PHYSICS

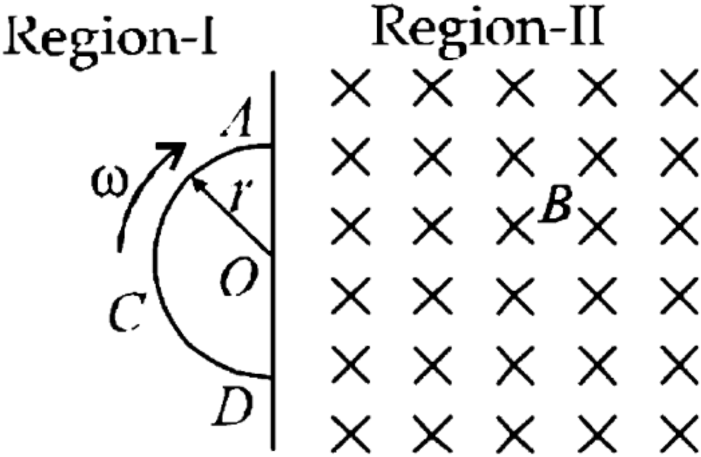
BOOKS - DHANPAT RAI & CO PHYSICS (HINGLISH)

ELECTROMAGNETIC INDUCTION

Problems For Competitive Examination

1. Space is divided by the line AD into two regions. Region I is field free and the Region II

has a unifrom magnetic field B direction into the plane of the paper. ACD is a simicircular conducting loop of radius r with center at O, hte plane of the loop being in the plane of the paper. The loop is now made to rotate with a constant angular velocity ω about an axis passing through O and the perpendicular to the plane of the paper. The effective resistance of the loop is R.



(i) obtain an expression for hte magnitude of the induced cureent in the loop.

(ii) Show the direction of the current when the loop is entering into the Rigion II.

Plot a graph between the induced e.m.f and the time of roation for two periods or rotation.

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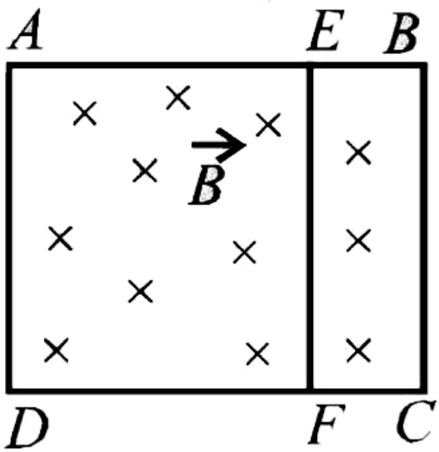
2. A rectangular frame ABCD, made of a uniform metal wire, has a straight connection between E and F made of the samae wire, as shown in fig. AEFD is a square of side 1m, and EB=FC=0.5m. The entire circuit is placed in steadily increasing, uniform magnetic field directed into the plane of the paper and normal to it. The rate of change of the magnetic field is $1T/s$. The resistance per unit length of the wire is $1\omega/m$. Find the magnitude and directions of the currents in the segments AE, BE and EF.



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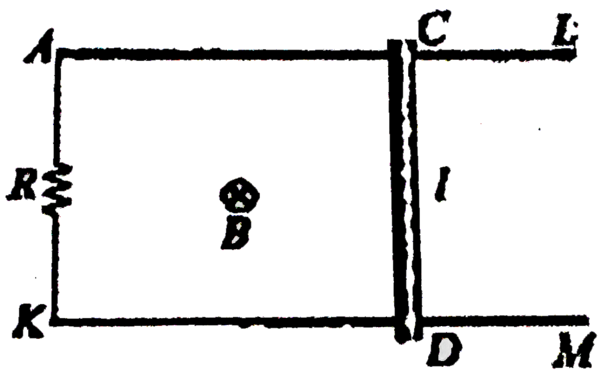
3. Two parallel wires AL and KM placed at a distance l are connected by a resistor R and placed in a magnetic field B which is perpendicular to the plane containing the wire

as shown in figure-5.340. Another wire CD now connects the two wires perpendicularly and made to slide with velocity v. Calculate the workdone needed to slide the wire CD. Neglect the resistance of all the wires.



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4. Two long parallel wires of zero resistance are connected to each other by a battery of $1.0V$. The separation between the wires is $0.5m$. A metallic bar, which is perpendicular to the wire and of resistance 10Ω moves on these wire when a magnetic field of 0.02 tesla is acting perpendicular to the plane containing the wire and the wires. Find the velocity of the bar as a function of time if the mass of the bar is $0.002kg$. Find also the steady-state velocity of the bar.

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5. An airplane, with a 20 m wing-spread, is flying at $250ms^{-1}$ straight south parallel to the earth's surface. The earth's magnetic field has a horizontal component of $2 \times 10^{-5} Wbm^{-2}$ and the dip angle is 60°. Calculate the emf induced across the tips of the wings

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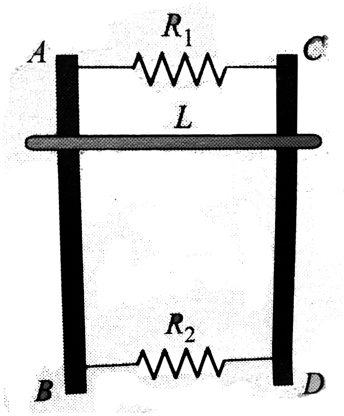
6. Two parallel vertical metellic rails AB and CD are separated by $1m$. They are connecting at two ends by resistances R_1 and R_2 as shown in Fig. 3.96. A horizontal metallic bar L mas $0.2kg$ slides without friction vertically down the rails under the action of gravity. There is a uniform horozontal magnetic field of $0.6T$ perpendicular to the plane of the rails. It is observed that when the terminal velocity is attained, thwe power dissipated in R_1 and R_2 are 0.76 and $1.2W$, respectively. Find the terminal velocity of the bar L and the values of R_1 and R_2.



