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Electromagnetic Induction — CBSE Class 12 Physics Chapter Test

FREE CHAPTER TEST · CLASS XII · PHYSICS (042) · PATTERN OF THE CBSE SAMPLE QUESTION PAPER 2026-27

TIME ALLOWED	MAXIMUM MARKS	QUESTIONS	NAME / ROLL NO.
1½ hours	37	17 (A 8 · B 3 · C 3 · D 1 · E 2)	

GENERAL INSTRUCTIONS

Read the following instructions very carefully and strictly follow them:

1. This question paper contains 17 questions. All questions are compulsory.
2. This question paper is divided into five sections: A, B, C, D and E.
3. Section A (Q1–8) contains 6 multiple choice questions and 2 assertion-reason based questions of 1 mark each.
4. Section B (Q9–11) contains short answer questions of 2 marks each.
5. Section C (Q12–14) contains short answer questions of 3 marks each.
6. Section D (Q15) contains case study based questions of 4 marks each, with four sub-parts of 1 mark.
7. Section E (Q16–17) contains long answer questions of 5 marks each.
8. There is no overall choice. However, an internal choice has been provided in 1 question in Section B, 1 question in Section C, 2 questions in Section E. Attempt only one of the alternatives in such questions.
9. Use of calculators is not allowed. You may use: $\mu_0 = 4\pi \times 10^{-7}$ T m A^{-1}.
10. This chapter test follows the section structure, question types and marks per question of the CBSE Class XII Physics (042) Sample Question Paper 2026-27, at about half the length of the 70-mark board paper: 37 marks in 1½ hours.
11. The answer key and the marking scheme are at the end of this booklet. Attempt the paper in 1½ hours before you look at them.

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Chapter: Electromagnetic Induction · **Topics:** Faraday's law and Lenz's law · Motional emf · Self-inductance and energy in an inductor · Mutual inductance · AC generator

SECTION A

This section comprises 8 questions of 1 mark each: 6 multiple choice questions (MCQs) and 2 assertion-reason based questions.

1. A coil of 200 turns and area 0.010 m^2 is perpendicular to a magnetic field which falls uniformly from 0.50 T to zero in 0.10 s. The average emf induced in the coil is 1

(A) 1.0 V (B) 100 V

(C) 10 V (D) 0.10 V

2. Lenz's law is a consequence of the law of conservation of 1

(A) energy (B) charge

(C) momentum (D) mass

3. A metal rod 0.50 m long moves at 4.0 m s^{-1} perpendicular to its length and to a uniform magnetic field of 0.30 T. The emf between its ends is 1

(A) 0.15 V (B) 6.0 V

(C) 2.4 V (D) 0.60 V

4. The current in a coil of self-inductance 0.25 H falls uniformly from 4.0 A to zero in 0.020 s. The emf induced in it is 1

(A) 5.0 V (B) 50 V

(C) 0.50 V (D) 200 V

5. The energy stored in an inductor of 0.20 H carrying a current of 3.0 A is 1

(A) 0.90 J (B) 0.60 J

(C) 1.8 J (D) 0.30 J

6. One henry is the same as 1

(A) 1 Wb A (B) 1 V A s^{-1}

(C) 1 T m^2 (D) 1 V s A^{-1}

7. **Assertion (A) :** The mutual inductance of two coils increases when a soft-iron core is placed inside them. 1

Reason (R) : The self-induced emf in a coil always opposes the change of current in it.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Assertion (A) is false and Reason (R) is also false.

8. **Assertion (A) :** The induced current in a closed coil opposes the change of magnetic flux that produces it. 1

Reason (R) : The emf induced in a coil is proportional to the magnetic flux linked with it.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Assertion (A) is false and Reason (R) is also false.

SECTION B

This section comprises 3 short answer questions of 2 marks each.

9. A coil of 50 turns and area 0.020 m^2, with its plane perpendicular to a magnetic field of 0.40 T, is turned in 0.050 s until its plane is parallel to the field. Find the average emf induced. If the coil has a resistance of 4.0 Ω, find the average current. 2

10. (a) Two coils have a mutual inductance of 0.15 H. The current in the first coil rises uniformly from zero to 4.0 A in 0.020 s. Find the emf induced in the second coil. What is the emf once the current becomes steady? 2

OR

(b) Define self-inductance. Obtain the expression for the self-inductance of a long solenoid of n turns per unit length, cross-sectional area A and length l.

11. A metal rod of length 0.40 m slides at a steady 5.0 m s^{-1} on two parallel rails joined by a 2.0 Ω resistor, in a uniform magnetic field of 0.50 T perpendicular to the plane of the rails. Neglecting other resistances, find the current and the force needed to keep the rod moving. 2

SECTION C

This section comprises 3 short answer questions of 3 marks each.

