PHYSICS

BOOKS - HC VERMA PHYSICS (HINGLISH)

MAGNETIC FIELD

Examples

1. A proton is projected with a speed of $3X10^6 ms^{-1}$ horizontally from est to west. A uniform magnetic field $\overrightarrow{B} ofstren > h2.0X10^{-3}$ T exists in the vertically upward direction(a) find the force on the proton just after it is projected. (b) what is the acceleration produced?

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2. A particle having a charge of $100\mu C$ and a mass of 10mg is projected in a uniform magnetic field of 25m T with a speed of $10ms^{-1}$. If the velocity is perpendicular to the magnetic field , how long will it take for the particle to come back to its original position for the first time after being projected.

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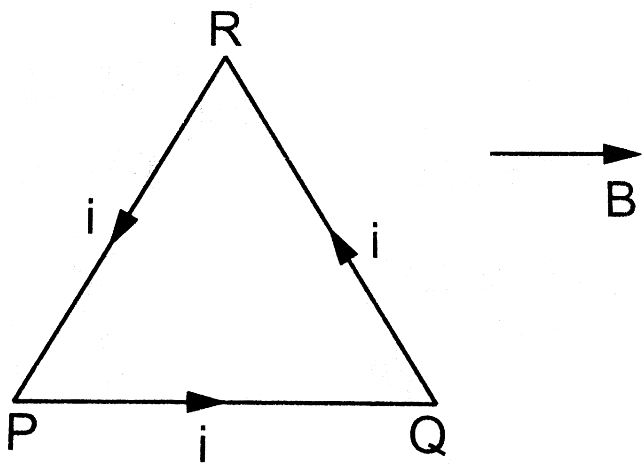
3. shows a triangular loop PQR carrying a current i. The triangle is equilateral with edge-length i. A uniform magnetic field B exists in a direction parallel to PQ. Find the forces acting on the three wirs PQ, QR and RP separately.



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4. A current of 10.0 nA is established in a circular loop of radius 5.0 cm. find the magnetic dipole moment of the current loop. : The magnetic dipole moment is $\vec{\mu} = \vec{i}A$.

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5. A wire placed along north-south direction carries a current of 10 A from south to north. Find the magnetic field due to a 1 cm piece of wire at a point 200cm north-east from the piece.

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6. Figure shows two long, straight wires carrying electric currents in opposite directions. The separation between the wires is 5.0 cm. Find the magnetic field at a point P midway between the wires.

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7. The long, staight wires, each carrying an electric current of 5.0 A, are kept parallel to each other at a separation of 2.5 cm. Find the magnitude of the magnetic force experienced by 10 cm of a wire.

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8. A circular coil of radius $1 \cdot 5 cm carries a current of 1 \cdot 5 A$. If the coil has 25 turns , find the magnetic field at the centre.

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9. A long solenoid is formed by winding 20 turns cm^{-1}. What current is necessary to produce a magnetic field of $20 mT$ inside the solenoid?

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Worked Out Examples

1. A charge of$2.0 \mu C$ moves with a speed of $2.0 X 10^6 ms^{-1}$ along the positive x-axis. A magnetic field $\vec{B}$ of strength $\left(0.20 \vec{J} + 0.40 \vec{k}\right) T$ exists in space. Find the magnetic force acting on the charge

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2. A wire is bent in the form of an equilateral triangle PQR of side 10 cm and carrise a current of 5.0 A. It is placed in a magnetic field B of magnitude 2.0 T directd perpendicularly to the plane of the loop. Find the forces on the three sides of the triangle.

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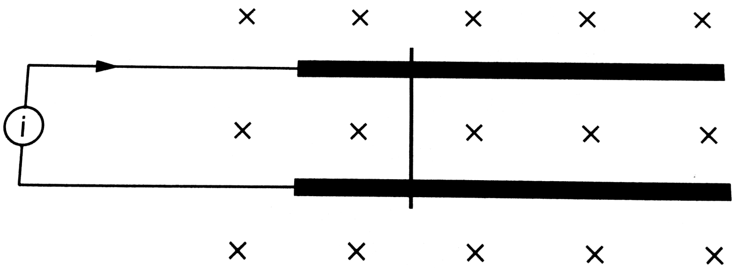
3. Shows two long metal rails placed horizontally and parallel to each other at a separation i. A uniform magnetic field b exists in the vertically downward direction. A wire of mass m can slide on the rails. The rails are connected to a constant current source which drives a current I in the circuirt. The friction coefficient between the rails and the wire is μ. (a) What should be the minimum value of μ which can prevent the wire from sliding on the rails? (b) Describe the motion of the wire if the value of μ is half the value found in the previous part.



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4. A proton, a deuteron and α-particle, whose kinetic energies are same, enter perpendicularly a uniform magnetic field. Compare the radii of their circular paths.

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5. Singly charged magnesium (A=24) ions are accelerated to kinetic energy $2keV$ and are projected perpendicularly into a magnetic field B of magnitude 0.6 T. (a) Find the radius of the circle formed by the ions. (b) If there are also singly charged ions of the isotope magnesium.26, what would be the radius for these particles?

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6. A particle having a charge$20\mu C$ and mass $20\mu g$ moves along a circle of radius 5.0 cm under the action of a magnetic field 5.0 cm under the action of a magnetic field B = 1.0 T. When the particle is at a point P, a uniform electric field is switched on and it is found that the particla continues on the tangent through P qith a uniform velocity. Find the electric field.

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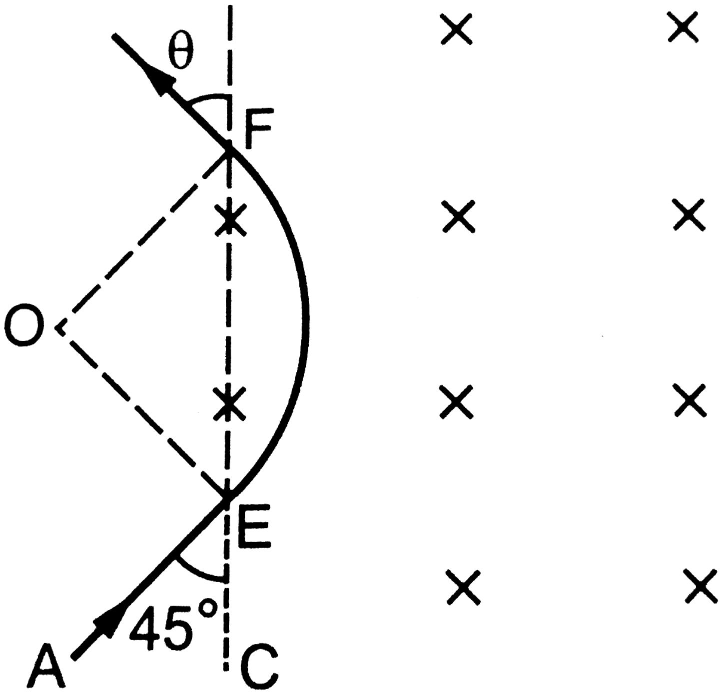
7. A particle of mass $m = 1.6 \times 10^{27}$ kg and charge $q = 1.6 \times 10^{-19}$ C moves at a speed of $1.0 \times 10^{7} ms^{-7}$. It enters a region of uniform magnetic field at a point E, as shown in The field has a strength of 1.0 T. (a) The magnetic field is directed into the plane of the paper. The particle leaves the region of the filed at the point F. Find the distance EF and the angle theta. (b) If the field is coming out of the paper, find the time spent by the particle in the region of the magnetic field after entering it at E.



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8. A beam of protons with a velocity of $4X10^5 ms^{-1}$ enters a uniform magnetic field of 0.3 T. The velocity makes an angle of 60° with the magnetic field. Find the radius of the helicla path taken by the proton beam and the pitch of the helix.

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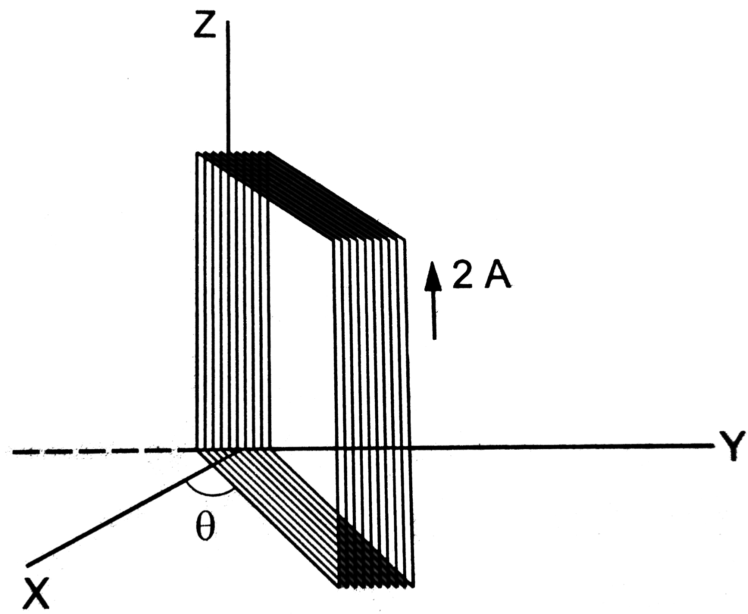
9. A rectangular coil of size 3.0 cm X4.0 cm and having 100 turns, is pivoted about the z-axis as shown in figure the colil carries an electric current of 2.0 A and a magnetic field of 1.0 T is present along the y-axis. Find the torque acting on the coil if the side in the x-y plane makes an angle $\theta = 37^{\circ}$ with the x - axis.



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10. An electron moves with a constant speed v along a circle of radius r.(a) find the equivalent current through a point on its path.(b) Find the magnetic moment of the circulating electron.(c) Find the ratio of the magnetic moment to the angular momentum of the electron.

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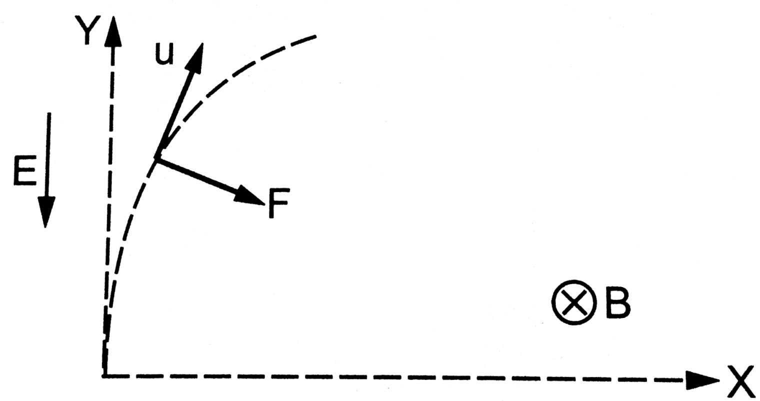
11. An electron is released from the origin at a place where a uniform electric field E and a uniform magnetic field B exist along the negative y-axis and the nagative z-axis respectively. Find the displacement of the electron along the y-axis when its velocitybecomes perpendicular to the electric feld for the first time.



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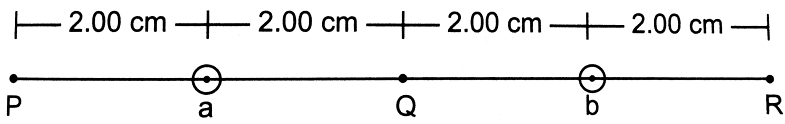
12. Two long wires a and b, carrying equal currents of 10*0A, are placed parallel to each other with a separation of 4*00 cm between them as shown in figure. Find the magnetic field B at each of the points P,Q and R.



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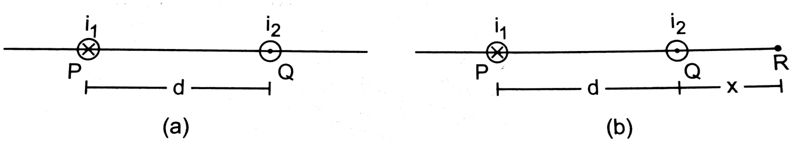
13. Two parallel wires P and Q placed at a separation

$d = 6cmcarrye \leq ctriccurrentsi_1 = 5A$ and $i_2 = 2A \in$

$oppositedirectionsasshown \in figure. F \in dthe$

$p\oint onthel \in ePQwherethereres\underline{\tan}tmag \neq ticfield$

is zero.



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14. Two long, straight wires a and b are $2 \cdot 0$ m apart,

perpendicular to the plane of the paper as shown in figure

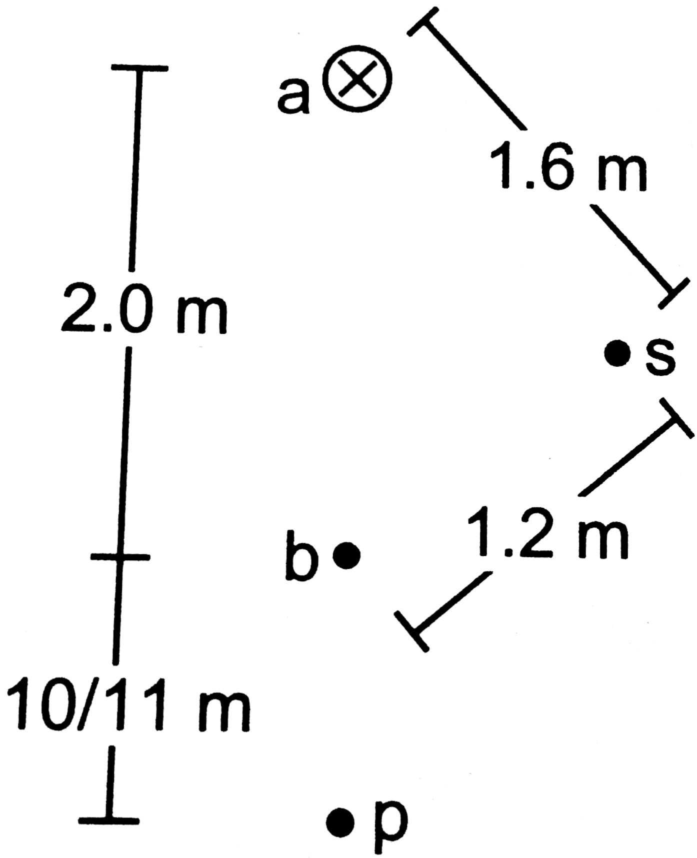
. The wire a carries a current of $9 \cdot 6A$ directed

into the plane of the figure,The magnetic field at the

point P at a distance of 10/11 m from the wire b is zero.

