PHYSICS

BOOKS - OSWAAL PUBLICATION PHYSICS (KANNADA ENGLISH)

ELECTROMAGNETIC INDUCTION

Topic 1 Faraday S Laws Lenz S Law Very Short Answer Type Questions

1. What is the significance of Lenz's law ?

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2. North Pole of a bar magnet is moved towards a metal ring. What is the direction of induced current in the ring when viewed from magnet side ?

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3. Name the rule which gives the direction of induced current in a conductor .

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4. Name the phenomenon in which an emf is induced in a coil due to the change of current in the same coil.

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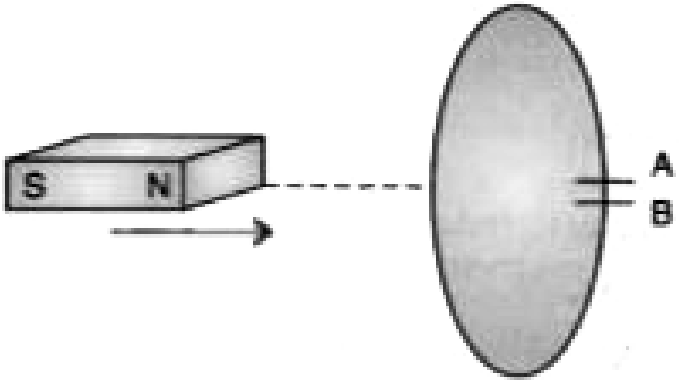
5. Predict the polarity of the plate A of the capacitor, when a magnet is moved towards it, as

shown in the figure.



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6. Two spherical bobs, one metallic and the other of glass, of the same size are allowed to fall freely from the same height above the ground. Which of the two would reach earlier and why ?

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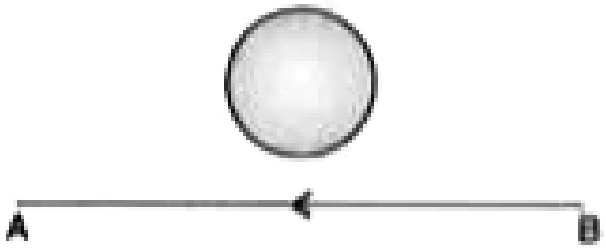
7. The electric current flowing in a wire in the direction from B to A is decreasing . Find out the direction of the induced current in the metallic loop kept above the wire as shown.



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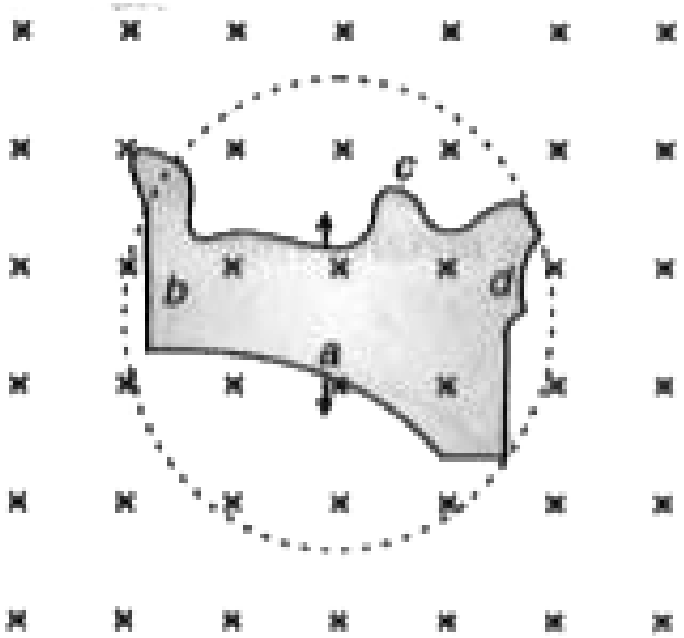
8. A flexible wire of irregular shape, abcd, as shown in the figure, turns into a circular shape when placed in a region of magnetic field which is directed normal to the plane of the loop away from the reader. Predict the direction of the induced current in the wire.



