PHYSICS

BOOKS - NCERT PHYSICS (ENGLISH)

ELECTROMAGNETIC INDUCTION

Multiple Choice Questions

1. A square of side L meters lies in the x-y plane in a region, where the magnetic field is given by $B = B_0\left(2\hat{i} + 3\hat{j} + 4\hat{k}\right)$T, where B_0 is constant. The magnitude of flux passing through the square is

A. $2B_0L^2Wb$

B. $3B_0L^2Wb$

C. $4B_0L^2Wb$

D. $\sqrt{29}B_0L^2Wb$

Answer: C

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2. A loop made of straight edges has six corners at $A(0, 0, 0), B(L, O, 0), C(L, L, 0), D(0, L, 0), E(0, L, L)$ and $F(0, 0, L)$. Where L is in meter. A magnetic field $B = B_0\left(\hat{i} + \hat{k}\right)T$ is present in the region. The flux passing through the loop $ABCDEFA$ (in that order) is

A. B_0L^2Wb

B. $2B_0L^2Wb$

C. $\sqrt{2}B_0L^2Wb$

D. $\sqrt{4}B_0L^2Wb$

Answer: B

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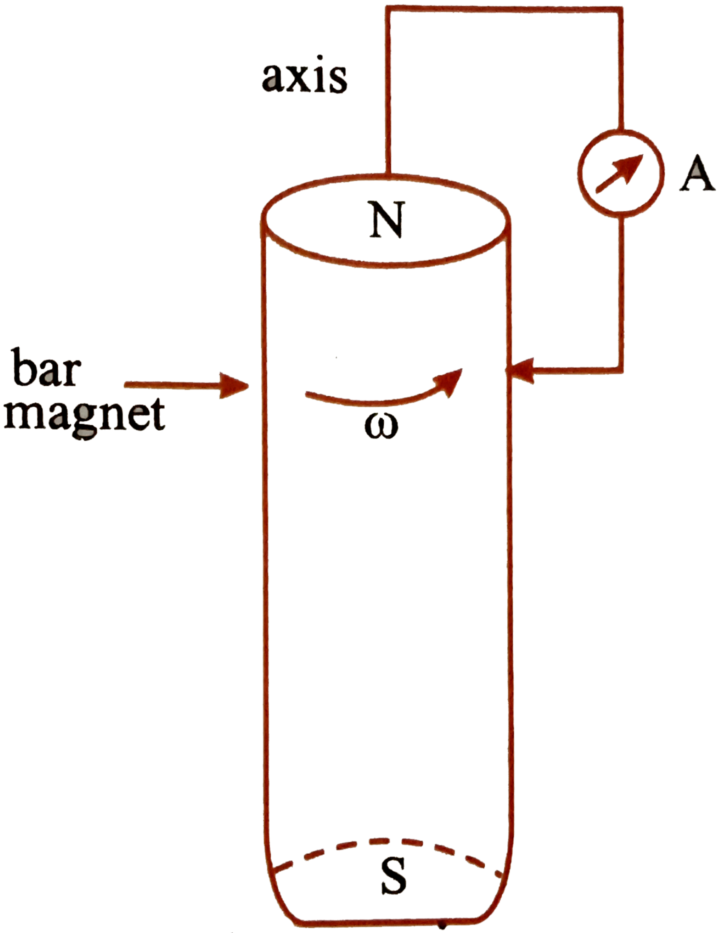
3. A cylindrical bar magnet is rotated about its axis (Figure). A wire is connect from the axis and is made to touch the cylindrical surface through a contact.

Then



A. A direct current flows in the ammeter A

B. No current flows through the ammeter A

C. An alternating sinusoidal current flows through the ammeter A with a time period $T = \frac{2\pi}{\Omega}$

D. A time varying non- sinusoidal current flows through the ammeter A

Answer: B

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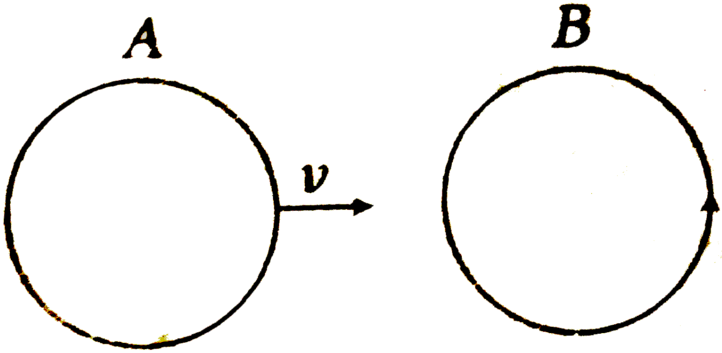
4. There are two coils A and B as shown in figure. A current starts flowing in B as shown, when A is moved towards B and stops when A stops moving. The current in A is counter-clockwise. B is kept stationary when A moves. We can infer that



