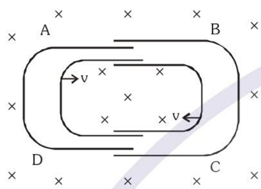
PREVIOUS YEARS' QUESTIONS — EXERCISE-II

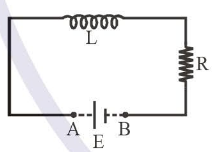
1. One conducting U-tube can slide inside another as shown in figure, maintaining electrical contacts between the tubes. The magnetic field B is perpendicular to the plane of the figure. If each tube moves towards the other at a constant speed v, then the emf induced in the circuit in terms of B, ℓ and v, where ℓ is the width of each tube, will be- **[AIEEE - 2005]**



(1) $B\ell v$ (2) $-B\ell v$
(3) zero (4) $2B\ell v$

2. The flux linked with a coil at any instant 't' is given by : $\phi = 10t^2 - 50t + 250$
The induced emf at t = 3s is- **[AIEEE - 2006]**
(1) – 190 V (2) – 10 V
(3) 10 V (4) 190 V

3. An inductor (L = 100 mH), a resistor (R = 100 Ω) and a battery (E = 100 V) are initially connected in series as shown in the figure. After a long time the battery is disconnected after short circuiting the points A and B. The current in the circuit 1 ms after the short circuit is- **[AIEEE - 2006]**



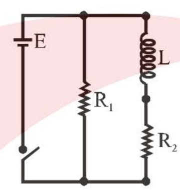
(1) 1/e A (2) e A
(3) 0.1 A (4) 1 A

4. In an AC generator, a coil with N turns, all of the same area A and total resistance R, rotates with frequency ω in a magnetic field B. The maximum value of emf generated in the coil is- **[AIEEE-2006]**
(1) NABRω (2) NAB (3) NABR (4) NABω

5. An ideal coil of 10 H is connected in series with a resistance of 5Ω and a battery of 5 V.2s after the connection is made, the current flowing (in ampere) in the circuit is- **[AIEEE - 2007]**
(1) (1 – e) (2) e
(3) e^{-1} (4) $(1 - e^{-1})$

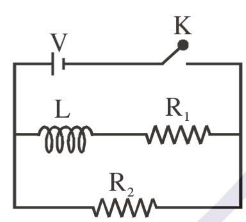
6. Two coaxial solenoids are made by winding thin insulated wire over a pipe of cross-sectional area A = 10 cm² and length = 20 cm. If one of the solenoids has 300 turns and the other 400 turns, their mutual inductance is $\left(\mu_0 = 4\pi \times 10^{-7}\,\text{TmA}^{-1}\right)$ **[AIEEE - 2008]**
(1) $2.4\pi \times 10^{-5}$ H (2) $4.8\pi \times 10^{-4}$ H
(3) $4.8\pi \times 10^{-5}$ H (4) $2.4\pi \times 10^{-4}$ H

7. An inductor of inductance L = 400 mH and resistors of resistances R_1 = 2Ω and R_2 = 2Ω are connected to a battery of emf 12V as shown in the figure. The internal resistance of the battery is negligible. The switch S is closed at t = 0. The potential drop across L as a function of time is:- **[AIEEE - 2009]**



(1) $6(1 - e^{-t/0.2})$V (2) $12e^{-5t}$ V
(3) $6e^{-5t}$ V (4) $\frac{12}{t}e^{-3t}$V

8. In the circuit show below, the key K is closed at t = 0. The current through the battery is : **[AIEEE - 2010]**



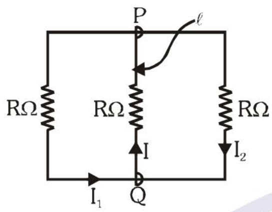
(1) $\frac{V(R_1+R_2)}{R_1R_2}$ at t = 0 and $\frac{V}{R_2}$ at t = ∞

(2) $\frac{VR_1R_2}{\sqrt{R_1^2+R_2^2}}$ at t = 0 and $\frac{V}{R_2}$ at t = ∞

(3) $\frac{V}{R_2}$ at t = 0 and $\frac{V(R_1+R_2)}{R_1R_2}$ at t = ∞

(4) $\frac{V}{R_2}$ at t = 0 and $\frac{VR_1R_2}{\sqrt{R_1^2+R_2^2}}$ at t = ∞

9. A rectangular loop has a sliding connector PQ of length ℓ and resistance RΩ and it is moving with a speed v as shown. The set-up is placed in a uniform magnetic field going into the plane of the paper. The three currents I_1, I_2 and I are :- **[AIEEE - 2010]**



