PHYSICS

BOOKS - VIKRAM PUBLICATION (ANDHRA PUBLICATION)

MAGNETISM AND MATTER

Problems

1. What is torque acting on a plane coil of "n" turns carrying a current "i" and having an area

A, when placed in a constant magnetic field B ?

Watch Video Solution

2. A coil of 20 turns has an area of $800mm^2$ and carries a current of 0.5 A. If it is placed in a magnetic field of intensity 0.3T with its plane parallel to the field, what is the torque that it experiences ?

Watch Video Solution

3. In the Bohr atom model the electrons move around the nucleus in circular orbits. Obtain an expression the magnetic moment (μ) of the electron in a Hydrogen atom in terms of its angular momentum L.

Watch Video Solution

4. A solenoid of length 22.5 cm has a total of 900 turns and carries a current of 0.8 A. What

is the magnetising field H near the centre and far away from the ends of the solenoid ?

Watch Video Solution

5. A bar magnet of length 0.1 m and with a magnetic moment of $5Am^2$ is placed in a uniform a magnetic field of intensity 0.4T, with its axis making an angle of 60° with the field. What is the torque on the magnet ?

Watch Video Solution

6. If the Earth's magnetic field at the equator is about $4 \times 10^{-5} T$, What is its approximate magnetic dipole moment ?

Watch Video Solution

7. The horizontal component of the earth's magnetic field at a certain place is $2.6 \times 10^{-5} T$ and the angle of dip is 60°. What is the magnetic field of the earth at this location ?

Watch Video Solution

8. A solenoid , of insulated wire, is wound on a core with relative permeability 400. If the number of turns per metre is 1000 and the solenoid carries a current of 2A, calculate H, B and the magnetisation M.

Watch Video Solution

9. In the magnetic meridian of a certain place, the horizontal component of the earth's

magnetic field is 0.26 G and the dip angle is 60°. What is the magnetic field of the earth at this location ?

Watch Video Solution

10. What is the magnitude of the equational and axial fields due to a bar magnet of length 8.0 cm at a distance of 50 cm from its mid-point ? The magnetic moment of the bar magnet is $0.40 Am^2$,

Watch Video Solution

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

Watch Video Solution

Textual Examples

1. In Fig, the magnetic needle has magnetic moment $6.7 \times 10^{-2} Am^2$ and moment of intertia $I = 7.5 \times 10^{-6} kgm^2$. It performs 10

complete oscillations is 6.70s. What is the magnitude of the magnetic field ?

Watch Video Solution

2. A short bar magnet placed with its axis at 30° with an external field of 800 G experiences a torque of 0.016 Nm.

What is the magnetic moment of the magnet ?

Watch Video Solution

3. A short bar magnet placed with its axis at 30° with an external field of 800 G experiences a torque of 0.016 Nm.

What is the work done in moving it from its most stable to most unstable position ?

Watch Video Solution

4. A short bar magnet placed with its axis at 30° with an external field of 800 G experiences a torque of 0.016 Nm.

The bar magnet is replaced by a solenoid of cross-sectional area $2 \times 10^{-4} m^2$ and 1000 turns, but of the same magnetic moment. Determine the current flowing through the solenoid.

Watch Video Solution

5. What happens if a bar magnet is cut into two pieces : (i) transverse to its lengths, (ii) along its length ?

Watch Video Solution

6. A magnetised needle in a uniform magnetic field experiences a torque but no net force. An iron nail near a bar magnet, however, experiences a force of attraction in addition to a torque. Why ?

