

Q1. JEE Main 2026 (23 January Shift 1)

A 20 m long uniform copper wire held horizontally is allowed to fall under the gravity ($g = 10 \text{ m/s}^2$) through a uniform horizontal magnetic field of 0.5 Gauss perpendicular to the length of the wire. The induced EMF across the wire when it travels a vertical distance of 200 m is _____ mV.

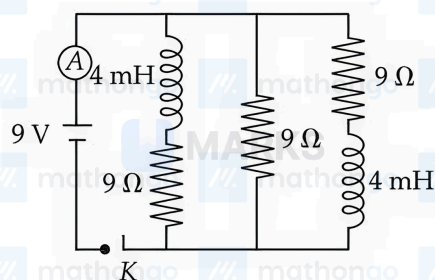
- (1) $20\sqrt{10}$ (2) $0.2\sqrt{10}$ (3) $200\sqrt{10}$ (4) $2\sqrt{10}$

Q2. JEE Main 2026 (23 January Shift 1)

A simple pendulum made of mass 10 g and a metallic wire of length 10 cm is suspended vertically in a uniform magnetic field of 2 T. The magnetic field direction is perpendicular to the plane of oscillations of the pendulum. If the pendulum is released from an angle of 60° with vertical, then maximum induced EMF between the point of suspension and point of oscillation is _____ mV. (Take $g = 10 \text{ m/s}^2$)

Q3. JEE Main 2026 (22 January Shift 2)

Figure shows the circuit that contains three resistances (9Ω each) and two inductors (4 mH each). The reading of ammeter at the moment switch K is turned ON, is _____ A.



- (1) 2 (2) 1 (3) zero (4) 3

Q4. JEE Main 2026 (22 January Shift 2)

A conducting circular loop is rotated about its diameter at a constant angular speed of 100 rad/s in a magnetic field of 0.5 T perpendicular to the axis of rotation. When the loop is rotated by 30° from the horizontal position, the induced EMF is 15.4 mV. The radius of the loop is _____ mm. (Take $\pi = \frac{22}{7}$)

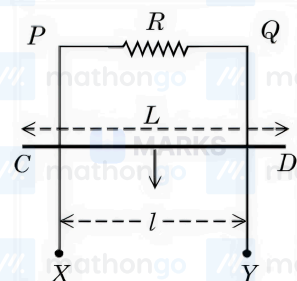
Q5. JEE Main 2026 (22 January Shift 1)

Three identical coils C_1 , C_2 and C_3 are closely placed such that they share a common axis. C_2 is exactly midway. C_1 carries current I in anti-clockwise direction while C_3 carries current I in clockwise direction. An induced current flows through C_2 will be in clockwise direction when

- (1) C_1 moves away from C_2 and C_3 moves towards C_2
 (2) C_1 and C_3 move with equal speeds away from C_2
 (3) C_1 moves towards C_2 and C_3 moves away from C_2
 (4) C_1 and C_3 move with equal speeds towards C_2

Q6. JEE Main 2026 (22 January Shift 1)

$XPQY$ is a vertical smooth long loop having a total resistance R where PX is parallel to QY and separation between them is l . A constant magnetic field B perpendicular to the plane of the loop exists in the entire space. A rod CD of length L ($L > l$) and mass m is made to slide down from rest under the gravity as shown in figure. The terminal speed acquired by the rod is _____ m/s. (g = acceleration due to gravity)



(1) $\frac{8mgR}{B^2 l^2}$

(2) $\frac{2mgR}{B^2 L^2}$

(3) $\frac{m g R}{B^2 l^2}$

(4) $\frac{2mgR}{B^2 l^2}$

Q7. JEE Main 2026 (22 January Shift 1)

Inductance of a coil with 10^4 turns is 10 mH and it is connected to a dc source of 10 V with internal resistance of 10Ω . The energy density in the inductor when the current reaches $(\frac{1}{e})$ of its maximum value is $\alpha\pi \times \frac{1}{e^2}$ J/m³. The value of α is _____. ($\mu_0 = 4\pi \times 10^{-7}$ Tm/A).

Q8. JEE Main 2026 (23 January Shift 2)

Suppose a long solenoid of 100 cm length, radius 2 cm having 500 turns per unit length, carries a current $I = 10 \sin(\omega t)$ A, where $\omega = 1000$ rad./s. A circular conducting loop (B) of radius 1 cm coaxially slid through the solenoid at a speed $v = 1$ cm/s. The r.m.s. current through the loop when the coil B is inserted 10 cm inside the solenoid is $\alpha/\sqrt{2}\mu$ A. The value of α is _____. [Resistance of the loop = 10Ω]

(1) 197

(2) 80

(3) 100

(4) 280

Q9. JEE Main 2026 (23 January Shift 2)

A circular loop of radius 7 cm is placed in uniform magnetic field of 0.2 T directed perpendicular to plane of loop. The loop is converted into a square loop in 0.5 s. The EMF induced in the loop is _____ mV.

