PHYSICS

BOOKS - DHANPAT RAI & CO PHYSICS (HINGLISH)

MAGNETISM

Examples

1. Two magnets south poles are located 4.0 cm apart. If the poles of each magnet have a

sterngth of 8.0 Am and are 20.0 cm apart, find the force exerted, by one south pole on the other

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2. A magnetic dipole of lrngth 10 cm has pole strength of 20 Am apart . Find the magnetic moment of the dipole

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3. A bar magnet of magnetic moment of $5 \cdot 0 Am^2$ has poles $20cm$ apart. Calculate the pole strength.

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4. A steel wire of length l has a magnetic moment M. It is bent into a semicircular arc. What is the new magnetic moment?

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5. Calculate the force acting between two magnets of length $15cm$ each and pole strength $80Am$ each when the separation between their north poles is $10cm$ and that between south poles is $40cm$.

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6. A magnetised needle of magnetic moment $4 \cdot 8 \times 10^{-2} JT^{-1}$ is placed at 30° with the direction of uniform magnetic field of

magnitude $3 \times 10^{-2} T$. What is the torque acting on the needle?

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7. A short bar magnetic moment of magnetic moment $0.9 JT^{-1}$, is placed with the axis at 45° to a uniform magnetic field. If it experience a torque of 0.063 J, (i) calculate the magnitude of the magnitudic field and (ii) what orientation of the bar magnet

corresponds to the stzble equillibrium in the magnetic field ?

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8. Each atom of an iron bar ($5cm \times 1cm \times 1cm$) has a magnetic moment $1 \cdot 8 \times 10^{-23} Am^2$.

(a) What will be the magnetic moment of the bar in the state of magnetic saturation.

(b) What will be the torque required to place this magnetised bar perpendicular to

magnetic field of $15000 gauss$?

Density of iron $= 7 \cdot 8 \times 10^3 kg/m^3$, Atomic wt. of iron $= 56$,

Avogadro's number $= 6 \cdot 023 \times 10^{23}/gm$ mole.

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9. A planar loop of irregular shape encloses an area of $7 \cdot 5 \times 10^{-4} m^2$, and carries a current of $12A$. The sense of flow of current appears to be clockwise to an observer. What is the

magnitude and direction of the magnetic moment vector associated with the current loop?

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10. A closely wound solenoid of 2000 turns and area of cross section $1.6 \times 10^{-4} m^2$, carrying a current of $4amp.$ is suspended through its centre allowing it to turn in a horizontal plane:

(a) What is the magnetic moment associated

with the solenoid?

(b) What are the force and torque on the solenoid if a uniform horizontal magnetic field of $7 \cdot 5 \times 10^{-2} T$ is set up at an angle of 30° with the axis of the solenoid?

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11. A bar magnet with poles $25.0 cm$ apart and of pole strength $14.4 Am$ rests with its centre on a friction less point. It is held in equilibrium at 60° to a uniform magnetic field of

induction $0.25T$ by applying a formce F at right angle to the axis, $12cm$ from its pivot. The magnitude of the force is

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12. Two magnects of magnetic moments M and $M\sqrt{3}$ are joined to form a cross (+). The combination is suspended freely in a uniform magnetic field. In equilibrium position, the magnet of magnetic moment M makes an angle θ with the field. Determine θ.

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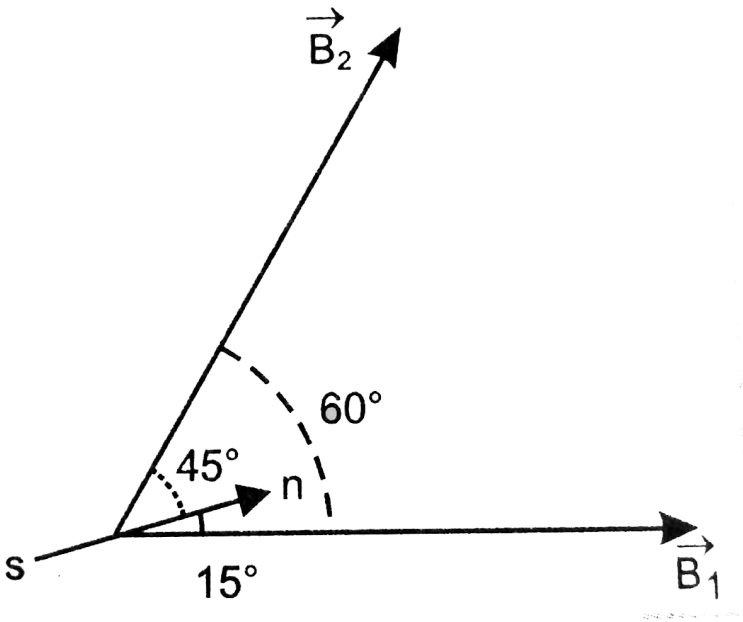
13. A magnetic dipole is under the influence of two magnetic fields. The angle between the field directions is 60° and one of the fields has a magnitude of $1 \cdot 2 \times 10^{-2}$ tesla. If the dipole comes to stable equilibrium at an angle of 15° with this field, figure, what is the

magnitude of the other field?



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14. A short bar magnet placed with its axis at 30° with a uniform external magnetic field of

$0 \cdot 16T$ experiences a torque of magnitude $0 \cdot 032J$. Estimate the magnetic moment of the magnet. If the bar were free to rotate, which orientations would correspond to its (i) , stable and (ii), unstable equilibrium? What is the potential energy of the magnet in the two case?

