PHYSICS

BOOKS - NN GHOSH PHYSICS (HINGLISH)

ELECTROMAGNETIC INDUCTION

Examples

1. The axles of the carriage of a train travelling at 72 km per hour anr 1.6 m long . Find the difference in potential at their ends if total intensity of the

earth's field is 0.5×10^{-4} tesla and angle of dip is 60° .

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2. A copper disc of radius 10 cm rotates 20 times per scond with its axis parallel to a uniform magnetic field of 0.5 tesla . Calculate the induced emf between the centre and the edge of the disc.

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3. 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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4. Calculate the self induction of a solenoid (iron-cored) of length 30 cm comprising of 100 turns and of radius 5 cm (μ_r of iron = 500)

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5. A coil of infucatance 0.2 mH and resistance 0.1Ω is connected to a cell of emf 1.5 V . Calculte (i) time constant of the circul, (ii) time in which current grow to 10 A. Also calculate the total energy stored in the core .

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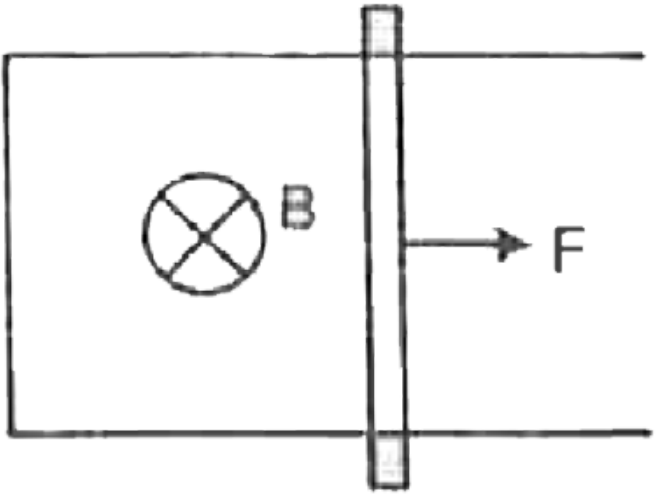
6. A rod closing the circuit shoew in the figure moves along a LI- shaped wire at a constant speed v under the action of the force F . The circult is in a unifron magnetic field perpendicluar to the plane .

Calculate F if rate of heat generation in the circuit is

Q.



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Exericises

1. A cicular loop of radius 10 cm and 500 turns in turend upside down on a horizontal table in 0.5 s . Calculate the mean emf generated .(Earth's vertical field $= 0.43 \times 10^4$ tesla)

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2. A copper disc of radius 20cm makes 1200 revolution per minute about its axis which is parallel to a uniform magnetic field fo 0.01 tesla . Find the potential difference between the centre and the edge of the disc.

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3. Find the difference of potential the ends of a horizaontal induction of earth's field $=2 \times 10^{-5}$ tesla)

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4. A rivulet , which 10m long is flowing northward along an insulated bed with a velocity of $0.3ms^{-1}$. Calculate the potenital difference between the water and the sides of the rivulet . $\left(B_0 = 34 \times 10^{-6} tesla \text{ and } dip = 60^\circ\right)$.

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5. Calculate the inductance of a coil of 100 turns of wire would on an iron ring of radius 10 cm and $10cm^2$ in cross-section, the relative permeability of iron being 700

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6. An all-metal aeroplane flies horizational at 600 km per hours at a place where the vertical induction is 4×10^{-5} tesla . If the wing -span is 10 m , will be the resulting p.d between the tips of the wings ?

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7. A field of 0.2 tesla acts acts at right angles to a coil of area $100cm^2m$ with 50 turns. The coil is removed from the field in 0.1s . Find the emf induced .

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8. A milliivoltmere is conneceted between the rails of a truck . Calcuate the voltmeter reading when a train pases at 600 km per hours . The vertical

component of the earth's field is 2×10^{-5} tesla and the distance between the rails is 1.5 m.

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9. Calculate the coefficient of self induction of a soleined of 500 turns and a length of 1 m . The area of cross-section is $7cm^2$ and permeability to the core is 1000.

