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CLASS 12 PHYSICS NCERT SOLUTIONS

NCERT Solutions for Class 12 Physics Chapter 6: Electromagnetic Induction – Free PDF Download

Chapter 6 introduces electromagnetic induction -- how a changing magnetic flux generates an emf, governed by Faraday's and Lenz's laws. These worked solutions cover the exercise questions on motional emf, AC generators, and self- and mutual inductance.

Contents

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NCERT Exercise Solutions

6.1 Predict the direction of induced current in the situations described by the following Figs. 6.18(a) to (f).
Ans: Applying Lenz's law (the induced current flows in the direction that opposes the change in flux producing it) to each panel: (a) along qrpq, (b) along prqp, (c) along yzxy, (d) along zyxz, (e) along xryx, and (f) **no current is induced**, since the magnetic field lines lie entirely in the plane of the loop (so the flux through the loop is zero throughout, and stays zero).

6.2 Use Lenz's law to determine the direction of induced current in the situations described by Fig. 6.19: (a) A wire of irregular shape turning into a circular shape; (b) A circular loop being deformed into a narrow straight wire.
Ans: (a) As the irregular wire straightens into a circle, the area it encloses **increases**, so the flux through it increases; by Lenz's law the induced current flows in the sense that creates a magnetic field opposing this increase (i.e., in the direction that would tend to shrink the loop back down). (b) As the circular loop is stretched into a narrow straight wire, the enclosed area — and hence the flux — **decreases** toward zero; the induced current here flows in the sense that opposes this decrease, i.e., in the direction that tries to maintain the original circular shape and flux.

6.3 A long solenoid with 15 turns per cm has a small loop of area 2.0 cm^2 placed inside the solenoid normal to its axis. If the current carried by the solenoid changes steadily from 2.0A to 4.0A in 0.1s, what is the induced emf in the loop while the current is changing?
Ans: Turns per unit length n=15/cm=1500/m. Rate of change of current $dI/dt=(4.0-2.0)/0.1=20$ A/s. The emf induced in the loop equals the rate of change of flux linked with it:
$\text{emf}=\mu_0 nA(dI/dt)=(4\pi\times10^{-7})\times1500\times2.0\times10^{-4}\times20\approx$ $\mathbf{7.54\times10^{-6}}$ **V**.

6.4 A rectangular wire loop of sides 8cm and 2cm with a small cut is moving out of a region of uniform magnetic field of magnitude 0.3T directed normal to the loop. What is the emf developed across the cut if the velocity of the loop is 1cm/s in a direction normal to the (a) longer side, (b) shorter side of the loop? For how long does the induced voltage last in each case?
Ans: emf=Blv, where l is the length of the side that sweeps across the field boundary (perpendicular to the direction of motion). (a) Moving normal to the longer (8cm) side, the side crossing the boundary is the shorter side, l=2cm=0.02m: $\text{emf}=0.3\times0.02\times0.01=$ $\mathbf{6\times10^{-5}}$ **V**, lasting t=(length of longer side)/v=0.08/0.01=**8s** (the time taken for the loop to fully exit the field). (b) Moving normal to the shorter (2cm) side, l=8cm=0.08m: $\text{emf}=0.3\times0.08\times0.01=$ $\mathbf{2.4\times10^{-4}}$ **V**, lasting t=0.02/0.01=**2s**.

6.5 A 1.0m long metallic rod is rotated with an angular frequency of 400 rad/s about an axis normal to the rod passing through its one end. The other end of the rod is in contact with a circular metallic ring. A constant and uniform magnetic field of 0.5T parallel to the axis exists everywhere. Calculate the emf developed between the centre and the ring.
Ans: For a rod rotating about one end, $\text{emf}=\tfrac{1}{2}B\omega l^2=0.5\times0.5\times400\times(1.0)^2=$ **100V**.

6.6 A circular coil of radius 8.0cm and 20 turns is rotated about its vertical diameter with an angular speed of 50 rad/s in a uniform horizontal magnetic field of magnitude $\mathbf{3.0\times10^{-2}}$T. Obtain the maximum and average emf induced in the coil. If the coil forms a closed loop of resistance 10Ω, calculate the maximum current in the coil and the average power loss due to Joule heating.

Where does this power come from?
Ans: Area $A=\pi r^2=\pi\times(0.08)^2\approx0.0201m^2$. Maximum emf $E_0=NBA\omega=20\times3.0\times10^{-2}\times0.0201\times50\approx$**0.603V**. Since the emf varies sinusoidally with time, its **average value over a complete cycle is zero**. Maximum current $I_0=E_0/R=0.603/10\approx$**0.0603A**. Average power loss$=\frac{1}{2}I_0^2R=\frac{1}{2}\times(0.0603)^2\times10\approx$**0.0182W**; this power is supplied by whatever external agent is rotating the coil, working against the retarding torque produced by the induced current.

6.7 A horizontal straight wire 10m long extending from east to west is falling with a speed of 5.0m/s, at right angles to the horizontal component of the earth's magnetic field, 0.30×10^{-4}Wb/m². (a) What is the instantaneous value of the emf induced in the wire? (b) What is the direction of the emf? (c) Which end of the wire is at the higher electrical potential?
Ans: (a) emf$=Blv=0.30\times10^{-4}\times10\times5.0=$**$1.5\times10^{-3}$ V (1.5mV)**. (b)&(c) Using the motional-emf force on a positive charge, $F=qv\times B$, with v pointing vertically downward and B pointing horizontally toward geomagnetic north, the force works out to point toward the **east**, so the **east end of the wire is at the higher potential**.

6.8 Current in a circuit falls from 5.0A to 0.0A in 0.1s. If an average emf of 200V is induced, give an estimate of the self-inductance of the circuit.
Ans: $|emf|=L(dI/dt) \Rightarrow L=|emf|/(dI/dt)=200\div((5.0-0.0)/0.1)=200\div50=$**4H**.

6.9 A pair of adjacent coils has a mutual inductance of 1.5H. If the current in one coil changes from 0 to 20A in 0.5s, what is the change of flux linkage with the other coil?
Ans: Change of flux linkage$=M\times\Delta I=1.5\times20=$**30 Wb**. (Note: the 0.5s duration is not needed to find the change in flux linkage itself — it would only be needed to find the induced emf.)

6.10 A jet plane is travelling towards west at a speed of 1800km/h. What is the voltage difference developed between the ends of the wing having a span of 25m, if the Earth's magnetic field at the location has a magnitude of 5×10^{-4}T and the dip angle is 30°?
Ans: Speed v=1800km/h=500m/s. Only the vertical component of the Earth's field, $B_v=B\sin(dip)=5\times10^{-4}\times\sin30°=2.5\times10^{-4}$T, drives a motional emf across the horizontal wingspan. Voltage$=B_v\times v\times l=2.5\times10^{-4}\times500\times25=$**3.125V**.

Class 12 Physics Chapter 6 – Notes and Extra Questions

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