PHYSICS

BOOKS - CHHAYA PHYSICS (BENGALI ENGLISH)

Magnetic Properties of Materials

Numerical Examples

1. A torque of 8 units is applied on a magnet when it is kept at 30° with the direction of a uniform magnetic field of intensity 0.32 units . Determine the magnetic moment of the magnet .

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2. If the distance between two north poles of equal strength be 2 cm , the mutual force of repulsion between them becomes 2.5 dyn . What should be the distance of separation between them for which the repulsive becomes 3.6 dyn ?

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3. The length of a bar magnet is 20 cm and its magnetic moment is 0.6 A m^2 . Determine the magnetic field at a point on the axis of the magnet and 30 cm away from the north pole .

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4. The length of a bar magnet is 20 cm and its magnetic moment is 0.6 A m^2 . Determine the magnetic field at a point on the axis of the magnet and 30 cm away from the north pole .

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5. The radius of a circular conducting coil of 100 turns is 10 cm . If 2 A current passes through the coil , what will be the magnetic moment generated ?

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6. If the magnetic moment of a straight magnetised wire is p_m , what will be its magnetic moment when the wire is bent in the form of a semicircle ?

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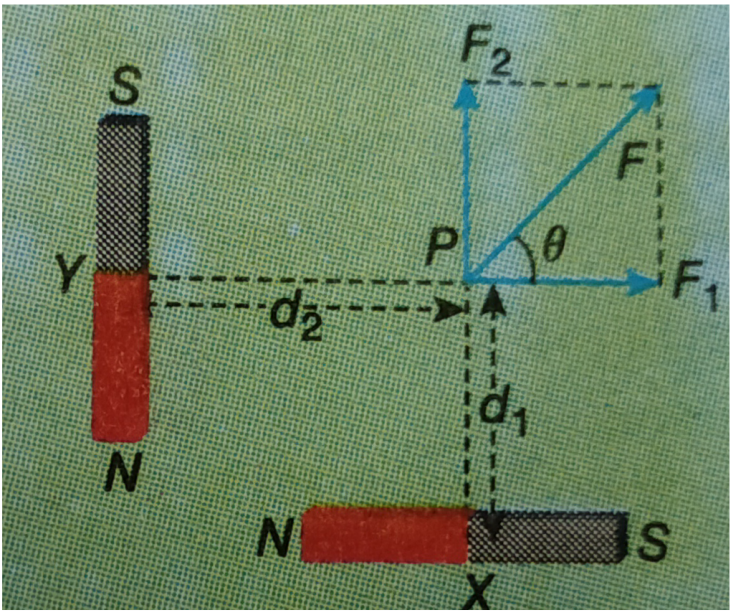
7. Magnetic moments' of two small magnets are p_m and p'_m , then are kept on a table as shown in the Fig . What will be the magnitude and direction of the magnetic fields produced by the magnets at the point ?

$[p_m = 2.7A.\,m^2, p'_m = 3.2A.\,m^2, d_1 = 30cm, d_2 = 40cm]$



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8. Two bar magnets A and B , each having a magnetic length of 4 cm are placed along a straight line with their north poles 8 cm apart and facing each other . The neutral point lies on the axis , 2 cm from the north pole

of the magnet A . Calculate the ratio of the magnetic moments of A and B . [Ignore the effect of earth ' s magnetic field] .

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9. The number of turns of a solenoid of length 10 cm is 1000 . If the air inside it is replaced by a magnetic material and 1 A current is passed through the coil , the magnitude 20 T . . Determine the magnetic intensity at that point and relative magnetic permeability of the magnetic permeability of the material .

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10. Relative magnetic permeability of a magnetic medium is 1000 .If magnetic field at any point in the medium be 0.1 Wb . m^{-2}what will be the values of magnetic intensity of magnetisation at that point .

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11. An iron cored toroid has ring radius 7 cm number of turns 500 . If 2 A current is passed through the wire , what will be the value of magnetic permeability of iron = 1500 .

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12. The angle of dip at a place is 30° and the horizontal component of earth ' s magnetic field at that place is 0.39 CGS units . Determine the vertical component of earth's magnetic field at that place .

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13. At tow places , the angels oa dip are $30^\circ N \text{ and } 30^\circ$ S and the earth 's magnetic filed is 0.42 Oe . Determine the horizontal and the vertical components of earth's magnetic field at these two places and also indicate their directions with the help of a diagram .

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14. At a place , the horizontal and vertical components of earth's magnetic field are 0.3 Oe and 0.2 Oe , respectively . Determine the resultant intensity and angle of dip there .

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15. The angle pf dip and the horizontal component of earth's magnetic field at a place are $30^\circ S$ and 0.36 Oe . Determine the magnitude and direction of the vertical component of earth 's magnetic field at thet place .

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16. At a place , the angle of declination is $30^\circ E$ and the angle of dip is $45^\circ N$. Determine the horizontal and vertical components of the geomagnetic intensity in geographical meridian at that place. Given , the horizontal component of earth's magnetic field at that place = 0.3 Oe .

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17. The mass of a magnetic needle is 7.5 g and its magnetic moment is 98 units . To keep the magnetic needle horizontal in the northern hemisphere , what should be the position of its fulcrum with respect to its

Centre of gravity ? Vertical component of earth's magnetic field = 0.25 Oe .

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18. The magnetic moment of a magnetic needle of mass 3.2 g is 980 CGS units . From which point should the needle be hung so that it will remain horizontal in the magnetic meridian ? Horizontal component of the earth's magnetic field at that place is 0.32 Oe and angle of dip $= 45^{\circ} N.$ [g = $980 \mathrm{cm}. s^{-2}$]

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19. Angle of dip at a place = θ, if the angle of dip in a vertical plane making angle δ with the magnetic meridian be θ' , show that ,

$\tan\theta' : \tan\theta = \sec\delta : 1$

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20. At a place , the apparent geomagnetic dip in a vertical place is 40° and in another plane perpendicular to it is 30° .what is the real dip at the place ?

similar problem : If θ_1 is the angle of dip of the magnetic axis of a magnetic needle with horizontal at any vertical plane and θ_2 is that in another vertical plane at right

former prove that real angle of dip , θ is given by $\cot^2\theta = \cot^2\theta_1 + \cot^2\theta_2$.