(1) $I_1 = I_2 = \frac{B\ell v}{6R}, I = \frac{B\ell v}{3R}$

(2) $I_1 = -I_2 = \frac{B\ell v}{R}, I = \frac{2B\ell v}{R}$

(3) $I_1 = I_2 = \frac{B\ell v}{3R},\ I = \frac{2B\ell v}{3R}$

(4) $I_1 = I_2 = I = \frac{B\ell v}{R}$

10. A boat is moving due east in a region where the earth's magnetic field is $5.0\times10^{-5} NA^{-1}m^{-1}$ due north and horizontal. The boat carries a vertical aerial 2m long. If the speed of the boat is $1.50\ ms^{-1}$, the magnitude of the induced emf in the wire of aerial is :- **[AIEEE - 2011]**

(1) 0.50 mV (2) 0.15 mV (3) 1 mV (4) 0.75mV

11. A horizontal straight wire 20 m long extending from east to west is falling with a speed of 5.0 m/s, at right angles to the horizontal component of the earth's magnetic field $0.30 \times 10^{-4}\ Wb/m^2$. The instantaneous value of the e.m.f. induced in the wire will be :- **[AIEEE - 2011]**

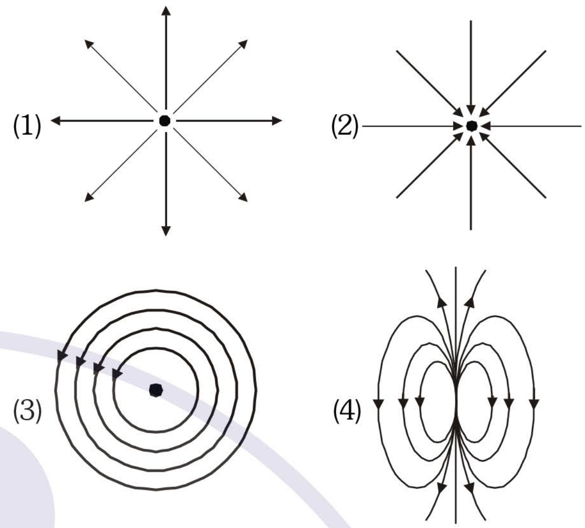
(1) 6.0 mV (2) 3 mV (3) 4.5 mV (4) 1.5 mV

12. A fully charged capacitor C with intial charge q_0 is connected to a coil of self inductance L at t = 0. The time at which the energy is stored equally between the electric and the magnetic fields is :- **[AIEEE - 2011]**

(1) $2\pi\sqrt{LC}$ (2) $\sqrt{LC}$

(3) $\pi\sqrt{LC}$ (4) $\frac{\pi}{4}\sqrt{LC}$

13. Which of the field patterns given below is valid for electric field as well as for magnetic field? **[JEE 2011]**



14. A coil is suspended in a uniform magnetic field, with the plane of the coil parallel to the magnetic lines of force. When a current is passed through the coil it starts oscillating; it is very difficult to stop. But if an aluminium plate is placed near to the coil, it stops. This is due to :- **[AIEEE - 2012]**

(1) Electromagnetic induction in the aluminium plate giving rise to electromagnetic damping

(2) Development of air current when the plate is placed

(3) Induction of electrical charge on the plate

(4) Shielding of magnetic lines of force as aluminium is a paramagnetic material

15. This question has Statement 1, Statement 2. Of the four choices given after the statement, choose the one that best describes the two statements.

Statement-1 : Self inductance of a long solenoid of length L, total number of turns N and radius r is less than $\frac{\pi\mu_0 N^2 r^2}{L}$.

Statement-2 : The magnetic induction in the solenoid in Statement 1 carrying current I is $\frac{\mu_0 NI}{L}$ in the middle of the solenoid but becomes less as we move towards its ends. **[AIEEE - 2012 (Online)]**

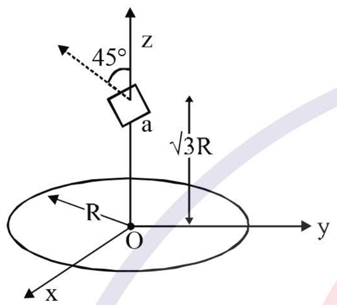
(1) Statement-1 is true, Statement-2 is true and Statement-2 is the correct explanation of Statement-1.

(2) Statement-1 is true, Statement-2 is true and Statement-2 is not the correct explanation of statement-1.