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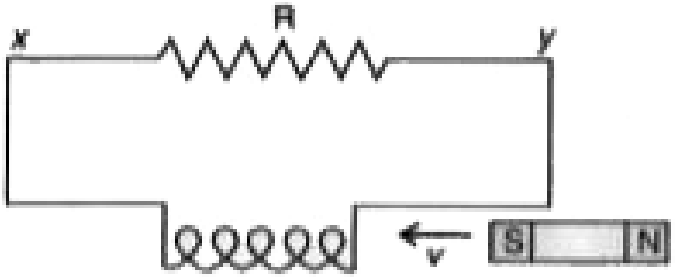
9. A magnet is moving towards a coil with a uniform speed v as shown in the figure. State the direction of the induced current in the resistor R.



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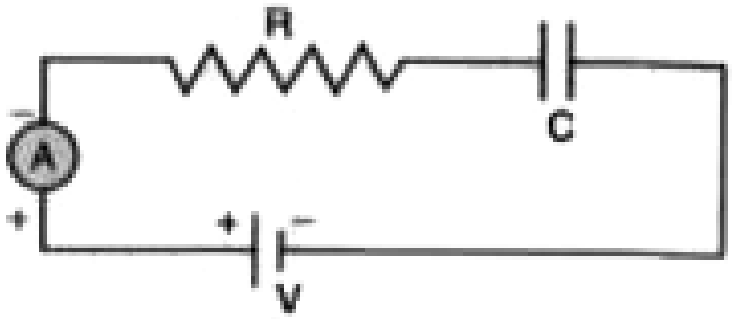
10. State the steady value of the reading of the ammeter in the circuit shown below :



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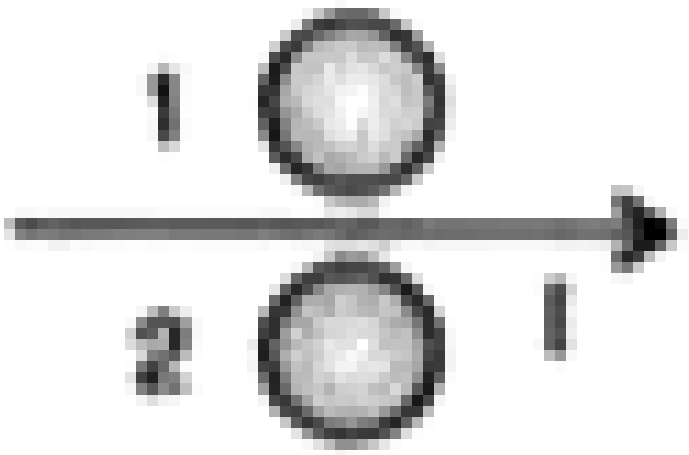
11. Predict the directions of induced currents in metal rings 1 and 2 lying in the same plane where

current I in the wire is increasing continuously.



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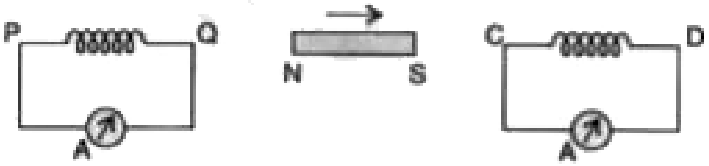
12. A bar magnet is moved in the direction indicated by the arrow between two coils PQ and CD. Predict the direction of induced current in

each coil.



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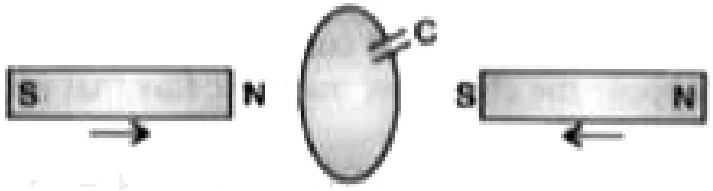
13. Two bar magnets are quickly moved towards a metallic loop connected across a capacitor .C. as shown in the figure. Predict the polarity of the capacitor.