Find (a) the magnitude and direction of the current in b,

(b) the magnitude of the magnetic field B at the point s and (c) the force per unit length on the wire b`.



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15. A current of$2 \cdot 00A$ exists in a square loop of edge $10 \cdot 0cm$. Find the magnetic field B at the centre of the square loop.

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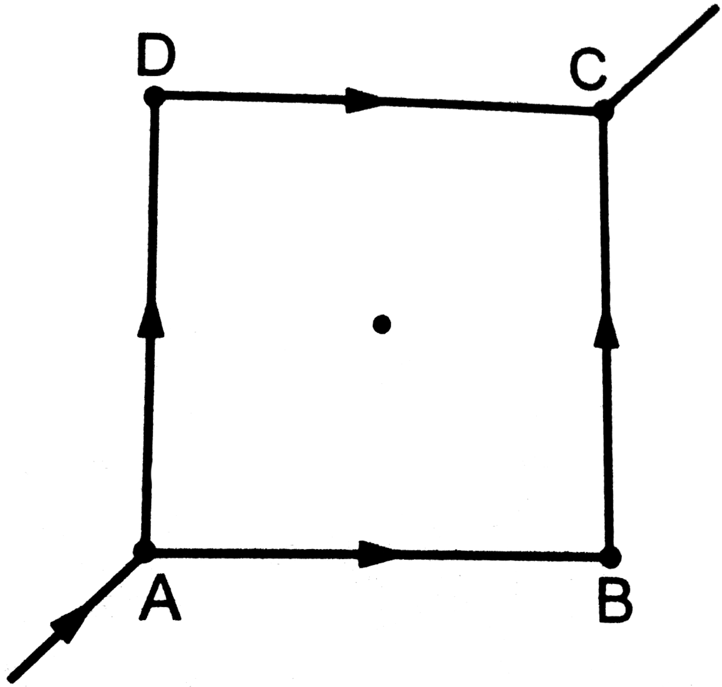
16. Figure shows a square loop made from a uniform wire. Find the magnetic field at the centre of the square if a battery is connected between the points A and C.



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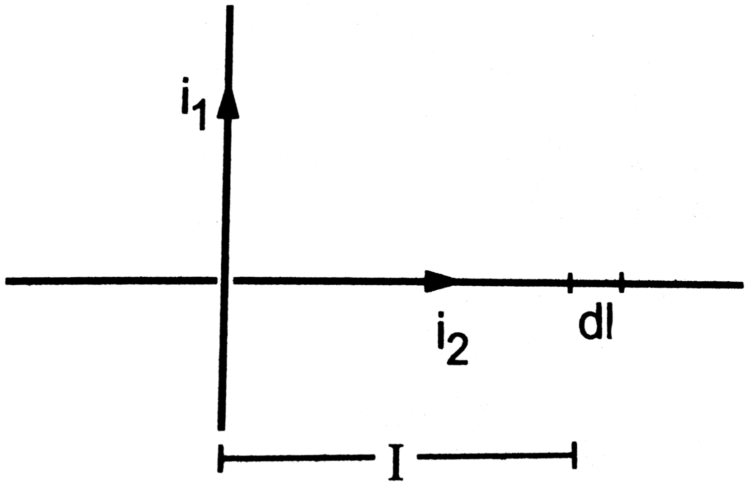
17. Two long wires, carrying currents i_1 and i_2, are placed perpendicular to each other in such a way that they just avoid a contact. Find the magnetic force on a small length dl of the second wire situated at a distance l from the first wire. (figure)



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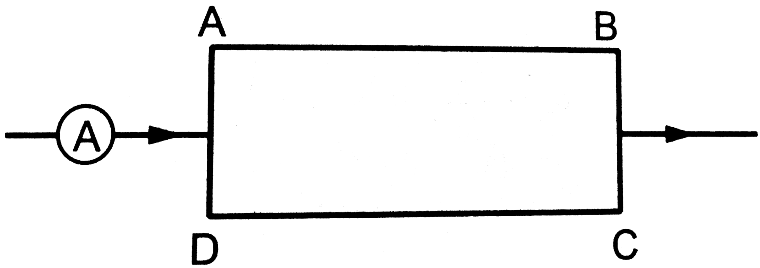
18. Figure shows a part of an electric circuit. ABCD is a rectangular loop made of uniform wire. The length AD= BC = 1 cm. The sides AB and DC are long as compared to the other two sides. Find the magnetic force per unit length acting on the wire DC due to the wire AB if the ammeter reads

10A.



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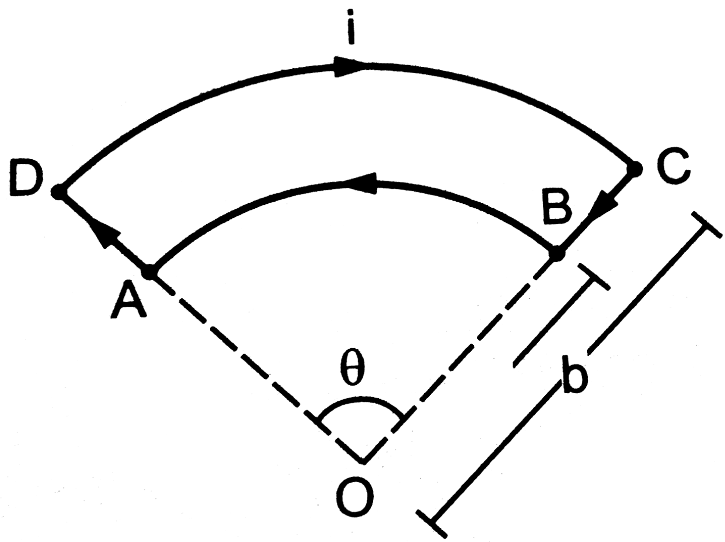
19. Figure shows a current loop having two circular arcs joined by two radial lines. Find the magnetic field B at the centre O.



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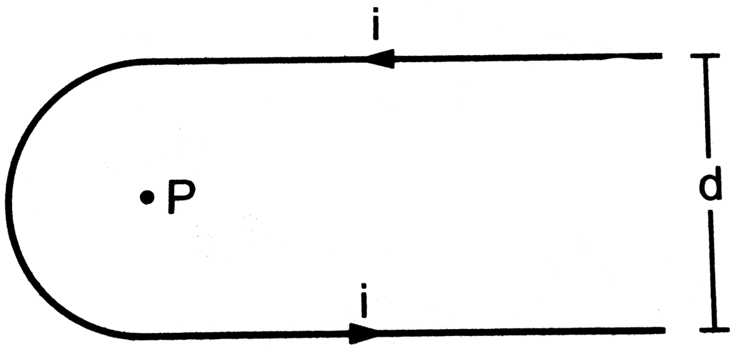
20. Find the magnetic field at the point P in figure. The curved portion is a semicircle and the straight wires are long.



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21. The magnetic field B due to a current- carrying circular loop of radius 12cm at its center is $0.50 \times (10^{-4})T$. Find the magnetic field due to this loop at a point on the axis at a distance of 5.0 cm from the centre.

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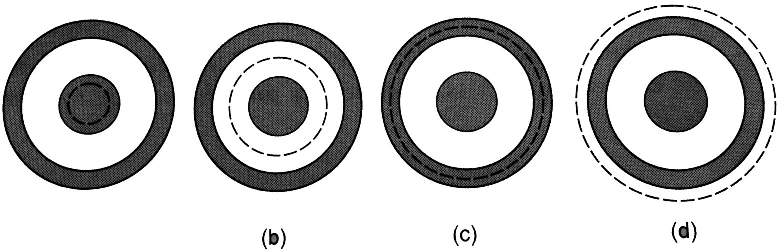
22. Consider a coaxial cable which consists of an inner wire of radius a surrounded by an outer shell of inner and outer radii b and c respectively. The inner wire carries an electric current (i_0) and the outer shell carries an equal current in opposite direction. Find the magnetic field at a distance x from the axis where (a) $x < a$, (b) $a < x < b$, (c) $b < x < c$ and (d)$x > c$. Assume that the current density is uniform in the inner wire and also uniform in the outer shell.



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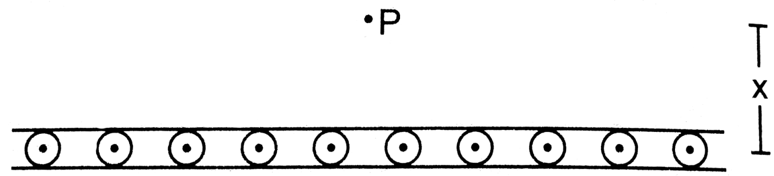
23. Figure shows a cross section of a large metal. Sheet carrying an electric current along its surface. The current in a strip of width dl is Kdl where K is a constant. Find the magnetic field at a point P at a distance x from the metal sheet.



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24. Consider the situation described in the previous example. A particle of mass m having a charge q is placed at a distance d from the metal sheet and is projected towards it. Find the maximum velocity of projection for which the particle does not hit the sheet.

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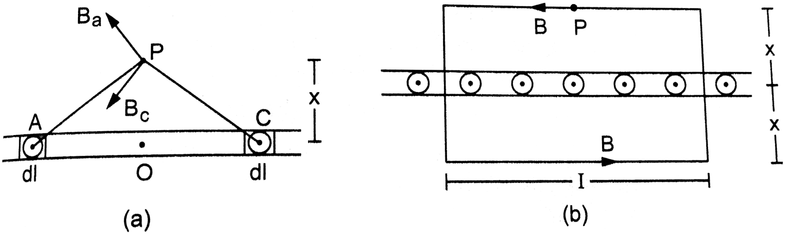
25. Three identical long solenoids P,Q and R are connected to each other as shown in figure . If the magnetic field at the centre of P is 2.0 T, what would be the field at the centre of Q? Assume that the field due to any solenoid is confined within the volume of that solenoid only.



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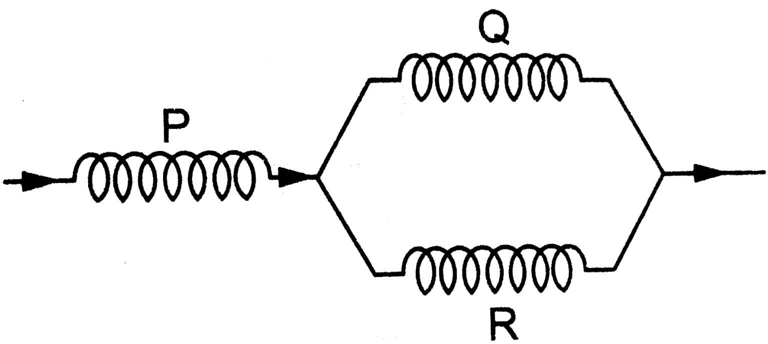
26. A long , straight wire carries a current i. A particle having a positive charge q and mass m, kept at a distance x_0 from the wire is projected towards it with a speed v. Find the minimum separation between the wire and the particle.



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Short Answer

1. Suppose a charged particle moves with a velocity v near a wire carrying an electric current. A magnetic force, therefore, acts on it. If the same particle is seen form a frame moving with velocity v in the same direction the charge will be found at rest. Will the magnetic force become zero in this frame? Will the magnetic field become zero in this frame?

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2. Can a charged particle be accelerated by a magnetic field? Can its speed be increased?

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3. Will a current loop placed in a magnetic always experience a zero force?

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4. The free electrons is conducting wire are in constant thermal motion. If such a wire, carrying no current, is placed in a magnetic field, is there a magnetic force on each free electron? Is there a magnetic force on the wire?

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5. Assume that the magnetic field is uniform in a cubical region and is zero outside. Can you project a charged particle from outside into the field so that the particle describes a complete circle in the field?

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6. An electron beam projected along the positive x-axis deflects along the positive y-axis deflects along the positive y-axis. If this deflection is caused by a magnetic field, what is the directon of the field? Can we conclude that is parallel to the z-asix?

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7. Is it possible for a current loop to stay without rotating in a uniform magnetic field? If yes, what should be the orientation of the loop?

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8. The net charge in a current carrying wire is zero. Them, why does a magnetic field exert a force on it?

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9. The torque on a current loop is zero if the angle between the positive normal and the magnetic field is either $\theta = 0$ or $\theta = 180^\circ$. In which of the two orientations, the equilibrium is stable?

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10. Verify that the units weber and volt second are the same.

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11. An electric current flows in a wire from north to south.