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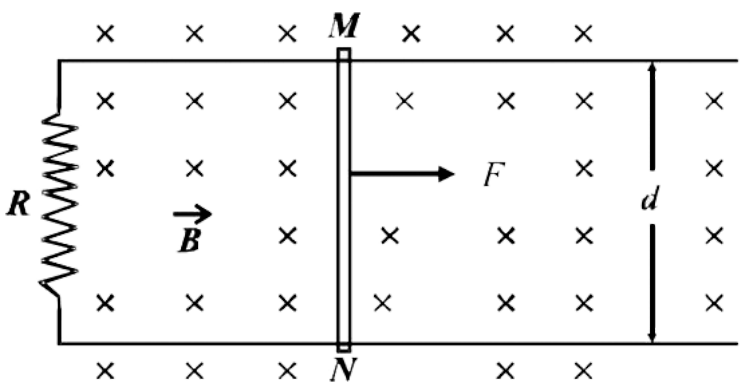
7. Two long parallel horizontal rails a, a distance d aprt and each having a risistance λ per unit length are joing at one end by a resistance R. A perfectly conduction rod MN of

mass m is free to slide along the rails without friction (see figure). There is a uniform magnetic field of induction B normal to the plane of the paper and directed into the paper. A variable force F is applied to the rod MN such that, as the rod moves a constant current flows through R.



(i) Find the velocity of the rod and the applied force F as function of the distance x of the rod from R.

(ii) What fraction of the work done per second by F is converted into heat?

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8. A copper rod of length $0.19m$ is moving with uniform velocity $10ms^{-1}$ parallel to a long straight wire carrying a current of $5.0A$. The rod is perpendicular to the wire with its ends at distances 0.01 and $0.2m$ from it. Calculate the emf induced in the rod.

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9. A current of 10 A is flowing in a long straight wire situated near a rectangular circuit whose two sides oflength 0.2m are parallel to the wire. One of them is at a distance of0.05m and the other at a distance of 0. I0m from the wire. The wire is in the plane of the rectangle. Find the magnetic flux through the rectangular circuit. If the current decays uniformly to zero in 0.02s, fmd the EMF induced in the circuit and indicate the direction in which the induced current flows.

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10. Two infinite long straight parallel wires A and B are separted by 0.1m distance and carry equal currents in opposite directions. A square loop of wire C of side 0.1m lies in the plane of A and B. The loop of wire C is kept parallel to both A and B at a distance of 0.1m from the nearest wire. Calculate the EMF induced in the loop C while the currents in A and B are increasing at the rate of $10^3 A / s$. Also indicate the direction of current in the loop C.

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11. A very small circular loop of area $5 \times 10^{-4} m^2$, resistance 2Ω and negligible inductance is initially coplanar and concentric with a much larger fixed circular loop of radius

$0.1m$. A constant current of $1A$ is passed in the bigger loop and the smaller loop is rotated with angular velocity $\omega rad / \sec$ about a diameter. Calculate (a) the flux linked with the smaller loop, (b) induced emf (c) induced current in the smaller loop, as a function of time.

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12. A long solenoid of diameter 0.1 m has 2×10^4 turns per meter. At centre of the solenoid is 100 turns coil of radius 0.01 m placed with its axis coinciding with solenoid axis. The current in the solenoid is decreased at a constant rate form + 2 A to - 2 A in 0.05 s. Find the e.m.f. induced in the coil. Also, find the total charge flowing through the coil during this time, when the resistance of the coil is $10\pi^2 ohm$.

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13. Find the magnetic flux linked with a rectangular coil of size $6cm \times 8cm$ placed at right angle to a magnetic field of 0.5 Wbm^{-2}

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14. A square coil of 600 turns, each side 20cm, is placed with its plane inclined at 30° to a uniform magnetic field of $4.5 \times 10^{-4} Wbm^{-2}$, Find the flux through the coil.

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15. The magnetic flux threading a coil changes from 12×10^{-3} Wb to 6×10^{-3} Wb in 0.1 s. Calculate the induced emf.

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16. A coil having 100 turns and area $0.020m^2$ is placed normally in a magnetic field. The magnetic field changes from $0.20Wbm^{-2}$ at a uniform rate over a period of 0.01 s. Calculate the induced emf in the coil.

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17. Find the magnitude of emf induced in a 200 turn coil with cross-sectional area of $0.16m^2$, if the magnetic field through the coil changes from 0.10 Wb m^{-2} to 0.50 Wb m^{-2} at a uniform rate over a period of 0.02 s.

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18. A 70 turn coil with average diameter of 0.02 m is placed perpendicular to magnetic field of 9000 T. If the magnetic field is changed to 6000 T is 3s, what is the magnitude of induced emf ?