Watch Video Solution

7. Must every magnetic configuration have a north pole and a south pole ? What about the field due to a toroid ?

View Text Solution

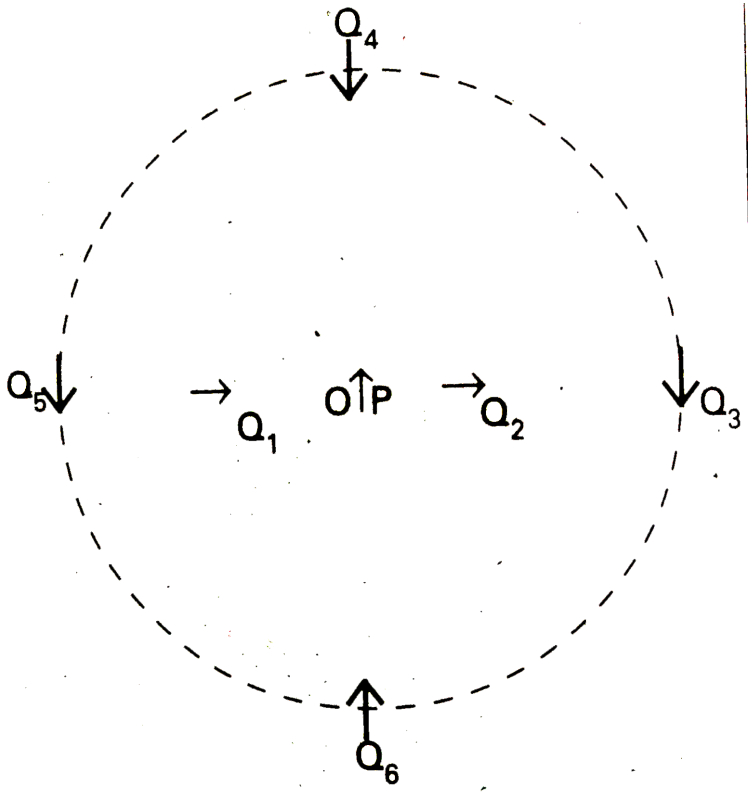
8. Two identical looking iron bars A and B are given, one of which is definitely known to be magnetised. (We do not know which one). How would one ascertain whether or noth both are magnetised ? If only one is magnetised how does one ascertain which one ? (Use nothing else but the bars A and B).

Watch Video Solution

9. Figure shows a small magnetised needle P placed at a point O. The arrow shows the direction of its magnetic moment. Te other arrows show different positions (and orientations of the magnetic moment) of another identical magnetised needle Q.

In which configuration the system is not in

equilibrium ?

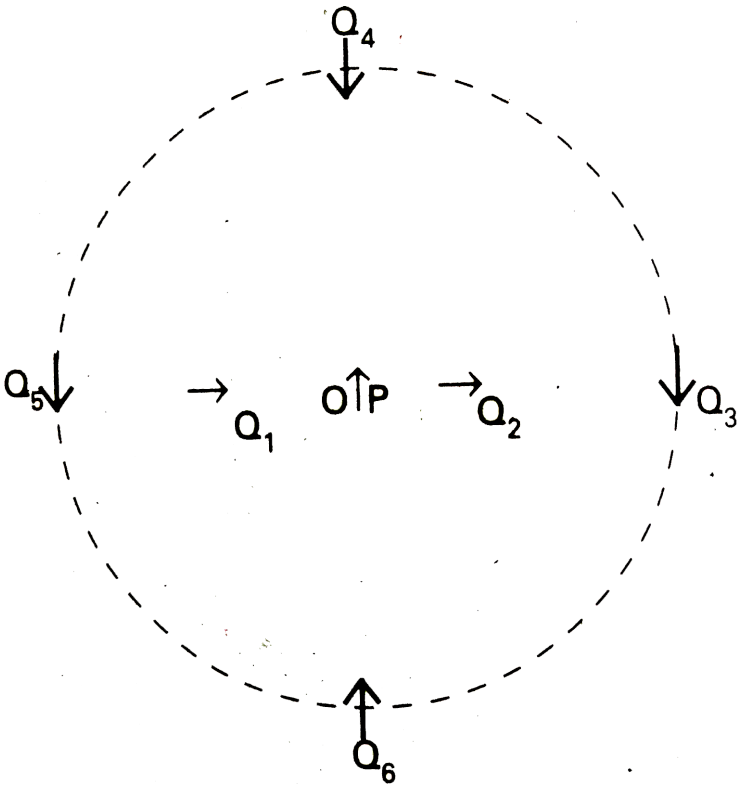


View Text Solution

10. Figure shows a small magnetised needle P placed at a point O. The arrow shows the direction of its magnetic moment. Te other arrows show different positions (and orientations of the magnetic moment) of another identical magnetised needle Q.

In which configuration is the system in (i)

stable, and (ii) unstable equilibrium ?