A. There is a constant current in the clockwise direction in A

B. There is a varying current in A

C. There is no current in A

D. There is a constant current in the counter clockwise direction in A

Answer: D

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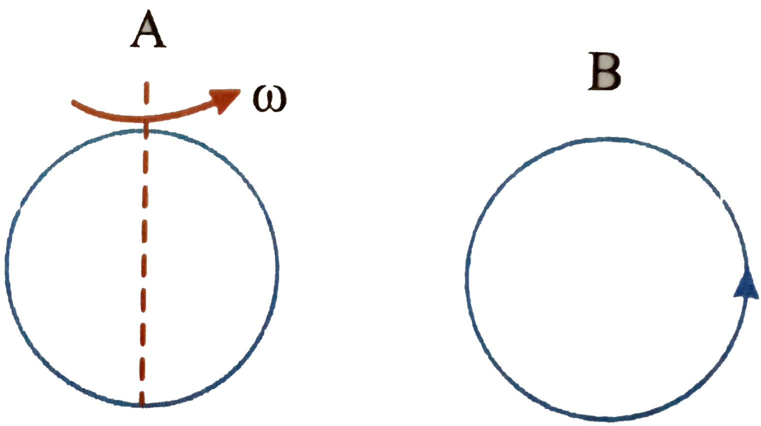
5. Same as problem 4 except the coil A is made to rotate about a vertical axis in the plane of the coil (Figure). No currents flows in B if A is at rest. The current in coil A, when the current in B (at $t = 0$) is counterclockwise and the coil A is as shown at this instant, $t = 0$, is



A. Constant current clockwise

B. Varying current clockwise

C. Varying current counter clockwise

D. Constant current counter clockwise

Answer: A

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6. The self inductance L of a solenoid of length l and area of cross-section A, with a fixed number of turns N increases as

A. l and a increase

B. l decreases and A increases

C. l increases and A decreases

D. both l and A decrease

Answer: B

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7. A metal plate can be heated by

A. A direct current is passing through the plate

B. It is placed in a time varying magetic field

C. It is placed in a space varying magnetic field, but does not vary with time

D. A current (either direct or alternating) is passing through the plate

Answer: A,B,D

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8. An e.m.f. is produced in a coil, which is not connected to an external voltage source. This can be due to

A. The coil being in a time varying magnetic field

B. The coil moving in a time varying magnetic field

C. The coil moving in a constant magnetic field

D. The coil is stationary in exteranl spatially magnetic field, which does not change with time

Answer: A,B,D

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9. The mutual inductance M_{12} of coil 1 with respect to coil 2

A. Increases when they are brought nearer

B. Depends on the current passing through the coils

C. Increases when one of them is rotated about an axis

D. Is the same as M_{21} of coils 2 with respect to coil 1

Answer: A,D

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10. A circular coil expands radially in a region of magnetic field and no electromotive force is produced in the coil. This can be because