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15. A bar magnet having a magnetic moment of $1.0 \times 10^4 JT^{-1}$ is free to rotate in a

horizontal plane. A horizontal magnetic field $B = 4 \times 10^{-5} T$ exists in the space. Find the work done in rotating the magnet slowly from a direction parallel to the field to a direction 60° from the field.

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16. A bar magnet of magnetic moment M is aligned parallel to the direction of a uniform magnetic field B. Calculate work done to align

the magnetic moment (i) opposite to the field

(ii) normal to field direction?

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

(a) What is the amount of work done to turn the magnet so as to align its mangetic moment

(i) normal to the field direction, (ii) opposite to

the field direction?

(b) What is the torque on the magnet in cases (i) and (ii)?

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18. A current of $7 \cdot 0A$ is flowing in a plane circular coil of radius $1 \cdot 0cm$ having 100 turns. The coil is placed in a uniform magnetic field of $0 \cdot 2Wb/m^2$. If the coil is free to rotate, what orientation would correspond to its (i) stable equilibrium and (ii) unstable

equilibrium? Calculate potential energy of the coil in the two cases.

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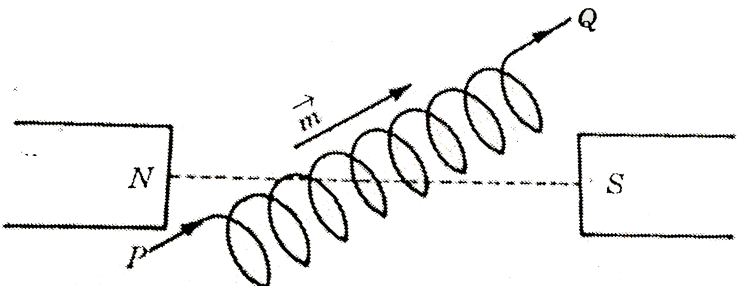
19. A closely wound solenoid of 1000 turns and area of cross-section $2.0 \times 10^{-4} m^2$, carrying a current of 2.0 A. It is placed with its horizontal axis at 30° with the direction of a uniform horizontal magenitic field of 0.16 T, as shown in Fig. 11.3.



(a) What is the torque experienced by the solenoid due to the field ?

(b) If the solenoid is free to turn about the verticle direction, specify its orientations of stabvle and unstable equilibriums. What is the amount of work needed to displace the solenoid from its stable orientation to its unstable orientations ?

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20. A circular coil of 100 turns has an effective radius of 0.05 m and carries a current of 0.1 A. How much work is required to turn it in an external magnetic field of $1.5 Wbm^{-2}$ through 180° about an axis perpendicular to the magnetic field. The plane of the coil is initially perpendicular to the magnetic field.

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21. The ratio of the horizontal to the resyultant magnetic field of earth at a given place is $1/\sqrt{2}$. What is the angle of the dip at that place ?

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22. The declination at a place is 15° west of north. In which direction should a ship be steered so that it reaches a place due east?

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23. A ship is to reach a place of 10° south of west. In which direction should it be steered if the declination at the place is 18° west of north.

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24. At a place, if the earth's horizontal and vertical components of magnetic field are equal, then the angle og dip will be

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25. The horizontal and verticle components of earth's field at a place are 0.22 gauss respectively. Calculate the angle of dip and resultant intensity of earth's field.

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26. What will be the value of the verticle components and total intensity of the earth's

field ata place where dip is 60°. Horizontal component is 0.3 G.

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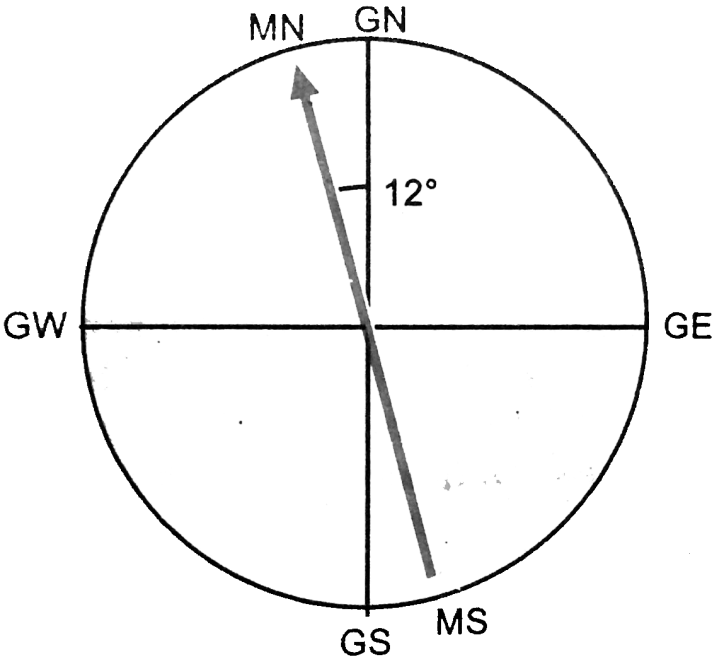
27. At a certain location in Africa, compass points 12° west of geographic north, figure. The north tip of magnetic needle of a dip circle placed in the plane of magnetic meridian points 60° above the horizontal. The horizontal component of earth's field is measured to be $0.16 gauss$. Specify the

direction and magnitude of the earth's field at the location.



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28. A long straight horizontal cable carries a current of $3 \cdot 3A$ in the direction 10° south of west to 10° north of east. The magnetic meridian of the plane happens to be 10° west of the geographic meridian. The earth's magnetic field at the location is $0 \cdot 33G$ and the angle of dip is zero degree. Locate the positions of neutral points?

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29. A telephonic cable at a place has four long straight horizontal wires carrying a current of $1.0 amp.$ 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 almost zero. What are the resultant magnetic fields at points $4.0 cm$ below and above the cable?