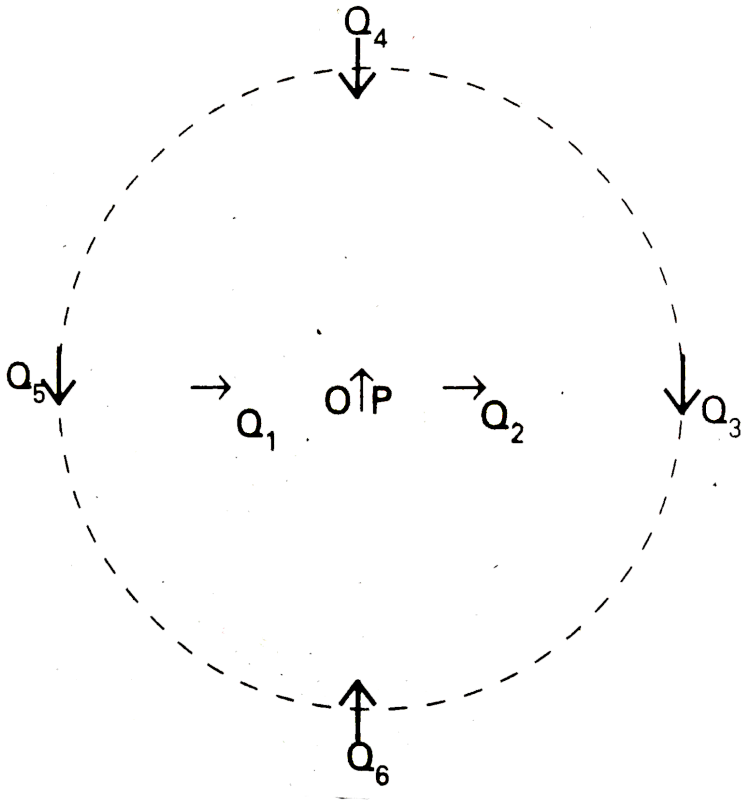


View Text Solution

11. Figure shows a small magnetised needle P placed at a point O. The arrow shows the direction of its magnetic moment. Te other arrows show different positions (and orientations of the magnetic moment) of another identical magnetised needle Q.

Which configuration corresponds to the lowest potential energy among all the

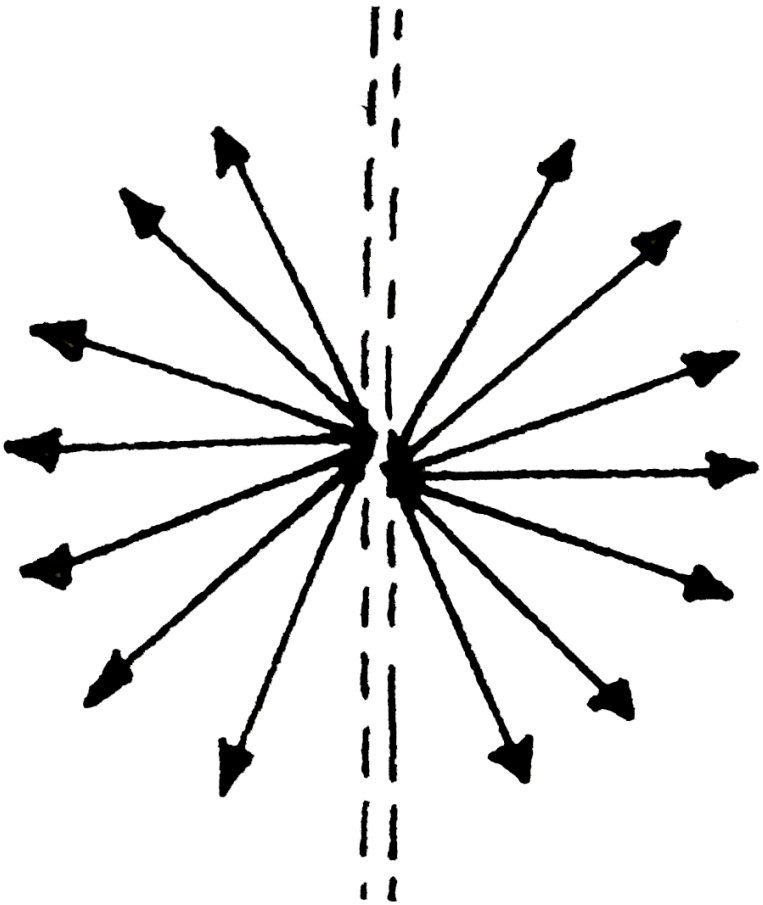
configurations shown ?



View Text Solution

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

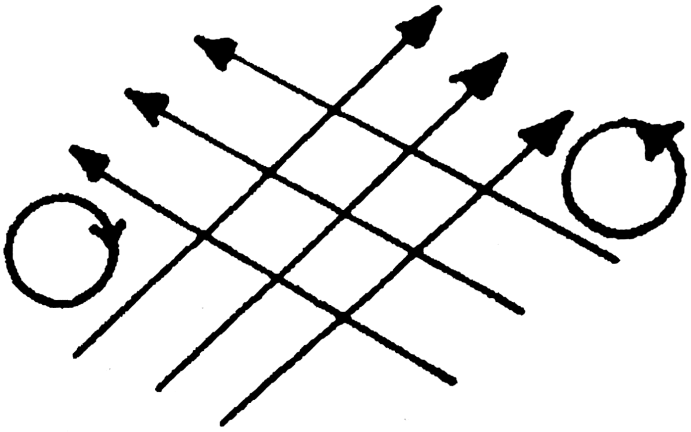
lines correctly. Point out which ones.