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19. A 70 turn coil with average diameter of 0.02 m is placed perpendicular to magnetic field of 9000 T. If the magnetic field is changed to

6000 T is 3s, what is the magnitude of induced emf.

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20. A magnetic field of flux density 10 T act normal to a 50 turn coil of $100 cm^2$ area. Find the emf induced in it if the coil is removed from the field in 1/20 s.

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21. A coil has 1000 turns and $500cm^2$ as its area. It is placed at right angles to a magnetic field of $2 \times 10^{-5} Wbm^{-2}$. The coil is rotated through 180° in 0.2s. Find the average emf induced in the coil.

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22. A coil of area $0.04m^2$ having 1000 turns is suspended perpendicular to a magnetic field of $5.0 \times 10^{-5} Wbm^{-2}$. It is rotated through

90° in 0.2 s. Calculate the average emf induced in it.

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23. A wire 40 cm long bent into a rectangular loop $15cm \times 5cm$ is placed perpendicular to the magnetic field whose flux density is $0.8Wbm^{-2}$. Within 1.0 second, the loop is changed into a 10 cm square and flux density increases to 1.4 Wbm^{-2}. Calculate the value of induced emf.

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24. The magnetic flux through a coil perpendicular to its plane and directed into paper is varying according to the relation $\phi = (5t^2 + 10t + 5)$ milliweber. Calculate the e.m.f. induced in the loop at $t = 5$ s.

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25. When a wheel with metal spokes 1.0 m long is rotated in a magnetic field of flux density

2×10^{-4} T normal to the plane of the wheel, an emf of $\pi \times 10^{-2}$ V is induced between the rim and the axle. Find the rate of rotation of the wheel.

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26. A fan blade of length 2a rotates with frequency f cycles per second perpendicular to a magnetic field B. Find the p.d between the centre and the end of the blade.

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27. In a ceiling fan, each blade rotates in a circle of radius of 0.5 m, If the fan makes 20 revolution per second and if the vertical component of earth's field is 8×10^{-5} Wb m^{-2}, calculate the p.d. developed between the ends of each blade.

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28. The magnetic flux linked with a coil of N turns and resistance R changes from

ϕ_1 to ϕ_2. Show that the charge that has passed through the coil is

$$q = -\frac{N(\phi_2 - \phi_1)}{R}.$$

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29. A closed coil of 50 turns of $300 cm^2$ area and of resistance 40Ω is held at right angles to a uniform field of 2×10^{-2}T. Find the charge induced in the coil, when it is turned through an angle of 30° about an axis perpendicular to the field.

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30. A metal disc of radius 200 cm is rotated at a constant angular speed of $60 rad s^{-1}$ in a plane at right angles to an external field of magnetic induction $0.05 Wb m^{-2}$. Find the e.m.f. induced between the centre and a point on the rim.

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31. A copper disc of radius 10 cm placed with its plane normal to a uniform magnetic field completes 1200 rotations per minute. If induced emf between the centre and the edge of the disc is 6.284 mV, Find the intensity of the magnitude field. Take $\pi = 3.142$

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32. A gramophone disc of brass of diameter 30 cm rotates horizontally at the rate of $100/3$

revolutions per minute. If the vertical component of the earth's magnetic field be $0.01 \text{ weber}/\text{metre}^2$, then the emf induced between the centre and the rim of the disc will be-

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33. A long solenoid with 15 turns per cm has small loop of area $2.0 cm^2$ placed inside, normal to the axis of the soleniod. If current carried by the solenoid changes steadily from

2 A to 4 A in 0.1 s, what is the induced voltage in the loop, while the current is changing ?

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34. An air-cored solenoid of length 50cm and area of cross-sectional $28cm^2$ has 200 turns and carries a current of 5.0 A. On switching off, the current decreases to zero within a time interval of 1.0 ms. Find the average emf induced across the ends of the open switch in the circuit.

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35. A closed coil consists of 500 turns has area $4cm^2$ and a resistance of 50Ω. The coil is kept with its plane perpendicular to a uniform magnetic field of $0.2W\frac{b}{m^2}$. Calculate the amount charge flowing through the coil if it is rotated through 180°

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36. A small flat search coil of area $5cm^2$ with 140 closely wound turns is placed between the poles of a powerful loud speaker magnet and then quickly snatched out of the field region. The total charge flown in the coil is 10.5 mC. If the resistance of the coil is 0.6Ω, what is the field strength of the magnet ?

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B

1. An aeroplane with a wingspan of 30 meters flies at a horizontal speed of 100 metres per second in a region where the vertical components of the magnetic field due to earth is 5.0×10^{-4} weber/ m^2. What is the potential difference between the tips of the wings?

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2. A jet plane is moving at a speed of 1000 kmh^{-1}. What is the potential difference across the ends of its wings 20 m long. Given total intensity of earth's magnetic field is 3.5×10^{-4} tesla and angle of dip at the place is 30°.

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3. If the vetical component of earth's magnetic field be 4.0×10^{-5} Wbm^{-2}, then what will be the potential difference induced between the rails of a metre- gange running north-south when a train is running on them with a speed of $36 kmh^{-1}$

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4. A straight conductor 1 meter long moves a right angles to both, its length and a uniform magnetic field. If the speed of the conductor is $2.0 ms^{-1}$ and the strength of the magnetic field is 10^4 gauss, find the value of induced emf in volt.

