PHYSICS

BOOKS - NN GHOSH PHYSICS (HINGLISH)

INTRODUCTORY NOTES

Example

1. A current element of strength 2×10^{-4} Am is at the corner A of a cube ABCDEFGH of sides

10cm, the element lying along the edge AB. Calcualte the B-field and H-field of the element at the diagonally opposite corner.

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2. Calculate the mass of a chatege particle which will have its horizontal velocity at right angles to the magnetic meridian unchanged. Charge of the particle $= 4.9 \times 10^{-9}$ C. Earth's horizontal intensity 36×10^{-6} T and velocity of particle $= 4 \times 10^{4} ms^{-1}$.

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3. In a hydrogen atoms an electron carrying a charge of 1.6×10^{-19} coulomb (C) makes 6×10^{15} revolutions per second. What is the magnetic moment associated with this orbital motion of the electron ? (radius of the orbit=0.5 $\mathring{A}$).

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4. A current of 0.5 A is passed through the coil of a galvanometer having 500 turns and each turns has an average area of $3 \times 10^{-4} m^2$ if a torque of 1.5 N-m is required for this coil carrying same current to set it parallel to a magnetic field calculate the strength of the magnetic field

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5. A current loop of magnetic moment 0.02 A m^2 or (J T^{-1}) si suspended freely in a magnetic field . In which position will it come to rest in the magnetic field? From this position of rest if it is turned through 60° , what is the work done? (B=0.2 T)

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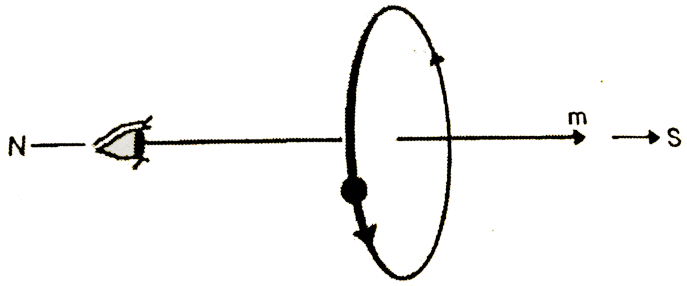
6. A ball suspended by a thread which is 1 m long is charged with +0.1 microcoulomb . It is

then whirled very rapidly ina vertical plane at right angle to the magnetic meridian at the rate of 10 revloutions per second. What is the magnetic moment associated with his motion of the ball? If to an observer to the north of it, ball appears to rotate in the clockwise , what is the specific direction of this magnetic moment ?



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7. A rod of tranverse section $3 \times 10^{-6} m^2$ is magnetized lengthwise to saturation by a strong magnetic field. The magnetic moment of each atom of the material of the rod is $10\mu_B$ (μ_B is the Bohr magnetic) . Calculate the pole strength of the rod if its length is 10cm . There are 5×10^{21} atoms per unit volume of the rod. $\left(\mu_B = 9.2 \times 10^{-24} Am^2\right)$

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8. A current I flows radius along a lengthy thin-walled tube of radisu R with longiitual slit of width h. Find the induction of the magnietic field inside the tube under the condition $h < < R$

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9. Two protons move parallel to each other with an equal velocity $v = 300kms^{-1}$. Find

the ratio of forces of magnetic and electric interaction of the protons.

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Exercise

1. A current element of 2 milliampere meter is at the corner. A of a unit cube ABCDEFGH, the element being along AB. Calculate the field at the remaining seven corners of the cube (figure 1.5).

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2. Two currrent elements 2×10^{-4} A m and 5×10^{-4} Am are placed at the vertices A and B of an equilateral triangle along AB in the same sense. Calculate the magnetic field at C. (Each side of the triangle measures 10 cm)

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3. Four corner elements of length 0.01 cm carrying 10^{-3} A lie at the four corners of a

square ABCD along AB, BC, CD and DA. Calculate the magneti field at the centre of the square. Each side of the square =10 cm.

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4. A current elemetns of 0.2 A m is fixed at the centre of a circle of radius 10 cm . Another element of strength 0.5 A m is placed along the circumference and moved round the circle. At which positions will they sent maximum force on each other? Calculate these forces.

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5. Two current elements of strength 0.2 A m and 0.4 A m from a cross at the centre of a circle of radius 10 cm Calculate the magnetic field at a point on the circle 30° away (anticlockwise) from the first element.

