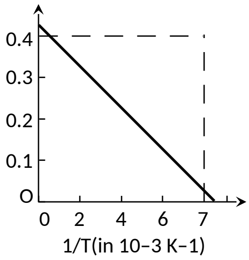
# 5.MAGNETISM AND MATTER

## Single Correct Answer Type

1. The $\chi - 1/T$ graph for an alloy of paramagnetic nature is shown in fig. the curie constant is




a) $57\,K$ b) $2.8\times10^{-3}K$ c) $570\,K$ d) $17.5\times10^{-3}K$

2. If a diamagnetic substance is brought near north or south pole of a bar magnet, it is

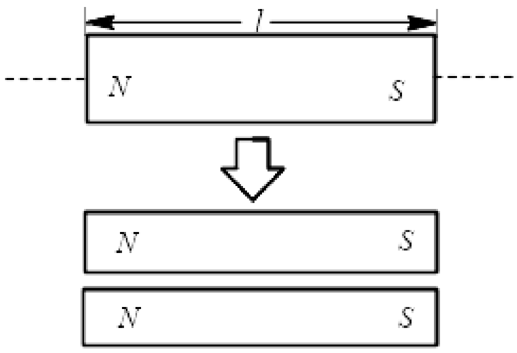
a) Attracted by the poles

b) Repelled by 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

3. If a bar magnet of length $l$ and cross-sectional area $A$ is cut into two equal parts as shown in figure, then the pole strength of each pole becomes




a) Half b) Double c) One-fourth d) Four time

4. A bar magnet $A$ of magnetic moment $M_A$ is found to oscillate at a frequency twice that of magnet $B$ of magnetic moment $M_B$ when placed in a vibrating $magneto-meter$. We may say that

a) $M_A=2M_B$ b) $M_A=8M_B$ c) $M_A=4M_B$ d) $M_B=8M_A$

5. 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

6. The magnet can be completely demagnetized by

a) Breaking the magnet into small pieces b) Heating it slightly

c) Droping it into ice cold water d) A reverse field of appropriate strength

7. A small bar magnet of moment $M$ is placed in a uniform field $H$. If magnet makes an angle of $30°$ with field, the torque acting on the magnet is

a) $MH$ b) $\frac{MH}{2}$ c) $\frac{MH}{3}$ d) $\frac{MH}{4}$

8. A current carrying small loop behaves like a small magnet. If $A$ be its area and $M$ its magnetic moment, the current in the loop will be

a) $M/A$ b) $A/M$ c) $MA$ d) $AM^2$

9. Nickel shows ferromagnetic property at room temperature. If the temperature is increased beyond Curie temperature, then it will show

a) Paramagnetism b) Anti-ferromagnetism

c) No magnetic property d) Diamagnetism

10. Force between two identical short bar magnets whose centers are $r$ metre apart is 8.1 N, when their axes are along the same line. If separation is increased to 3 $r$ and the axis are rearranged perpendicularly, the force between them would become

a) 2.4 N b) 1.2 N c) 0.1 N d) 1.15 N

11. A magnet is parallel to a uniform magnetic field. If it is rotated by $60°$, the work done is $0.8\,J$. How much work is done in moving it $30°$ further

a) $0.8\times10^7\,erg$ b) $0.4\,J$ c) $8\,J$ d) $0.8\,erg$

12. The magnetic susceptibility is negative for

a) Paramagnetic materials b) Diamagnetic materials

c) Ferromagnetic materials d) Paramagnetic and ferromagnetic materials

13. The magnetic moment of a magnet of length $10\,cm$ and pole strength $4.0\,Am$ will be

a) $0.4\,Am^2$ b) $1.6\,Am^2$ c) $20\,Am^2$ d) $8.0\,Am^2$

14. Before using the tangent galvanometer, its coil is set in

a) Magnetic meridian (or vertically north south)

b) Perpendicular to magnetic meridian

c) At angel of $45°$ to magnetic meridian

d) It does not require any setting

15. A vibration magnetometer consists of two identical bar magnets placed one over the other such that they are perpendicular and bisect each other. The time period of oscillation in a horizontal magnetic field is $2^{5/4}$ second. One of the magnets is removed and if the other magnet oscillates in the same field, then the time period in second is

a) $2^{1/4}$ b) $2^{1/2}$ c) 2 d) $2^{5/4}$

16. A copper rod is suspended a non homogenous magnetic field region. The rod when in equilibrium will align itself

a) In the region where magnetic field is strongest

b) In the region where magnetic field is weakest and parallel to direction of magnetic field there

c) In the direction in which it was originally suspended

d) In the region where magnetic field is weakest and perpendicular to the direction of magnetic field there

17. The force between two magnetic poles is $F$. If the distance between the poles and pole strengths of each pole are doubled, then the force experienced is

a) $2F$ b) $\frac{F}{2}$ c) $\frac{F}{4}$ d) $F$

18. There is no couple acting when two bar magnets are placed coaxially separated by a distance because

a) There are no forces on the poles

b) The force are parallel and their lines of action do not coincide

c) The forces are perpendicular to each other

d) The forces act along the same line

19. The magnetic force required to demagnetize the material is

a) Retaintivity b) Coercivity c) Energy loss d) Hysteresis

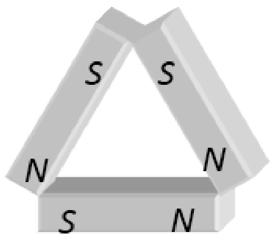
20. The points $A \wedge B$ are situated perpendicular to the axis of 2 cm long bar magnet at large distances $x$ and $3x$ from the centre on opposite sides. The ratio of magnetic fields at $A \wedge B$ will be approximately equal to

a) 27 : 1 b) 1 : 27 c) 9 : 1 d) 1 : 9

21. If magnetic lines of force are drawn by keeping magnet vertical, then number of neutral points will be

a) One b) Two c) Four d) Five

22. Three identical bar magnets each of magnetic moment $M$ are placed in the form of an equilateral triangle as shown. The net magnetic moment of the system is




a) Zero b) $2M$ c) $M\sqrt{3}$ d) $\frac{3M}{2}$

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

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

24. The value of the horizontal component of the earth's magnetic field and angle of dip are $1.8 \times 10^{-5} weber/m^2$ and $30°$ respectively at some place. The total intensity of earth's magnetic field at that place will be

a) $2.08 \times 10^{-5} weber/m^2$ b) $3.67 \times 10^{-5} weber/m^2$

c) $3.18 \times 10^{-5} weber/m^2$ d) $5.0 \times 10^{-5} weber/m^2$

25. Due to a small magnet, intensity at a distance $x$ in the end on position is $9\,gauss$. What will be the intensity at a distance $\frac{x}{2}$ on broad side on position

a) $9\,gauss$ b) $4\,gauss$ c) $36\,gauss$ d) $4.5\,gauss$

26. A small bar magnet has a magnetic moment $1.2\,A\text{-}m^2$. The magnetic field at a distance $0.1\,m$ on it axis will be: ¿-$m/A$ ¿

a) $1.2 \times 10^{-4} T$ b) $2.4 \times 10^{-4} T$ c) $2.4 \times 10^{4} T$ d) $1.2 \times 10^{4} T$

27. Which of the following is the most suitable material for making permanent magnet

a) Steel b) Soft iron c) Copper d) Nickel

28. Two bar magnets of the same mass, same length and breadth but having magnetic moments $M$ and 3M are joined together pole for pole and suspended by a string.

The time period of assembly in a magnetic field of strength $H$ is 3 s. If now the polarity of one of the magnets is reversed and the combination is again made to oscillate in the same field, the time of oscillation is

a) 3 s
b) $3\sqrt{3}$ s
c) $3/\sqrt{3}$ s
d) 6 s

29. Two short magnets $AB$ and $CD$ are in the $X$-$Y$ plane and are parallel to $X$-axis and co-ordinates of their centers respectively are (0, 2) and (2, 0). Line joining the north-south poles of $CD$ is opposite to that of $AB$ and lies along the positive $X$-axis. The resultant field induction due to $AB$ and $CD$ at a point $P$ (2, 2) is $100 \times 10^{-7} T$. When the poles of the magnet $CD$ are reversed, the resultant field induction is $50 \times 10^{-7} T$. The value of magnetic moments of $AB$ and $CD$ (in $Am^2$) are

a) 300; 200
b) 600; 400
c) 200; 100
d) 300; 150

30. When $\sqrt{3}\, ampere$ current is passed in a tangent galvanometer, there is a deflection of $30°$ in it. The deflection obtained when $3\, amperes$ current is passed, is

a) $30°$
b) $45°$
c) $60°$
d) $75°$

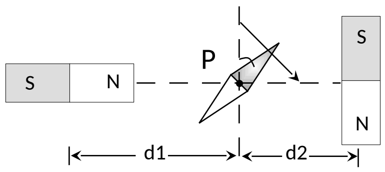
31. The true value of angle of dip at a place is $60°$, the apparent dip in a plane inclined at an angle of $30°$ with magnetic meridian is

a) $\tan^{-1}\frac{1}{2}$
b) $\tan^{-1}(2)$
c) $\tan^{-1}\left(\frac{2}{3}\right)$
d) None of these

32. Demagnetisation of magnets can be done by

a) Rough handling
b) Heating
c) Magnetising in the opposite direction
d) All the above

33. Two magnets $A$ and $B$ are identical and these are arranged as shown in the figure. Their length is negligible in comparison to the separation between them. A magnetic needle is placed between the magnets at point $P$ which gets deflected through an angle $\theta$ under the influence of magnets. The ratio of distance $d_1$ and $d_2$ will be




a) $(2\tan\theta)^{1/3}$
b) $(2\tan\theta)^{-1/3}$
c) $(2\cot\theta)^{1/3}$
d) $(2\cot\theta)^{-1/3}$

34. A bar magnet is equivalent to

a) Torroid carrying current
b) Straight conductor carrying current
c) Solenoid carrying current
d) Circular coil carrying current

35. A bar magnet of length 10 cm and having pole strength equal to $10^{-3}$ Wb is kept in a magnetic field having magnetic induction $B$ equal to $4\pi \times 10^{-3}$T. It makes an angle of 30° with the direction of magnetic induction. The value f the torque acting on the magnet is

a) 0.5 Nm
b) $2\pi \times 10^{-5}$ Nm
c) $\pi \times 10^{-5}$ Nm
d) $0.5 \times 10^{-5}$ Nm

36. If a piece of metal was thought to be magnet, which one of the following observations would offer conclusive evidence

a) It attracts a known magnet
b) It repels a known magnet
c) Neither (a) nor (b)
d) It attracts a steel screw driver

37. The strength of the magnetic field in which the magnet of a vibration magnetometer is oscillating is increased 4 times its original value. The frequency of oscillation would then become

a) Twice its original value
b) Four times it original value
c) Half its original value
d) One-fourth its original value

38. The magnet of a vibration magnetometer is heated so as to reduce its magnetic moment by 19%. By doing this the periodic time of the magnetometer will

a) Increase by 19% b) Decrease by19% c) Increase by 11% d) Decrease by 21%

39. A permanent magnet

a) Attracts all substances

b) Attracts only magnetic substances

c) Attracts magnetic substances and repels all non-magnetic substances

d) Attracts non-magnetic substances and repels magnetic substances

40. At a temperature of $30°$ C, the susceptibility of a ferromagnetic material is found to be $X$. Its susceptibility at $333°$ C is

a) $X$ b) $0.5 X$ c) $2 X$ d) $0.09 X$

41. The material of permanent magnet has

a) High retentivity, low coercivity b) Low retentivity, high coercivity

c) Low retentivity, low coercivity d) High retentivity, high coercivity

42. There are four light-weight-rod samples, $A, B, C, D$ separately suspended by threads. A bar magnet is slowly brought near each sample and the following observations are noted

(i) $A$ is feebly repelled
(ii) $B$ is feebly attracted
(iii) $C$ is strongly attracted
(iv) $D$ remains unaffected

Which one of the following is true

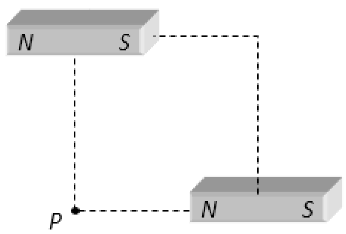
a) $A$ is of a non-magnetic material

b) $B$ is of a paramagnetic material

c) $C$ is of a diamagnetic material

d) $D$ is of a ferromagnetic material

43. Two short magnets of magnetic moment $1000\, A\, m^2$ are placed as shown at the corners of a square of side $10\, cm$. The net magnetic induction at $P$ at




a) $0.1\, T$ b) $0.2\, T$ c) $0.3\, T$ d) $0.4\, T$

44. A bar magnet has coercivity $4 \times 10^3\, A\, m^{-1}$. It is desired to demagnetise it by inserting it inside a solenoid $12\, cm$ long and having 60 turns. The current that should be sent through the solenoid is

a) $2\, A$ b) $4\, A$ c) $6\, A$ d) $8\, A$

45. The horizontal component of flux density of earth's magnetic field is $1.7 \times 10^{-5}$T. The value of horizontal component of intensity of earth's magnetic field will be?

a) $24.5\, A\, m^{-1}$ b) $13.5\, A\, m^{-1}$ c) $1.53\, A\, m^{-1}$ d) $0.35\, A\, m^{-1}$

46. A bar magnet of magnetic moment $200\,A\text{-}m^2$ is suspended in a magnetic field of intensity $0.25\,N/A\text{-}m$. The couple required to deflect it through $30°$ is

a) $50\ N\text{-}m$ b) $25\ N\text{-}m$ c) $20\ N\text{-}m$ d) $15\ N\text{-}m$

47. A coil of 50 turns and area $1.25 \times 10^{-3}\,m^2$ is pivoted about a vertical diameter in a uniform horizontal magnetic field and carries a current of 2 A. When the coil is held with its plane is $N-S$ of 2A. When the coil is held with its plane in $N-S$ direction, it experience a couple of 0.04 N-m; and when its plane is $E-W$, the corresponding couple is 0.03 N-m. The magnetic induction is

a) 0.2 T b) 0.3 T c) 0.4 T d) 0.5 T

48. The magnetic needle of a tangent galvanometer is deflected at angle of $30°$ due to a current in its coil. The horizontal component of earth's magnetic field is $0.34 \times 10^{-4}\,T$, then magnetic field at the center of the coil due to current

a) $1.96 \times 10^{-5}\,T$ b) $1.96 \times 10^{-4}\,T$ c) $1.96 \times 10^{4}\,T$ d) $1.96 \times 10^{5}\,T$

49. The period of oscillations of a magnetic needle in a magnetic field is $1.0\,sec$. If the length of the needle is halved by cutting it, the time period will be

a) $1.0\,sec$ b) $0.5\,sec$ c) $0.25\,sec$ d) $2.0\,sec$

50. A magnet is suspended in the magnetic meridian with an untwisted wire. The upper end of wire is rotated through $180°$ to deflect the magnet by $30°$ from magnetic meridian. When this magnet is replaced by another magnet, the upper end of wire is rotated through $270°$ to deflect the magnet $30°$ from magnetic meridian. The ratio of magnetic moments of magnets is

a) $1:5$ b) $1:8$ c) $5:8$ d) $8:5$

51. If a magnetic substance is kept in a magnetic field then which of the following substance is thrown out?

a) Paramagnetic b) Ferromagnetic c) Diamagnetic d) Antiferromagnetic

52. A magnet performs 10 oscillations per minute in a horizontal plane at a place where the angle of dip is $45°$ and the total intensity is 0.707 CGS units. The number of oscillations per minute at a place where dip angle is $60°$ and total intensity is 0.5 CGS units will be

a) 5 b) 7 c) 9 d) 11

53. Two identical bar magnets are placed one above the other such that they are mutually perpendicular and bisect each other. The time period of this combination in a horizontal magnetic field is $T$. The time period of each magnet in the same field is

a) $\sqrt{2}T$ b) $2^{\frac{1}{4}}T$ c) $2^{\frac{1}{4}}T$ d) $2^{\frac{1}{2}}T$

54. Ratio of magnetic intensities for an axial point and a point on broad side-on position at equal distance $d$ from the centre of magnet will be or The magnetic field at a distance $d$ from a short bar magnet in longitudinal and transverse positions are in the ratio

a) $1:1$ b) $2:3$ c) $2:1$ d) $3:2$

55. A magnetic dipole is placed at right angles to the direction of lines of force of magnetic induction $B$. If it is rotated through an angle of 180°, then the work done is

a) $MB$ b) $2MB$ c) $-2\,MB$ d) Zero

56. A domain in a ferromagnetic substance is in the form of a cube of side length $1\,\mu m$. If it contains $8 \times 10^{10}$ atoms and each atomic dipole has a dipole moment of $9 \times 10^{-24}\,A\,m^2$, then magnetization of the domain is

a) $7.2 \times 10^{5}\,A\,m^{-1}$ b) $7.2 \times 10^{3}\,A\,m^{-1}$ c) $7.2 \times 10^{9}\,A\,m^{-1}$ d) $7.2 \times 10^{12}\,A\,m^{-1}$

57. 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 center of magnet

a) North and south b) East and west

c) North-east and south-west
d) North-east and south-east

58. Aurora Borealis is a luminous electrical discharge in the upper layers of the atmosphere, which is visible more frequently in
a) Polar regions
b) Equator
c) Lunar eclipse
d) Regions of earth's magnetic poles

59. 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 $N_1 \wedge N_2$ strongly but reple $N_3$
b) Attract $N_1$ strongly, $N_2$ weakly and reple $N_3$ weakly
c) Attract $N_1$ strongly, but reple $N_2$ and $N_3$ weakly
d) Attract all three of them

60. If a magnetic dipole of dipole moment $M$ rotated through an angle $\theta$ with respect to the direction of the field *H*, then the work done is
a) $MH \sin\theta$
b) $MH(1-\sin\theta)$
c) $MH \cos\theta$
d) $MH(1-\cos\theta)$

61. The magnetic moment of a magnet is 0.1 amp × $m^2$. It is suspended in a magnetic field of intensity $3\times10^{-4}\,Wb\,m^{-2}$. The couple acting upon it when deflected by 30° from the magnetic field is
a) $1\times10^{-5}$N m
b) $1.5\times10^{-5}$N m
c) $2\times10^{-5}$N m
d) $2.5\times10^{-5}$N m

62. A small bar magnet $A$ oscillates in a horizontal plane with a period $T$ at a place where the angle of dip is $60°$. When the same needle is made to oscillate in a vertical plane coinciding with the magnetic meridian, its period will be
a) $\frac{T}{\sqrt{2}}$
b) $T$
c) $\sqrt{2}T$
d) $2T$

63. A magnet oscillating in a horizontal plane has a time period of $2\,second$ at a place where the angle of dip is $30°$ and $3\,seconds$ at another place where the angle of dip is $60°$. The ratio of resultant magnetic fields at the two places is
a) $\frac{4\sqrt{3}}{7}$
b) $\frac{4}{9\sqrt{3}}$
c) $\frac{9}{4\sqrt{3}}$
d) $\frac{9}{\sqrt{3}}$

64. A straight wire carrying current $i$ is turned into a circular loop. If the magnitude of magnetic moment associated with it in M.K.S. unit is $M$, the length of wire will be
a) $4\pi iM$
b) $\sqrt{\frac{4\pi M}{i}}$
c) $\sqrt{\frac{4\pi i}{M}}$
d) $\frac{M\pi}{4i}$

65. The magnetising field required to be applied in opposite direction to reduce residual magnetism to zero is called
a) Coercivity
b) Retentivity
c) Hysteresis
d) None of these

66. What happens to the force between magnetic poles when their pole strength and the distance between them are both doubled
a) Force increases to two times the previous value
b) No change
c) Force decreases to half the previous value
d) Force increases to four times the previous value

67. Two short magnets having magnetic moments in the ratio $27:8$, when placed on opposite sides of a deflection magnetometer, produce no deflection. If the distance of the weaker magnet is $0.12\,m$ from the centre of deflection magnetometer, the distance of the stronger magnet from the centre is

a) $0.06\,m$ b) $0.08\,m$ c) $0.12\,m$ d) $0.18\,m$

68. A magnet 20 cm long with its poles concentrated at its ends is placed vertically with its north pole on the table. At a point due 20 cm south (magnetic) of the pole, a neutral point is obtained. If $H=$¿0.3 G, then the pole strength of the magnet is approximately

a) 185 ab-amp-cm b) 185 amp-m c) 18.5 ab-amp-cm d) 18.5 amp-cm

69. A magnetic needle lying parallel to a magnetic field requires $W$ units of work to turn it through $60°$. The torque required to keep the needle in this position will be

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

70. Which of the following statements is incorrect about hysteresis

a) This effect is common to all ferromagnetic substances

b) The hysteresis loop area is proportional to the thermal energy developed per unit volume of the material

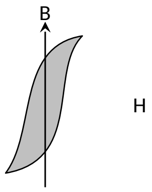
c) The hysteresis loop area is independent of the thermal energy developed per unit volume of the material

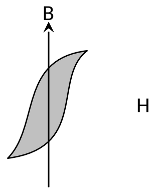
d) The shape of the hysteresis loop is characteristic of the material

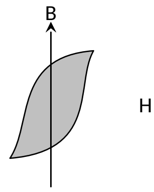
71. The area of hysteresis loop of a material is equivalent to $250\,joule$. When $10\,kg$ material is magnetized by an alternating field of $50\,Hz$ then energy lost in one hour will be (density of material is $7.5\,gm/cm^3$)

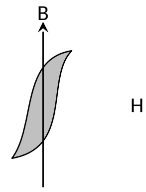
a) $6\times10^4\,J$ b) $6\times10^4\,erg$ c) $3\times10^2\,J$ d) $3\times10^2\,erg$

72. For substances hysteresis ¿-$H$) curves are given as shown in figure. For making temporary magnet which of the following is best

a) 


b) 


c) 


d) 


73. The effective length of a magnet is 31.4 cm and its pole strength is 0.5 Am. Calculate its magnetic moment. If it is bent in form of semicircle, then magnetic moment will be

a) $0.157\,Am^2, 0.01\,Am^2$ b) $0.357\,Am^2, 0.01\,Am^2$

c) $1.157\,Am^2, 1.01\,Am^2$ d) None of these

74. A short bar magnet of magnetic moment 255 $JT^{-1}$ is placed with its axis perpendicular to earth's field direction. At what distance from the center of the magnet, the resultant field is inclined at $45°$ with earth's field, $H=0.4\times10^{-4}\,T$?

a) 5 m b) 0.5m c) 2.5 m d) 0.25 m

75. When a piece of a ferromagnetic substance is put in a uniform magnetic field, the flux density inside it is four times the flux density away from the piece. The magnetic permeability of the material(in $N/A^2$) is

a) 1 b) 2 c) 3 d) 4

76. Each atom of an iron bar $(5\,cm\times1\,cm\times1\,cm)$ has a magnetic moment $1.8\times10^{-23}\,Am^2$. Knowing that the density of iron is $7.78\times10^3\,kg\,m^{-3}$, atomic weight is 56 and Avogadro's number of $6.02\times10^{23}$ the magnetic moment of bar in the state of magnetic saturation will be

a) $4.75\,Am^2$ b) $5.74\,Am^2$ c) $7.54\,Am^2$ d) $75.4\,Am^2$

77. Susceptibility of ferromagnetic substance is

a) >1 b) <1 c) Zero d) 1

78. The period of oscillations of a magnet is 2 s. When it is magnetized that the pole strength is 4 times, its period will be

a) 4 s b) 1 s c) 2 s d) $\frac{1}{2}$ s

79. The needle of a deflection galvanometer shows a deflection of $60°$ due to a short bar magnet at a certain distance in tan $A$ position. If the distance is double the deflection is

a) $\sin^{-1}\left[\frac{\sqrt{3}}{8}\right]$ b) $\cos^{-1}\left[\frac{\sqrt{3}}{8}\right]$ c) $\tan^{-1}\left[\frac{\sqrt{3}}{8}\right]$ d) $\cot^{-1}\left[\frac{\sqrt{3}}{8}\right]$

80. Magnets $A$ and $B$ are geometrically similar but the magnetic moment of $A$ is twice that of $B$. If $T_1$ and $T_2$ be the time periods of the oscillation when their like poles and unlike poles are kept together respectively, then $\frac{T_1}{T_2}$ will be

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

81. A vibration magnetometer placed in magnetic meridian has a small bar magnet. The magnet executes oscillations with a time period of 2 sec in earth's horizontal magnetic field of 24 microtesla. When a horizontal field of 18 microtesla is produced opposite to the earth's field by placing a current carrying wire, the new time period of magnet will be

a) $4s$ b) $1s$ c) $2s$ d) $3s$

82. A bar magnet is situated on a table along east-west direction in the magnetic field of earth. The number of neutral points, where the magnetic field is zero, are

a) 2 b) 0 c) 1 d) 4

83. The magnetic susceptibility of a material of a rod is 499. The absolute permeability of vacuum is $4\pi \times 10^{-7} H M^{-1}$. The absolute permeability of the material of a road is

a) $\pi \times 10^{-4} H M^{-1}$ b) $2\pi \times 10^{-4} H M^{-1}$ c) $3\pi \times 10^{-4} H M^{-1}$ d) $4\pi \times 10^{-4} H M^{-1}$

84. A frog can be levitated in magnetic field produced by a current in a vertical solenoid placed below the frog. This is possible because the body of the frog behaves as

a) Paramagnetic b) Diamagnetic c) Ferromagnetic d) Anti-ferromagnetic

85. A short bar magnet placed with its axis at $30°$ with a uniform external magnetic field of $0.16$ tesla experiences a torque of magnitude 0.032 J. The magnetic moment of bar magnet will be

a) 0.23 J/T b) 0.40 J/T c) 0.80 J/T d) Zero

86. Which of the following is represented by the area enclosed by a hysteresis loop (*B-H* curve)?

a) Permeability b) Retentivity

c) Heat energy lost per unit volume in the sample d) Susceptibility

87. The magnetic potential at a point on the axial line of a bar magnet of dipole moment $M$ is $V$. What is the magnetic potential due to a bar magnet of dipole moment $\frac{M}{4}$ at the same point

a) $4V$ b) $2V$ c) $\frac{V}{2}$ d) $\frac{V}{4}$

88. A wire of length $L$ metre carrying current $i$, ampere is bent in the form of a circle. What is the magnitude of magnetic of magnetic dipole moment?

a) $iL^2/4\pi$ b) $i^2L^2/4\pi$ c) $i^2L/8\pi$ d) $iL^2/8\pi$

89. If the magnetic is cut into four equal parts such that their lengths and breadths are equal. Pole strength of each part is

a) $m$ b) *m/2* c) *m/4* d) *m/8*

90. To shield an instrument from external magnetic field, it is placed inside a cabin made of

a) Wood

b) Ebonite

c) Iron

d) Diamagnetic substance

91. The magnetic susceptibility of any paramagnetic material changes with absolute temperature $T$ as

a) Directly proportional to $T$

b) Remains constant

c) Inversely proportional to $T$

d) Exponentially decaying with $T$

92. Magnetic susceptibility of a diamagnetic substance

a) Decreases with temperature

b) Is not affected by temperature

c) Increases with temperature

d) First increase then decrease with temperature

93. A very small magnet is placed in the magnetic meridian with its south pole pointing north. The null point is obtained $20\,cm$ away from the centre of the magnet. If the earth's magnetic field (horizontal component) at this point is $0.3\,gauss$, the magnetic moment of the magnet is

a) $8.0\times10^{2}\,e.m.u$

b) $1.2\times10^{3}\,e.m.u$

c) $2.4\times10^{3}\,e.m.u$

d) $3.6\times10^{3}\,e.m.u$

94. Lines which represent places of constant angle of dip are called

a) Isobaric lines

b) Isogonic lines

c) Isoclinic lines

d) Isodynamic lines

95. The hysteresis cycle for the material of a transformer core is

a) Short and wide

b) Tall and narrow

c) Tall and wide

d) Short and narrow

96. A magnet of magnetic moment 20 CGS units is freely suspended in a uniform magnetic field of intensity 0.3 CGS units. The amount of work done in deflecting it by an angle of $30°$ in CGS units is

a) 6

b) $3\sqrt{3}$

c) $3(2-\sqrt{3})$

d) 3

97. Magnetic lines of force due to a bar magnet do not intersect because

a) A point always has a single net magnetic field

b) The lines have similar charges and so repel each other

c) The lines always diverge from a single point

d) The lines need magnetic lenses to be made to intersect

98. The angle of dip at a place is $37°$ and the vertical component of the earth's magnetic field is $6\times10^{-5}T$. The earth's magnetic field at this place is ¿)

a) $7\times10^{-5}T$

b) $6\times10^{-5}T$

c) $5\times10^{-5}T$

d) $10^{-4}T$

99. Hysteresis loss is minimized by using

a) Alloy of steel

b) Shell type of core

c) Thick wire which has low resistance

d) Mu metal

100. The distance of two points on the axis of a magnet from its centre is $10\,cm$ and $20\,cm$ respectively. The ratio of magnetic intensity at these points is $12.5:1$. The length of the magnet will be

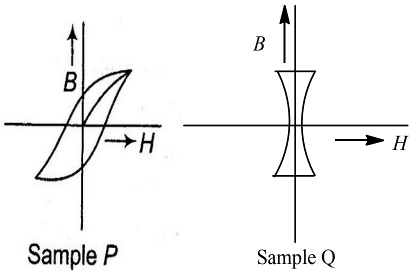
a) $5\,cm$

b) $25\,cm$

c) $10\,cm$

d) $20\,cm$

101. If the $B-H$ curves of two samples of $P$ and $Q$ of iron are as shown below, then which one of the following statements is correct?




a) Both $P$ and $Q$ are suitable for making permanent magnet

b) $P$ is suitable for making permanent magnet and $Q$ for making electromagnet

c) $P$ is suitable for making electromagnet and $Q$ is suitable for permanent magnet

d) Both $P$ and $Q$ are suitable for making electromagnets

102. The magnetic susceptibility of a paramagnetic substance at $-73\,°$ C is 0.0060, then its value at $-173\,°$C will be

a) 0.0030 b) 0.0120 c) 0.0180 d) 0.0045

103. A short bar magnet experiences a torque of magnitude 0.64 J. When it is placed in a uniform magnetic field of 0.32 T, taking an angle of $30\,°$ with the direction of the field. The magnetic moment of the magnet is

a) $1\,A\,m^2$ b) $4\,A\,m^2$ c) $6\,A\,m^2$ d) None of these

104. Two short magnets with their axes horizontal and perpendicular to the magnetic meridian are placed with their centres $40\,cm$ east and $50\,cm$ west of magnetic needle. If the needle remains undeflected, the ratio of their magnetic moments $M_1 : M_2$ is

a) $4:5$ b) $16:25$ c) $64:125$ d) $2:\sqrt{5}$

105. The coil in a tangent galvanometer is 16 cm in radius. If a current of 20 mA is to produce a deflection of $45\,°$ then the number of turns wound on it, is (Take horizontal component of earth's magnetic field ¿$0.36 \times 10^{-4}\,T \wedge \mu_0 = 4\pi \times 10^{-7}\,Wb\,A^{-1} m^{-1}$)

a) 229 b) 458 c) 689 d) 916

106. A deflection magnetometer is adjusted in the usual way. When a magnet is introduced, the deflection observed is $\theta$, and the period of oscillation of the needle in the magnetometer is $T$. When the magnet is removed, the period of oscillation is $T_0$.Find the relation between $T \wedge T_0$ is

a) $T^2 = T_0^2 \cos\theta$ b) $T = T_0 \cos\theta$ c) $T = \frac{T_0}{\cos\theta}$ d) $T^2 = \frac{T_0^2}{\cos\theta}$