A. The magnetic field is constant

B. The magnetic field is in the smae plane as the circular coil and it may or may not vary

C. The magnetic field has a perpendicular (to the palne of the coil) component whose magnitude is decreasing suitably

D. There is a constant magnetic fied in the perpendicular (to the plane of the coil direction)

Answer: B,C

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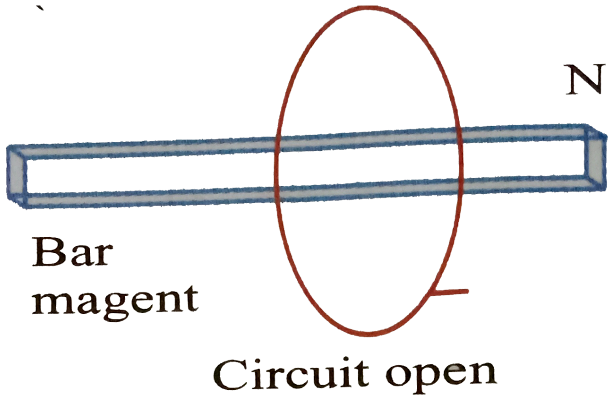
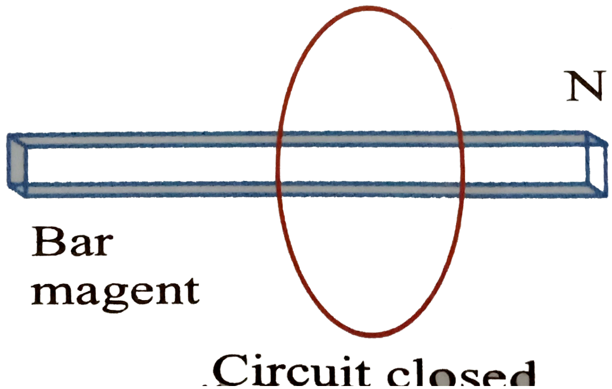
Very Short Answer

1. Consider a magnet surround by a wire with an on $/$ of switch S (figure) if the switch is thrown from the off position (open circuit) to the on position the (closed circuit).





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2. A wire in the form of a tightly wound solenoid is connected to a DC source, and carries a current. If

the coil is stretched so that there are gaps between successive elements of the spiral coil, then

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3. A solenoid is connected to a battery so that a steady current flows through it. If an iron core is inserted into the solenoid, the current will

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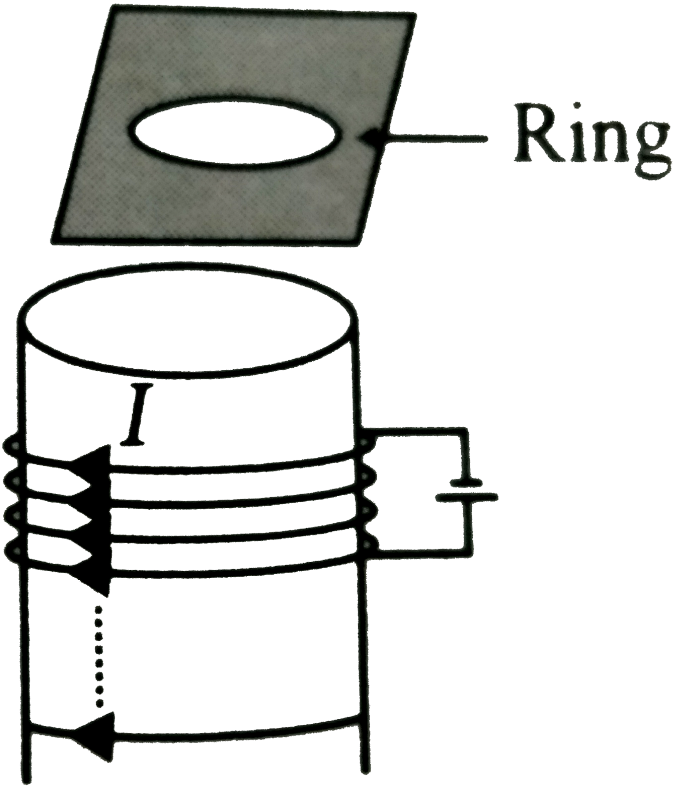
4. A metal ring kept (supported by a card borad) on the top of a fixed soleniod carry a current I as shown in figure. The center of the ring coincides with the axis of the solenoid. If the current in the soleniod is switched off, then