What will be the direction of the magnetic field due to this wire at a point.

A. east of the wire,

B. west of the wire,

C. vertically above the wire and

D. vertically below the wire?

Answer:

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12. The magnetic field due to a long straight wire has been derived in terms of μ_0,i and d. Express this in terms of varepsilon_0, c, I, and d.

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13. You are facing a circular wire carrying an electric current. The current is clockwise as seen by you. Is the field at the centre coming towards you or going away from you?

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14. In Ampere's law $\left(\oint\left(\overrightarrow{B}\right).\left(\overrightarrow{d}l\right)\right)=(\mu_0)I$, the current outside the curve is not included on the right hand side. Does it mean that the magnetic field B calculated by using Ampere's law , gives the contribution of only the currents crossing the area bounded by the curve?

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15. The magnetic field inside a tightly wound, long solenoid is $B = (\mu_0)ni$. It suggests that the field does not depend on the total length of the solenoid, and hence if we add more loops at the ends of a solenoid the field should not increase. Explain qualitatively why the extra added loops do not have a considerable effect on the field inside the solenoid.

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16. A long, straight wire carries a current. Is Ampere's law valid for a loop that does not enclose the wire, or that encloses the wire but is not circular?

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17. A straight wire carrying an electric current is placed along the axis of a uniformly charged ring. Will there be a magnetic force on the wire if the ring starts rotating about the wire? If yes, in which direction?

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18. Two wires carrying equal currents i each, are placed perpendicular to each other, just avoiding a contact. If one wire is held fixed and the other is free to move under magnetic forces, what kind of motion wil results?

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19. Two proton beams going in the same direction repel each other whereas two wires carrying currents in the same direction attract each other. Explain.

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20. In order to have a current in a long wire, it should be connected to a battery or some such device. Can we obtain the magnetic field due to a straight, long wire by using Ampere's law without mentioning this other part of the circuit?

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21. Quite often, connecting wires carrying currents in opposite directions are twisted together in using electrical appliances. Explain how it avoids unwanted magnetic fields.

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22. Two currents- carrying wires may attract each other. In absence of other forces, the wires will move towards each other increasing the kinetic energy . Does it contradict the fact that the magnetic force cannot do any work and hence cannot increase the kinetic energy?

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Objective 1

1. A positively charged particle projected towards east is deflected towards north by a magnetic field. The field may be

A. towards west

B. towards south

C. upward

D. downward

Answer: downward

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2. A charged particle is whirled in a horizontal circle on a frictionless table by attaching it to a string fixed at one pint. If a magnetic field is switched on in the vertical direction, the tension in the string

A. will increase

B. will decrease

C. will remai the same

D. may increase or decrease

Answer: may increasec or decrease

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3. Which of the following particles will describe will experience maximum magnetic force(magnitude) when projected with the same velocity perpendicular to a magnetic field?

A. Electron

B. Proton

C. He^{+}

D. Li^{++}

Answer: D

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4. Which of the following particles will describe the smallest circle when projected with the same velocity perpendicular to a magnetic field?

A. Electron

B. Proton

C. He^{+}

D. Li^{++}

Answer: A

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5. Which of the follwing particles will have minimum frequency of revolution when projected with the same velocity perpendicular to a magnetic field?

A. Electron

B. Proton

C. He^{+}

D. Li^{++}

Answer: D

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6. A circular loop of area $1cm^2$, carrying a current of 10 A , is placed in a magnetic field of 0.1 T perpendicular to the plane of the loop. The torque on the loop due to the magnetic field is

A. Zero

B. $10^{-4}Nm$

C. $10^{-2}Nm$

D. 1 N m

Answer: A

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7. A beam consisting of protons and electrons moving at the same speed goes through athin region in which there is a magnetic field perpendicular to the beam. Protons and the electrons

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8. A charged particle moves in a uniform magnetic field. The velocity of the particle at some instant makes an acute angle with the magnetic field. The path of the particle will be

A. a straight line

B. a circle

C. a helix with uniform pitch

D. a helix with nonuniform pitch

Answer: a helix with uniform pitch

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9. A particle moves in a region having a uniform magnetic field and a parallel, uniform electric field. At some instant, the velocity of the particle is perpendicular to the field directjion. The path of the particle will be

A. a straight line

B. a circle

C. a helix with uniform pitch

D. a helix with nonuniform pitch

Answer: a helix with nonuniform pitch

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10. An electric current I enters and leaves a uniform circular wire of radius a through diametrically opposite points. A charged paricle q moving along the axis of the circular wire passes through its centre at speed v. The magnetic force acting on the particle when it passes through the centre has a magnitude

A. $qv\frac{\mu_0 i}{2a}$

B. $qv\frac{\mu_0 i}{2\pi a}$

C. $qv\frac{\mu_0 i}{a}$

D. zero

Answer: D

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11. A vertical wire carries a current in upward direction. An electron beam sent horizontally towards the wire will be deflected

A. towards right

B. towards left

C. upwards

D. downwards

Answer: C

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12. A current- carrying straight wire is kept along the axis of a circular loop carrying a current. The straight wire

A. will exert an inward force on the circular loop

B. will exert an outward force on the circular loop

C. will not exert any force on the circular loop

D. will exert a force on the circular loop parallel to itself.

Answer: C

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13. A proton beam is going from north to south and an electron beam is going from south to north. Neglecting the earth's magnetic field, the electron beam will be deflected

A. towards the proton beam

B. away from the proton beam

C. upwards

D. downwards

Answer: A

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14. A circular loop is kept in that vertical plane which contains the north-south direction. It carries a current that is towards north at the topmost point. Let A be a point on the axis of the circle to the east of it and B a point on this axis to the west of it. The magnetic field due to the loop.

A. is towards east at A and towards west at B

B. is towards west at A and towards east at B

C. is towards east at both A and B

D. is towards west at both A and B.

Answer: D

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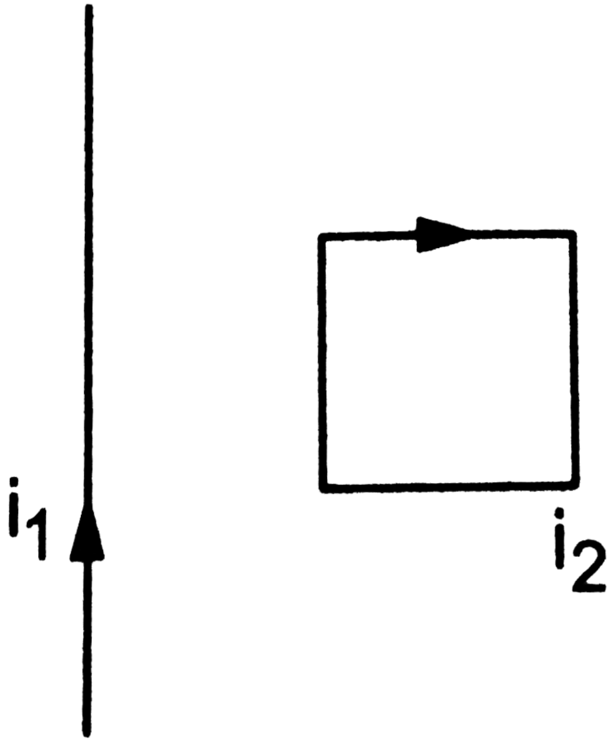
15. Consider the situation shown in figure. The straight wire is fixed but the loop can move under magnetic force. The loop will



A. remain stationary

B. move towards the wire

C. move away form the wire

D. rotate about the wire.

Answer: B

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16. A charged particle is moved along a magnetic field line. The magnetic force on the particle is

A. along its velocity

B. opposite to its velocity

C. perpendicular to its velocity

D. zero.

Answer: D

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17. A moving charge produces

A. electric field only

B. magnetic field only

C. both of them

D. none of them.

Answer: C

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18. A particle is projected in a plane perpendicular to a uniform magnetic field. The area bounded by the path described by the particle is proportional to

A. the velocity

B. the momentum

C. the kinetic energy

D. none of them.

Answer: C

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19. Two particle X and Y having equal charge, after being accelerated through the same potential difference enter a region of uniform magnetic field and describe circular paths of radii R_1 and R_2 respectively. The ratio of the mass of X to that of Y is

A. $\left(\frac{R_1}{R_2}\right)^{\frac{1}{2}}$

B. $\frac{R_1}{R_2}$

C. $\left(\frac{R_1}{R_2}\right)^2$

D. $(R_1)(R_2)$

Answer: C

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20. Two parallel wires carry currents of 20A and 40A in opposite directions. Another wire carrying a current antiparallel to 20A is placed midway between the two wires. The magnetic force on it will be

A. towards 20 A

B. towards 40 A

C. zero

D. perpendicular to the plane of the currents .

Answer: B

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21. Two parallel, long wires carry currents i_1 and i_2 with $i_1 > i_2$. When the currents are in the same direction, the magnetic field at a point midway between the wires is 10mu T. If the direction of i_2 is reversed, the field becomes 30mu T . The ration $\frac{i_1}{i_2}$ is

A. 4

B. 3

C. 2

D. 1

Answer: C

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22. Consider a long, straight wire of cross-sectional area A carrying a current i. Let there be n free electrons per unit volume. An observed places himself on a trolley moving in the direction opposite to the current with a moving in the direction opposite to the current with a speed `(v= i/nAe) and separated from the wire by a distance r. The magnetic field seen by the observer is very nearly

A. $\frac{\mu_0 i}{2\pi r}$

B. zero

C. $\frac{\mu_0 i}{\pi r}$

D. $\frac{(2\mu_0)i}{\pi r}$

Answer: A

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Objective 2

1. If a charged particle at rest experiences no electromagnetic force, then electric field in that region

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2. If a charged particle kept at rest experiences an electromagnetic force,

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3. if a charged particle projected in a gravity free room deflects,

A. there must be an electric field

B. there must be an magnetic field

C. both field cannot be zero

D. both fields can be zero

Answer: (c)both field cannot be zero (d)both fields can be zero

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4. a charged particle moves in a gravity free space without change in velocity. Which of the following is/are possible?

A. $E = 0, B = 0$

B. $E = 0, B \neq 0$

C. $E \neq 0, B = 0$

D. $E \neq 0, B \neq 0$

Answer: (a) (b) (d)

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5. A charged particle moves along a circle under the action of possible constant electric and magnetic fields. Which of the following are possible?

A. $E = 0, B = 0$

B. $E = 0, B \neq 0$

C. $E \neq 0, B = 0$

D. $E \neq 0, B \neq 0$

Answer: $E = 0, B \neq 0$

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6. A charged paricle goes undeflected in a region containing electric and magnetic field. It is possible that

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7. If a charged particle goes unaccelerated in a region containing electric and magnetic fields,

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8. Two ions have equal masses but one is singly- ionized and the other is doubly- ionized. They are pojected from the same place in a uniform magnetic field with the same velocity perpendicular to the field.

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9. A positively charged particle is moving along the positive X-axis.You want to apply a magnetic field for a short time so that the particle may reverse its direction and move parallel to the negative X-axis.This can be done be applying the magnetic field along.

A. y-axis

B. z-axis

C. y-axis only

D. z-axis only

Answer: (a) (b)

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10. Let vecE and vecB denote electric and magnetic fields in a frame S and vecE and vecB in another frame S moving with respect to S at a velocity vecv. Two of the following equations are wrong. Identify them.

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11. The magnetic field at the origin due to a current element I $\left(\vec{d}\ l\right) placedataposi \rightarrow n\left(\vec{r}\right) is$

A. $\left(\left(\frac{\mu_0 i}{4\pi}\right)\frac{\vec{dl} \times \vec{r}}{r^3}\right)$

B. $\left(-\left((\mu_0)\frac{i}{4\pi}\left(\vec{r} \times \frac{\vec{dl}}{r^3}\right)\right)\right)$

C. $\left((\mu_0)\frac{i}{4\pi}\left(\vec{r}\times\frac{\vec{dl}}{r^3}\right)\right)$

D. $\left(-\left((\mu_0)\frac{i}{4\pi}\frac{\vec{dl}\times\vec{r}}{r^3}\right)\right)$

Answer: C::D

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12. Consider three quantities ($x=\frac{E}{B}, y=\left(\sqrt{\frac{1}{(\mu_0)(\varepsilon_0)}}\right)$ and $z=\left(\frac{1}{C}R\right)$. Here, l is the length of a wire, C is a capacitance and R is a resistance. All other symbols have standard meanings.

A. x,y have the same dimensions.

B. y,z have the same dimensions.

C. z,x have the same dimensions.

D. none of the three pairs have the same dimensions.

Answer: A::B::C

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13. A long, straight wire carries a current along the z-axis. One can find two points in the x-y plane such that

A. the magnetic fields are equal

B. the directions of the magnetic fields are the same

C. the magnitudes of the magnetic fields are equal

D. the field at one point is opposite to that at the other point.

Answer: B::C::D

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14. A long, straight wire of radius R carries a current distributed uniformly over its cross section. The magnitude of the magnetic field is

A. maximum at the axis of the wire

B. minimum at the axis of the wire

C. maximum at the surface of the wire

D. minimum at the surface of the wire.

Answer: B::C

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15. A hollow tube is carrying an electric current along its length distributed uniformly over its surface. The magnetic field

A. increase linearly from the axis to the surface.

B. is constant inside the tube

C. is zero at the axis

D. is zero just outside the tude.

Answer: B::C

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16. In a coaxial, straight cable, the central conductor and the outer conductor carry equal currents in opposite directions. The magnetic field is zero.