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5. A straight conductor of length 0.4 m is moved with a speed of 7 m/s perpendicular to the magnetic field of intensity of $0.9Wb/m^2$. The induced e.m.f. across the conductor will be

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6. A horizontal telephone wire 1 km long is lying along east-west in earth's magnetic field. If falls freely to the ground from a height of 10 m. Calculate the e.m.f. induced in the wire on striking the ground. Given horizontal component of earth's field is 0.32 gauss.

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7. A horizontal wire 24 cm long falls in the field of flux density 0.8 T. Calculate the emf induced in it at the end of 3s, after it was dropped from rest. Suppose the wire moves perpendicular to its length as well as to magnetic field. Take $g = 9.8ms^{-2}$

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8. An aircraft with wingspan of 40 m flies with a speed of $1000 kmh^{-1}$ in the eastward direction at a constant altitude in the northern hemiphere where the horizontal component of earth 's field is 1.6×10^{-5} T and the angle of dip is 71.6°. Find the emf that develops between the tips of the aircraft.

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9. A straight rod 2m long is placed in an aeroplane in the east-west direction. The aeroplane lifts itself in the upward direction at a speed of $36kmh^{-1}$. Find the potential difference between the two ends of the rod if the vertical component of earth's magnetic field is $\frac{1}{4\sqrt{3}}$ gauss and angle of dip=30°

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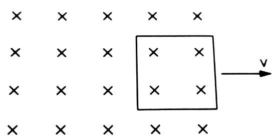
10. Shows a square loop having 100 turns, an area of $2.5 \times 10^{-3} m^2$ and a resistance of 100Ω. The magnetic field has a magnitude B =0.40 T. Find the work done in pulling the loop out of the field, slowly and uniformly is 1.0 s.



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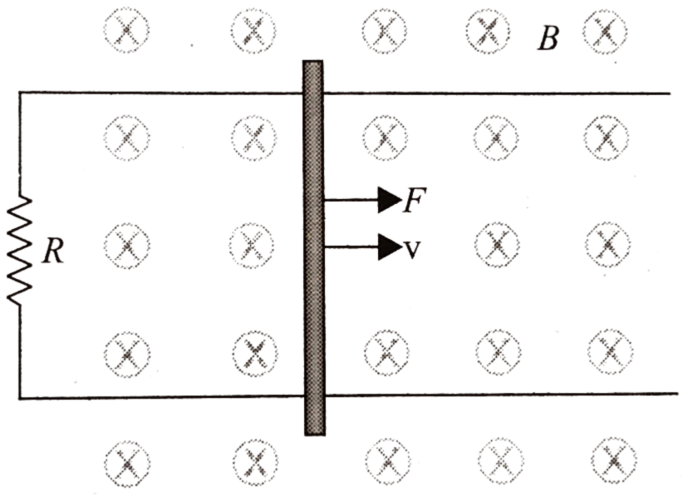
11. A rod closing the circuit shown in Fig moves along a U shaped wire at a constant speed v under the action of the force F. The circuit is in a uniform magnetic field perpendicular to the plane. Calculate F if the rate of heat generation in the circuit is Q.



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12. Fig. 12.32 shows a long, rectangular, conducting loop of with l, mass m and resistance R placed partly in a perpendicular magnetic field B. With what velocity should it be pushed downwards so that it may continue to fall wihtout any acceleration?

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C

1. A closely wound rectangular coil of 200 turns and size $0.3m \times 0.1m$ is rotating in a magnetic field of induction $0.005Wbm^{-2}$ with a frequency of revolution 1800 rpm about an axis normal to the field. Calculate the maximum value of induced emf.

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2. A rectangular coil of dimensions $40cm \times 25cm$ having 1000 turns rotates in a

uniform magnetic field of strength 0.08 Wbm^{-2} about an axis perpendicular to the field. If the coil makes 300 revolution per minute, find the instantaneous emf when the plane of the coil make and angle of (i) 0° (ii) 45° and (iii) 90° with the magnetic lines of force.

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3. A rectangular coil of dimensions $0.1m \times 0.5m$ consisting of 2000 turns rotates about and axis parallel to its long side, making 2100 revolutions per minute in a field of 0.1 T. What is the maximum emf indcuced in the coil? Also find the instantaneous emf, when the coil is 60° to the field.

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4. The armature coil of a generator has 20 turns and its area is $0.127m^2$. How fast should it be rotated in a magnetic field of 0.2

Wbm^{-2} so that eh peak value of induced emf is 160 V?

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5. A coil has 50 turns and its area is $500cm^2$. It is rotating at the rate of 50 r.p.s. at right angles to a magnetic field of $0.5Wb/m^2$. Calculate the maximum value of electromotive force developed across the ends of the coil.

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6. Calculate the maximum emf induced in a coil of 100 turns and $0.01m^2$ area rotating at the rate of 50 rps about an axis perpendicular to a uniform magnetic field of 0.05 T. If the resistance of the coil is 30Ω, what is the maximum power generated by it ?

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D

1. A magnetic flux of 8×10^{-4} weber is linked with each turn of a 200 - turn coil when there is an electric current of 4 A in it. Calculate the self inductance of the coil.