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21. A bar magnet of length 6 cm is kept vertically with its north pole on the ground . If the distance of neutral point on the ground is 8 cm from the north pole , what will be the magnetic moment of that magnet ? [H=0.36 CGS units]

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22. A bar magnet of length 8 cm is placed on a horizontal plane in the magnetic with its north pole pointing north . If the magnetic moment moment of the the magnet be 90 CGB units and the horizontal component of earth's magnetic field be 0.35 Oe , determine the positions of the neutral points .

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23. At a place ,the vertical component of earth's magnetic field is $\sqrt{3}$ times its horizontal component . What will be the angle of dip at that place ?

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Section Ralated Questions

1. Define magnetic moment of a bar magnet .

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2. A charge q is revolving along a circular path of radius r with velocity v . Determine its magnetic moment .

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3. Determine the relation between magnetic permeability and magnetic susceptibility.

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4. How would you convert a ferromagnetic material to a paramagnetic material ?

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5. what is curie point ?

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6. How is the horizontal component of earth's magnetic field related with the total intensity of earth's magnetic field and the angle of dip ?

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7. What do you mean by neutral point for a bar magnet placed in the geomagnetic field ? What will be the positions of neutral points for the bar magnet with its (i) north pole pointing north , (ii) north pole pointing south ? Show them with the help of suitable diagrams .

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Higher Order Thinking Skill Hots Questions

1. Indicate the magnetic axis and magnetic length for a permanent horse - shoe (U - shaped) magnet .

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2. A magnetised steel wire is bent in the form of L . One arm of L is of length 4 cm and the other arm is of length 3cm . If the magnetic moment before bending is p_m , what will be the new magnetic moment ?

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3. Two identical bar magnets having magnetic moments $2p_m$ and $3p_m$ are kept one over the other in such a manner that their

like poles are in contact

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4. Two identical bar magnets having magnetic moments $2p_m$ and $3p_m$ are kept one over the other in such a manner that their

opposite poles are in contact . Determine the resultant magnetic moments in each case .

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5. If a permanent bar magnet is cut along its breadth into two equal parts , what will be the pole - strength and magnetic moment of each part ?

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6. If a permanent bar magnet is cut along its breadth its two equal parts , what will be the pole - strength and magnetic moment of each part ?

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7. What is a 'magnet proof ' watch ?

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8. An electron (charge =-e) is revolving around a nucleus along a circular path of radius r with frequency f . What will be the magnetic moment of the electron due to its orbital motion ?

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9. According to the mariner 's compass , a ship is sailing towards east . If the declination at the place is $20^{\circ} E$, what is the actual direction of motion of the ship ?

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10. Explain why a mariner 's compass does not work inside a submarine ?

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11. In a hydrogen atom , an electron of charge e revolves in an orbit of radius r with speed v . Find the magnetic moment associated with the electron .

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12. A vertical iron , pillar , partially dipped inside the ground , is found to be magnetised after several years . What will be the polarity at the top of the pillar when it is at the northern hemisphere of earth ?

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13. A magnetic needle lying parallel to a magnetic field requires W unit of work to turn it through 60° . How much torque should be needed to maintain the needle in this position ?

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14. I ampere current is flowing through a l metre long conducting . If the wire is shaped into a circular loop, then what will be its magnetic moment ?

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15. Indicate the zero - potential line of a magnet .

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16. Two particles , each of mass m and charge q , are kept at the two ends of a light rod of length 2l and is rotated with a uniform angular velocity about the vertical axis passing through the centre of the rod . Determine the ratio of the magnetic moment and the angular momentum of the combination with respect to the centre of the rod .

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17. An iron gains kinetic energy due to the force of attraction by a magnet . What is the source of this

kinetic energy ?

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Ncert Textbook Questions With Answer Hint

1. Answer the following questions regarding earth's magnetism

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

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2. Answer the following questions regarding earth's magnetism

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

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3. Answer the following questions regarding earth's magnetism

If a map of magnetic field lines is prepared at Melbourne in Australia , would the lines seem to go into the ground or come out of the ground .

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4. Answer the following questions regarding earth's magnetism

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

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

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6. Age of earth is 4 to 5 billion years . Geologists believe thant during this period earth's magnetism has changed , even reversed its direction several times . How can geologists know about earth's field in such distant past ?

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7. A short bar magnet placed on a horizontal plane has its axis aligned along the magnetic north- south direction . Null points are found on the magnet . The earth's magnetic field at the place is 0.36G . What is the magnet at the total magnetic field on the normal bisector of the same distance as the null points (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 .)

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8. where will the new null points be located if the bar magnet in the previous example is rotated through 180° ?

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9. A short bar magnet of magnetic moment $5.25 \times 10^{-2} J.T^{-1}$ is placed with its axis perpendicular to the earth's magnetic field . At what distance from the

centre of the magnet , the magnet , the resultant field is inclined at 45° with the earth's field on its normal bisector

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10. A short bar magnet of magnetic moment $5.25 \times 10^{-2} J.T^{-1}$ is placed with its axis perpendicular to the earth's magnetic field . At what distance from the centre of the magnet , the magnet , the resultant field is inclined at 45° with the earth's field on its axis Ignore the length of the magnet in comparison to the distance involved .

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11. Why is diamagnetism almost independent of temperature ?

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

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13. If a toroid uses bismuth for its core , will the field in the core be greater or less than when the core is empty .

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

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15. 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 ?

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16. A system displaying a hysteresis loop such as a ferromagnet is a device for storing memory '. Explain the meaning of the statement .

