

Electromagnetic Induction — CBSE Pattern Test 1

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

Test 1 — 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)

- The SI unit of magnetic flux is the
 - weber
 - tesla
 - henry
 - gauss
- The induced emf in a coil of N turns is
 - $-N \frac{d\Phi}{dt}$
 - $-\frac{d\Phi}{dt}$
 - $N\Phi$
 - $-N\Phi^2$
- Lenz's law is a consequence of the conservation of
 - energy
 - charge
 - momentum
 - mass
- The motional emf induced in a rod of length l moving with velocity v perpendicular to B is
 - Blv
 - Blv^2
 - Bv/l
 - Bl/v
- The SI unit of inductance is the
 - henry
 - weber
 - tesla
 - farad
- The energy stored in an inductor carrying current I is
 - $\frac{1}{2}LI^2$
 - LI^2
 - LI
 - $\frac{1}{2}L^2I$
- The peak emf of an AC generator is
 - $NBA\omega$

(B) NBA/ω

(C) $NBA\omega^2$

(D) NBA

8. A transformer works on the principle of

(A) mutual induction

(B) self-induction

(C) electrostatic induction

(D) resonance

9. Define magnetic flux.

10. State Lenz's law.

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

11. The flux through a 100-turn coil changes from 0.01 Wb to 0.05 Wb in 0.2 s. Find the induced emf.

12. A rod of length 0.5 m moves at 2 m/s perpendicular to a field of 0.4 T. Find the emf induced.

13. The current in a 0.5 H coil changes at 2 A/s. Find the induced emf.

14. A transformer has 100 primary and 500 secondary turns with 220 V primary. Find the secondary voltage.

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

15. State Faraday's laws of electromagnetic induction and derive the expression for the induced emf.

16. Derive the expression for the motional emf in a rod moving in a magnetic field.

17. Define self-inductance and derive the expression for the self-inductance of a long solenoid.

18. Describe the construction and working of a transformer and derive $V_s/V_p = N_s/N_p$.

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

19. State Faraday's laws and Lenz's law. Explain, using Lenz's law as a consequence of the conservation of energy, the direction of the induced current when a magnet approaches a coil.

20. Derive the expression for the motional emf in a rod moving on rails in a magnetic field, and show that the mechanical power supplied equals the electrical power dissipated in the circuit.

Answer Key (Marking Scheme)

Q1 — (A) weber. Q2 — (A) $-N d\Phi/dt$. Q3 — (A) energy. Q4 — (A) Blv .

Q5 — (A) henry. Q6 — (A) $\frac{1}{2}LI^2$. Q7 — (A) $NBA\omega$. Q8 — (A) mutual induction.

Q9 — The number of magnetic field lines crossing a surface: $\Phi = BA \cos\theta$, SI unit weber.

Q10 — The induced current opposes the change in magnetic flux that produces it.

Q11 — $e = N \Delta\Phi/\Delta t = 100 \times 0.04/0.2 = 20$ V.

Q12 — $e = Blv = 0.4 \times 0.5 \times 2 = 0.4$ V.

Q13 — $e = L di/dt = 0.5 \times 2 = 1$ V.

Q14 — $V_s = V_p N_s/N_p = 220 \times 5 = 1100$ V.

Q15 — $e = -d\Phi/dt$ and $e = -N d\Phi/dt$; integrate the Faraday law for the coil.

Q16 — The rod cuts field lines; charge separation gives $e = Blv$.

Q17 — $e = -L di/dt$; for a solenoid $B = \mu_0 nI$, $\Phi = BA$, so $L = \mu_0 N^2 A/l$.

Q18 — Mutual induction between two coils; $V_s/V_p = N_s/N_p$ (ideal, no loss).

Q19 — Faraday: $\mathcal{E} = -N \, d\Phi/dt$; Lenz: oppose the change. As the magnet approaches, flux increases, so the induced current opposes it, requiring work to be done, consistent with energy conservation.

Q20 — $\mathcal{E} = Blv$, $I = Blv/R$, $F = BIl = B^2 l^2 v/R$, $P_{\text{mech}} = Fv = B^2 l^2 v^2/R = I^2 R = P_{\text{electrical}}$.