12. (a) A conducting rod of length l moves with velocity v perpendicular to a uniform magnetic field B on a pair of rails joined by a resistance R. Derive the expression for the induced emf. Show that the mechanical power needed to move the rod equals the power dissipated in R. 3

OR

(b) (i) Show that the charge that flows through a coil of N turns and resistance R when the flux through each turn changes by $\Delta\Phi$ is $N\Delta\Phi/R$, however fast the change happens.

(ii) A coil of 100 turns, area 4.0×10^{-3} m^2 and resistance 8.0 Ω lies perpendicular to a field of 0.50 T and is pulled quickly out of the field. Find the charge that flows through it.

13. A metal rod of length l rotates with angular speed ω about an axis through one end, perpendicular to the rod and parallel to a uniform magnetic field B. Derive the emf between its ends. Find it for l = 0.60 m, ω = 200 rad s^{-1} and B = 0.25 T. 3

14. When the current in a coil changes uniformly from 2.0 A to 6.0 A in 0.050 s, an emf of 8.0 V is induced in it. 3

(i) Find the self-inductance of the coil.

(ii) Find the increase in the energy stored in it.

(iii) Why does a spark often appear at a switch when a circuit containing a large inductor is opened?

SECTION D

This section comprises 1 case study based question of 4 marks, with four sub-parts of 1 mark each.

15. Many phones can be charged without a cable. A coil in the charging pad carries a rapidly changing current; a second coil inside the phone, placed just above it, picks up an emf. Suppose the mutual inductance of the two coils is 4.0 μH and the current in the pad coil changes at a rate of up to 5.0×10^4 A s^{-1}.

(I) The charger works on the principle of

(A) self-induction (B) mutual induction (C) electrostatic induction (D) the photoelectric effect [1]

(II) The largest emf induced in the phone coil is

(A) 0.20 V (B) 2.0 V (C) 0.020 V (D) 20 V [1]

(III) If the phone is lifted further away from the pad, the mutual inductance

(A) increases (B) remains the same (C) becomes negative (D) decreases [1]

(IV) If a steady direct current flowed in the pad coil, the phone coil would have

(A) a large emf (B) a steadily rising emf (C) no emf (D) an alternating emf [1]

SECTION E

This section comprises 2 long answer questions of 5 marks each.

16. (a) (i) State Faraday's law of electromagnetic induction and Lenz's law. Explain how Lenz's law is consistent with the conservation of energy. 5

(ii) A square loop of side 10 cm and resistance 0.50 Ω is pulled out at a steady 2.0 cm s^{-1}, with one side leaving first, from a region of uniform magnetic field of 0.40 T perpendicular to its plane. Find the induced current and the heat produced while it leaves the field.

OR

(b) (i) Define mutual inductance. Derive the expression for the mutual inductance of two long coaxial solenoids of the same length, and show that $M_{12} = M_{21}$.

(ii) An outer solenoid 0.50 m long has 1000 turns. Inside it, along the same axis, is a solenoid of the same length with 200 turns and radius 2.0 cm. Find their mutual inductance.

17. (a) (i) Describe the principle of an AC generator. Derive the expression for the emf induced in a coil of N turns and area A rotating with angular speed ω in a uniform magnetic field B. 5

(ii) A coil of 200 turns and area 0.030 m^2 rotates at 50 revolutions per second in a uniform field of 0.050 T. Find the peak emf. If the coil is connected to a 30 Ω resistor (coil resistance negligible), find the peak current.

OR

(b) (i) Show that the energy stored in an inductor L carrying a current I is ½LI^2. Hence show that the energy per unit volume of the magnetic field inside a long solenoid is $B^2/2\mu_0$.

(ii) A solenoid of length 0.40 m has 800 turns and a cross-sectional area of 5.0 cm^2. Find its self-inductance and the energy stored in it when it carries a current of 2.0 A.

END OF THE QUESTION PAPER

ANSWER KEY — SECTION A

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
(C)	(A)	(D)	(B)	(A)	(D)	(B)	(C)

MARKING SCHEME AND WORKED SOLUTIONS

Marks for each step are shown in brackets, as in the CBSE marking scheme. Any correct alternative method earns full marks.

Q1. Answer (C). $\varepsilon = N\Delta\Phi/\Delta t = 200 \times 0.010 \times 0.50/0.10 = 10$ V.

Q2. Answer (A). If the induced current helped the change, energy would be created from nothing; opposing it means work must be done: energy is conserved.