(3) Statement-1 is true, Statement-2 is false

(4) Statement-1 is false, Statement-2 is true

16. A circular wire loop of radius R is placed in the x-y plane centred at the origin O. A square loop of side a (a<<R) having two turns is placed with its center at $z = \sqrt{3}R$ along the axis of the circular wire loop, as shown in figure. The plane of the square loop makes an angle of 45° with respect to the z-axis. If the mutual inductance between the loops is given by $\frac{\mu_0 a^2}{2^{p/2}R}$, then the value of p is **[JEE 2012]**

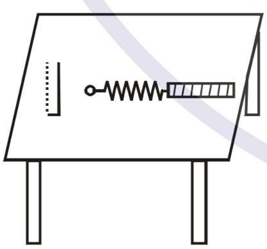


(1) 3 (2) 7 (3) 4 (4) 5

17. A current carrying infinitely long wire is kept along the diameter of a circular wire loop, without touching it. The correct statement(s) is (are) **[JEE 2012]**

(1) The emf induced in the loop is zero if the current is constant.
(2) The emf induced in the loop is infinite if the current is constant.
(3) The emf induced in the loop is zero if the current decreases at a steady rate.
(4) The emf induced in the loop is finite if the current decreases at a steady rate.

18. A metallic rod of length 'ℓ' is tied to a string of length 2l and made to rotate with angular speed ω on a horizontal table with one end of the string fixed. If there is a vertical magnetic field 'B' in the region, the e.m.f. induced across the ends of the rod is : **[JEE(Main) - 2013]**

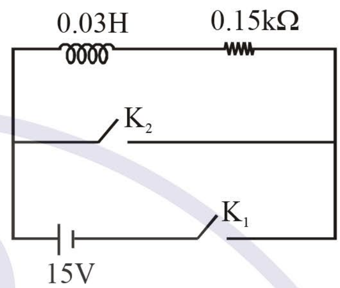


(1) $\frac{2B\omega\ell^2}{2}$ (2) $\frac{3B\omega\ell^2}{2}$ (3) $\frac{4B\omega\ell^2}{2}$ (4) $\frac{5B\omega\ell^2}{2}$

19. A circular loop of radius 0.3 cm lies parallel to a much bigger circular loop of radius 20 cm. The centre of the small loop is on the axis of the bigger loop. The distance between their centres is 15 cm. If a current of 2.0 A flows through the smaller loop, then the flux linked with bigger loop is :- **[JEE(Main) - 2013]**

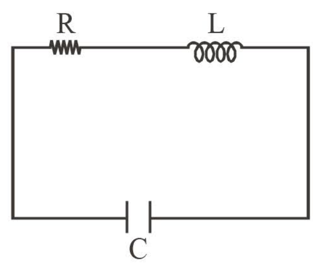
(1) 9.1×10^{-11} weber (2) 6×10^{-11} weber
(3) 3.3×10^{-11} weber (4) 6.6×10^{-9} weber

20. An inductor (L = 0.03 H) and a resistor (R = 0.15 kΩ) are connected in series to a battery of 15V EMF in a circuit shown below. The key K_1 has been kept closed for a long time. Then at t = 0, K_1 is opened and key K_2 is closed simultaneously. At t = 1ms, the current in the circuit will be ($e^5 \cong 150$) :- **[JEE(Main)-2015]**

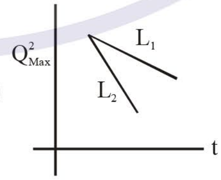


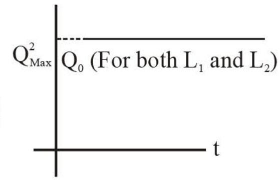
(1) 6.7 mA (2) 0.67 mA
(3) 100 mA (4) 67 mA

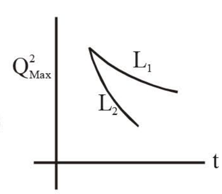
21. An LCR circuit is equivalent to a damped pendulum. In an LCR circuit the capacitor is charged to Q_0 and then connected to the L and R as shown below :- **[JEE(Main)-2015]**

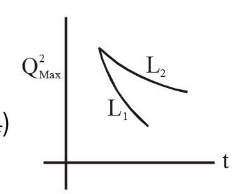


If a student plots graphs of the square of maximum charge (Q^2_{Max}) on the capacitor with time (t) for two different values L_1 and L_2 ($L_1 > L_2$) of L then which of the following represents this graph correctly ? (plots are schematic and not drawn to scale)

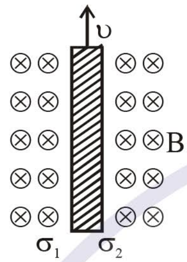
(1)


(2)


(3)


(4)


22. Consider a thin metallic sheet perpendicular to the plane of the paper moving with speed 'v' in a uniform magnetic field B going into the plane of the paper (See figure). If charge densities σ_1 and σ_2 are induced on the left and right surfaces, respectively, of the sheet then (ignore fringe effects) :-
[JEE (Main)–2016 (On Line)]



(1) $\sigma_1 = \in_0 \upsilon B,\ \sigma_2 = -\in_0 \upsilon B$

(2) $\sigma_1 = \frac{-\in_0 \upsilon B}{2}, \sigma_2 = \frac{\in_0 \upsilon B}{2}$