(a)

Watch Video Solution

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

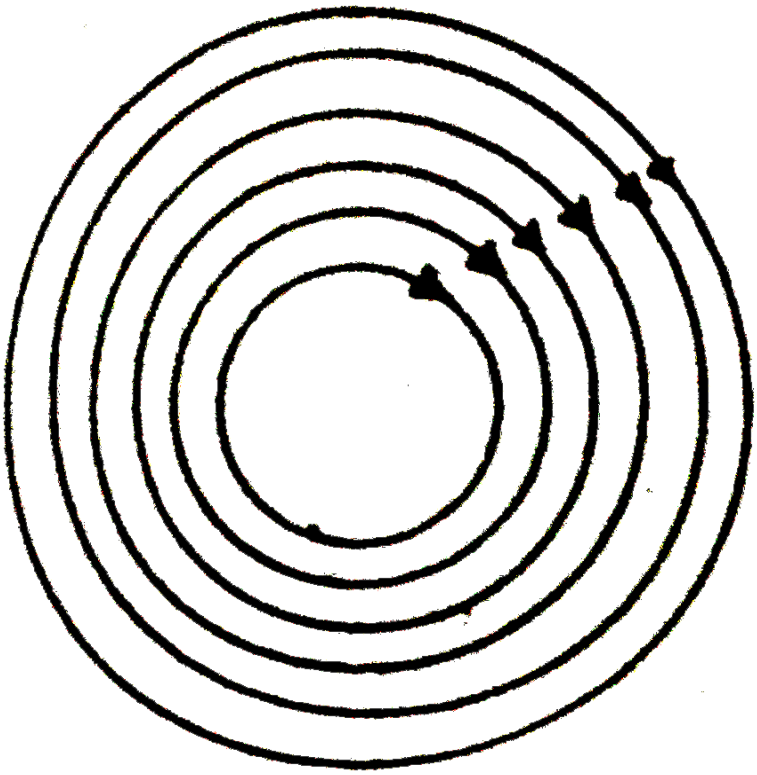


(b)

Watch Video Solution

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

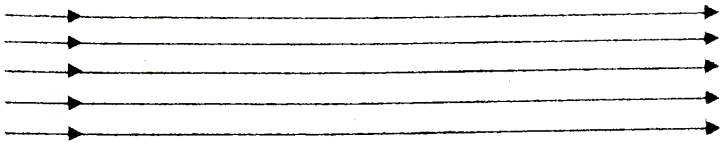
lines correctly. Point out which ones.



(c)

Watch Video Solution

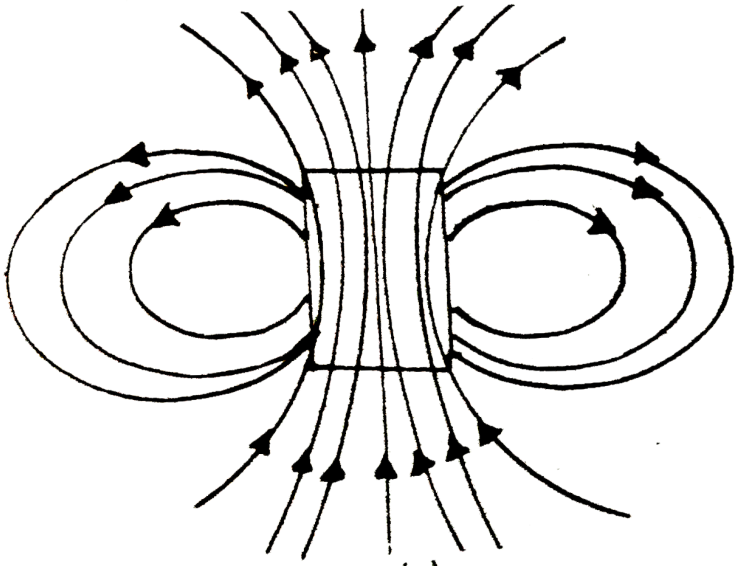
15. Many of the diagrams given in Fig. show magnetic field lines (thick lines in the figure) wrongly. Point out what is wrong with them. Some of them may describe electrostatic field lines correctly. Point out which ones.