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30. If θ_1 and θ_2 be the apparent angles of dip observed in two vertical planes at right angles to each other, then show that the true angle of dip, θ is given by $\cot^2\theta = \cot^2\theta + \cot^2\theta$.

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31. A dip circle shows an apparent dip of 60° at a place where the true dip is 45°. If the dip circle is rotated through 90°, what apparent dip will it show?

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32. The value of dip at a place is 45°. The plane of the dip circle is turned through 60° from the magnetic meridian. Find the apparent value of dip.

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33. A short bar magnet has a magnetic moment of $0 \cdot 48 JT^{-1}$. Give the direction and magnitude of the magnetic field produced by

the magnet at a distance of $10cm$ from the centre of the magnet on (i) the axis (ii) the equatorial line (normal bisector) of the magnet.

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34. A bar magnet of length $10cm$ has a pole strength of $10Am$. Calculate the magnetic field at a distance of $0 \cdot 2m$ from its centre at a point on its (i) axial line (ii) equatorial line.

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35. A bar magnet of length $10cm$ is placed in the magnetic meridian with its north pole pointing towards the geographical north. A neutral point is obtained at a distance of $12cm$ from the centre of the magnet. Find the magnetic moment of the magnet, when $H = 0 \cdot 34gauss.$

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36. Two small magnets are placed horizontally perpendicular to magnetic meridian. Their north poles are at $30cm$ east and $20cm$ west from a compass needle. Compare the magnetic moments of the magnets, if compass needle remains undeflected.

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37. The magnetic moment of a short bar magnet is $1 \cdot 6Am^2$. It is placed in the

magnetic meridian with north pole pointing south. The neutral point is obtained at $20cm$ from the centre of the magnet. Calculate the horizontal component H of earth's field. If magnet be reversed i.e. north pole pointing north, find the position of the neutral point.

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38. The intensities of magnetic field at teo points on the axis of bar magnet at distance of 10 cm and 20 cm from the middle point in

the ratio $18:1$. Find the distance between the pole of the magnets.

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39. Two short magnets P and Q are placed one over another with their magnetic axes mutually perpendicular to each other. It is found that resultant magnetic field at a point on the prolongation of magnetic axis of P is inclined at 30° with this axis. Compare the magnetic moments of the two magnets.

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40. A short bar magnet of mangetic moment $5 \cdot 25 \times 10^{-2} JT^{-1}$ is placed with its axis perpendicular to earth's field direction. At what distance from the centre of the magnet, is the resultant field inclined at 45° with earth's field on (i) its normal bisector, (ii) its aixs? Magnitude of earth's field at the place $0 \cdot 42G$. Ignore the length of the magnet in comparison to the distances involved.

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41. A magnet placed in the magnetic meridian with its north pole pointing north of the earth produces a neutral point at a distance of $0 \cdot 15m$ from either pole. It is then broken into two equal parts and one such piece is placed in a similar position. Find the position of the neutral point.

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42. The magnetic field at a point on the magnetic equator is found to be $3.1 \times 10^{-5} T$. Taking the earth's radius to be 6400 km, calculate the magneitc moment of the assumed dipole at the earth's centre.

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43. 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 $14cm$ from the centre of the magnet. The earth's magnetic field at the plane is $0 \cdot 36G$ 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 points (i.e. 14 cm) from the centre of the magnet? (At null points, field due to a magnet is equal and apposite to the horizontal component of earth's magnetic field).

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44. If the bar magnet in the above problem is turned around by 180°, where will the new null points be located?

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45. A current carrying planar loop suspended in a vertical plane normal to magnetic meridian is in stable equilibrium. The horizontal component of earth's magnetic field is $0 \cdot 32G$. Another horizontal magnetic field of magnetude $0 \cdot 48G$ parallel to the

plane of the loop is set up along magnetic west to east. Specify the new stable equilibrium.

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46. A current of 0.5 A prioduces a deflection of 45° in a tangent galvanometre. What current will produce a deflection of 30° in the same tangent galvanometer.

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47. The coil of a tangent galvanometer has 50 turns of mean diameter 20 cm. Find the current required to produce a deflection of 30°. Given B_H=0.3 G.

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48. A tangent galvanometer has 66 turns and the diameter of its coil is 22cm. It gives a deflection of $45^\circ f$ or 0.10 A current. What is the value of the horizontal component of the earth's magnetic field?

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49. A tangent galvanometer has a cooil of 22 turns and mean radius 0.1 m. Find the reduction factor at a place , where $B_H = 0.3 \times 10^{-4} T$.

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50. Two tangent galvanometer have redii $7.5cm$ and $10cm$, number of turns are 15 and

10 and resistances are 8Ω and 12Ω. They are joined in parallel in circuit. If deflection in one is 60° the deflection in second galvanometer is :

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51. Two tangent galvanometer A and B differing only in the number of turns in their coils are connected in series. On passing a current through them, the deflections in A and

B are 40° and 26.5° respectively. Calculate the ratio of their numbers of turns.

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52. A tangent galvanometer gives a deflection of 30° whewn a current of 250 mA is passed through its coil. If the radius of the coil is 8 cm and $B_H = 2.5 \times 10^{-5} Wbm^{-2}$. Find the length of the wire used in winding the coil.

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53. A tangent galvanometer of 50 turns 8 cm mean radius, is connected in series with a silver voltameter and a battery. If the galvanometer shows a steady deflection of 45° and 0.185 g of silver is deposited in 30 minute, find the horizontal component of the earth's magnetic field (E.C.E. of silver = 0.001118 g/coulomb).