Q3. Answer (D). $\varepsilon = Blv = 0.30 \times 0.50 \times 4.0 = 0.60$ V.

Q4. Answer (B). $\varepsilon = L\,\Delta I/\Delta t = 0.25 \times 4.0/0.020 = 50$ V.

Q5. Answer (A). $U = \tfrac{1}{2}LI^2 = \tfrac{1}{2} \times 0.20 \times 9.0 = 0.90$ J.

Q6. Answer (D). $\varepsilon = L\,dI/dt$ gives $L = \varepsilon/(dI/dt)$: $V/(A\,s^{-1}) = V\,s\,A^{-1}$ (also Wb A^{-1}).

Q7. Answer (B). A is true ($M \propto \mu_r$). R is true (Lenz's law) but is about self-induction and does not explain A. Answer (B).

Q8. Answer (C). A is Lenz's law, true. R is false: the emf is proportional to the rate of change of flux, not to the flux. Answer (C).

Q9. (2 marks) Answer: 8.0 V; 2.0 A.
Flux per turn changes from $BA = 0.40 \times 0.020 = 8.0 \times 10^{-3}$ Wb to zero. $\varepsilon = N\Delta\Phi/\Delta t = 50 \times 8.0 \times 10^{-3}/0.050 = 8.0$ V. [1]
$I = \varepsilon/R = 8.0/4.0 = 2.0$ A. [1]

Q10. (2 marks) Answer: (a) 30 V; zero when steady; (b) $L = \mu_0 n^2 Al$.
(a) $\varepsilon_2 = M\,\Delta I_1/\Delta t = 0.15 \times 4.0/0.020 = 30$ V. [1]
Once the current is steady the flux through the second coil does not change, so the emf is zero. [1]
OR (b) Self-inductance L is the flux linkage per unit current, $N\Phi = LI$ (equivalently $\varepsilon = -L\,dI/dt$). [1]
For a long solenoid $B = \mu_0 nI$, flux linkage $= (nl)(\mu_0 nI)A$, so $L = \mu_0 n^2 Al$. [1]

Q11. (2 marks) Answer: 0.50 A; 0.10 N.
$\varepsilon = Blv = 0.50 \times 0.40 \times 5.0 = 1.0$ V; $I = \varepsilon/R = 0.50$ A. [1]
At steady speed the applied force balances the magnetic force: $F = BIl = 0.50 \times 0.50 \times 0.40 = 0.10$ N. [1]

Q12. (3 marks) Answer: (a) $\varepsilon = Blv$; both $B^2l^2v^2/R$; (b) 2.5×10^{-2} C.
(a) In time dt the area of the circuit grows by lv dt, so $d\Phi/dt = Blv$ and $|\varepsilon| = Blv$. [1]
$I = Blv/R$; the magnetic force on the rod is $BIl = B^2l^2v/R$, opposing the motion. [1]
Mechanical power $= Fv = B^2l^2v^2/R$; power in $R = I^2R = (Blv/R)^2R = B^2l^2v^2/R$ — the same. [1]
OR (b) (i) $\varepsilon = -N\,d\Phi/dt$, so $I = \varepsilon/R$ and $Q = \int I\,dt = (N/R)\int d\Phi = N\Delta\Phi/R$, which depends only on the change of flux, not on how fast it happens. [1½]
(ii) $Q = NBA/R = 100 \times 0.50 \times 4.0 \times 10^{-3}/8.0 = 2.5 \times 10^{-2}$ C. [1½]

Q13. (3 marks) Answer: $\varepsilon = \tfrac{1}{2}B\omega l^2$; 9.0 V.
An element dr at distance r moves at $v = \omega r$, so $d\varepsilon = B\omega r\,dr$. [1]
$\varepsilon = \int_0^l B\omega r\,dr = \tfrac{1}{2}B\omega l^2$. [1]
$\varepsilon = \tfrac{1}{2} \times 0.25 \times 200 \times (0.60)^2 = 9.0$ V. [1]

Q14. (3 marks) Answer: (i) 0.10 H; (ii) 1.6 J.
(i) $L = \varepsilon/(\Delta I/\Delta t) = 8.0 \times 0.050/4.0 = 0.10$ H. [1]
(ii) $\Delta U = \tfrac{1}{2}L(I_2^2 - I_1^2) = \tfrac{1}{2} \times 0.10 \times (36 - 4) = 1.6$ J. [1]
(iii) Opening the switch makes I fall very fast; the large induced emf L dI/dt (which opposes the fall) appears across the gap and can ionise the air. [1]