107. A tangent galvanometer shows a deflection $45\,°$ when $10\,mA$ current passes through it. If the horizontal component of the earth's field is $3.6 \times 10^{-5}\,T$ and radius of the coil is $10\,cm$. The number of turns in the coil is

a) 5700 turns b) 57 turns c) 570 turns d) 5.7 turns

108. A small rod of bismuth is suspended freely between the poles of a strong electromagnet. It is found to arrange itself at right angles to the magnetic field. This observation establishes that bismuth is

a) Diamagnetic b) Paramagnetic c) Ferri-magnetic d) Antiferro-magnetic

109. A magnet performs 10 oscillations per minute in a horizontal plane at a place where the angle o dip is $45\,°$ and the total intensity is 0.707 units. The number of oscillations per minute at a place where dip angle is $60\,°$ and total intensity is 0.5 CGS units will be

a) 5 b) 7 c) 9 d) 11

110. Two short magnets have equal pole strengths but one is twice as long as other. The shorter magnet is placed 20 cm in tan $A$ position from the compass needle. The longer magnet must be placed on the other side of the magnetometer for no deflection at a distance equal to

a) 20 cm b) $20 \times (2)^{1/3}\,cm$ c) $20 \times (2)^{2/3}\,cm$ d) $20 \times (2)\,cm$

111. In an experiment with vibration magnetometer, the value of $4\pi^2 I/T^2$ for a short bar magnet is observed as $36\times10^{-4}$. In the experiment with deflection magnetometer with the same magnet, the value of $4\pi d^3/2\mu_0$ is observed as $10^8/36$. The magnetic moment of the magnet used is

a) 50 A-m b) 100 A-m c) 200 A-m d) 1000 A-m

112. The relative magnetic permeability of ferromagnetic materials is of the order of

a) 10 b) 100 c) 1000 d) 10000

113. Diamagnetic substance are

a) Feebly attracted by magnets
b) Strongly attracted by magnets
c) Feebly repelled by magnets
d) Strongly repelled by magnets

114. A magnet of length 14 cm and magnetic moment $M$ is broken into two parts of length 6 cm and 8 cm. They are put at a right angle to each other with opposite poles together. The magnetic moment of the combination is

a) $M/10$ b) $M$ c) $M/1.4$ d) 2.8 $M$

115. The earth's magnetic induction at a certain point is $7\times10^{-5}\,Wb\,m^{-2}$. This is to be annulled by the magnetic induction at the center of a circular conducting loop of radius 15 cm. The required current in the loop is

a) 0.56 A b) 5.6 A c) 0.28 A d) 2.8 A

116. A bar magnet is oscillating in the earth's magnetic field with time period *T*. If its mass is increased four times, then its time period will be

a) $4T$ b) $2T$ c) $T$ d) $\frac{T}{2}$

117. The deflection magnetometer is most sensitive when deflection $\theta$ is

a) Nearly zero b) Nearly 30° c) Nearly 45° d) Nearly 90°

118. A magnetic dipole is placed in a uniform magnetic field. The net magnetic force on the dipole

a) Is always zero
b) Depends on the orientation of the dipole
c) Can never be zero
d) Depends on the strength of the dipole

119. Substances in which the magnetic moment of a single atom is not zero, is known as

a) Diamagnetism
b) Ferromagnetism
c) Paramagnetism
d) Ferrimagnetism

120. When two magnetic moments are compared using equal distance method the deflections produced are $45°$ and $30°$. If the length of magnets are in the ratio $1:2$, the ratio of their pole strength is

a) $3:1$ b) $3:2$ c) $\sqrt{3}:1$ d) $2\sqrt{3}:1$

121. With a standard rectangular bar magnet the time period of a vibration magnetometer is 4 s. The bar magnet is cut parallel to its length into four equal pieces. The time period of vibration magnetometer when one piece is used (in second) (bar magnet breadth is small) is

a) 16 b) 8 c) 4 d) 2

122. A rigid circular loop of radius $r$ and mass $m$ lies in the $x-y$ plane of a flat table and has a current $i$ flowing in it. At this particular place the earth's magnetic field is $B=B_x\hat{i}+B_z\hat{k}$. The value of $i$ so that the loop start tilting is

a) $\frac{mg}{\pi r\sqrt{B_x^2+B_z^2}}$ b) $\frac{mg}{\pi r B_x}$ c) $\frac{mg}{\pi r B_z}$ d) $\frac{mg}{\pi r\sqrt{B_x B_z}}$

123. Magnetic permeability is maximum for

a) Diamagnetic substance
b) Paramagnetic substance
c) Ferromagnetic substance
d) All of these

124. At a certain place, a magnet makes 30 oscillations per min. At another place where the magnetic field is double, its time period will be
a) 4 s
b) 2 s
c) $1/2$ s
d) $\sqrt{2}$ s

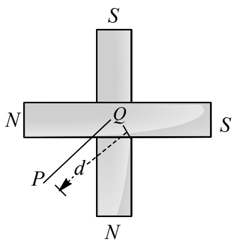
125. When the $N$-pole of a bar magnet points towards the south and $S$-pole towards the north, the null points are at the
a) Magnetic axis
b) Magnetic centre
c) Perpendicular divider of magnetic axis
d) $N$ and $S$ poles

126. The angle of dip at the magnetic equator is
a) $0°$
b) $45°$
c) $30°$
d) $90°$

127. The mathematical equation for magnetic field lines of force is
a) $\vec{\nabla}\cdot\vec{B}=0$
b) $\vec{\nabla}\cdot\vec{B}\neq 01$
c) $\vec{\nabla}\cdot\vec{B}>0$
d) $\vec{\nabla}\cdot\vec{B}<0$

128. Using a bar magnet $P$, a vibration magnetometer has time period $2\,seconds$. When a bar $Q$ (identical to $P$ in mass and size) is placed on top of $P$, the time period is unchanged. Which of the following statements is true
a) $Q$ is of non-magnetic material
b) $Q$ is a bar magnet identical to $P$, and its north pole is placed on top of $P$'s north pole
c) $Q$ is of unmagnetized ferromagnetic material
d) Nothing can be said about $Q$'s properties

129. Two short bar magnets of equal dipole moment $M$ are fastened perpendicularly at their centers, figure. The magnitude of resultant of two magnetic field at a distance $d$ from the center on the bisector of the right angle is



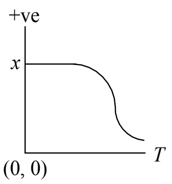

a) $\frac{\mu_0}{4\pi}\frac{2\sqrt{2}M}{d^3}$
b) $\frac{\mu_0}{4\pi}\frac{2M}{d^3}$
c) $\frac{\mu_0}{4\pi}\frac{M}{d^3}$
d) $\frac{\mu_0}{4\pi}\frac{2\sqrt{2}M}{d^3}$

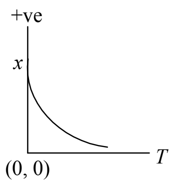
130. A superconducting material is
a) Ferromagnetic
b) Ferroelectric
c) Diamagnetic
d) Paramagnetic

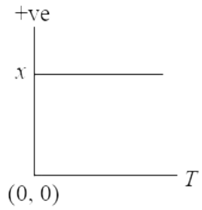
131. Two normal uniform magnetic fields contain a magnetic needle making an angle $60°$ with $F$. Then the ratio of $\frac{F}{H}$ is
a) $1:2$
b) $2:1$
c) $\sqrt{3}:1$
d) $1:\sqrt{3}$

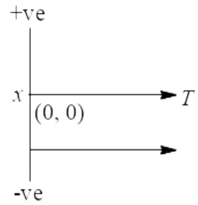
132. Permanent magnet has properties retentivity and coercivity respectively
a) High-high
b) Low-low
c) Low-high
d) High-low

133. The variation of magnetic susceptibility $(X)$ with absolute temperature $T$ for a ferromagnetic is given in figure , by

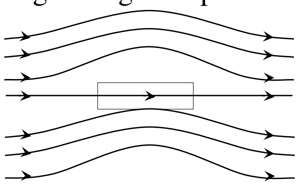
a) 


b) 


c) 


d) 


134. The given figure represents a material which is



a) Paramagnetic b) Diamagnetic c) Ferromagnetic d) None of these

135. Direction of magnetic field at equatorial point is

a) Parallel to **M**
b) Perpendicular to **M**
c) Making an angle of angle $45°$ with **M**
d) Antiparallel to **M**

136. A bar magnet is oscillating in the Earth's magnetic field with a period $T$. What happens to its period of motion if its mass is quadrupled?

a) Motion remains SHM with time period $=T/2$
b) Motion remains SHM and period remains nearly constant
c) Motion remains SHM with time period ¿$2T$
d) Motion remains SHM with time period¿$4T$

137. Susceptibility of $Mg$ at $300\,K$ is $1.2\times10^{-5}$. The temperature at which susceptibility will be $1.8\times10^{-5}$ is

a) $450\,K$ b) $200\,K$ c) $375\,K$ d) None of these

138. Water is

a) Diamagnetic b) Paramagnetic c) Ferromagnetic d) None of these

139. The magnetic field due to short bar magnet of magnetic dipole moment $M$ and length $2l$, on the axis at a distance $z$ (where $z \gg l$) from the center of the magnet is given by formula

a) $\frac{\mu_0 M}{4\pi z^3}\widehat{M}$ b) $\frac{2\mu_0 M}{4\pi z^3}\widehat{M}$ c) $\frac{4\pi M}{\mu_0 z^2}\widehat{M}$ d) $\frac{\mu_0 M}{2\pi z^3}\widehat{M}$

140. At a certain place the horizontal component of the earth's magnetic field is $B_0$ and the angle of dip is $45°$ then total intensity of field at that place will be

a) $B_0^2$ b) $2B_0$ c) $\sqrt{2}B_0$ d) $B_0$

141. The north pole of the earth's magnet is near the geographical

a) South b) East c) West d) North

142. A magnet makes 5 oscillations per min in $B=0.3\times10^{-4}$T. By what amount should the field be increased so that number of oscillations is 10 in the same time?

a) $0.3\times10^{-4}$T b) $0.6\times10^{-4}$T c) $0.9\times10^{-4}$T d) $1.2\times10^{-4}$T

143. Resultant force acting on a diamagnetic material in a magnetic field is in direction

a) From stronger to the weaker part of the magnetic field

b) From weaker to the stronger part of the magnetic field

c) Perpendicular to the magnetic field

d) In the direction making $60°$ to the magnetic field

144. The use of study of hysteresis curve for a given material is to estimate the

a) Voltage loss
b) Hysteresis loss
c) Current loss
d) All of these

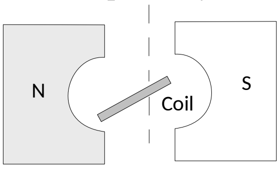
145. In a vibration magnetometer, the time period of a bar magnet oscillating in horizontal component of earth's magnetic field is 2 s. When a magnet is brought near and parallel to it, the time period reduces to 1 s. The ratio $\frac{F}{H}$ of the fields, $F$ due to magnet and $H$, the horizontal component will be

a) $\sqrt{3}$
b) $\frac{1}{\sqrt{3}}$
c) $\frac{1}{3}$
d) 3

146. If a diamagnetic solution is poured into a U-tube and one arm of this U-tube is placed between the poles of a strong magnet, with the meniscus in line with the field, then the level of solution will

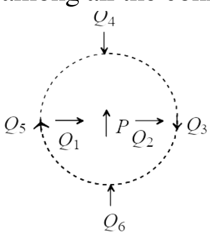
a) Rise
b) Fall
c) Oscillate slowly
d) Remain as such

147. The figure below shows the north and south poles of a permanent magnet in which $n$ turn coil of area of cross-section $A$ is resting, such that for a current $i$ passed through the coil, the plane of the coil makes an angle $\theta$ with respect to the direction of magnetic field B. If the plane of the magnetic field and the coil are horizontal and vertical respectively, the torque on the coil will be




a) $\tau = niAB\cos\theta$
b) $\tau = niAB\sin\theta$
c) $\tau = niAB$
d) None of the above, since the magnetic field is radial

148. The figure shows the various positions (labelled by subscripts) of small magnetised needless $P$ and $Q$. The arrows show the direction of their magnetic moment. Which configuration corresponds to the lowest potential energy among all the configurations shown




a) $PQ_3$
b) $PQ_4$
c) $PQ_5$
d) $PQ_6$

149. The space inside a toroid is filled with tungsten shoes susceptibility is $6.8 \times 10^{-5}$. The percentage increase in the magnetic field will be

a) 0.0068%
b) 0.068%
c) 0.68%
d) None of these

150. A rod of ferromagnetic material with dimensions $10\,cm \times 0.5\,cm \times 0.2\,cm$ is placed in a magnetic field of strength $0.5 \times 10^4\,A-m^{-1}$ as a result of which of which a magnetic moment of 0.5 $A-m^{-2}$ is produced in rod. The value of magnetic induction will be

a) 0.54 T
b) 6.28 T
c) 0.358 T
d) 2.591 T

151. The magnetic needle of a vibration magnetometer makes 12 oscillations per minute in the horizontal component of earth's magnetic field. When an external short bar magnet is placed at some distance along the axis of the needle in the same line, it makes 15 oscillations per minute. If the poles of the bar magnet are interchanged, the number of oscillations it makes per minute is

a) $\sqrt{61}$
b) $\sqrt{63}$
c) $\sqrt{65}$
d) $\sqrt{67}$

152. Ferromagnetic show their properties due to

a) Filled inner subshells
b) Vacant inner subshells
c) Partially filled inner subshells
d) All the subshells equally filled

153. The time period of a thin bar magnet in earth's magnetic field is $T$. If the magnet is cut into equal parts perpendicular to its length, the time period of each part in the same field will be
a) $T/2$
b) $T/4$
c) $\sqrt{2}T$
d) $2T$

154. Relative permittivity and permeability of a material are $\varepsilon_r$ and $\mu_r$, respectively. Which of the following values of these quantities are allowed for a diamagnetic material?
a) $\varepsilon_r=0.5, \mu_r=1.5$
b) $\varepsilon_r=1.5, \mu_r=0.5$
c) $\varepsilon_r=0.5, \mu_r=0.5$
d) $\varepsilon_r=1.5, \mu_r=1.5$

155. Two identical thin bar magnets each of length $l$ and pole strength $m$ are placed at right angle to each other with north pole of one touching south pole of the other. Magnetic moment of the system is
a) $ml$
b) $2ml$
c) $\sqrt{2}ml$
d) $\frac{1}{2}ml$

156. Magnetic field intensity is defined as
a) Magnetic moment per unit volume
b) Magnetic induction force acting on a unit magnetic pole
c) Number of lines of force crossing per unit area
d) Number of lines of force crossing per unit volume

157. The intensity of magnetic field due to an isolated pole of strength $m$ at a point distance $r$ from it will be
a) $\frac{m}{r^2}$
b) $mr^2$
c) $\frac{r^2}{m}$
d) $\frac{m}{r}$

158. Two like magnetic poles of strength 10 and 45 SI units are separated by a distance $30\,cm$. The intensity of magnetic field is zero on the line joining them
a) At a point $10\,cm$ from the stronger pole
b) At a point $20\,cm$ from the stronger pole
c) At the mid-point
d) At infinity

159. The only property possessed by ferromagnetic substance is
a) Hysteresis
b) Susceptibility
c) Directional property
d) Attracting magnetic substances

160. The hysteresis curve is studied generally for
a) Ferromagnetic materials
b) Paramagnetic materials
c) Diamagnetic materials
d) All of the above

161. A steel wire of length $l$ has a magnetic moment $M$. It is bent at its middle point at an angle of 60°. Then the magnetic moment of new shape of wire will be
a) $M/\sqrt{2}$
b) $M/2$
c) $M$
d) $\sqrt{2}M$

162. Let $\phi_1$ and $\phi_2$ be the angles of dip observed in two vertical planes at right angles to each other and $\phi$ be the true angle of dip, then
a) $\cos^2\phi=\cos^2\phi_1+\cos^2\phi_2$
b) $sec^2\phi=sec^2\phi_1+sec^2\phi_2$
c) $\tan^2\phi=\tan^2\phi_1+\tan^2\phi_2$
d) $\cot^2\phi=\cot^2\phi_1+\cot^2\phi_2$

163. A dip needle vibrates in the vertical plane perpendicular to magnetic meridian. The time period of vibration is found to be 2 s. The same needle is then allowed to vibrate in the horizontal plane and time period is again found

to be 2s. Then the angle of dip is

a) $0°$ b) $30°$ c) $45°$ d) $90°$

164. At a place, the magnitudes of the horizontal component and total intensity of the magnetic field of the earth are 0.3 and 0.6 *oersted* respectively. The value of the angle of dip at this place will be

a) $60°$ b) $45°$ c) $30°$ d) $0°$

165. Two identical short bar magnets, each having magnetic moment of $10\,A\,m^2$, are arranged such that their axial lines are perpendicular to each other and their centres be along the same straight line in a horizontal plane. If the distance between their centres is $0.2\,m$, the resultant magnetic induction at a point midway between them is $(\mu_0 = 4\pi \times 10^{-7}\,H\,m^{-1})$

a) $\sqrt{2} \times 10^{-7}\,tesla$ b) $\sqrt{5} \times 10^{-7}\,tesla$ c) $\sqrt{2} \times 10^{-3}\,tesla$ d) $\sqrt{5} \times 10^{-3}\,tesla$

166. The magnetic moment of a diamagnetic atom is

a) Much greater than one
b) 1
c) Between zero and one
d) Equal to zero

167. Which one of the following is not a characteristics of diamagnetism?

a) The diamagnetic materials are repelled by a bar magnet
b) The magnetic susceptibility of the materials is small and negative
c) The origin of dia magnetism is the spin of electrons
d) The material move from a region of strong magnetic field to weak magnetic field

168. A short bar magnet with the north pole facing north forms a neutral point a $P$ in the horizontal plane. If the magnet is rotated by 90° in the horizontal plane, the net magnetic induction at $P$ is (Horizontal component of earth's magnetic field¿ $B_H$ ¿

a) Zero b) $2\ B_H$ c) $\frac{\sqrt{5}}{2} B_H$ d) $\sqrt{5}\ B_H$

169. The time period of a freely suspended magnet is $2\,sec$. If it is broken in length into two equal parts and one parts is suspended in the same way, then its time period will be

a) $4\ sec$ b) $2\ sec$ c) $\sqrt{2}\,sec$ d) $1\ sec$

170. At a certain place, the angle of dip is 30° and the horizontal component of earth's magnetic field is 0.50 oersted. The earth's total magnetic filed (in oersted) is

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

171. When a metallic plate swings between the poles of a magnet

a) No effect on the plate
b) Eddy currents are set inside the plate and the direction of the current is along the motion of the plate
c) Eddy currents are set up inside the plate and the direction of the current oppose the motion of the plate
d) Eddy currents are set up inside the plate

172. Which of the following relations is correct in magnetism

a) $I^2 = V^2 + H^2$ b) $I = V + H$ c) $V = I^2 + H^2$ d) $V^2 = I + H$

173. The time period of a freely suspended bar magnet in a field is 2 s. It is cut into two equal parts along its axis, then the time period is

a) 4 s b) 0.5 s c) 2 s d) 0.25 s

174. The direction of lines of magnetic field of bar magnet is

a) From south pole to north pole

b) From north pole to south pole

c) Across the bar magnet

d) From south pole to north pole inside the magnet and from north pole is south pole outside the magnet

175. Two magnets $A$ and $B$ are identical in mass, length and breadth but have different magnetic moments. In a vibration magnetometer, if the time period of $B$ is twice the time period of $A$. The ratio of the magnetic moments $M_A / M_B$ of the magnets will be

a) 1/2 b) 2 c) 4 d) 1/4

176. Electromagnets are made of soft iron because soft iron has

a) Low susceptibility and low retentivity b) Low susceptibility and high retentivity

c) High permeability and low retentivity d) High permeability and high coercivity

177. The permanent magnet is made from which one of the following substances

a) Diamagnetic b) Paramagnetic c) Ferromagnetic d) Electromagnetic

178. A bar-magnet of moment of inertia $49 \times 10^{-2} kg-m^2$ vibrate in a magnetic field of induction $0.5 \times 10^{-4} T$. The time period of vibration is 8.8 s. The magnetic moment of the bar magnet is

a) $350\, A-m^2$ b) $490\, A-m^2$ c) $3300\, A-m^2$ d) $5000\, A-m^2$

179. Unit of magnetic flux density (or magnetic induction) is

a) $Tesla$ b) $Weber/metre^2$

c) $Newton/ampere-metre$ d) All of the above

180. If the magnetic flux is expressed in $weber$, then magnetic induction can be expressed in

a) $Weber/m^2$ b) $Weber/m$ c) $Weber\text{-}m$ d) $Weber\text{-}m^2$

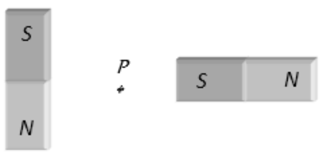
181. A bar magnet when placed at an angle of $30°$ to the direction of magnetic field induction of $5 \times 10^{-2} T$, experiences a moment of couple $25 \times 10^{-6} N-m$. If the length of the magnet is 5 cm, its pole strength is

a) $2 \times 10^{-2}$ A-m b) $5 \times 10^{-2}$ A-m c) 2 A-m d) 5 A-m

182. The ultimate individual unit of magnetism is any magnet is called

a) North pole b) South pole c) Dipole d) Quadrupole

183. Two equal bar magnets are kept as shown in the figure. The direction of resultant magnetic field, indicated by arrow head at the point $P$ is (approximately)




a) $\longrightarrow$ b) $\nearrow$ c) $\searrow$ d) $\uparrow$

184. The radius of the coil of a tangent galvanometer which has 10 turns is 0.1 m. The current required to produce a deflection of $60° \left(B_H = 4 \times 10^{-5} T\right)$ is

a) 3 A b) 1.1 A c) 2.1 A d) 1.5 A

185. The magnetic field due to a short magnet at a point on its axis at distance $X\, cm$ from the middle point of the

magnet is $200\,gauss$. The magnetic field at a point on the neutral axis at a distance $X\,cm$ from the middle of the magnet is

a) $100\,gauss$ b) $400\,gauss$ c) $50\,gauss$ d) $200\,gauss$

186. Among the following properties describing diamagnetism identify the property that is wrongly stated

a) Diamagnetic material do not have permanent magnetic moment

b) Diamagnetism is explained in terms of electromagnetic induction

c) Diamagnetic materials have a small positive susceptibility

d) The magnetic moment of individual electrons neutralize each other

187. For a paramagnetic material, the dependence of the magnetic susceptibility $X$ on the absolute temperature is given as

a) $X \propto T$ b) $X \propto 1/T^2$ c) $X \propto 1/T$ d) Independent

188. The magnetic field at a point $x$ on the axis of a small bar magnet is equal to the field at a point $y$ on the equator of the same magnet. The ratio of the distances of $x$ and $y$ from the centre of the magnet is

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

189. The magnetic induction in air at a distance $d$ from an isolated point pole of strength $m$ unit will be

a) $\frac{m}{d}$ b) $\frac{m}{d^2}$ c) $md$ d) $m\,d^2$

190. The magnetic field of earth is due to

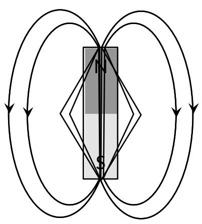
a) Motion and distribution of some material in and outside the earth

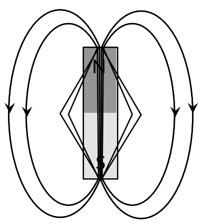
b) Interaction of cosmic rays with the current of earth

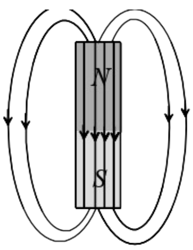
c) A magnetic dipole buried at the centre of the earth

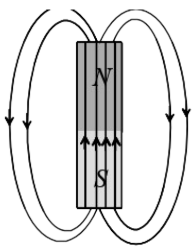
d) Induction effect of the sun

191. The magnetic field lines due to a bar magnet are correctly shown in

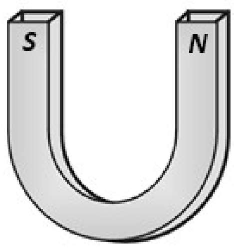
a) 


b) 


c) 


d) 


192. The distance between the poles of a horse shoe magnet is $0.1\,m$ and its pole strength is $0.01\,amp\text{-}m$. The induction of magnetic field at a point midway between the poles will be




a) $2 \times 10^{-5}\,T$ b) $4 \times 10^{-6}\,T$ c) $8 \times 10^{-7}\,T$ d) Zero

193. A bar magnet 20 cm in length is placed with it south pole towards geographic north. The neutral points are situated at a distance of 40 cm from centre of the magnet.

If horizontal component of earth's field ¿$3.2\times10^{-5}$ T, then pole strength of magnet is

a) 5 AM b) 10 AM c) 45 AM d) 20 AM

194. If two identical bar magnets, each of length $l$, pole strength $m$ and magnet moment $M$, are placed perpendicular to each other with their unlike poles in contact, the magnetic moment of the combination is

a) $\frac{M}{\sqrt{2}}$ b) $lm(\sqrt{2})$ c) $2lm(\sqrt{2})$ d) $2M$

195. Which of the following is diamagnetic

a) Aluminium b) Quartz c) Nickel d) Bismuth

196. A bar magnet of magnetic moment $\vec{M}$ is placed in a magnetic field of induction $\vec{B}$. The torque exerted on it is

a) $\vec{M}.\vec{B}$ b) $-\vec{M}.\vec{B}$ c) $\vec{M}\times\vec{B}$ d) $\vec{B}\times\vec{M}$

197. A short magnet of moment $6.75\,A\,m^2$ produces a neutral point on its axis. If horizontal component of earth's magnetic field is $5\times10^{-5}\,Wb/m^2$, then the distance of the neutral point should be

a) $10\,cm$ b) $20\,cm$ c) $30\,cm$ d) $40\,cm$

198. The magnetic susceptibility is

a) $\chi=\frac{I}{H}$ b) $\chi=\frac{B}{H}$ c) $\chi=\frac{M}{V}$ d) $\chi=\frac{M}{H}$

199. A vibration magnetometer consists of two identical bar magnets placed one over the other such that they are perpendicular and bisect each other. The time period of oscillation in a horizontal magnetic field is $2^{2/5}$s. One of the magnets is removed and if the other magnet oscillates in the same field , then the time period in second is

a) $2^{1/4}$ b) $2^{1/2}$ c) 2 d) 4

200. A bar magnet having centre O has a length of $4\,cm$. Point $P_1$ is in the broad side-on and $P_2$ is in the end side-on position with $OP_1=OP_2=10\,metres$. The ratio of magnetic intensities $H$ at $P_1$ and $P_2$ is

a) $H_1:H_2=16:100$ b) $H_1:H_2=1:2$ c) $H_1:H_2=2:1$ d) $H_1:H_2=100:16$

201. If the angular momentum of an electron is $\vec{J}$then the magnitude of the magnetic moment will be

a) $\frac{eJ}{m}$ b) $\frac{eJ}{2m}$ c) $eJ\,2m$ d) $\frac{2m}{eJ}$

202. A magnetic needle is kept in a non-uniform magnetic field. It experiences force and torque both due to unequal forces acting on poles.

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

203. At the magnetic north pole of the earth, the value of the horizontal component of earth's magnetic field and angle of dip are respectively

a) Zero, maximum b) Maximum, minimum c) Maximum , maximum d) Minimum , minimum

204. At magnetic poles of earth, angle of dip is

a) Zero b) $45°$ c) $90°$ d) $180°$

205. The magnetic needle of an oscillation magnetometer makes 10 oscillations per min under the action of earth's magnetic field alone. When a bar magnet is placed at some distance along the axis of the needle, it makes 14 oscillations per min. If the bar magnet is turned so that its poles interchange their positions, then the new frequency of oscillation of the needle is

a) $10\,vibs\text{-}m^{-1}$ b) $2\,vibs\text{-}m^{-1}$ c) $4\,vibs\text{-}m^{-1}$ d) $20\,vibs\text{-}m^{-1}$

206. A deflection magnetometer is adjusted in the usual way. When a magnet is introduced, the deflection observed is$\theta$, and the period of oscillation of the needle in the magnetometer is $T$. When the magnet is removed, the period of

oscillation is $T_0$. The relation between $T$ and $T_0$ is

a) $T^2 = T_0^2 \cos\theta$  b) $T = T_0 \cos\theta$  c) $T = \frac{T_0}{\cos\theta}$  d) $T^2 = \frac{T_0^2}{\cos\theta}$

207. The number of turns and radius of cross-section of the coil of a tangent galvanometer are doubled. The reduction factor $K$ will be

a) $K$  b) $2K$  c) $4K$  d) $K/4$

208. Let $B_V \wedge B_H$ be the vertical and horizontal components of earth's magnetic field at any point on earth. Near the north pole

a) $B_V \gg B_H$  b) $B_V <¿ B_H$  c) $B_V = B_H$  d) $B_V = B_H = 0$

209. At the magnetic poles of the earth, a compass needle will be

a) Vertical  b) Bent slightly

c) Horizontal  d) Inclined at $45°$ to the horizontal

210. A current carrying coil is placed with its axis parallel to N-S direction. Let horizontal component of earth's magnetic field be $H_0$ and magnetic field inside the loop is $H$. If a magnet is suspended inside the loop, it makes angle $\theta$ with $H$. Then $\theta$ is equal to

a) $\tan^{-1}\left(\frac{H_0}{H}\right)$  b) $\tan^{-1}\left(\frac{H}{H_0}\right)$  c) $cosec^{-1}\left(\frac{H}{H_0}\right)$  d) $\cot^{-1}\left(\frac{H_0}{H}\right)$

211. Two small magnets each of magnetic moment $10\,A\text{-}m^2$ are placed in end-on position $0.1\,m$ apart from their centres. The force acting between them is

a) $0.6 \times 10^7\,N$  b) $0.06 \times 10^7\,N$  c) $0.6\,N$  d) $0.06\,N$

212. A magnet is placed on a paper in a horizontal plane for locating neutral points. $A$ dip needle placed at the neutral point will be horizontal at the

a) Magnetic poles  b) Magnetic equator  c) Latitude angle 45°  d) Latitude angle of 60°

213. Magnetic dipole moment is a

a) Scalar quantity  b) Vector quantity  c) Constant quantity  d) None of these

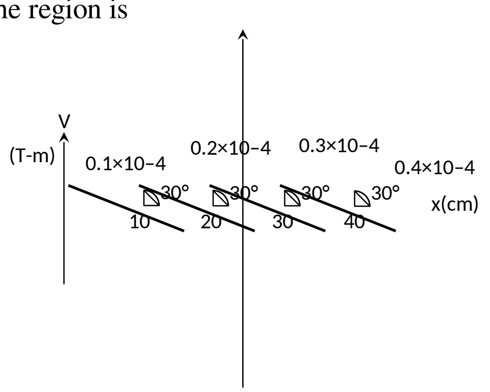
214. The angle of dip at a certain place where the horizontal and vertical components of the earth's magnetic field are equal is

a) 30°  b) 90°  c) 60°  d) 45°

215. A compass needle placed at a distance $r$ from a short magnet in a tan $A$ position shows a deflection of 60°. If the distance is increased to $r(2)^{1/3}$, the deflection of compass needle is

a) 30°  b) 60°  c) 45°  d) 0°

216. Some equipotential surfaces of the magnetic scalar potential are shown in the figure. Magnetic field at a point in the region is




a) $10^{-4}T$  b) $2 \times 10^{-4}T$  c) $0.5 \times 10^{-4}T$  d) None of these

217. Curie temperature is the one above which

a) Paramagnetic substance changes of ferromagnetic

b) Paramagnetic changes to diamagnetic

c) Diamagnetic changes to paramagnetic

d) Ferromagnetic changes to paramagnetic

218. The plane of a dip circle is set in the geographic meridian and the apparent dip is $\delta_1$.
It is then set in a vertical plane perpendicular to the geographic meridian. The apparent dip angle is $\delta_2$. The declination $\theta$ at the place is

a) $\theta = \tan^{-1}$¿¿ b) $\theta = \tan^{-1}$¿¿

c) $\theta = \tan^{-1}\left(\frac{\tan\delta_1}{\tan\delta_2}\right)$ d) $\theta = \tan^{-1}$¿¿