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10. Calculate the coefficient of self induction of a soleined of 500 turns when a current of 1.25 A produce a magnetic flux of one microweber.

[Hint : See exerices 5]

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11. A rectangular conductor of area $0.2m^2$ is placed in a unifrom magnetic field with a B-vector strenght of 2T with its normal at an angle 30° . Calculate the magnetic flux linked with the conductor.

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12. The self inductance of a closely wound coils of 100 turns is 5 mH . What is the flux throught the coil when the current in it is 10 mA ?

[Hint : See exerices 5]

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Exericises B

1. Half of the core of a solenoid of $2 \times 10^{-3} m^2$ cross -section , is made up of air and the other half iron $(\mu_r = 500)$. The length of the solenoid is 2 m .

If the number of turns is 1000, calculate its coefficient of self induction .

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2. A solenoid of 50 cm length and 8 cm diameter is would with 500 turns of wire . Another coil of 20 insulated wire is colsely wound over it at its middle region . Calculate the coefficient of mutual induction

[Hint : Use the formula $M = \frac{\mu_0 \mu_r N_1 N_2 S}{l} henry$]

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3. A metal wire of mass m sides without friction magnetic fields of induction B. A battery of constant emf ε is connected to the rails . What is the terminal speed of the slider ?

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4. A wire with a resistance p per unit length is bent in the from of the letter A of vertical angle 2α . There is a magnetic field B perpendicular into the plane of the letter . Calculate the current flowing in the loop when the cross-piece cut moves down at a

constant speed v . Assume that it maintains contact with the sides as it moves down .

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5. A copper bar of mass m sides under gravity on two smooth parallel rails l distance apart and set at angle α to the horizontal . At the lop , the rails are joined by a resistor R. Calculate the steady velocity of the bar the n when there is a unifrom magnetic field B perpedicular to the plane of the rails .

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6. A copper bar of mass m rest at right angles to two parallel horizontal l distance apart . The rails are connected by a resistor R at one end and kept open at the other ends . Ther is a uniform upward magnetic fields of induction B.The bar is pulled away from the closed end by a constant force F. Calculate the terminal velocity of the bar when μ is the coefficient of frction between the rails and the bar .

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7. A rod of mass m length l can rotate without friction about the centre of a vertical ring . There is

a unifrom mafgnetic filed B into the plane of the ring . A variable emf ε is applied between the centre and the rotating end of the rod . Caulcate the current which keeps the rod rotating with unifrom speed ω and the emf requried to maintain the required current

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8. Two coils of self inductance L_1 and L_2 are connected by in parllel and the then to cell of emf ε and of resistance R throught a Key . Find the instantaneous current throught L after the key is closed .

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9. A pure inductance is connected in parallel to a resistor R and then connected to a cell of emf ε and of resistance R through at key . Find the instantaneous current through L after the key is closed .

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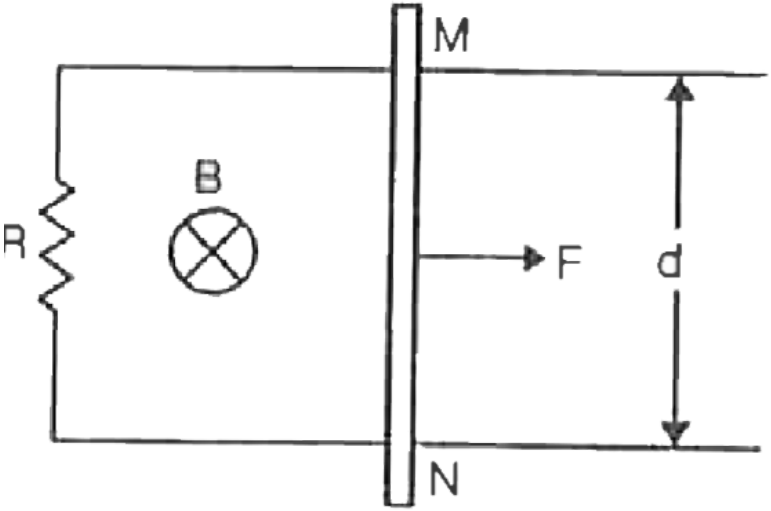
10. Two long parallel horizonal rails , a distance d apart and each having a resistance λ per unit length are jointed at one end by a resitance R. A perfectly

conducting rod MN of mass m is free to slide along the rails . A variable force F is applied to the rod MN , such that ,as the rd moves, a constant current i flows through R.