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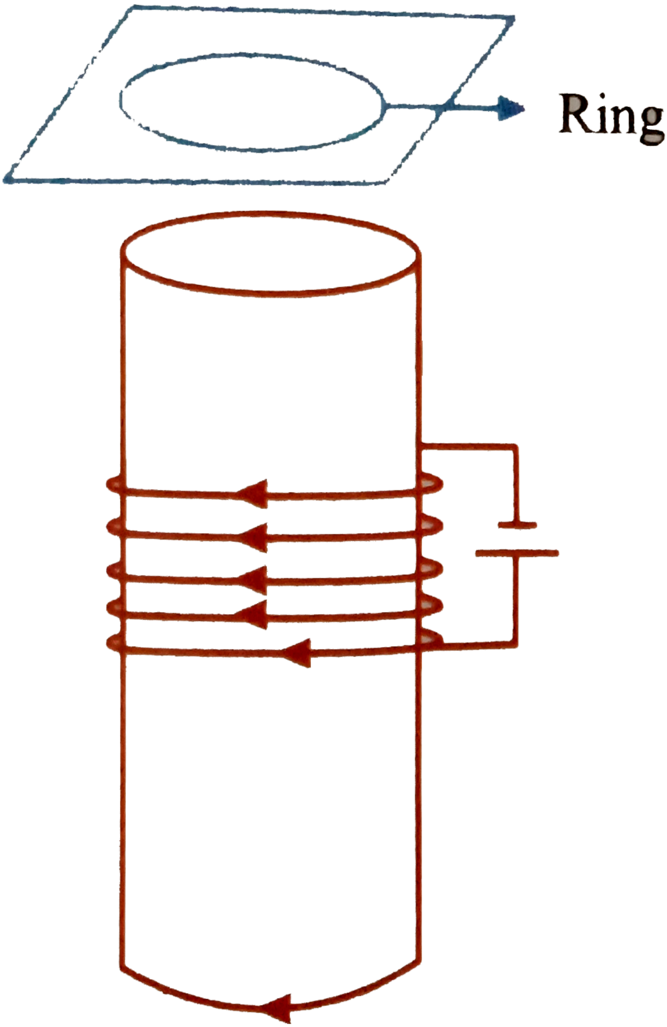
5. Consider a metal ring kept on top of a fixed solenoid (say on a carboard) The centre of the ring coincides with the axis of the solenoid. If the current is suddenly switched on then



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6. Consider a metallic pipe with an inner radius of 1 cm. If a cylindrical bar magnet of radius 0.8 cm is dropped through the pipe, it takes more time to come down than it takes for a similar unmagnetised cylindrical iron bar dropped through the metallic pipe. Explain.

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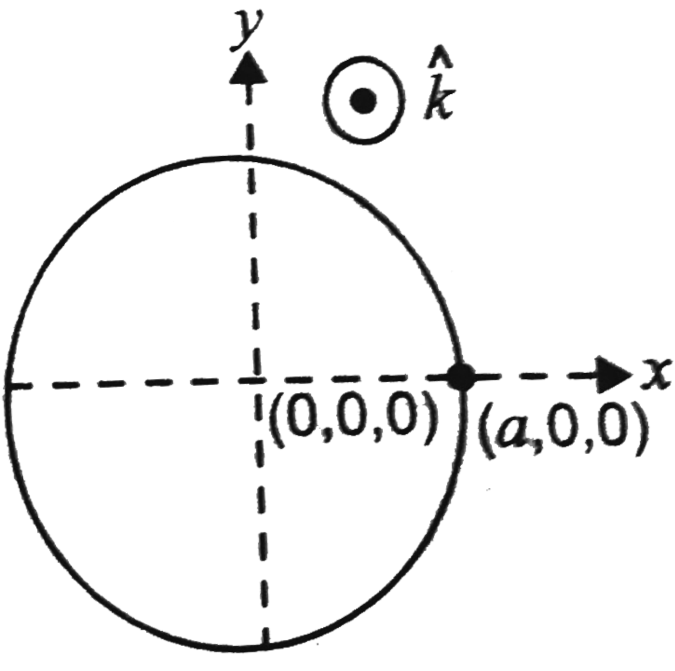
Short Answer Type Questions

1. A magnetic field in a certain region is given by $B = B_0 \cos(\omega t)\hat{k}$ and a coil of radius a with resistance R is placed in the x-y plane with its centre at the origin in the magnetic field, Fig. Find the magnitude and the direction of the current at (a,0,0) $att = \pi / 2\omega, t = \pi / \omega$ and $t = 3\pi / 2\omega$.



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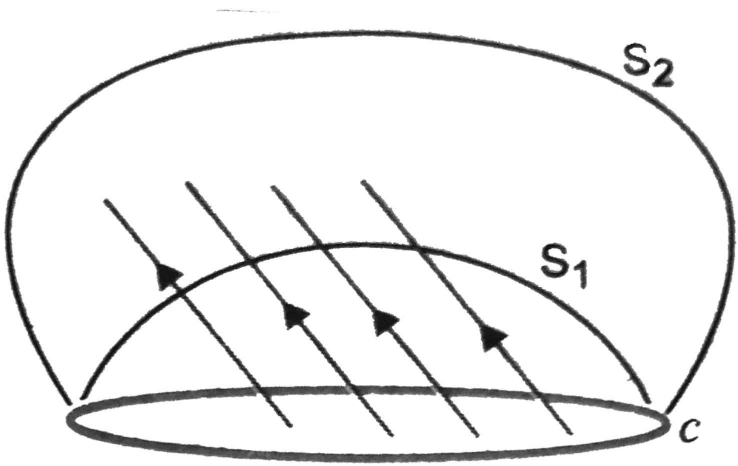
2. Consider a closed loop C in a magnetic field, Fig. The flux passing through the loop is defined by choosing a surface whose edge coincides with the loop and using the formula $\phi = B_1 . dA_1 + B_2 . Da_2 +$ ....Now if we chose two different surfaces S_1 and S_2 having C as their edge, would we get the same answer for flux. Justify your answer.