219. A bar magnet of magnetic moment $M$ and moment of inertia $I$ is freely suspended such that the magnetic axial line is in the direction of magnetic meridian. If the magnet is displaced by a very small angle ($\theta$), the angular acceleration is (Magnetic induction of earth's horizontal field ¿ $B_H$)

a) $\frac{MB_H\theta}{I}$ b) $\frac{IB_H\theta}{M}$ c) $\frac{M\theta}{IB_H}$ d) $\frac{I\theta}{MB_H}$

220. The magnetized wire of moment $M$ and length $l$ is bent in the form of semicircle of radius $r$. Then its magnetic moment is

a) $\frac{2M}{\pi}$ b) $2M$ c) $\frac{M}{\pi}$ d) Zero

221. In which direction, the magnetic field on the axis at a distance z from the centre of the bar magnet would be?

a) In the perpendicular direction of the magnetic moment (**M**) of the magnet

b) In the direction of the magnetic dipole moment (**M**) of the magnet

c) Its direction depends on the magnitude of the magnetic moment (**M**) of the magnet

d) In the opposite direction of the magnetic dipole moment(**M**) of the magnet

222. A dip needle lies initially in the magnetic meridian when it shows an angle of dip $\theta$ at a place. The dip circle is rotated through an angle $x$ in the horizontal plane and then it shows an angle of dip $\theta$'. Then $\frac{\tan\theta'}{\tan\theta}$ is

a) $\frac{1}{\cos x}$ b) $\frac{1}{\sin x}$ c) $\frac{1}{\tan x}$ d) $\cos x$

223. The time period of a bar magnet suspended horizontally in the earth's magnetic field and allowed to oscillate

a) Is directly proportional to the square root of its mass

b) Is directly proportional to its pole strength

c) Is inversely proportional to its magnetic moment

d) Decrease if the length increases but pole strength remains same

224. A long magnetic needle of length $2L$, magnetic moment $M$ and pole strength $m$ units is broken into two pieces at the middle. The magnetic moment and pole strength of each piece will be

a) $\frac{M}{2}, \frac{m}{2}$ b) $M, \frac{m}{2}$ c) $\frac{M}{2}, m$ d) $M, m$

225. If the total magnetic field due to earth is 28 $Am^{-1}$; then the total magnetic induction due to earth is

a) 28 T  b) $280\ ab - Ac\,m^{-1}$  c) 0.352 G  d) 0.325 T

226. A coil in the shape of an equilateral triangle of side $0.02\,m$ is suspended from its vertex such that it is hanging in a vertical plane between the pole pieces of permanent magnet producing a uniform field of $5 \times 10^{-2}T$. If a current of $0.1\,A$ is passed through the coil, what is the couple acting

a) $5\sqrt{3} \times 10^{-7}\,N-m$  b) $5\sqrt{3} \times 10^{-10}\,N-m$  c) $\frac{\sqrt{3}}{5} \times 10^{-7}\,N-m$  d) None of these

227. The vertical component of earth's magnetic field is zero at or The earth's magnetic field always has a vertical component except at the

a) Magnetic poles  b) Geographical poles  c) Every place  d) Magnetic equator

228. A magnet freely suspended in a vibration magnetometer makes 40 oscillations per minute at a place $A$ and 20 oscillations per minute at a place $B$. If the horizontal component of earth's magnetic field at $A$ is $36 \times 10^{-6}$T, then its value at $B$ is

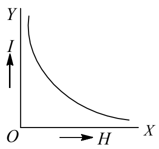
a) $36 \times 10^{-6}$T  b) $9 \times 10^{-6}$T  c) $144 \times 10^{-6}$T  d) $228 \times 10^{-6}$T

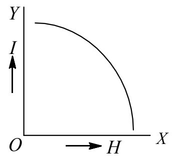
229. Magnetic moment of two bar magnets may be compared with the help of

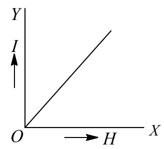
a) Deflection magnetometer  b) Vibration magnetometer

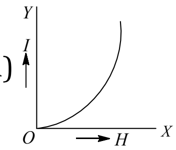
c) Both of the above  d) None of the above

230. The correct $I-H$ curve for a paramagnetic material is represented by, figure.

a) 


b) 


c) 


d) 


231. A tangent galvanometer has a reduction factor of 1 A and it is placed with the plane of its coil perpendicular to the magnetic meridian. The deflection produced when a current of 1 A is passed through it is

a) $60°$  b) $45°$  c) $30°$  d) None of these

232. The materials 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

233. Two tangent galvanometer having coils of the same radius are connected in series. A current flowing in them produces of $60°$and $45°$ respectively. The ratio of the number of turns in the coil is

a) 4/3  b) $(\sqrt{3}+1)/1$  c) $\frac{\sqrt{3}+1}{\sqrt{3}-1}$  d) $\frac{\sqrt{3}}{1}$

234. Isogonic lines on magnetic map will have

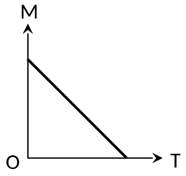
a) Zero angle of dip  b) Zero angle of declination

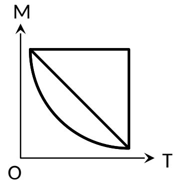
c) Same angle of declination  d) Same angle of dip

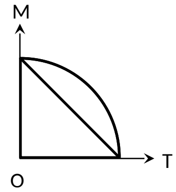
235. Two identical magnetic dipoles of magnetic moment 2 $Am^2$ are placed at a separation of 2 m with their axis perpendicular to each other in air. The resultant magnetic field at a mid-point between the dipoles is

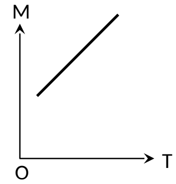
a) $4\sqrt{5} \times 10^{-5}T$  b) $2\sqrt{5} \times 10^{-5}T$  c) $4\sqrt{5} \times 10^{-7}T$  d) $2\sqrt{5} \times 10^{-7}T$

236. A curve between magnetic moment and temperature of magnet is

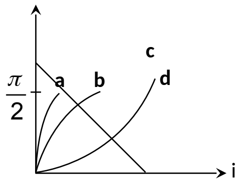
a) 


b) 


c) 


d) 


237. Which curve may best represent the current deflection in a tangent galvanometer

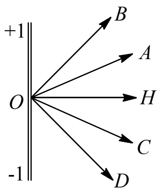



a) $A$ b) $B$ c) $C$ d) $D$

238. The hysteresis cycle for the material of permanent magnet is

a) Short and wide b) Tall and narrow c) Tall and wide d) Short and narrow

239. The variation of intensity of magnetization $(I)$ with respect to the magnetizing field $(H)$ in a diamagnetic substance is described by the graph in figure.




a) $OD$ b) $OC$ c) $OB$ d) $OA$

240. If a magnet of pole strength $m$ is divided into four parts such that the length and width of each part is half that of initial one, then the pole strength of each part will be

a) $m/4$ b) $m/2$ c) $m/8$ d) $4m$

241. A magnetic dipole is placed in two perpendicular magnetic fields $\vec{B}$ and $\vec{H}$ and is in equilibrium taking angle $\theta$ with $\vec{B}$. Then

a) $B=H$ b) $B\cos\theta=H\sin\theta$ c) $B\sin\theta=H\cos\theta$ d) $B=H\tan\theta$

242. A magnet of magnetic moment $M$ and pole strength $m$ is divided in two equal parts, then magnetic moment of each part will be

a) $M$ b) $M/2$ c) $M/4$ d) $2M$

243. As magnetising field on a ferromagnetic material is increased, its permeability

a) Increases b) Decreases c) Remains constant d) Cannot say

244. The error in measuring the current with a tangent galvanometer is minimum when the deflection is about

a) $0°$ b) $30°$ c) $45°$ d) $60°$

245. When a magnetic substance is heated, then it

a) Becomes a strong magnet b) Losses its magnetism

c) Does not effect the magnetism d) Either (a) or (c)

246. $Weber/m^2$ is equal to

a) $Volt$ b) $Henry$ c) $Tesla$ d) All of these

247. A magnet makes 40 oscillations per minute at a place having magnetic field intensity of $0.1\times10^{-5}T$. At another place, it takes $2.5\,sec$ to complete one vibration. The value of earth's horizontal field at that place is+

a) $0.25\times10^{-6}T$ b) $0.36\times10^{-6}T$ c) $0.66\times10^{-8}T$ d) $1.2\times10^{-6}T$

248. The magnetic moment of atomic neon is equal to

a) Zero b) $\frac{1}{2}\mu_B$ c) $\frac{3}{2}\mu_B$ d) $2\ \mu_B$

249. A paramagnetic substance of susceptibility $3\times10^{-4}$ is placed in a magnetic field of $4\times10^{-4}Am^{-1}$. Then the intensity of magnetization in the units of $Am^{-1}$ is

a) $1.33\times10^{8}$ b) $0.75\times10^{-8}$ c) $12\times10^{-8}$ d) $14\times10^{-8}$

250. The angle of dip at a place on the earth gives

a) The horizontal component of the earth's magnetic field

b) The location of the geographic meridian

c) The vertical component of the earth's field

d) The direction of the earth's magnetic field

251. Which of the following statements is not true

a) While taking reading of tangent galvanometer, the plane of the coil must be set at right angles to the earth's magnetic meridian

b) A short magnet is used in a tangent galvanometer since a long magnet would be heavy and may not easily move

c) Measurement with the tangent galvanometer will be more accurate when the deflection is around $45°$

d) A tangent galvanometer can not be used in the polar region

252. To measure which of the following , is a tangent galvanometer used

a) Charge b) Angle c) Current d) Magnetic intensity

253. A tangent galvanometer is connected directly to an ideal battery. If the number of turns in the coil is doubled, the deflection will

a) Increase b) Decrease

c) Remain unchanged d) Either increase or decrease

254. Tangent galvanometer is used to measure

a) Steady currents b) Current impulses

c) Magnetic moments of bar magnets d) Earth's magnetic field

255. If a magnet is hanged with its magnetic axis then it stops in

a) Magnetic meridian b) Geometric meridian c) Angle of dip d) None of these

256. An example of a diamagnetic substance is

a) Aluminium b) Copper c) Iron d) Nickel

257. For an isotropic medium $B,\mu,H$ and $M$ are related as (where $B,\mu_0,H$ and $M$ have their usual meanings in the context of magnetic material)

a) $(B-M)=\mu_0 H$ b) $M=\mu_0(H+M)$ c) $H=\mu_0(H+M)$ d) $B=\mu_0(H+M)$

258. The period of oscillation of a vibration magnetometer depends on which of the following factors
Where $I$ is the moment of inertia of the magnet about the axis of suspension, $M$ is the magnetic moment of the magnet and $H$ is the external magnetic field

a) $I$ and $M$ only b) $M$ and $H$ only c) $I$ and $H$ only d) $I, M$ and $H$ only

259. When a magnet is placed vertically on horizontal board, number of neutral points obtained on the board is

a) Four b) Three c) Two d) One

260. A tangent galvanometer has a coil with 50 turns and radius equal to $4\,cm$. A current of $0.1\,A$ is passing through it. The plane of the coil is set parallel to the earth's magnetic meridian. If the value of the earth's horizontal component of the magnetic field is $7 \times 10^{-5}\,tesla$ and $\mu_0 = 4\pi \times 10^{-7}\,weber/amp \times m$, then the deflection in the galvanometer needle will be

a) $45°$ b) $48.2°$ c) $50.7°$ d) $52.7°$

261. The relation between $B, H \wedge I$ in SI unit is

a) $B = \mu_0(H+I)$ b) $B = H + 4\mu I$ c) $H = ¿\,\mu_0(B+I)$ d) None of these

262. A dip circle is at right angles to the magnetic meridian.

a) $0°$ b) $90°$ c) $45°$ d) 4 : 1

263. In sum and difference method vibration magnetometer, the time period is more if

a) Similar poles of both magnets are on same sides

b) Opposite poles of both magnets are on same sides

c) Both magnets are perpendicular to each other

d) Nothing can be said

264. A magnet of magnetic moment $50\hat{i}\,A\text{-}m^2$ is placed along the $x$-axis in a magnetic field $\vec{B} = (0.5\hat{i} + 3.0\hat{j})\,T$. The torque acting on the magnet is

a) $175\hat{k}\,N\text{-}m$ b) $150\hat{k}\,N\text{-}m$ c) $75\hat{k}\,N\text{-}m$ d) $25\sqrt{37}\hat{k}\,N\text{-}m$

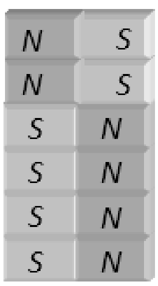
265. At two places $A$ and $B$ using vibration magnetometer, a magnet vibrates in a horizontal plane and it respective periodic time are $2\,sec$ and $3\,sec$ and at these places the earth's horizontal components are $H_A$ and $H_B$ respectively. Then the ratio between $H_A$ and $H_B$ will be

a) $9:4$ b) $3:2$ c) $4:9$ d) $2:3$

266. A thin rectangular magnet suspended freely has a period of oscillation equal to $T$. Now it is broken into two equal halves (each having half of the original length) and one piece is made to oscillate freely in the same field. If its period of oscillation is $T'$, the ratio $T'/T$

a) $\frac{1}{2\sqrt{2}}$ b) $\frac{1}{2}$ c) 2 d) $\frac{1}{4}$

267. The length of a magnet is large compared to it's width and breadth. The time period of its oscillation in a vibration magnetometer is $T$. The magnet is cut along it's length into six parts and these parts are then placed together as shown in the figure. The time period of this combination will be




a) $T$ b) $\frac{T}{\sqrt{3}}$ c) $\frac{T}{2\sqrt{3}}$ d) Zero

268. A magnetic needle suspended horizontally by an unspun silk fibre, oscillates in the horizontal plane because of the restoring force originating mainly from

a) The torsion of the silk fibre

b) The force of gravity

c) The horizontal component of earth's magnetic field

d) All of the above factors

269. Two tangent galvanometers $A$ and $B$ have coils of radii 8 cm and 16 cm respectively and resistance $8\,\Omega$ each. They are connected in parallel with a cell of emf 4 V and negligible internal resistance. The deflections produced in the tangent galvanometers $A$ and $B$ are $30° \wedge 60°$ respectively. If $A$ has 2 turns, then $B$ must have

a) 18 turns b) 12 turns c) 6 turns d) 2 turns

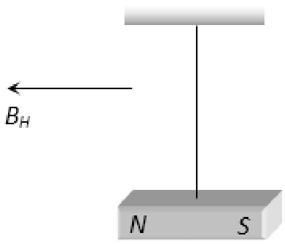
270. The field due to a magnet at a distance $R$ from the centre of the magnet is proportional to

a) $R^2$ b) $R^3$ c) $1/R^2$ d) $1/R^3$

271. The ratio of magnetic moments of two bar magnets is $13:5$. These magnets held together in a vibration magnetometer oscillate with 15 oscillations per minute in earth's magnetic field with like poles together. What will be the frequency of oscillations of system if unlike poles are together

a) $10\, oscillations/min$ b) $15\, oscillations/min$ c) $12\, oscillations/min$ d) $\frac{75}{13} oscillations/min$

272. A magnet is suspended horizontally in the earth's magnetic field. When it is displaced and then released it oscillates in a horizontal plane with a period $T$. If a piece of wood of the same moment of inertia (about the axis of rotation) as the magnet is attached to the magnet, what would be the new period of oscillation of the system

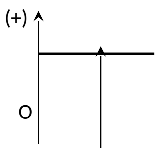


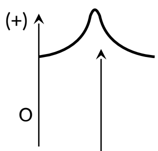

a) $\frac{T}{3}$ b) $\frac{T}{2}$ c) $\frac{T}{\sqrt{2}}$ d) $T\sqrt{2}$

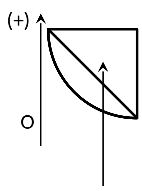
273. A bar magnet is held at right angles to a uniform magnetic field. The couple acting on the magnet is to be halved by rotation it from this position. The angle of rotation is

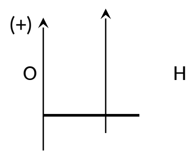
a) $60°$ b) $45°$ c) $30°$ d) $75°$

274. The variation of magnetic susceptibility $(\chi)$ with magnetising field for a paramagnetic substance is

a) 


b) 


c) 


d) 


275. When $2\, amperes$ current is passed through a tangent galvanometer, it gives a deflection of $30°$. For $60°$ deflection, the current must be

a) $1\, amp$ b) $2\sqrt{3}\, amp$ c) $4\, amp$ d) $6\, amp$

276. The magnetism of a magnet is due to

a) The earth

b) Cosmic rays

c) The spin motion of electrons

d) Pressure of big magnet inside the earth

277. The magnetic needle of a tangent galvanometer is deflected at an angle $30°$ due to a magnet. The horizontal component of earth's magnetic field $0.34 \times 10^{-4}$ T is along the plane of the coil. The magnetic intensity is

a) $1.96 \times 10^{-4}$ T b) $1.96 \times 10^{4}$ T c) $1.96 \times 10^{-5}$ T d) $1.96 \times 10^{5}$ T

278. A bar magnet has a magnetic moment equal to $5 \times 10^{-5}$ Wb-m. It is suspended in a magnetic field which has a magnetic induction $B$ equal to $8\pi \times 10^{-4}$ T. The magnet vibrates with a period of vibration equal to 15 s. The moment of inertia of magnet is

a) $4.54 \times 10^{4} kg-m^2$ b) $4.54 \times 10^{-5} kg-m^2$ c) $4.54 \times 10^{-4} kg-m^2$ d) $4.54 \times 10^{5} kg-m^2$

279. A magnetic needle is made to vibrate in uniform field $H$, then it time period is $T$. If it vibrates in the field of intensity $4H$, its time period will be

a) $2T$ b) $T/2$ c) $2/T$ d) $T$

280. A bar magnet having a magnetic moment of $2 \times 10^{4} J T^{-1}$ is free to rotate in a horizontal plane. A horizontal magnetic field $B = 6 \times 10^{-4} T$ exists in the space. The work done in taking the magnet slowly from a direction parallel to the field to a direction $60°$ from the field is

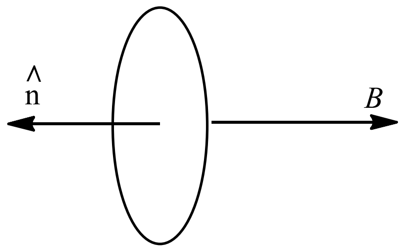
a) $0.6 J$ b) $12 J$ c) $6 J$ d) $2 J$

281. Two bar magnets with magnetic moments $2M$ and $M$ are fastened together at right angles to each other at their centres to form a crossed system, which can rotate freely about a vertical axis through the centre. The crossed system sets in earth's magnetic field with magnet having magnetic moment $2M$ making an angle $\theta$ with the magnetic meridian such that

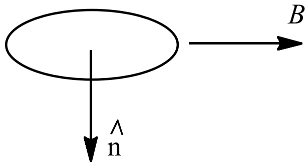
a) $\theta = \tan^{-1}\left(\frac{1}{\sqrt{3}}\right)$ b) $\theta = \tan^{-1}(\sqrt{3})$ c) $\theta = \tan^{-1}\left(\frac{1}{2}\right)$ d) $\theta = \tan^{-1}\left(\frac{3}{4}\right)$

282. A current carrying loop is placed in a uniform magnetic field in four different orientations, I, II, III and IV, arrange them in the decreasing order of potential energy

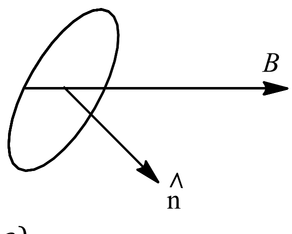
I.



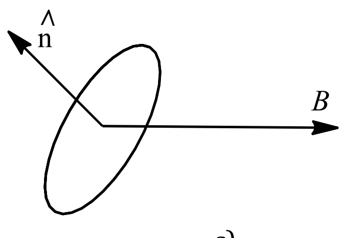

II.




III.




IV.




a) $I > III > II > IV$ b) $I > II > III > IV$ c) $I > IV > II > I II$ d) $III > IV > I > II$

283. The mass of specimen of a ferromagnetic material is 0.6 kg and the density is $7.8 \times 10^{3} kg m^{-3}$. If the area of hysteresis loop of alternating magnetizing field of frequency 50 Hz is 0.722 MKS units, then hysteresis loss per second will be

a) $27.77 \times 10^{-5} J$ b) $2.777 \times 10^{-5} J$ c) $27.27 \times 10^{-4} J$ d) $27.77 \times 10^{-6} J$

284. If the angles of dip at two places are $30°$ and $45°$ respectively, then the ratio of horizontal components of earth's magnetic field at the two places will be

a) $\sqrt{3}:\sqrt{2}$ b) $1:\sqrt{2}$ c) $1:\sqrt{3}$ d) 1:2

285. A magnetic needle is placed on a cork floating in a still lake in the northern hemisphere. Does the needle together

with the cork move towards the north of the lake

a) Yes

b) No

c) May be or may not be move

d) Nothing can be said

286. The direction of the null points is on the equatorial line of a bar magnet, when the north pole of the magnet is pointing

a) North
b) South
c) East
d) West

287. At a place, if one earth's horizontal and vertical components of magnetic fields are equal, then the angle of dip will be

a) $30°$
b) $90°$
c) $45°$
d) $0°$

288. Relative permeability of iron is 5500, then it magnetic susceptibility will be

a) $5500 \times 10^{7}$
b) $5500 \times 10^{-7}$
c) 5501
d) 5499

289. A vibration magnetometer is placed at south pole, then the time period will be

a) Zero
b) Infinity

c) Same as at magnetic equator
d) Same as at any other place on earth

290. The lines of force due to earth's horizontal component of magnetic field are

a) Parallel straight lines
b) Concentric circles
c) Elliptical
d) Parabolic

291. The bob of a simple pendulum is replaced by a magnet. The oscillation are set along the length of the magnet. A copper coil is added so that one pole of the magnet passes in and out of the coil. The coil is short-circuited. Then which one of the following happens

a) Period decreases
b) Period does not change

c) Oscillations are damped
d) Amplitude increases

292. Two uniform magnetic fields $B$ and $H$ are perpendicular to each other at a place. When a magnetic needle is placed in the field, it rest making angle $60°$ and $30°$ with $B$ and $H$ respectively. The value of $B:H$ is

a) $1:2$
b) $2:1$
c) $\sqrt{3}:1$
d) $1:\sqrt{3}$

293. Due to the earth's magnetic field, charged cosmic ray particles

a) Require greater kinetic energy to reach the equator than the poles

b) Require less kinetic energy to reach the equator than the poles

c) Can never reach the equator

d) Can never reach the poles

294. The universal property of all substances is

a) Diamagnetism
b) Ferromagnetism
c) Paramagnetism
d) All of these

295. The torque on a bar magnet due to the earth' magnetic field is maximum when the axis of the magnet is

a) Perpendicular to the field of the earth

b) Parallel of the vertical component of the earth's field

c) At an angle of $33°$ with respect $N$-$S$ direction

d) Along the North-South ($N$-$S$) direction

296. A magnet of magnetic moment $M$ is rotated through $360°$ in a magnetic field $H$. The work done will be

a) $MH$ b) $2\,MH$ c) $2\pi MH$ d) Zero

297. A current loop placed in a magnetic field behaves like a

a) Magnetic dipole b) Magnetic substance c) Magnetic pole d) All are true

298. The time period of oscillation of a bar magnet suspended horizontally along the magnetic meridian is $T_0$. If this magnet is replaced by another magnet of the same size and pole strength but with double the mass, the new time period will be

a) $\frac{T_0}{2}$ b) $\frac{T_0}{\sqrt{2}}$ c) $\sqrt{2}T_0$ d) $2\,T_0$

299. A compass needle whose magnetic moment is $60\,amp \times m^2$ pointing geographical north at a certain place, where the horizontal component of earth's magnetic field is $40\,\mu\,Wb/m^2$, experiences a torque $1.2 \times 10^{-3}\,N \times m$. What is the declination at this place

a) $30°$ b) $45°$ c) $60°$ d) $25°$

300. If the magnetic dipole moment of an atom of diamagnetic material, paramagnetic material and ferromagnetic material is denoted by $\mu_d, \mu_p, \mu_f$ respectively then

a) $\mu_d \neq 0$ and $\mu_f \neq 0$ b) $\mu_p \neq 0$ and $\mu_f \neq 0$ c) $\mu_d \neq 0$ and $\mu_p \neq 0$ d) $\mu_d \neq 0$ and $\mu_p \neq 0$

301. A magnet is suspended in such a way that it oscillates in the horizontal plane. It makes $20\,oscillations\ per\ minute$ at a place where dip angle is $30°$ and $15\,oscillations\ per\ minute$ at a place where dip angle $60°$. The ratio of total earth's magnetic field at the two places is

a) $3\sqrt{3}:8$ b) $16:9\sqrt{3}$ c) $4:9$ d) $2\sqrt{3}:9$

302. A loop of area $0.5\,m^2$ is placed in a magnetic field of strength 2 T in direction making an angle of $30°$ with the field. The magnetic flux linked with the loop will be

a) $\frac{1}{2}$ Wb b) $\sqrt{\frac{3}{2}}$Wb c) 2 Wb d) $\frac{\sqrt{3}}{2}$Wb

303. Two short magnets placed along the same axis with their like poles facing each other repel each other with a force which varies inversely as

a) Square of the distance b) Cube of the distance

c) Distance d) Fourth power of the distance

304. A short magnet oscillates with a time period $0.1\,s$ at a place where horizontal magnetic field is $24\,\mu t$. A downward current of $18\,A$ is established in a vertical wire $20\,cm$ east of the magnet. The new time period of oscillator

a) $0.1\,s$ b) $0.089\,s$ c) $0.076\,s$ d) $0.057\,s$

305. Ferromagnetic materials used in a transformer must have

a) Low permeability and high hysteresis loss b) High permeability and low hysteresis loss

c) High permeability and high hysteresis loss d) Low permeability and low hysteresis loss

306. An iron rod of volume $10^{-4}\,m^3$ and relative permeability 1000 is placed inside a long solenoid wound with $5\,turns/cm$. If a current of 0.5 $A$ is passed through the solenoid, then the magnetic moment of the rod is

a) $10\,A\,m^2$ b) $15\,A\,m^2$ c) $20\,A\,m^2$ d) $25\,A\,m^2$

307. The relative permeability is represented by $\mu$ and the susceptibility is denoted by $\chi$ for a magnetic substance. Then for a paramagnetic substance

a) $\mu_r<1, \chi<0$ b) $\mu_r<1, \chi>0$ c) $\mu_r>1, \chi<0$ d) $\mu_r>1, \chi>0$

308. The horizontal component of the earth's magnetic field is $0.22\, gauss$ and total magnetic field is $0.4\, gauss$. The angle of dip is

a) $\tan^{-1}(1)$ b) $\tan^{-1}(\infty)$ c) $\tan^{-1}(1.518)$ d) $\tan^{-1}(\pi)$

309. Rate of change of torque $\tau$ with defelection $\theta$ is maximum for a magnet suspended freely in a uniform magnetic field of induction *B,* when

a) $\theta=0°$ b) $\theta=45°$ c) $\theta=60°$ d) $\theta=90°$

310. The susceptibility of a paramagnetic material is $K$ at $27℃$. At what temperature will its susceptibility be $K/2$?

a) $600\,℃$ b) $287℃$ c) $54℃$ d) $327℃$

311. A vibration magnetometer consists of two identical bar magnets placed one over the other such that they are mutually perpendicular and bisect each other. The time period of combination is 4 s. If one of the magnets is removed, find the period of other

a) 5 s b) 3.36 s c) 4.36 s d) 5.36 s

312. Two lines of force due to a bar magnet

a) Intersect at the neutral point

b) Intersect near the poles of the magnet

c) Intersect on the equatorial axis of the magnet

d) Do not intersect at all

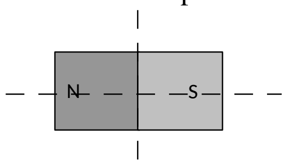
313. Two similar bar magnets $P$ and $Q$, each of magnetic moment $M$, are taken, If $P$ is cut along it axial line and $Q$ is cut along its equatorial line, all the four pieces obtained have

a) Equal pole strength b) Magnetic moment $\frac{M}{4}$ c) Magnetic moment $\frac{M}{2}$ d) Magnetic moment $M$

314. A certain amount of current when flowing in a properly set tangent galvanometer, produces a deflection of $45°$. If the current be reduced by a factor of $\sqrt{3}$, the deflection would

a) Decrease by $30°$ b) Decrease by $15°$ c) Increase by $15°$ d) Increase by $30°$

315. Time period for a magnet is $T$. If it is divided in four equal parts along its axis and perpendicular to its axis as shown then time period for each part will be




a) $4\,T$ b) $T/4$ c) $T/2$ d) $T$

316. When a ferromagnetic material is heated to temperature above its curie point, the material

a) Is permanently magnetized b) Remains ferromagnetic

c) Behaves like a diamagnetic material d) Behaves like a paramagnetic material

317. Intensity of magnetic field due to earth at a point inside a hollow steel box is

a) Less than outside b) More than outside c) Same d) Zero

318. The angle between magnetic meridian and geographical meridian is known as

a) Magnetic dip b) Magnetic latitude

c) Magnetic Declination d) Magnetic longitude

319. An electron of charge $e$ moves in a circular orbit of radius $r$ around the nucleus at a frequency v. The magnetic moment associated with the orbital motion of the electron is.