(d)

Watch Video Solution

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

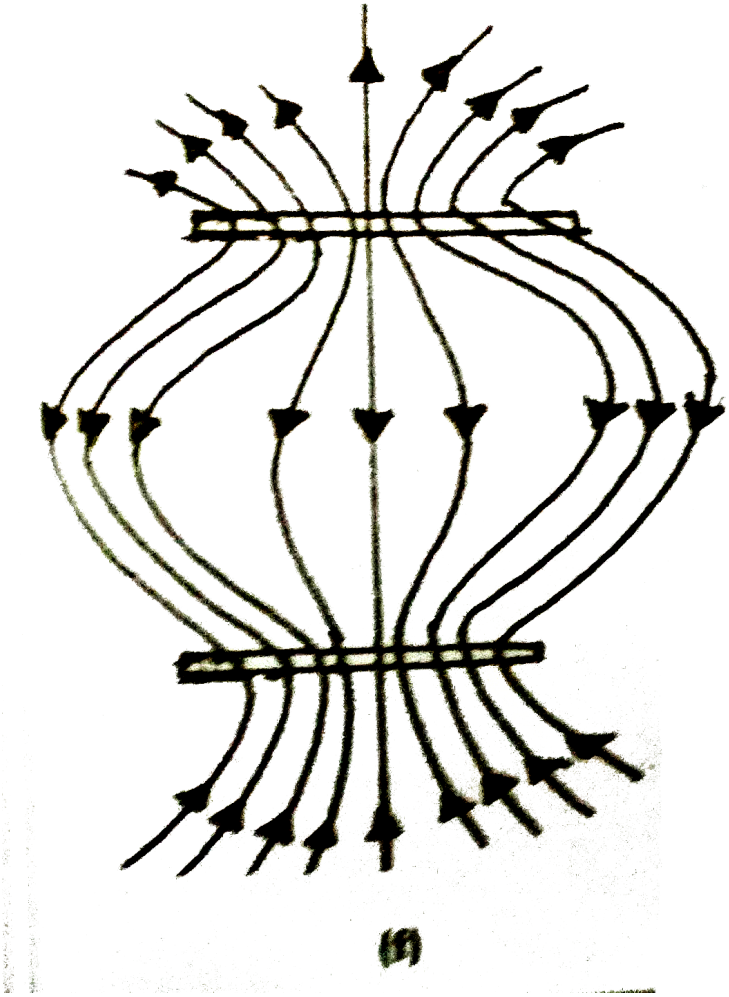


(e)

Watch Video Solution

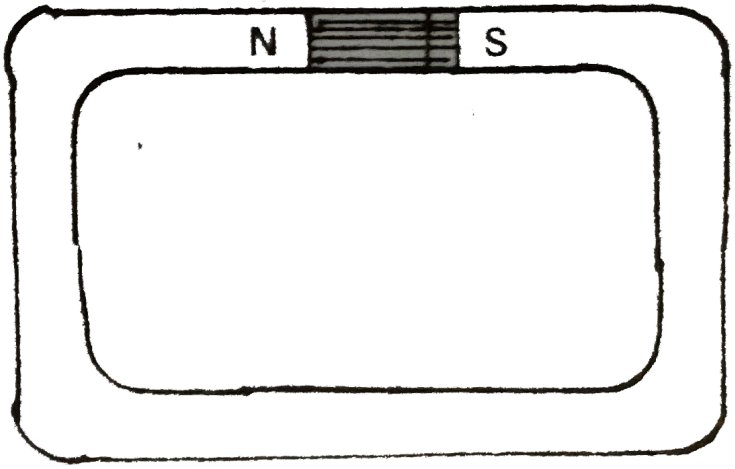
17. Many of the diagrams given in Fig. show magnetic field lines (thick lines in the figure) wrongly. Point out what is wrong with them. Some of them may describe electrostatic field

lines correctly. Point out which ones.



Watch Video Solution

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



Watch Video Solution

19. Magnetic field lines show the direction (at every point) along which a small magnetised needle aligns (at the point). Do the magnetic field lines also represent the lines of force on a moving charged particle at every point ?

Watch Video Solution

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

Watch Video Solution

21. If magnetic monopoles existed, how would tha Gauss's law of magnetism be modified ?

Watch Video Solution

22. Does a bar magnet exert a torque on itself due to its own field ? Does one element of a curren-carrying wire exert a force on another element of the same wire ?

Watch Video Solution

23. Magnetic field arises due to charges in motion. Can a system have magnetic moments even though its net charge is zero ?

Watch Video Solution

24. A solenoid has a core of a material with relative permeability 400. The windings of the solenoid are insulated from the core and carry

of 2A. If the number of turns is 1000 per metre, calculate H.

Watch Video Solution

25. A solenoid has a core of a material with relative permeability 400. The windings of the solenoid are insulated from the core and carry of 2A. If the number of turns is 1000 per metre, calculate M.

