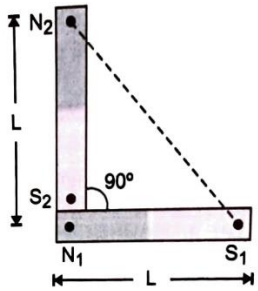
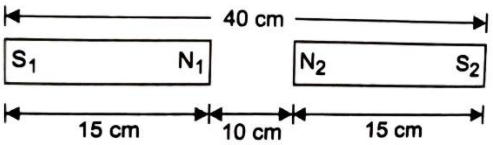
MAGNETIC MOMENT AND FORCE BETWEEN MAGNETIC POLES

1. Can ever there be a magnet (i) with no pole (ii) with two similar poles (iii) with three poles?
2. No two magnetic lines of force can intersect. Why?
3. How is the magnetic force between two poles affected when the strength of each pole is doubled and the distance between them is halved?
4. Define the unit pole from Coulomb's law of magnetism.
5. Does the length of an iron bar change when it is magnetized? *(Hint: Magnetostriction effect)*
6. What is meant by magnetic screening or shielding?
7. Distinguish between a magnetic and an electric dipole.
8. What are the S.I. units of pole strength and magnetic moment?
9. What is the strength of the earth's magnetic field at the surface of the earth?
10. Two similar magnetic poles, having pole strengths in the ratio 1: 2 are placed 1 m apart. Find the point where a unit pole experiences no net force due to the two poles. *(Ans: 0.414 m)*
11. Two identical thin bar magnets, each of length L and pole strength m are placed at the right angles to each other, with the N pole of one touching the S pole of the other. Find the magnetic moment of the system. *(Ans: √2mL)*

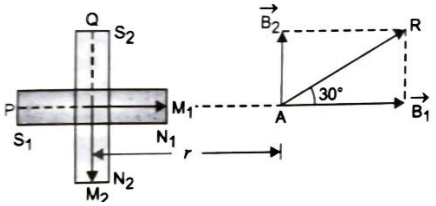


12. Calculate the force acting between two magnets of length 15 cm each and the pole strength 80 Am each when the separation between their north poles is 10 cm and that between south poles is 40 cm. *(Ans: -0.048 N)*



MAGNETIC FIELD STRENGTH DUE TO A BAR MAGNET

13. What is meant by magnetic field? How is it produced?
14. How does the compass needle behave at the neutral point?
15. Derive an expression for the magnetic field intensity at any point on the axial line of a bar magnet.
16. Derive an expression for the magnetic field intensity at any point on the equatorial line of a bar magnet.
17. The earth's magnetic field at the equator is approximately 0.4 G. Estimate the earth's dipole moment. *(Ans: 1.05 x 10^{23} Am^2)*
18. What is the magnitude of the equatorial and axial fields due to a bar magnet of length 5 cm at a distance of 50 cm from its midpoint? The magnetic moment of the bar magnet is 0.40 Am^2. *(Ans: 3.2 x 10^{-7}T, 6.4 x 10^{-7} T)*
19. Two short magnets P and Q are placed one over another with their magnetic axes mutually perpendicular to each other. It is found that the resultant magnetic field at a point on the prolongation of the magnetic axis of P is inclined at 30° with this axis. Compare the magnetic moments of the two magnets. *(Ans: √3/2)*



MAGNETIC FIELD STRENGTH DUE TO A CIRCULAR LOOP

20. Write the formula for the magnetic moment of a current loop.

21. Why is a current loop considered a magnetic dipole?

22. Write an expression for the magnetic moment when an electron revolves at a speed of v around the orbit of radius r in the hydrogen atom.

23. A magnetised steel wire 31.4cm long has a pole strength of 0.2 Am. It is bent in the form of a semicircle. Calculate its magnetic moment. *(Ans: 0.04 Am^2)*

24. An electron in an atom revolves around the nucleus in an orbit of radius 0.5 A^o. Calculate the equivalent magnetic moment if the frequency of revolution of the electron is 10^{10} MHz. *(Ans: 1.256 x 10^{-23} Am^2)*

25. A loop of wire having 50 turns carries a current of 10 A in an anticlockwise direction. If the diameter of the loop is 10 cm, what is the magnitude and direction of the magnetic moment of the current loop? *(Ans: 3.925 Am^2, perpendicular to the plane of the loop and away from the observer)*

TORQUE ON A MAGNET IN A MAGNETIC FIELD AND ITS POTENTIAL ENERGY

26. A bar magnet is placed in a uniform magnetic field with its magnetic moment making an angle θ with the field. Write an expression for the torque on the bar magnet and the potential energy of the bar magnet in this orientation. When is this energy minimum?

27. A bar magnet of magnetic moment M is aligned parallel to the direction of a uniform magnetic field B. Calculate the work done to align the magnetic moment (i) opposite to the field (ii) normal to the field direction. *(Ans: 2MB, MB)*

28. Under what situations will a magnet suspended in a uniform magnetic field be (i) in stable equilibrium and (ii) in unstable equilibrium?

29. A short bar magnet placed with its axis at 30° to a uniform magnetic field of 0.2 T experiences a torque of 0.06 N-m. Calculate the magnetic moment of the magnet. What orientation of the magnet corresponds to its stable equilibrium in the magnetic field? *(Ans: 0.6 Am^2, 0°)*

30. A short bar magnet of magnetic moment 0.9 JT^{-1} is placed with its axis at 30° to a uniform magnetic field. It experiences a torque of 0.063 Nm. Calculate the magnitude of the magnetic field. In which orientation will the bar magnet be in stable equilibrium in the magnetic field? *(Ans: 0.14 T, M must be parallel to B)*

31. A bar magnet of magnetic moment 6 J/T is aligned at 60° with a uniform external magnetic field of 0.44 T. Calculate

(i) the work done in turning the magnet to align its magnetic moment,
   (a) normal to the magnetic field,
   (b) opposite to the magnetic field.