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

320. A uniform magnetic needle is suspended from its centre by a thread. Its upper end is now loaded with a mass 50 mg, and the needle becomes horizontal. If the strength of each pole is 98.1 ab-amp-cm and g=981 $cm\,s^{-2}$, then the vertical component of earth's magnetic induction is

a) 0.50 G b) 0.25 G c) 0.005 G d) 0.05 G

321. The vertical component of the earth's magnetic field is zero at a place where the angle of dip is

a) $0°$ b) $45°$ c) $60°$ d) $90°$

322. Two short magnets with pole strengths of 900 ab amp-cm and 100 ab-amp-cm are placed with their axes in the same vertical line, with similar poles facing each other. Each magnet has a length of 1 cm. When separation between the nearer poles is 1 cm, the weight of upper magnet is supported by the repulsive force between the magnets. If g¿ $1000\,cm\,s^{-2}$, then the mass of upper magnet is

a) 100 g b) 55 g c) 45 g d) 77.5 g

323. If a ferromagnetic material is inserted in a current carrying solenoid, the magnetic field of solenoid

a) Large increases b) Slightly increases c) Largely decreases d) Slightly decreases

324. The tangent galvanometers having coils of the same radius are connected in series. Same current flowing in them produces deflections of $60°$ and $45°$ respectively. The ratio of the number of turns in the coil is

a) $\frac{4}{\sqrt{3}}$ b) $\frac{\sqrt{3}+1}{1}$ c) $\frac{\sqrt{3}+1}{\sqrt{3}-1}$ d) $\frac{\sqrt{3}}{1}$

325. The incorrect statement regarding the lines of force of the magnetic field $B$ is

a) Magnetic intensity is a measure of lines of force passing through unit area held normal to it

b) Magnetic lines of force form a closes curve

c) Inside a magnet, its magnetic lines of force move from north pole of a magnet towards its south pole

d) Due to a magnet magnetic lines of force never cut each other

326. The work done in turning a magnet of magnetic moment '$M$' by an angle of $90°$ from the meridian is '$n$' times the corresponding work done to turn it through an angle at $60°$, when '$n$' is given by

a) 1/2 b) 2 c) 1/4 d) 1

327. Which one of the following is a non-magnetic substance

a) Iron b) Nickel c) Cobalt d) Brass

328. A short bar magnet of magnetic moment $0.4\,J\,T^{-1}$ is placed in a uniform magnetic field of $0.16\,T$. The magnet is in stable equilibrium when the potential energy is

a) $-0.082\,J$ b) $0.064\,J$ c) $-0.064\,J$ d) Zero

329. The line on the earth surface joining the point where the field is horizontal, is called

a) Magnetic equator b) Magnetic Line c) Magnetic axis d) Magnetic inertia

330. At which place, earth's magnetism becomes horizontal

a) Magnetic pole b) Geographical pole c) Magnetic meridian d) Magnetic equator

331. A dip needle which is free to move in a vertical plane perpendicular to magnetic meridian will remain

a) Horizontal
b) Vertical
c) Neither horizontal nor vertical
d) Inclined

332. The correct relation is
[Where $B_H = ¿$ Horizontal component of earth's magnetic field; $B_V = ¿$ Vertical component of earth's magnetic field and $B = ¿$Total intensity of earth's magnetic field]
a) $B = \frac{B_V}{B_H}$
b) $B = B_V \times B_H$
c) $|B| = \sqrt{B_H^2 + B_V^2}$
d) $B = B_H + B_V$

333. The resultant magnetic moment of neon atom will be
a) Infinity
b) $\mu_B$
c) Zero
d) $\frac{\mu_B}{2}$

334. Two magnets, each of magnetic moment '$M$' are placed so as to form a cross at right angles to each other. The magnetic moment of the system will be
a) $2\,M$
b) $\sqrt{2}M$
c) $0.5\,M$
d) $M$

335. The correct measure of magnetic hardness of a material is
a) Remanant magnetism
b) Hysterses loss
c) Coercivity
d) Curie temperature

336. Magnetic lines of force
a) Always intersect
b) Are always closed
c) Tend to crowd far away from the poles of magnet
d) Do not pass through vacuum

337. For protecting a sensitive equipment from the external magnetic field, it should be
a) Placed inside an aluminium case
b) Placed inside an iron case
c) Wrapped with insulation around it when passing current through it
d) Surrounded with fine copper sheet

338. Two magnets of same size and mass make respectively 10 and $15\,oscillations\;per\;minute$ at certain place. The ratio of their magnetic moments is
a) $4:9$
b) $9:4$
c) $2:3$
d) $3:2$

339. On applying an external magnetic field, to a ferromagnetic substance domains
a) Align in the direction of magnetic field
b) Align in the direction opposite to magnetic field
c) Remain unaffected
d) None of the above

340. At a place the angle of dip is $30°$. If the horizontal component of earth's magnetic field is $B_H$, then the total field intensity is
a) $\frac{B_H}{2}$
b) $\frac{2B_H}{\sqrt{3}}$
c) $B_H\sqrt{2}$
d) $B_H\sqrt{3}$

341. Two identical short bar magnets, each having magnetic moment $M$, are placed a distance of $2d$ apart with axes perpendicular to each other in a horizontal plane. The magnetic induction at a point midway between them is
a) $\frac{\mu_0}{4\pi}(\sqrt{2})\frac{M}{d^3}$
b) $\frac{\mu_0}{4\pi}(\sqrt{3})\frac{M}{d^3}$
c) $\left(\frac{2\mu_0}{\pi}\right)\frac{M}{d^3}$
d) $\frac{\mu_0}{4\pi}(\sqrt{5})\frac{M}{d^3}$

342. The time of vibration of a dip needle vibrating in the vertical plane is 3s. When magnetic needle is made to vibrate in the horizontal plane, the time of vibration is $3\sqrt{2}$s. Then the angle of dip is

a) $30°$ b) $45°$ c) $60°$ d) $90°$

343. An electron moving around the nucleus with an angular momentum $l$ has a magnetic moment

a) $\frac{e}{m}l$ b) $\frac{e}{2m}l$ c) $\frac{2e}{m}l$ d) $\frac{e}{2\pi m}l$

344. With a standard rectangular bar magnet of length ($l$), breadth $(b; b \ll l)$ and magnetic moment $M$, the time period of the magnet in vibration magnetometer is 4 s. If the magnet is cut normal to its length into four equal pieces, the time period (in second) with one of the pieces

a) 16 b) 2 c) 1 d) $\frac{1}{4}$

345. The angle of dip at a certain place on earth is $60°$ and the magnitude of earth's horizontal component of magnetic field is 0.26 G. The magnetic field at the place on earth is

a) 0.13 G b) 0.26 G c) 0.52 G d) 0.65 G

346. A bar magnet of magnetic moment $10^4\ J/T$ is free to rotate in a horizontal plane. The work done in rotating the magnet slowly from a direction parallel to a horizontal magnetic field of $4 \times 10^{-5}\ T$ to a direction $60°$ from the field will be

a) $0.2\ J$ b) $2.0\ J$ c) $4.18\ J$ d) $2 \times 10^2\ J$

347. The value of angle of dip is zero at the magnetic equator because on it

a) $V \wedge H$ are equal
b) The value of $V \wedge H$ is zero
c) The value of $V$ iszero
d) The value of $H$ iszero

348. The magnetic field due to a small magnetic dipole of magnetic moment $M$, at distance $r$ from the centre on the equatorial line is given by (in M.K.S system)

a) $\frac{\mu_0}{4\pi} \times \frac{M}{r^2}$ b) $\frac{\mu_0}{4\pi} \times \frac{M}{r^3}$ c) $\frac{\mu_0}{4\pi} \times \frac{2M}{r^2}$ d) $\frac{\mu_0}{4\pi} \times \frac{2M}{r^3}$

349. The sensitivity of a tangent galvanometer is increased if

a) Number of turn decreases
b) Number of turn increases
c) Field increases
d) None of the above

350. The time period of a freely suspended magnet does not depend upon

a) Length of magnet
b) Pole strength of magnet
c) Horizontal component of earth's field
d) Length of the suspension

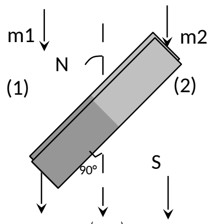
351. The length of magnet is large compared to its width and breadth. The time period of its oscillation in a vibration magnetometer is 2 s. The magnet is cut along its length into three equal parts and these parts are then placed on each other with their like poles together. The time period of this combination will be

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

352. Two magnets held together in earth's magnetic field with same polarity together make 12 $vib-min^{-1}$¿ when opposite poles together make 4 $vib-min^{-1}.The$ ratio of magnetic moments is

a) 9 :1 b) 1 : 3 c) 1 : 9 d) 10 : 8

353. Two magnets of equal mass are joined at right angles to each other as shown. Magnet 1 has a magnetic moment 3 times that of magnet 2. This arrangement is pivoted so that it is free to rotate in the horizontal plane. In equilibrium what angle will the magnet 1 subtend with the magnetic meridian

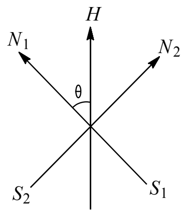



a) $\tan^{-1}\left(\frac{1}{2}\right)$ b) $\tan^{-1}\left(\frac{1}{3}\right)$ c) $\tan^{-1}(1)$ d) $0°$

354. A magnet of distance moment 2 J $T^{-1}$ is aligned in the direction of magnetic field of 0.1 T. What is the net work done to bring, the magnet normal to the magnetic field?
a) 0.1 J b) 0.2 J c) 1 J d) 2 J

355. The dimensions of magnetic permeability are
a) $[MLT^{-2}A^{-2}]$ b) $[ML^2T^{-2}A^{-2}]$ c) $[ML^2T^{-2}A^{-1}]$ d) $[M^{-1}LT^{-2}A^{-2}]$

356. Two magnets of equal mass are joined at 90° each other as shown in figure. Magnet $N_1S_1$ has a magnetic moment $\sqrt{3}$ times that of $N_2S_2$. The arrangement is pivoted so that it is free to rotate in horizontal plane. When in equilibrium, what angle should $N_1S_1$ make with magnetic meridian?




a) 75° b) 60° c) 30° d) 45°

357. A bar magnet is placed in the position of stable equilibrium in a uniform magnetic field of induction *B*. If it is rotated through an angle 180°, then the work done is ($M=$¿Magnetic dipole moment of bar magnet)
a) $MB$ b) $2MB$ c) $\frac{MB}{2}$ d) Zero

358. Vibration magnetometer works on the principle of
a) Torque acting on the bar magnet
b) Force acting on the bar magnet
c) Both the force and the torque acting on the bar magnet
d) None of these

359. The earth's magnetic field at a certain place has a horizontal component $0.3\, gauss$ and the total strength $0.5\, gauss$. The angle of dip is
a) $\tan^{-1}\frac{3}{4}$ b) $\sin^{-1}\frac{3}{4}$ c) $\tan^{-1}\frac{4}{3}$ d) $\sin^{-1}\frac{3}{5}$

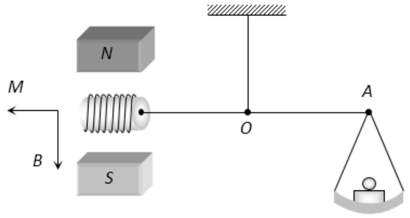
360. An inductor of 10 mH shows 50 mH when operate with a core mad e of ferrite. The susceptibility of ferrite is
a) 5 b) 4 c) 3 d) None of these

361. Which one of the following characteristics is not associated with a ferromagnetic material?
a) It is strongly attracted by a magnet
b) It tends to move from a region of strong magnetic field to a region of low magnetic field
c) Its origin is the spin of electrons
d) Above the Curie temperature, it exhibits paramagnetic properties

362. The intensity of magnetic field is $H$ and moment of magnet is $M$. The maximum potential energy is

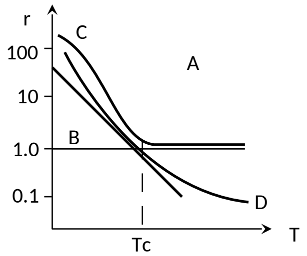
a) $MH$ b) $2\ MH$ c) $3\ MH$ d) $4\ MH$

363. A small coil $C$ with $N=200$ turns is mounted on one end of a balance beam and introduced between the poles of an electromagnet as shown in figure. The cross sectional area of coil is $A=1.0\,cm^2$, length of arm OA of the balance beam is $l=30\,cm$. When there is no current in the coil the balance is in equilibrium. On passing a current $I=22$ mA through the coil the equilibrium is restored by putting the additional counter weight of mass $\Delta m=60\,mg$ on the balance pan. Find the magnetic induction at the spot where coil is located




a) $0.4\ T$ b) $0.3\ T$ c) $0.2\ T$ d) $0.1\ T$

364. The relative permeability $(\mu_r)$ of a ferromagnetic substance varies with temperature ($T$) according to the curve

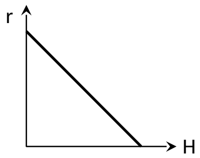


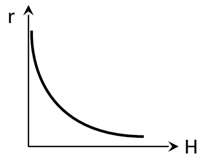

a) $A$ b) $B$ c) $C$ d) $D$

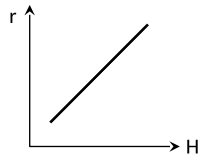
365. A dip circle is so that its needle moves freely in the magnetic meridian. In this position, the angle of dip is $40°$. Now the dip circle is rotated so that the plane in which the needle moves makes an angle of $30°$ with the magnetic meridian. In this position, the needle will dip by an angle

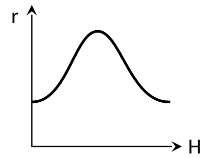
a) $40°$ b) $30°$ c) More than $40°$ d) Less than $40°$

366. For ferromagnetic material, the relative permeability $(\mu_r)$ versus magnetic intensity $(H)$ has the following shape

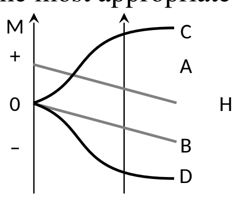
a) 


b) 


c) 


d) 


367. The most appropriate magnetization $M$ versus magnetizing field $H$ curve for a paramagnetic substance is




a) $A$ b) $B$ c) $C$ d) $D$

368. A short bar magnet, placed with its axis at $30°$ with an external magnetic field of 0.16 T, experiences a torque of magnitude 0.032 J. The magnetic moment of the bar magnet is (in units of J/T)

a) 4 b) 0.2 c) 0.5 d) 0.4

369. Tangent galvanometer measures

a) Capacitance b) Current c) Resistance d) Potential difference

370. 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) $X \wedge Y$ both are paramagnetic
d) $X$ is diamagnetic and $Y$ is paramagnetic

371. The period of oscillation of a bar magnet in a vibration magnetometer is 2 s. The period of oscillation of another bar magnet whose moment is 4 times that of 1st magnet is
a) 4 s
b) 1 s
c) 2 s
d) 0.5 s

372. At a certain place the horizontal component of the earth's magnetic field is $B_0$ and the angle of dip is 45°. The total intensity of the field at that place will be
a) $B_0$
b) $\sqrt{2}\, B_0$
c) $2\, B_0$
d) $B_0^2$

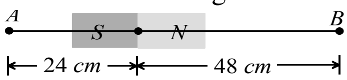
373. In the hysteresis cycle, the value of $H$ needed to make the intensity of magnetization zero is called
a) Retentivity
b) Coercive force
c) Lorentz force
d) None of the above

374. The time period of a vibration magnetometer is $T_0$. Its magnet is replaced by another magnet whose moment of inertia is 3 times and magnetic moment is 1/3 of the initial magnet. The time period now will be
a) $3T_0$
b) $T_0$
c) $T_0/\sqrt{3}$
d) $T_0/3$

375. A magnet of length 0.1 m and pole strength $10^{-4}$ A-m is kept in a magnetic field of 30 Wb $m^{-2}$ at an angle $30°$. The couple acting on it is ……..$\times 10^{-4}$ Nm.
a) 7.5
b) 3.0
c) 4.5
d) 1.5

376. A magnet when placed perpendicular to a uniform field of strength $10^{-4} Wb/m^2$ experiences a maximum couple of moment $4 \times 10^{-5}\, N/m$. What is its magnetic moment
a) $0.4\, A \times m^2$
b) $0.2\, A \times m^2$
c) $0.16\, A \times m^2$
d) $0.04\, A \times m^2$

377. A bar magnet of length $3\, cm$ has points $A$ and $B$ along its axis at distances of $24\, cm$ and $48\, cm$ on the opposite sides. Ratio of magnetic fields at these points will be




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

378. Domain formation is the necessary feature of
a) Ferromagnetism
b) Paramagnetism
c) Diamagnetism
d) All of these

379. Two small bar magnets are placed in a line with like poles facing each other at a certain distance $d$ apart. If the length of each magnet is negligible as compared to $d$, the force between them will be inversely proportional to
a) $d$
b) $d^2$
c) $\frac{1}{d^2}$
d) $d^4$

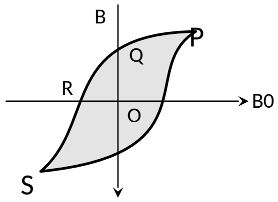
380. At a point on the right bisector of a magnetic dipole magnetic
a) Potential varies as $\frac{1}{r^2}$
b) Potential is zero at all points on the right bisector
c) Field varies as $r^2$
d) Field is perpendicular to the axis of dipole

381. Magnetic moment of bar magnet is $M$. The work done to turn the magnet by $90°$ of magnet in direction of magnetic field $B$ will be
a) Zero
b) $\frac{1}{2} MB$
c) $2\, MB$
d) $MB$

382. Which of the following is most suitable for the core of electromagnets

a) Soft iron b) Steel c) Copper-nickel alloy d) Air

383. The figure illustrates how $B$, the flux density inside a sample of unmagnetised ferromagnetic material, varies with $B_0$, the magnetic flux density in which the sample is kept. For the sample to be suitable for making a permanent magnet




a) $OQ$ should be large, ¿ should be small

b) $OQ$ and ¿ should both be large

c) $OQ$ should be small and ¿ should be large

d) $OQ$ and ¿ should both be small

384. Choose the correct statement

a) A paramagnetic material tends to move from a strong magnetic field to weak magnetic field

b) A magnetic material is in the paramagnetic phase below its Curie temperature

c) The resultant magnetic moment in an atom of a diamagnetic substance is zero

d) Typical domain size of a ferromagnetic material is 1 nm

385. A very long magnet is placed vertically with one pole on the table. A neutral point was found at 20 cm from the pole. What is the pole strength if the vertical component of earth's field is $0.4 \times 10^{-4}\, Wb\, m^{-2}$?

a) 16 A-m b) 8 A-m c) 4 A-m d) None of these

386. Which of the following is true

a) Diamagnetism is temperature dependent

b) Paramagnetism is temperature dependent

c) Paramagnetism is temperature dependent

d) None of these

387. A long magnet is cut into two equal parts, such that the length of each half is same as that of original magnet. If the period of original magnetic is $T$, the period of new magnet is

a) $T$ b) $\frac{T}{2}$ c) $\frac{T}{4}$ d) $2T$

388. The effect due to uniform magnetic field on a freely suspended magnetic needle is as follows

a) Both torque and net force are present b) Torque is present but no net force

c) Both torque and net force are absent d) Net force is present but not torque

389. The period of oscillation of a freely suspended bar magnet is 4 s. If it is cut into two equal parts in length, then the time period of each part will be

a) 4 s b) 2 s c) 0.5 s d) 0.25 s

390. The time period of oscillation of a freely suspended bar magnet with usual notations is given by

a) $T=2\pi\sqrt{\frac{I}{M B_H}}$ b) $T=2\pi\sqrt{\frac{M B_H}{I}}$ c) $T=\sqrt{\frac{I}{M B_H}}$ d) $T=2\pi\sqrt{\frac{B_H}{MI}}$

391. Curie-Weiss law is obeyed by iron

a) At Curie temperature only
b) At all temperatures
c) Below Curie temperature
d) Above Curie temperature

392. A bar magnet is $10\,cm$ long, and is kept with its north (N)- pole pointing north. A neutral point is formed at a distance of $15\,cm$ from each pole. Given the horizontal component of earth's field to be 0.4 Gauss, the pole strength of the magnet is

a) $9\ A\text{-}m$
b) $6.75\ A\text{-}m$
c) $27\ A\text{-}m$
d) $1.35\ A\text{-}m$

393. Liquid oxygen remain suspended between two poles of magnet because it is

a) Diamagnetic
b) Paramagnetic
c) Ferromagnetic
d) Antiferromagnetic

394. Magnetic intensity for an axial point due to a short bar magnet of magnetic moment $M$ is given by

a) $\frac{\mu_0}{4\pi} \times \frac{M}{d^3}$
b) $\frac{\mu_0}{4\pi} \times \frac{M}{d^2}$
c) $\frac{\mu_0}{2\pi} \times \frac{M}{d^3}$
d) $\frac{\mu_0}{2\pi} \times \frac{M}{d^2}$

395. Iron would become paramagnetic at about

a) $200\,°C$
b) $400\,°C$
c) $600\,°C$
d) $800\,°C$

396. A circular loop of radius 0.0157 m carries a current of 2.0 A. The magnetic field at the center of the loop is $[\mu_0 = 4\pi \times 10^{-7}\,Wb - A^{-1} m^{-1}]$

a) $1.57 \times 10^{-5}\,Wb - m^2$
b) $8.0 \times 10^{-5}\,Wb - m^2$
c) $2.0 \times 10^{-5}\,Wb - m^2$
d) $3.14 \times 10^{-5}\,Wb - m^2$

397. The magnetic susceptibility of paramagnetic materials is

a) Positive, but very high
b) Negative, but very small
c) Negative, but very high
d) Positive, but small

398. Consider a short magnetic dipole of magnetic length 10 cm. Its geometric length is

a) 12 cm
b) 8 cm
c) 10 cm
d) 14 cm

399. The magnetic field of a small bar magnet varies in the following manner by the influence of a magnet placed at a large distance *d*.

a) $\frac{1}{d}$
b) $\frac{1}{d^2}$
c) $\frac{1}{d^3}$
d) $\frac{1}{d^4}$

400. Curie's law can be written as

a) $\chi \propto (T - T_c)$
b) $\chi \propto \frac{1}{T - T_c}$
c) $\chi \propto \frac{1}{T}$
d) $\chi \propto T$

401. 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) $2.5 \times 10^3\,Am^{-1}$
b) $2.5 \times 10^5\,Am^{-1}$
c) $2.0 \times 10^3\,Am^{-1}$
d) $2.0 \times 10^5\,Am^{-1}$

402. A superconductor exhibits perfect

a) Ferrimagnetism
b) Ferromagnetism
c) Paramagnetism
d) Diamagnetism

403. In the case of bar magnet, lines of magnetic induction

a) Start from the north pole and end at the south pole

b) Run continuously through the bar and outside

c) Emerge in circular paths from the middle of the bar

d) Are produced only at the north pole like rays of light from a bulb

404. 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

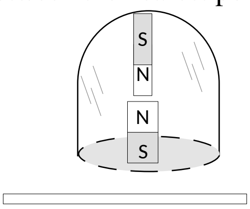
405. A bar magnet of magnetic moment $3.0\, A\text{-}m^2$ is placed in a uniform magnetic induction field of $2 \times 10^{-5}\, T$. If each pole of the magnet experiences a force of $6 \times 10^{-4}\, N$, the length of the magnet is

a) $0.5\, m$ b) $0.3\, m$ c) $0.2\, m$ d) $0.1\, m$

406. Identify the paramagnetic substance

a) Iron b) Aluminium c) Nickel d) Hydrogen

407. Two identical bar magnets with a length $10\, cm$ and weight $50\, g\text{-}weight$ are arranged freely with their poles facing in a inverted vertical glass tube. The upper magnet hangs in the air above the lower one so that the distance between the nearest pole of the magnet is $3\, mm$. Pole strength of the poles of each magnet will be




a) $6.64\, amp \times m$ b) $2\, amp \times m$ c) $10.25\, amp \times m$ d) None of these

408. Two magnets are held together in a vibration magnetometer and are allowed to oscillate in the earth's magnetic field. With like poles together, 12 oscillations per minute are made but for unlike poles together only 4 oscillations per minute are executed. The ratio of their magnetic moment is

a) $3:1$ b) $1:3$ c) $3:5$ d) $5:4$

409. The length of a magnet is large compared to its width and breadth. The time period of its oscillation in a vibration magnetometer is 2 s. The magnet is cut along its length into three equal parts and three parts are then placed on each other with their like poles together. The time period of this combination will be

a) 2 s b) 2/3 s c) $2\sqrt{3}\, s$ d) $2/\sqrt{3}\, s$

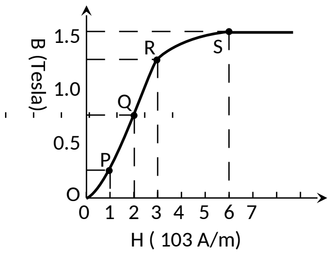
410. A magnet of magnetic moment $M$ oscillating freely in earth's horizontal magnetic field makes $n$ oscillations per minute. If the magnetic moment is quadrupled and the earth's field is doubled, the number of oscillations made per minute would be

a) $\frac{n}{2\sqrt{2}}$ b) $\frac{n}{\sqrt{2}}$ c) $2\sqrt{2}n$ d) $\sqrt{2}n$

411. Keeping dissimilar poles of two magnets of equal pole strength and length same side, their time period will be

a) Zero b) One second c) Infinity d) Any value

412. The basic magnetization curve for a ferromagnetic material is shown in figure. Then, the value of relative permeability is highest for the point




a) $P$ b) $Q$ c) $R$ d) $S$

413. A short bar magnet has a length $2l$ and a magnetic moment $10\,A\,m^2$. Find the magnetic field at a distance of $z=0.1\,m$ from its centre on the axial line. Here, $l$ is negligible as compared to $z$.

a) $2\times10^{-3}T$ b) $3\times10^{-3}T$ c) $1\times10^{-3}T$ d) $4\times10^{-3}T$

414. The magnetic susceptibility does not depend upon the temperature in

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

415. A long magnet is placed vertically with its $S-¿$pole resting on the table. A neutral point is obtained 10 cm from the pole the geographic north of it. If $H=3.2\times10^{-5}$T ,then the pole strength of magnet is

a) 8 ab-A-$cm^{-1}$ b) 16 ab-A-$cm^{-1}$ c) 32 ab-A-$cm^{-1}$ d) 64 ab-A-$cm^{-1}$

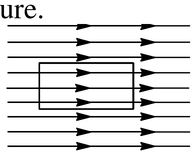
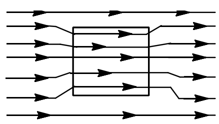
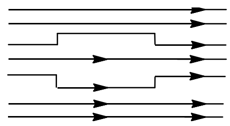
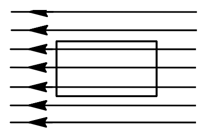
416. Two bar magnets having same geometry with magnetic moments $M$ and 2 $M$ are firstly placed in such a way that their poles are same side. Time period of oscillations is $T_1$. Now the polarity of one of the magnets is reversed, and time period of oscillations is $T_1$. Now the polarity of one of the magnets is reversed, and time period of oscillations is $T_2$.

a) $T_1<T_2$ b) $T_1=T_2$ c) $T_1>T_2$ d) $T_2=\infty$

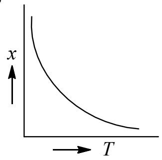
417. The unit for molar susceptibility is

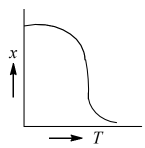
a) $m^3$ b) $kg\text{-}m^{-3}$ c) $kg^{-1}m^3$ d) No units

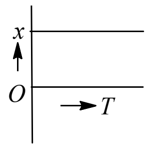
418. A uniform magnetic field parallel to the plane of paper, existed in space initially directed from left to right. When a bar of soft iron is placed I the field parallel to it, the lines of force passing through it will be represented by figure.

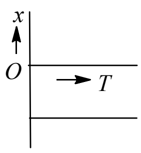
a) 
b) 
c) 
d) 

419. The variation of magnetic susceptibility $(X)$ with temperature for a diamagnetic substance is best represented by figure

a) 

b) 

c) 

d) 


420. A short magnetic needle is pivoted in a uniform magnetic field of strength $1T$. When another magnetic field of strength $\sqrt{3}T$ is applied to the needle in a perpendicular direction, the needle deflects through an angle $\theta$, where $\theta$ is

a) $30°$ b) $45°$ c) $90°$ d) $60°$

421. A paramagnetic liquid is taken in a U-tube and arranged so that one of its limbs is kept between pole pieces of the magnet. The liquid level in the limb

a) Goes down
b) Rises up
c) Remains same
d) First goes down and then rises

422. Magnetic meridian is a

a) Point b) Horizontal plane c) Vertical plane d) Line along $N$-$S$

423. A tangent galvanometer has a coil of 25 turns and a radius of 15 cm. The horizontal component of the earth's magnetic field is $3 \times 10^{-5}$T. The current required to produce a deflection of 45° in it is

a) 0.29 A b) 0.14 A c) 1.2 A d) $3.6 \times 10^{-5}$ A

## : ANSWER KEY :

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1) | a | 2) | b | 3) | a | 4) | c | 169) | d | 170) | c | 171) | c | 172) | a |
| 5) | d | 6) | d | 7) | b | 8) | a | 173) | c | 174) | d | 175) | c | 176) | c |
| 9) | a | 10) | c | 11) | a | 12) | b | 177) | c | 178) | d | 179) | d | 180) | a |
| 13) | a | 14) | a | 15) | c | 16) | d | 181) | a | 182) | c | 183) | b | 184) | b |
| 17) | d | 18) | d | 19) | b | 20) | a | 185) | a | 186) | c | 187) | c | 188) | d |
| 21) | a | 22) | b | 23) | c | 24) | a | 189) | b | 190) | a | 191) | d | 192) | c |
| 25) | c | 26) | b | 27) | a | 28) | b | 193) | c | 194) | b | 195) | d | 196) | c |
| 29) | a | 30) | b | 31) | b | 32) | d | 197) | c | 198) | a | 199) | c | 200) | b |
| 33) | c | 34) | c | 35) | a | 36) | b | 201) | b | 202) | c | 203) | a | 204) | c |
| 37) | a | 38) | c | 39) | b | 40) | d | 205) | b | 206) | a | 207) | a | 208) | a |
| 41) | d | 42) | b | 43) | a | 44) | d | 209) | b | 210) | a | 211) | c | 212) | b |
| 45) | b | 46) | b | 47) | c | 48) | a | 213) | b | 214) | d | 215) | a | 216) | b |
| 49) | b | 50) | c | 51) | c | 52) | b | 217) | d | 218) | c | 219) | a | 220) | a |
| 53) | c | 54) | c | 55) | d | 56) | a | 221) | a | 222) | a | 223) | a | 224) | c |
| 57) | b | 58) | d | 59) | b | 60) | d | 225) | c | 226) | a | 227) | d | 228) | b |
| 61) | b | 62) | a | 63) | c | 64) | b | 229) | c | 230) | c | 231) | b | 232) | c |
| 65) | a | 66) | b | 67) | d | 68) | a | 233) | d | 234) | c | 235) | d | 236) | c |
| 69) | d | 70) | c | 71) | a | 72) | d | 237) | b | 238) | c | 239) | b | 240) | b |
| 73) | a | 74) | b | 75) | d | 76) | c | 241) | c | 242) | b | 243) | b | 244) | c |
| 77) | a | 78) | b | 79) | c | 80) | c | 245) | b | 246) | c | 247) | b | 248) | a |
| 81) | a | 82) | b | 83) | b | 84) | b | 249) | c | 250) | d | 251) | a | 252) | c |
| 85) | b | 86) | c | 87) | d | 88) | a | 253) | c | 254) | a | 255) | a | 256) | b |
| 89) | b | 90) | c | 91) | c | 92) | b | 257) | d | 258) | d | 259) | d | 260) | b |
| 93) | b | 94) | c | 95) | b | 96) | c | 261) | a | 262) | b | 263) | b | 264) | b |
| 97) | a | 98) | d | 99) | d | 100) | c | 265) | a | 266) | b | 267) | c | 268) | c |
| 101) | b | 102) | b | 103) | b | 104) | c | 269) | b | 270) | d | 271) | a | 272) | d |
| 105) | b | 106) | a | 107) | c | 108) | a | 273) | a | 274) | a | 275) | d | 276) | c |
| 109) | b | 110) | b | 111) | b | 112) | d | 277) | c | 278) | d | 279) | b | 280) | c |
| 113) | c | 114) | c | 115) | b | 116) | b | 281) | c | 282) | c | 283) | c | 284) | a |
| 117) | a | 118) | a | 119) | c | 120) | d | 285) | b | 286) | a | 287) | c | 288) | d |
| 121) | c | 122) | b | 123) | c | 124) | d | 289) | b | 290) | a | 291) | c | 292) | d |
| 125) | a | 126) | a | 127) | a | 128) | b | 293) | c | 294) | a | 295) | a | 296) | d |
| 129) | a | 130) | c | 131) | d | 132) | a | 297) | a | 298) | c | 299) | a | 300) | c |
| 133) | a | 134) | b | 135) | d | 136) | c | 301) | b | 302) | d | 303) | d | 304) | c |
| 137) | b | 138) | a | 139) | b | 140) | c | 305) | b | 306) | d | 307) | d | 308) | c |
| 141) | a | 142) | c | 143) | a | 144) | b | 309) | a | 310) | d | 311) | b | 312) | d |
| 145) | d | 146) | b | 147) | a | 148) | d | 313) | c | 314) | b | 315) | c | 316) | d |
| 149) | a | 150) | b | 151) | b | 152) | c | 317) | d | 318) | c | 319) | a | 320) | b |
| 153) | b | 154) | b | 155) | c | 156) | b | 321) | a | 322) | b | 323) | a | 324) | d |
| 157) | a | 158) | b | 159) | a | 160) | a | 325) | c | 326) | b | 327) | d | 328) | c |
| 161) | b | 162) | d | 163) | c | 164) | a | 329) | a | 330) | d | 331) | b | 332) | c |
| 165) | d | 166) | d | 167) | c | 168) | d | 333) | c | 334) | b | 335) | c | 336) | b |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **337)** | **b** | **338)** | **a** | **339)** | **a** | **340)** | **b** |
| **341)** | **d** | **342)** | **c** | **343)** | **b** | **344)** | **c** |
| **345)** | **c** | **346)** | **a** | **347)** | **c** | **348)** | **b** |
| **349)** | **b** | **350)** | **d** | **351)** | **d** | **352)** | **d** |
| **353)** | **b** | **354)** | **b** | **355)** | **a** | **356)** | **c** |
| **357)** | **b** | **358)** | **a** | **359)** | **c** | **360)** | **b** |
| **361)** | **b** | **362)** | **a** | **363)** | **a** | **364)** | **c** |
| **365)** | **c** | **366)** | **d** | **367)** | **a** | **368)** | **d** |
| **369)** | **b** | **370)** | **d** | **371)** | **b** | **372)** | **b** |
| **373)** | **b** | **374)** | **a** | **375)** | **d** | **376)** | **a** |
| **377)** | **a** | **378)** | **a** | **379)** | **d** | **380)** | **a** |
| **381)** | **d** | **382)** | **a** | **383)** | **b** | **384)** | **c** |
| **385)** | **a** | **386)** | **b** | **387)** | **a** | **388)** | **b** |
| **389)** | **b** | **390)** | **a** | **391)** | **d** | **392)** | **d** |
| **393)** | **b** | **394)** | **c** | **395)** | **d** | **396)** | **b** |
| **397)** | **d** | **398)** | **a** | **399)** | **c** | **400)** | **c** |
| **401)** | **b** | **402)** | **d** | **403)** | **b** | **404)** | **b** |
| **405)** | **d** | **406)** | **b** | **407)** | **a** | **408)** | **d** |
| **409)** | **b** | **410)** | **c** | **411)** | **c** | **412)** | **b** |
| **413)** | **a** | **414)** | **c** | **415)** | **c** | **416)** | **a** |
| **417)** | **a** | **418)** | **b** | **419)** | **d** | **420)** | **d** |
| **421)** | **b** | **422)** | **c** | **423)** | **a** | | |

# : HINTS AND SOLUTIONS :

1 **(a)**

$X = C \times \frac{1}{T} = \frac{0.4}{7 \times 10^{-3}} = 57\,K$

2 **(b)**

Repelled due to induction of similar poles

3 **(a)**

Pole strength depends on material of magnet, state of magnetization and cross-sectional area. As $m \propto A$, so if $A$ becomes half, pole strength gets half.