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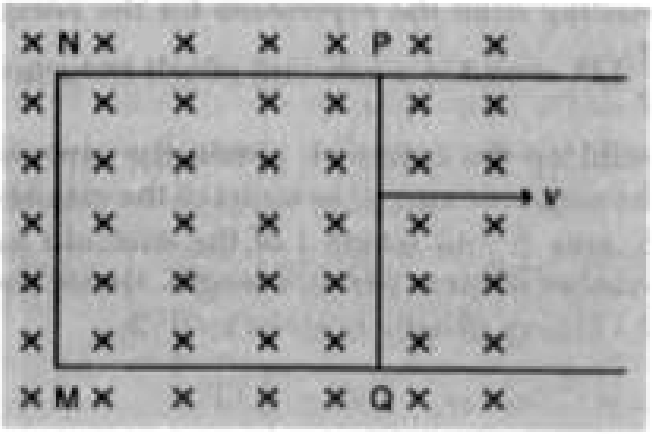
Topic 1 Faraday S Laws Lenz S Law Short Answer Type Questions I

1. A rectangular loop PQMN with movable arm PQ of length 10 cm and resistance 2Ω is placed in a uniform magnetic field of 0.1 Tesla perpendicular to the plane of the loop as shown in the figure. The resistances of the arms MN, NP and MQ are negligible. Calculate the (i) emf induced in the arm PQ and (ii) current induced in the loop when arm

PQ is moved with velocity 20 m/s.



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2. Describe a simple experiment (or activity) to show that the polarity of emf induced in a coil is always such that it tends to produce a current which opposes the change of magnetic flux that produces it.

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3. State Lenz.s Law. A metallic rod held horizontally along east-west direction, is allowed to fall under gravity. Will there be an emf induced at its ends? Justify your answer.

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4. Starting from the expression for the energy $W = \frac{1}{2}LI^2$, stored in a solenoid of self-inductance L to build up the current I, obtain the

expression for the magnetic energy in terms of the magnetic field B, area A and length l of the solenoid having n number of turns per unit length. Hence show that the energy density is given by $B^2 / 2\mu_0$.

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5. A metallic rod of length .L. is rotated with angular frequency of . ω. with one end hinged at the centre and the other end at the circumference of a circular metallic ring of radius R, about an axis passing through the centre and

perpendicular to the plane of the ring. A constant and uniform magnetic field B parallel to the axis is present everywhere. Deduce the expression for the emf between the centre and the metallic ring.

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6. A horizontal straight wire of length L extending from east to west is falling with speed v at right angles to the horizontal component of Earth.s magnetic field B.

(i) Write the expression for the instantaneous value of the emf induced in the wire.

(ii) What is the direction of the emf ?

(iii) Which end of the wire is at the higher potential ?

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Topic 1 Faraday S Laws Lenz S Law Short Answer Type Questions Ii

1. Describe the coil and barmagnet experiment to demonstrate the phenomenon of electromagnetic induction.

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2. Derive the expression for emf induced in a straight conductor moving perpendicular to a uniform magnetic field.

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3. Derive the expression for emf induced in a straight conductor moving perpendicular to a uniform magnetic field.

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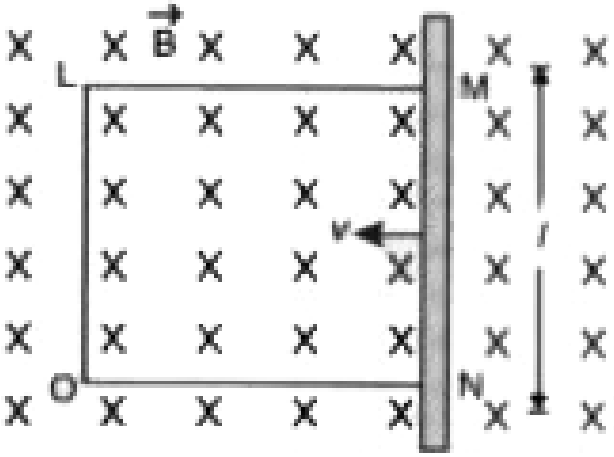
4. A rectangular conductor LMNO is placed in a uniform magnetic field of 0.5 T. The field is directed perpendicular to the plane of the conductor. When



the arm MN of length of 20 cm is moved towards left with a velocity of $10ms^{-1}$, calculate the emf induced in the arm. Given the resistance of the arm to the 5Ω (assuming that other arms are of

negligible resistance) find the value of the current in the arm.

