamagnetic material which acquire very high magnetism in external magnetic field. It is strongly attracted by the magnetic field.
The relative permeability of magnetic material is given by μ_r, =X +1,where X is susceptibility of the material.
(i) When a diamagnetic material is placed in a magnetic field, then how it is oriented?
(ii) The value of magnetic field B and the magnetic intensity H in magnetic material are found to be 6.28 x 10^{-2}T and 100 Am^{-1}, respectively. Determine the value of relative permeability and magnetic susceptibility of the magnetic material.
(iii) Mention the three difference between diamagnetic substances and paramagnetic substances.
(iv) Which types of materials are called soft ferromagnets. Give any two examples of such materials.

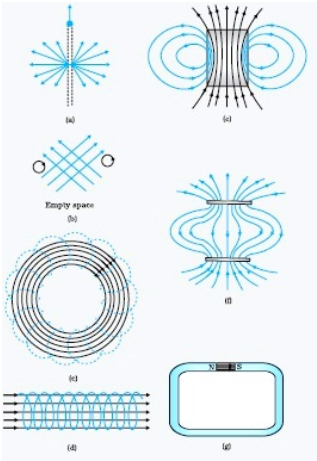
5 Marks 33 x 5 = 165

221) (a) What happens if a bar magnet is cut into two pieces:
(i) transverse to its length,
(ii) along its length?
(b) A magnetised needle in a uniform magnetic field experiences a torque but no net force. An iron nail near a bar magnet, however, experiences a force of attraction in addition to a torque. Why?
(c) Must every magnetic configuration have a north pole and a south pole? What about the field due to a toroid?
(d) Two identical looking iron bars A and B are given, one of which is definitely known to be magnetised. (We do not know which one.) How would one ascertain whether or not both are magnetised? If only one is magnetised, how does one ascertain which one? [Use nothing else but the bars A and B.]

222) Figure shows a small magnetised needle P placed at a point O. The arrow shows the direction of its magnetic moment. The other arrows show different positions (and orientations of the magnetic moment) of another identical magnetised needle Q.
(a) In which configuration the system is not in equilibrium?
(b) In which configuration is the system in
(i) stable, and
(ii) unstable equilibrium?
(c) Which configuration corresponds to the lowest potential energy among all the configurations shown?



223) Many of the diagrams given in Fig. show magnetic field lines (thick lines in the figure) wrongly. Point out what is wrong with them. Some of them may describe electrostatic field lines correctly Point out which ones.



224) (a) Magnetic field lines show the direction (at every point) along which a small magnetised needle aligns (at the point). Do the magnetic field lines also represent the lines of force on a moving charged particle at every point?
(b) If magnetic monopoles existed, how would the Gauss's law of magnetism be modified?
(c) Does a bar magnet exert a torque on itself due to its own field? Does one element of a current-carrying wire exert a force on another element of the same wire?
(d) Magnetic field arises due to charges in motion. Can a system have magnetic moments even though its net charge is zero?

225) A solenoid has a core of a material with relative permeability 400. The windings of the solenoid are insulated from the core and carry a current of 2A. If the number of turns is 1000 per metre, calculate (a) H, (b) M, (c) B and (d) the magnetising current I_m.

226) A short bar magnet of magnetic moment m = 0.32 J/T is placed in a uniform magnetic field of 0.15 T. If the bar is free to rotate in the plane of the field, which orientation would correspond to its
(i) stable and
(b) unstable equilibrium?
What is the potential energy of the magnet in each case?

227) A bar magnet of magnetic moment 1.5 J T^{-1} lies aligned with the direction of a uniform magnetic field of 0.22 T.
(a) What is the amount of work required by an external torque to turn the magnet so as to align its magnetic moment:
(i) normal to the field direction,
(ii) opposite to the field direction?
(b) What is the torque on the magnet in cases (i) and (ii)?

228) A closely wound solenoid of 2000 turns and area of cross-section 1.6 x 10^{-4} m^2, carrying a current of 4.0 A, is suspended through its centre allowing it to turn in a horizontal plane.
(a) What is the magnetic moment associated with the solenoid?
(b) What is the force and torque on the solenoid if a uniform
horizontal magnetic field of 7.5 x 10^{-2} T is set up at an angle of 30º with the axis of the solenoid?

229) A short bar magnet has a magnetic moment of 0.48 J T^{-1}. Give the direction and magnitude of the magnetic field produced by the magnet at a distance of 10 cm from the centre of the magnet on
(a) the axis,
(b) the equatorial lines (normal bisector) of the magnet.

230) A short bar magnet placed with its axis at 30º with an external field of 800 G experiences a torque of 0.016 Nm.
(a) What is the magnetic moment of the magnet?
(b) What is the work done in moving it from its most stable to most unstable position?
(c) The bar magnet is replaced by a solenoid of cross-sectional area 2 x 10^{-4} m^2 and 1000 turns, but of the same magnetic moment. Determine the current flowing through the solenoid.