4 **(c)**

$c = \frac{1}{2\pi}\sqrt{\frac{M B_H}{I}} \Rightarrow v \propto \sqrt{M}$

$\Rightarrow \frac{v_A}{v_B} = \sqrt{\frac{M_A}{M_B}} \Rightarrow \frac{2}{1} = \sqrt{\frac{M_A}{M_B}} \Rightarrow M_A = 4 M_B$

5 **(d)**

Inside bar magnet, lines of force are from south to north.

7 **(b)**

$\tau = MH \sin\theta = MH \sin 30° = \frac{MH}{2}$

8 **(a)**

Magnetic moment, $M = iA \Rightarrow i = \frac{M}{A}$

9 **(a)**

If the temperature of a ferromagnetic material is raised above a certain critical value, called the Curie temperature, the exchange coupling ceases to be effective. Most such materials then become simply paramagnetic; that is, the dipoles still tend to align with an external field but much more weakly, and thermal agitation can now more easily disrupt the alignment.

10 **(c)**

When axes are in the same line,

$F = \frac{\mu_0}{4\pi}\frac{6 M_1 M_2}{r^4}\, ie, F \propto \frac{1}{r^4}$

When, $r$ becomes thrice, $F\, becomes\, \frac{1}{(3)^4}$ time

$ie, \frac{1}{81}$ time. Therefore, $F' = \frac{8.1}{81} = 0.1$ N

11 **(a)**

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

When the magnet is rotated from $0°$ to $60°$, then work done is $0.8\,J$

$0.8 = MB(\cos 0° - \cos 60°) = \frac{MB}{2}$

$\Rightarrow MB = 1.6\,N - m$

In order to rotate the magnet through an angle of $30°$, $i.e.$, from $60°$ to $90°$, the work done is

$W' = MB(\cos 60° - \cos 90°) = MB\left(\frac{1}{2} - 0\right)$

¿ $\frac{MB}{2} = \frac{1.6}{2} = 0.8\,J = 0.8 \times 10^7\, erg$

13 **(a)**

$M = mL = 4 \times 10 \times 10^{-2} = 0.4\,A \times m^2$

15 **(c)**

Time period of magnet in vibration magnetometer

$T = 2\pi\sqrt{\frac{I}{MH}}$

First case $T_1 = 2\pi\sqrt{\frac{I_1 + I_2}{M' H}}$

Where $M$= resultant magnetic moment of two magnets

Here, two identical magnets are placed perpendicular to each other.

$\therefore I_1 = I_2 = I\,(Let)$

And $M' = \sqrt{M^2 + M^2} = M\sqrt{2}$

$$\therefore T_1 = 2\pi\sqrt{\frac{2I}{\sqrt{2}MH}}$$

$$2^{5/4} = 2\pi\sqrt{\frac{2I}{\sqrt{2}MH}} \ldots (i)$$

When one magnet is removed, then time period

$$T_2 = 2\pi\sqrt{\frac{I}{MH}} \ldots (ii)$$

Dividing Eq. (i) by Eq.(ii)

$$\frac{2^{5/4}}{T_2} = \sqrt{\frac{2}{\sqrt{2}}}$$

$$\frac{2^{5/4}}{T_2} = 2^{1/4}$$

$$T_2 = \frac{2^{5/4}}{2^{1/4}} = 2s$$

16 **(d)**

Copper is a diamagnetic material, therefore its rod aligh itself where magnetic field is weaker and perpendicular to the direction of magnetic field there.

17 **(d)**

$$F = \frac{\mu_0}{4\pi} \cdot \frac{m_1 m_2}{r^2} \ldots (i)$$

When pole strength of each pole become double.

$$\therefore F' = \frac{\mu_0}{4\pi} \cdot \frac{(2m_1)(2m_2)}{(2r)^2} = F$$

19 **(b)**

The coercivity of a substance is a measure of the reverse magnetizing field required to destroy the residual magnetism of the substance.

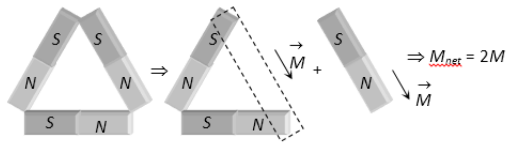
20 **(a)**

On equatorial line, magnetic field due to magnet varies inversely as cube of the distance, therefore,

$$\frac{B_1}{B_2} = \left(\frac{3x}{x}\right)^3 = 27:1$$

22 **(b)**

The resultant magnetic moment can be calculated as follows:




23 **(c)**

$$\tan\delta = \frac{V}{H} = \frac{V}{\sqrt{3}V} = \frac{1}{\sqrt{3}}$$

$\therefore \delta = 30° = \pi/6$ rad

24 **(a)**

Horizontal component $B_H = B\cos\phi$

Total intensity of earth's magnetic field $B = \frac{B_H}{\cos\phi}$

$$¿\ \frac{1.8\times10^{-5}}{\cos 30°} = \frac{1.8\times10^{-5}}{\sqrt{3}/2} = 2.08\times10^{-5}\,Wb/m^2$$

25 **(c)**

In C.G.S. $B_{axial} = 9 = \frac{2M}{x^3}$ …(i)

$$B_{equatorial} = \frac{M}{\left(\frac{x}{2}\right)^3} = \frac{8M}{x^3} \ldots (ii)$$

From equation (i) and (ii), $B_{equatorial} = 36\,gauss$

26 **(b)**

$$B = \frac{\mu_0}{4\pi} \cdot \frac{2M}{d^3} \Rightarrow B = 10^{-7} \times \frac{2\times1.2}{(0.1)^3} = 2.4\times10^{-4}\,T$$

28 **(b)**

In pole for pole combination,

$M_1 = 3M \wedge M_2 = M$

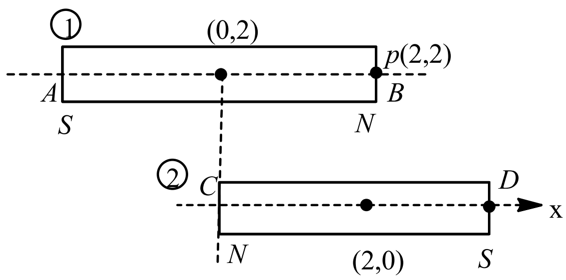
$T_2 = ?$

$$\frac{T_2}{T_1} = \sqrt{\frac{M_1}{M_2}} = \sqrt{\frac{3M}{M}} = \sqrt{3}$$

$T_2 = \sqrt{3}T_1 = 3\sqrt{3}$ s

29 **(a)**

As shown in figure,



$$B = B_1 + B_2 = \frac{\mu_0}{4\pi}\left(\frac{2M_1}{r_1^3} + \frac{M_2}{r_2^3}\right)$$

$$100 \times 10^{-7} = 10^{-7}\left(\frac{2M_1}{8} + \frac{M^2}{8}\right)$$

$$\Longrightarrow 2M_1 + M_2 = 800..(i)$$

If the poles of the magnet $CD$ are reversed, then

$$50 \times 10^{-7} = 10^{-7}\left(\frac{2M_1}{8} - \frac{M_2}{8}\right)$$

$$\Longrightarrow 2M_1 - M_2 = 400\ldots(ii)$$

Solving Eqs. (i) and (ii), we obtain

$$M_1 = 300\,A\,m^2, M_2 = 200\,A\,m^2$$

30 **(b)**

$$i \propto \tan\theta \Rightarrow \frac{i_1}{i_2} = \frac{\tan\theta_1}{\tan\theta_2} \Rightarrow \frac{\sqrt{3}}{3} = \frac{\tan 30°}{\tan\theta_2} \Rightarrow \theta = 45°$$

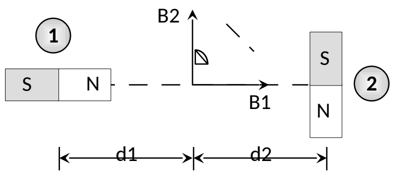
31 **(b)**

$\tan\phi = \frac{\tan\phi}{\cos\beta}$; where $\phi =$¿ Apparent angle of dip, $\phi =$¿ True angle of dip, $\beta =$¿ Angle made by vertical plane with magnetic meridian

$$\Rightarrow \tan\phi = \frac{\tan 60°}{\cos 30°} = 2 \Rightarrow \phi = \tan^{-1}(2)$$

33 **(c)**

In equilibrium $B_1 = B_2 \tan\theta$




$$\Rightarrow \frac{\mu_0}{4\pi}\cdot\frac{2M}{d_1^3} = \frac{\mu_0}{4\pi}\cdot\frac{M}{d_2^3}\tan\theta$$

$$\Rightarrow \frac{d_1}{d_2} = (2\cot\theta)^{1/3}$$

34 **(c)**

A bar magnet is equivalent to a current carrying solenoid due to the following facts:

(i) Both rest in north-south direction when suspended freely

(ii) Both have two poles: north pole and the south pole.

(iii) The like poles of both repel each other while the unlike poles attract each other.

35 **(a)**

In SI unit of pole strength is Amp-meter. Here, the pole strength is given in Weber, which is the unit of $(\mu\square_0 m)$.

$\therefore \mu\square_0 m = 10^{-3}$Wb

$$m = \frac{10^{-3}}{\mu\square_0}$$

Magnetic moment of magnet

$$M = m \times 2l = \frac{10^{-3}}{\mu\square_0}(0.1) = \frac{10^{-4}}{\mu\square_0}.$$

Torque, $\tau = MB\sin\theta$

¿ $\frac{10^{-4}}{4\pi \times 10^{-7}}(4\pi \times 10^{-3}) \times \frac{1}{2} = 0.5$ Nm

36 **(b)**

Repulsion is the sure test of magnetism

37 **(a)**

Frequency $\nu \propto \sqrt{B_H}$

38 **(c)**

Time period, $T = 2\pi\sqrt{\frac{I}{M B_H}}$

$$\Rightarrow T \propto \frac{1}{\sqrt{M}}$$

$$\Rightarrow \frac{T_1}{T_2} = \sqrt{\frac{M_2}{M_1}}$$

If $M_1 = 100$ then $M_2 = (100 - 19) = 81$

So, $\frac{T_1}{T_2} = \sqrt{\frac{81}{100}} = \frac{9}{10}$

$$\Rightarrow T_2 = \frac{10}{9}T_1 = 1.11\,T_1$$

⇒Time period increase by 11%

40 **(d)**

Susceptibility of ferromagnetic material is inversely proportional to temperature

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

$$\frac{X_1}{X_2}=\frac{T_2}{T_1}$$

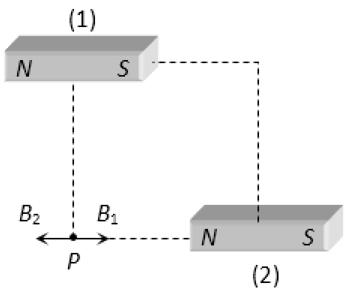
Given , $T_1=30\,°C, T_2=333\,°C, X_1=X$

$$\therefore X_2=\frac{T_1}{T_2}X=\frac{30}{333}X=0.09\,X$$

41 **(d)**
From the characteristic of $B$-$H$ curve

42 **(b)**
Diamagnetic will be feebly repelled. Paramagnetic will be feebly attracted. Ferromagnetic will be strongly attracted

43 **(a)**
Point $P$ lies on equatorial lines of magnet (1) and axial line of magnet (2) as shown




$$B_1=\frac{\mu_0}{4\pi}.\frac{M}{d^3}=10^{-7}\times\frac{1000}{(0.1)^3}=0.1T$$

$$B_2=\frac{\mu_0}{4\pi}.\frac{2M}{d^3}=10^{-7}\times\frac{2\times1000}{(0.1)^3}=0.2\,T$$

$$\therefore B_{net}=B_2-B_1=0.1\,T$$

44 **(d)**
The bar magnet has coercivity $4\times10^3\,A\,m^{-1}$, $i.e.$, it requires a magnetic intensity $H=4\times10^3\,Am^{-1}$ to get demagnetised. Let $i$ be the current carried by solenoid having $n$ number of turns per metre length, then by definition $H=¿$. Here

$$H=4\times10^3 amp\,turn\,metr\,e^{-1}$$

$$n=\frac{N}{l}=\frac{60}{0.12}=500\,turn\,m\,etr\,e^{-1}$$

$$\Rightarrow i=\frac{H}{n}=\frac{4\times10^3}{500}=8.0\,A$$

45 **(b)**
Here, $B=1.7\times10^{-5}T, H=?$

$$H=\frac{B}{\mu_0}=\frac{1.7\times10^{-5}}{4\pi\times10^{-7}}=13.53\,Am^{-1}$$

46 **(b)**
$\tau=MB\sin\theta$
$\tau=200\times0.25\times\sin30°=25\,N\times m$

47 **(c)**
$M=¿\,A=50\times2\times1.25\times10^{-3}=0.125\,Am^2$
If normal to the face of the coil makes an angle $\theta$ with the magnetic induction $B$, then in 1st case, torque $¿\,MB\cos\theta=0.04$, and in second case, Torque $¿\,MB\sin\theta=0.03$

$$\therefore MB=\sqrt{(0.04)^2+(0.03)^2}=0.05$$

$$B=\frac{0.05}{M}=\frac{0.05}{0.125}=0.4\text{T}$$

48 **(a)**

Given that, the horizontal component of earth's magnetic field $B_H=0.34\times10^{-4}T$

$\theta=30°$

We know that, for tangent galvanometer

$B=B_H\tan\theta$

$\Rightarrow B=0.34\times10^{-4}\times\tan30°$

$¿1.96\times10^{-5}T$

49 **(b)**

$$T=2\pi\sqrt{\frac{I}{MB}}=2\pi\sqrt{\frac{wl^2/12}{Pole\ strength\times2l\times B}}$$

$$\therefore T\propto\sqrt{Wl}$$

$$\therefore\frac{T_2}{T_1}=\sqrt{\frac{w_2}{w_1}\times\frac{l_2}{l_1}}=\sqrt{\frac{w_1/2}{w_2}\times\frac{l_1/2}{l_1}}=\frac{1}{2}$$

$$\Rightarrow T_2=\frac{T_1}{2}=0.5\,sec$$

50 **(c)**
Let $M_1$ and $M_2$ be the magnetic moments of magnets and $H$ the horizontal component of earth's field. We have $\tau=MH\sin\theta$. If $\phi$ is the twist of wire, then $\tau=C\phi$, C being restoring couple per unit twist of wire

$\Rightarrow C\phi=MH\sin\theta$

Here $\phi_1=(180°-30°)=150°\times\frac{\pi}{180}rad$

$\phi_2 = (270° - 30°) = 240° = 240 \times \frac{\pi}{180} rad$

So, $C\phi_1 = M_1 H \sin\theta$ [For deflection $\theta = 30°$ of I magnet]

$C\phi_2 = M_2 H \sin\theta$ [For deflection $\theta = 30°$ of II magnet]

Dividing $\frac{\phi_1}{\phi_2} = \frac{M_1}{M_2}$

$$\Rightarrow \frac{M_1}{M_2} = \frac{\phi_1}{\phi_2} = \frac{150 \times \left(\frac{\pi}{180}\right)}{240 \times \left(\frac{\pi}{180}\right)} = \frac{15}{24} = \frac{5}{8}$$

$\Rightarrow M_1 : M_2 = 5 : 8$

51 **(c)**

Magnetic substance when kept in a magnetic field is feebly repelled or thrown out if the substance is diamagnetic.

52 **(b)**

Here, $n_1 = 10$ oscillations per min

$\delta_1 = 45°, T_1 = 0.707$ CGS units

$n_2 = ?, \delta_2 = 60°, R_2 = 0.5$ CGS units

$$\frac{n_2}{n_1} = \sqrt{\frac{H_2}{H_1}} = \sqrt{\frac{R_2 \cos\delta_2}{R_1 \cos\delta_1}}$$

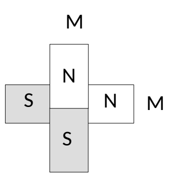
$$\frac{n_2}{10} = \sqrt{° \frac{0.5 \cos 60°}{0.707 \cos 45°} = ¿ \sqrt{\frac{0.5 \times 1/2}{0.5 \times \sqrt{2} \times 1/\sqrt{2}} = \frac{1}{\sqrt{2}} ¿}}$$

$$n_2 = \frac{10}{\sqrt{2}} = 7.07$$

53 **(c)**

Time period of combination

$$T = 2\pi \sqrt{\frac{2I}{\sqrt{2} M.H}} \ldots (i)$$




and time period of each magnet

$$T' = 2\pi \sqrt{\frac{I}{MH}} \ldots (ii)$$

From (i) and (ii), we get

$$T' = \frac{T}{2^{1/4}} = 2^{-1/4} T$$

54 **(c)**

$$B_1 = \frac{2M}{d^3}, B_2 = \frac{M}{d^2}; \therefore \frac{B_1}{B_2} = 2:1$$

55 **(d)**

$\theta_1 = 90°, \theta_2 = 270°,$

$W = -MB[\cos 270° - \cos 90°] = ¿$zero

56 **(a)**

The volume of the cubic domain is

$V(10^{-6} m)^3 = 10^{-18} m^3$

Net dipole moment $m_{net} = 8 \times 10^{10} \times 9 \times 10^{-24} A m^2$

$¿ 72 \times 10^{-14} A m^2$

Magnetization, $M = \frac{m_{net}}{Domain\,volume}$

$$¿ \frac{72 \times 10^{-14} A m^2}{10^{-18} m^3} = 72 \times 10^4 A m^{-1} = 7.2 \times 10^5 A m^{-}$$

57 **(b)**

Points of zero magnetic field *ie*, neutral points lie on equatorial line of magnetic *ie*, along east and west.

58 **(d)**

This luminous electrical discharge is visible frequently in regions of earth's magnetic poles.

59 **(b)**

Ferromagnetic substance have strong tendency to get magnetized (induced magnetic moment) in the same direction as that of applied magnetic field, so magnet attract $N_1$ strongly. Paramagnetic substances get weakly magnetized (magnetic moment induced is small) in the same direction as that of applied magnetic field, so magnet attracts $N_2$ weakly. Diamagnetic substances also get weakly magnatised when placed in an external magnetic field but in opposite direction and hence, $N_3$, is weakly repelled by magnet.

60 **(d)**

The potential energy of a magnetic dipole of magnetic moment $M$ placed in magnetic field $H$ is given as

$$U_\theta = -M.H = -MH\cos\theta$$

Where $\theta$ is angle between the vector **M** and **H**. Initially the dipole possesses minimum potential energy $U_0$, therefore work requires to turn through angle $\theta$ is

$W = U_{\theta} - U_{0}$

¿ $- MH\cos\theta - (-MH\cos\theta)$

¿ $- MH\cos\theta + MH$

$W = MH(1-\cos\theta)$

61 **(b)**

$\tau = MB\, sin\theta = 0.1 \times 3 \times 10^{-4} \sin 30°$

¿ $1.5 \times 10^{-5}$ N-m

62 **(a)**

$T = 2\pi\sqrt{\frac{1}{MB}} \Rightarrow \frac{T}{T'} = \sqrt{\frac{B'}{B}} = \sqrt{\frac{B}{B_H}}$

$\frac{T}{T'} = \sqrt{\frac{1}{\cos\phi}} = \sqrt{\frac{1}{\cos 60°}} = \sqrt{2} \Rightarrow T' = \frac{T}{\sqrt{2}}$

63 **(c)**

$T \propto \frac{1}{\sqrt{B_H}} \propto \frac{1}{\sqrt{B\cos\phi}} \Rightarrow \frac{T_1}{T_2} = \sqrt{\frac{B_2\cos\phi_2}{B_1\cos\phi_1}}$

$\Rightarrow \frac{B_1}{B_2} = \frac{T_2^2}{T_1^2} \times \frac{\cos\phi_2}{\cos\phi_1} = \left(\frac{3}{2}\right)^2 \times \left(\frac{\cos 60°}{\cos 30°}\right) \Rightarrow \frac{B_1}{B_2} = \frac{9}{4\sqrt{3}}$

64 **(b)**

Magnetic moment of circular loop carrying current

$M = IA = I(\pi R^2) = I\pi\left(\frac{L}{2\pi}\right)^2 = \frac{IL^2}{4\pi} \Rightarrow L = \sqrt{\frac{4\pi M}{I}}$

65 **(a)**

This magnetising field is a measure of coercivity of the material.

66 **(b)**

$F \propto \frac{m_1 m_2}{r^2}$

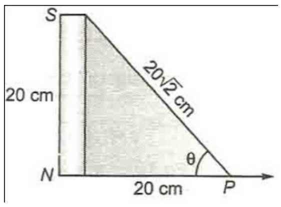
67 **(d)**

$\frac{M_1}{M_2} = \left(\frac{d_1}{d_2}\right)^3 \Rightarrow \frac{27}{8} = \left(\frac{d_1}{0.12}\right)^3$

$\Rightarrow \frac{3}{2} = \frac{d_1}{0.12} \Rightarrow 0.18\, m$

68 **(a)**

$NS$ is a magnet held vertically with its north pole on the table. $P$ is neutral point, where $NP = 20$ cm, figure. Clearly,




69 **(d)**

$W = mB\cos\theta$

¿ $mB\cos 60°$

¿ $mB \times \frac{1}{2}$

$\tau = mB\sin\theta$

¿ $mB\sin 60°$

¿ $\sqrt{3}\, W$ $\quad [\because mB = 2W]$

70 **(c)**

The energy lost per unit volume of a substance in a complete cycle of magnetization is equal to the area of the hysteresis loop

71 **(a)**

$E = nAVt = nA\frac{m}{d}t = \frac{50 \times 250 \times 10 \times 3600}{7.5 \times 10^3} = 6 \times 10$

72 **(d)**

For a temporary magnet the hysteresis loop should be long and narrow

73 **(a)**

The effective length of magnet

$2l = 31.4\, cm = 0.314\, m$

Pole strength $m = 0.5\, Am$

So, the magnetic moment, $M = m \times 2l$

¿ $(0.5 \times 0.314)\, Am^2$

¿ $0.157\, Am^2$

When magnet is bent in the form of semicircle (of diameter *d*), then length of magnet ¿ $\pi\frac{d}{2}$

$\therefore 31.4 = \frac{\pi d}{2}$

$\Rightarrow d=\frac{31.4\times 2}{3.14}=20\,cm$

$\therefore$ Effective length of magnet

$2l'=d=20\,cm=0.2cm$

Hence, its magnetic moment will be

$M'=m\times 2l'$

$¿0.5\times 0.2=0.1\,A\,m^2$

74 **(b)**

Since, $B$ and $H$ are perpendicular to each other and the resultant field is inclined at an angle $45°$ with.

So, $B=H$

$\frac{\mu_0}{4\pi}\frac{2M}{r^3}=H$

$\therefore r^3=\frac{\mu_0}{4\pi}\frac{2M}{H}=0.5\,m$

75 **(d)**

Permeability is given by

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

When $B$ is magnetic flux density and $H$ the auxiliary field strength.

Given, $B=4H$,

$\therefore \mu=\frac{4H}{H}=4\,N\,A^{-2}$

76 **(c)**

The number of atoms per unit volume in a specimen

$n=\frac{\rho N_A}{A}$

For iron, $\rho=7.8\times 10^3\,kg\,m^{-3}$,

$N_A=6.02\times 10^{26}/kgmol, A=56$

$\Rightarrow n=\frac{7.8\times 10^3\times 6.02\times 10^{26}}{56}=8.38\times 10^{28}\,m^{-3}$

Total number of atoms in the bar is

$N_0=nV=8.38\times 10^{28}\times (5\times 10^{-2}\times 1\times 10^{-2}\times 1\times 1($

$N_0=4.19\times 10^{23}$

The saturated magnetic moment of bar

$¿4.19\times 10^{23}\times 1.8\times 10^{-23}=7.54\,A\,m^2$

78 **(b)**

When pole strength becomes 4 times, magnetic moment $M$ becomes four times.

As $T\propto\frac{1}{\sqrt{M}}$

$\therefore T\,becomes\frac{1}{\sqrt{4}}=\frac{1}{2}$ times

$T=\frac{2}{2}=¿1$ s.

79 **(c)**

For short bar magnet in tan $A$ position

$\frac{\mu_0}{4\pi}\frac{2M}{d^3}=H\tan\theta\ldots$(i)

When distance is doubled, then new deflection $\theta'$ is given by

$\frac{\mu_0}{4\pi}\frac{2M}{(2d)^3}=H\tan\theta'$ ….(ii)

$\therefore\frac{\tan\theta'}{\tan\theta}=\frac{1}{8}$

$\Rightarrow\theta'=\frac{tan\theta}{8}=\frac{\tan 60°}{8}=\frac{\sqrt{3}}{8}$

$\Rightarrow\theta'=\tan^{-1}\left[\frac{\sqrt{3}}{8}\right]$

80 **(c)**

$T_{\sum ¿=2\pi\sqrt{\frac{(I_1+I_2)}{(M_1+M_2)B_H}}¿}$

$T_{diff}=2\pi\sqrt{\frac{I_1+I_2}{(M_1-M_2)B_H}}$

$\Rightarrow\frac{T_s}{T_d}=\frac{T_1}{T_2}=\sqrt{\frac{M_1-M_2}{M_1+M_2}}=\sqrt{\frac{2M-M}{2M+M}}=\frac{1}{\sqrt{3}}$

81 **(a)**

$T=2\pi\sqrt{\frac{1}{MB_H}}, T'=2\pi\sqrt{\frac{1}{M(B_H-B)}}\Rightarrow T'=2T=$

83 **(b)**

Absolute permeability of material of rod

$\mu=\mu_r\mu_0=(1+X_m)\mu_0$

$\therefore \mu = (1+499) \times 4\pi \times 10^{-7} = 2\pi \times 10^{-4} H m^{-1}$

84 **(b)**

Frog is leveited in magnetic field produced by the current in vertical solenoid below the frog due to repulsion, so body of frog behaves as diamagnetic substance.

85 **(b)**

Torque, $\tau = MB_H \sin\theta$

$\Rightarrow 0.032 = M \times 0.16 \sin 30°$

$\Rightarrow M = 0.4 J/T$

86 **(c)**

Area enclosed by $B-H$ curve represents energy lost. If the area of hysteresis loop is less energy loss is low whereas if the area of hysteresis loop is large energy loss is high.

87 **(d)**

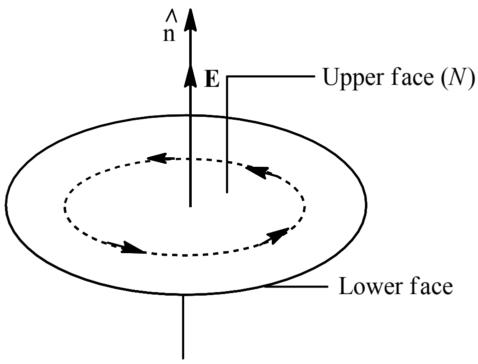
Magnetic potential at a distance $d$ from the bar magnet on it's axial line is given by

$V = \frac{\mu_0}{4\pi} \cdot \frac{M}{d^2} \Rightarrow V \propto M \Rightarrow \frac{V_1}{V_2} = \frac{M_1}{M_2}$

$\Rightarrow \frac{V}{V_2} = \frac{M}{M/4} \Rightarrow V_2 = \frac{V}{4}$

88 **(a)**

The magnetic dipole moment of the current loop (*M*) is directly proportional to (i) strength of current(i) through the loop and (ii) area (*A*) enclosed by the loop.




*ie,* $M \propto i$ and $M \propto A$

$\therefore M = kiA \ldots (i)$

Where $k$ is constant of proportionality.

If we define unit magnetic dipole moment as that of a small one turn loop of unit area carrying unit current, then from Eq.(i)

$1 = k \times 1 \times 1$ or $k = 1$

∴From Eq.(i)

$M = iA$

For $N$ such turns

$M = NiA$

Now, length of given wire $L = 2\pi r$

Or $r = \frac{L}{2\pi}$

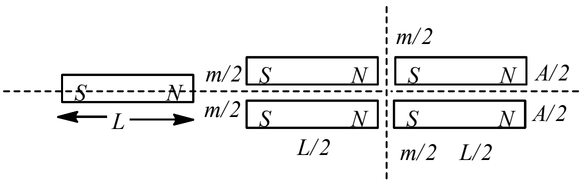
Now, area of the coil, $A = \pi r^2 = \frac{\pi L^2}{4\pi^2}$

¿ $\frac{L^2}{4\pi}$

Hence, magnitude of magnetic dipole moment is

$M = iA = \frac{iL^2}{4\pi}$

89 **(b)**




For each part $m' = \frac{m}{2}$

90 **(c)**
Cabin must be made of iron, which has large permeability.

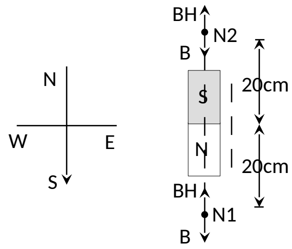
92 **(b)**

Magnetic susceptibility is give as

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

Large value of $X_m$ implies that the material is more susceptible to the field and hence can be easily magnetized. For diamagnetic substance $X_m$ is small and negative and is independent of temperature.

93 **(b)**




At neutral point

$|B| = |B_H| \Rightarrow \frac{2M}{(20)^3} = 0.3 \Rightarrow M = 1.2 \times 10^3\, emu$

95 **(b)**
Transformer core is of soft iron which has large retentivity and small coercivity. Therefore, its hysteresis loop is tall and narrow.

96 **(c)**

Work done, $W = MB.(1 - \cos\theta)$

¿ $20 \times 0.3(1 - \cos 30°)$

¿ $6\left(1 - \frac{\sqrt{3}}{2}\right) = 3(2 - \sqrt{3})$

98 **(d)**

Given $\tan 37° = \frac{3}{4}$

The vertical component of the earth's magnetic field

$B_H = 6 \times 10^{-5}\, T$

$\sin 37° = \frac{3}{5}$

For vertical component

$B_H = B \sin\theta$

¿ $B = \frac{B_H}{\sin\theta}$

or $B = \frac{2 \times 10^{-5}}{5} \times 5$

¿ $B = 10 \times 10^{-5}$

or $B = 10^{-4}$ T

99 **(d)**
Hysteresis loss is minimised by using Mu metal.