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



(b) What fraction η of the work done by F per second in converted into heat ?

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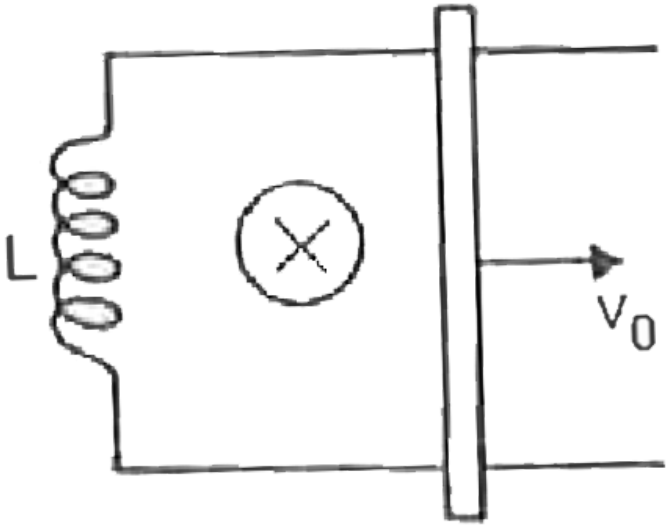
11. A rod of length l and mass m rests on two smooth parallel conductors shorted at one end by an inductor L and open at the end . The circuits is in a unifrom field B perpendcular in to the plance . The conductor is suddenly imparted an initial velocity V_0 direction to the right . Show that the motion is simple harmonic . Find its angular frequency and

amplitude .



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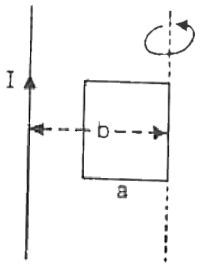
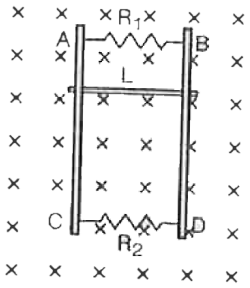
12. A sqare frame with side a=5 cm and a , long straight conductor carrying steady current I=5 A are located in the same plane . The inductance and the resistance of the frame are L=0.1 mH and $R = 1\Omega$.

The frame is turned suddenly through 180 about the side parallel to the conductor which is at a distance b=10 cm .Find the charge through the frame .





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13. Two parallel vertivcal inetallic ralis AB and CD are serparated by l= 1 m . They are connected at the ends by resistance R_1 and R_2 as show in the figure . A horizationl metallic bar L of mass m= 0.2 kg slides without friction vertically down the rails under the

action of gravity . These is a unifrom horizonal magnetic field of a $B = 0.6T$ perpendicular to the plane to rails . It is observed that when the termainal veloctity is attained , the power disspated in R_1 and R_2 are $P_1 = 0.76W$ and $P_2 = 1.2W$ respectively . Find the terminal velocity of bar L and the values of R_1 and R_2