A. outside the cable

B. inside the inner conductor

C. inside the outer conductor

D. in between the two conductor

Answer: A

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17. A steady electric current is flowing through a cylindrical conductor. Then,

A. The electric field at the axis of the conductor is zero.

B. The magnetic field at the axis of the conductor is zero.

C. The electric field in the vicinity of the conductor is zero.

D. The magnetic field in the vicinity of the conductor is zero.

Answer: B::C

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Exercises

1. An alpha particle is projected vertically upward a speed of $3.0 \times 10^4 kms^{-1}$ in a region where a magnetic field of magnitude 1.0 T exists in the direction south to north. Find the magnetic force that acts on the a particle.

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2. An electron is projectd horizontally with a kinetic energy of 10 keV. A magnetic feld of strength $1.0X10^{-7}$ T exists in the vertically upward direction. (a)will the electron deflect towards right or towards left of its motion? (b) calculate the sideways deflection of the electrion in travelling through 1m. make appropriate approximations.

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3. A magnetic field of $\left(4.0X10^{-3}\vec{k}\right)$ T exerts a force of $\left(4.0\vec{i}+3.0\vec{j}x10^{-10}\right.$ N on a particle having a charge of $1.0X10^{-9}$ C and going in the x-y plane. Find the velocity of the particle.

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4. An experimenter's diary reads as follows: "a charged particle is projected in a magnetic feld of $\left(7.0\vec{i}-3.0\vec{j}\right)X10^{-3}$ T. The acceleraation of the particle is found to be

$\left(sqrare\overrightarrow{i}+7.0\overrightarrow{j}\right)X10^{-6}ms^{-2}'. The\nu mber \rightarrow the \leq ftof$vec i` in the last expression was not readable. What can this number be?

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5. A 10 g bullet having a charge of $4.00\mu C$ is fired at a speed of $270ms^{-1}$ in a horizontal direction. A vertical magnetic field of $500\mu T$ exists in the space. Find the deflection of the bullet due to the magnetic field as it travels through 100m. make appropriate approximations.

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6. when a proton is released from rest in a room, it starts with an initital acceleration a_0 towards west . When it is projected towards north with a speed v_0, it moves with an initial acceleration $3a_0$ towards west. Find the elecrtic field and the minimum possible magnetic field in the room.

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7. Consider a 10cm long protion of a straight wire carrying a current of 10 A placed in a magnetic field of 0.1 T making an angle of 53° with the wire. What magnetic force does the wire experience?

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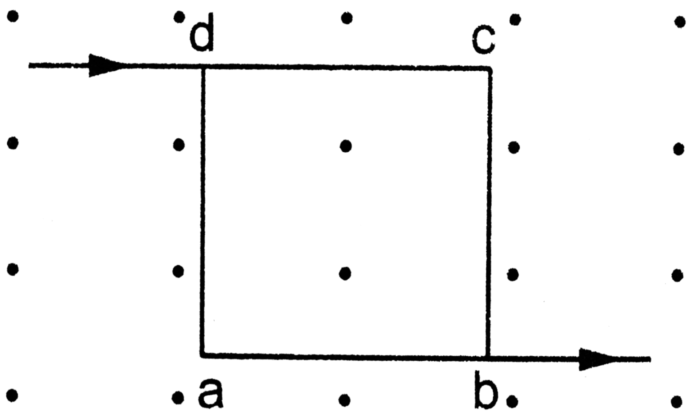
8. A current of 2 A enters at the corner d of a square frame abcd of side 20 cm and leaves at the opposite corner b. A magnetic field B= 0.1 T exists in the space in a direction perpendicular to the plane of the frame as shown in Find the magnitude and direction of the magnetic forces on the four sides of the frame.



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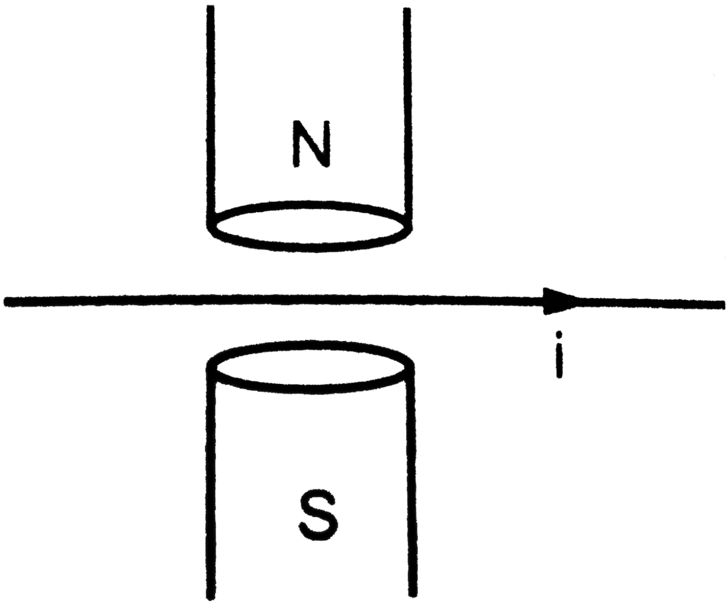
9. A magnetic field of strength 1.0 T is produced by a strong electromagnet in a cylindrical region of radius 4.0 cm as shown in . A wire, carrying a current of 2.0 A, is placed perpendiuclar to and intersecting the axis of the cylindreical region. Find the magnitude of the force acting on the wire.



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10. A wire of length l carries a current I along the x-asis. A magnetic field exists which is given as $\vec{B} = B_0\left(\vec{i} + \vec{j} + \vec{k}\right)$ T. find the magnitude of the magnetic force acting on the wire.

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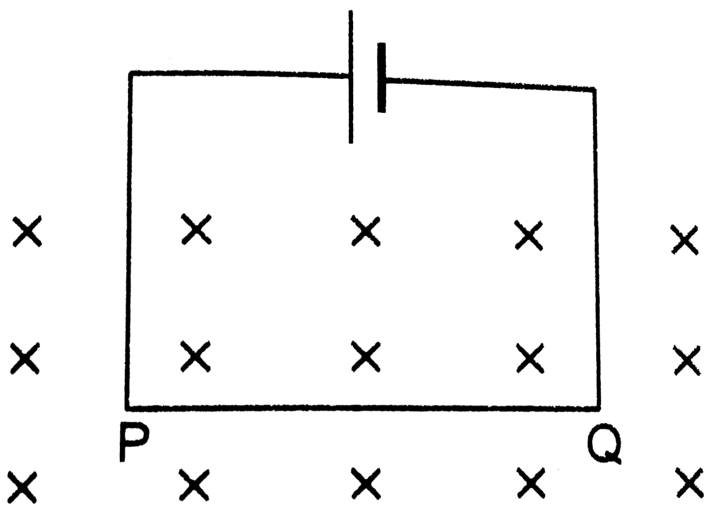
11. A current of 5.0 A exists in the circuit shown in The wire PQ has a length of 50 cm the magnetic field in which it is immersed has a magnitude of 0.20 T. Find the magnetic force acting on the wire PQ.



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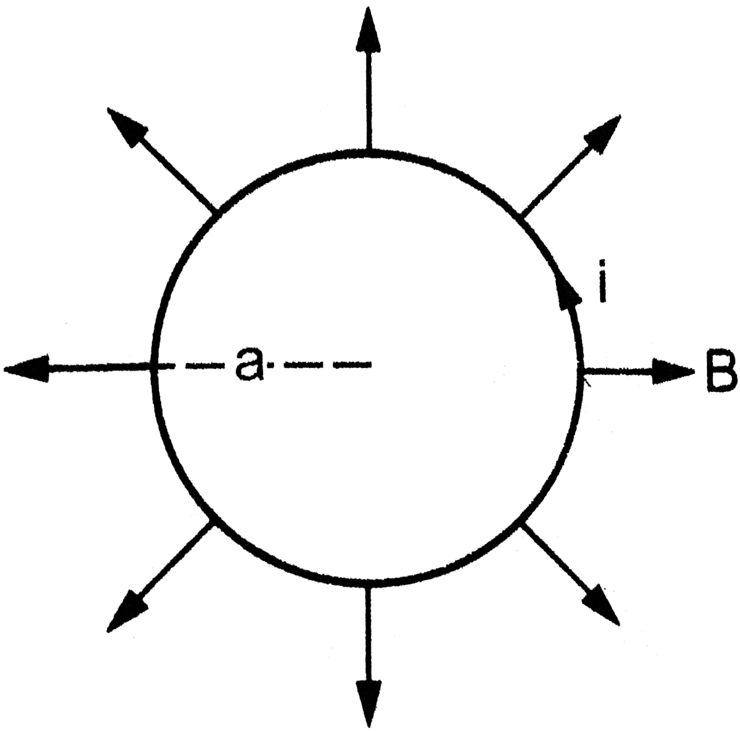
12. A circular loop of radius a, carrying a current I, is placed in a tow dimensional magnetic field. The centre of the loop coincides with the centre of the filed The strenght of the magnetic field at the pariphery of the loop is B. find the magnetic force on the wire.



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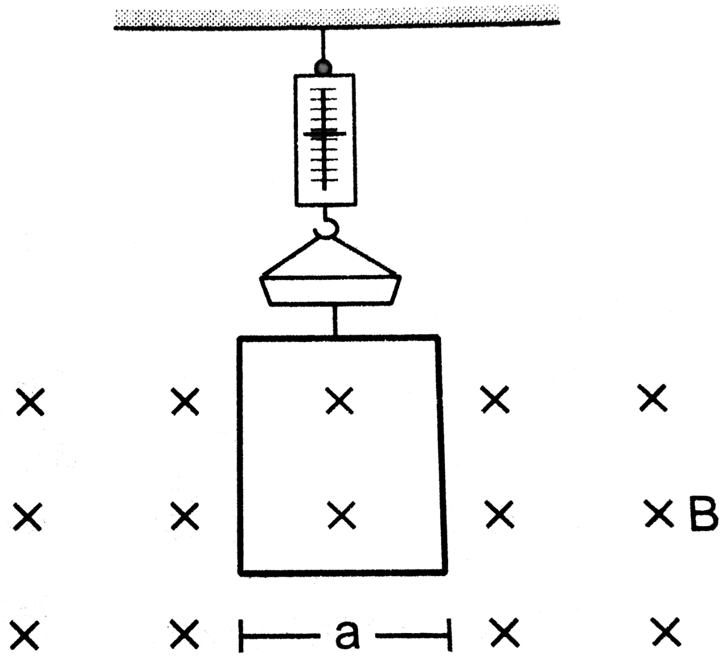
13. A hypthetical magnetic field existing in a region is given by $\overrightarrow{B} = B_0 \overrightarrow{e}_r$, where $\overrightarrow{}r$ denotes the uit vector along the redial direction. A circular loop of radus a, carrying a current I, is placed with its plane parallel to the x-y plane and the centre at (0,0, d) .Find the magnitude of the magnetic force acting on the loop.

Watch Video Solution

14. A rectangular wire-loop of width a is suspended from the insulated pan of a spring blance as shown in A current I exists in the anticlockwise direction in the loop. A magnetic field B exists in the lower region.Find the change in the tension of the spring if the current in the loop is reversed.



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15. A current loop of arbitrary shape lien in a uniform magnetic field B. show that the net magnetic force acting on the loop is zero.

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16. Prove that the force acting on a current carrying wire, joining two fixed points a and b in a uniform magnetic field, is independent of the shap of the wire.

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17. A semicircular wire of radius 5.0 cm carries a current of 5.0 A. A magnetic field B of magnitude 0.50 T exists along the perpendicular to the plane of the wire. Find the magnitude of the magnetic force acting on the wire.

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18. A wire, carrying a current i, is kept in the $x-y$ plane along the curve $y = A\sin\left(\frac{2\pi}{\lambda}x\right)$. A magnetic field B exista in the z-direction. Find the magnitude of the magnetic force on the portion of the wire between $x = 0$ and $x = \lambda$.

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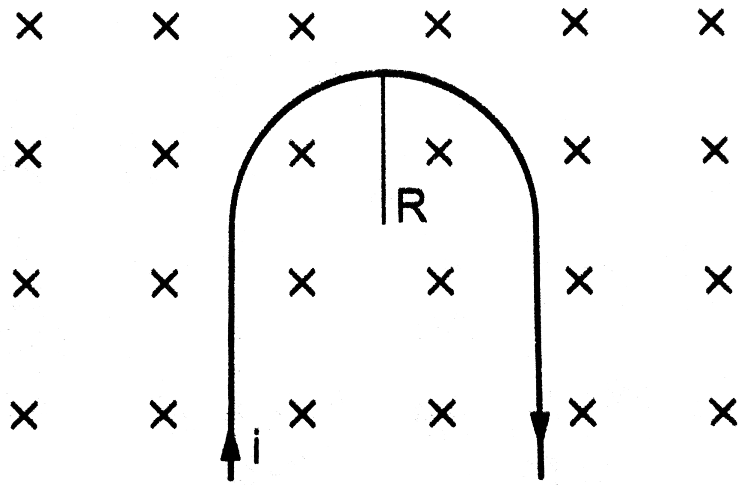
19. A rigid wire consists of a semicircular portion of radius R and two straight sections the wire is partially immersed in a perpendicular magnetic field B as shown in the figure. Find the magnetic force on the wire if it carries a current i.



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20. A straight horizontal wire of mass 10mg and length 1.0 cm carries a current of 2.0 A. what minimum magnetic field B should be applied in the region so that the magnetic force on the wire may balance its weight?