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17. What type of ferromagnetic material is used as the memory store of modern computers .

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18. Suggest a method to shield certain region of space from magnetic fields .

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19. A long straight horizontal cable carries a current of 2.5 A in the direction from 10° in 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 angle of dip is zero . Locate the line of neutral point . (ignore the thickness of the cable .)

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20. The magnetic moment vectors μ_s and μ_l associated with the intrinsic spin angular momentum $\vec{s}$ and orbital angular angular momentum $\vec{l}$ respectively , of an electron are predicted by quantum theory to be given by

$\mu_s = -\left(\frac{e}{m}\right)s, \mu_1 = -\left(\frac{e}{2m}\right)l$

Which of these relations is in accordance with the result expected classically ? Outline the derivation of the classical result.

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

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Ncert Exemplar Questions With Answer Hint Mcq 1

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

A. the declination varies between $11.3^{\circ}W \text{ to } 11.3^{\circ}E$

B. the leat declination is 0°

C. the plane defined by the dipole axis and earth axis passes through Greenwich

D. declinaton averaged over earth must be always negative

Answer: A

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2. A paramagnetic sample shows a net magnetisation of $8A.m^{-1}$ when placed in an external magnetic field of 0 .6T at a temperature of 4 K . When the same sample is placed in an external magnetic field of 0.2T at a temperature of 16 K , the magnetisation would be

A. $\frac{32}{3}A.m^{-1}$

B. $\frac{2}{3}A.m^{-1}$

C. $6A.\ m^{-1}$

D. $2.4A.\ m^{-1}$

Answer: B

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3. A current carrying circular loop of radius R is placed on the xy place with centre at the origin . Half of the loop with $x > 0$ is now bent so that it now lies on the yz plane .

A. the magnitude of magnetic moment now diminishes

B. the magnetic moment does not change

C. the magnitude of $\vec{B}$ at $(0, 0, z), (z > > R)$ increases

D. $\vec{B}$ at $(0, 0, z), (z > > R)$ is unchanged

Answer: A

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4. A circular current loop of magnetic moment M is in an arbitrary orientation in an external magnetic field $\vec{B}$. The work done to rotate the loop by 30° about an axis perpendicular to its plane is

A. MB.

B. $\frac{\sqrt{3}}{2}MB$

C. $\frac{MB}{2}$

D. zero

Answer: D

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Ncert Exemplar Questions With Answer Hint Mcq 2

1. S is the surface of a lump of magnetic material .

A. Lines of $\vec{B}$ are necessarily continuous across S .

B. Some lines of $\overrightarrow{B}$ must be discontinuous across S .

C. Lines of $\overrightarrow{H}$ are necessarily continuous across S .

D. Some lines of $\overrightarrow{H}$ must be discontinuous across S .

Answer: A::D

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2. if the earth's magnetic field is supposed to be due a magnetic dipole placed at the centre of earth , then the angle of dip at a point on the geographic equator

A. is always zero

B. can be zero at specific points

C. can be positive or negative

D. depends on existing conditions

Answer: B::C::D

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3. A long solenoid has 1000 turns per metre and carries a current of 1 A . It has a soft iron core of $\mu_r = 1000$. The core is heated beyond Curie temperature T_c .

A. The $\overrightarrow{H}$ field in the solenoid is almost unchanged but the $\overrightarrow{B}$ field reduces drastically .

B. The $\overrightarrow{H}$ and $\overrightarrow{B}$ fields in the solenoid are nearly unchanged .

C. The magnetisation in the core reverses direction .

D. The magnetisation in the core diminishes by a factor of 10^8 .

Answer: A::D

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4. The gyromagnetic ratio of an electron in a H - atom according to Bohr model , is

A. independent of which orbit it is in

B. negative

C. positive

D. increases with quantum number n

Answer: A::B

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Exercise Multiple Choice Questions

1. If a current I flows through a loop of area A and the strength of the pole thus generated be q_m , the magnetic moment of the loop is

A. IA

B. IA^2

C. $q_m A$

D. $q_m A^2$

Answer: A

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2. The torque acting on a bar magnet of magnetic moment M in a uniform magnetic field B will be

A. $MB \sin \theta$

B. $MB / \sin \theta$

C. $MB \cos \theta$

D. $MB/\cos\theta$

Answer: A

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3. When a magnet is placed in a uniform magnetic field , it experiences

A. a force but no torque

B. a torque but no force

C. a force and also a torque

D. neither a force nor a torque

Answer: B

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4. In the case of a 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

Answer: B

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5. The basic element of magnetism is a

A. north pole

B. south pole

C. dipole

D. quadrapole

Answer: C

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6. While entering a paramagnetic material from air , the spacing between the magnetic lines of force

A. remains the same

B. decreases

C. increases

D. quadrapole

Answer: B

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7. The magnetic susceptibility of a diamagnetic material is

A. nearly 1000

B. slightly greater than 1

C. in between 0 and 1

D. less than 0

Answer: D

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8. Curie temperature is the temperature above which

A. ferromagnetic material becomes paramagnetic

B. ferromagnetic material becomes diamagnetic

C. paramagnetic material becomes diamagnetic

D. paramagnetic material becomes ferromagnetic

Answer: A

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9. Therefore 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

A. B is of a paramagnetic material

B. C is of a diamagnetic material

C. D is of a ferromagnetic material

D. A is of a non - magnetic material

Answer: A

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10. At a place on earth 's surface where the horizontal and vertical components of earth's magnetic field are equal ,

A. the angle of dip is 0°

B. the angle of dip is 90°

C. the angle of dip is 45°

D. the angle of dip is 30°

Answer: C

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11. At any place in the northern hemisphere of earth , the value of the angle of dip

A. is positive everywhere

B. is negative everywhere

C. is zero everywhere

D. may be zero , positive or negative depending on the position of the place

Answer: A

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12. If the intensity of geomagnetic field at a place on the magnetic equator of the earth be $28A.m^{-1}$, the horizontal component of the geomagnetic intensity there is

