

CLASS 12 PHYSICS — FORMULA SHEET

Chapter 6 : Electromagnetic Induction (NCERT)

6.1 Magnetic Flux

Concept	Formula
Magnetic flux	$\Phi = B \cdot A = BA \cos \theta$; unit weber (Wb)
1 weber	$1 \text{ Wb} = 1 \text{ T} \cdot \text{m}^2$
Maximum flux	When B perpendicular to plane ($\theta = 0^\circ$): $\Phi = BA$
Zero flux	When B parallel to plane ($\theta = 90^\circ$)
Flux through N turns	$\Phi_{\text{total}} = N \times BA \cos \theta$

6.2 Faraday's & Lenz's Laws

Concept	Formula / Statement
Faraday's first law	EMF is induced when magnetic flux linked with a circuit changes
Faraday's second law	$\epsilon = -d\Phi/dt$ (EMF = rate of change of flux)
For N turns	$\epsilon = -N d\Phi/dt$
Lenz's law	Induced current opposes the change causing it (the minus sign)
Basis of Lenz's law	Conservation of energy
Induced charge	$q = \Delta\Phi/R = N \Delta\Phi/R$ (independent of time taken)
Average induced EMF	$\epsilon_{\text{avg}} = -N (\Phi_2 - \Phi_1)/\Delta t$

6.3 Motional EMF

Concept	Formula
Motional EMF (rod)	$\epsilon = B l v$ (rod of length l moving with speed v)
Induced current	$I = Blv \div R$
Force on rod	$F = BIl = B^2 l^2 v \div R$ (opposes motion)
Power dissipated	$P = F v = B^2 l^2 v^2 \div R$
Rotating rod EMF	$\epsilon = \frac{1}{2} B l^2 \omega$ (rod rotating about one end)
Rotating disc EMF	$\epsilon = \frac{1}{2} B R^2 \omega$

6.4 Self-Inductance

Concept	Formula
Self-inductance	$\Phi = L I$; $\epsilon = -L (dI/dt)$; unit henry (H)
Solenoid inductance	$L = \mu_0 n^2 A l = \mu_0 N^2 A \div l$
Energy stored in inductor	$U = \frac{1}{2} L I^2$
Energy density (magnetic)	$u = B^2 \div (2\mu_0)$

Concept	Formula
EMF from changing current	$\varepsilon = -L (dI/dt)$

6.5 Mutual Inductance

Concept	Formula
Mutual inductance	$\Phi_2 = M I_1$; $\varepsilon_2 = -M (dI_1/dt)$; unit henry (H)
Two coupled solenoids	$M = \mu_0 n_1 n_2 A l$ (sharing area A)
Reciprocity	$M_{12} = M_{21} = M$
Coupling coefficient	$k = M \div \sqrt{(L_1 L_2)}$; $0 \leq k \leq 1$
Maximum coupling	$k = 1 \rightarrow M = \sqrt{(L_1 L_2)}$

6.6 AC Generator & Eddy Currents

Concept	Formula / Detail
AC generator EMF	$\varepsilon = NBA\omega \sin(\omega t) = \varepsilon_0 \sin(\omega t)$
Peak EMF	$\varepsilon_0 = NBA\omega$
Principle	Electromagnetic induction (rotating coil in magnetic field)
Eddy currents	Induced circulating currents in bulk conductors
Eddy current uses	Electric brakes, induction furnace, dead-beat galvanometer
Reducing eddy losses	Use laminated (slotted) cores

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Faraday's law	$\varepsilon = -N d\Phi/dt$. Faster flux change $\rightarrow$ larger EMF.
Lenz's law	The minus sign = opposition. Induced effects fight the change (energy conservation).
Motional EMF	$\varepsilon = Blv$. Rotating rod: $\frac{1}{2}Bl^2\omega$ (note the $\frac{1}{2}$ and the square).
Induced charge	$q = N\Delta\Phi/R$ — depends only on flux change & resistance, NOT on time.
Self-inductance	$\Phi = LI$; energy $U = \frac{1}{2}LI^2$ (analogous to $\frac{1}{2}mv^2$).
Mutual inductance	$M = k\sqrt{(L_1 L_2)}$; $M_{12} = M_{21}$ always.
AC generator	$\varepsilon = NBA\omega \sin\omega t$; peak $\varepsilon_0 = NBA\omega$.
Eddy currents	Reduced by laminating the core ; used in braking & induction heating.