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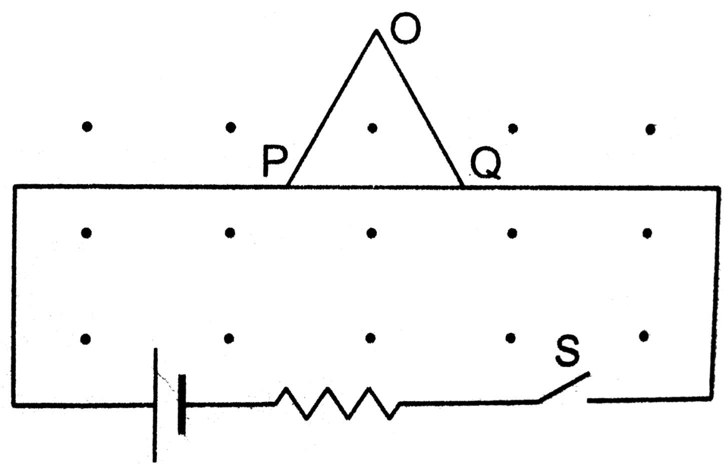
21. Shows a rod PQ of length 20.0 cm and mass 200g suspended through a fixed point O by two threads of lengths 20.0 cm each. A magnetic field of strenght 0.500 T exists in the vicinity of the wire PQ as shown in the figure. The exists in the vicinity of the wire PQ as shown in the figure. The wires conecting PQ with the battery are loose and exert no force on PQ. (a) find the tension in the threads when the switch S is open. (b) A current of 2.0 A is established when the switch S is closed. Find the tension in the threads now.



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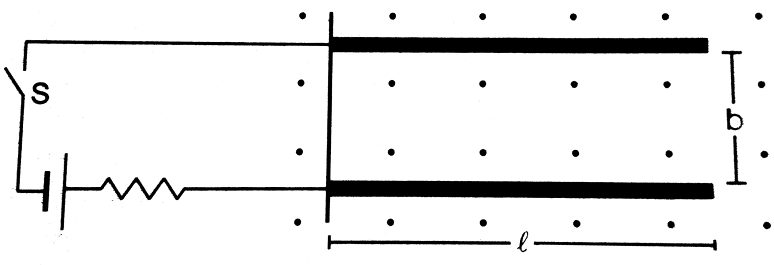
22. Two metal strips, each of length, each of length l, are clamped parallel to each other on a horizontal floor with a separation b between them. A wire of mass m line on them perpendicularly as shown in figure. A vertically upward magnetic field of strenght B exists in the space. The matal strips are smooth but the cofficient of freiction between the wire and the floor is μ. A current i is established when the switch S is closed at the instant $t=0$. Discuss the motion of the wire after the switch is closed. How far away from the strips will the wire reach?



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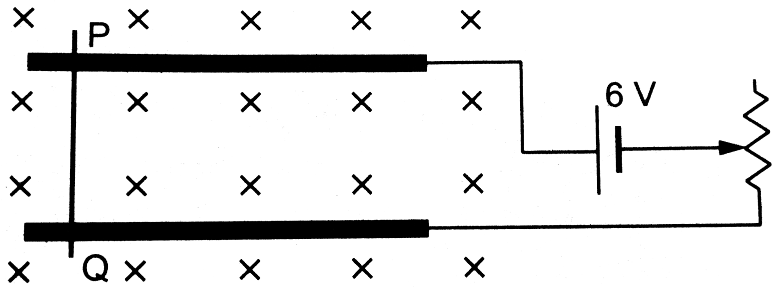
23. A metal wire PQ of mass 10g lies at rest on two horizontal metal rails separated by 4.90 cm . A vertically downward magnetic field of magnitude 0.800 T exists in the space. The resistance of the circuit is slowly decreased and it is found that when the resistance goes below 20.0Ω, the wire PQ starts sliding on the rails. Find the coefficient of friction.



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24. A straight wire of length l can slide on two parallel plastic rails kept in a horizontal plane with a separation d. The coefficient of friction between the wire and the rails is μ. If the wire carries a current I, what minimum magnetic field should exist in the space in order to slide the wire on the rails.

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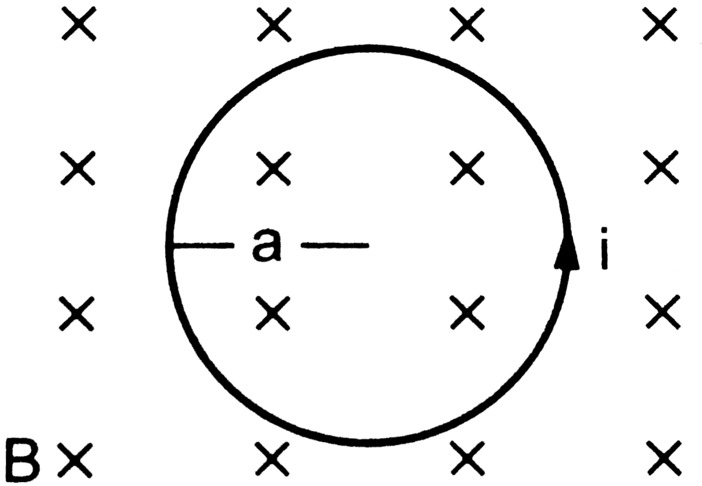
25. Shows a circular wire-loop of radius a m carrying a current I, placed in a perpendicualr matgnetic field B. (a) Consider a small part dl of the wire. Find the force on this part of the wire exerted by the magnetic field. Find the force of compression in the wire.



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26. Suppose that the radius of cross section of the wire used in the previons problem is r. Find the increase in the radius of the loop if the magnetic field is switched off. The young modulus of the material of the wire is Y.

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27. The magnetic field existing in a region is given by $\vec{B} = B_0\left(1 + \frac{x}{l}\right)\vec{k}$. A square loop of edge l and carrying a current I, is placed with its edges parallel to the x-y axes. Find the magnitude of the net magnetic force experienced by the loop.

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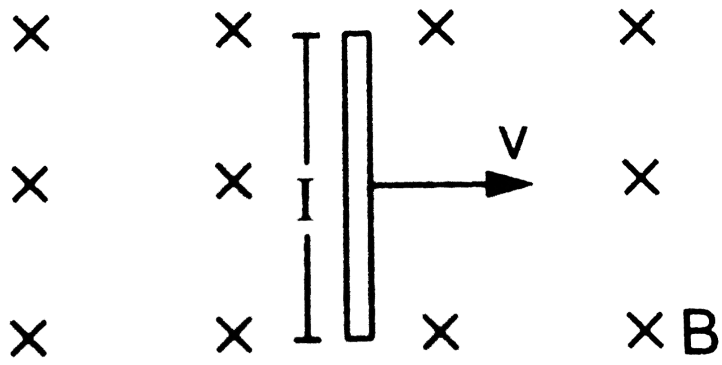
28. A conducting wire of length l, lying normal to a magnetic field B, moves with a velocity v as shown in (a) Find the average magnetic fore on a free electron of the wire. Due to this magnetic force, electrons concentrate at one end resulting in an electric field inside the wire. The redistribution stops when the electric force on the free electrons balances themagnetic force. Find the electric field developed inside the wire when the redistribution field developed inside the wire when the redistribution stops. (c) what potential difference is developed between the ends of the wire?



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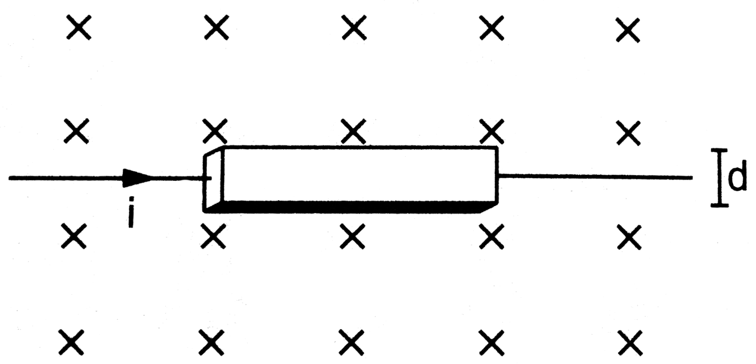
29. A currrent I is passed through a silver strip of width d and area of cross section A. The number of free electrons per unit volume is n. (a) Find the drift velocity v of the electrons. (b) If a magnetic field B exists in the region as shown in what is the average magnetic force on the free electrons? (c) Due to the magnetic force, the free electrons get accumulated on one side of the conductor along its length. This produces a transverse electric field in the conductor which opposes the magnetic force on the electrons. Find the magnitude of the electric field which will be the potential diference developed across the width of the conductor due to the electron- accumulation? The appearance of a transverse emf, when a current-carrying wire is placed in a magnetic field, is called hall effect.



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30. A particle having a charge of $2.0X10^{-8}C$ and a mass of $2.0X10^{-10}g$ is projected with a speed of $2.0X10^{3}ms^{-1}$ in a region having a uniform magnetic field of 0.10 T. The velocity is perpendicular to the field. Find the radius of the circle formed by the particle and also the time period.

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31. A proton describes a circle of radius 1 cm in a magnetic field of strength 0.10 T. What would be the radius of the circle described by an a-particle moivng with the same speed in the same magnetic field?

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32. An electron having a kinetic energy of 100eV circulates in a path of radius 10cm in a magnetic field. Find the magnetic field and the number of revolutons per second made by the electron.

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33. Protons having kinetic energy K emerge from an accelerator as a narrow beam. The beam is bent by a perpendicular magnetic field so that it just misses a plane target kept at a distance I in front of the accelerator. Find the magnetic field.

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34. A charged particle is accelerated through a potential difference of 12 kV and acquires a speed of $1.0X10^6 ms^{-1}$. It is then injected perpendicular into a magnetic field of strength 0.2 T. find the radius of the circle described by it.

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35. Doubly ionized helium ions are projected with a speed of $10kms^{-1}$ in a direction perpendicular to a uniform magnetic field of magnitude 1.0 T. Find (a) the force acting on an ion, (b) the radius of the circle in which it circulates and (c) the time taken by an ion to complete the circle.

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36. A proton is projected with a velocity of $3X10^6 ms^{-1}$ perpendicular to a uniform magnetic field of 0.6 T. find the acceleration of the proton.

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37. (a) An electron moves along a circle of radius 1m in a perpendicular magnetic field of strength 0.50 T. What would be its speed? Is it reasonable?(b) If a proton moves along a circel of the same radius in the same magnetic field, what would be its speed?

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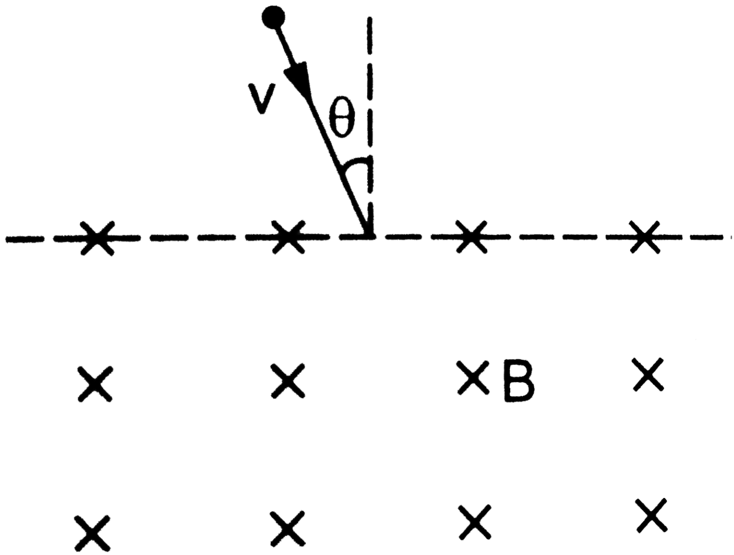
38. A particle of mass m and positive charge q, moving with a uniform velocity v, enters a magnetic field B as shown in Find The radius of the circular are it describes in the magnetic field. (b) find the angle subtended by the arc at the centre. (c) How long does the particle stay inside the magnetic field? (d) Solve the three parts of the above problem if the charge q on the particle is negative.