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54. Show that in a tangent galvanometer the percentage error in the measurement of current is minimum when the deflection is 45° .

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55. A compass needle free to turn in a horizontal plane is placed at the centre of a 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 $0.35 amp.$, the needle points west to east.

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

(b) The current in the coil is reversed and the coil is rotated about its vertical axis by an angle of 90° in the anticlockwise sense looking from above. Predict the direction of the needle. Take the magnetic declination at the places to be zero.

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56. A bar magnet takes $\frac{\pi}{10}$ second to complete one oscillation in an oscillation magnetometer. The moment of inetria of the magnet about the axis of rotation is 1.2 xx 10^(-4) kg m^2 and $theearth'sh$ or $izontalmag \neq ticfieldis$ 30 muT`. Find the magentic moment of the magnet.

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57. A circular coil of 16 turns and radius 10cm carrying a current of 0.75A rests with its plane normal to an external field of magnitude $5 \cdot 0 \times 10^{-2} T$. 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 $2 \cdot 0 s^{-1}$. What is the moment of inertia of the coil about its axis of rotation?

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58. A bar magnet of mass 100 g, length 7.0 cm, width 1.0 cm and height 0.50 cm takes $\frac{\pi}{2}$ seconds to complete an oscillation in an oscillation magnetometer placed in a horizontal magnetic field of $25\mu T$. (a) Find the magnetic moment of the magnet. (b) If the magnet is put in the magnetometer with its $0.50cm$ edge horizontal, what would be the time period?

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59. A magnetised needle of magnetic moment $4.8 \times 10^{-2} JT^{-1}$ ispivoted through the centre of its mass and is free to rotate in the plane of the magnetic field of the magnitude 3×10^{-2}T. If the needed is displaced slightly from its stable equilibrium and releaased, predict the angular frequency of its oscillations. The moment bof inertia of the needle about its axis of rotation is given to be $2.25 \times 10^{-5} kgm^2$.

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60. A bar magnet, held horizontally, is set intom angular oscillations in earth's magnetic field. It has time periods T_1 and T_2 at two place, where the angles of dip are δ_1 and δ_2 respectively. Deduce an expression for the ratio of the resultant magnetic fields at the two places.

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61. A magnet oscillating in a horizontal plane, has a time period of 3 seconds at a place

where the angle of dip is 30° and 4 seconds at another place, where the dip is 60°. Compare the resultant magnetic field at the two places.

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62. Two bar magnets are bound side by side, and are suspended so as to swing once in 12 s when like poles are together. When the direction of one of the magnets is reversed, the combination makes 3.75 vibrations per

minute. Compare the magnetic moments of the two magnets.

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63. An iron rod whose length is 20 cm and radius is 2 cm is uniformly magnetised and its period of oscillation is 4 s. It is broken into four parts. Find the time period of each part.

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64. A small magnet oscillating horizontally in the earth's magnetic field has a time period of 4 s. When another magnet is brought near it, it completes 50 oscillations in 160 s. Compare the magnetic field due to the magnet and the horizontal component of earth's field when (i) both the fields are in the same direction and (ii) the fields are in opposite directions.

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65. A magnet is placed in the magnetic meridian with its north pole pointing north. The neutral point is obtained at a point at a point P towards east of middle point of the magnet. When the magnet is reversed end to end at the same place, a magnetic needle completes 12 oscillations per minute at the point P. If the magnet be removed , how many oscillations will the needle perform per minute ?

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66. The magnetic needle of a $V.M.M$ completes 10 oscillations in 92seconds. When a small magnet is placed in the magnetic meridian $10cm$ due north of needle with north pole towards south completes 15 oscillations in 69seconds. The magnetic moment of magnet

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67. A magnet of magnetic moment $2 \cdot 5 Am^2$ weighs $66g$. If density of material of the magnet is $7500 kg/m^3$, find the intensity of magnetisation.

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68. A magnetic field of $1600 Am^{-1}$ produces a magnetic flux of $2 \cdot 4 \times 10^{-5}$ weber in a bar of iron of cross section $0 \cdot 2 cm^2$. Calculate permeability and susceptibility of the bar.

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69. The maximum value of permeability of μ-metal $(77\,\%\,Ni, 16\,\%\,Fe, 5\,\%\,Cu, 2\,\%\,Cr)$ is $0\cdot 126T - m/A$. Find the maximum relative permeability and susceptibility.

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70. An iron rod of $0\cdot 2cm^2$ cross-sectional area is subjected to a magnetising field of $1200Am^{-1}$. The suscaptibility of iron is 599.

Find the permeability and the magnetic flux produced.

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71. A sample of paramagnetic salt contains 2×10^{24} atomic dipoles, each of moment $1.5 \times 10^{-23} JT^{-1}$. The sample is placed under a homogeneous magnetic field of $0.64T$ and cooled to a temperature of $4.2K$. The degree of magnetic saturation archieved is equal to $15\,\%$. What is the total dipole moment of the

sample for a mangetic field of $0.98T$ and a temperature of $2.8K$. (Assume Curie's law).

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72. A Rowland rign of mean radius $18cm$ has 3500 turns of wire wound on a ferromagnetic core of relative permeability 800. What is the magnetic field in the core for a magnetising current of $1 \cdot 2amp$.?

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73. The core of a toroid having $3000 turns$ has inner and outer radii of $11 cm$ and $12 cm$ respectively. The magnetic field in the core for a current of $0 \cdot 70 A$ is $2 \cdot 5 T$. Calculate relative permeability of the core?