(ii) The torque on the magnet in the final orientation in case (b) *(Ans: 1.32 J, 3.96 J, Zero)*

32. A circular coil of 100 turns and having an effective radius of 5 cm carries a current of 0.1 Ampere. How much work is required to turn it in an external magnetic field of 1.5 Wb/m^2 through 180° about an axis perpendicular to the magnetic field? The plane of the coil is initially perpendicular to the magnetic field. *(Ans: 0.24 J)*

MAGNETISM OF EARTH, MAGNETIC ELEMENTS, AND NEUTRAL POINTS

33. Name the elements or parameters of Earth's magnetic field.

34. Where is the vertical component of Earth's magnetic field zero?

35. What are isogonic, isoclinic, and isodynamic lines?
36. In the Northern Hemisphere, do magnetic lines of force due to the Earth's field point towards or away from the Earth?
37. What is the maximum value of the angle of dip? At what place does it occur? *(Ans: 90°)*
38. What is the angle of dip at a place where horizontal and vertical components of the earth's field are equal? *(Ans: 45°)*
39. The angle of dip at two places are respectively 0° and 90°. Where are these values on the earth? *(Ans: 0° and 90°)*

MAGNETIC PROPERTIES OF MATERIALS

40. What is the relative magnetic permeability of superconductors?
41. What is the magnetic susceptibility of superconductors?
42. What is the Meissner effect?
43. What are the units of magnetic permeability?
44. How does the magnetic susceptibility of a paramagnetic material change with temperature?
45. What are SI units of magnetic susceptibility?
46. A magnetizing field of 1600 Am^{-1} produces a magnetic flux of 2.4×10^{-5} Weber in a bar of iron of cross-section 0.2 cm^2. calculate the permeability and susceptibility of the bar. (Ans: $7.5 \times 10^{-4} TA^{-1}m$, 596.1)
47. A solenoid of 500 turns per metre carries a current of 3A. Its core is made of iron which has a relative permeability of 5000. Determine the magnitudes of magnetic intensity, intensity of magnetization, and magnetic field inside the core. *(Ans: 1500 Am^{-1}, 7.5×10^6 Am^{-1}, 9.4T)*
48. A solenoid has a core of a material with a relative permeability of 400. The windings of the solenoid are insulated from the core and carry a current of 2A. If the number of turns is 1000 per metre calculate (i) H, (ii) B, (iii) Intensity of magnetization I, and (iv) the magnetizing current.
49. An ideal solenoid having 2000 turns per metre has an iron core of permeability 500 and carries a current of 1A. Calculate (i) magnetizing intensity, H at the centre of the solenoid, (ii) magnetic permeability of iron (iii) magnetic susceptibility of Iron, (iv) intensity of magnetization. *(Ans: 2000 A/m, 6.28×10^{-4} Tm/A, 499, 9.98×10^5 A/m)*
50. A bar of 5×10^{-3} m^2 area is subjected to a field of 600 Am. If the susceptibility of the material is 499. Calculate (i) permeability (ii) flux density and (iii) magnetic flux. *(Ans: 6.28×10^{-4} $TA^{-1}m$, 0.377 T, 1.885×10^{-3} Wb)*

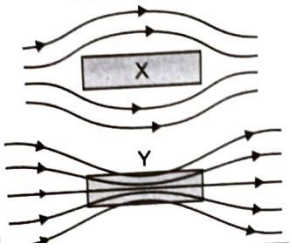
CLASSIFICATION OF MAGNETIC MATERIALS

51. Which of the following substances are diamagnetic? Copper, Aluminium, Sodium, Bismuth.
52. Which of the following substances are paramagnetic? Al, Bi, Cu, Ca, Pb, Ni
53. Classify the following into diamagnetic and para-magnetic substances: water, mercury, oxygen, and hydrogen.
54. Write the names of three ferromagnetic substances.
55. The magnetic moment of atoms of certain materials is zero. Name such materials.
56. Which materials have relative magnetic permeability > 1?
57. Can there be a non-magnetic material?
58. The permeability of Bismuth is 0.9983. To which class of magnetic material Bi belongs?
59. The susceptibility of a magnetic material is 1.9×10^{-5}. What type of material does it represent?
60. The susceptibility of a magnetic material is -4.2×10^{-6}. What type of material does it represent?
61. How does the intensity of magnetization of a paramagnetic material vary with increasing applied magnetic field?
62. Why do magnetic lines of force prefer to pass through ferromagnetic materials?
63. The susceptibility of a magnetic material is 0.9853. Identify the type of magnetic material. Draw the modification of the field pattern by keeping a piece of this material in a uniform magnetic field.

Contact: Vinita Chawla, 91-8168258349, www.physicsinduction.com

64. How are wristwatches protected from powerful magnets?

65. A uniform magnetic field gets modified as shown in the figure. When two specimens X and Y are placed in it. Identify the specimens X and Y.



66. Three identical specimens of magnetic materials nickel, antimony, and aluminium are kept in a non-uniform magnetic field. Draw the modifications in the field lines in each case. Justify your answer.

67. What is the susceptibility and permeability of a perfectly diamagnetic substance?

68. Two substances A and B have relative permeabilities slightly greater or less than unity respectively. What is their magnetic nature?

69. Out of the two magnetic materials 'A' has a relative permeability slightly greater than the unity while 'B' has less than the unity. Identify the nature of the materials A and B. Will their susceptibilities be positive or negative?

70. Two magnetic materials A and B have relative permeabilities of 0.96 and 500. Identify the magnetic materials A and B.