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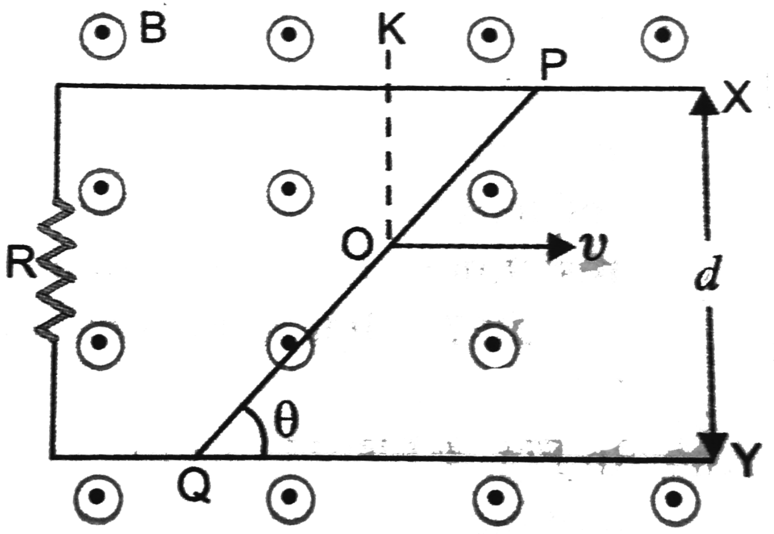
3. Find the current in the wire PQ for the configuration shown in Fig.Wire PQ has negligible resistance.B, the magnetic field is coming out of the paper. θ is a fixed angle made by PQ travelling smoothly over two conducting parallel wires separated by a distance d.



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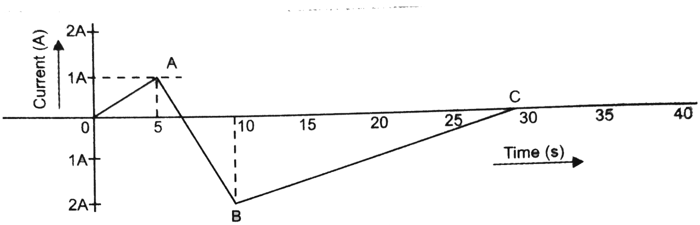
4. A (current vs time) graph of the current passing through a solenoid is shown in Fig. For which time is the back electromotive force (u) a maximum? If the back emf t = 3 s is e, find the back emf at t = 7 s, 15 s and 40 s OA, AB and BC are straight line segments.



5. There are two coils A and B seperated by some distance. If a current of 2 A flows through A, a magnetic flux of 10^{-2} Wb passes through B (no current through B). If no current passes through A and a current 1 A passes through B, what is the flux through A?

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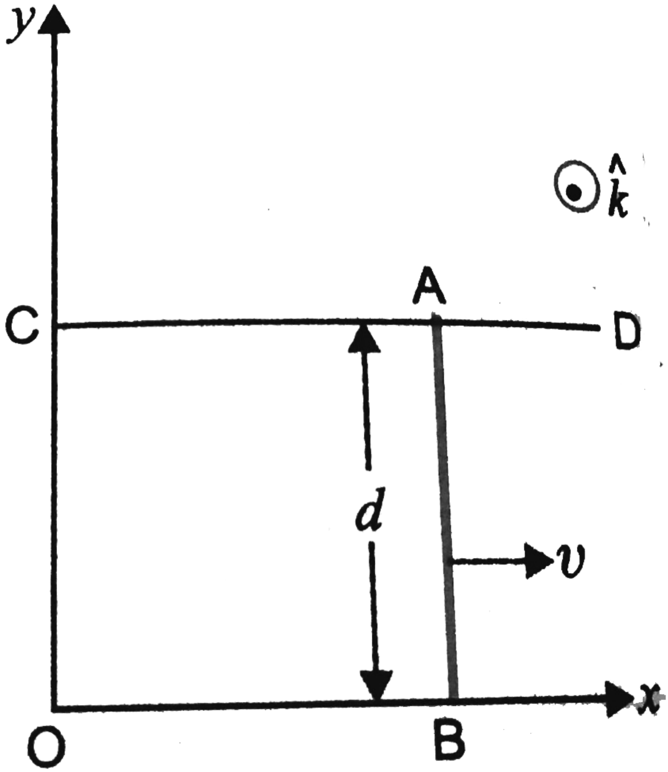
Long