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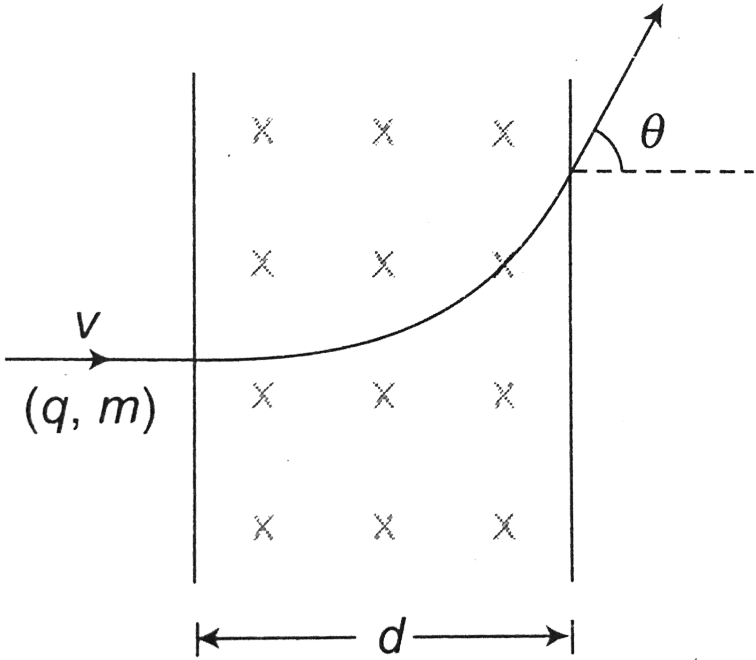
39. A charged particle (q, m) enters perpendicular in a uniform magnetic field B and comes out field as shown. The angle of deviation θ time taken by particle to cross magnetic field will be



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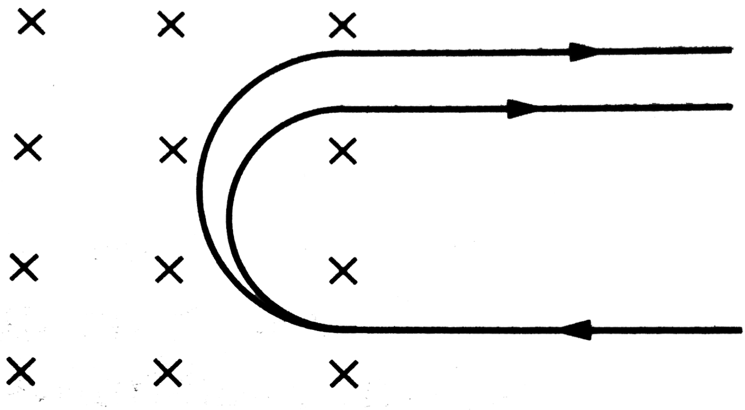
40. A narrow beam of singley charged carbon ions, moving at a constant velocity of $6.0X10^4 ms^{-1}$, is sent perpendicularly in a rectangular region having uniform magnetic field B=0.5 T . It is found that two beams emerge from the field in the backward derection, the separations from the incident beam being 3.0 cm and 3.5cm. Identify the isotopes persent in the ion beam. Take the mass of an ion = $A\left(1.6X10^{-27}\right.$ kg, where A is the mass number.



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41. Fe ^+ ions are accelerated through a potential difference of 500 V and are injected normally into a homogeneous magnetic field B of strength 20.0 m T. Find the radius of the circular paths followed by the isotopes with mass numbers 57 and 58. Take the mass of an $ion = A\left(1.6X10^{-27}\right.$ kg where A is the mass number.

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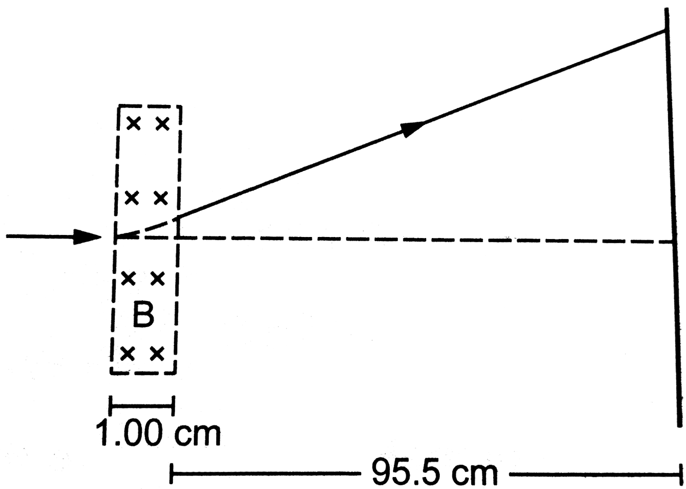
42. A nerrow beam of singly charged potassium ions of kinetic energy 32keV is injected into a region of width 1.00 cm having a magnetic field of strenght 0.500 T as shown in . The ions are collected at a screen 95.5cm away from the field region. If the beam contains isotopes of atomic weights 39 and 41, find the separaton between the points where these isotopes strike the screen. Take the mass of a potassium $ion = A(1.6X10^{-27}$ kg where A is the mass number.



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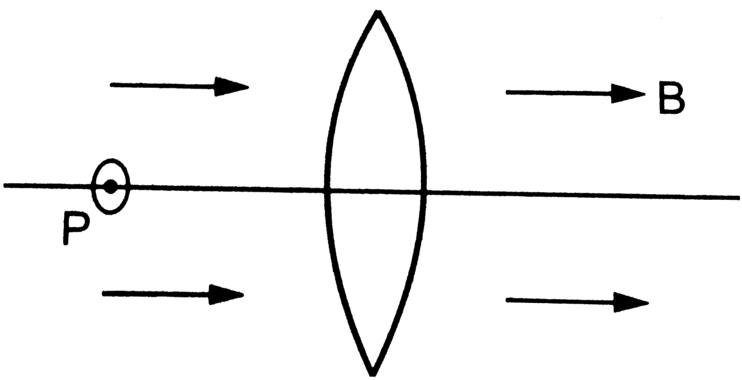
43. Shows a convex lens of focal length 12 cm lying in a uniform magnetic field B of magnitude 1.2 T parallel to its principal axis. A particle having a charge $2.0X10^{-3}C$ and mass $2.0X10^{-5}$ kg is projected perpendiucular to the plane of the diagram with a speed of $4.8ms^{-1}$. The particle moves along a circle with its centre on the principal axis at a distance of 18 cm from the lens. Show that the image of the particle goes along a circle end find the radius of thet circle.



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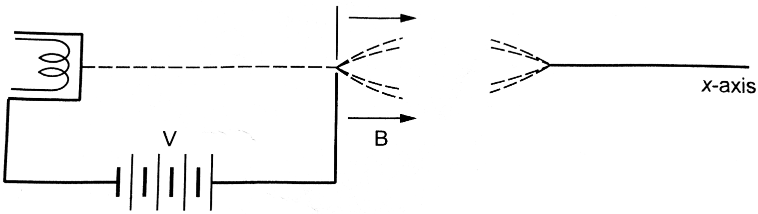
44. Electrons emitted with negligible speed from an electron gun are accelerated through a potential difference V along the x-axis. These electrons emerge from a narrow hole into a uniform magnetic field B directed along this axis. However. Some of the electrons emerging from the hole make slightly divergent angles as shown in . show that these paraxial electrons are refocussed on the x-axis at a distance $\frac{\sqrt{8\pi^2 mV}}{eB^2}$.



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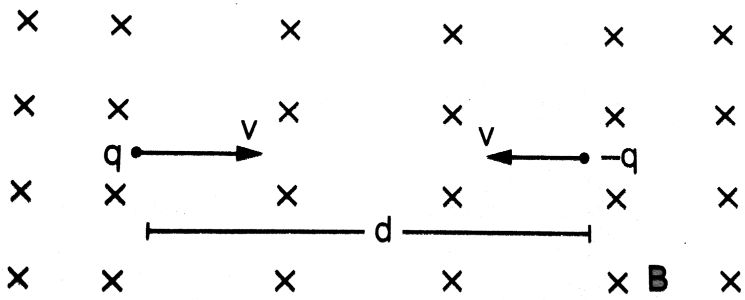
45. Two particles, each having a mass m are placed at a separation d in a uniform magnetic field B as shown in they have opposite charges of equal magnitude q. at time t =0, the particles are projectd towards each other,each with a speed v. suppose the coulomb force between the charges is switched off. (a) Find the maximum value v_m of the projection speed so that the two particles do not collide. (b) What would be the minimum and maximum separation between the particles if $v = \frac{v_m}{2}$? (c) At what instant will a collision occur between the particles if $v = 2v_m$? (d) Suppose $v = 2v_m$ and the collision between the particles is completely inelastic. Describe the motion after the collision.



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46. A uniform magnetic field of magnitude 0.20 T exists in space from east to west what speed should a particle of mass 0.010 g and having a charge $1.0 \times 10^{-5} C$ be projected from south to north so that it moves with a uniform velocity?

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47. A particle moves in a circle of diameter 1.0 cm under the action of magnetic field of 0.40 T, An electric field of $200 V m^{-1}$ makes the path straight. Find the charges/mass ratio of the particle.

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48. A proton goes undeflected in a crossed electric and magnetic field (the fields are perpendicular to each other) at a speed of $2.0 \times 10^5 ms^{-1}$. The velocity is perpendicular to both the fields. When the electric field is switched off, the proton moves along a circle of radius 4.0 cm. Find the magnitudes of the electric and the magnetic fields. take the mass of the proton $= 1.6 \times 10^{-27}$ kg.

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49. A particle having a charge of $5.0 \mu C$ and a mass of $5.0 \times 10^{-12} kg$ is projected with a speed of $1.0 kms^{-1}$ in a magnetic field of a magnetic field of magnitude 5.0 m T. The angle between the magnetic field and the velocity is $\sin^{-1}(0.90)$. show that the path of the particle will be a helix. Find the diameter of the helix and its pitch.

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50. A proton projected in a magnetic field of 0.020 T travels along a helical path of radius 5.0 cm and pitch 20 cm. Find the components of the velocity of the proton along and perpendicular to the magnetic field. Take the mass of the proton $= 1.6 \times 10^{-27}$kg.

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51. A particle having mass m and charge q is released from the origin in a region in which electric field and magnetic field are given by

$\overrightarrow{B} = -B_0\overrightarrow{J}$ and $\overrightarrow{E} = E_0\overrightarrow{K}$.

Find the speed of the particle as a function of its z-coordinate.

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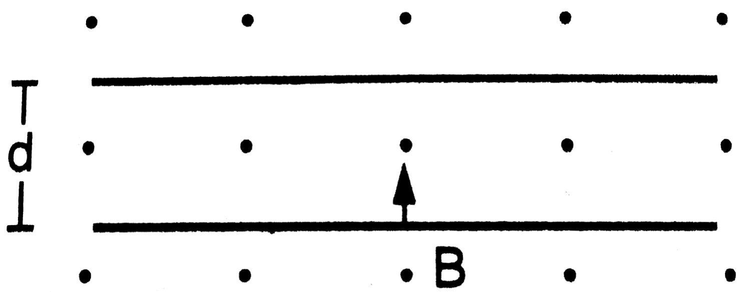
52. An electron is emitted with negligible speed from th nagative plate of a parallel plate capacitor charged ot a potential difference V. The separtion between the plates is d and a magnetic field B exists in the space as shown in . Show that the electron will fail to strike the upper plate if ltdgt $\left(\frac{2m_eV}{eB_0^2}\right)^{\frac{1}{2}}$.



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53. A rectangular coil of 100 turns has length 5 cm and width 4 cm. it is placed with its plane parallel to a uniform magnetic field and a current of 2 A is sent through the coil. Find the magnitude of the magnetic field B, if the torque acting on the coil is $0.2Nm^{-1}$.

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54. A 50 turn circular coil of radius 2.0 cm carrying a current of 5.0 A is rotated in a magnetic field of strength 0.20 T. (a) What is the maximum torque that acts on the coil? (b) in a particular position of the coil, the torque acting on it is half of this maximum. What is the angle between the magnetic field and the plane of the coil?

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55. A rectangular loop of sides 20 cm and 10 cm carries a current of 5.0 A. A uniform magnetic field of magnitude 0.20 T exists parallel to the longer side of the loop (a) What is the force acting on the loop? (b) what is the torque acting on the loop?

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56. A circular coil of radius 2.0 cm has 500 turns in it and carries a current of 1.0 A . Its axis makes an angel of 30° with the uniform magnetic field of ,magnetic field that exists in the space. Find the torque acting on the total.

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57. A circular loop carrying a current a current I has wire of total length L. A uniform magnetic field B exists parallel to the plane of the loop. (a) find the torque on the loop.(b) If the same length of the wire is used to form a square loop, what would be the torque? Which is larger?

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58. A square coil of edge l having n turns carries a curent i. it is kept on a smooth horizontal plate. A uniform magnetic field B exists in a direction parallel to an edge the total mass of the coil is M. What should be the minimum value of B for which the coil will start tipping over?

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59. consider a nonconducting ring of radius r and mass m which has a totoal chargej q distributed uniformly on it the ring is rotated about its axis with an angular speed ω. (a) Find the equivalent electric current in the ring (b) find the magnetic moment μ of the . (c) show that$\mu = \frac{q}{2m}$

where l is the angular momentum of the ring about its axis of rotation.

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60. Consider a non conducting plate of radius a and mass m which has a charge q distributed uniformly over it, The plate is rotated about its own axis with a angular speed ω. Show that the magnetic moment M and the angular momentum L of the plate are related as $\frac{M}{L} = \frac{q}{2m}$.

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61. Consider a non conducting plate of radius a and mass m which has a charge q distributed uniformly over it, The plate is rotated about its own axis with a angular speed ω. Show that the magnetic moment M and the angular momentum L of the plate are related as $\frac{M}{L} = \frac{q}{2m}$.

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62. Using the formulae ($\left(\vec{F}\right) = \left(\vec{q}\, v\right) \times \left(\vec{B}\right)$ and $\left(B = (\mu_0)\frac{i}{2}\pi r\right)$, show that the SI units of the magnetic field B and the permeability constant (mu_0) may be written as (N mA ^-1) and (NA^-2) respectively.

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63. A current of 10A is established in a long wire along the positive z-axis. Find the magnetic field `(vec B) at the point (1m , 0 , 0).

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64. A copper wire of diameter 1.6 mm carries a current of 20A. Find the maximum magnitude of the magnetic field (vec B)due to this current.

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65. A transmission wire carries a current of 100A. What would be the magnetic field B at a point on the road if the wire is 8 m above the road?