231) A domain in ferromagnetic iron is in the form of a cube of side length 1μm. Estimate the number of iron atoms in the domain and the maximum possible dipole moment and magnetisation of the domain. The molecular mass of iron is 55 g/mole and its density is 7.9 g/cm^3. Assume that each iron atom has a dipole moment of 9.27×10^{-24} A m^2.

232) Answer the following questions regarding earth's magnetism:
(a) A vector needs three quantities for its specification. Name the three independent quantities conventionally used to specify the earth's magnetic field.
(b) The angle of dip at a location in southern India is about 18º. Would you expect a greater or smaller dip angle in Britain?
(c) If you made a map of magnetic field lines at Melbourne in Australia, would the lines seem to go into the ground or come out of the ground?
(d) In which direction would a compass free to move in the vertical plane point to, if located right on the geomagnetic north or south pole?
(e) The earth's field, it is claimed, roughly approximates the field due to a dipole of magnetic moment 8×10^{22} J T^{-1} located at its centre. Check the order of magnitude of this number in some way.
(f) Geologists claim that besides the main magnetic N-S poles, there are several local poles on the earth's surface oriented in different directions. How is such a thing possible at all?

233) Answer the following questions:
(a) The earth's magnetic field varies from point to point in space. Does it also change with time? If so, on what time scale does it change appreciably?
(b) The earth's core is known to contain iron. Yet geologists do not regard this as a source of the earth's magnetism. Why?
(c) The charged currents in the outer conducting regions of the earth's core are thought to be responsible for earth's magnetism. What might be the 'battery' (i.e., the source of energy) to sustain these currents?
(d) The earth may have even reversed the direction of its field several times during its history of 4 to 5 billion years. How can geologists know about the earth's field in such distant past?
(e) The earth's field departs from its dipole shape substantially at large distances (greater than about 30,000 km). What agencies may be responsible for this distortion?
(f) Interstellar space has an extremely weak magnetic field of the order of 10^{-12} T. Can such a weak field be of any significant consequence? Explain.

234) A circular coil of 16 turns and radius 10 cm carrying a current of 0.75 A rests with its plane normal to an external field of magnitude 5.0×10^{-2} T. The coil is free to turn about an axis in its plane perpendicular to the field direction. When the coil is turned slightly and released, it oscillates about its stable equilibrium with a frequency of 2.0 s^{-1}. What is the moment of inertia of the coil about its axis of rotation?

235) A short bar magnet placed in a horizontal plane has its axis aligned along the magnetic north-south direction. Null points are found on the axis of the magnet at 14 cm from the centre of the magnet. The earth's magnetic field at the place is 0.36 G and the angle of dip is zero. What is the total magnetic field on the normal bisector of the magnet at the same distance as the null–point (i.e., 14 cm) from the centre of the magnet? (At null points, field due to a magnet is equal and opposite to the horizontal component of earth's magnetic field.)

236) If the bar magnet in exercise 5.13 is turned around by 180º, where will the new null points be located?

237) A short bar magnet of magnetic moment 5.25×10^{-2} J T^{-1} is placed with its axis perpendicular to the earth's field direction. At what distance from the centre of the magnet, the resultant field is inclined at 45º with earth's field on (a) its normal bisector and (b) its axis. Magnitude of the earth's field at the place is given to be 0.42 G. Ignore the length of the magnet in comparison to the distances involved.

238) (a) Why does a paramagnetic sample display greater magnetisation (for the same magnetising field) when cooled?
(b) Why is diamagnetism, in contrast, almost independent of temperature?
(c) If a toroid uses bismuth for its core, will the field in the core be (slightly) greater or (slightly) less than when the core is empty?
(d) Is the permeability of a ferromagnetic material independent of the magnetic field? If not, is it more for lower or higher fields?
(e) Magnetic field lines are always nearly normal to the surface of a ferromagnet at every point. (This fact is analogous to the static electric field lines being normal to the surface of a conductor at every point.) Why?
(f) Would the maximum possible magnetisation of a paramagnetic sample be of the same order of magnitude as the magnetisation of a ferromagnet?

239) Answer the following questions:
(a) Explain qualitatively on the basis of domain picture the irreversibility in the magnetisation curve of a ferromagnet.
(b) The hysteresis loop of a soft iron piece has a much smaller area than that of a carbon steel piece. If the material is to go through repeated cycles of magnetisation, which piece will dissipate greater heat energy?
(c) 'A system displaying a hysteresis loop such as a ferromagnet, is a device for storing memory?' Explain the meaning of this statement.
(d) What kind of ferromagnetic material is used for coating magnetic tapes in a cassette player, or for building 'memory stores' in a modern computer?
(e) A certain region of space is to be shielded from magnetic fields. Suggest a method.

