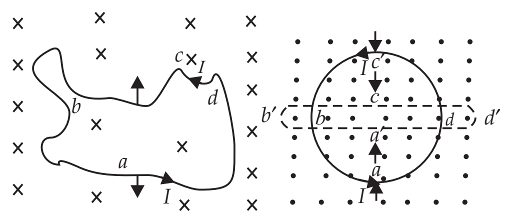
CHAPTER 6

Electromagnetic Induction

NCERT FOCUS **ANSWERS**

Topic 1

1.



(a) (b)

(a) Due to change in shape, area increases and consequently, magnetic flux linked with it also increases. Using Lenz's law, an induced current is set up in the circular wire in the anticlockwise direction to produce opposing flux. So magnetic field due to it, is directed upward.

(b) Due to deformation of circular loop into a straight wire, its area decreases and consequently magnetic flux linked with it decreases. So an induced current is set up in the anticlockwise direction, hence magnetic field is upward.

2. Direction of induced current in all the situations shown above can be decided in the light of Lenz's law.

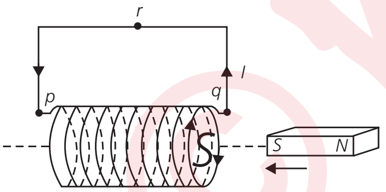


Fig. (a)

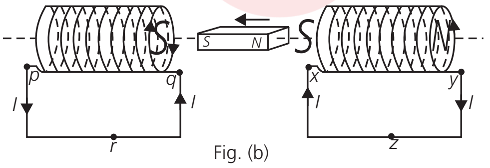
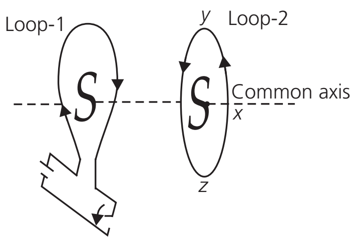
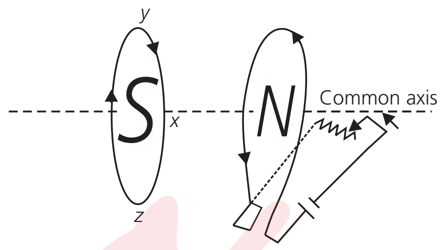


Fig. (b)



(Tapping key just closed)
Fig. (c)



Rheostat setting being changed
Fig. (d)

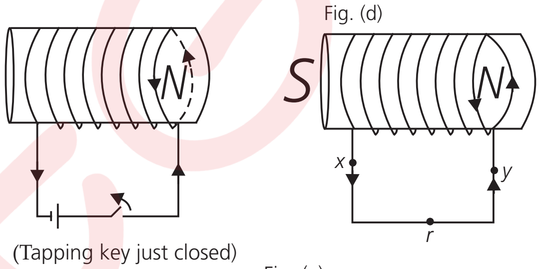


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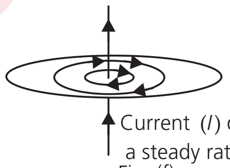
Fig. (e)



Current (I) decreasing at a steady rate
Fig. (f)

Fig. (a) : South pole is moving closer, so the current is clockwise in the end of solenoid closest to magnet.

Fig. (b) : Following Lenz's law, the current flow anticlockwise in the loop at the left and clockwise in the loop at the right.

Fig. (c) : Inner side of loop-1 become south pole whose strength increasing with increase in current. So the inner side of loop should also become south pole according to Lenz's law.

Fig. (d) : Current is decreasing with increase in rheostat, so North pole is getting weaker, the current in inner part of loop-1 will flow clockwise.

Fig. (e) : Induced current in the right coil is from X to Y.

Fig. (f) : No induced current since magnetic lines of force are in the plane of the loop.