Q15. (4 marks) Answer: (I) B; (II) A; (III) D; (IV) C.
(I) (B) A changing current in one coil induces an emf in a neighbouring coil: mutual induction. [1]
(II) (A) $\varepsilon = M\,dI/dt = 4.0 \times 10^{-6} \times 5.0 \times 10^{4} = 0.20$ V. [1]
(III) (D) Less of the pad coil's flux links the phone coil: M decreases. [1]
(IV) (C) A steady current gives a steady flux, and no change of flux means no emf. [1]

Q16. (5 marks) Answer: (a) 1.6×10^{-3} A; 6.4×10^{-6} J; (b) $M = \mu_0 n_1 n_2 \pi r_2^2 l$; $\approx 6.3 \times 10^{-4}$ H.
(a) (i) Faraday: $\varepsilon = -d\Phi/dt$ (for N turns, $-N\,d\Phi/dt$). [1] Lenz: the induced current flows so as to oppose the change in flux that produces it. [½] If it aided the change, a magnet pushed towards a coil would be pulled in faster, with kinetic energy and heat produced from nothing; because it opposes, work must be done against it, and that work appears as electrical energy. [1½]
(ii) $\varepsilon = Blv = 0.40 \times 0.10 \times 0.020 = 8.0 \times 10^{-4}$ V; $I = \varepsilon/R = 1.6 \times 10^{-3}$ A. [1] It takes $0.10/0.020 = 5.0$ s to leave: heat $= I^2Rt = (1.6 \times 10^{-3})^2 \times 0.50 \times 5.0 = 6.4 \times 10^{-6}$ J. [1]
OR (b) (i) Mutual inductance: the flux linkage of coil 2 per unit current in coil 1, $N_2\Phi_2 = M_{21}I_1$. [1] Outer solenoid (n_1 turns per unit length) gives $B_1 = \mu_0 n_1 I_1$ inside the inner one (radius r_2, n_2 turns per unit length, length l): $N_2\Phi_2 = (n_2 l)(\pi r_2^2)\mu_0 n_1 I_1$, so $M_{21} = \mu_0 n_1 n_2 \pi r_2^2 l$. [1½] A current I_2 in the inner one gives flux only over πr_2^2 of the outer turns: $N_1\Phi_1 = (n_1 l)(\pi r_2^2)\mu_0 n_2 I_2$, so $M_{12} = M_{21}$. [1]
(ii) $M = \mu_0(N_1/l)N_2\pi r_2^2 = 4\pi \times 10^{-7} \times 2000 \times 200 \times \pi(0.020)^2 \approx 6.3 \times 10^{-4}$ H. [1½]

Q17. (5 marks) Answer: (a) $\varepsilon = NBA\omega \sin \omega t$; ≈ 94 V; ≈ 3.1 A; (b) $u = B^2/2\mu_0$; ≈ 1.0 mH; $\approx 2.0 \times 10^{-3}$ J.
(a) (i) A coil rotated in a magnetic field has a continually changing flux through it, so an alternating emf is induced (electromagnetic induction). [1] At angle $\theta = \omega t$ between the normal and B: $\Phi = NBA \cos \omega t$, so $\varepsilon = -d\Phi/dt = NBA\omega \sin \omega t$, with peak $\varepsilon_0 = NBA\omega$. [2]
(ii) $\varepsilon_0 = 200 \times 0.050 \times 0.030 \times 2\pi \times 50 \approx 94$ V. [1] $I_0 = \varepsilon_0/R \approx 94/30 \approx 3.1$ A. [1]
OR (b) (i) Building the current from 0 to I against the back emf L di/dt needs work $\int L\,i\,di = \tfrac{1}{2}LI^2$, stored as magnetic energy. [1½] For a solenoid $L = \mu_0 n^2 Al$ and $B = \mu_0 nI$: $U = \tfrac{1}{2}\mu_0 n^2 AlI^2 = (B^2/2\mu_0)(Al)$, so the energy per unit volume is $B^2/2\mu_0$. [1½]
(ii) $n = 800/0.40 = 2000$ m^{-1}; $L = \mu_0 n^2 Al = 4\pi \times 10^{-7} \times (2000)^2 \times 5.0 \times 10^{-4} \times 0.40 \approx 1.0 \times 10^{-3}$ H. [1] $U = \tfrac{1}{2}LI^2 = \tfrac{1}{2} \times 1.0 \times 10^{-3} \times 4.0 \approx 2.0 \times 10^{-3}$ J. [1]

All questions are original and © Master Testing Agency. Free to download and use for personal practice; not for resale. Every answer in this paper was checked independently by computer: emfs by differentiating the flux, the rotating rod by integrating vB along it, the pulled loop by stepping it out of the field and adding up the heat.