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6. calculate the force experinced by an electron when it enters a uniform magnetic

field of strength 2 T with vleocity $0.2 \times 10^{8} ms^{-1}$ at right angles to the field. What kind of motion will it have in the magnetic field ? (Charge of electron 1.6×10^{-19} coulomb.)

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7. An electron of velocity $2 \times 10^{6} ms^{-1}$ is moving in magneitc field of strength 1 T making an angle 45° with it. Find the magnitude and direction of the magnetic

force experienced by it. Charge of electron $= 1.6 \times 10^{-19}$ C.

[Hint : $\vec{F} = q_0 \vec{v} \times \vec{B}$.]

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8. A ball of mass 2×10^{-3} kg carries a charge of 2×10^{-8} C. This ball is given an initial horizontal velocity of $5 \times 10^4 ms^{-1}$ in the earth's gravitational field. What is the magnetic field required to keep the ball moving without deflection ?

[Hint : F_m (magnetic force) $= q_0 v B \sin\theta = \omega g$

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9. The plane of a rectangular coil of wire of dimensions $0.05 \times 0.10 m$ and carrying a current of 10 A ,is parallel to a magnetic field of 0.1 T . What is the torque on the coil? What will be the torque when the normal to the coil makes an angle of 30° with the direction of the field ?

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10. Considering $\theta = \pi/2$ as the zero-energy position of a current loop of magnetic moment m placed in a magnetic field of strength B,find the minimum potential energy. In what position is the potential energy minimum? Is this an equilibrium position ? What will be the work done in turning it through α from this position ? Examine whether you get the dame position for

equilibrium and same value for work if $\theta = 0$ is taken as the zero-energy position.

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11. A ring of dielectric material, with a total charge +q distributed uniformly over its surface, rotates with angular speed ω. Find the magnetic moment of the ring .Compare its magnetic moment with its angular momentum , assuming that its mass is m.

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12. A this disc of dielectric material, with a total charge +q distributed uniformly over its surface, rotates with angular speed ω about an axis perpendicular to the disc and passing through its centre .Find the magnetic moment with its angular momentum , assuming that its mass is m.

[Hint : Consider a ring of radius x and thickness dx. Calculate charge on it and then the current consituited by its rotation .Find its

magnetic moment and integrate for the whole disc.]

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13. Electric charge +q is iniformaly distributed over the entire volume of a sphere of radius r. Calculate the magnetic moment of the sphere if it spins about its diameter with angular speed ω . Compare this moment with its angular momentum, assuming that its mass is m.

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14. An insulated wire is wound so that it forms a flat coil with N=100 turns. The radius of the innermost turns is $R_1 = 4cm$. What magnetic moment will this coil have when a current of I=10 mA flows in it ?

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15. Apply Ampere's solenoid in terms of linear density of turns n and current I.

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16. Apply Ampere's circuital law to determine the magnetic induction inside a thick wire of radius R and carrying I amperes of current.

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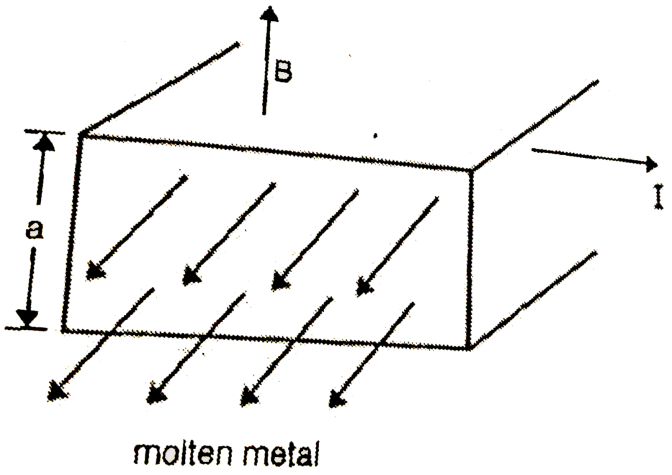
17. In a device called electronmagnetic pump for transferring molten metals ,a rectangular pipe is placed in a uniform magneitc field B

perpendicular to its axis and one of the sides of the section and a strong current I in then passed perpendicular to both B and the axes of the pipe . The molten metal is then passed through the pipe . What is the guage pressure produced by the pump ?



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18. A current I flows in a long thin walled cylinder of radius R. What pressure do the walls of the cylinder experience ?

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19. A current I flows in a long single layer solenoid with cross-sectional radius R. The number of turns per unit length of the solenoid equals n. Find the limiting current at

which the winding may ruputure if the tensile strength of the wire is equal to F_{lim}.

