

Electromagnetic Induction — CBSE Pattern Test 2

Class 12 Physics · 90 minutes · 40 marks · Sections A–D with answer key · Narayan Gurukul Academy

Test 2 — CBSE Pattern (90 minutes, 40 marks)

Class 12 Physics · Electromagnetic Induction · Narayan Gurukul Academy (ClassApna)

General Instructions: (1) This paper has four sections — Section A (1×10), Section B (2×4), Section C (3×4) and Section D (5×2) — total 40 marks. Time allowed: 90 minutes.

(2) All questions are compulsory. No overall choice is given; internal choice, where allowed, is clearly marked.

(3) For MCQ questions choose the single correct option; for VSA answers write a single line.

(4) Take $g = 10 \text{ m/s}^2$. All symbols carry their usual meaning. Use of a calculator is not permitted.

Section A — MCQ & VSA ($10 \times 1 = 10$ marks)

- Faraday's law states that the induced emf equals the negative of the
 - rate of change of magnetic flux
 - magnetic flux
 - magnetic field
 - charge enclosed
- The negative sign in Faraday's law is due to
 - Lenz's law
 - Ohm's law
 - Ampere's law
 - Coulomb's law
- When a magnet is pushed towards a coil, the induced current
 - opposes the motion of the magnet
 - aids the motion of the magnet
 - has no effect on the magnet
 - is zero
- The self-induced emf in a coil is
 - $-L \, di/dt$
 - $-L \, i$
 - $-L \, di^2/dt$
 - $L \, di/dt$
- The mutual inductance of two coils depends on
 - the geometry and separation of the coils
 - only the current
 - only the resistance
 - the charge on the coils
- In a step-up transformer, the secondary voltage is
 - greater than the primary voltage
 - less than the primary voltage
 - equal to the primary voltage
 - zero
- The force required to move the rod at constant velocity against the magnetic force is
 - $B^2 l^2 v / R$

- (B) Blv
 (C) Blv/R
 (D) B^2l^2/R
8. The motional emf is induced because the rod
 (A) cuts the magnetic field lines
 (B) has resistance
 (C) carries a current
 (D) has a magnetic moment
9. Define self-inductance.
10. State the principle of an AC generator.

Section B — Short Answer I ($4 \times 2 = 8$ marks)

11. A coil of area 0.1 m^2 in a 0.5 T field is rotated so its flux changes fully in 0.1 s . Find the average emf for 200 turns.
12. A rod 0.5 m long moves at 2 m/s perpendicular to a 0.4 T field. Find the emf induced.
13. Define mutual inductance and give its SI unit.
14. A transformer steps down 2200 V to 220 V with 2000 primary turns. Find the secondary turns.

Section C — Short Answer II ($4 \times 3 = 12$ marks)

15. State Lenz's law and show that it is a consequence of the conservation of energy.
16. Derive the expression for the emf induced in an AC generator.
17. Define mutual inductance of two coils and derive the expression for two coaxial solenoids.
18. Derive the expression for the motional emf and the force needed to keep a rod moving uniformly on rails.

Section D — Long Answers ($2 \times 5 = 10$ marks)

19. Describe the construction and working of an AC generator. Derive the expression for the instantaneous and peak emf, and explain the variation of emf with time.
20. Describe the construction and working of a transformer. Derive $V_s/V_p = N_s/N_p = I_p/I_s$, and describe the various energy losses and how each is minimised.

Answer Key (Marking Scheme)

- Q1 — (A) rate of change of magnetic flux. Q2 — (A) Lenz's law. Q3 — (A) opposes the motion of the magnet. Q4 — (A) $-L \, di/dt$.
- Q5 — (A) the geometry and separation of the coils. Q6 — (A) greater than the primary voltage. Q7 — (A) B^2l^2v/R . Q8 — (A) cuts the magnetic field lines.
- Q9 — The flux linkage per unit current: $L = N\Phi/I$, SI unit henry.
- Q10 — A coil rotating in a magnetic field has a changing flux, inducing an emf.
- Q11 — $e = N\Phi/\Delta t = 200 \times 0.5 \times 0.1/0.1 = 100 \text{ V}$.
- Q12 — $e = Blv = 0.4 \text{ V}$.
- Q13 — $M = N_2\Phi_2/I_1$; SI unit henry.
- Q14 — $N_s = N_p V_s/V_p = 2000 \times 220/2200 = 200$.
- Q15 — Opposing the change means work must be done to produce the electrical energy, so energy is conserved.

Q16 — $\Phi = NBA \cos \omega t$, $e = -N \frac{d\Phi}{dt} = NBA\omega \sin \omega t$, peak $e_0 = NBA\omega$.

Q17 — $M = \mu_0 N_1 N_2 A / l$ for two coaxial solenoids.

Q18 — $e = Blv$; $I = Blv/R$; $F = BIl = B^2 l^2 v / R$.

Q19 — Coil rotates in a field; flux $\Phi = NBA \cos \omega t$; $e = NBA\omega \sin \omega t$ is sinusoidal with peak $NBA\omega$.

Q20 — Two coils on a laminated core; the changing flux links them, giving $V_s/V_p = N_s/N_p$; ideal transformer has $I_p/I_s = N_s/N_p$. Losses: copper (thick wires), eddy currents (laminated core), hysteresis (soft iron core), flux leakage (good core design).