A. $28A.m^{-1}$

B. $> 28A.m^{-1}$

C. $< 28A.m^{-1}$

D. zero

Answer: A

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13. If the intensity of geomagnetic field at the magnetic poles of the earth be $32A.m^{-1}$, the horizontal component of the geomagnetic field intensity there is

A. $32A.m^{-1}$

B. $> 32A.m^{-1}$

C. $< 32A.m^{-1}$

D. zero

Answer: D

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14. Two short bar magnets of length 1 cm each have magnetic moments $1.20A.m^2$ and $1.00A.m^2$ respectively . They are placed on a horizontal table parallel to each other with their N poles pointing towards the south . They have a common magnetic equator and are separated by a distance of 20.0 cm . The value of the resultant horizontal magnetic induction at the mid - point O of line joining their centres is close to

(horizontal component of earth's magnetic induction is $3.6 \times 10^{-5} \mathrm{Wb} \ . m^{-2}$)

A. $3.50 \times 10^{-4} \ \mathrm{Wb} \ . m^{-2}$

B. $5.80 \times 10^{-4} \ \mathrm{Wb} \ . m^{-2}$

C. $3.6 \times 10^{-5} \ \mathrm{Wb} \ . m^{-2}$

D. $2.56 \times 10^{-4} \ \mathrm{Wb} \ . m^{-2}$

Answer: D

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Exercise Very Short Answer Type Questions

1. magnetic moment of a small bar magnet is $1A.m^2$ What will be the magnetic field at a point 1 m away from the centre of the magnet along its length?

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2. If the magnetic moment of a bar magnet of length 5 cm be $1A.m^2$, what is the strength of each pole ?

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3. Pole -strengths of two magnetic poles are 1 A .m and 2 A. m.if thye are keep 1m apart in air then what is the magnitude of the force acting between them?

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4. A short bar magnet , placed with its axis at an angle θ With a uniform external magnet field B, experiences a torque τ.what is the moment of the magnet?

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5. What is the unit of magnetic susceptibility?

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6. What is the unit of intensity of magnetisation $\overrightarrow{M}$?

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7. If the relative magnetic permeability of a material be 1.00004, what be its magnetic susceptibility?

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8. If the magnetic intensity at a point in a material is $100A.m^{-1}$ and the magnetic susceptibility is 1000? What will be the value of the magnetic field at that point?

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9. The ratio of the magnetic field $\vec{B}$ at a point in a material to the magnetic ..... Of the material is called the intensity of the magnetic field $\vec{H}$ at that point.

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10. Magnetic moment per unit volume of a material due to unit magnetic ..... Is called the magnetic susceptibility of that material.

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11. If the magnetic susceptibility of a material is -0.0002, what is its relative magnetic permeability ?

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12. The area of hysteresis loop of a magnetic material A is larger than of another magnetic materialB. Which of the two materials is better suited for use as the core of an electromagnet?

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13. Relative permeability of iron is 5500. what is its magnetic susceptibility?

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14. Curie temperature of nickel is $360^{\circ} C$ In which group of magnetic materials will you place nickel at $500^{\circ} C$?

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15. Name a non magnetic alloy of iron.

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16. Name a material which is used as the core of an electromagnet.

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17. For which type of material the magnetic susceptibility is negative ?

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18. For which type of material, the magnetic susceptibility is independent of temperature?

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19. How dose the magnetic susceptibility per unit mass (x) of a paramagnetic gas depend on absolute temperature T ?

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20. If the intensity of geomagnetic field at a place be $60A.m^{-1}$ and the horizontal component of that intensity be $30A.m^{-1}$ determine the angle of dip.

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21. Where on the surface of the earth , the value of angle of dip is zero ?

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22. Where on the earth's surface , the value of angle of dip is 90° ?

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23. Horizontal component of earth's magnetic field exists at all regions except at the geomagnetic .....[Fill in the blank]

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24. The vertical component of earth's magnetic field at a place is $\sqrt{3}$ Times of the horizontal component. What is the angle of dip at this place ?

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25. The horizontal component of earth's magnetic field at a place is $\sqrt{3}$ Time the vertical component. What is the angle of dip at this place?

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Exercise Short Answer Type Questions I

1. Curie point of nickel is $360^{\circ} C$ what do you mean by this statement?

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2. The angle of declination at London is $10^{\circ} W$ What do you mean by this statement ?

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3. State with reason what will be the nature of polarity at the top of a vertical iron rod grounded partially at a place in the southern hemisphere of earth.

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4. If a permanent bar magnet is cut along its length into two equal parts, what will be the pole - strength and magnetic moment of each part ?

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5. Two bar magnets of equal length and equal magnetic moment are placed at right angles to each other in such a way that the north pole of one is in touch with the south pole of the other at the junction. What is the magnetic moment of the combination?

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6. A vertical iron pillar is magnetised in a few years if it is partially pit underground. In the northern hemisphere, what would be the polarity at its top?

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Exercise Short Answer Type Questions Ii

1. A bar magnet of moment P is aligned parallel to the direction of a uniform magnetic field B. what is the potential energy of the magnet? What amount of work is required to be done to align the magnet

opposite to the direction of B

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2. A bar magnet of moment P is aligned parallel to the direction of a uniform magnetic field B. what is the potential energy of the magnet? What amount of work is

required to be done to align the magnet

normal to the direction of B ?

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3. A permanent bar magnet is cut

longitudinally along its axis

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4. A permanent bar magnet is cut

transverse to its axis , into two equal parts. What will be the magnetic moment of each part relative to that of the initial uncut magnet ?

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Exercise Problem Set I

1. Radius of a circular conducting coil is 7 cm and the number of turns in it is 50 . If 1A current is sent through it , determine the magnetic moment of the coil .