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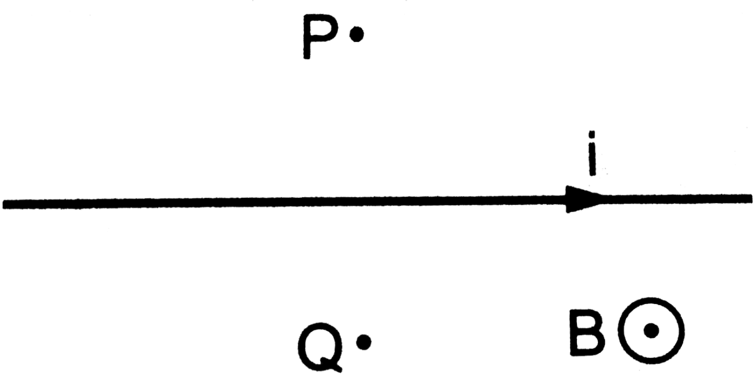
66. A long, straight wire carrying a current of 1.0 A is placed horizontally in a uniform magnetic field B= (1.0×10^{-5}) T pointing vertically upward. Find the magnitude of the resultant magnetic field at the points P and Q, both situated at a distance of 2.0 cm from the wire in the same horizontal plane.



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67. A long, straight wire of radius r carries a current i and is placed horizontally in a uniform magnetic field B pointing vertically upward. The

current is uniformly distributed over its cross section. (a) At what points will the resultantant magnetic field have maximum magnitude? What will be the maximum magnitude? (b) What will be the minimum magnitude of the resultant magnetic field?

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68. A long, straight wire carrying a current of 30 A is placed in an external uniform magnetic field of 4.0×10^{-4} T exists from south to north. Find at a point 2.0 away from the wire.

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69. A long vertical wire carrying a current of 10A in the upward direction is placed in a region where a horizontal magnetic field of magnitude(2.0×10^{-3}) T exists from south to north. Find the point where the resultant magnetic field is zero.

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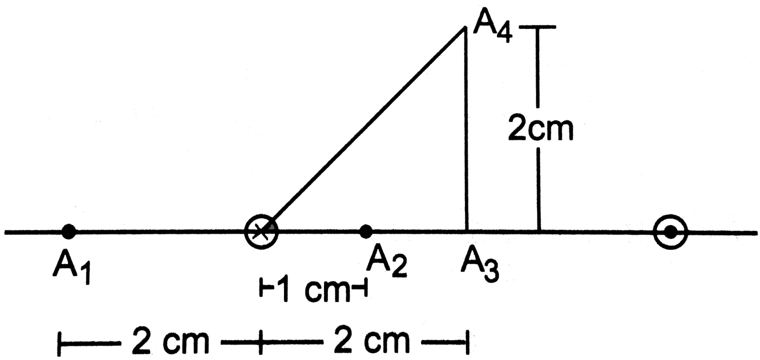
70. Figure shows two parallel wires separated by a distance of 4.0 cm and carrying equal currents of 10A along opposite directions. Find the magnitude of the magnetic field B at the points A_1, A_2, A_3 and A_4.



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71. Two parallel wires carry equal currents of 10A along the same direction and are separated by a distance of 2.0 cm. Find the magnetic field at a point which is 2.0 cm away from each of these wires.

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72. Two long, straight wires, each carrying a current of 5A, are placed along the x and y axes respectively. The currents point along the positive directions of the axes. Find the magnetic fields at the points (a) (1m, 1m), (b) (-1m, 1m), (c) (-1m, -1m) and (d) (1m, -1m).

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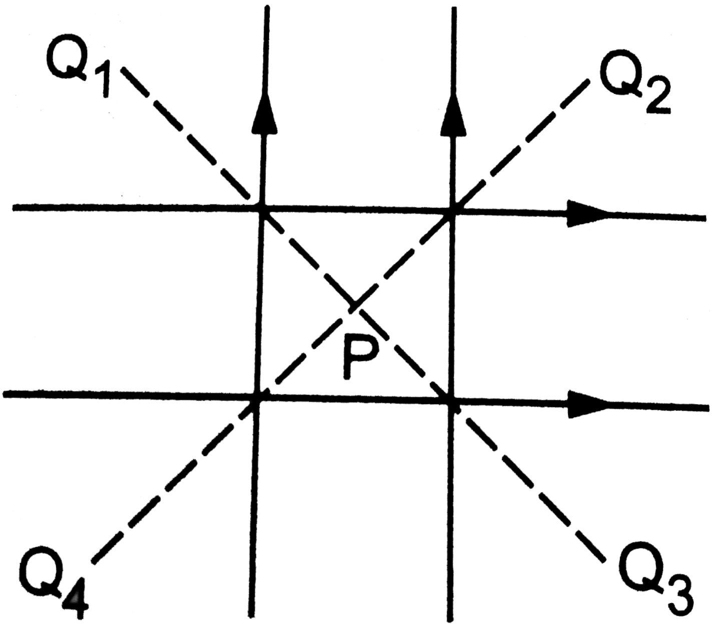
73. Four long, straight wires, each carrying a current of 5.0 A, are placed in a plane as shown in figure . The points of intersection form a square of side 5.0 cm. (a) Find the magnetic field at the centre P of the square. (b) Q_1, Q_2, Q_3 and Q_4 are points situated on the diagonals of the square and at a distance from P that is equal to the length of the diagonal of the square. Find the magnetic fields at these points. `



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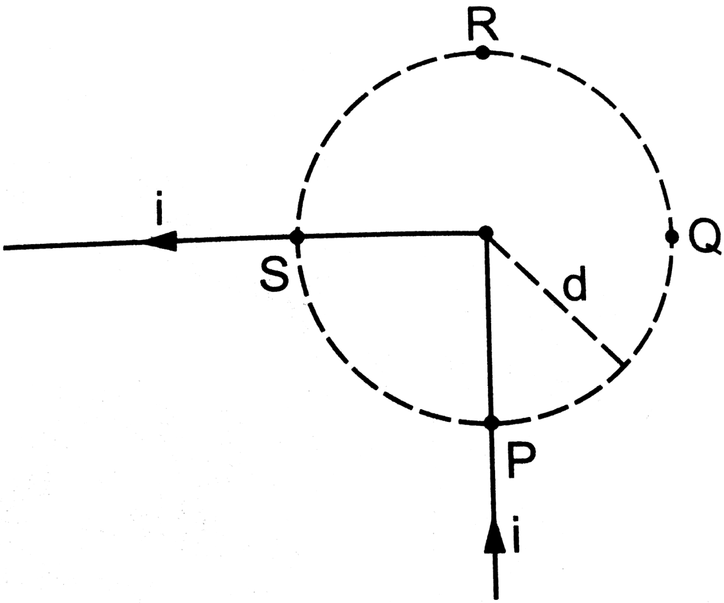
74. Figure shows a long wire bent at the middle to form a right angle. Show that the magnitudes of the magnetic fields at the points P,Q, R and

S are equal and find this magnitude. `



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75. Consider a straight piece of length x of a wire carrying a current i. Let P be a point on the perpendicular bisector of the piece, situated at a distance d from its middle point. Show that for dgtgtx, the magnetic field at P varies as $\left(\frac{1}{d^2}\right)$ whereas for dltltx, it varies as 1/d.

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76. Consider a 10-cm long piece of a wire which carries a current of 10A . Find the magnitude of the magnetic field due to the piece at a point which makes an equilateral triangle with the ends of the piece.

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77. A long, straight wire carries a current i. Let `B_1 be the magnetic field at a point P at a distance d from the wire. Consider a section of length l of this wire such that the point P lies on a perpendicular bisector of the section. Let B_2 be the magnetic field at this point due to this section only. Find the value of d/l so that B_2 differs from B_1 by 1 %.

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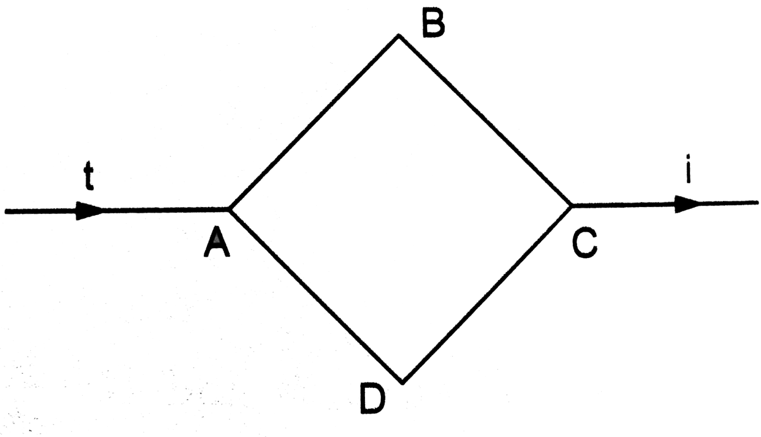
78. Figure shows a square loop ABCD with edge length a. The resistance of the wire ABC is r and that of ADC is 2r. Find the magnetic field B at the centre of the loop assuming uniform wires. `



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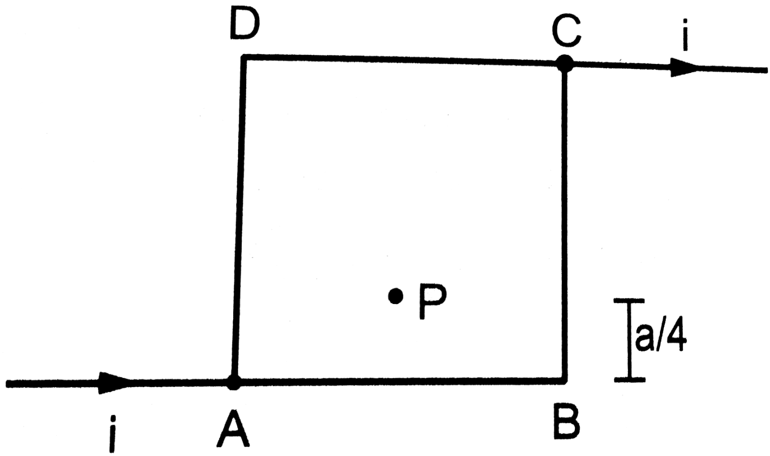
79. Figure shows a square loop of edge a made of a uniform wire. A current i enters the loop at the point A and leaves it at the point C. Find the magnetic field at the point P which is on the perpendicular bisector of

AB at a distance a/4 from it.`



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80. Consider the situation described in the previous problem. Suppose the current I enters the loop at the point A and leaves it at the point B. Find the magnetic field at the centre of the loop.

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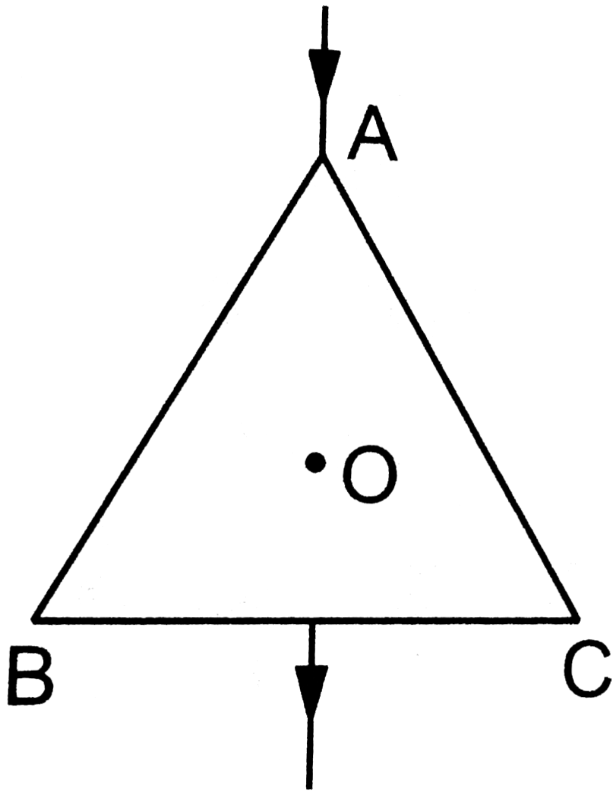
81. The wire ABC shown in figure forms an equilateral triangle. Find the magnetic field B at the centre O of the triangle assuming the wire to be uniform. `



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82. A wire of length l is bent in the form of an equilateral triangle and carries an electric current i. (a) Find the magnetic field B at the centre. (b) If the wire is bent in the form of a square, what would be the value of B at the centre?

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83. $Alongwirecarry \in gacurrentiisbent \to f \text{ or } mapla \ne \angle\alpha.$

$F \in dthemag \ne ticfieldBatap \oint onthebi\sec \to rofthis\angle situatedatadis$ta

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84. Find the magnetic field B at the centre of a rectangular loop of length l and width b, carrying a current i.

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85. A regular polygon of n sides is formed by bending a wire of total length $2\pi r$ which carries a current i. (a) Find the magnetic field B at the centre of the polygon. (b) By letting $n \to \infty$, deduce the expression for the magnetic field at the centre of a circular current.

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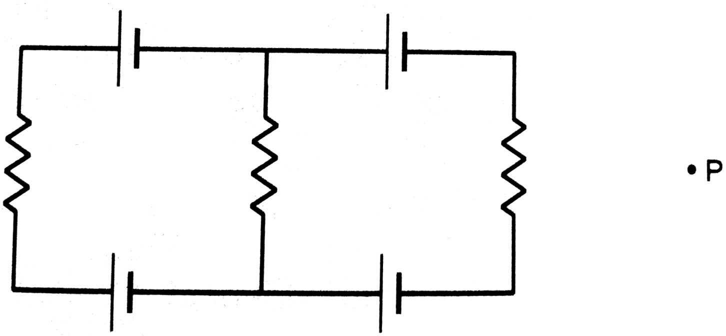
86. Each of the batteries shown in figure has an emf equal to 5 V. Show that the magnetic field B at the point P is zero for any set of values of the resistances .