Watch Video Solution

26. A solenoid has a core of a material with relative permeability 400. The windings of the solenoid are insulated from the core and carry of 2A. If the number of turns is 1000 per metre, calculate B.

 Watch Video Solution

27. A solenoid has a core of a material with relative permeability 400. The windings of the solenoid are insulated from the core and carry

of 2A. If the number of turns is 1000 per metre, calculate the magnetising current I_m.

Watch Video Solution

28. A domain in ferromagnetic iron is in the form of a cube of side length $1\mu m$. Estimate the number of iron atoms in the domain and the maximum possible dipole moment and magnetisation of the domain. The molecular mass of iron 55g/mole and is density is

$7.9g/cm^3$. Assume that each iron atom has a dipole moment of $9.27 \times 10^{-24} Am^2$.

Watch Video Solution

Very Short Answer Questions

1. A magnetic dipole placed in a magnetic field experiences a net force. What can you say about the nature of the magnetic field ?

Watch Video Solution

2. What happens to compass needles at the Earth's poles ?

Watch Video Solution

3. What do you understand by the 'magnetization' of a sample ?

Watch Video Solution

4. What is the magnetic moment associated with a solenoid ?

Watch Video Solution

5. What are the units of magnetic moment, magnetic induction and magnetic field ?

Watch Video Solution

6. Magnetic lines form continuous closed loop.

Why ?

Watch Video Solution

7. Define magnetic declination.

Watch Video Solution

8. Define magnetic inclination or angle of dip.

Watch Video Solution

9. Classify the following materials with regard to magnetism : Maganese, Cobalt, Nickel, Bismuth, Oxygen, Copper.

Watch Video Solution

10. A magnetic dipole placed in a magnetic field experiences a net force. What can you say about the nature of the magnetic field ?

Watch Video Solution

11. Do you find two magnetic field lines intersecting ? Why ?

Watch Video Solution

12. What happens to compass needles at the Earth's poles ?

Watch Video Solution

13. What do you understand by the 'magnetization' of a sample ?

Watch Video Solution

14. What is the magnetic moment associated with a solenoid ?

Watch Video Solution

15. What are the units of magnetic moment, magnetic induction and magnetic field ?

Watch Video Solution

16. Magnetic lines form continuous closed loop. Why ?

Watch Video Solution

17. Define magnetic declination.

Watch Video Solution

18. Define magnetic inclination or angle of dip.

Watch Video Solution

19. Classify the following materials with regard to magnetism : Maganese, Cobalt, Nickel, Bismuth, Oxygen, Copper.

Watch Video Solution

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

Watch Video Solution

Short Answer Questions

1. Derive an expression for the axial field of a solenoid of radius "a", containing "n" turns per

unit length and carrying current "I".

View Text Solution

2. The force between two magnet poles separated by a distance 'd' in air is 'F'. At what distance between them does the force become doubled ?

Watch Video Solution

3. Compare the properties of para, dia and ferromagnetic substances.

Watch Video Solution

4. Explain the elements of the Earth's magnetic field and draw a sketch showing the relationship between the vertical component, horizontal component and angle of dip.

Watch Video Solution

5. Define retentivity and coercivity. Draw the hysteresis curve for soft iron and steel. What do you infer from these curves ?

Watch Video Solution

6. If B is the magnetic field produced at the centre of a circular coil of one turn of length L carrying current I the what is the magnetic field at the centre of the same coil which is made into 10 turns ?

Watch Video Solution

7. If the number of turns of a solenoid is doubled, keeping the other factors constant, how does the magnetic field at the axis of the solenoid change?

Watch Video Solution

8. Derive an expression for magnetic field induction on the equatorial line of a barmagnet.

Watch Video Solution

9. Prove that a bar magnet and a solenoid produce similar fields.

View Text Solution

10. What are ferromagnetic materials ? Give examples. What happens to a ferromagnetic material at curie temperature ?

Watch Video Solution

Long Answer Questions

1. Derive an expression for the magnetic field at a point on the axis of a current carrying circulat loop.

View Text Solution

2. A small magnetic needle is set into oscillations in a magnetic field B obtain an expression for the time period of oscillation.

Watch Video Solution

3. 4 bar magnet, held horizontally, is set into angular oscillations in the Earth's magnetic field. It has time periods T_1 and T_2 at two places, where the angles of dip are θ_1 and θ_2 respectively. Deduce an expression for the ratio of the resultant magnetic fields at the two places.

Watch Video Solution

4. Define magnetic susceptibility of a material. Name two elements one having positive susceptibility and other having negative susceptibility.