240) A long straight horizontal cable carries a current of 2.5 A in the direction 10º south of west to 10º north of east. The magnetic meridian of the place happens to be 10º west of the geographic meridian. The earth's magnetic field at the location is 0.33 G, and the angle of dip is zero. Locate the line of neutral points (ignore the thickness of the cable). (At neutral points, magnetic field due to a current-carrying cable is equal and opposite to the horizontal component of earth's magnetic field.)

241) A telephone cable at a place has four long straight horizontal wires carrying a current of 1.0 A in the same direction east to west. The earth's magnetic field at the place is 0.39 G, and the angle of dip is 35º. The magnetic declination is nearly zero. What are the resultant magnetic fields at points 4.0 cm below the cable?

242) A compass needle free to turn in a horizontal plane is placed at the centre of circular coil of 30 turns and radius 12 cm. The coil is in a vertical plane making an angle of 45º with the magnetic meridian. When the current in the coil is 0.35 A, the needle points west to east.
(a) Determine the horizontal component of the earth's magnetic field at the location.
(b) The current in the coil is reversed, and the coil is rotated about its vertical axis by an angle of 90º in the anticlockwise sense looking from above. Predict the direction of the needle. Take the magnetic declination at the places to be zero.

243) A monoenergetic (18 keV) electron beam initially in the horizontal direction is subjected to a horizontal magnetic field of 0.04 G normal to the initial direction. Estimate the up or down deflection of the beam over a distance of 30 cm ($m_e = 9.11 \times 10^{-19}$ C). [Note: Data in this exercise are so chosen that the answer will give you an idea of the effect of earth's magnetic field on the motion of the electron beam from the electron gun to the screen in a TV set.]

244) A sample of paramagnetic salt contains 2.0×10^{24} atomic dipoles each of dipole moment 1.5×10^{-23} J T^{-1}. The sample is placed under a homogeneous magnetic field of 0.64 T, and cooled to a temperature of 4.2 K. The degree of magnetic saturation achieved is equal to 15%. What is the total dipole moment of the sample for a magnetic field of 0.98 T and a temperature of 2.8 K? (Assume Curie's law)

245) A Rowland ring of mean radius 15 cm has 3500 turns of wire wound on a ferromagnetic core of relative permeability 800. What is the magnetic field B in the core for a magnetising current of 1.2 A?

246) The magnetic moment vectors μs and μl associated with the intrinsic spin angular momentum S and orbital angular momentum l, respectively, of an electron are predicted by quantum theory (and verified experimentally to a high accuracy) to be given by:
$\mu_s = -(e/m)\, S$,
$\mu_l = -(e/2m)\, l$
Which of these relations is in accordance with the result expected classically? Outline the derivation of the classical result.

247) (i) Discuss briefly electron theory of magnetism for diamagnetic and paramagnetic materials.
(ii) Give two methods to destroy the magnetism of a magnet.

248) (i) A bar magnet of magnetic moment M is aligned parallel to the direction of a uniform magnetic field B. What is the work done, to turn the magnets, so as to align its magnetic moment
(a) opposite to field direction and
(b) normal to field direction?
(ii) Steel is preferred for making permanent magnets, whereas soft iron is preferred for making electromagnets. Give one reason.

249) A magnetic needle suspended in a vertical plane at 30° from the magnetic meridian makes an angle of 45° with the horizontal. Find the true angle of dip.

250) A solenoid of 600 turns per metre is carrying a current of 4 A. Its core is made of iron with relative permeability of 5000. Calculate the magnitudes of magnetic intensity, intensity of magnetisation and magnetic field inside the core.

251) A solenoid having 5000 turns/m carries a current of 2A. An aluminium ring at temperature 300K inside the solenoid provides the core.
(a) If the magnetisation I is 2 x 10^{-2} A/m, find the susceptibility of aluminium at 300 K.
(b) If temperature of the aluminium ring is 320 K, what will be the magnetisation?

252) Derive the expression for the magnetic field at the site of a point nucleus in a Hydrogen atom due to the circular motion of the electron. Assume that the atom is in its ground state and give the answer in terms of fundamental constants.

253) Draw the magnetic field lines due to a circular loop of area $\vec{A}$ carrying current I. Show that it acts as a bar magnet of magnetic moment $\vec{m} = \overrightarrow{IA}$.
(b) Derive the expression for the magnetic field due to a solenoid of length 2l, radius a having n number of turns per unit length and carrying a steady current I at a point on the axial line, distance r from the centre of the solenoid. How does this expression compare with the axial magnetic field due to a bar magnet of magnetic moment m?

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