7.Electromagnetic Induction with Answers

1. The normal to a certain $1m^2$ area makes an angle of 60° with a uniform magnetic field. The magnetic flux through this area is same as the flux through a second area that is perpendicular to the field, if the second area is _____.

Ans. Flux through the first surface will be $\Phi_1 = BA\cos\theta = B(1)\cos 60^0 = \frac{1}{2}B$.

For the second area the flux is same, it is placed perpendicular to the field, so angle between area and the field is zero degrees. $\Phi_2 = B(A)\cos 0^0 = BA$

Flux is same through both the areas $\frac{1}{2}B = BA$

$A = 1/2m^2$

2. State the SI unit of magnetic field and magnetic flux.

Ans SI unit of magnetic field is tesla(T)
SI unit of magnetic flux is weber(Wb)

3. What is the induced emf in a circuit if a flux of one weber is reduced to zero in one second.

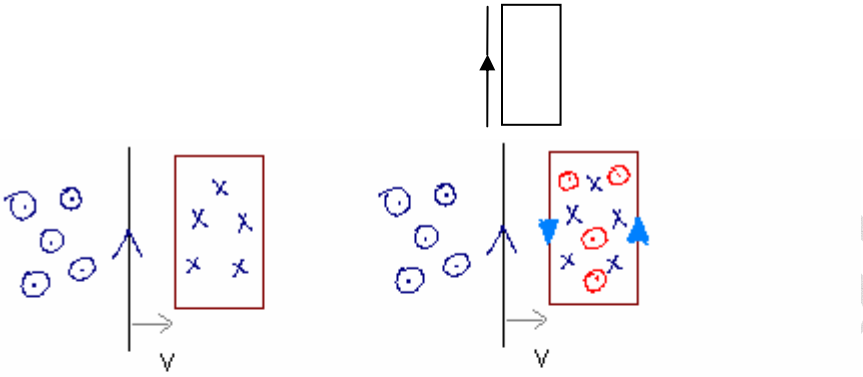
Ans. $\varepsilon = -\frac{d\Phi}{dt} = -\frac{(1-0)Wb}{1s}$ = 1V. Induced emf is 1volt. The negative sign shows the direction of the induced emf, it is such that it opposes the cause that produces it.

4. State Faraday's law of electromagnetic induction.

Ans.The magnitude of the emf E induced in a conducting loop is equal to the rate at which the magnetic flux through that loop changes with time.

5. A long straight wire is in the plane of a rectangular conducting loop. The straight wire carries a constant current I, as shown while the wire is being moved toward the rectangle, what is the direction of current in the rectangle?

Ans.

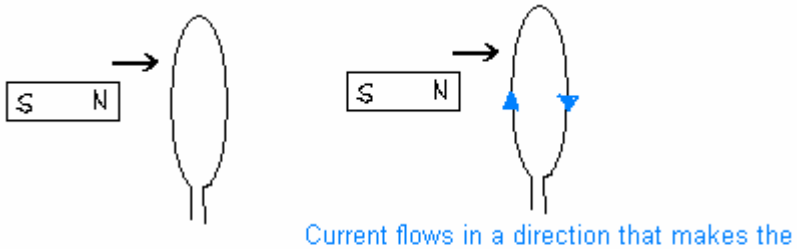


As wire moves towards rectangular loop, the field in the downward direction increases, through the loop, To oppose this a current will flow in the loop in the upward direction.

⊙ field is due to current in the loop

6. You push a permanent magnet with its north pole away from you toward a loop of conducting wire in front of you. Before the North Pole enters the loop, what is the direction of the current in the loop?

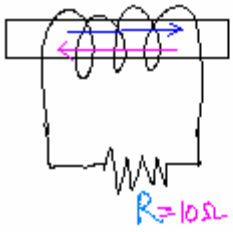
Ans.



Current flows in a direction that makes the end of the loop facing the approaching magnet north. So in loop current will be anticlockwise on face near approaching magnet.

7. One hundred turns of insulated copper wire are wrapped around an iron core of cross-sectional area $0.001 m^2$. The circuit is completed by connecting the wire to a 10 Ω resistor. The magnetic field along the coil axis is made to change from 1.00 T in one direction to 1.0T in the other direction. What is the total charge that flows through the resistor in this process?

Ans.



$\Phi = \int \vec{B} \cdot d\vec{A}$

$\Phi = NBA$

$N = 100$

$A = 0.001 m^2$

$\frac{dB}{dt} = \frac{2T}{t}$

$\mathcal{E} = -\frac{d\Phi}{dt} = -NA\frac{dB}{dt}$

$= 100(0.001m^2)\left(\frac{2T}{t}\right)$

$\mathcal{E} = \frac{0.2T}{t}$

$\mathcal{E} = IR = \frac{q}{t}R$

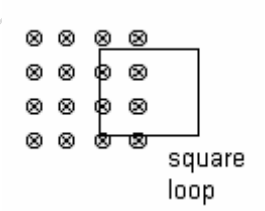
$q = \frac{\mathcal{E}t}{R} = \frac{0.2}{10} = 0.02C$

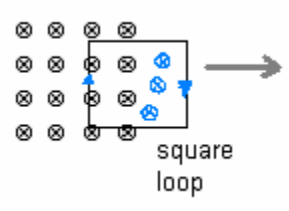
8. Explain how does Lenz's law follow from the Principle of Conservation of Energy.