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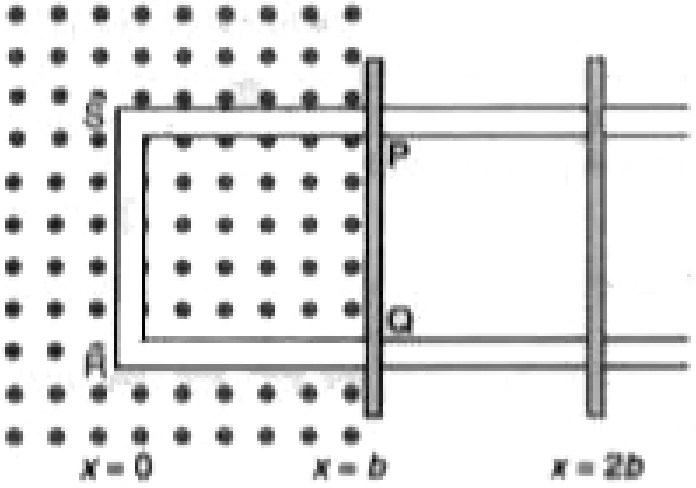
Topic 1 Faraday S Laws Lenz S Law Long Answer Type Questions

1. State Faraday.s law of electromagnetic induction. Figure shows a reactangular conductor PQRS in which the conductor PQ is free to move in a uniform magnetic field B perendicular to the plane of the paper. The field extends from $x = 0$

to $x = b$ and is zero for $x > b$. Assume that only the arm PQ possesses resistance r. When the arm PQ is pulled outward from $x = 0$ to $x = 2b$ and is then moved backward to $x = 0$ with constant speed v. Obtain the expressions for the flux and the induced emf. Sketch the variations of these quantities with distance $0 < x < 2b$.



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2. A metallic rod of length l and resistance R is rotated with a frequency v, with one end hinged at the centre and the other end at the circumference of a circular metallic ring of radius l, about an axis passing through the centre and perpendicular to the plane of the ring. A constant and uniform magnetic field B parallel to the axis is present everywhere.

(a) Derive the expression for the induced emf and the current in the rod.

(b) Due to the presence of the current in the rod and of the magnetic field, find the expression for the magnitude and direction of the force acting

on this rod.

(c) Hence obtain the expression for the power required to rotate the rod.

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3. State the law which relates to the generation of induced emf in a conductor being moved in a magnetic field.

Apply this law to obtain an expression for the induced emf when one .rod. of a rectangular conductor is free to move in a uniform, time independent and .normal. manetic field.

Apply the concept of the Lorentz (magnetic) force acting on a moving charge to justify the expression obtained.

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Topic 1 Faraday S Laws Lenz S Law Numerical Problems

1. Magnetic field through a coil having 200 turns and corss sectional area $0.04m^2$ changes from $0.1wbm^{-2}$ to $0.04wbm^{-2}$ in 0.02s. Find the induced emf.

Data : $N = 200, A = 0.04m^2, B_1 = 0.1wbm^{-2},$

B_(2)=0.04wbm^(-2), t=0.02s, e=?`

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2. An aircraft having a wingspan of 20.48 m flies due north at a speed of $40ms^{-1}$. If the vertical component of earth.s magnetic field at the place is 2×10^{-5} T. Calculate the emf induced between the ends of the wings.

Data :

$l = 20.48m, v = 40ms^{-1}, B = 2 \times 10^{-5}T, e = ?$

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3. An AC generator consists of a coil of 10,000 turns and of area $100cm^2$. The coil rotates at an angular speed of 140 rpm in a uniform magnetic field of $3.6 \times 10^{-2}T$. Find the maximum value of the emf induced.

Data : $N = 10,000$, $A = 10^2 cm^2 = 10^{-2} m^2$,

$v = 140r \pm = \frac{140}{60} rps$,

$B = 3.6 \times 10^{-2} T$, $E_0 = ?$

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Topic 2 Eddy Current Self Mutual Inductance Very Short Answer Type Questions

1. Mention any three application of eddy currents.

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2. A metallic piece gets hot when surrounded by a coil carrying high frequency alternating current. Why ?

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3. How does the mutual inductance of a pair of coils change when: Number of turns in the coils is increased?