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74. An iron rod of volume $10^{-4} m^3$ and relative permeability 1000 is placed inside a long solenoid wound with $5 \text{turns} / \text{cm}$. If a current

of $0.5A$ is passed through the solenoid, then the magnetic moment of the rod is

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Problems From Competitive Examinations

1. Two identical magnetic dipoles of magnetic moments $1 \cdot 0Am^2$ each are placed at a separation of $2m$ with their axes perpendicular to each other. What is the

resultant magnetic field at a point midway between the dipoles?

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2. A bar magnetic with poles $25cm$ apart and pole strength $14 \cdot 4A.\, m$ rests with its centre on a frictionless pivot. It is held in equilibrium at 60° to a uniform magnetic field of induction $0 \cdot 25T$ by applying a force F at right angles to its axis, $10cm$ from the pivot.

Calculate the value of F. What will happen if the force is removed?

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3. A bar magnet of length 2 l and magnetic moment m is suspended freely in a uniform magnet field B. Find the amount of work done to deflect the magnet through an angle θ from the direction of the field.

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4. A small magnet of magnetic moment M is placed at broad side on position of a magnet of magnetic M', length 2l' in such a way that the axis of former coincides with the perpendicular bisector of the latter. The separation between their centres is d. Calculate the nature of interaction (force or couple) among them. What is its limiting value, when d becomes very large ?

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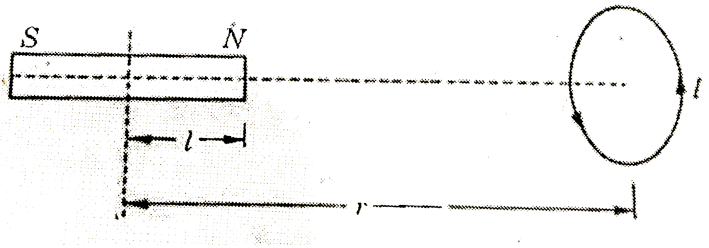
5. A small coil of radius 0.002 m is placed on the axis of a magnet of magnetic moment 10^5 JT^{-1} and length 0.1 m at a distance of 0.15 m from the centre of the magnet. The plane of the coil is perpendicular to the axis of the magnet. Find the force on the when a current of 2.0 A is passed through it.



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

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7. A small magnet of magnetic moment $\pi \times 10^{-3} Am^2$ is placed on the Y-axis at a distance of 0.1 from the origin with its axis parallel to the X-axix. A coil have 169 turns and radius 0.05 m is placed on the X-axis at a distance of 0.12 m from the origin with the axis of the coil coinciding with the X-axis. Find the magnitude and direction of the current in the coil for a compass needle placed at the origin, to point in the north-south direction.

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8. A circular of radius 0.157 m has turns. It is placed such that its axis is in magnetic meridian. A dip needle is supported at the centre of the coil with its axis of rotation horizontal, and in the plane of the coil. The angle of dip is 30° when a current flows through the coil. The angle of dip becomes 60° on reversing the current. Find the current in the coil assuming that the magnetic field due to the coil is smaller than the horizontal component of earth's magnetic field, $H = 3 \times 10^{-5} T$.

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9. Two circular coils, each of 100 turns, are held that one lies in the vertical plane and the other in the horizontal plane with their centres coinciding. The radii of the vertical and the horizontal coils are respectively 20 cm and 30 cm. If the directions of the currents in them are such that the earth's magnetic field at the centre of the coils is exactly neutralised, then calculate the current in each coil. (Horizontal

component of earth's magnetic field $= 27.8 Am^{-1}$, angle of dip $= 30^{\circ}$

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10. A compass needle whose magnetic moment is $60 Am^2$ pointing geograhic north at a certain place, where the horizontal component of earth's magnetic field is $40 \mu Wbm^{-2}$ experiences a torque $1 \cdot 2 \times 10^{-3} Nm$. What is the declination of the place?

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11. The periodic times of oscillation of a dip needle in two perpendicular vertical planes are t_1 and t_2 respectively. If the periodic time of the same needle in the magnetic meridian is t, showthat

$$\frac{1}{t_1^4} + \frac{1}{t_2^4} = \frac{1}{t_4}\left(1 + \sin^2\delta\right)$$

where δ is the angle of dip.

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12. The period of oscillation of a suspended thin cylindrical magnet is 4 seconds. It is broken into exactly two halves. Find the period of oscillation of each half when freely suspended.

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13. A vibration magnetometer consists of two identical bar magnets placed one over the other, such that they are mutually

perpendicular and bisect each other The time period of oscillation in horizontal magnetic field is 4 s. If one the magnets is taken away, find the period of oscillation of the other in the same field.

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Based On Coulomb S Law And Dipole Moment Of A Magnet

1. Two similar magnetic poles, having pole strengths in the ratio $1:2$ are placed $1m$ apart. Find the point where a unit pole experiences no net force due to the two polese.

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2. A magnetic dipole of length $15cm$ has a dipole moment of $1-5Am^2$. What is the pole of strength?

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3. Two magnetic poles, one of which is four times stronger than the other, exert a force of $10gf$ on each other, when placed at a distance of $10cm$ in air. Find the strength of each pole.

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4. Two bar magnets of length 0.1 m and pole strength $75Am$ each , are placed on the same line . The distance between their centres is 0.2

m . What is the resultant force due to one on the other when (i) the north pole of one faces the south pole of the other and (ii) the north pole of one faces the north pole of the other ?

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5. A magnetised steel wire $31.4cm$ long has a pole strength of $0 \cdot 2Am$. It is bent in the form of a semicircle. Calcualte its magnetic moment.