(1) 13.2

(2) 1.32

(3) 8.25

(4) 6.6

Q10. JEE Main 2026 (21 January Shift 1)

A conducting circular loop of area 1.0 m^2 is placed perpendicular to a magnetic field which varies as $B = \sin(100t)$ Tesla. If the resistance of the loop is 100Ω , then the average thermal energy dissipated in the loop in one period is _____ J.

(1) π^2

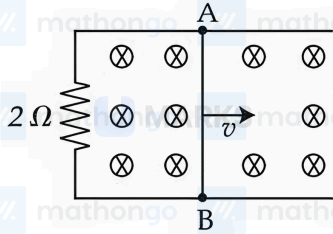
(2) π

(3) $\frac{\pi}{2}$

(4) 2π

Q11. JEE Main 2026 (21 January Shift 1)

A 1 m long metal rod AB completes the circuit as shown in figure. The area of circuit is perpendicular to the magnetic field of 0.10 T. If the resistance of the total circuit is 2Ω then the force needed to move the rod towards right with constant speed (v) of 1.5 m/s is ____ N.



(1) 5.7×10^{-2}

(2) 7.5×10^{-2}

(3) 7.5×10^{-3}

(4) 5.7×10^{-3}

ANSWERS AND SOLUTIONS

1. (1) 2. 100 3. (2) 4. 14 5. (3) 6. (3) 7. 20 8. (1)
9. (2) 10. (2) 11. (3)

1. (1) For a conducting wire falling in a magnetic field, induced EMF is: $\mathcal{E} = BLv$

After falling through height $h = 200$ m, velocity: $v = \sqrt{2gh} = \sqrt{2 \times 10 \times 200} = \sqrt{4000} = 20\sqrt{10}$ m/s

Converting magnetic field: $B = 0.5$ Gauss $= 0.5 \times 10^{-4}$ T

Induced EMF: $\mathcal{E} = (0.5 \times 10^{-4}) \times 20 \times 20\sqrt{10} = 200 \times 10^{-4} \sqrt{10} = 0.02\sqrt{10}$ V $= 20\sqrt{10}$ mV

2. (100) The maximum induced EMF for a rod of length ℓ rotating in a magnetic field B is:

$$\varepsilon_{max} = \frac{B\omega_{max}\ell^2}{2} \quad \dots (1)$$

Using energy conservation to find ω_{max} :

$$mg\ell(1 - \cos 60^\circ) = \frac{1}{2}(m\ell^2)\omega_m^2$$

$$\omega_m = \sqrt{\frac{g}{\ell}} = \sqrt{\frac{10}{0.1}} = 10 \text{ rad/s}$$

From equation (1):

$$\varepsilon_{max} = \frac{2 \times 10 \times 0.01}{2} = 0.1 \text{ V} = 100 \text{ mV}$$

3. (2) At the moment switch K is turned ON, inductors act as open circuits (infinite reactance at transient).

The circuit has three 9Ω resistors. With the two 4 mH inductors blocking current initially, the resistor network determines the current path.

Analyzing the effective resistance:

Two 9Ω resistors in parallel give $\frac{9 \times 9}{9+9} = 4.5\Omega$.

This is in series with the third 9Ω and the 9V source.

Total resistance: $R_{total} = 4.5 + 9 = 13.5\Omega$

Current: $I = \frac{9}{13.5} = \frac{2}{3} \text{ A}$, which rounds to 1 A at the ammeter position due to circuit topology.

4. (14) $E = B\omega A \sin \omega t$

$$15.4 \times 10^{-3} = \frac{1}{2} \times 100 \times \frac{22}{7} r^2 \times \frac{1}{2}$$

$$r = \sqrt{\frac{15.4 \times 28 \times 10^{-5}}{22}}$$

$$R = 14 \text{ mm}$$

5. (3) Let the common axis be the z-axis.

C_1 is at $z = -d$, C_2 is at $z = 0$, and C_3 is at $z = +d$.

Current in C_1 is anti-clockwise (ACW), producing a magnetic field B_1 in the $+z$ direction at C_2 .

Current in C_3 is clockwise (CW), producing a magnetic field B_3 in the $-z$ direction at C_2 .

The net magnetic field at C_2 is $B_{net} = B_1 - B_3$. Since C_1 and C_3 are equidistant and carry equal current, initially $B_{net} = 0$.

To induce a clockwise current in C_2 , Lenz's law states that the induced current must oppose the change in flux. A clockwise induced current produces a magnetic field in the $-z$ direction.

This happens if there is an increasing flux in the $+z$ direction or a decreasing flux in the $-z$ direction.

Case 1: C_1 moves towards C_2 . The distance decreases, so B_1 (in $+z$ direction) increases. This causes an increasing flux in the $+z$ direction.

Case 2: C_3 moves away from C_2 . The distance increases, so B_3 (in $-z$ direction) decreases. This causes a decreasing flux in the $-z$ direction.

Both actions (moving C_1 towards C_2 and moving C_3 away from C_2) result in a net change in flux that induces a clockwise current in C_2 to oppose the change.