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2. Calculate the induced emf in a coil of 10 H inductance in which the current changes from 8A to 3A in 0.2 s.

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3. How much is the self-induced voltage across a 4 H inductances, produced by a current change of 12 As^{-1} ?

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4. Calculate the self- inductance of a coil when a change of current from 0 to 2A in 0.05 s induces an emf of 80 V.

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5. A coil of inductance 0.5 H is connected to a 18 V battery. Calculate the rate of growth of current.

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6. An average emf of 25 V is induced in an inductor when the current in it is changed from 2.5 A in one direction ot the same value in the opposite direction in 0.1s. Find the self-inductance of the inductor.

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7. A coil has a self inductance of 10 mH. What is the maximum magnitude of the induced e.m.f. in the coil when a current of I $= 0.1 \sin 200t$ ampere is sent through it ?

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8. An air-cored solenoid has 150 turns and cross-sectional area $2cm^2$. If it is 40 cm long, what is its self-inductance?

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9. What is the self-inductance of an air core solenoid 1 m long, diameter 0.05 m, if it has 700 turns?

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10. A coil of wire of a certain radius has 600 turns and a self-inductance of $108 mH$. The self-inductance of a 2^{nd} similar coil of 500 turns will be

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11. The current is a solenoid of 240 turns, having a length of 12 cm and a radius of 2 cm, changes at a rate of $0.8 A s^{-}$. Find the emf indcued in it.

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12. The mutual inductance between two coil is 2.5 H. If the current in one coil is changed at the rate $2.0 A s^{-1}$, what will be the emf induced in the other coil?

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13. Calculate the mutual inductance between two coils when the currents change from 2 to 5 A in 0.25s in one coil, induces an emf of 12 mV in the other.

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14. A carspark coil developes an induced e.m.f. of 40000 V in the secondary when when current in primary changes form 4 A to zero in $10\mu s$. What is the mutual inductance of the coil ?

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15. If the current in the primary circuit of a pair of coils changes from 10 A to 0 in 0.1 s, calculate (i) the induced emf in the secondary if the mutual inductance between the two coils is 2 H and (ii) the change of flux per turn in the secondary if it has 500 turns.

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16. A conducting wire of 100 turns is wound over and near the centre of a solenoid of 100 cm length and 2 cm radius having 600 turns. Calculate mutual inductance of two coils.

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17. A solenoid 1.0 m long and 0.05 m in diameter, has 700 turns. Another solenoid of 50 turns is tightly wound over the first solenoid. Find (i) the mutual inductance of the two solenoinds and (ii) the induced emf in the second solenoid, when the current in the first changes from 0 to 5.0 A in 0.01 s

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18. A solenoid has 2000 turns wound over a length of $0.3m$. Its cross-sectional area is equal to $1.2 \times 10^{-3} m^2$. Around its central cross-section a coil of 300 turns in wound. If an initial current of $2A$ flowing in the solenoid is reversed in $0.25s$, the emf induced in the coil is

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19. Find the mutual inductance between the two coils if a current of 10 ampere in primary coil changes the flus by 500 Wb per turn in the secondary coil of 200 turns. Also, find the induced e.m.f. acorss the ends of the secondary coil if this change occurs in 0.5 sec.

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Others

1. A rectangular loop of area $20cm \times 30cm$ is held in a magnetic field of 0.3 T with its plane inclined at (i) 30° to the field (ii) parallel to the field. Find magnetic flux linked with the coil in each case.

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2. A coil of 100 turns is pulled in 0.04 s from between the poles of a magnet , where its area includes flux of 40×10^{-6} weber per turn to a place where it includes of flux of 10^{-5} weber per turn. Calculate the average emf induced in the coil .

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3. The mangnetic flux passsing perpendicular to the plane of a coil and directed into the paper is given by $\phi = 5t^2 + 6t + 2$ where ϕ is in milliwebers and t in seconds.

(a) What is the magnitude of the induced emf set up in the loop at $t = 1s$?

(b) What is the direction of current through the resistor R ?

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4. A coil of area $500cm^2$ and having 1000 turns is held perpendicular to a uniform field of 0.4 gauss. The coil is turned through 180° in $1/10\,\text{sec}$. Calculate the average induced e.m.f.

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5. A coil with an average diameter of 0.02 m is placed perpendicular to a magnetic field of 6000 T. If the induced e.m.f. is 11 V when magnetic field is changed to 1000 T in 4 s, what is the number of turns in the coil ?

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6. A wire 88 cm long bent into a circular loop is placed perpendicular to the magnetic field of flux density is increased to 3.0 wbm^{-2}.

Calculate the value of the emf induced .

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7. A magnetic field of flux density 10 T acts normal to a cail of 50 turns having $100cm^2$ area. Find the emf induced, if the coil is removed from the magnetic field in 0.1 s.

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8. 5.5×10^{-4} Magnetic flux lines are passing through a coil of resistance 10 ohm and number of turns 1000. If the number of flux lines reduces to 5×10^{-5} in 0.1 sec. Then

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9. A coil of area A lies in a uniform magnetic field B with its plane perpendicular to the field. In this position the normal to the coil makes an angle 0° with a field. The coil rotates at a uniform rate about its diameter to complete one rotation in time T. Find the average induced e.m.f. in the coil during the interval when coil rotates from:

(a) 0° to 90°

(b) 90° to 180°

(c) 180° to 270°

(d) 270° to 360°

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10. A long solenoid of 10 turns / cm has a small loop of area 1 sq. cm placed inside with the normal of the loop parallel to the axis. Calculate the placed across the small loop if the current in the solenoid is changed from 1 A to 2 A in 0 .1 s, during the duration of this change.