Ans. Lenz's law states that an induced current has a direction such that the magnetic field due to the current opposes the change in the magnetic flux that induces the current.

If we are getting current in a loop which means energy, this is not without the expense of energy in some other part of the circuit.

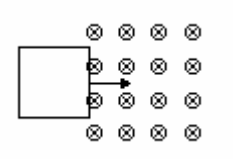
9. A square loop of wire is positioned half in and half out of a region of uniform B field directed into the page. Which direction should the loop be moved to induce a clockwise current in the loop.



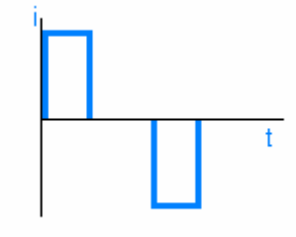


As the current in the clockwise direction will produce a magnetic field in the downward direction, so to reduce the magnetic field through the coil the loop should be moved out of the magnetic field.

10. A square loop of wire moves with a constant speed v from a field-free region into a region of uniform B field. Draw a graph to correctly show the induced current in the loop as a function of time t?



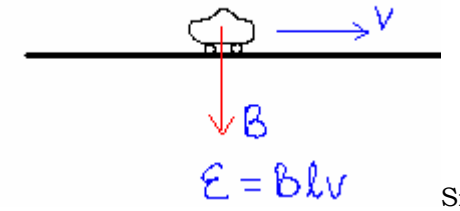
Ans.



When the loop enters the magnetic field the magnetic field through the loop will increase and this produces an induced emf in the coil and hence a current will flow in it. As the loop leaves the magnetic field the induced emf will cause a current to flow in the opposite direction, as the flux through the loop decreases as the loop moves out of the magnetic field.

11. A car travels northward at 75 km/h along a straight road in a region where the Earth's magnetic field has a vertical component of 0.50×10^{-4}T. What is the emf induced between the left and right side, separated by 1.7m?

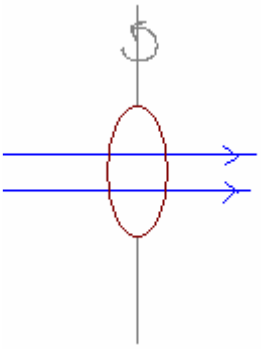
Ans. $\varepsilon = Blv = (0.5\times10^{-4})(1.7m)(\frac{75\times1000m}{3600s})$



Simplify this to arrive at the final answer.

12. A single loop of wire with a radius of 7.5 cm rotates about a diameter in a uniform magnetic field 1.6 T. At what speed should it rotate to produce a maximum emf of 1.0V?

Ans.



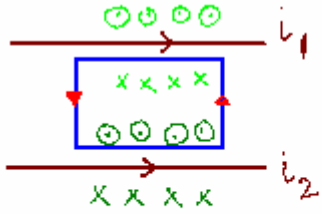
$$\varepsilon = NBA\omega = (1)(1.6T)(\pi.075^2)\omega$$

$$1V = (1)(1.6T)(\pi.075^2)\omega$$

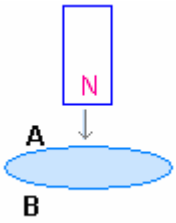
$$\omega = \frac{1V}{(1)(1.6T)(\pi(0.075^2)} radians$$

13. Look at the figure , it shows a loop of wire placed midway between two long straight parallel conductors as shown The conductors carry currents as indicated. Current i_1 is increasing and i_2 is constant, what is the direction of induced current in the loop?

ans

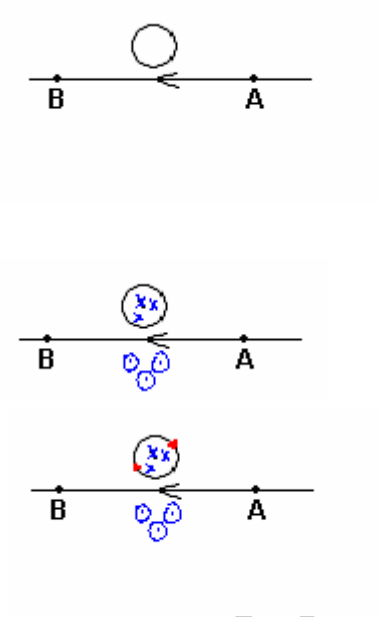


14. Give the direction of current when a magnet falls through a coil in the direction shown:



When north enters the coil, the current in the coil flows so that the end A of the coil is a north pole. When the magnet moves away from end A, the direction of current reverses in the coil and end A behaves like a south pole. At the instant when the midpoint of the magnet is in the plane of the loop, induced current at point P, is essentially zero.

15. The electric current in a wire in the direction from B to A is decreasing. What is the direction of induced current in the figure?



As current is decreasing magnetic field through the coil, in the downward direction, will decrease. Current will flow in such a manner to increase this current. Here current will flow in clockwise direction as indicated by red arrows.

I have taken care that there are no mistakes, however if you find any errors, please let me know at www.TutorBreeze.com