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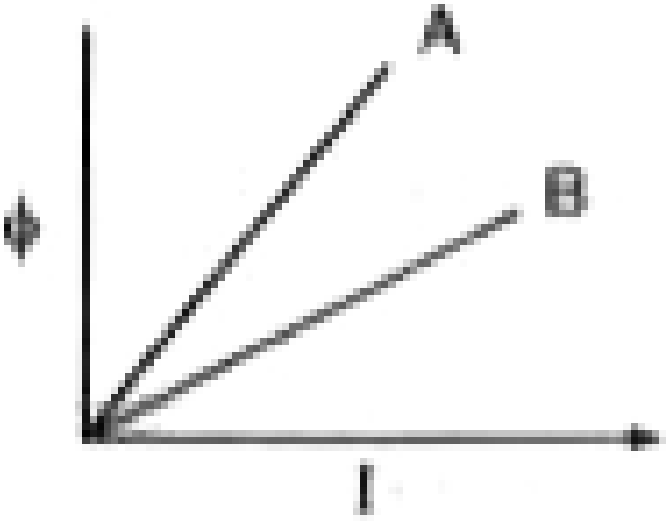
4. A plot of magnetic flux (ϕ) versus current (I) is shown in the figure for two inductors A and B. Which of the two has larger value of self

inductance ?



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5. Define self-inductance and give its SI unit. Derive an expression for self-inductance of a long, air

cored solenoid of length l, radius r and having N number of turns.

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Topic 2 Eddy Current Self Mutual Inductance Short Answer Type Questions I

1. Current in a coil falls from 2.5a to 0.0a in 0.1 second inducing an emf of 200v.calculate the value of self inductance .

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2. Mention any three application of eddy currents.

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3. Current in a coil falls from 5 A to 0 A in 0.1 s, calculate the induced emf in a coil if its self inductance is 4H.

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4. What are eddy currents ? Mention two applications of eddy currents.

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Topic 2 Eddy Current Self Mutual Inductance Short Answer Type Questions Ii

1. (a) Obtain the expression for the magnetic energy stored in a solenoid in terms of magnetic field B, area A and length l of the solenoid. (b) How does this magnetic energy compare with the electrostatic energy stored in a capacitor?

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2. The current flowing through an inductor of self inductance L is continuously increasing. Plot a graph showing the variation of

(i) Magnetic flux versus the current

(ii) Induced emf versus dI/dt

(iii) Magnetic potential energy stored versus the current.

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3. Define the term .mutual inductance. between the two coils. Obtain the expression for mutual

inductance of a pair of long coaxial solenoids each of length l and radii r_1 and $r_2(r_2 > > r_1)$. Total number of turns in the two solenoids are N_1 and N_2 respectively.

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4. The currents flowing in the two coils of self-inductance $L_1 = 16$ mH and $L_2 = 12$ mH are increasing at the same rate. If the power supplied to the two coils are equal, find the ratio of (i) induced voltages, (ii) the currents and (iii) the energies stored in the two coils at a given instant.

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Topic 2 Eddy Current Self Mutual Inductance Long Answer Type Questions

1. What is self-inductance of a coil ? Write its SI U Unit.

Obtain the expression for energy stored in an inductor.

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2. Calculate the self-inductance of the coil by direct method by using the following data :

Trial Number	DC part		AC Part	
	Ammeter reading (A)	Voltmeter reading (V)	Ammeter reading (A)	Voltmeter reading (V)

$$\begin{cases} 1 & 1.0 & 1.5 & 0.4 & 1.5 \\ 2 & 1.3 & 2.0 & 0.6 & 2.0 \end{cases}$$

Frequency of AC $= 50$ Hz.

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Topic 2 Eddy Current Self Mutual Inductance Numerical Problems

1. A solenoid of length 1 m and 0.05 m diameter has 500 turns. If a current of 2A passes through the coil, calculate (i) the coefficient of self induction of the coil and (ii) the magnetic flux linked with the coil.

Data :

$l = 1m, d = 0.05m, r = 0.025m, N = 5000, I = 2A$

,

(i) $L = ?(ii)\phi = ?$

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2. Calculate the mutual inductance between two coils when a current of 4A changing to 8A in 0.5s in one coil, induces an emf of 50 mV in the other coil.

Data : $I_1 = 4A, I_2 = 8A, dt = 0.5s,$

$e = 50mV = 50 \times 10^{-3}V, M = ?$

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3. A wheel with 10 metallic spokes each 0.5 m long is rotated with a speed of 120 rev/min in a plane normal to the horizontal component of earth's

magnetic field H_E at a place. If H_E = 0.4 G at the place, what is the induced emf between the axle and the rim of the wheel? Note that $1G = 10^{-4}$ T.

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