100 **(c)**

$$\frac{B_1}{B_2}=\frac{d_1}{d_2}\left(\frac{d_2^2-l^2}{d_1^2-l^2}\right)^2 \Rightarrow \frac{12.5}{1}=\frac{10}{20}\left(\frac{400-l^2}{100-l^2}\right)^2$$

$\Rightarrow l=5\,cm$

Hence length of magnet ¿ $2l=10\,cm$

101 **(b)**

For permanent magnet we prefer a material with high retentivity (so as to make a stronger magnet) and high coercivity (so that magnetization may not be wiped out easily). For electromagnet we prefer high saturated magnetism, low coercivity and least possible area of hysteresis loop so that electromagnet develops high magnetization, is easily demagnetized and energy loss in a magnetization cycle is least. Therefore, $P$ is suitable for making permanent magnet and $Q$ for making electromagnet.

102 **(b)**

$X_m \propto \frac{1}{T}$, Therefore,

$$\frac{X_2}{X_1}=\frac{T_1}{T_2}$$

$$\frac{X_2}{0.0060}=\frac{273-73}{273-173}=\frac{200}{100}=2$$

Or $X_2=2\times 0.0060=0.0120$

103 **(b)**

Torque, $\tau=0.64\,J, B=0.32\,T, \theta=30°$

Torque, $\tau=MB\sin\theta$

$0.64=M\times 0.32\sin 30°$

$0.64=M\times 0.32\times\frac{1}{2}$

$$M=\frac{2\times 0.64}{0.32}=4\,Am^2$$

104 **(c)**

For null deflection $\frac{M_1}{M_2}=\left(\frac{d_1}{d_2}\right)^3=\left(\frac{40}{50}\right)^3=\frac{64}{125}$

105 **(b)**

Current in coil of tangent galvanometer

$$i=\frac{2rB_H}{\mu_0 n}\tan\theta$$

$$\Longrightarrow n=\frac{2rB_H}{\mu_0 i}\tan\theta$$

$$\therefore n=\frac{2\times 16\times 10^{-2}\times 0.36\times 10^{-4}}{4\pi\times 10^{-7}\times 20\times 10^{-3}}\tan 45°$$

¿ $458$

106 **(a)**

In the usual setting of deflecting magnetometer, field due to magnet $(F)$ and horizontal component $(H)$ of earth's field are perpendicular to each other. Therefore, the net field on the magnetic needle is $\sqrt{F^2+H^2}$

$$\therefore T=2\pi\sqrt{\frac{I}{M\sqrt{F^2+H^2}}} \qquad \ldots\text{(i)}$$

When magnet is removed,

$$T_0=2\pi\sqrt{\frac{I}{MH}} \qquad \ldots\text{(ii)}$$

Also, $\frac{F}{H}=tan\theta$

Dividing Eq. (i) by Eq.(ii), we get

$$\frac{T}{T_0}=\sqrt{\frac{H}{\sqrt{F^2+H^2}}}$$

¿ $\sqrt{\frac{H}{\sqrt{H^2\tan^2\theta+H^2}}}=\sqrt{\frac{H}{H\sqrt{sec^2\theta}}}$

¿ $\sqrt{cos\theta} \vee \frac{T_2^2}{T_0^2}=cos\theta$

$T^2=T_0^2 cos\theta$.

107 **(c)**

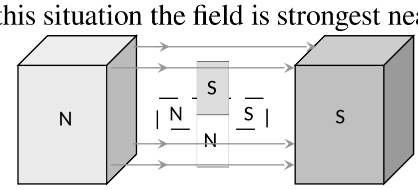
$$K=\frac{2rB_H}{\mu_0 n}$$

or

$$n=\frac{2rB_H}{\mu_0 K}=\frac{2\times 0.1\times 3.6\times 10^{-5}}{4\pi\times 10^{-7}\times 10\times 10^{-3}}=\frac{1.8\times 10^3}{3.14}=57$$

108 **(a)**

A diamagnetic rod set itself perpendicular to the field if free to rotate between the poles of a magnet as in this situation the field is strongest near the poles



109 **(b)**

Here, $n_1 = 10$ oscillation per min

$\delta_1 = 45°, B_1 = 0.707$ CGS units

$n_2 = ?, \delta_2 60°, B_2 = 0.5$ CGS units

$$\frac{n_2}{n_1} = \sqrt{\frac{H_2}{H_1}} = \sqrt{\frac{B_2 \cos\delta_2}{B_1 \cos\delta_1}}$$

$$\frac{n_2}{n_1} = \sqrt{\frac{0.5 \cos 60°}{0.707 \cos 45°}} = \sqrt{\frac{0.5 \times 1/2}{0.5 \times \sqrt{2} \times \frac{1}{\sqrt{2}}}}$$

$$\frac{n_2}{10} = \frac{1}{\sqrt{2}} \Longrightarrow n_2 = \frac{10}{\sqrt{2}} = 7.07 \approx 7$$

110 **(b)**

For no deflection in tan $A$ position

$$\frac{\mu_0}{4\pi} \frac{2M_1}{d_1^3} = \frac{\mu_0}{4\pi} \frac{2M_2}{d_2^3}$$

$$\therefore \frac{M_1}{M_2} = \left(\frac{d_1}{d^2}\right)^3$$

Or $\quad \frac{1}{2} = \left(\frac{20}{d^2}\right)^3$

$¿ d_2 = 20 \times (2)^{1/3} cm$

111 **(b)**

In a vibration magnetometer,

$$T = 2\pi\sqrt{\frac{I}{MH}}.$$

$$\therefore 4\pi^2 \frac{I}{T^2} = MH = 36 \times 10^{-4} \quad \text{....(i)}$$

In a deflection magnetometer,

$$H = \frac{\mu_0}{4\pi} \frac{2M}{d^3}$$

$$\frac{4\pi d^3}{2\mu_0} = \frac{M}{H} = \frac{10^8}{36} \quad \text{....(ii)}$$

Multiplying Eq. (i) and Eq. (ii), we get

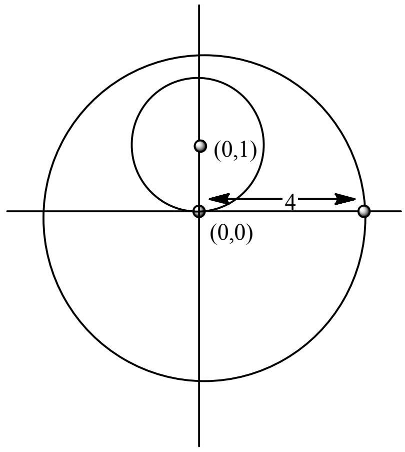
$$M^2 = 36 \times 10^{-4} \times \frac{10^8}{36} = 10^4$$

$M = 10^2 = 100$ A-m

114 **(c)**

Pole strength of original magnet, $m = \frac{M}{14}$

Effective distance between the poles $= AB$




$$M' = m.2l = \frac{M}{14} \times 10 = \frac{M}{1.4}$$

115 **(b)**

From $B = \frac{\mu_0 i}{2r}$

$$7 \times 10^{-5} = \frac{4\pi \times 10^{-7} \times i}{2 \times 5 \times 10^{-2}}$$

$$i = \frac{7 \times 10^{-5}}{4\pi \times 10^{-6}} = 5.6 \text{ A}$$

116 **(b)**

The time period of vibration magnetometer is given by

$$T = 2\pi\sqrt{\frac{I}{M B_H}}$$

Where $I$ is moment of inertia, $M$ the magnetic moment and $B_H$ the horizontal component of earth's magnetic field.

Also, $I = m r^2$

Where $m$ is mass and $r$ the radius.

When mass is increased four times

$I' = 4I$

$$\therefore T' = 2\pi\sqrt{\frac{4I}{M B_H}} \text{ T}$$

$¿2 \times 2\pi\sqrt{\frac{I}{M B_H}}=2T$

117 **(a)**

The deflection magnetometer is most sensitive in the null method $ie$, when $\theta=0°$.

118 **(a)**

A bar magnet having *N*-*S* pole, strength $m$ and length 2**I** be placed in a uniform magnetic field of strength $B$ making an angle $\theta$ with the direction of the magnetic field. Force on *N*-pole of the magnet=*mB* (along the direction of magnetic field *B*.)

Force on *S*-pole of the magnet $¿mB$ (along the direction of magnetic field *B*.)

Force on *S*-pole of the magnet $¿mB$ (opposite to the direction of magnetic field *B*).

Therefore, net magnetic force on the dipole is zero.

119 **(c)**

The property of paramagnetism is found in these substances whose atoms have an excess of electrons spinning in the same direction. Hence atoms of paramagnetic substances have a net non-zero magnetic moment of their own

120 **(d)**

$$\frac{M_1}{M_2}=\frac{\tan\theta_1}{\tan\theta_2} \Rightarrow \frac{m_1 L_1}{m_2 L_2}=\frac{\tan\theta_1}{\tan\theta_2}$$

$$\Rightarrow \frac{m_1}{m_2}=\frac{2}{1}\times\frac{\tan 45°}{\tan 30°}=\frac{2\sqrt{3}}{1}$$

121 **(c)**

Time period of magnet, $T=2\pi\sqrt{\frac{I}{M B_H}}$

When magnet is cut parallel to its length into four equal pieces. Then new magnet moment, $M'=\frac{M}{4}$

New moment of inertia, $I'=\frac{I}{4}$

$\therefore$ New time period, $T'=2\pi\sqrt{\frac{I'}{M' B_H}}$

$\Rightarrow T=T'=4\,s$

122 **(b)**

Torque($\tau$) is given by

$\tau=|M \times B|$

Where $M$ is magnetic dipole moment of loop given by,

$M=i A$

$\therefore M=(i\pi r^2)\hat{k}$

$\tau=¿M \times B \vee ¿(\pi r^2 i B_x)$

Now, torque of weight will be *mgr.*

$mgr=\pi r^2 i B_x$

$\Rightarrow i=\frac{mg}{\pi r B_x}$

124 **(d)**

As $T=2\pi\sqrt{\frac{I}{MB}} \therefore T \Rightarrow \frac{1}{\sqrt{2}}$ time.

Initial time period = 60/30 = 2 s

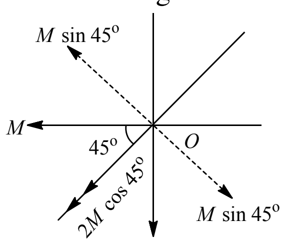
$\therefore$New $T=\frac{2}{\sqrt{2}}=\sqrt{2}$s

128 **(b)**

$T=2\pi\sqrt{\frac{1}{M B_H}}$. If $Q$ is an identical bar magnet then time period of system will be $T'=2\pi\sqrt{\frac{2I}{(2M)B_H}}=T$

129 **(a)**

Resolving the magnetic moments along $OP$ and perpendicular to $OP$, figure we find that component $OP$ perpendicular $OP$ cancel out. Resultant magnetic moment along $OP$ is $=M\cos 45°+M\cos 45°$




$¿2M\cos 45°=\frac{2M}{\sqrt{2}}=\sqrt{2}M$

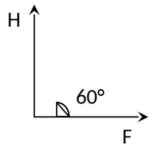
The point $P$ lies on axial line of magnet of moment $¿\sqrt{2}M$

$$\therefore B=\frac{\mu_0}{4\pi}\frac{2(\sqrt{2}M)}{d^3}$$

130 **(c)**

A superconducting material is diamagnetic.

131 **(d)**




From figure, at equilibrium

$$\tan 60°=\frac{H}{F}$$

$$\Rightarrow\sqrt{3}=\frac{H}{F}\Rightarrow\frac{F}{H}=\frac{1}{\sqrt{3}}$$

132 **(a)**

The materials for a permanent magnet should have high retentivity (so that the magnet is strong) and high coercivity (so that the magnetism is not wiped out by stray magnetic fields). As the material in this case is never put to cyclic changes of magnetization, hence hysteresis is immaterial.

133 **(a)**

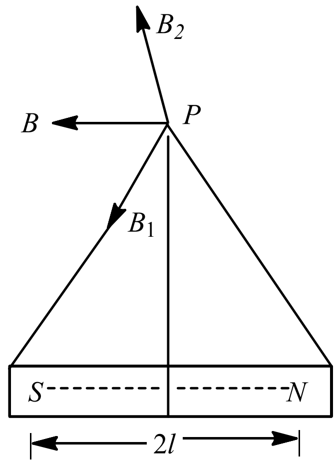
As temperature of a ferro-magnetic material is raised, its susceptibility $X$ remains constant first and then decreases as shown in Fig. (a).

135 **(d)**

Magnetic field due to a magnet at any point or equatorial line is given by

$$B=\frac{\mu_0}{4\pi}\frac{M}{d^3}$$

Direction of $B$ is shown in figure.




Hence, in equatorial position, the direction of magnetic field is parallel to magnetic axis in direction from north pole to south pole *ie,* anti-parallel to **M.**

136 **(c)**

When mass is quadrupled, *ie*, made 4 times.

$I$ becomes four times. As $T\propto\sqrt{I}$.

$\therefore T$ becomes twice, *ie*, motion remains SHM with time period ¿$2T$.

137 **(b)**

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

$$\therefore\chi_1T_1=\chi_2T_2$$

Hence $T_2=\dfrac{1.2\times10^{-5}\times300}{1.8\times10^{-5}}=200\,K$

138 **(a)**

Water is dia-magnetic.

139 **(b)**

Consider a point $P$ located on the axial line of a short bar magnet of magnetic length $2l$ and strength $m$. Let us find **B** at a point $P$ which is at a distance z from the center of magnet. Magnetic flux density at $P$ due to $N$ pole is

$$B_1=\frac{\mu_0}{4\pi}\frac{m}{(z-l)^2}\,along\ NP$$

Similarly, on $S$ pole

$$B_2=\frac{\mu_0}{4\pi}\frac{m}{(z+l)^2}\,along\ S$$

Net magnetic flux at $P$ is

$$B=B_1-B_2=\frac{\mu_0}{4\pi}\left[\frac{m}{(z-l)^2}-\frac{m}{(z+l)^2}\right]$$

$$¿\frac{\mu_0}{4\pi}\left[\frac{4\,mzl}{(z^2-l^2)^2}\right]$$

$$¿\frac{\mu_0}{4\pi}\left[\frac{m\times 2l}{(z^2-l^2)^2}.2z\right]$$

$$¿\frac{\mu_0}{4\pi}\left[\frac{2\,Mz}{(z^2-l^2)^2}\right]$$

$$B=\frac{\mu_0}{4\pi}\frac{2M}{z^3}(\because z>¿l^2)$$

140 **(c)**

Using the formula for total intensity

$$I=\frac{B_H}{\cos\theta}=\frac{B_H}{\cos 45°}$$

$$¿\frac{B_0}{1\sqrt{2}}=\sqrt{2}B$$

142 **(c)**

$$\frac{B_2}{B_1}=\frac{n_2^2}{n_1^2}=\frac{10^2}{5^2}=4$$

$$B_2=4B_1=4\times 0.3\times 10^{-4}T=1.2\times 10^{-4}T$$

Increase in field $¿B_2-B_1=0.9\times 10^{-4}$ T

143 **(a)**

Resultant force acting on a diamagnetic material in a magnetic field is in direction from stronger to the weaker part of the magnetic field.

145 **(d)**

As $T=2\pi\sqrt{\frac{I}{MH}}\therefore 2=2\pi\sqrt{\frac{I}{MH}}$ …(i)

When an external magnet is brought near and parallel to $H$, and the time period reduces to 1 s, net field must be $(F+H)$.

$$\therefore 1=2\pi\sqrt{\frac{I}{M(F+H)}}$$ ...(ii)

Divided Eq. (i) by Eq. (ii),

$$\frac{1}{2}=\sqrt{\frac{F+H}{H}}=\sqrt{\frac{F}{H}+1}$$

$$\frac{F}{H}+1=4$$

$$\frac{F}{H}=4-1=3$$

146 **(b)**

A dia-magnetic liquid moves from stronger parts of magnetic field to weaker parts. Therefore the meniscus of the level of solution will fall.

147 **(a)**

Plane of coil is having angle $\theta$ with the magnetic field $\therefore\tau=MB\sin(90-\theta)$ or $\tau=niAB\cos\theta$ [As $M=niA$]

148 **(d)**

$PQ_6$ corresponds to the lowest potential energy among all the configurations shown

149 **(a)**

When space inside the toroid is filled with air,

$B_0=\mu_0 H$

When filled with tungsten,

$B=\mu H=\mu_0\mu_r H=\mu_0(1+X_m)H$

Percentage increase in magnetic field/ induction

$$¿\frac{(B-B_0)\times 100}{B_0}=\frac{\mu_0 X_m\times 100}{\mu_0 H}=X_m\times 100$$

$¿6.8\times 10^{-5}\times 100=0.0068\%$.

150 **(b)**

Here, $V=(10\times 0.5\times 0.2)\,cm^3$

$¿1\,cm^3=10^{-6}m^3$

$H=0.5\times 10^4\,Am^{-1}, M=5\,Am^2, B=?$

$I=\frac{M}{V}=\frac{5}{10^{-6}}=5\times 10^6$ Am

From $B=\mu_0¿)$

$B=4\pi\times 10^{-7}(5\times 10^6+0.5\times 10^4)=¿6.28$ T

151 **(b)**

**Ist case:** $n=\frac{1}{2\pi}\sqrt{\frac{MB_H}{I}}$

$$\Longrightarrow n\propto\sqrt{B_H}\Longrightarrow\frac{n_1}{n_2}=\sqrt{\frac{B_H}{B_H+B_{H1}}}$$

$$\Longrightarrow\frac{12}{15}=\sqrt{\frac{B_H}{B_H+B_{H1}}}$$

$$\Longrightarrow B_{H1}=\frac{9}{16}B_H$$

**IInd case:**

$$\frac{n_2}{n_3}=\sqrt{\frac{B_H+B_{H1}}{B_H-B_{H1}}}$$

$$\Longrightarrow \frac{15}{n_3}=\sqrt{\frac{B_H+\frac{9}{16}B_H}{B_H-\frac{9}{16}B_H}}$$

$$\frac{15}{n_3}=\sqrt{\frac{B_H+\frac{9}{16}B_H}{B_H-\frac{9}{16}B_H}}$$

$\therefore n_3=\sqrt{63}$

152 **(c)**

Partially filled inner subshells are responsible for ferro-magnetic behaviour of such substances.

153 **(b)**

Mass becomes 1/¿4 and length becomes 1/¿4.

$\therefore$ Moment of inertia $I$ becomes $\frac{1}{4}\left(\frac{1}{4}\right)^2=\frac{1}{64}$,

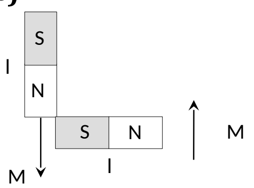
Magnetic moment $M$ becomes $1/4$th.

As $T=2\pi\sqrt{\frac{1}{MH}}$, $\therefore T$ becomes $1/4$th.

154 **(b)**

For diamagnetic material, $0<\mu_r<1$ and for any material $\varepsilon_r>1$.

155 **(c)**




$M_{net}=\sqrt{2}M=\sqrt{2}ml$

156 **(b)**

Number of lines of force passing through per unit area normally is intensity of magnetic field, hence option (c) is incorrect. The correct option is (b)

157 **(a)**

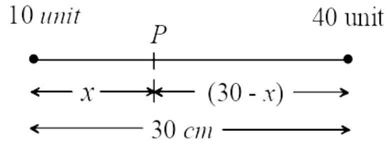
The magnetic field (**B**) due to an isolated pole at a distance *r* from it is given by

$$B=\frac{\mu_0}{4\pi}\cdot\frac{m}{r^2}$$

Where *m* pole strength.

158 **(b)**

Suppose magnetic field is zero at point $P$ which lies at a distance $x$ from 10 unit pole. Hence at $P$




$$\frac{\mu_0}{4\pi}\cdot\frac{10}{x^2}=\frac{\mu_0}{4\pi}\cdot\frac{40}{(30-x)^2}\Rightarrow x=10\,cm$$

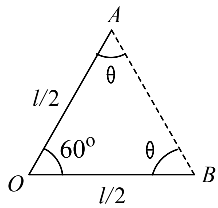
So from stronger pole distance is $20\,cm$

160 **(a)**

Hysteresis loop is studied generally for ferro-magnetics only.

161 **(b)**

Pole strength ¿$m=\frac{M}{l}$. When the wire is bent at its middle point $O$ $at$ $60°$, then as is clear from figure.




$60°+\theta+\theta=180°$

$2\theta=180°-60°=120°$,

$\therefore OAB$ is an equilateral triangle.

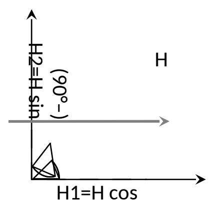
$\therefore AB=2l'=l/2$

New magnetic moment

$$M'=m(2l')=\frac{ml}{2}=\frac{M}{2}$$

162 **(d)**

Let $\alpha$ be the angle which one of the planes make with the magnetic meridian. The other plane makes an angle $(90°-\alpha)$ with it. The components of $H$ in these planes will be $H\cos\alpha$ and $H\sin\alpha$ respectively. If $\phi_1$ and $\phi_2$ are the apparent dips in these two planes, then



$\tan\phi_1 = \frac{V}{H\cos\alpha}, i.e., \cos\alpha = \frac{V}{H\tan\phi_1} \ldots (i)$

$\tan\phi_2 = \frac{V}{H\sin\alpha}, i.e., \sin\alpha = \frac{V}{H\tan\phi_2} \ldots (ii)$

Squaring and adding (i) and (ii), we get

$\cos^2\alpha + \sin^2\alpha = \left(\frac{V}{H}\right)^2 \left(\frac{1}{\tan^2\phi_1} + \frac{1}{\tan^2\phi_2}\right)$

$i.e., 1 = \frac{V^2}{H^2}\left[\cot^2\phi_1 + \cot^2\phi_2\right]$

or

$\frac{H^2}{V^2} = \cot^2\phi_1 + \cot^2\phi_2, i.e., \cot^2\phi = \cot^2\phi_1 + \cot^2\phi_2$

This is the required result

163 **(c)**

$T_1 = 2\pi\sqrt{\frac{I}{MV}}$

$T_2 = 2\pi\sqrt{\frac{I}{MH}}$

$\frac{T_2}{T_1} = \sqrt{\frac{V}{H}} = \sqrt{tan\theta}$

or $tan\theta = \left(\frac{T_2}{T_1}\right)^2 = \left(\frac{2}{2}\right)^2 = 1$

$\theta = 45°$

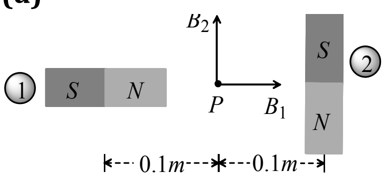
164 **(a)**

$B_H = 0.3\,oersted, I = 0.6\,oersted$

We have $B_H = I\cos\phi \Rightarrow \cos\phi = \frac{B_H}{I} = \frac{0.3}{0.6} = \frac{1}{2}$

$\therefore \phi = 60°$

165 **(d)**



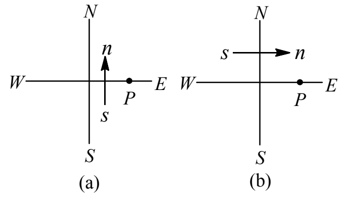

From figure $B_{net} = \sqrt{B_a^2 + B_e^2}$

¿ $\sqrt{\left(\frac{\mu_0}{4\pi}\cdot\frac{2M}{d^3}\right)^2 + \left(\frac{\mu_0}{4\pi}\cdot\frac{M}{d^3}\right)^2}$

¿ $\sqrt{5}.\frac{\mu_0}{4\pi}.\frac{M}{d^3} = \sqrt{5}\times10^{-7}\times\frac{10}{(0.1)^3} = \sqrt{5}\times10^{-3}\,tesla$

168 **(d)**

In Fig. (a), at neutral point $P$,




$B_H = \frac{\mu_0}{4\pi}\left(\frac{M}{d^3}\right)$

In Fig. (b)

Net magnetic induction at $P$ = resultant of

$\frac{\mu_0}{4\pi}\frac{2M}{d^3} = 2B_H$ along horizontal and $B_H$ along

vertical ¿ $\sqrt{(2B_H)^2 + (B_H)^2} = \sqrt{5}B_H$

169 **(d)**

$T' = \frac{T}{n} \Rightarrow T' = \frac{2}{2} = 1\,sec$

170 **(c)**

$R = \frac{H}{\cos\delta} = \frac{0.50}{\cos 30°} = \frac{0.50\times2}{\sqrt{3}} = \frac{1}{\sqrt{3}}$

171 **(c)**

When a changing magnetic flux is applied to a bulk piece of conducting material then circulating current is called eddy currents are induced in material.

173 **(c)**

Time period, $T = 2\pi\sqrt{\frac{I}{MB}}$

$T = 2s, I' = \frac{I}{2}, M' = \frac{M}{2}$

$\therefore T' = T$

$\Longrightarrow T' = 2\,s$

175 **(c)**

$T = 2\pi\sqrt{\frac{1}{MB_H}} \Rightarrow T \propto \frac{1}{\sqrt{M}} \Rightarrow \frac{M_A}{M_B} = \left(\frac{T_B}{T_A}\right)^2 = \frac{4}{1}$

176 **(c)**

Electromagnets are made of soft iron because soft iron has high permeability and low retentivity

178 **(d)**

Time period of magnet is

$$T = 2\pi\sqrt{\frac{I}{M B_H}}$$

Or $M = \frac{4\pi^2 I}{T^2 B_H}$

0r $M = \frac{4 \times (3.14)^2 \times 49 \times 10^{-2}}{(8.8)^2 \times 0.5 \times 10^{-4}}$

¿ $M = 5000\ A - m^2$

180 **(a)**

Flux ¿ $B \times A ; \therefore B = \frac{Flux}{A} = weber/m^2$

181 **(a)**

Torque, $\tau = MB\sin\theta$

$\Rightarrow \tau = (mL) B\sin\theta$

$\Rightarrow 25 \times 10^{-6} = (m \times 5 \times 10^{-2}) \times 510^{-2} \times \sin 30°$ ¿

$\Rightarrow m = 2 \times 10^{-2} A - m$

182 **(c)**

Dipole is the ultimate individual unit of magnetism in any magnet.

184 **(b)**

Current, $I = B_H \times \frac{2r\tan\theta}{n\mu_0}$

¿ $4 \times 10^{-5} \times \frac{2 \times 0.1 \times \tan 60°}{10 \times 4\pi \times 10^{-7}} = 1.1\ Å$

185 **(a)**

Along the axis of magnet $B_a = \frac{2M}{X^3} = 200\ gauss$

$\Rightarrow B_a = \frac{M}{X^3} = 100\ gauss$

186 **(c)**

Diamagnetic materials have negative susceptibility. Thus, (c) is wrongly stated.

187 **(c)**

For paramagnetic materials, the magnetic susceptibility gives information on the molecular dipole moment and hence on the electronic structure of the molecules in the material. The paramagnetic contribution to the molar magnetic susceptibility of a material, $X$ is related to the molecular magnetic moment $M$ by the Curie relation

$$X = constant \times \frac{M}{T} \Longrightarrow X \propto \frac{1}{T}$$

188 **(d)**

$B_1 = \frac{2M}{x^3}$ and $B_2 = \frac{M}{y^3}$

As $B_1 = B_2$

Hence $\frac{2M}{x^3} = \frac{M}{y^3}$ or $\frac{x^3}{y^3} = 2$ or $\frac{x}{y} = 2^{1/3}$

189 **(b)**

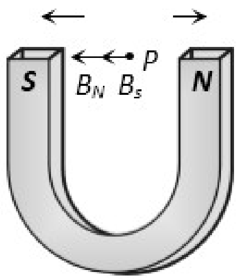
$B = \frac{m}{d^2}$ in C.G.S. system

192 **(c)**

Net magnetic field at mid point $P, B = B_N + B_S$

where $B_N =$ ¿ magnetic field due to $N$-pole

$B_S =$ ¿ magnetic field due to $S$-pole




$B_N = B_S = \frac{\mu_0}{4\pi}\frac{m}{r^2}$

¿ $10^{-7} \times \frac{0.01}{\left(\frac{0.1}{2}\right)^2} = 4 \times 10^{-7} T$

$\therefore B_{net} = 8 \times 10^{-7} T$

193 **(c)**

Here, $2l = 20\,cm \Rightarrow l = 10\,cm, d = 40\,cm$.

As neutral point, $H = B = \frac{\mu_0}{4\pi}\frac{2Md}{(d^2 - l^2)^2}$

$3.2 \times 10^{-5} = \frac{10^{-7} \times 2M(0.4)}{15 \times 15 \times 10^{-4}}$

$\therefore M = \frac{3.2 \times 15 \times 15 \times 10^{-4} \times 10^{-5}}{0.8 \times 10^{-7}} = 9$

$m = \frac{M}{2l} = \frac{9}{0.2} = 45$A-m

194 **(b)**

When magnet are placed perpendicular to each other then,

Resultant magnetic moment

$M' = \sqrt{M_1^2 + M_2^2}$

Here, $M_1 = M_2 = M$

$So, M' = M\sqrt{2} = ml\sqrt{2}$

197 **(c)**

At neutral point

$\left|\begin{matrix}Magnetic\,field\,due \\ ¿\,magnet\end{matrix}\right| = \left|\begin{matrix}Magnetic\,field\,due \\ ¿\,earth\end{matrix}\right|$

$\frac{\mu_0}{4\pi} \cdot \frac{2M}{d^3} = 5\times10^{-5} \Rightarrow 10^{-7}\times\frac{2\times6.75}{d^3} = 5\times10^{-5}$

$\Rightarrow d = 0.3\,m = 30\,cm$

199 **(c)**

When two identical bar magnets are held perpendicular to each other.

$M_1 = \sqrt{M^2+M^2} = M\sqrt{2}, I_1 = I$

$T_1 = 2^{5/4}\,s, T_2 = ?$

$M_2 = M$ (as one magnet is removed)

$I_2 = I_1/2$

$\frac{T_2}{T_1} = \sqrt{\frac{I_2}{M_2}\frac{M_1}{I_1}} = ¿\sqrt{\frac{1}{2}\cdot\frac{M\sqrt{2}}{M}} = \left(\frac{1}{\sqrt{2}}\right)^{1/2} ¿$

$¿\frac{1}{2^{1/4}}$

$T_2 = T_1\times\frac{1}{2^{1/4}} = 2^{5/4}\times\frac{1}{2^{1/4}} = ¿2\text{s}$

200 **(b)**

Magnetic intensity on end side-on position is twice than broad side on position

201 **(b)**

As we know for circulating electron magnetic moment

$M = \frac{1}{2}evr\ldots(i)$

And angular momentum $J = mvr\ldots$(ii)

From equation (i) and (ii), $M = \frac{eJ}{2m}$

202 **(c)**

Magnetic needle is placed in non-uniform magnetic field. It experience force and torque both due to unequal forces acting on poles.

203 **(a)**

At magnetic north pole of earth, $H=0$ and $\delta = 90°$, maximum.