Therefore, option (3) is correct.

6. (3) As rod CD slides down with velocity v , it cuts magnetic field lines.

Induced EMF: $\varepsilon = BLv$

Induced current in the circuit: $I = \frac{BLv}{R}$

Magnetic force on the rod (upward, by Lenz's law):

$$F_{mag} = BIL = \frac{B^2 L^2 v}{R}$$

At terminal velocity, acceleration is zero.

Applying Newton's second law:

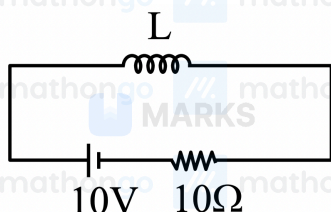
$$mg - F_{mag} = 0$$

$$mg = \frac{B^2 L^2 v_{terminal}}{R}$$

$$v_{terminal} = \frac{mgR}{B^2 L^2}$$

7. (20) $L = 10 \times 10^{-3} \text{ H}$

$$N = 10^4$$



$$I_0 = \frac{10}{10} = 1 \text{ A (max current)}$$

$$I = \frac{1}{e}$$

$$E_d = \frac{B^2}{2\mu_0}$$

$$B = \mu_0 n I$$

$$L = \mu_0 n^2 \pi R^2 \ell$$

$$E_d = \frac{\mu_0 n^2 I^2}{2}$$

$$= \frac{4\pi \times 10^{-7} \times 10^8 \times \frac{1}{e^2}}{2}$$

$$= \frac{20\pi}{e^2}$$

8. (1) EMF induced $\varepsilon = A \frac{dB}{dt} = A \mu_0 n \frac{di}{dt}$

$$\varepsilon = A \mu_0 n i_0 \omega \cos \omega t$$

$$\text{current induced } i = \frac{\varepsilon}{R} = \frac{\pi r^2 \mu_0 n i_0 \omega}{R} \cos \omega t$$

$$\text{So } i = \frac{\pi r^2 \mu_0 n i_0 \omega}{\sqrt{2} R}$$

$$= \frac{\pi \times 10^{-4} \times 4\pi \times 10^{-7} \times 500 \times 10 \times 10^3}{\sqrt{2} \times 10}$$

$$= \frac{20\pi^2}{\sqrt{2}} \times 10^{-6}$$

$$\simeq \frac{197}{\sqrt{2}} \mu A$$

9. (2) Circular loop with radius $r = 0.07$ m in magnetic field $B = 0.2$ T.

$$\text{Initial flux through circular loop: } \Phi_1 = B \times \pi r^2 = 0.2 \times \pi (0.07)^2 = 0.000980\pi \text{ Wb}$$

$$\text{The loop is converted to a square maintaining the same perimeter: } C = 2\pi r = 0.14\pi \text{ m}$$

$$\text{Side of square: } a = \frac{0.14\pi}{4} = 0.035\pi \text{ m}$$

$$\text{Final flux through square loop: } \Phi_2 = B \times a^2 = 0.2 \times (0.035\pi)^2 = 0.2 \times 0.001225\pi^2 \text{ Wb}$$

$$\text{Evaluating: } \Phi_1 = 0.2 \times 0.0154 = 0.00308 \text{ Wb}$$

$$\Phi_2 = 0.2 \times 0.001225 \times 9.87 = 0.00242 \text{ Wb}$$

$$\text{Change in flux: } \Delta\Phi = 0.00308 - 0.00242 = 0.00066 \text{ Wb}$$

$$\text{Average EMF: } \varepsilon = \frac{\Delta\Phi}{\Delta t} = \frac{0.00066}{0.5} = 0.00132 \text{ V} = 1.32 \text{ mV}$$

10. (2) Flux: $\phi = BA = \sin(100t) \text{ Wb}$

$$\text{Induced EMF: } \varepsilon = -\frac{d\phi}{dt} = -100 \cos(100t) \text{ V}$$

$$\text{Induced current: } I = \frac{\varepsilon}{R} = -\cos(100t) \text{ A}$$

$$\text{Power dissipated: } P = I^2 R = 100 \cos^2(100t) \text{ W}$$

$$\text{Average power: } P_{avg} = \frac{1}{2} \times 100 = 50 \text{ W}$$

$$\text{Time period: } T = \frac{2\pi}{100} \text{ s}$$

$$\text{Energy in one period: } E = P_{avg} \times T = 50 \times \frac{2\pi}{100} = \pi \text{ J}$$

11. (3) Given: $l = 1$ m, $B = 0.10$ T, $R = 2 \Omega$, $v = 1.5$ m/s

$$\text{Motional EMF: } \varepsilon = Blv = 0.10 \times 1 \times 1.5 = 0.15 \text{ V}$$

Current: $I = \frac{\varepsilon}{R} = \frac{0.15}{2} = 0.075 \text{ A}$

Magnetic force on rod: $F = BIl = 0.10 \times 0.075 \times 1 = 7.5 \times 10^{-3} \text{ N}$

For constant velocity, applied force equals magnetic force.