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20. What pressure does the lateral surface of a long straight solenoid with n turns per unit length experience when a current I flows through it.

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21. Find the magntiude and diraction of the magnitude induction vector B

(a) of an infinite palne carrying a current of linear density I, the vector i is the same at all points of the plane,

(b) of two parallel infinite planes carrying currents of linear densities a dn -1, the vectors i and $-i$ are cohnstant at all points of the corresponding planes.

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22. A unifrom current of density f flows inside an infinite plate of thickness $2d$ parallel to its surface . Find the magentic induction induced by this current as a funcition of the distance x from the median palane of the plate. The magnitude permeability is assumed to be equal to unity both inside and outside the plates.

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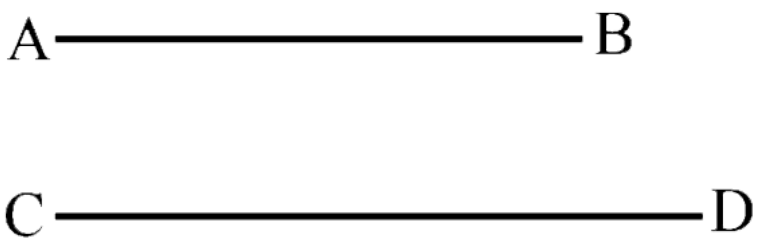
23. A long horizontal wire AB, which is free to move in a vertical plane and carries a steady current of $20A$, is in equilibrium at a height of $0.01m$ over another parallel long wire CD which is fixed in a horizontal plane and carries a steady current of $30A$, as shown in figure. Shown that when AB is slightly depressed, it executes simple harmonic motion. Find the

period of oscillations.



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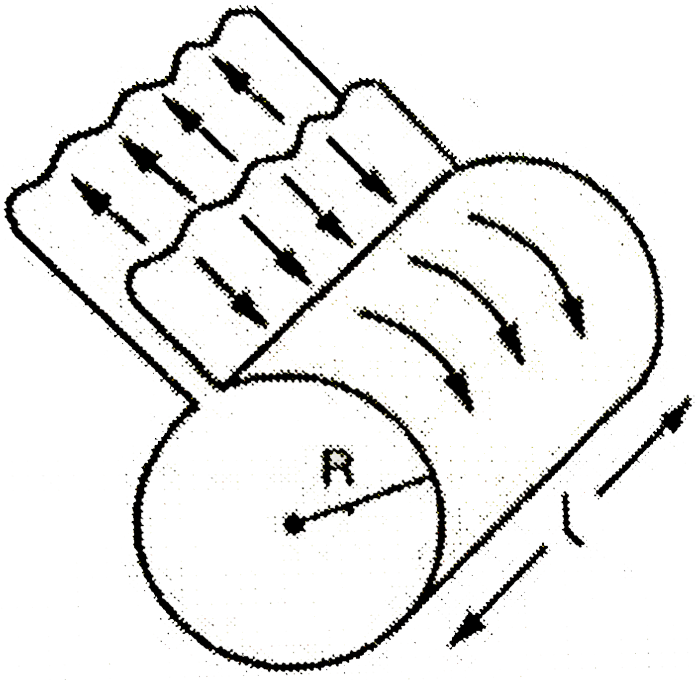
24. A wide copper strip of width l is bent into piece of slendder tubing of radius R with two plane extension as shown (Fig. 1.12). A current I flows through the strip, distributed uniformly

over its width. Ib this way, one-turn solenoid has been formed (a) Derive an expression for the magnetic field in the tubular part.



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25. Figure shows a cross-section of a long ribbon of width ω that is carrying a uniformly distributed total current i into the page. Calculate the magnitude and direction of the magnetic field B at a point P in the plane of the ribbon at a distance d from its edge. `

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26. The current density $\bar{J}$ inside a long, solid cylindrical wire of radius $a = 12mm$ is in the direction of the central axis, and its magnitude varies linearly with radial distance r from the axis according to $J = \frac{J_0 r}{a}$, where $J_0 = \frac{10^5}{4\pi} A/m^2$. Find the magnitude of the magnetic field at $r = \frac{a}{2}$ in μT

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27. A long cylindrical conductor of radius a contains a long cylindrical holr of radius l. The axes of the two cylinders are parallel and are at a distance d apart. A current I is uniformly distributed over the cross-section. Find the magnetic field at the centre of the hole.

[Hint: Apply the principle of superposition of magnetic field]

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