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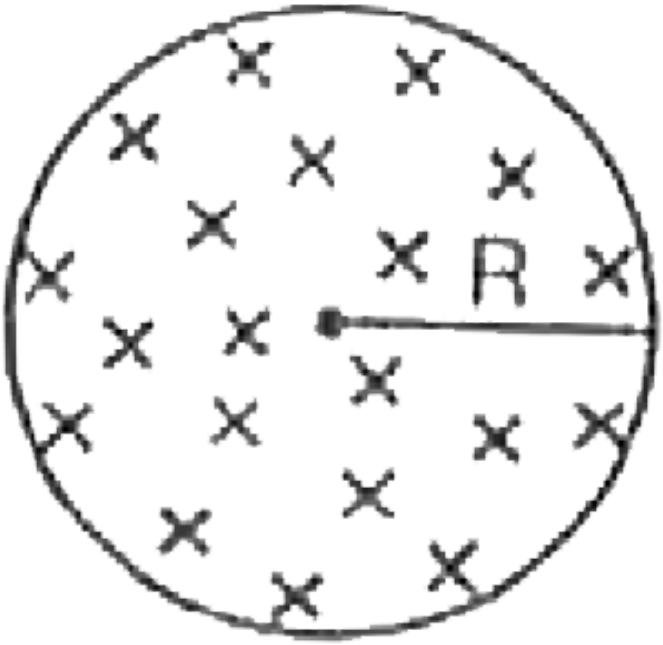
14. A cylinder space of radius R is filled with a unifrom magnetic induction a parallel to the axis of the space . If B change at the rate .Find the electric

field at a distance (i) $r < R$ (ii) $r > R$



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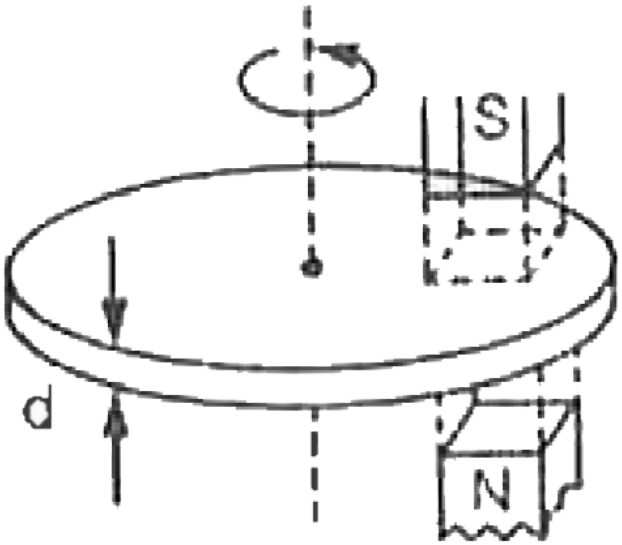
15. An electromagnetic eddy current brak a consists of a disc of conductivity σ and thickness d rotating about axis through its centre between rectangular

poles of face area A at a distance from the centre from the centre . Calculate the torque tending to show down the disc .



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16. A solenoid has an inductance of 10 H and a resistance $R = 5\Omega$. It is connected ta a 10 V battery

. How long will be it take for the magnetic energy to reach $\frac{1}{4}$ of its maximum value ?

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17. In the circuits show $\varepsilon = 15V, R_1 = 1\Omega, R_2 = 1\Omega, R_3 = 2\Omega$ and $L = 15H$. Find the current i_1, i_2, i_3 (i) immediately after the switch is closed (ii) immediately after the opening from the closed position (iii) sufficiently long after , the switch is opened f rom the colsed position,

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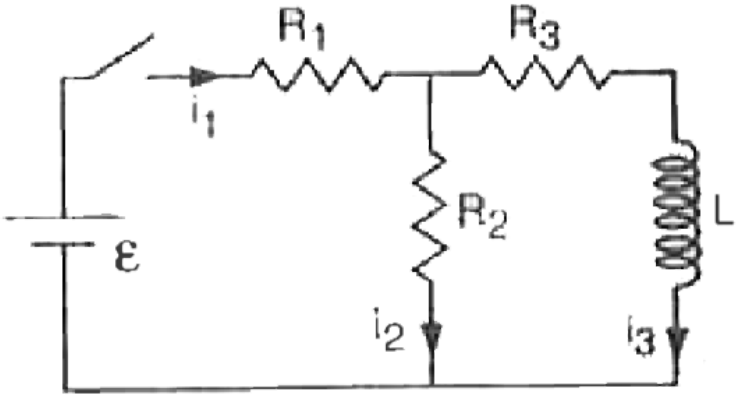
18. A semicircular wire of radius R= 20 cm rotates in its own plance about one end with angular velocity $w = 10 rad/s$ in uniformm magnetic field B=5 mT perpendicular into the plane of the wire gtFind the voltage developend between the ends of the wire



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