Watch Video Solution

5. Obtain Gauss'Law for magnetism and explain it.

View Text Solution

6. What do you understand by "hysterisis"? How does this property infulence the choice of materials used in different appliances where electromagnets are used ?

View Text Solution

Textual Exercises

1. A vector needs three quantities for its specification. Name the three independent

quantities conventionally used to specify the earth's magnetic field.

Watch Video Solution

2. The angle of dip at a location in southern India is about 18°. Would you expect a greater or smaller dip angle in Britain ?

Watch Video Solution

3. If you made a map of magnetic field lines at Melbourne in Australia, would the lines seem to go into the ground or come out of the ground ?

Watch Video Solution

4. In which direction would a compass free to move in the vertical plane point to, if located right on the geomagnetic north or south pole ?

View Text Solution

5. The earth's field, it is claimed, roughly approximates the field due to a dipole to magnetic moment $8 \times 10^{22} JT^{-1}$ located at its centre. Check the order of magnitude of this number in some way.

Watch Video Solution

6. Geologists claim that besides the main magnetic N-S poles, there are several local

poles on the earth's surface oriented in different directions. How is such a thing possible at all ?

Watch Video Solution

7. The earth's magnetic field varies from point to point in space. Does it also change with time ? If so, on what time scale does it change appreciably ?

View Text Solution

8. The earth's core is known to contain iron. Yet geologists do not regard this as a source of the earth's magnetism. Why ?

Watch Video Solution

9. The charged currents in the outer conducting regions of the earth's core are thought to be responsible for earth's magnetism. What might be the 'battery' (i.e., the source of energy) to sustain these currents ?

Watch Video Solution

10. The earth may have been reversed the direction of its field several times during its history of 4 to 5 billion years. How can geologists know about the earth's field in such distant past ?

Watch Video Solution

11. The earth's field departs fromits dipole shape substantially at large distances (greater than about 30,000 km). What agencies may be responsible for this distortion ?

View Text Solution

12. Interestellar space has an extremely weak magnetic field of the order of $10^{-12}T$. Can such a weak field be of any significant consequence ? Explain.

View Text Solution

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

Watch Video Solution

14. A short bar magnet of magnetic moment $m = 0.32 JT^{-1}$ is placed in a unifrom

magnetic field of 0.15T. If the bar is free to rotate in the plane of the field, which orientation would corresponds to its (a) stable, and (b) unstable equilibrium ? What is the potential energy of the magnet in each case ?

Watch Video Solution

15. A closely wound solenoid of 800 turns and area of cross section $2.5 \times 10^{-4} m^2$ carries a current of 3.0 A. Explain of the sense in which

the solenoid acts like a bar magnet. What is its associated magnetic moment ?

Watch Video Solution

16. If the solenoid is free to turn about the vertical direction and a uniform horizontal magnetic field of 0.25 T is applied, what is the magnitude of torque on the solenoid when its axis makes an angle of 30° with the direction of applied field ? Here $M = 0.6JT^{-1}$

Watch Video Solution

17. A bar magnet of magnetic moment $1.5JT^{-1}$ lies aligned with the direction of a uniform magnetic field of 0.22 T.

(a) What is the amount of worl required by an external torque to turn the magnet so as to align its magnetic moment : (i) normal to the field direction, (ii) opposite to the field direction ?

Watch Video Solution

18. A bar magnet of magnetic moment $1.5JT^{-1}$ lies aligned with the direction of a uniform magnetic field of 0.22 T.

magnetic moment : (i) normal to the field direction, (ii) opposite to the field direction ? What is the torque on the magnet in cases (i) and (ii) ?

Watch Video Solution

19. A closely wound solenoid of 2000 turns and area of cross-section $1.6 \times 10^{-4} m^2$, carrying a current of 4.0 A, is suspended through its centre allowing it to turn in a horizontal plane. What is the magnetic moment associated with the solenoid ?

Watch Video Solution

20. A closely wound solenoid of 2000 turns and area of cross-section $1.6 \times 10^{-4} m^2$,

carrying a current of 4.0 A, is suspended through its centre allowing it to turn in a horizontal plane.

What is the force and torque on the solenoid if a uniform horizontal magnetic field of $7.5 \times 10^{-2} T$ is set up at an angle of 30° with the axis of the solenoid ?

Watch Video Solution

21. A circular coil of 16 turns and radius 10 cm carrying a current of 0.75 A rests with its plane

normal to an external field of magnitude $8.0 \times 10^{-2} T$. The coil is free to turn about an axis in its plane perpendicular to the field direction. When the coil is turned slightly and released, it oscillates about its stable equilibrium with a frequency of $2.0 s^{-1}$. What is the moment of intertia of the coil about its axis of rotation.