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Based On Torque And Potential Energy Of Dipole In Magnetic Field

1. A short bar magnet placed with its axis at 30° with a uniform external magnetic field of $0 \cdot 25T$ experiences a torque of magnitude equal to $4 \cdot 5 \times 10^{-2}J$. What is the magnitude of magnetic moment of the magnet?

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2. A circular coil of 300 turns and diameter $14cm$ carries a current of $15A$. What is the magnitude of magnetic moment linked with the loop?

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3. A closely wound solenoid of 800 turns and area of cross section $2 \cdot 5 \times 10^{-4} m^2$ carries a current of $3 \cdot 0A$. Explain the sense in which the solenoid acts like a bar magnet. What is its associated magnetic moment?

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4. If the solenoid in the above question is free to turn about the vertical direction, and a uniform horizontal magnetic field of $0 \cdot 25T$ is applied, what is the magnitude of the torque on the solenoid when its axis makes an angle of 30° with the direction of the applied field?

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5. Calculate the magnitude of torque required to hold a bar magnet of magnetic moment $200Am^2$ along a direction making an angle of 30° with the direction of uniform magnetic field of $0 \cdot 36G$.

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6. Calculate the torque acting on a magnet of length 20 cm and of pole strength $2 \times 10^{-5}Am$, placed in earth's magnetic field

of flux density $2 \times 10^{-5} T$, when (i) magnet is parallel to the field (ii) magnet is perpendicular to the field .

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7. The magnetic dipole moment of earth is $6 \cdot 4 \times 10^{21} Am^2$. If we consider it to be due to a current loop wound around the magnetic equator of the earth, then what should be the magnitude of the current? Take earth to be a sphere of radius $6400 km$.

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8. A straight solenoid of length $50cm$ has 1000 turns and a mean cross sectional area of $2 \times 10^{-4} m^2$. It is placed with its axis at 30° with a uniform magnetic field of $0 \cdot 31T$. Find the torque acting on the solenoid when a current of $2A$ is passed through it.

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9. A circular coil of radius $4cm$ and of 20 turns carries a current of 3 amperes. It is placed in a magnetic field of intensity of $0.5weber/m^2$. The magnetic dipole moment of the coil is

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10. A flat circular coil of wire 8.4 in diameter has 28 turns of copper wire and carries a current of 3.6 A . If his coil is placed in a uniform magnetic field of 0.25 T . (a) what is

the magnitude of the magnetic dipole moment and (b) how much energy is required to turn the coil from its stable equilibrium position through an angle of 180° ?

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11. A short magnet placed with its axis at 30° with a uniform external magnetic field of 0.2 T experiences a torque of 4×10^{-2} J .

(a) Calculate the magnetic moment of the magnet .

(b) If the magnet were free to rotate , which orientations would correspond to its (i) stable and (ii) unstable equilibrium ? What is its potential energy in the field for cases (i) and (ii) ?

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12. A closely wound solenoid of 200 turns and area of cross-section $1.5 \times 10^{-4} m^2$ carries a current of $2.0 A$ It is suspended through its centre and perpendicular to its length,

allowing it to turn in a horizontal plane in a uniform magnetic field $5 \times 10^{-2} T$, making an angle of 30° with the axis of the solenoid. The torque on the solenoid will be

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13. A bar of magnetic moment $2.5 Am^2$ is free to rotate about a vertical axis through its centre . The magnet is released from the rest from the east - west direction . Find the kinetic energy of the magnet as it aligns itself in the

north - south direction . The horizontal component of earth's magnetic field is $0.3G$

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14. Calculate the work done in rotating a magnet of magnetic moment $3 \cdot 0JT^{-1}$ through an angle of 60° from its position along a magnetic field of strength $0 \cdot 34 \times 10^{-4}T$.

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Based On I Earth S Magnetism Ii Magnetic Field Of A Bar Magnet

1. A ship is sailing due west according in Mariner's compass . If the delination of the place is 15° east of north , what is true direction of the ship ?

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2. A ship is sailing due east according to Mariner's compass . If the declination of the

place is 18° east of north , what is the true direction of the ship ?

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

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4. The ratio of the vertical component to the horizontal component of earth's magnetic field at a place is 1 . What is the angle of dip at that place ?

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5. The horizontal component of the earth's magnetic field is 0.22 Gauss and total magnetic field is 0.4 Gauss. The angle of dip. Is

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6. Calculate earth's surface magnetic field at a place , where an angle of dip is 60° and vertical component of earth's field is $0.40G$.

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7. Find the value of the vertical components of earth's magnetic at a place , where the angle of dip is 60° and $B_H = 0.2 \times 10^{-4}T$.

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8. The vertical and horizontal components of earth's magnetic at a place are 0.2 G and 0.3464 G respectively . Calculate the angle of dip and earth's magnetic field at that place .

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9. A vertical wire in which current is flowing produces a neutral point with the earth's horizontal field at a distance of 5 cm from the

wire in air . What is current , if $B_H = 0.18 \times 10^{-4} T$?

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10. A compass needle whose magnetic moment is $60 Am^2$ pointing geograhic north at a certain place, where the horizontal component of earth's magnetic field is $40 \mu Wbm^{-2}$ experiences a torque $1 \cdot 2 \times 10^{-3} Nm$. What is the declination of the place?

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11. A magnetic needle free to rotate about the vertical direction (compass) point 3.5 west of the geographic north . Another magnetic needle free to rotate in a vertical plane parallel to the magnetic meridian has its north tip pointing down at 18° with the horizontal . The magnitude of the horizontal component of the earth ' magnetic field at the place is known to be $0.40G$. what is the direction and

magnitude of the earth's magnetic field at the place ?