205 **(b)**

In the first case, $T_1 = \frac{60}{10} = 6$ s

$T_1 = 2\pi\sqrt{\frac{I}{MH}} = 6 \quad \ldots$(i)

In the second case, $T_2 = \frac{60}{14} = \frac{30}{7}$ s

If $B$ magnetic induction due to external magnet, then

$T_2 = 2\pi\sqrt{\frac{I}{M(H+B)}} = \frac{30}{7} \quad \ldots$.(ii)

Dividing Eq. (i) by Eq. (ii), we get

$\frac{6}{30/7} = \sqrt{\frac{H+B}{H}} = \sqrt{1+\frac{B}{H}}$

or $\left(\frac{7}{5}\right)^2 = 1+\frac{B}{H}$

or $\frac{B}{H} = \frac{49}{25} - 1 = \frac{24}{25}$

If $n$ is number of vibrations/min in the third case when polarity of external magnet is reversed, then

$T_3 = \frac{60}{n} = 2\pi\sqrt{\frac{I}{M(H-B)}} \quad \ldots$(iii)

Dividing Eq. (i) by Eq. (iii), we get

$\frac{60}{60/n} = \sqrt{\frac{H-B}{H}} = \sqrt{1-\frac{B}{H}} = \sqrt{1-\frac{24}{25}}$

$\frac{n}{10} = \frac{1}{5}, n = 2\,vibs - min^{-1}.$

206 **(a)**

For first case

$T = 2\pi\sqrt{\frac{I}{M\sqrt{F^2+H^2}}}\ldots(i)$

When magnet is removed

$T_0 = 2\pi\sqrt{\frac{T}{MH}}\ldots(ii)$

Also, $\frac{F}{H} = \tan\theta$

From Eqs. (i) and (ii) we have

$\frac{T}{T_0} = \sqrt{\frac{H}{\sqrt{F^2+H^2}}}$

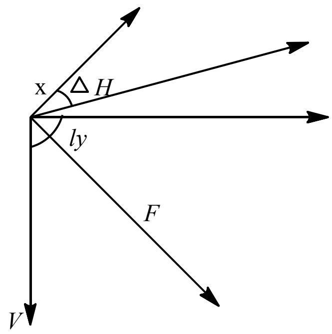
$$\frac{T^2}{T_0^2}=\cos\theta T^2=T_0^2\cos\theta$$

207 **(a)**

$K=\frac{2RB_H}{\mu_0 N}$ ¿ Radius, $N=$ ¿ number of turns]

208 **(a)**

Near the north and south poles, the field points directly into or out of the earth. Near the equator the field is parallel to the surface. Near cleveland the earth's magnetic field has a north-south horizontal component and a much larger vertical component into the ground.




$F=$ total intensity magnetic field vector

$H=$ horizontal component of magnetic field vector

$V=$ the vertical component of magnetic field vector.

209 **(b)**

Earth's field is the effect of complex convention currents in the magma, which must be described as several dipoles, each with a different intensity and orientation, the compass actually point to the sum of the effects of these dipoles. In other words, it aligns itself with the magnetic lines of force. Other factors, of local and solar origin, further complicate the resulting field. It may be all right to say that a compass needle points "magnetic north" but it only roughly points to the north magnetic dipole. Hence, at the magnetic poles of the earth, a compass needle will be bent slightly.

211 **(c)**

$F=\frac{\mu_0}{4\pi}\left(\frac{6MM'}{d^4}\right)$ in end-on position between two small magnets

$$\therefore F=10^{-7}\left(\frac{6\times10\times10}{(0.1)^4}\right)=0.6\,N$$

212 **(b)**

Dip needle at neutral point will be horizontal at magnetic equator where angle of dip is zero degree.

214 **(d)**

$$\tan\delta=\frac{V}{H}=\frac{H}{H}=1$$

$$\therefore\delta=45°$$

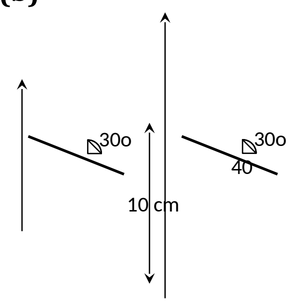
215 **(a)**

$$\frac{\tan\theta_2}{\tan\theta_1}=\frac{d_1^3}{d_2^3}=\frac{r^3}{\left[r(3)^{1/3}\right]^3}=\frac{1}{3}$$

$$\tan\theta_2=\frac{1}{3}\tan\theta_1=\frac{\tan 60°}{3}=\frac{\sqrt{3}}{3}=\frac{1}{\sqrt{3}}$$

$$\therefore\theta_2=30°.$$

216 **(b)**



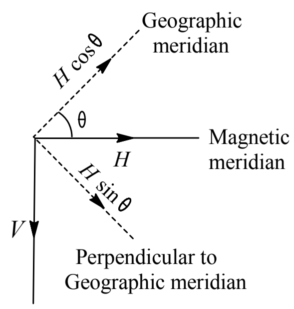

$$|B|=\frac{\Delta V}{\Delta x}=\frac{0.1\times10^{-4}}{0.1\sin 30°}=2\times10^{-4}T$$

217 **(d)**

The curie temperature or curie point of a ferromagnetic material is the temperature above which it looses its characteristic ferromagnetic ability to possess a net magnetization in the absence of an external magnetic field. Hence, above curie temperature material is purely paramagnetic.

218 **(c)**

Let $\theta$ be the declination at the place. As is clear from figure.



$$\tan\delta_1 = \frac{V}{H\,cos\theta}$$

$$\tan\delta_2 = \frac{V}{H\cos(90°-\theta)} = \frac{V}{H\,sin\theta}$$

$$\frac{\tan\delta_1}{\tan\delta_2} = \frac{sin\theta}{cos\theta} = tan\theta$$

$$\therefore \theta = \tan^{-1}\left(\frac{\tan\delta_1}{\tan\delta_2}\right).$$

219 **(a)**

When magnet is displaced by a very small angle $\theta$, then restoring couple acting on the magnet is

$$\tau = -M\,B_H \sin\theta$$

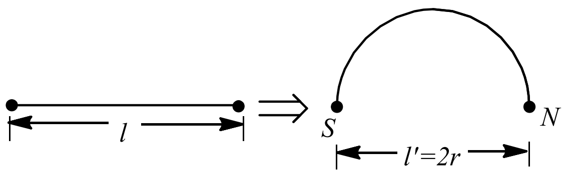
Negative sing shows the restoring nature of torque. Now since $\tau = I\alpha$ and $\sin\theta \approx \theta$ for small angular displacement

$$\therefore I\alpha = M\,B_H\,\theta$$

Or $\alpha =$¿ angular acceleration¿ $\frac{M\,B_H\,\theta}{I}$

220 **(a)**

On bending a wire its pole strength remains unchanged whereas its magnetic moment changes




New magnetic moment,

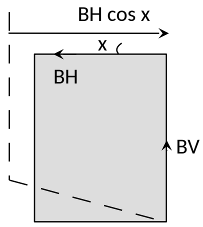
$$M' = m(2r) = m\left(\frac{2l}{\pi}\right) = \frac{2M}{\pi}$$

222 **(a)**

In first case $\tan\theta = \frac{B_V}{B_H}$ …(i)

Second case $\tan\theta = \frac{B_V}{B_H \cos x}$ …(ii)

From equation (i) and (ii), $\frac{\tan\theta'}{\tan\theta} = \frac{1}{\cos x}$

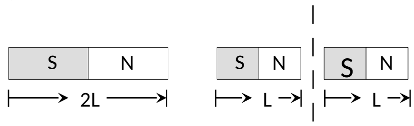



223 **(a)**

$$T = 2\pi\sqrt{\frac{1}{M\,B_H}} \text{ and } I = \frac{w(l^2+b^2)}{12}; \therefore T \propto \sqrt{w}$$

¿ Mass of the magnet)

224 **(c)**




Pole strength of each part ¿ $m$

Magnetic moment of each part

¿ $M' = m'L' = mL = \frac{M}{2}$

225 **(c)**

$B = \mu_0 H = 4\pi \times 10^{-7} \times 28 = 325 \times 10^{-7}$T

¿ $352 \times 10^{-3}$ G=0.352 G

226 **(a)**

Torque $\tau = iAB\sin\theta, i = 0.1\,A, \theta = 90°$

$$A = \frac{1}{2} \times base \times height$$

or $A = \frac{1}{2}a \times \frac{a\sqrt{3}}{2}$

¿ $\frac{\sqrt{3}a^2}{4} = \frac{\sqrt{3}\times(0.02)^2}{4}$

¿ $\sqrt{3}\times 10^{-4} m^2; \theta = 90°$

$\tau = 0.1 \times \sqrt{3} \times 10^{-4} \times 5 \times 10^{-2} \sin 90°$

¿ $5\sqrt{3} \times 10^{-7} N-m$

227 **(d)**

At magnetic equator, the angle of dip is $0°$. Hence the vertical component $V = I\sin\phi = 0$

228 **(b)**

Here, $n_1 = 40, n_2 = 20, H_1 = 36 \times 10^{-6}$T,

$H_2 = ?$

$$\frac{H_2}{H_1} = \frac{n_2^2}{n_1^2} = \frac{(20)^2}{(40)^2} = \frac{1}{4},$$

$$H_2 = \frac{36 \times 10^{-6}}{4} = 9 \times 10^{-6}\text{T}$$

230 **(c)**

In a paramagnetic material, $I \propto H$. Therefore, the graph between $H \wedge I$ is a straight line represented by choice (c) in figure.

231 **(b)**

Deflection in tangent galvanometer

$$\tan\theta = \frac{I}{K}$$

Where, $K = ¿$ reduction factor

$$tan\theta = \frac{1}{1} = 1 = \tan 45°$$

$$\therefore \theta = 45°$$

232 **(c)**

Electromagnets are made of soft iron. The soft iron has high retentivity and low corectivity.

233 **(d)**

In series, same current flows through two tangent galvanometer.

$$i = \frac{2rH}{\mu_0 n_1}\tan\theta_1 = \frac{2rH}{\mu_0 n_2}\tan\theta_2$$

$$\therefore \frac{n_1}{n_2} = \frac{\tan\theta_1}{\tan\theta_2} = \frac{\tan 60°}{\tan 45°} = \sqrt{3}$$

235 **(d)**

$$R = \sqrt{P^2 + Q^2}$$

$$B = \left[\left\{\frac{2P}{(d/2)^3}\right\}^2 + \left\{\frac{P}{(d/2)^3}\right\}\right]^{1/2} \times 10^{-7}$$

$$¿\sqrt{(4^2+4)} \times 10^{-7}$$

$$¿\sqrt{20} \times 10^{-7} = 2\sqrt{5} \times 10^{-7}\ \text{T}$$

236 **(c)**

Magnetism of a magnet falls with rise of temperature and becomes practically zero above curie temperature

237 **(b)**

$i \propto \tan\theta$

238 **(c)**

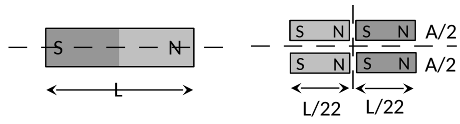
Permanent magnet should have large coercivity and large retentivity. Therefore, the hysteresis cycle of the material should be tall and wide.

239 **(b)**

For a dia-magnetic substance, $I$ is negative and $-I \propto H$. Therefore, the variation is represented by $OC \vee OD$. As magnetisation is small, $OC$ is better choice.

240 **(b)**

For each part $m' = \frac{m}{2}$




241 **(c)**

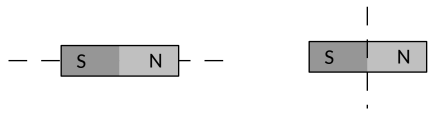
As $\theta$ is with $B$, therefore according to tangent law,

$$H = B\tan\theta = \frac{B\,sin\theta}{cos\theta} \vee B\,sin\theta = H\,cos\theta$$

242 **(b)**

If cut along the axis of magnet of length $l$, then new pole strength $m' = \frac{m}{2}$ and new length $l' = l$

$\therefore$ New magnetic moment $M' = \frac{m}{2} \times l = \frac{ml}{2} = \frac{M}{2}$




If cut perpendicular to the axis of magnet, then new pole strength $m' = m$ and new length, $l' = l/2$

$\therefore$ New magnetic moment $M' = m \times \frac{l}{2} = \frac{ml}{2} = \frac{M}{2}$

243 **(b)**

For lower magnetising fields, $\mu = B/H$ is high, as is clear from shape of hysteresis curve. As $H$ increases, $\mu$ decreases.

244 **(c)**

In case of tangent galvanometer as $i = k\tan\phi$

Differentiating both side $w.r.t.\phi$

$$\frac{di}{d\phi} = k\,sec^2\phi \Rightarrow di = k\,sec^2 d\phi$$

$$\Rightarrow \frac{di}{i} = \frac{d\phi}{\sin\phi\cos\phi} = \frac{2\,d\phi}{\sin 2\phi}$$

Hence the error in the measurement will be least when

$\sin 2\phi = max\,¿\,1 \Rightarrow 2\phi = 90° \Rightarrow \phi = 45°$

246 **(c)**

Magnetic flux $\phi = BA \Rightarrow B = \frac{\phi}{A} = \frac{weber}{m^2} = tesla$

247 **(b)**

$$T=2\pi\sqrt{\frac{I}{M\times B_H}}\Rightarrow T\propto\frac{1}{\sqrt{B_H}}$$
$$\Rightarrow\frac{T_1}{T_2}=\sqrt{\frac{(B_H)_2}{(B_H)_1}}\Rightarrow\frac{60/40}{2.5}=\sqrt{\frac{(B_H)_2}{0.1\times10^{-5}}}$$
$$\Rightarrow(B_H)_2=0.36\times10^{-6}T$$

248 **(a)**

Atomic neon is dia-magnetic. So its intrinsic magnetic moment is zero.

249 **(c)**

Susceptibility $(X)=\frac{intensity\ of\ magnetisation\ (I)}{magnetic\ field\ (B)}$

Or $I=xB$

$\therefore I=3\times10^{-4}\times4\times10^{-4}$

Or $I=12\times10^{-8}\ Am^{-1}$

251 **(a)**

In tangent galvanometer experiment the plane of the coil is first set in the magnetic meridian

253 **(c)**

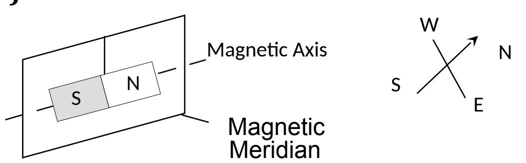
Using tangent law

$\frac{\mu_0}{4\pi}.\frac{2\pi nI}{r}=H\tan\theta$

¿ $\propto\tan\theta$

On increasing no. of turns, resistance and length increases so current decreases and ¿ remains same

255 **(a)**




257 **(d)**

Net magnetic induction $B=B_0+B_m=\mu_0H+\mu_0M$

259 **(d)**

At one point only, vertical component of earth's magnetic field may balance the field due to vertical magnet (which is vertical being along the axis of the magnet).

260 **(b)**

For tangent galvanometer $I=\frac{2rB}{\mu_0 n}\tan\theta$

$\therefore\tan\theta=\frac{I\mu_0 n}{2rB}=\frac{0.1\times4\pi\times10^{-7}\times50}{0.04\times7\times10^{-5}\times2}=1.12$

or $\theta=\tan^{-1}(1.12)=48.2°$

261 **(a)**

In SI units, we have $B=\mu_0(H+I)$

262 **(b)**

Where the dip is at right angles to magnetic meridian, vertical component of earth's magnetic field is effective. The dip needle stands vertical. Therefore, apparent dip¿ $90°$ .

263 **(b)**

In sum position: $T_S=2\pi\sqrt{\frac{I_3}{(M_1+M_2)B_H}}$

In difference position: $T_d=2\pi\sqrt{\frac{I_d}{(M_1-M_2)B_H}}$

It is clear that $T_d>T_s$

264 **(b)**

$\vec{\tau}=\vec{M}\times\vec{B}\Rightarrow\vec{\tau}=50\hat{i}\times(0.5\hat{i}+3\hat{j})$

¿ $150(\hat{i}\times\hat{j})=150\hat{k}\ N\times m$

265 **(a)**

$$T=2\pi\sqrt{\frac{l}{MH}}\Rightarrow T\propto\frac{1}{\sqrt{H}}\Rightarrow\frac{T_A}{T_B}=\sqrt{\frac{H_B}{H_A}}$$
$$\Rightarrow\frac{H_A}{H_B}=\left(\frac{T_B}{T_A}\right)^2=\left(\frac{3}{2}\right)^2=\frac{9}{4}$$

266 **(b)**

When magnet is divided into two equal parts, the magnetic dipole moment

$M'=$¿ pole strength$\times\frac{l}{2}=\frac{M}{2}$

(pole strength remains same)

Also, the mass of magnet becomes half, *ie,*

$m'=\frac{m}{2}$

Moment of inertia of magnet

$I=\frac{ml^2}{12}$

New moment of ineria

$$I'=\frac{1}{12}\left(\frac{m}{2}\right)\left(\frac{l}{2}\right)^2=\frac{ml^2}{12\times 8}$$

$$\therefore I'=\frac{I}{8}$$

Now, $T=2\pi\sqrt{\left(\frac{I}{MB_H}\right)}$

$$T'=2\pi\sqrt{\left(\frac{I'}{M'B_H}\right)}=2\pi\sqrt{\left(\frac{I/8}{MB_H/2}\right)}$$

$$\therefore T'=\frac{T}{2}\Longrightarrow\frac{T'}{T}=\frac{1}{2}$$

267 **(c)**

$T=2\pi\sqrt{\frac{I}{MH}}$; $MI$ of each part ¿ $\frac{I}{6^3}$

and magnetic moment of each part ¿ $\frac{M}{6}$

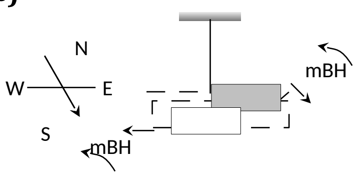
so net $MI$ of system ¿ $\frac{I}{6^3}\times 6=\frac{I}{6^2}$

and net magnetic moment ¿ $\frac{4M}{6}-\frac{2M}{6}=\frac{M}{3}$

∴ Time period of the system

$$T'=2\pi\sqrt{\frac{I/36}{(M/3)H}}=\frac{1}{2\sqrt{3}}2\pi\sqrt{\frac{I}{MH}}=\frac{T}{2\sqrt{3}}$$

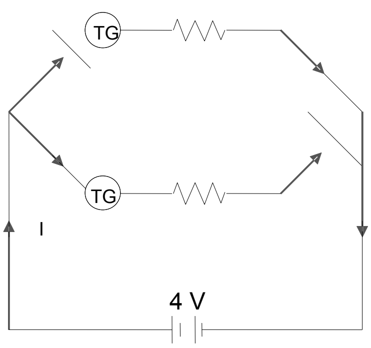
268 **(c)**




269 **(b)**

Current in tangent galvanometer

$$I=\frac{2rB_H}{\mu_0 N}\tan\theta\,..(i)$$




Here $R_1 \wedge R_2$ are parallel

$$\therefore\frac{1}{R_{net}}=\frac{1}{R_1}+\frac{1}{R_2}$$

¿ $\frac{R_2+R_1}{R_1R_2}=\frac{8+8}{8\times 8}$

$$R_{net}=4\,\Omega$$

Hence, $I=\frac{V}{R}=\frac{4}{4}=1\,A$

From Eq. (i), we get

$$\frac{r\tan\theta}{N}=\frac{\mu_0 I}{2B_H}$$

$$\therefore\frac{r_A\tan\theta_A}{N_A}=\frac{r_B\tan\theta_B}{N_B}$$

$$\Rightarrow\frac{8\times 1}{\sqrt{3}}=\frac{16}{N_B}$$

$$\therefore N_B=12\,turns$$

270 **(d)**

Provided length of magnet is << the distance

271 **(a)**

$$\frac{M_1}{M_2}=\frac{v_s^2+v_d^2}{v_s^2-v_d^2}\Rightarrow\frac{13}{5}=\frac{(15)^2+v_d^2}{(15)^2-v_d^2}$$

$$\Rightarrow v_d=10\,oscillations/min$$

272 **(d)**

Due to wood moment of inertia of the system becomes twice but there is no change in magnetic moment of the system

Hence by using

$$T=2\pi\sqrt{\frac{I}{MB_H}}\Rightarrow T\propto\sqrt{I}\Rightarrow T=\sqrt{2}T$$

273 **(a)**

Torque, $\tau=MB\sin\theta$

Where $\theta=90°$

$$\therefore\tau=MB$$

Given, $\tau_2 = \frac{1}{2}\tau_1$

$\therefore MB\sin\theta = \frac{1}{2}MB$

$\therefore \sin\theta$ ¿ $\frac{1}{2}$

$\Rightarrow \theta = 30°$

Angle of rotation is ¿ $90° - 30° = 60°$

274 **(a)**

Susceptibility of a paramagnetic substance is independent of magnetising field

275 **(d)**

$i \propto \tan\phi \Rightarrow \frac{i_1}{i_2} = \frac{\tan\phi_1}{\tan\phi_2}$

$\Rightarrow \frac{2}{i_2} = \frac{\tan 30}{\tan 60} \Rightarrow i_2 = 6\,amp$

276 **(c)**

The magnetism of the magnet is due to the spin motion of electrons.

277 **(c)**

In a tangent galvanometer, applying tangent law

$B = H\tan\theta$

$B = 0.34\times10^{-4}\tan 30° = 0.34\times10^{-4}\times\frac{1}{\sqrt{3}}$

$B = 1.96\times10^{-5}$ T.

278 **(d)**

Here, magnetic moment is given in weber-meter, which is the unit of $\mu_0 M$.

$\therefore \mu_0 M = 5\times10^{-5}$ Wb-m

$M = \frac{5\times10^{-5}}{\mu_0} A\,m^2$

Also, $B = 8\pi\times10^{-4} = \mu_0 H$

$\therefore H = \frac{8\pi\times10^{-4}}{\mu_0}$

$T = 2\pi\sqrt{\frac{I}{MH}}$

$I = \frac{MHT^2}{4\pi^2} = \frac{5\times10^{-5}\times8\pi\times10^{-4}\times15^2}{4\pi^2\mu_0^2}$

¿ $\frac{5\times10^{-5}\times8\pi\times10^{-4}\times225}{4\pi^2(4\pi\times10^{-7})^2}$

$I = \frac{2250\times10^{-9}}{\pi(16\pi^2)\times10^{-14}} = 4.54\times10^5\,kg\,m^2$

279 **(b)**

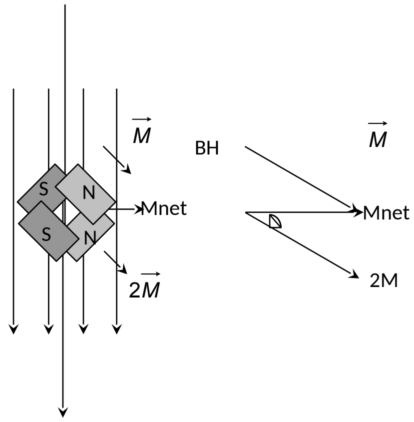
$T = 2\pi\sqrt{\frac{I}{M B_H}} \Rightarrow \frac{T_1}{T_2} = \sqrt{\frac{(B_H)_2}{(B_H)_1}}$

$\Rightarrow T_2 = T\sqrt{\frac{(BH)_1}{(BH)_2}} = \frac{T}{2}\left[\because (B_H)_2 = 4(B_H)_1\right]$

280 **(c)**

$W = MB(1-\cos\theta) = 2\times10^4\times6\times10^{-4}(1-\cos 60) =$

281 **(c)**




$\Rightarrow \tan\theta = \frac{M}{2M} = \frac{1}{2} \Rightarrow \theta = \tan^{-1}\left(\frac{1}{2}\right)$

282 **(c)**

Potential energy, $U = M.B = -MN\cos\theta$

Here **M =** magnetic moment of the loop

$\theta =$ ¿ angle between **M** and **B**

$U$ is maximum when $\theta = 180°$ and minimum when $\theta = 0°$. So as $\theta$ decrease from $180°$ ¿ $0°$ its PE also decreases.

283 **(c)**

If $V =$ ¿volume of the material = mass/density

$A =$ ¿ area of hysteresis loop

$v =$ ¿ frequency of alternate magnetic field applied

$t =$ ¿ time for which field is applied

Then, energy loss in the material in $t$ second is

$E = VAvt = \left(\frac{m}{d}\right)Avt$

¿ $\frac{0.6}{7.8\times10^3}\times0.722\times50\times1$

¿ $2.77\times10^3$

¿ $27.7\times10^{-4}$ J

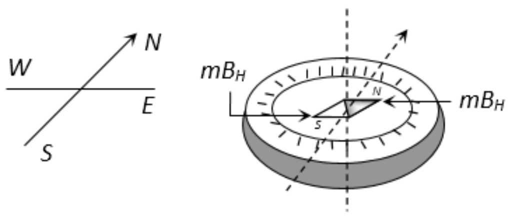
284 **(a)**

The horizontal components are $(B_H)_1 = B\cos\phi_1$ and $(B_H)_2 = B\cos\phi_2$

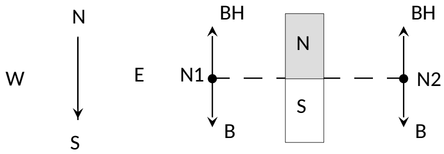
$\therefore \frac{(B_H)_1}{(B_H)_2} = \frac{\cos\phi_1}{\cos\phi_2} = \frac{\cos 30°}{\cos 45°} = \frac{\sqrt{3}}{2}\sqrt{2} = \frac{\sqrt{3}}{\sqrt{2}}$

285 **(b)**

Magnetic needle is a dipole which is in earth' uniform magnetic field and as a dipole in a uniform field does not experience any net force but may experience a couple as shown in figure, so the needle together with the cork will not translate $i.e.$ move towards the north of the lake, but rotate and set itself parallel to the field with it's north pole pointing north




286 **(a)**




$N_1$ and $N_2$ are two null points. And $B_H = ¿$ Horizontal component of earth's magnetic field

$B = ¿$ Magnetic field due to bar magnets

287 **(c)**

$B_V = B_H \tan\phi$; If $B_V = B_H$, then $\tan\phi = 1$ or $\phi = 45°$

288 **(d)**

$\chi_m = (\mu_r - 1) \Rightarrow \chi_m = (5500 - 1) = 5499$

289 **(b)**

At south pole, $H = 0$

$T = 2\pi\sqrt{\frac{1}{MH}} = ¿ \infty ¿$

291 **(c)**

It is due to the magnetic field produced by coil

292 **(d)**

$B = B_0 \cos 60°$

$H = B_0 \cos 30°$

$$\frac{B}{H} = \frac{\cos 60°}{\cos 30°} = \frac{\frac{1}{2}}{\frac{\sqrt{3}}{2}} = \frac{1}{\sqrt{3}}$$

293 **(c)**

As they enter the magnetic field of the earth, they are deflected away from the equator

295 **(a)**

Torque on a bar magnet in earths magnetic field $(B_H)$ is $\tau = M B_H \sin\theta . \tau$ will be maximum if $\sin\theta = ¿$ maximum $i.e. \theta = 90°$. Hence axis of the magnet is perpendicular to the field of earth

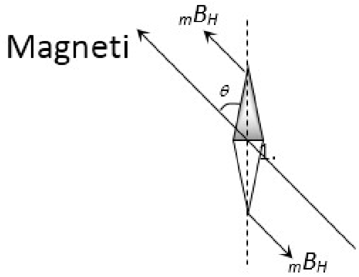
296 **(d)**

$W = MB(\cos\theta_1 - \cos\theta_2); \theta_1 = 0°$ and $\theta_2 = 360° \Rightarrow W = 0$

298 **(c)**

$T = 2\pi\sqrt{\frac{1}{M B_H}} \Rightarrow T \propto \sqrt{I} \propto \sqrt{w} \Rightarrow T' = \sqrt{2} T_0$

299 **(a)**




As the compass needle is free to rotate in a horizontal plane and points along the magnetic meridian, when it is pointing along the geographic meridian it will experience a torque due to the horizontal component of earth's magnetic field, $i.e., \tau = M B_H \sin\theta$ where $\theta = ¿$ angle between geographical and magnetic meridians called angle of declination

So, $\sin\theta = \frac{1.2 \times 10^{-3}}{60 \times 40 \times 10^{-6}} = \frac{1}{2} \Rightarrow \theta = 30^o$

301 **(b)**

Given, $v_1 = \frac{20}{60} = \frac{1}{3} sec^{-1} ¿ v_2 = \frac{15}{60} = \frac{1}{4} sec^{-1}$

Now

$v = \frac{1}{2\pi}\sqrt{\frac{M B_H}{I}} = \frac{1}{2\pi}\sqrt{\frac{MB\cos\phi}{I}} [\because B_H = B\cos\phi]$

$$\therefore \frac{v_1}{v_2}=\sqrt{\frac{B_1 \cos\phi}{B_2 \cos\phi}} \Rightarrow \frac{B_1}{B_2}=\left(\frac{v_1}{v_2}\right)^2\left(\frac{\cos\phi_2}{\cos\phi_1}\right)^2$$

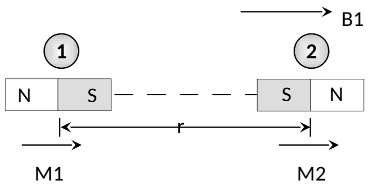
$$\Rightarrow \frac{B_1}{B_2}=\left(\frac{1/3}{1/4}\right)^2 \frac{\cos 60°}{\cos 30°}=\frac{16}{9}\times\frac{1/2}{\sqrt{3}/2}=\frac{16}{9\sqrt{3}}$$

302 **(d)**

Here $A=0.5\,m^2, B=2T, \theta=30°$

$$\phi=BA\,cos\theta=2\times 0.5\cos 30°=\frac{\sqrt{3}}{2}\text{Wb}$$

303 **(d)**




Both the magnets are placed in the field of one another, hence potential energy of dipole (2) is

$U_2 = -M_2 B_1 \cos 0 = -M_2 B_1 = M_2 \times \frac{\mu_0}{4\pi} \cdot \frac{2M_1}{r^3}$

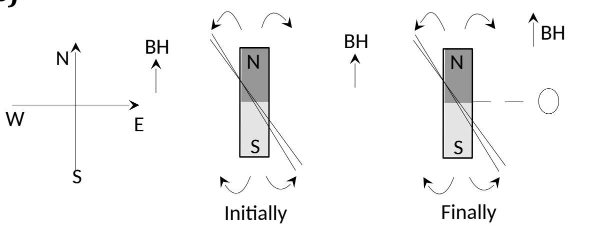
By using $F = \frac{-dU}{dr}$, force on magnet (2) is

$F_2 = \frac{-dU_2}{dr} = \frac{-d}{dr}\left(\frac{\mu_0}{4\pi} \cdot \frac{2M_1M_2}{r^3}\right) = \frac{-\mu_0}{4\pi} .6 \frac{M_1M_2}{r^4}$

It can be proved that $|F_1| = |F_2| = F = \frac{\mu_0}{4\pi} \cdot \frac{6M_1M_2}{r^4}$

$\Rightarrow F \propto \frac{1}{r^4}$

304 **(c)**




Initially $T = 2\pi\sqrt{\frac{I}{mB_H}}$,Finally

$T' = 2\pi\sqrt{\frac{I}{m(B+B_H)}}$

Where $B =$¿ Magnetic field due to downward conductor

¿ $\frac{\mu_0}{4\pi} \cdot \frac{2i}{a} = 18\,\mu T$

$\therefore \frac{T'}{T} = \sqrt{\frac{B_H}{B+B_H}} \Rightarrow \frac{T'}{0.1} = \frac{24}{18+24} \Rightarrow T' = 0.076\,s$

305 **(b)**

Ferromagnetic materials used in a transformer must have high permeability and low hysteresis loss.