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2. Diameter of a circular conducting coil 20 cm and the number of turns in it is 500 . If 3 a current is sent through it , the strength of the coil becomes equal to

the strength of a bar magnet of length 5cm . Determine the pole - strength of the bar magnet .

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3. A magnetised steel wire of length 32.8 cm has pole - strength $1A.m$ If the wire is bent in the form of a semicircle , what will be its magnetic moment ?

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4. Radius of the first circular orbit of hydrogen atom is $0.53 \times 10^{-10}m$ Speed of the revolving electron (charge

$1.6 \times 10^{-19} C$) In this orbit is $2.186 \times 10^{6} m.\, s^{-1}$ determine the magnetic moment of the electron.

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5. Strengths of two magnetic poles are 0.5 A m 2 A.m If they are a distance of 5 cm from each other in air, what will be the mutual force acting between them ? For what separation dose that force become $10^{-5} N$?

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6. The ratio of pole- strengths of two like magnetic poles is 9 : 1 and the distance between then is 12 cm . At what

point between the two poles , will the magnetic field be zero?

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7. Determine the magnetic field of a bar magnet of length 10 cm , having a moment of $0.5A.m^2$ On the axis at a point 20 cm away from the mid-point of the magnet.

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8. Magnetic moment of a small bar magnet is $2A.m^2$ Determine the magnetic field at a point 10 cm from the centre of the magnet on its perpendicular bisector.

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9. The ratio of the magnetic fields at distances 30 cm and 60 cm respectively from the center of a bar magnet is 25 : 2 . Determine the length of the magnet .

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10. The length of a magnet AB is 20 cm and its magnetic moment is $0.24A.\ m^2$ is equilateral triangle. Determine the magnetic field at the point C.

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11. Force experienced by a magnetic pole, when kept in a uniform magnetic field of $4 \times 10^{-5} T$, Is the same as the force experienced by that pole. Determine the pole _ strength of the unknown pole.

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12. The magnetic moment of a a small bar magnet is $0.9a.\, m^2$ If it is placed in a uniform magnetic field making an angle of 30° It , a torque of $0.063N.\, m$ Acts on it. What is the magnetic field ?

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13. The length of straight solenoid is 10 cm, number of turns is 5000 , current through it is 10 mA and the relative permeability of the material of its 1500. Determine the magnetic intensity H and the magnetic field B on the axis of the solenoid .

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14. Magnetic field at a point a material is 0.02 T and the relative permeability of the material is 1.0001 . Determine the magnetic intensity H and intensity of magnetisation M at that point .

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15. Diameter of a toroid is 10 cm and number of turns is 5000. find the magnetic intensity and magnetic field at any point on its axis for 2.5 A current when the relative magnetic permeability of the core is 1500.

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16. An 1 m long straight solenoid has 1000 number of turns the relative permeability of its core material is 1000. if a current of 1 A passes through the magnetic field along its axis ?

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17. The angle of dip at a place is 45° And the earth's magnetic field is $4 \times 10^{-5} T$. Determine the horizontal (H) and vertical (V) components of earth's magnetic field there?

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18. If the horizontal component of earth's magnetic field intensity at a place is half the total intensity , determine the angle of dip there.

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19. Vertical component of the intensity of geomagnetic field at a place is $15.9A.\,m^{-1}$ and the angle of dip is 30° Determine the total intensity and horizontal component of the intensity of geomagnetic field .

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20. At a place A intensity of geomagnetic field is $39.8A.\,m^{-1}$ And angle of dip is 60° At another place B, intensity is $43.8A.\,m^{-1}$ and angle of dip is 72° . compare the horizontal components of geomagnetic intensity at these two place.

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21. Angle of declination at a place is 20° What will be the horizontal and vertical components of earth's magnetic field on the geographical meridian at that place? Given $H = 2 \times 10^{-5} T$ and angle of dip at that place 60°

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22. A small bar magnet is place in the magnetic meridian with its north pole pointing north . If a neutral point is formed on it perpendicular bisector at a distance of 10 cm from its centre , determine the magnetic moment of the magnet [given , $H = 4 \times 10^{-5} T$]

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23. A small bar magnet is place horizontally in the magnetic meridian with its north pole pointing south ,. A neutral point is formed on the axis of the bar magnet at a distance of 24 cm from its south pole. If the horizontally component of earth's magnetic field is 0.18×10^{-4} what will be the magnetic field at a distance of 20 cm north of the south pole?

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24. A vertical circular coil of radius 0.1 m and of 10 turns caries a steady current. When the plane of the coil is normal to the magnetic meridian a neutral point is observed at the centre of the coil . If

$B_H = 0.314 \times 10^{-4} T$ What is the magnitude of the current flowing through the coil?

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25. The geomagnetic field and the angle of dip at a place are $2 \times 10^{-5} T And 30^{\circ}$ Respectively . What are the horizontal and vertical fields at this place ?

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Exercise Problem Set Ii

1. An electron in an atom is moving in a circular in a circular orbit of radius 0.53Å . If the frequency of revolution is $10^{10} MHz$, what is the magnetic dipole moment equivalent to the orbit of the electron ?

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2. The core of solenoid is of a material of relative permeability 500 and its windings carry a current of 1 A. the number of turns of the solenoid 500 per meter.what is the approximate magnetisation of the material?

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3. Two bar magnets of magnetic moments M and $\sqrt{3}M$ are tied at the mid -points together in the form of a 'cross' and is suspended vertically from the centre of the combination . How will this combination align itself in the geomagnetic field .

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4. Two bar magnets M_1 and M_2 of equal lengths are such that the moment of the magnet M_1 is double that of the magnet M_2 . The magnets are fixed at right angle with each other such that their north poles are in the junction . If this combination is placed on a floating cork

on water , find the angle of declination of the magnet M_1 in equilibrium.

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5. Assuming that the geomagnetic field is developed due to a bar magnet situated at the centre of the earth , prove that , at the magnetic poles , the geomagnetic field is twice that at the magnetic equator .