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12. The true dip at a place is 30° . What is the apparent dip when the dip circle is turned 60° out of the magnetic meridian ?

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13. The values of the apparent angles of dip in two planes at right angles to each other are 30° and 45°. Then the true value of the angle of dip at the place is

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14. A dip circle lies initially in the magnetic meridian. If it is now rotated through angle θ in the horizontal plane, then tangent of the angle of dip is changed in the ratio:

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15. A magnetic needle of length 10cm, suspended at its middle point through a thread, stays at a an angle of 45° with the horizontal. The horizontal component of the earth's magnetic field is $18\mu T$. (a) Find the vertical component of this field. (b) If the pole strength of the needle is $1.6A - m$, what vertical force should be applied to an end so as to keep it in horizontal position?

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16. A long bar magnet has a pole strength of $10Am$. Find the magnetic field at a point on the axis of the magnet at a distance of 5cm from the north pole of the magnet.

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17. Calculate the magnetic field due to a bar magnet $2cm$ long and having pole strength of $100A - m$ at a point $10cm$ from each pole.

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18. A bar magnet of length 0.1 m has a pole strength of 50 Am . Calculate the magnetic field at a distance of 0.2 m from its centre on (i) its axial line and (ii) its equitorial line .

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19. A bar magnet has a length of 8cm. The magnetic field at a point at a distnace 3cm from the centre in the broadside-on position

is found to be $4 \times 10^{-6} T$. Find the pole strength of the magnet.

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20. The magnetic moment of a current carrying loop is $2.1 \times 10^{-25} amp \times m^2$. The magnetic field at a point on its axis at a distance of $1 Å$ is

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21. If the earth's magnetic field has a magnitude $3.4 \times 10^{-5} T$ at the magnetic equator of the earth, what would be its value at the earth's goemagnetic poles?

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22. The intensities of magnetic field at two points on the axis of a bar magnet at distances 0.1 m and 0.2 m from its middle

point are in the ratio $12.5:1$. Calculate the distance between the poles of the magnetic .

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23. Two magnets N_1S_1 and N_2S_2 having their magnetic moments as M and 3M respectively are joined at an angle of 60° as shown in figure. The combination is placed on a floating cork in water. Determine the angle θ which the weaker magnet makes with the magnetic meridian.

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24. A short bar magnet of magnetic moment $0 \cdot 5JT^{-1}$ is placed with its magnetic axis in the magnetic meridian, with its north pole pointing geographic north. A neutral point is obtained at a distance of $0 \cdot 1m$ from the centre of the magnet. Find the horizontal component of earth's magnetic field.

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25. A magnetic dipole of magnetic moment $1.44Am^2$ is placed horizontally with the north pole pointing towards north. Find the positon of the neutral point if the horizontal component of the earth's magnetic field is $18\mu T$.

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26. A bar magnet 30 cm long is placed in the magnetic meridian with its north pole

pointing geographical south . The neutral point is found at a distance of 30 cm from its centre . Calculate the pole strength of the magnet . Given $B_H = 0.34G$.

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27. A neutral point is found on the axis of a bar magnet at a distance of $10cm$ from its one end. If the length of the magnet be $10cm$, and $H = 0 \cdot 3G$. Find the magnetic moment of the magnet.

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28. A short bar magnet is placed with its north pole pointing north. The neutral point is $10cm$ away from the centre of the magnet. If $H = 0.4G$, calculate the magnetic moment of the magnet.

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29. A magnet place in the north pointing north position, balances the earth's magnetic field at

a point, which is 27 cm from either pole. If it is broken into three pieces and one such piece is similarly placed, find the position of the neutral point.

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30. A short bar magnet is placed in a horizontal plane with its axis in the magnetic merdian . Null points are found on its equitorial line (i.e., its normal bisector) at 12.5 G and the angle of dip is zero.

(i) What is the total magnetic field at points on the axis of the magnet located by the same distance (12.5 cm) as the null-points from the centre?

(ii) Locate the null points when the magnet is turned around by 180° .

Assume that the length of the magnet is negligible as compared to the distance of the null-point from the centre of the magnet.

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31. A tangent galvanometer ha s60 turns of wire of mean diameter 20 cm . Find the reduction factor of the tangent galvanometer at a place where the horizontal component of earth's magnetic field $0.32 \times 10^{-4} T$.

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32. The coil of a tangent galvanometer is 11 cm in radius . How many turns of the wire should be wound on it if a current of 70μ A is to

produce a deflection of 45° . Given $B_H = 0.32$ gauss.

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33. A current of 70 mA is passed through a tangent galvanometer of 50 turns having a coil connected to a battery of 6 V having internal resistance of 15Ω. Find the galvanometer resistance.

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34. A tangent galvanometer has a reduction factor of 0. 2A . It gives a deflection of 45° when connected to a bettery of 6 V having internal resistance of 15Ω . Find the galvanometer resistance.

View Text Solution

35. A tangent galvanometer has two circular coils having turns in the ratio 1:10 . When the coil with smaller number of turns is used,a current of 0.5A produces a deflection of 45° .

What will be the reduction factor of the galvanometer when the coil with larger number of turns is used?

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36. A cell having an emf of 2 V and internal resistance of 0.5Ω is sending current through a tangent galvanometer of resistance 4.5Ω. If another external resistance of 95Ω is introducedm the deflection of the

galvanometer is 45° , calculate the reduction factor fof the galvanometer?

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37. Two tangent galvanometer P and Q differ only in the number of turns of their coils and are connected in series. On passing a current through them, the deflections in P and Q are found to gbe 45° and 35° respectively. Calculate the ratio of the number of turns

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38. Two tangent galvanometers P and Q connected in series . The number of turns in P is four times than of Q. When a current is passed through them P shows a deflection of 60° and Q shows a deflection of 30°. What is ratio of the radii of the coils of the two tangent galvanometers ?