306 **(d)**

We have, $B = \mu_0 H + \mu_0 I$

or $I = \frac{B - \mu_0 H}{\mu_0}$ or $I = \frac{\mu H - \mu_0 H}{\mu_0} = \left[\frac{\mu}{\mu_0} - 1\right] H$

$I = (\mu_r - 1) H$

For a solenoid of $n$-turns per unit length and current $i$

$H =$¿

$\therefore I = (\mu_r - 1) \ni$¿$(1000-1) \times 500 \times 0.5$

$I = 2.5 \times 10^5\,A m^{-1}$

$\therefore$ Magnetic moment $M = IV$

$M = 2.5 \times 10^5 \times 10^{-4} = 25\,A m^2$

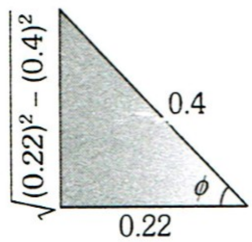
308 **(c)**

By using $B_H = B \cos\phi$

$\Rightarrow \cos\phi = \frac{B_H}{B} = \frac{0.22}{0.4}$

$\Rightarrow \tan\phi = \frac{\sqrt{(0.4)^2 - (0.22)^2}}{0.22}$

$\Rightarrow \phi = \tan^{-1}(1.518)$




309 **(a)**

As $\tau = MB\sin\theta$

$\frac{d\tau}{d\theta} = MB\cos\theta$

It will be maximum, when $\theta = 0°$.

310 **(d)**

For a para-magnetic material, $K \propto \frac{1}{T}$

$\therefore \frac{K_2}{K_1} = \frac{T_1}{T_2}$

$\frac{K/2}{K} = \frac{27+273}{T_2}$

$T_2 = 600\,K = 600 - 273 = 327\,°C$.

311 **(b)**

As magnets are perpendicular to each other, the resultant magnetic moment

¿ $\sqrt{M^2 + M^2} = \sqrt{2}$ M

$\therefore T_1 = 2\pi\sqrt{\frac{2I}{\sqrt{2}MH}}$ ….(i)

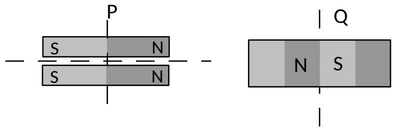
In the second case, $T_2 = 2\pi\sqrt{\frac{I}{MH}}$

$$\frac{T_2}{T_1}=\frac{1}{(2)^{1/4}}$$

$$\therefore T_2=\frac{4}{(2)^{1/4}}=3.36\,s$$

313 **(c)**

If pole strength, magnetic moment and length of each part are $m'$, $M'$ and $L'$ respectively then




$$m'=\frac{m}{2}\,m'=m$$

$$L'=L\,L'=\frac{L}{2}$$

$$\Rightarrow M'=\frac{M}{2}\Rightarrow M'=\frac{M}{2}$$

314 **(b)**

In tangent galvanometer, $I\propto\tan\theta$

$$\therefore\frac{I_1}{I_2}=\frac{\tan\theta_1}{\tan\theta_2}\Rightarrow\frac{I_1}{I_1/\sqrt{3}}=\frac{\tan 45°}{\tan\theta_2}$$

$$\Rightarrow\sqrt{3}\tan\theta_2=1\Rightarrow\tan\theta_2=\frac{1}{\sqrt{3}}\Rightarrow\theta_2=30°$$

So deflection will decrease by $45°\text{-}30°=15°$

315 **(c)**

When magnet of length $l$ is cut into four equal parts then $m'=\frac{m}{2}$ and $l'=\frac{l}{2};\therefore M'=\frac{m}{2}\times\frac{l}{2}=\frac{ml}{4}=\frac{M}{4}$

New moment of inertia

$$I'=\frac{wl^2}{12}=\frac{\frac{w}{4}.\left(\frac{1}{2}\right)^2}{12}=\frac{1}{16}.\frac{wl^2}{12}$$

Here $w$ is the mass of magnet

$\therefore I'=\frac{1}{16}I;$ Time period of each part

$$T'=2\pi\sqrt{\frac{I'}{M'B_H}}$$

$$¿2\pi\sqrt{\frac{I/16}{(M/4)B_4}}=2\pi\sqrt{\frac{I}{4MB_H}}=\frac{T}{2}$$

316 **(d)**

Ferromagnetic substance are strongly attracted by a magnet, show all properties of a paramagnetic substance to a much higher degree. While paramagnetic substances are feebly attracted by a magnet. When ferromagnetic substance is heated, then at a definite temperature the ferromagnetic property of the substance suddenly disappears and the substance becomes paramagnetic. The temperature above which a ferromagnetic substance becomes paramagnetic is called the curie temperature (point) of the substance.

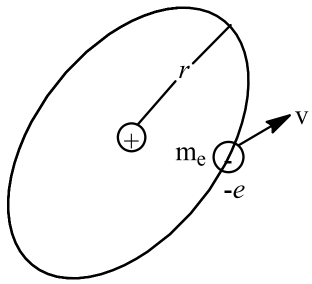
317 **(d)**

No magnetic lines of force pass through the steel box

319 **(a)**

Magnetic moment or magnetic dipole moment is given by

$$M=iA\ldots(i)$$




Where $i$ is current and $A$ the area.

The effective current (i) is $i=\frac{e}{T}$

Where $e$ is electron charge and $T$ the time period.

Also, $v=\frac{1}{T}=¿$ frequency

And area $A=\pi r^2$, where $r$ is radius of circular path.

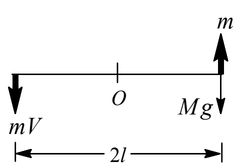
Putting these values in Eq. (i), we get

$$M=ev.\pi r^2$$

320 **(b)**

As shown in figure,

mass $M=50\,mg=50\times10^{-3}$ g strength of each pole, $m=98.1$ab-amp-cm, g = 981 $cm\,s^{-2}, V=?$




In equilibrium, $mV\times2l=Mg\times l$

$$V=\frac{Mg}{2m}$$

$$V=\frac{50\times10^{-3}\times981}{2\times98.1}=¿0.25\text{ G}$$

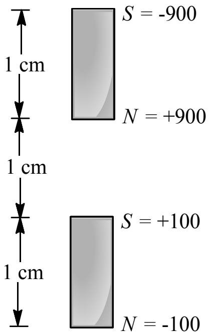
321 **(a)**

The vertical component of earth's magnetic field is zero at equator where angle of dip is also zero

322 **(b)**

In CGS system, $\frac{\mu_0}{4\pi}=1$

In equilibrium, net repulsion due to magnetic interaction = weight of upper magnet. Therefore, as is clear from figure.




$$\frac{900(100)}{1^2}+\frac{900(-100)}{2^2}-\frac{900(100)}{2^2}-\frac{900(-100)}{3^2}=$$

$$900\times 100\left[\frac{1}{1^2}-\frac{1}{2^2}-\frac{1}{2^2}+\frac{1}{3^2}\right]=m\times 1000$$

$$90\left(\frac{11}{18}\right)=m$$

$ie, m=55$ g

324 **(d)**

For tangent galvanometer the number of turns

$N\propto \tan\theta$

Hence, $\frac{N_1}{N_2}=\frac{\tan\theta_1}{\tan\theta_2}$

Or $\frac{N_1}{N_2}=\frac{\tan 60°}{\tan 45°}$

Or $\frac{N_1}{N_2}=\frac{\sqrt{3}}{1}$

325 **(c)**

Inside a magnet, magnetic lines of force move from south pole to north pole

326 **(b)**

$W_1=MB(\cos 0°-\cos 90°)=MB(1-0)=MB$

$W_2=MB(\cos 0°-\cos 60°)=MB\left(1-\frac{1}{2}\right)=\frac{MB}{2}$

$\therefore W_1=2W_2\Rightarrow n=2$

328 **(c)**

For stable equilibrium

$U=-MB$

¿$-(0.4)(0.16)=-0.064\,J$

329 **(a)**

The line of force on the earth surface where the field is horizontal, is known as magnetic equator.

330 **(d)**

At equator angle of dip is zero

331 **(b)**

$\tan\delta'=\frac{tan\delta}{cos\theta}=\frac{tan\delta}{\cos 90°}=\frac{tan\delta}{0}=\infty.$

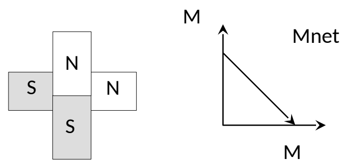
$\therefore \delta'=90°$

$\therefore$ Dip needle will stand vertical.

333 **(c)**

Neon is diamagnetic, hence its magnetic moment is zero.

334 **(b)**




$\Rightarrow M_{net}=\sqrt{M^2+M^2}=\sqrt{2}\,M$

335 **(c)**

The correct measure of hardness of a material is its coercivity, $ie$, the field strength required to be applied in opposite direction to reduce the residual magnetism of the specimen to zero.

337 **(b)**

Concept of magnetic screening

338 **(a)**

$$T=2\pi\sqrt{\frac{1}{M\,B_H}}\Rightarrow\frac{T_1}{T_2}=\sqrt{\frac{M_2}{M_1}}\Rightarrow\frac{M_1}{M_2}=\frac{T_2^2}{T_1^2}=\frac{(60/15)^2}{(60/10)^2}$$

339 **(a)**

On applying magnetic field, domains of ferromagnetic substance align themselves in the direction of magnetic field.

340 **(b)**

Angle of dip is defined as the angle at a particular point on the earth's surface between the direction of the earth's magnetic field and

$B_H = B\cos\delta$

Where $B$ is total field intensity, $B_H$ the horizontal component of earth's magnetifc field and $\theta$ the dip angle.

Given, $\delta = 30°$

$\because \cos 30° = \frac{\sqrt{3}}{2}$

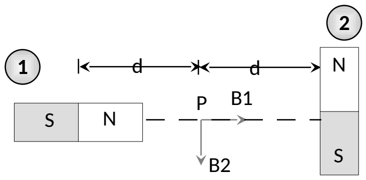
$\therefore B = \frac{B_H}{\cos 30°} = \frac{2B_H}{\sqrt{3}}$

341 **(d)**

At point $P$ net magnetic field $B_{net} = \sqrt{B_1^2 + B_2^2}$

Where $B_1 = \frac{\mu_0}{4\pi} \cdot \frac{2M}{d^3}$ and $B_2 = \frac{\mu_0}{4\pi} \cdot \frac{M}{d^3}$

$\Rightarrow B_{net} = \frac{\mu_0}{4\pi} \cdot \frac{\sqrt{5}M}{d^3}$




342 **(c)**

$t_1 = 3 = 2\pi\sqrt{\frac{I}{MR}}$, where $R$ resultant intensity of earth's field.

$t_2 = 3\sqrt{2} = 2\pi\sqrt{\frac{I}{MH}}$

Divide $\frac{1}{\sqrt{2}} = \sqrt{\frac{H}{R}} = \sqrt{\frac{R\cos\delta}{R}} = \sqrt{\cos\delta}$

$\cos\delta = \frac{1}{2}, \delta = 60°$.

343 **(b)**

An electron moving around the nucleus has a magnetic moment $\mu$ given by

$\mu = \frac{e}{2m} l$

Where $l$ is the magnitude of the angular momentum of the circulating electron around the nucleus. The smallest value of $\mu$ is called the bohr magneton $\mu_B$ and its value is $\mu_B = 9.27 \times 10^{-24}\, J\,T^{-1}$

344 **(c)**

Time period of magnet in vibration magnetometer

$T = 2\pi\sqrt{\frac{I}{M\,B_H}}$

Where $I =$ ¿ moment of inertia of magnet,

$M =$ ¿ magnetic moment,

$B_H =$ ¿ horizontal component of earth's magnetic field.

$\therefore \frac{T_1}{T_2} = \sqrt{\frac{I_1}{I_2} \cdot \frac{M_2}{M_1}}$

$\frac{4}{T_2} = \sqrt{\frac{ml/12 \times M/4}{m/4(l/4)^2/12 \times M}}$

¿ $\sqrt{\frac{4 \times 16 \times 12}{12 \times 4}} = \sqrt{16}$

$\frac{4}{T_2} = 4$

$\Longrightarrow T_2 = 1\mathrm{s}$

345 **(c)**

Horizontal component of earth's magnetic field is the component of earth's magnetic field along the horizontal direction.

$B_H = B\cos\delta$

$0.26 = B\cos 60°$

$\Rightarrow B = \frac{0.26}{\cos 60°} = 0.52\,G$

346 **(a)**

Magnetic moment of bar $M = 10^4\, J/T$

$B = 4 \times 10^{-5}\, T$

Hence work done $W = \vec{M}.\vec{B}$

¿ $10^4 \times 4 \times 10^{-5} \times \cos 60° = 0.2\, J$

347 **(c)**

At magnetic equator, $V = 0$

$\therefore \tan\phi = \frac{V}{H} = 0$

$\therefore \delta = 0$

348 **(b)**

$B_{equatorial} = \frac{\mu_0}{4\pi} \frac{M}{r^3}$

349 **(b)**

Sensitivity $S=\frac{\theta}{i}=\frac{\theta}{K\tan\theta}$ where $K=\frac{2RB_H}{\mu_0 N}$

For increasing sensitivity $K$ should be decreased and hence number of turns should be increased

350 **(d)**

From $R=2\pi\sqrt{I/MH}$; length of suspension is not involved.

351 **(d)**

$T=2s=2\pi\sqrt{\frac{I}{MH}}$.

When the magnet is cut along its length into three equal parts, moment of inertia of each part becomes $I/3$ and magnetic moment of each part also becomes $M/3$.

As the three parts are placed on each other with their like poles together, therefore for the combination,

$T'=2\pi\sqrt{\frac{I/3+I/3+I/3}{(M/3+M/3+M/3)B}}$

¿ $2\pi\sqrt{\frac{I}{MB}}=2s$

352 **(d)**

$\frac{M_1}{M_2}=\frac{T_2^2+T_1^2}{T_2^2-T_1^2}=\frac{n_2^2+n_1^2}{n_1^2-n_2^2}$

¿ $\frac{4^2+12^2}{12^2-4^2}=\frac{160}{128}=10:8$

353 **(b)**

For equilibrium of the system torques on $M_1$ and $M_2$ due to $B_H$ must counter balance each other, $i.e., M_1\times B_H=M_2\times B_H$. If $\theta$ is the angle between $M_1$ and $B_H$, then angle between $M_2$ and $B_H$ will be $(90-\theta)$; so $M_1B_H\sin\theta=M_2B_H\sin(90-\theta)$

$\Rightarrow\tan\theta=\frac{M_2}{M_1}=\frac{M}{3M}=\frac{1}{3}\Rightarrow\theta=\tan^{-1}\left(\frac{1}{3}\right)$

354 **(b)**

The work done in rotating the magnet through an angle $\theta$ in magnetic field $B$ is given by

$W=\int_0^\theta MH\sin\theta\,d\theta$

$W=MB[-\cos\theta]_0^\theta=MB(\cos 0-\cos\theta)$

$W=MB(1-\cos\theta)$

Give, $M=2\,J\,T^{-1}, B=0.1\,T, \theta=90°$

$\therefore W=2\times 0.1\times(1-\cos 90°)=0.2\,J$

355 **(a)**

From Coulomb's law, $F=\frac{\mu_0}{4\pi}\frac{m_1m_2}{r^2}$; *where*, $m_1, m_2$ are pole strengths

$\therefore\mu_0=\frac{4\pi r^2F}{m_1m_2}=\frac{[L^2(MLT^{-2})]}{(AL)^2}=[MLT^{-2}A^{-2}]$

356 **(c)**

In equilibrium, the resultant magnetic moment will be along magnetic meridian. Let $N_1S_1$ make $\angle\theta$ with resultant

$tan\theta=\frac{M_2}{M_1}=\frac{M}{\sqrt{3}M}=\frac{1}{\sqrt{3}}\therefore\theta=30°$

357 **(b)**

$W=MB(1-\cos\theta)$

¿ $MB(1-\cos 180°)=2MB$

359 **(c)**

$B^2=B_V^2+B_H^2\Rightarrow B_V=\sqrt{B^2-B_H^2}=\sqrt{(0.5)^2-(0.3)^2}=0.4$

Now $\tan\phi=\frac{B_V}{B_H}=\frac{0.4}{0.3}=\frac{4}{3}\Rightarrow\phi=\tan^{-1}\left(\frac{4}{3}\right)$

360 **(b)**

$\mu_r=\frac{L'}{L}=\frac{50}{10}=5$

$X_m=\mu_r-1=5-1=4$

361 **(b)**

Ferromagnetic material moves from a region of small magnetic field to a region of strong magnetic field.

362 **(a)**

Potential energy $U=-MB\cos\theta$

$\Rightarrow U_{max}=MH$ [at $\theta=180°$ ¿

363 **(a)**

On passing current through the coil, it acts as a magnetic dipole. Torque acting on magnetic dipole is counter balanced by the moment of additional weight about position $O$. Torque acting on a magnetic dipole

$\tau=MB\sin\theta=(NiA)B\sin 90°=NiAB$

Again $\tau=Force\times Lever\,arm=\Delta mg\times l$

$\Rightarrow NiAB = \Delta mgl ; \Delta m = 60 \times 10^{-3} g = 60 \times 10^{-6} kg$

$\Rightarrow B = \frac{\Delta mgl}{NiA} = \frac{60 \times 10^{-6} \times 9.8 \times 30 \times 10^{-2}}{200 \times 22 \times 10^{-3} \times 1 \times 10^{-4}} = 0.4\,T$

365 **(c)**

Angle of dip

$\therefore \tan \delta = \frac{B_V}{B_H}$

In new position.

$\Rightarrow \delta' = \tan^{-1}\left(\frac{B'_V}{B'_H}\right) = \tan^{-1}\left(\frac{B_V}{B_H \cos 30°}\right)$

$\Rightarrow \delta' = \tan^{-1}\left(\frac{2}{\sqrt{3}} \delta\right)$

Hence, $\theta = ¿$true dip $¿ 40°$

$\therefore \theta' > \theta$

Hence , in this position, the needle will dip by an angle more than $40°$.

366 **(d)**

$\mu_r = 1 + \frac{I}{H}$; as we know $I$ dependent on $H$, initially value of $\frac{1}{H}$ is small so value of $\mu_r$ increases with $H$ but slowly. With further increase of $H$, value of $\frac{1}{H}$ also increases, $i.e.,\mu_r$ increases speedily. When material is fully magnetized $I$ becomes constant, then with the increase of $H\left[\frac{1}{H} decreases\right]\mu_r$ decreases.

This is in accordance with the option (d)

367 **(a)**

For paramagnetic substance magnetization $M$ is proportional to magnetising field $H$, and $M$ is positive

368 **(d)**

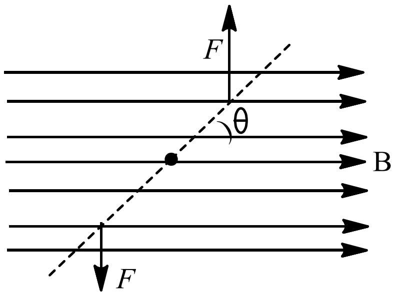
The instantaneous moment of the deflecting couple is given by

$\tau = MB \sin \theta$

Where $M$ is magnetic moment of magnet.

Given, $\tau = 0.032\,J, B = 0.16\,T, \theta = 30°$

$M = \frac{\tau}{B \sin 30°}$




$$M=\frac{0.032}{0.16\times\sin 30°}=\frac{0.032\times 2}{0.16}$$

$$M=0.4\,J\,T^{-1}$$

369 **(b)**

When a current is passed through the galvanometer coil, then a magnetic field $B$ is produced at right angles to the plane of the coil, *ie,* at right angles to the horizontal component of earth's magnetic field $B_H$. Under the influence of two crossed magnetic fields $B$ and $B_H$, the magnetic needle of galvanometer undergoes a deflection $\theta$ which is given by the tangent law. Using tangent law, we can find a relation

$$I\propto\tan\theta$$

Which clearly indicates that tangent galvanometer is an instrument used for detection of electric current in a circuit.

370 **(d)**

As $\mu_r<1$ for substance $X$, it must be diamagnetic. And $\mu_r>1$ for substance $Y$, is must be para-magnetic.

371 **(b)**

As $T\propto\frac{1}{\sqrt{M}};\wedge M$ becomes 4 times, therefore, $T$ becomes half. New $T=1$ s

372 **(b)**

For $H=R\cos\delta$

$$\therefore R=\frac{H}{\cos\delta}$$

$$¿\frac{B_0}{\cos 45°}=\sqrt{2}B_0$$

374 **(a)**

$T=2\pi\sqrt{\frac{1}{M\,B_H}};I\rightarrow 3$ times and $M\rightarrow\frac{1}{3}$ times

So $T\rightarrow 3$ times, $i.e.,T'=3T_0$

375 **(d)**

Torque, $\tau=MB\sin\theta$

$$¿m\times(2l)\times B\sin\theta$$

$$¿10^{-4}\times 0.1\times 30\sin 30°=1.5\times 10^{-4}\,N-m$$

376 **(a)**

$C_{max}=MB\Rightarrow 4\times 10^{-5}=M\times 10^{-4}\Rightarrow M=0.4\,A\times m^{;}$

377 **(a)**

Both points $A$ and $B$ lie on axial position

$$B\propto\frac{1}{d^3}\Rightarrow\frac{B_A}{B_B}=\left(\frac{d_B}{d_A}\right)^3=\left(\frac{48}{24}\right)^3=\frac{8}{1}$$

378 **(a)**

Domain formation is the necessary feature of ferromagnetism

379 **(d)**

$F=\frac{\mu_0}{4\pi}\left(\frac{6M\,M'}{d^4}\right)$ in end-on position

380 **(a)**

The magnetic potential due to a magnetic dipole at distance $r$ is

$$V=\frac{\mu_0}{4\pi}\frac{M\cos\theta}{r^2}$$

On the right bisector(*ie*, on axial line), $\theta=0°$

$$\therefore v=\frac{\mu_0}{4\pi}\frac{M}{r^2}$$

or $V\propto\frac{1}{r^2}$

381 **(d)**

Work done, $W=MB(1-\cos\theta)$

$$\theta=90°$$

$$\therefore W=MB$$

382 **(a)**

Soft iron is highly ferromagnetic

383 **(b)**

In the given figure $OQ$ refers to retentivity while ¿ refers to coercivity. For permanents both retentivity and coercivity should be high

384 **(c)**

Diamagnetic substances are those substances in which resultant magnetic moment in an atom is zero.
A paramagnetic material tends to move from a weak magnetic field to strong magnetic field.
A magnetic material is in the paramagnetic phase above its Curie temperature.
Typical domain size of a ferromagnetic material is 1 mm.
The susceptibility of a ferromagnetic material is $\chi \gg 1$

385 **(a)**

At neutral point, $\frac{\mu_0}{4\pi} \times \frac{m}{d^2} = V$

$10^{-7} \times \frac{m}{(20/100)^2} = 0.4 \times 10^{-4}$

$m = \frac{0.4 \times 10^{-4}}{25 \times 10^{-7}} = 16$ A-m

386 **(b)**

With rise in temperature their magnetic susceptibility decrease, $i.e., \chi_m \propto \frac{1}{T}$

387 **(a)**

Time period $T = 2\pi\sqrt{\frac{I}{M B_H}}$

As the magnet is cut into two equal parts along parts along axis, then for each part

$I' = \frac{I}{2}$

$M' = \frac{M}{2}$

$\therefore$ Time period of new magnet,

$T' = \sqrt{\frac{I'}{M'B}} = \sqrt{\frac{I \times 2}{2 \times M \times B}}$

$T' = T$

388 **(b)**

When a magnetic needle is placed in a uniform magnetic field, equal and opposite forces act on the poles of the needle which give rise to a torque, but not net force.

389 **(b)**

From $T = 2\pi\sqrt{\frac{I}{MB}}, 4 = 2\pi\sqrt{\frac{I}{MB}}$.

When it is cut into two equal parts in length, mass of each part becomes $1/2$, $I = mass\frac{(length)^2}{12}$ becomes $\frac{1}{8}th$ and $M$ becomes $\frac{1}{2}$.

$T' = 2\pi\sqrt{\frac{I/8}{(M/2)B}}$

$\therefore = \frac{1}{2}\left(2\pi\sqrt{\frac{I}{MB}}\right)$

$¿\frac{1}{2}T = 2$s

391 **(d)**

Iron is a ferromagnetic substance and ferromagnetic substance obeys Curie-Weiss law above its Curie temperature.

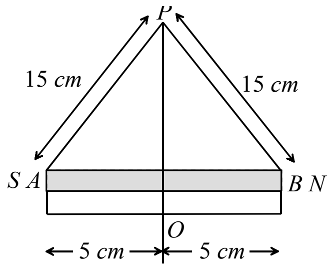
392 **(d)**

Length of magnet

$¿ 10\,cm = 10 \times 10^{-2} m$

$r = 15 \times 10^{-2} m$

$OP = \sqrt{225 - 25} = \sqrt{200}\,cm$




Since, at the neutral point, magnetic field due to the magnet equal to $B_H$

$B_H = \frac{\mu_0}{4\pi} \cdot \frac{M}{(OP^2 + AO^2)^{3/2}}$

$0.4 \times 10^{-4} = 10^{-7} \times \frac{M}{(200 \times 10^{-4} + 25 \times 10^{-4})^{3/2}}$

$\frac{0.4 \times 10^{-4}}{10^{-7}} \times (225 \times 10^{-4})^{3/2} = M$

$0.4 \times 10^3 \times 10^{-6} (225)^{3/2} = M$

$M = 1.35\, A - m$

393 **(b)**

Liquid oxygen is paramagnetic.

394 **(c)**

$B_a = \frac{\mu_0}{4\pi}\frac{2M}{d^3} = \frac{\mu_0}{2\pi}\frac{M}{d^3}$

396 **(b)**

$r = 0.0157\,m, I = 2$A

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

$¿\frac{4\pi\times10^{-7}\times2}{2\times0.0157}=8\times10^{-5}\,Wb\,m^{-2}\,Wb\,m^{-2}$.

397 **(d)**

Magnetic susceptibility

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

For paramagnetic substance $X_m$ is slightly positive.

398 **(a)**

Geometric length of a magnet is $\frac{6}{5}$ times its magnetic length.

$\therefore$ Geometric length $¿\frac{6}{5}\times10=12\,cm$

399 **(c)**

Magnetic field due to short magnet

$B=10^{-7}\frac{2M}{d^3}$

Or $B\propto\frac{1}{d^3}$

401 **(b)**

Here, $n=500$ turns/m, $I=1\,A,\mu_r=500$

Magnetic intensity,

$H=¿=500\,m^{-1}\times1\,A=500\,A\,m^{-1}$

As $\mu_r=1+\chi$, where $\chi$ is the magnetic susceptibility of the material

or $\chi=(\mu_r-1)$

Magnetisation, $M=\chi H=(\mu_r-1)H$

$¿(500-1)\times500\,A\,m^{-1}=499\times500\,A\,m^{-1}$

$¿2.495\times10^5\,A\,m^{-1}$

$¿2.5\times10^5\,A\,m^{-1}$

404 **(b)**

Since magnetic field is in vertical direction and needle is free to rotate in horizontal plane only so magnetic force can not rotate the needle in horizontal plane so needle can stay in any position

405 **(d)**

$F=mB\Rightarrow F=\frac{M}{L}\times B$

$\Rightarrow6\times10^{-4}=\frac{3}{L}\times2\times10^{-5}\Rightarrow L=0.1\,m$

407 **(a)**

The weight of upper magnet should be balanced by the repulsion between the two magnets

$\therefore \frac{\mu_0}{4\pi} \cdot \frac{m^2}{r^2} = 50\, gwt$

$\Rightarrow 10^{-7} \times \frac{m^2}{(9 \times 10^{-6})} = 50 \times 10^{-3} \times 9.8$

$\Rightarrow m = -6.64\, amp \times m$

408 **(d)**

In the sum and difference method of vibration magnetometer

$\frac{M_1}{M_2} = \frac{T_2^2 + T_1^2}{T_2^2 - T_1^2}$

Here $T_1 = \frac{1}{n_1} = \frac{60}{12} = 5\, sec$, $T_2 = \frac{1}{n_2} = \frac{60}{4} = 15\, sec$

$\therefore \frac{M_1}{M_2} = \frac{15^2 + 5^2}{15^2 - 5^2} = \frac{225 + 25}{225 - 25} = \frac{5}{4}$

409 **(b)**

The time period of oscillations of magnet

$T = 2\pi \sqrt{\left(\frac{I}{M B_H}\right)} \ldots (i)$

Where $I =$ ¿ moment of inertia of magnet

¿ $\frac{mL^2}{12}$ (*m*, being the mass of magnet)

When the three equal parts of magnet are placed on one another with their like poles together, then

$I' = \frac{1}{12}\left(\frac{m}{3}\right) \times \left(\frac{L}{3}\right)^2 \times 3$

¿ $\frac{1}{12} \frac{mL^2}{9} = \frac{I}{9}$

and $M' =$ ¿ pole strength $\times \frac{L}{3} \times 3 = M$

Hence, $T' = 2\pi \sqrt{\left(\frac{I/9}{M B_H}\right)}$

$\Rightarrow T' = \frac{1}{3} \times T$

$T' = \frac{2}{3} s$

410 **(c)**

No. of oscillation per minute ¿ $\frac{1}{2\pi} \sqrt{\frac{M B_H}{I}}$

$\Rightarrow n \propto \sqrt{M B_H}\,; M \to 4 \times$ ¿

$B_H \to 2 \times$ ¿

So $v \to \sqrt{8} \times i.e.\, v' = \sqrt{8} v = 2\sqrt{2} n$

411 **(c)**

$T = 2\pi \sqrt{\frac{I_1 + I_2}{(M_1 - M_2) B_H}}$

Here $M_1 = M_2 = M, \therefore T = \infty$

412 **(b)**

$B = \mu_0 \mu_r H \Rightarrow \mu_r \propto \frac{B}{H} =$ ¿ slope of $B.H$ curve

According to the given graph, slope of the graph is highest at point $Q$

413 **(a)**

On axial position

$B_a = \frac{\mu_0}{4\pi} \frac{2Mr}{(r^2 - l^2)^2}; if\, l <$ ¿ $r, then\, B_a = \frac{\mu_0}{4\pi} \frac{2M}{r^3}$

$B_a = \frac{10^{-7} \times 2 \times 10}{(0.1)^3} = 2 \times 10^{-3} T\, [\because z = r]$

415 **(c)**

As the magnet is long, we assume that the upper north pole produces no effect, $B$ due to south pole of the magnet is equal and opposite to horizontal component of earth's magnetic field $ie,$

$B = \left(\frac{\mu_0}{4\pi}\right) \frac{m}{r^2} = H$

In CGS system, $\frac{\mu_0}{4\pi} = 1$

$\therefore 1 \times \frac{m}{10^2} = 3.2 \times 10^{-5} \times 10^4$ (gauss)

$m = 32$ab-amp-cm.

416 **(a)**

When polarity is reversed, net magnetic moment $2M - M = M$, decreases. Therefore time period of oscillation increases $ie, T_2 > T_1 \vee T_1 < T_2$.

417 **(a)**

Molar susceptibility

¿ $\frac{Volume\, susceptibility}{Density\, of\, material} \times$ molarcular weight

¿ $\frac{I/H}{\rho} \times M = \frac{I/H}{M/V} \times M$

So it's unit is $m^3$

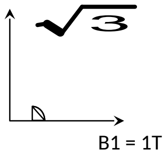
418 **(b)**

Because of large permeability of soft iron, magnetic lines of force prefer to pass through it. Concentration of lines in soft iron bar increases as shown in Fig. (b).

419 **(d)**

For dia-magnetic substances, the magnetic susceptibility is negative, and it is independent of temperature. Therefore, choice (d) is correct in figure.

420 **(d)**




In balance condition $B_2 = B_1 \tan\theta$

$\Rightarrow \tan\theta = \frac{\sqrt{3}}{1}$

$\Rightarrow \theta = 60°$

421 **(b)**

When a paramagnetic liquid is taken in U-tube and one arm is placed between the poles of strong magnet, the liquid is feebly attracted by the magnet. Therefore, the level of the solution in the arm rises.

423 **(a)**

$n = 25, r = 15\,cm = 15 \times 10^{-2} m,$

$H = 3 \times 10^{-5} T, i = ?\ \theta = 45°$

From $F = \frac{\mu_0 n_i}{2r} = H \tan\theta$

$i = \frac{2rH\,tan\theta}{\mu_0 n} = 2 \times \frac{15 \times 10^{-2} \times 3 \times 10^{-5} \tan 45°}{(4\pi \times 10^{-7}) \times 25}$

¿ 0.29 A