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Hots Numerical Problems

1. The orbital radius of the electrons inside an atom is directly proportional to the square of the serial number (n) of that orbit (quantum number), whereas their orbital velocity is inversely proportional to n . Determine the ratio of the magnetic moments of the electron in the first , second , third ... orbits .

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2. At any place on earth's surface having magnetic latitude λ , if the angle of the be θ , prove that , $\tan\theta = 2\tan\lambda$. Assume that , earth behaves as a magnetised sphere .

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3. The original value of the angle of dip at a place is 45° what will be the apparent dip angle on a plane inclined at 60° with the magnetic meridian ?

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4. Magnetic moments of two small magnets are $0.108A.m^2$ and $0.192A.m^2$. The magnets are placed perpendicular to each other on a horizontal plane . They are at distances of 30 cm and 40 cm , respectively , from the junction point of their axes . Determine the magnitude and direction of the resultant magnetic field at this junction point .

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Entrnce Corner Assertion Reason Type

1. Statement I : The magnetic moment of an electron rotating in an atom is proportional to its angular momentum .

Statement II : The electrons in an atom can rotate only if those orbits for which the angular momentum of the electron is an integral multiple of $\frac{h}{2\pi}$ (h - Planck 's constant).

A. Statement I is true , statement II is true , statement II is a correct explanation for statement I .

B. Statement I is true ,statement II is true , statement II is not a correct explanation for statement I .

C. Statement I is true , statement II is false

D. statement I is false , statement II is true

Answer: B

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2. Statement I : soft iron is preferred for making electromagnets .

Statement II : Both permeability and retentively of soft iron are high .

A. Statement I is true , statement II is true , statement II is a correct explanation for statement I .

B. Statement I is true ,statement II is true , statement II is not a correct explanation for statement I .

C. Statement I is true , statement II is false

D. statement I is false , statement II is true

Answer: C

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3. Statement I : The magnetic lines of force inside a piece of copper placed in a uniform magnetic field move away from each other .

Statement II : Permeability of diamagnetic material is less than one .

A. Statement I is true , statement II is true , statement II is a correct explanation for statement I .

B. Statement I is true ,statement II is true , statement II is not a correct explanation for statement I .

C. Statement I is true , statement II is false

D. statement I is false , statement II is true

Answer: A

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4. Statement I : The intensity of earth's magnetic field may be different even if the horizontal component of earth's magnetic field is the same at two different places .

Statement II : the horizontal component of earth's magnetic field is $I \sin \theta$ where I is the intensity of earth's magnetic field and θ is the angle of dip at a place .

A. Statement I is true , statement II is true , statement II is a correct explanation for statement I .

B. Statement I is true ,statement II is true , statement II is not a correct explanation for statement I .

C. Statement I is true , statement II is false

D. statement I is false , statement II is true

Answer: C

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5. Statement I : The B - H curve of a ferromagnetic material is not linear which means that these materials do not obey $\vec{B} = \mu\vec{H}$ rule.

Statement II : Permeability of a ferromagnetic material is not constant , it can even have a negative value .

A. Statement I is true , statement II is true , statement II is a correct explanation for statement I .

B. Statement I is true ,statement II is true , statement II is not a correct explanation for statement I .

C. Statement I is true , statement II is false

D. statement I is false , statement II is true

Answer: D

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Entrnce Corner Multiple Correct Answers Type

1. Magnetic field at a distance x along the axis of a short bar magnet is

A. inversely proportional to x^2

B. inversely proportional to x^3

C. proportional to the dipole moment of the magnet

D. twice the field at the same distance along perpendicular bisector of the axis of the magnet

Answer: B::C::D

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2. In the classification of magnetic materials based on their behaviour ,

A. relative magnetic permeability of paramagnets is more than 1

B. relative magnetic permeability of diamagntes is negative

C. magnetic permeability of diamagntes does not depend on temperature

D. magnetic permeability of paramagnets does not depend on temperature

Answer: A::B

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3. Magnetic moment of a particle with charge q rotating in a circular orbit of radius r and velocity v is p . Then

A. $p \propto q$

B. $p \propto v$

C. $p \propto \frac{1}{r}$

D. p and the angular momentum of the particle is always in opposite direction

Answer: A::B

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4. At a place on the surface of earth , the angle of dip is θ , intensity of earth's magnetism is I and the horizontal and vertical components of earth's magnetism are h and h' respectively . Then

A. $H' = H \tan \theta$

B. $H' = I \cos \theta$

C. $I = H \sec \theta$

D. the value of I is infinity both at magnetic north and south pole

Answer: A::C

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5. Each molecule of iron or nickel behaves as a magnetic dipole . The origin of this magnetism is

A. electric charge of the molecular electrons

B. orbital rotation of the electron about the nucleus

C. spin of the electrons

D. orbital motion and spin of the electrons

Answer: A::C

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6. Magetic moment of a straight iron wire of length l is p . If is bent in the shape of a semicircle . Then

A. magnetic moment is p

B. magnetic moment is $\frac{2p}{\pi}$

C. magnetic length is l

D. magnetic length is $\frac{l}{\pi}$

Answer: B::D

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Entrnce Corner Comprehension Type

1. Relation between the magnetic field vector $\vec{B}$ and magnetic intensity $\vec{H}$ at a point in a magnetic field $\vec{B} = \mu\vec{H}$ where μ is the magnetic permeability of the medium in which the point is situated . Magnetic permeability of vacuum $\mu_0 = 4\pi \times 10^{-7} H.m^{-1}$. Thus the relative magnetic permeability of the medium $\mu_r = \frac{\mu}{\mu_0}$.