Watch Video Solution

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

Watch Video Solution

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

Watch Video Solution

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

Watch Video Solution

25. A short bar magnet placed in a horizontal plane has its axis aligned along the magnetic

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

26. A short bar magnet placed in a horizontal plane has its axis aligned along the magnetic north-south direction. Null points are found on the axis of the magnet at 14 cm from the centre of the magnet. The earth's magnetic field at the place is 0.36 G and the angle of dip is zero.If the bar magnet is turned around by 180°, where will the new null points be located ?

Watch Video Solution

27. A short bar magnet of magnetic moment $5.25 \times 10^{-2} JT^{-1}$ is placed with its axis perpendicular to the earth's field direction. At what distance from the centre of the magnet, the resultant field is inclined at 45° with earth's field on (a) Its normal bisector and (b) its axis. Magnitude of the earth's field at the place is given to be 0.42 G. Ignore the length of the magnet in comparison to the distances involved.

Watch Video Solution

Additional Exercises

1. Why does a paramagnetic sample display greater magnetisation (for the same magnetising field) when cooled?

Watch Video Solution

2. Why is diamagnetism, in contrast, almost independent of temperature?

Watch Video Solution

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

Watch Video Solution

4. Is the permeability of a ferromagnetic material independent of the magnetic field ? If not, is it more for lower or higher fields ?

Watch Video Solution

5. Magnetic field mass lines are always nearly normal to the surface of a ferromagnetic at every point. (This fact is analogous to the static electric field lines being normal to the surface of a conductor at every point.) Why ?

View Text Solution

6. Would the maximum possible magnetisation of a paramagnetic sample be of the same order of magnitude as the magnetisation of a ferromagnet ?

Watch Video Solution

7. Explain qualitatively on the basis of domain picture the irreversibility in the magnetisation curve of a ferromagnet.

Watch Video Solution

8. The hysteresis loop of a soft iron piece has a much smaller area than that of a carbon steel piece. If the material is to go through

repeated cycles of magnetisation, which piece will dissipate greater heat energy.

Watch Video Solution

9. A system displaying a hysterisis loop such as a ferromagnet, is a device for storing memory?' Explain the meaning of this statement.

Watch Video Solution

10. What king of ferromagnetic material is used for coating magnetic tapes in a cassette player, or for building 'memory stores' in a modern computer ?

Watch Video Solution

11. A certain region of space is to be shielded from magnetic fields. Suggest a method.

Watch Video Solution

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

Watch Video Solution

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

Watch Video Solution

14. A compass needle free to turn in a horizontal plane is placed at the centre of circular coil of 30 turns and radius 12 cm. The coil is in a vertical plane making an angle of 45° with the magnetic meridian. When the current in the coil is 0.35 A, the needle points west to east.

(a) Determine the horizontal component of the earth's magnetic field at the location.

(b) The current in the coil is reversed, and the coil is rotated 90° about its vertical axis by an

the needle. Take the magnetic declination at the places to be zero.

Watch Video Solution

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

Watch Video Solution

16. A monoenergetic (18 keV) electron beam initially in the horizontal direction is subjected to a horizontal magnetic field of 0.04G normal to the initial direction. Estimate the up or down deflection of the beam over a distance of 30 cm $\left(m_e = 9.11 \times 10^{-31} kg\right)$. [Note : Data in this exercies are so chosen that the answer will give you an idea of the effect of earth's magnetic field onthe motion of the

electron beam from electron gun to the screen in a TV set].

View Text Solution

17. A sample of paramagnetic salt contains 2.0×10^{24} atomic dipoles each of dipoles moment $1.5 \times 10^{-23} JT^{-1}$. The sample is placed under a homogeneous magnetic field of 0.64 T, and cooled to a temperature of 4.2K. The degree of magnetic saturation achieved is equal to 15%. What is the total dipole moment

of the sample for a magnetic field of 0.98 T and a temperature of 2.8 K? (Assume Curie's law)

Watch Video Solution

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

Watch Video Solution

19. The magnetic moment vectors $\vec{\mu}_s$ and $\vec{\mu}_l$ associated with the intrinsic spin angular momentum $\vec{S}$ and orbital angular momentum $\vec{l}$ respectively, of an electron are predicted by quantum theory (and verified experimentally to a high accuracy to be given by $\vec{\mu}_s = -\left(\frac{e}{m}\right)\vec{S}$ and $\vec{\mu}_l = -\left(\frac{e}{2m}\right)\vec{l}$ Which of these relations is in accordance with the result expected classically? Outline the derivation of the classical result.

Watch Video Solution