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11. An air cored solenoid with length 30 cm, area of cross-section $25cm^2$ and number of turns 500 carries a current of $2.5A$. The current is suddenly switched off in a brief time of 10^{-3} s. How much is the average back e.m.f. induced across the ends of the open switch in the cuicuit ? Ignore the variation in magnetic field near the ends of the solenoid.

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12. A copper rod of length L rotates with an angular with an angular speed 'ω' in a uniform magnetic field B. find the emf developed between the two ends of the rod. The field in perpendicular to the motion of the rod.

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13. A metal disc of radius R rotates with an angular velcoity ω about an axis perpendicular to its plane passing through its centre in a magnetic field B acting perpendicular to the plane of the disc. Calculate the induced emf between the rim and the axis of the disc.

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14. A wheel with ten metallic spokes each $0.50m$ long is rotated with a speed of $120rev/\min$ in a plane normal to the earth's magnetic field at the place. If the magnitude of the field is 0.4 gauss, the induced e.m.f.

between the axle and the rim of the wheel is equal to

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15. When a wheel with metal spokes 1.2 m long rotates in a magnetic field of flux density 5×10^{-5} T normal to the plane of the wheel, an e.m.f. of 10^{-2} V is induced between the rim and the axle. Find the rate of rotation of the wheel.

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16. A metallic rod of 1 m length is rotated with a frequency of 50 rev/s, with on end hinged at the centre and the other end at the circumference of a circular metallic ring of radius 1 m, about an axis passing through the centre and perpendicular at to the plane of the ring. A constant uniform magnetic field of 1 T parallel to the axis is persent eveywhere. what is the e.m.f. between the centre and the metallic ring?

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17. A circular copper disc of 10 cm radius rotates at $20\pi\ radian/\sec$ about an axis through its centre and perdendicular to the disc. A uniform magnetic field of 0.2 T acts perpendicular to the disc. Calculate the potential difference developed between axis of the disc and the ring. What is the induced current if resistance of disc is 2 ohm ?

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18. Prove that the charge induced does not depend on the rate of change of magnetic flux.

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19. It is desired to measure the magnitude of field between the poles of a powerful loud speaker magnet. A small flat search coil of area $2cm^2$ with 25 closely wound turns is positioned normal to the field direction and then quickly snatched out of the field region (Equivalently, one can give it a quick 90° turn to bring its plane parallel to the field direction). The total charge flowing in the coil (measured by a ballastic galvanometer connected to the coil) is 7.5 mC. The resistance of the coil and galvanometer is 0.5Ω. Estimate the field strength of the magnet.

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20. A 10 ohm resistance coil has 1000 turns and at a time, magnetic flux 5.5×10^{-4} Wb passes through it. If the flux falls to

0.5×10^{-4} Wb in 0.1 s, find the emf generated in the coil and the charge that flows through the coil.

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21. A circuilar brass loop of radius a and resistance R is placed with it plane perpendicular to a magnetic field, which varies with time as $B = B_0 \sin \omega t$. Obtain the expression for the induced current in the loop.

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22. A conducting cirular loop is placed in a unifrom transcerse magnetic field of 0.02 T . Somehow , the radius of the loop begins to decrease at a constant rate of 1. 0 mm/s . Find the emf induced in the loop at the instant when the radius is 2 cm.

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23. A small piece of metal wire is dragged across the gap between the pole pieces of a magnet in 10 s. The magnetic flux between the pole pieces is 8×10^{-4} Wb. Find the magnitude of induced e.m.f.

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24. An aircraft with a wingspan of 40 m flies a speed of 1080 km hr_1 in the eastward direction at a constant altitude in the northern hemisphere, where the vertical component of earth's magnetic fieldis

1.75×10^{-5} T. Find the e.m.f. that develops between the tips of the wings.

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25. The two rails of a railway track, insulated from each other and the ground, are connected to a milli voltmeter. What is the reading of the milli voltmeter when a train travels at a speed of $180 km / hours$ along the track, given that the vertical components of earth's magnitic field is $0.2 \times 10^{-4} weber / m^2$

& the rails are separated by 1 meter?

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26. A jet plane is travelling west at the speed of 1800 $km. . h$. What is the voltage difference developed between the ends of the wing 25 m long, if the earth's magnetic field at the location has a magnitude of 5.0×10^{-4} T and the dip angle is 30°

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27. A bicycle generator creates a 3 . 0 V , when the bicycle is travelling a speed of $9.0 km h^{-1}$. How much emf is generated when the bieycls is travelling a $15 km h^{-1}$.

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28. A conductor of length 1.0 m falls freely under gravity from a heigth of 10 m so that it cuts the lines of force the horizontal component of earth's magnetic field of

$3 \times 10(-5) Wbm^{-2}$. Find the emf induced in the conductor .