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87. A straight , long wire carries a current a current of 20A. Another wire carrying equal current is placed parallel to it. If the force acting on a length of 10cm of the second wire is $(2.0 \times (10^{-5}))N$, what is the separation between them?

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88. Three coplanar parallel wires, each carrying a current of 10 A along the same direction, are placed with a separation 5.0 cm between the consecutive ones. Find the magnitude of the magnetic force per unit length acting on the wires.

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89. Two parallel wires separated by a distance of 10cm carry currents of 10 A and 40 A along the same direction, Where should a third current be placed so that it experience no magnetic force?

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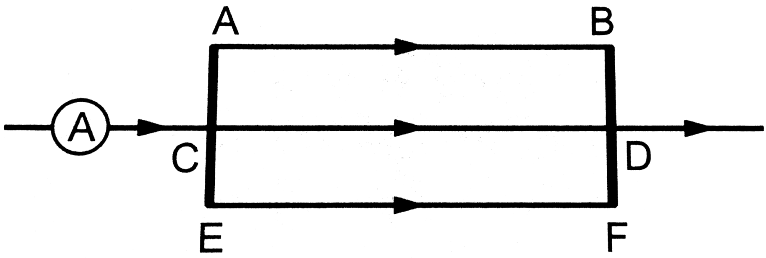
90. Figure shows a part of an electric circuit. The wires AB, CD, and EF are long and have identical resistances. The separation between the neighbouring wires is 1.0 cm. The wires AE and BF have negligible resistances and the ammeter reads 30 A . Calculate the magnetic force per unit length of AB and CD. `



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91. A long, straight wire is fixed horizontally and carries a current of 50.0 A. A second wire having linear mass directly above this wire at a separation of 5.0 mm. What current should this second wire carry such that the magnetic repulsion can balance its weight?

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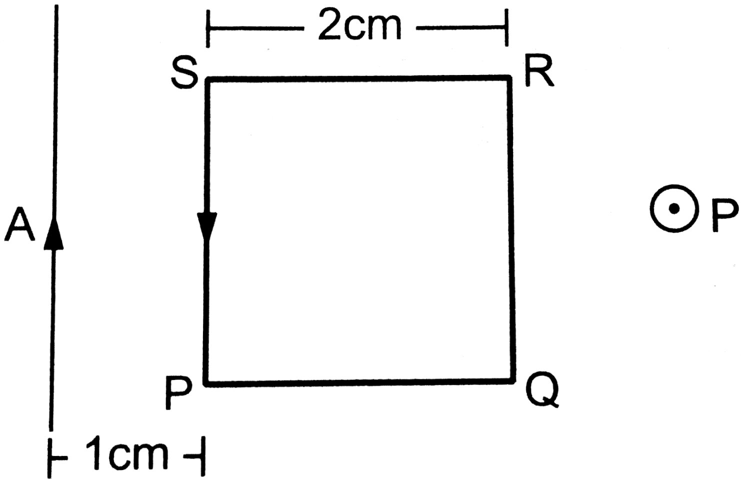
92. A square loop PQRS carrying a current of 6.0 A is placed near a long wire carrying 10 A as shown in figure . (a) Show that the magnetic force acting on the part PQ is equal and opposite to that on the part RS. (b)

Find the magnetic force on the square loop.`



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93. A circular loop of one turn carries a current of 5.00 A. If the magnetic field B at the centre is 0.200 mT, find the radius of the loop.

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94. A current - carrying circular coil of 100 turns and radius 5.0 cm produces a magnetic field of (6.0×10^{-5}) T at its centre. Find the value of the current.

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95. An electron makes (3×10^5) revolutions per second in a circle of radius 0.5 angstrom. Find the magnetic field B at the centre of the circle.

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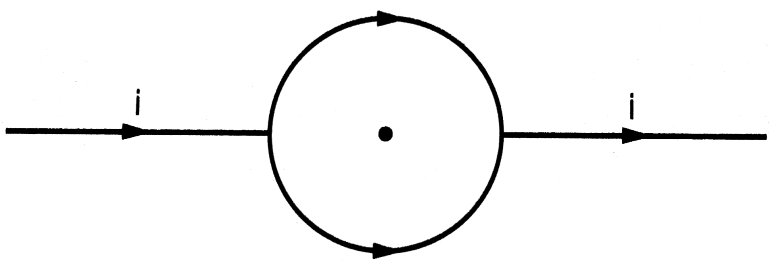
96. A conducting circular loop of radius a is connected to two long, straight wires . The straight wires carry a current I as shown in figure . Find the magnetic field B at the centre of the loop.



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97. Two circular coils of radii 5.0 cm and 10 cm carry equal currents of 2.0 A. The coils have 50 and 100 turns respectively and are placed in such a way that their planes as well as the centres coincide. Find the magnitude of the magnetic field B at the common centre of the coils if the currents in the coils are (a) in the same sense (b) in the opposite sense.

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98. If the outer coil of the precious problem is rotated through 90^@ about a diameter, what would be the magnitude of the magnetic field B at the centre ?

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99. A circular loop of radius 20 cm carries a current of 10 A. An electron crosses the plane of the loop with a speed of (` 2.0 xx (10^6) m s^-1). The direction of motion makes an angle of 30^@ with the axis of the circle and passes through its centre. Find the magnitude of the magnetic force on the electron at the instant it crosses the plane.

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100. A circular loop of radius R carries a current I. Another circular loop of radius r(ltltR) carries a current I. The plane of the smaller loop makes an angle of 30^@ with that of the larger loop. The planes of the two circles are at right angle to each other. Find the torque acting on the smaller loop.

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101. A circular loop of radius r carrying a current i is held at the centre of another circular loop of radius R(>> r) carrying a current I. The plane of the smaller loop makes an angle of 30° with that of the larger loop. It the smaller loop is held fixed in this position by applying a single force at a point on its periphery, what would be the minimum magnitude of this force?

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102. Find the magnetic field B due to a semicircular wire of radius 10.0 cm carrying a current of 5.0A at its centre of curvature .

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103. A piece of wire carrying a current of 6.00 A is bent in the form of a circular arc of radius 10.0 cm, and it subtends an angle of 120° at the centre. Find the magnetic field B due to this piece of wire at the centre.

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104. A circular loop of radius r carries a current i. How should a long , straight wire carrying a current 4i be placed in the plane of the circle so that the magnetic field at the centre becomes zero?

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105. A circular coil of 200 turns has a radius of 10 cm and carries a current of 2.0 A. (a) Find the magnitude of the magnetic field $\left(\overrightarrow{B}\right)$ at the centre of the coil. (b) At what distance from the centre along the axis of the coil will the field B drop to half its value at the centre?

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106. A circular loop of radius 4.0 cm is placed in a horizontal plane and carries an electric current of 5.0 A in the clockwise direction as seen from above. Find the magnetic field (a) at a point 3.0 cm above the centre of the loop (b) at a point 3.0 cm below the centre of the loop.

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107. A charge of $\left(3.14 \times 10^{-6}\right)$ C is distributed uniformly over a circular ring of radius 20.0 cm. The ring rotates about its axis with an angular velocity of 60.0 rad ` s^-1 . Find the ratio of the electric field to the magnetic field at a point on the axis at a distance of 5.00 cm from the centre.

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108. A thin but long, hollow, cylindrical tube of radius r carries a current i along its length. Find the magnitude of the magnetic field at a distance r/2 from the surface (a) inside the tube (b) outside the tube.

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109. A long, cylindrical tube of inner and outer radii a and b carries a current i distributed uniformly over its cross section. Find the magnitude of the magnetic field at a point (a) just inside the tube (b) just outside the tube.

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110. A long, cylindrical wire of radius b carries a current i distributed uniformly over its cross section. Find the magnitude of the magnetic field at a point inside the wire at a distance a from the axis.

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111. A solid wire of radius 10 cm carries a current of 5.0 A distributed uniformly over its cross section. Find the magnetic field B at a point at a distance (a) 2 cm (b) 10 cm and (c) 20 cm away from the axis. Sketch a graph of B versus x for 0ltxlt20 cm .

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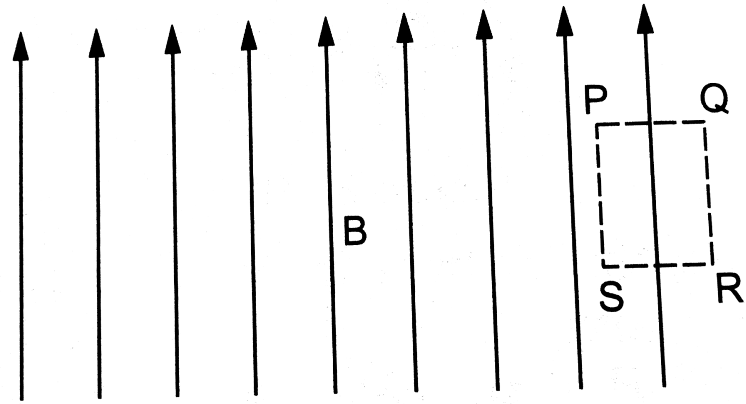
112. Sometimes we show an idealised magnetic field which is uniform in a given region and falls to zero abruptly. One such field is represented in figure . Using Ampere's law over the path PQRS, show that such a field is not possible.



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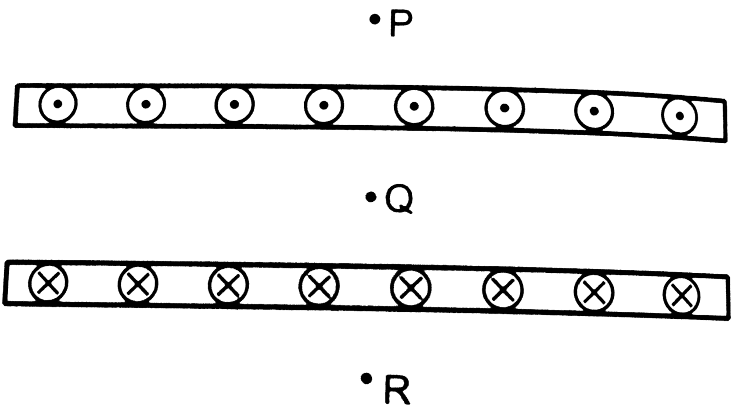
113. Two large metal sheets carry surface currents as shown in figure . The current through a strip of width dl is Kdl where K is a constant . Find the magnetic field at the points P,Q and R. `



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114. Consider the situation of the previous problem. A particle having charge q and mass m is projected from the point Q in a direction going into the plane of the diagram. It is found to describe a circle of radius r between the two plates. Find the speed of the charged particle.

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115. The magnetic field B inside a long solenoid, carrying a current of 5.00 A, is $\left(3.14 \times 10^{-2}\right)$ T. Find the number of turns per unit length of the solenoid.

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116. A long solenoid is fabricated by closely winding a wire of radius 0.5 mm over a cylindrical nonmagnetic frame so that the successive turns nearly touch each other. What would be the magnetic field B at the centre of the solenoid if it carries a current of 5 A?

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117. A copper wire having resistance 0.01 ohm in each metre is used to wind a 400 turn solenoid of radius 1.0 cm and length 20 cm. Find the emf of a battery which when connected across the solenoid will cause a magnetic field of $\left(1.0 \times 10^{-2}\right)$ T near the centre of the solenoid.

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118. A tightly- wound solenoid of radius a and length l has n turns per unit length. It carries an electric current i. Consider a length dx of the solenoid at a distance x from one end. This contains n dx turns and may be approximated as a circular current I n dx. (a) Write the magnetic field at the centre of the solenoid due to this circular current. Integrate this expression under proper limits to find the magnetic field at the centre of the solenoid. (b) Verify that if $l > \ > a$, the field tends to $(B = (\mu_0)ni)$

and if $a >> 1$, the field tends to $B = \left((\mu_0)ni\frac{l}{2}a\right)$. Interpret these results.

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119. A tightly- wound , long solenoid carries a current of 2.00 A. An electron is found to execute a uniform circular motion inside the solenoid with a frequency of $(1.00 \times 10^8 revs^{-1})$. Find the number of turns per metre in the solenoid.

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120. A tightly-wound, long solenoid has n turns per unit length, a radius r and carries a current i. A particle having charge q and mass m is projected from a point on the axis in a direction perpendicular to the axis. What can be the maximum speed for which the particle does not strike the solenoid?

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121. A tightly- wound, long solenoid is kept with its axis parallel to a large metal sheet carrying a surface current. The surgace current through a width dl of the sheet is Kdl and the number of turns per unit length of the solenoid is n. The magnetic field near the centre of the solenoid is found to be zero. (a) find the current in the solenoid. (b) If the solenoid is rotated to make its axis perpendicular to the metal sheet, what would be the magnitude of the magnetic field near its centre?

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122. A capacitor of capacitance $100\mu F$ is connected to a battery of 20 volts for a long time and then disconnected from it. It is now connected across a long solenoid having 4000 turns per meter. It is found that the potential difference across the capacitor drops to 90° of its maximum value in 2.0 seconds. Estimate the average magnetic field produced at the centre of the solenoid during this period.

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