Topic 2

1. When the current changes through the solenoid, a change in magnetic field also take place within it.

Initial magnetic field in solenoid,

$$B_1 = \mu_0 n i_1 = 4\pi \times 10^{-7} \times \frac{15}{10^{-2}} \times 2 = 120\pi \times 10^{-5}\ \text{T}$$

Final magnetic field, $B_2 = \mu_0 n i_2$

$B_2 = 4\pi \times 10^{-7} \times \dfrac{15}{10^{-2}} \times 4 = 240\pi \times 10^{-5}$ T

Initial flux through coil inside solenoid placed normal to axis.

$\phi_i = B_1A = 120\pi \times 10^{-5} \times 2 \times 10^{-4}$

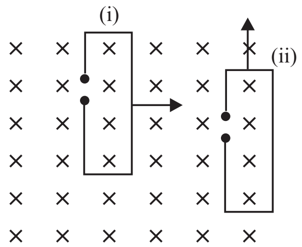
$\phi_i = 240\pi \times 10^{-9}$ Wb

Final flux, $\phi_f = B_2\, A = 240\pi \times 10^{-5} \times 2 \times 10^{-4}$

$\phi_f = 480\pi \times 10^{-9}$ Wb

Induced emf, $\varepsilon = -\dfrac{(\phi_f - \phi_i)}{t} = -\dfrac{240 \times 10^{-9} \times 3.14}{0.1} = -7.5\ \mu$V

2. Here $A = 8 \times 2 = 16$ cm^2 $= 16 \times 10^{-4}$ m^2,
$B = 0.3$ T; $v = 1$ cm s^{-1} $= 10^{-2}$ m s^{-1}
Induced emf, ε = ?



(i) When velocity is normal to longer side,
$l = 8$ cm $= 8 \times 10^{-2}$ m
$\varepsilon = Blv = 0.3 \times 8 \times 10^{-2} \times 10^{-2} = 2.4 \times 10^{-4}$ V

Time, $t = \dfrac{\text{distance moved}}{\text{velocity}} = \dfrac{2 \times 10^{-2}}{10^{-2}} = 2$ sec

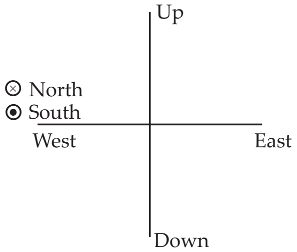
(ii) When velocity is normal to shorter side, $l = 2$ cm $= 2 \times 10^{-2}$ m
$\varepsilon = Blv = 0.3 \times 2 \times 10^{-2} \times 10^{-2} = 0.6 \times 10^{-4}$ V

Time, $t = \dfrac{\text{distance moved}}{\text{velocity}} = \dfrac{8 \times 10^{-2}}{10^{-2}} = 8$ sec

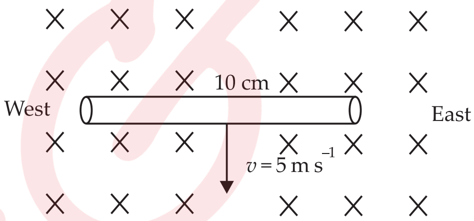
3. Constant and uniform magnetic field is parallel to axis of the wheel and thus normal to plane of the wheel.

Induced emf, $\varepsilon = \dfrac{B\omega l^2}{2}$; $\varepsilon = \dfrac{0.5 \times 400 \times 1}{2} = 100$ V

4. The direction of earth's magnetic field is in the direction of geographical south to geographical north



Let us take a convenient way to represent all the directions.

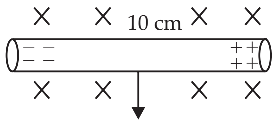


(a) Instantaneous emf $\varepsilon = Bvl$

$\varepsilon = 0.3 \times 10^{-4} \times 5 \times 10 = 15 \times 10^{-4}$ volt $= 1.5$ mV

(b) Direction of emf. will be west to east.

(c) West end of the wire will be charged at higher potential.



5. Let 'L' is the coefficient of self inductance, the back emf

$\varepsilon = -L\dfrac{dI}{dt}$; $200 = -L\dfrac{(i_f - i_i)}{t}$ or $200 = -L\dfrac{(0-5)}{0.1}$

$L = 4$ H.