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29. Twelve wires of equal lenghts (each 10 cm) are connected in the form of a skeleton cube. If the cube is moving with a velocity 0.05 m/s, find the emf induced in each arm of the cube if the cube moves parallel to field. If the cube moves perpendicular to the field, What will be the induced e.m.f. in each arm ? Given B=5 Wb/m^2

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30. A rectangular loop of sides 8 cm and 2 cm with a small cut is moving out of a region of uniform megnetic field of magnitude 0.3 tesla directed normal to the loop. What is the voltage developed acorss the cut if velocity of the loop is $1cms^{-1}$ in a direction normal to the (i) longer side (ii) shorter side of the loop ?

For how long does the induced voltage last in each case?

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31. Fig. shows a metal rod PQ resting on the rails A, B and positoned between the poles of a permanent magnet. The rails, the rod and the magnetic field are in three mutually perperdicular directions. A galvanometer connects the rails through a switch K. Length of the rod = 15 cm, B = 0.50 T, resistance of closed loop containing the rod $= 9.0m\Omega$

Answer the following questions.

(a) Suppose K is open and the rod moves with a speed of $12cm/s$ in the direction shown, Give the polarity and magnitude of induced e.m.f

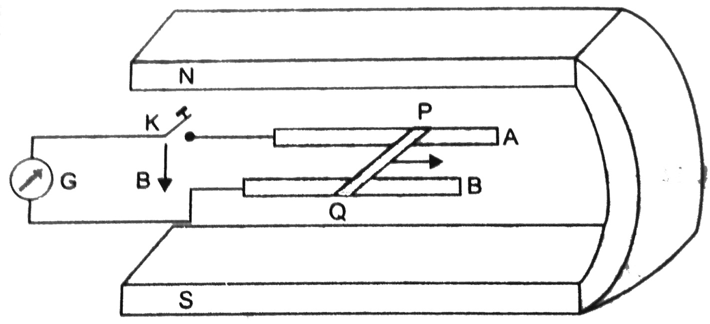
(b) Is there on excess charge built up at the ends of rods when K is open ? What if K is closed ?

(c) With K open and the rod moving uniformly, there is no net force on the electron in the rod PQ even though they do experience magnetic froce due to the motion of the rod Explain.

(d) What is the retarding force on the rod when K is closed?

(e) How much powe s required (by an external agent) to keep the rod moving at the same speed $(=12cm/s)$ when K is closed. (f) How much power is dissipated as heat in the closed circuit ? What is the source of this power?

(g) What is the induced e.m.f. in the following in the moving rod when the permanent magnet is rotated to a vertical position so that the field is parallel to the rails instead of being perpendicular ?



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32. A square loop of side $12cm$ with its sides parallel to x and y- axes is moved with a velocity $8cm/s$ along positive x-direction in an environment containing magnetic field along $+ve$ z-direction. The field has a gradient of 10^{-3}tesla/em along $-ve$ x-direction (increasing along $-ve$ x-axis) and also decreases with time at the rate of 10^{-3}tesla/s. The emf induced in the loop is

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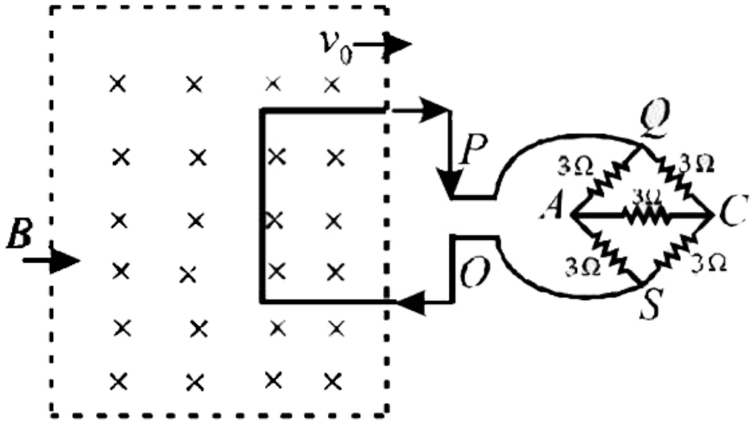
33. A square metal wire loop of side 10 cm and resistance 1 ohm is moved with a constant velocity (v_0) in a uniform magnetic field of induction $B = 2weber/m^2$ as shown in the figure. The magnetic field lines are perpendicular to the plane to the loop (directed into the paper). The loop is connected to a network of resistors each of value 3 ohms. The resistances of hte lead wire OS and PQ are negligible. What should be the speed of the loop so as to have a steady current of 1 milliampere in the loop? Given the direction of current in the loop.



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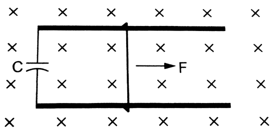
34. A wire of mass m and length l can freely slide on a pair of parallel, smooth, horizontal rails placed in a vertical magnetic field B . The rails are connected by a capacitor of capacitance C. The electric resistance of the rails and the wire is zero. If a constant force F acts on the wire as shown in the figure, find the acceleration of the wire.



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35. A circular coil of area $300cm^2$ and 25 turns rotates about its vertical diameter with an angular speed of $40s^{-1}$ in a uniform horizontal magnetic field of magnitude 0.05 T .

Obtain the maximum voltage induced in the coil .

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36. A rectangular coil of length 1 cm and width 0.5, and 10 turns isroatated 50 revoltions per second . The magnetic field with in which the coil is rotated I s B = 0.5 T. calculate the peak value of the voltage generated acrosss the ends of the coil .