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39. A current of 10 A produces a deflection of 45° in a tangent galvanometer. What is the value of the current which will produce a deflection of 30° in the same galvanometer?

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40. In a tangent galvanometer, when a current of $10mA$ is passed, the deflection is 31°. By what percentage, the current has to be

increased, so at to produce a deflection of 42° ?

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41. A circuit coil of radius 20 cm and 20 turns of wire is mounted vertically withits plane in the magnetic meridian. A small magnetic needle placed at the center of the coil is deflected through 45° when a current is passed through the coil. What is the value of

the current? (horizontal induction of earth's field = $3.6x10^{-5}Wb/m^2$

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42. Two tangent galvanometer P and Q are connected in series and a current is passed through them . Radii of coils of P and Q are in the ratio 4:3 while their number of turns are in ratio 4:9 . If the galvanometer P shows a deflection of 30° , find the deflection shown by Q.

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43. A magnetic needle of dipole moment $0.067JT^{-1}$ oscillates with a period of 2/3 s in a uniform magnetic field of 100 G . Find the moment of inertia of the needle about the axis of oscillations.

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44. A small bar magnet of magnetic moment $9.75 \times 10^{-3}JT^{-1}$ is suspended from its

centre of garvity and is free to rotate in a plane containing a uniform magnetic filed. It is displaced from its stable equilibrium and the period of oscillations is found to be 2.50 s.If the moment of inertia of the magnet about its axis of rotation is $1.25 \times 10^{-5} kgm^2$, determine of inertia of the magnetic field.

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45. A magnetic needle pivoted through it centre of mass and free to rotate in a plane

containing a uniform magnetic field of 100 G is displaced slightly from its stable equilibrium . The frequency of its angular oscillations of small amplitudes is measured to be $1.5s^{-1}$. If the moment of inertia of the needle about its axis of rotation is $0.75 \times 10^{-5} kgm^2$, determine the magnetic moment of the needle.

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46. A magnet suspended so as to swing horizontally makes 50 vibrations per minutes at a place where dip is 30° ,and 40 vibrations where sip is 45° . Compare the earth's total fields at the two places.

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47. A magnet is suspended in such a way that it oscillates in the horizontal plane. It makes 20 oscillations per minute at a place where dip

angle is 30° and 15 oscillations minute at a place where dip angle is 60°. The ratio of total earth's magnetic field at the two places is

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48. A magnet makes 12 oscillations per minutes at a place a where the horizontal component of earth's field is $3.2 \times 10^{-3} T$. It is found to require 4 seconds per oscillation at another place B. Calculate the vertical

component of earth's field at place B, if dip at B is 45°.

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49. A magnet makes 10 oscilllations per minute at a place where the angle of dip is 45° and the total intensity is 0.4 gauss. The number of oscillations made per sec by the same magnet at another place where the angle of dip is 60° and the total intensity 0.5 gauss is approximately.

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50. The combination of two bar magnets makes 10 oscillations per second in an oscillation magnetometer when like poles are tied together and 2 oscillations per second when unlike poles are tied together. Find the ratio of the magnetic moments of the magnets. Neglect any induced magnetism.

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51. A small magnet A makes 10 vibrations in 90 seconds in earth's field. When another magnet B of short length is placed 0.1 m due south of the direction of earth's field, the magnet A makes 10 vibrations in 45 seconds . Calculate the magnetic moment of magnet B. Given $B_H = 0.3G$

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52. A thin rod $30cm$ long is uniformly magnetised and its period of oscillation is $4s$. It is broken into three equal parts normal to its length. The period of oscillation of each part is

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53. A short magnet oscillates in a vibration magnetometer with a time period of 0.10 s where the horizontal component of earth's

magnetic field is $24\mu T$. An upward current of 18 A is established in the vertical wire placed 20 cm east of the magnet . Find the new time period.

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54. A bar magnet made of steel has a magnetic moment of $2.5Am^2$ and mass of $6.6 \times 10^{-5}kg$. If the density of steel is $7.9 \times 10^3 kgm^{-3}$, find the intensity of magnetization of the magnet.

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55. Find the percent increase in the magnetic field B when the space within a current-carrying toroid is filled with aluminium. The susceptibility of aluminium is 2.1×10^{-5}.

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56. The susceptibility of magnesium at $300K$ is 1.2×10^{-5}. At what temperature will the susceptibility increase to 1.8×10^{-5}?

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57. An iron rod 0.2 m long, 10 mm in diameter and of permeability 1000 is placed inside a long soleniod wound with 300 turns per meter. If a current of 0.5 ampere is passed through the rod, find the magnetic moment of the rod.

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58. An iron ring of mean circumferential length 30 cm and cross-section 1 cm^2 is wound uniformly with 300 turns of wire . When a current of 0.032 A flows in the windings , flux in the ring 2×10^{-6}Wb . Find the flux density in the ring , magnetising field intensity and relative permeability of iron.

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59. A material core has 10 turns per cm of wire wound uniformly upon it which carries a current of 2.0 A. The flux density in the material is 1.0 WBm^{-2}. Find the magnetising field intensity and magnetisation of the material. What is the relative permeability of the core ?

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60. An iron ring having 500 turns of wire and mean diameter of 12 cm carries a current of 0.3 A. The relative permeability of iron is 600. What is the magnetic flux density in the core ? What is the magnetisation field intensity ? What part of the density is due to the electronic loop currents in the core ?

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