1. A magnetic field $B = B_0 \sin(\omega t)\hat{k}$ covers a large region where a wire AB slides smoothly over two parallel conductors separated by a distance d, Fig. The wires are in the x-y plane. The wire AB (of length d) has resistance R and parallel wires have negligible resistance. If AB is moving with velocity v, what is the current in the circuit ? What is the force needed to keep the wire moving at constant velocity ?



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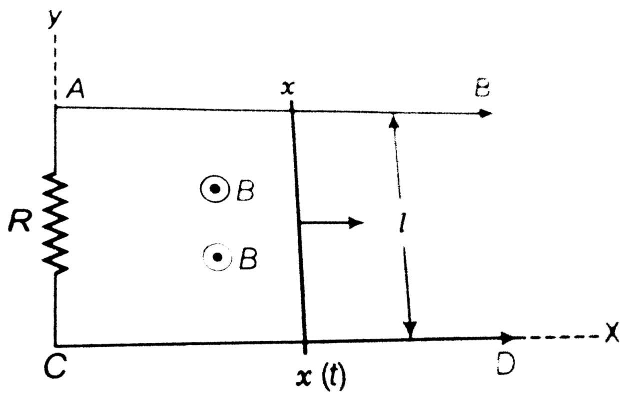
2. A conducting wire XY of mass M and negligible resistance slides smothly on two parallel conducting wires as shown in figure. The closed circuit has a resistance R due to AC. AB and CD are perfect conductors. There is a magnetic field $B = B(t)\hat{k}$



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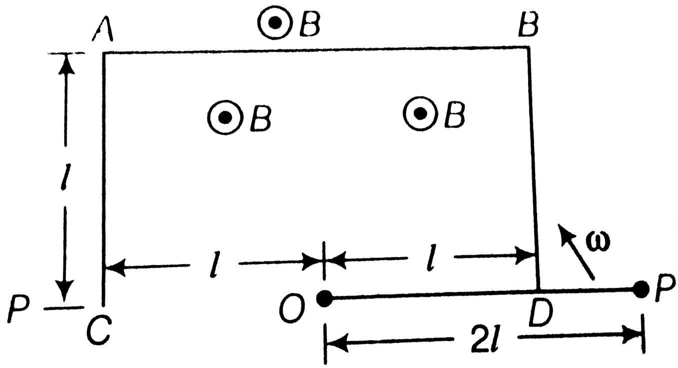
3. ODBAC is a fixed rectangular conductor of negligible resistance (CO is not connected) and OP is a conductor which clockwise with an angular velocity ω (figure). The entire system is in a uniform magnetic field B whose direction is along the normal to the surface of the rectangular conductor ABDC. The conductor OP is in electirc contact with ABDC. The rotaating conductor has a resistance of λ per unit length. Find the current in the rotating conductor, as it rotates by 180°.



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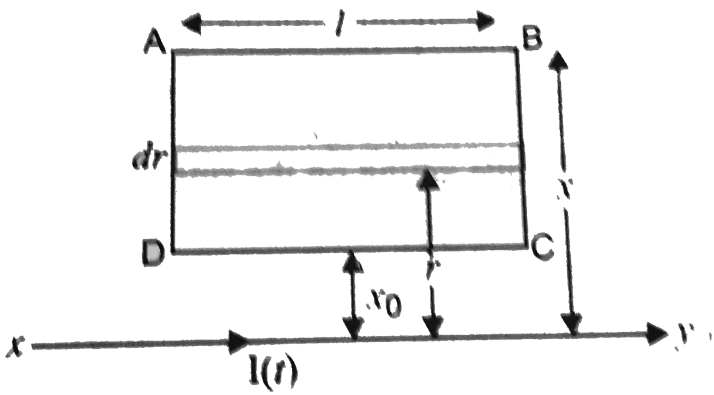
4. Consider an infinitely long wire carrying a current I