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37. A rectangular coil of wire has dimensions $0.2m \times 0.1m$. The coil has 2000 turns . The coil rotates in a magnetic field about an axis parallel to its length and peroendicular to the magnetic field fo 0.2 wb m^{-2} . The speed of rotation of the coil (ii) the instantaneous value of induced emf when the plane of the coil has rotated through an angle of 30° from the initial position .

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38. A circular coil of radius 8.0 cm and 20 turns rotates about its vertical diameter with an angular speed of 50 s^{-1} in a uniform horizontal magnetic field of magnitude $3 \times 10^{-2} T$. Obtain the maximum and average e.m.f. induced in the coil . If the coil forms a closed loop of resistance 10Ω, calculate the maximum value of current in the coil. Calculate the average power loss due to Joule heating.

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39. A rectangular coil of 200 turns or wire $15 \times 40 cm^2$ makes 50 r.p.s. about an axis in its plane parallel to its longer side and perpendicular to a magnetic field of intensity $0.08 Wb/m^2$. What are the instantaneous values of induced e.m.f. when the plane of the coil makes an angle with magnetic field of (a) 0° (b) 60° (c) 90° ?

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40. Magnetic flux of 5 microweber is linked with a coil when a current of 1 mA flows through it. What is self inductance of the coil ?

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41. A 200 turn coil of self - inductance 20 mH carries a current of 4 mA. Find the magnetic flux linked with each turn of the coil .

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42. Calculate the induced emf in a coil of 10 H inductance in which the current changes from 8A to 3A in 0.2 s.

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43. A $12V$ battery connected ot a $6\Omega, 10H$coil through a switch drives a constant current in the cirucitit. The switch is suddenly opened. Assuming that it took 1 ms to open the swith, calculate the average emf induced across the coil.

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44. A 10 H inductor carries a steady current of 2 A. how can a self - induced emf of 100 V be made to appear in the inductor ?

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45. What is the self - inductance of a solenoid of length 40 cm , area of cross - section $20cm^2$ and total number of turns 800 .

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46. What is the self - inductance of an air code solenoid 50 cm long and 2 cm radius if it has 500 turns ?

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47. An air cored solenoid with length 30 cm, area of cross-section $25cm^2$ and number of turns 500 carries a current of $2.5A$. The current is suddenly switched off in a brief time of 10^{-3} s. How much is the average back e.m.f. induced across the ends of the open switch in the cuicuit ? Ignore the variation in magnetic field near the ends of the solenoid.

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48. What is the mutal induetance of a pair of coils if a current change of six ampere in one coil causes the flux in the second coil of 2000 turns to change by 12×10^{-4} Wb per turn ?

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49. An emf of 50 mV is induced in a coil . When the current in the neighbouring coil changes form 10A to 5 A in 0.1 s . What is the mutal inductance of the two coils ?

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50. If the current in the primary circuit of a pair of coils changes from 5 A to 1 A in 0.02 s. Calculate (i) induced emf in the secondary coil if the mutal inductance between the two coills is 0.5 H and

(ii) the change of flux per turn in the secondary ,if it has 200 turns .

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51. Over a solenoid of 50 cm length and 2 cm radius having 500 turns. Is wound another wire of 50 turns near the centre. Calculate mutual inductance of the two coils. If currents in primary changes From 0 to 5 a in 0.02 s, what is the emf induced in secondary coil ?

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52. A solenoid of length 50 cm with 20 turns per cm and area of cross section 40 cm^2 comletely surrounds another co-axial solenoid of the same length, area of cross seciton $25cm^2$ with 25 turns per cm. Calculate the mutual inductance of the system.

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53. A torodal solenoid with an air core has an average radius of 15 cm, area of cross-section `12 cm^(2) and 1200 turns. Obtain the self inductance of the toroid. Ignore field variations across the cross-section of the toroid.

(b) A second coil of 300 turns is wound closely on the toroid above. If the current in the primary coil is increased from zero to 2.0 A in 0.05 s, obtain the induced e.m.f. in the second coil.

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54. The conducting circular loops of radii R_1 and R_2 are placed in the same plane with their centres coinciding. If $R_1 > > R_2$, the mutual inductance M between them will be directly proportional to

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55. A circular loop of radius 0.3 cm lies parallel to amuch bigger circular loop of radius 20 cm.

The centre of the small loop is on the axis of the bigger loop. The distance between their centres is 15 cm. If a current of 2.0 A flows through the smaller loop, then the flux linked with bigger loop is

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56. A circuit contains two inductors of self-inductance L_1 and L_2 in series (Fig) If M is the mutual inductance, then the effective inductance of the circuit shows will be

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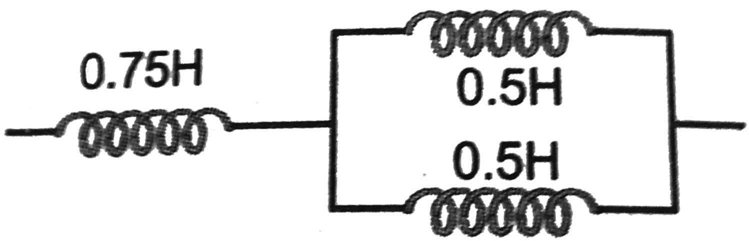
57. Three inductances are connected as shown in Calculate the resultant inductance.



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