To define the magnetic field at a point in a medium another vector needs mention , which is magnetisation $\overrightarrow{M}$. The magnetic field is known as the magnetisation of the point . In most cases $\overrightarrow{M} \propto \overrightarrow{H} \quad \text{or}, \quad \overrightarrow{M} = k\overrightarrow{H}$, this k is called the magnetic susceptibility of the medium . The relation among these vectors is expressed as $\overrightarrow{B} = \mu_0\left(\overrightarrow{H} + \overrightarrow{M}\right)$.

Magnetic permeability at a point in the medium is $0.002H.m^{-1}$. The magnetic susceptibility of the medium is

A. -0.03

B. -0.003

C. 0.03

D. 0.003

Answer: D

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2. Relation between the magnetic field vector $\vec{B}$ and magnetic intensity $\vec{H}$ at a point in a magnetic field $\vec{B} = \mu\vec{H}$ where μ is the mangnetic permeability of the medium in which the point is situated . Magnetic permeability of vacuum $\mu_0 = 4\pi \times 10^{-7} H.m^{-1}$. Thus the relative magnetic permeability of the medium $\mu_r - \frac{\mu}{\mu_0}$.

To define the magnetic field at a point in a medium another vector needs mention , which is magnetisation $\vec{M}$. The magnetic field is known as the magnetisation of

the point . In most cases $\vec{M} \propto \vec{H}$ or, $\vec{M} = k\vec{H}$, this k is called the magnetic susceptibility of the medium . The relation among these vectors is expressed as $\vec{B} = \mu_0\left(\vec{H} + \vec{M}\right)$.

Magnetisation at a point in the medium is $0.002A.\ m^{-1}$. The intensity at the point is (in $A.\ m^{-1}$)

A. 2.52×10^{-9}

B. 6×10^{-6}

C. 0.667

D. 1.5

Answer: C

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3. Relation between the magnetic field vector $\overrightarrow{B}$ and magnetic intensity $\overrightarrow{H}$ at a point in a magnetic field $\overrightarrow{B} = \mu\overrightarrow{H}$ where μ is the mangnetic permeability of the medium in which the point is situated . Magnetic permeability of vacuum $\mu_0 = 4\pi \times 10^{-7} H.m^{-1}$. Thus the relative magnetic permeability of the medium $\mu_r - \frac{\mu}{\mu_0}$.

To define the magnetic field at a point in a medium another vector needs mention , which is magnetisation $\overrightarrow{M}$. The magnetic field is known as the magnetisation of the point . In most cases $\overrightarrow{M} \propto \overrightarrow{H}$ or, $\overrightarrow{M} = k\overrightarrow{H}$, this k is called the magnetic susceptibility of the medium . The relation among these vectors is expressed as

$\vec{B} = \mu_0\left(\vec{H} + \vec{M}\right)$.

Magnetic field at the same point (in $Wb.\ m^{-2}$)is

A. 4.2×10^{-7}

B. 8.4×10^{-7}

C. 4.2×10^{-6}

D. 8.4×10^{-6}

Answer: B

View Text Solution

Entrnce Corner Integer Answer Type

1. The magnetic field at a point in air is $8.8 \times 10^{-6} T$ and the magnetic intensity (in $A.m^{-1}$) is (n+0.006) . What is the value of n ? Take π be 3.14.

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2. The ratio of the magnetic fields at the same distance (r) along the magnetic axis and along the perpendicular bisector of the magnet $(r > > l$, the length of the magnet) is n :1 . What is the value of n ?

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3. A circular coil of N turns is made of a conducting wire of a certain length . When a current I is sent through it , the magnetic moment is p , Another coil of 2N turns is made with the same wire and the same current is sent through it .

The magnetic moment becomes p'. If p : p ' = n : 1 , what is the value of n ?

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4. The relative magnetic permeability of two media are $1.0004 \text{ and } 1.00005$. Ration of their magnetic susceptibility is n :1 . Find n .

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5. What is the value of the magnetic moment of an electron revolving in the K-sell of the atom (in Bohr magnetron unit)?

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6. The ratio of the radii of two circular conducting loops is 1 :2 . If the magnetic moments are equal , then the ratio of the currents flowing through them is $x:1$. Find x .

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Examintion Archive Wbchse

1. A wire is kept horizontally at a place in the northern hemisphere of the earth . In what direction will force act on the wire due to the vertical component of the earth's magnetic field , if electric current flows through the wire from south to north ?

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2. A copper wire of length L metre is bent to form a circular loop . If I ampere current flows through the loop , Find out the magnitude of magnetic moment of the loop , .

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3. Compare paramagnetic , diamagnetic and ferromagnetic substances on the basis of magnetic permeability and magnetic susceptibility .

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4. Suppose that the source of earth's magnetism is a magnetic dipole at the earth. Find the moment of this magnetic dipole if the strength of earth's magnetic field at the equator is 4×10^{-5} T . Given , radius of the earth $6.4 \times 10^{6} m$ and $\frac{\mu_0}{4\pi} = 10^{-7} T.\, m.\, A^{-1}$.

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5. If current I flows in a coil of area A and number of turns n , the magnetic moment of the coil is

A. nIA

B. n^2IA

C. $\frac{nl}{A}$

D. $\frac{nl}{\sqrt{A}}$

Answer: A

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6. The ratio of magnetic intensities at points at equal distance on end - on position and broad -side -on position of a short bar magnet is

A. $2:1$

B. $1:2$

C. $3:1$

D. $1:1$

Answer: A

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7. Define angle of dip at a place . What will be the value of the angle at the poles and at the equator of the earth? At what place on the earth's surface will the horizontal component of the earth's magnetic field and its vertical component be equal ?

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8. The relative magnetic permeability of a diamagnetic substance is

A. zero

B. slightly greater than 1

C. slightly less than 1

D. slightly less than zero

Answer: C

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9. In a hydrogen atom , an electron of charge e revolves in an orbit of radius r with speed v . Find the resulting magnetic moment of the electron .

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10. Define magnetic permeability and magnetic susceptibility of a magnetic material . Determine the

relation between magnetic permeability and magnetic susceptibility .