(t),

With $\frac{dI}{dt} = \lambda$ = constant . Find the current produced in the rectangular loop of wire ABCD if its resistance is

R, Fig



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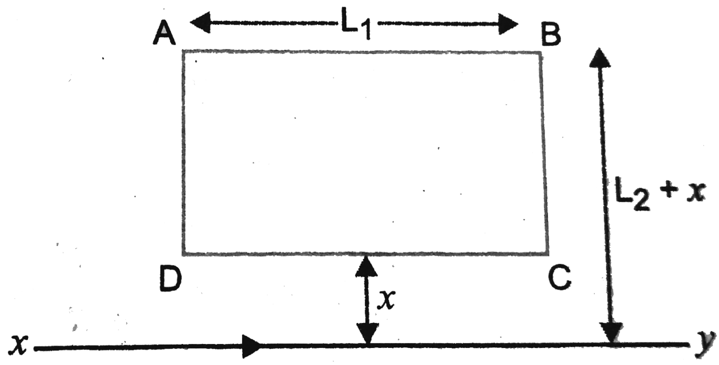
5. A rectangular loop of wire ABCD is kept close to an infinitely long wire carrying a current I (t) $= I_0(1 - t/T)$ for $0 \leq t \leq$ T and I(0) = 0 for t>T, Fig. Find the total charge passing through a given point in the loop, in time T. resistance of the loop is R



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6. A magnetic field B is confined to a region $r \leq$ a and points out of the paper (the z-axis), r = 0 being the centre of the cicular region. A charged ring (charge = Q) of radius b,bgt a and mass m lie in the x-y plane with its centre at origin. The ring is free to rotate and is at rest. The magnetic field is brougth to zero in time Δt. Find the angular velocity `omega or the ring after the field vanishes.

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7. A rod of mass m and resistance R slides smoothly over two parallel perfectly conducting wires kept sloping at an angle θ with respect to the horiaontal, Fig. The circuit is closed through a perfert conductor at the top. There is a constant magnetic field B along the vertical direction. If the rod is initially at rest, find the velocity of the rod as a function of time.

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8. Find the current in the sliding rod AB (resistance = R) for the arranged shown in Fig. B is constant and is out of the paper. Paralllel wires have no resistance. v is constant. Switch is closed at time t = 0.

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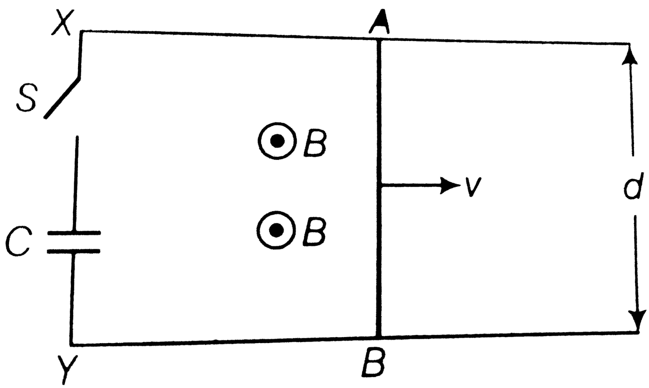
9. Find the current in the sliding rod AB (resistance = R) for the arrangement shown in figure. B is constant and is out of the paper. Parallel wires have no resistance , v is constant . Switch S is closed at time t=0.



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10. A metallic ring of field. If z is the radius l (ring being horizontal is falling under gravity in a region haivng a magnetic field. If z is the vertical direction, the z-component of magnetic field is $B_z = B_0(1 + \lambda z)$. If R the resistance of the ring and if the ring falls with a velocity v, find the energy lost in the resistance If the ring has reached a constant velocity, use the conservation of energy to determine v in terms of m, B, λ and acceleration due to gravity g.

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11. A long solenoid 'S' has 'n' turns per meter, with diameter 'a'. At the center of this coil, we place a smaller coil of 'N' turns and diameter 'b' (where b < a). If the current in the solenoid increase linearly with time, what is the induced emf appearing in the smaller coil. Plot graph showing nature of variation in emf, if current varies as a function of $mt^2 + C$.

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