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11. On what physical quantity does the magnetic moment of an electron revolving in an orbit depend ?

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12. A current carrying loop behaves as a magnetic dipole- explain .

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13. Show diagrammatically the behaviour of magnetic field lines in presence of

paramagnetic

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14. Show diagrammatically the behaviour of magnetic field lines in presence of

diamagnetic substances . Explain the reason of such behaviour .

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15. Two similar bar magnets of magnetic moment M each are attached at right angle with each other at their ends. The magnetic moment of the system will be.

A. M

B. 2M

C. $\frac{M}{\sqrt{2}}$

D. $\sqrt{2}$M

Answer: D

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16. Why is diamagnetism independent of temperature?

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Examintion Archive Wbjee

1. The intensity of magnetsation of a bar magnet is $5.0 \times 10^4 A.\, m^{-1}$ The magnetic length and area of cross section of the magnet are 12cm and 1cm^2 Respectively. The magnitude of magnetic moment of this this bar magnet is (in SI unit)

A. 0.6

B. 1.3

C. 1.24

D. 2.4

Answer: A

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2. An electron in a circular orbit of radius 0.05nm performs 10^{16} revolutions per second. The magnetic moment due to this rotation of electron is (in A . m^2)

A. 2.16×10^{-23}

B. 3.21×10^{-22}

C. 3.21×10^{-24}

D. 1.26×10^{-23}

Answer: D

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3. If X stands for the magnetic susceptibility of a substance, μ for its magnetic permeability and μ_0 For the permeability of free space, then

A. for a paramagnetic substance : $x > 0, \mu > 0$

B. for a paramagnetic substance : $x > 0, \mu > \mu_0$

C. for a diamagnetic substance : $x > 0, \mu < 0$

D. for a ferragnetic substance : $x > 1, \mu > \mu_0$

Answer: B::D

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Examintion Archive Jee Main

1. The coercivity of a small magnet where the ferromagnet gets demagnetised is $3 \times 10^3 A.m^{-1}$ The current required to be passed in a solenoid of length 10cm and number of turns 100 so that the magnet gets demagnetised when inside the solenoid is

A. 6A

B. 30 mA

C. 60 mA

D. $3A$

Answer: D

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2. A magnetic needle of magnetic moment $6.7 \times 10^{-2} A.\, m^2$ And moment of inertia $7.5 \times 10^{-6} \mathrm{kg}.\, m^2$ Is performing simple harmonic oscillations in a magnetic field of 0.01 T. time taken for 10 complete oscillations is

A. $6.65s$

B. $8.89s$

C. $6.98s$

D. $8.76s$

Answer: A

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3. The dipole moment of a circular loop carrying a current I , is m and the magnetic field at the centre of the loops is B_1 . When the dipole moment is doubled by keeping the current constant , the magnetic field at the the centre of the loop is B_2 . The ratio $\frac{B_1}{B_2}$ is

A. $\sqrt{2}$

B. $\frac{1}{\sqrt{2}}$

C. 2

D. $\sqrt{3}$

Answer: A

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Examintion Archive Aipmt

1. Following figures show an arrangement of bar magnets in different configurations . Each magnet has magnetic dipole moment $\vec{m}$. Which configuration has highest net magnetic dipole moment ?

A. 

B. 

C. 

D. 

Answer: C

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Examintion Archive Neet

1. The magnetic susceptibility is negative for

A. paramagnetic material only

B. ferromagnetic material only

C. paramagnetic and ferromagnetic materials

D. diamagnetic material only

Answer: D

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2. Two reasons for using soft iron as the material for electromagnets .

A. low permeability and high receptivity

B. high permeability and low receptivity

C. low permeability and low receptivity

D. high permeability and high receptivity

Answer: B

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3. A thin diamagnetic rod is placed vertically between the poles of an electromagnet . When the current in the

electromagnet is switched on , then the diamagnetic rod is pushed up , out of the horizontal magnetic field . Hence the rod gains gravitational potential energy . The work required to do this comes from

A. the lattice structure of the material of the rod

B. the magnetic field

C. the current source

D. the induced electric field due to the changing magnetic field .

Answer: C

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Cbse Scanner

1. A rectangular loop of size $l \times b$ carrying a steady current I is placed in a uniform magnetic field $\vec{B}$. Prove that the torque $\vec{\tau}$ acting on the loop is given by $\vec{\tau} = \vec{m} \times \vec{B}$, when $\vec{m}$ is the magnetic moment of the loop .

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2. A circular coil of N turns and diameter d carries a current I . It is unwound and rewound to make another coil of diameter 2d , current I remaining the same .

Calculate the ratio of the magnetic moments of the new coil and the original coil .

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3. A circular coil of closely wound N turns and radius r carries a current I . Write expressions for the following : the magnetic field at its centre ,

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4. A circular coil of closely wound N turns and radius r carries a current I . Write expressions for the following : the magnetic moment

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5. Show diagrammatically the behaviour of magnetic field lines in the presence of

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6. Draw the magnetic field lines distinguishing diamagnetic and paramagnetic materials .

Give a simple explanation to account for the difference in the magnetic behaviour of these materials .

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

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8. At a place , the horizontal component of earth's magnetic field is B and angle of dip is 60° . What is the value of horizontal component of earth's magnetic field at equator ?

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9. The susceptibility of a magnetic material is 0.9853 . Identify the type of magnetic material . Draw the

modification of the field pattern on keeping a piece of this material in a uniform magnetic field .

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10. A bar magnet of magnetic moment $6J.T^{-1}$ is aligned at 60° with a uniform external magnetic field of $0.44T$. Calculate

the work done in turning the magnet to align ist magnetic moment (i) normal to the magnetic field , (ii) opposite to the magnetic field

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11. A bar magnet of magnetic moment $6J.T^{-1}$ is aligned at 60° with a uniform external magnetic field of $0.44T$. Calculate

the torque on the magnet in the final orientation in case (ii).

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