(3) $\sigma_1 = \frac{\in_0 \upsilon B}{2}, \sigma_2 = \frac{-\in_0 \upsilon B}{2}$

(4) $\sigma_1 = \sigma_2 = \in_0 \upsilon B$

23. A fighter plane of length 20 m, wing span (distance from tip of one wing to the tip of the other wing) of 15 m and height 5 m is flying towards east over Delhi. Its speed is 240 ms^{-1}. The earth's magnetic field over Delhi is 5×10^{-5} T with the declination angle ~0° and dip of θ such that $\sin\theta = \frac{2}{3}$. If the voltage developed is V_B between the lower and upper side of the plane and V_W between the tips of the wings then V_B and V_W are close to :-
[JEE (Main)–2016 (On Line)]

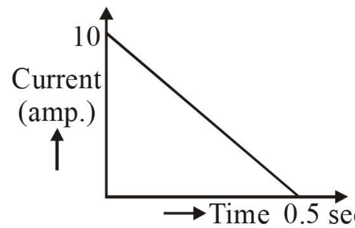
(1) V_B = 40 mV; V_W = 135 mV with right side of pilot at high voltage

(2) V_B = 45 mV; V_W = 120 mV with right side of pilot at higher voltage

(3) V_B = 40 mV; V_W = 135 mV with left side of pilot at higher voltage

(4) V_B = 45 mV; V_W = 120 mV with left side of pilot at higher voltage

24. In a coil of resistance 100 Ω, a current is induced by changing the magnetic flux through it as shown in the figure. The magnitude of change in flux through the coil is : **[JEE(Main)-2017]**



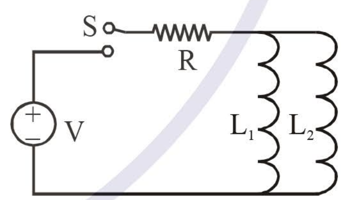
(1) 250 Wb (2) 275 Wb
(3) 200 Wb (4) 225 Wb

25. A small circular loop of wire of radius a is located at the centre of a much larger circular wire loop of radius b. The two loops are in the same plane. The outer loop of radius b carries an alternating current $I = I_0 \cos(\omega t)$. The emf induced in the smaller inner loop is nearly : **[JEE (Main)–2017 (On Line)]**

(1) $\pi\mu_0 I_0 \frac{a^2}{b}\omega\sin(\omega t)$ (2) $\frac{\pi\mu_0 I_0 a^2}{2b}\omega\cos(\omega t)$

(3) $\frac{\pi\mu_0 I_0 a^2}{2b}\omega\sin(\omega t)$ (4) $\frac{\pi\mu_0 I_0 b^2}{2}\omega\cos(\omega t)$

26. A source of constant voltage V is connected to a resistance R and two ideal inductors L_1 and L_2 through a switch S as shown. There is no mutual inductance between the two inductors. The switch S is initially open. At t = 0, the switch is closed and current begins to flow. Which of the following options is/are correct? **[JEE Advance-2017]**



(1) The ratio of the currents through L_1 and L_2 is fixed at all times (t > 0)

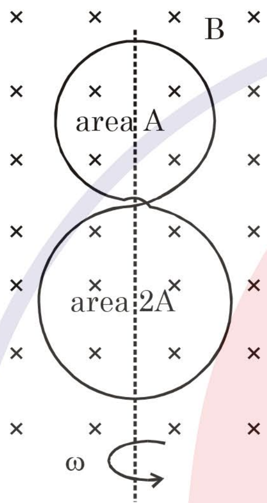
(2) After a long time, the current through L_1 will be $\frac{V}{R}\frac{L_2}{L_1+L_2}$

(3) After a long time, the current through L_2 will be $\frac{V}{R}\frac{L_1}{L_1+L_2}$

(4) At t = 0, the current through the resistance R is $\frac{V}{R}$

27. A circular insulated copper wire loop is twisted to form two loops of area A and 2A as shown in the figure. *At the point of crossing the wires remain electrically insulated from each other.* The entire loop lies in the plane (of the paper). A uniform magnetic field $\vec{B}$ points into the plane of the paper. At t = 0, the loop starts rotating about the common diameter as axis with a constant angular velocity ω in the magnetic field. Which of the following options is/are correct?

[JEE Advance-2017]



(1) The rate of change of the flux is maximum when the plane of the loops is perpendicular to plane of the paper

(2) The net emf induced due to both the loops is proportional to cos ωt

(3) The emf induced in the loop is proportional to the sum of the areas of the two loops

(4) The amplitude of the maximum net emf induced due to both the loops is equal to the amplitude of maximum emf induced in the smaller loop alone

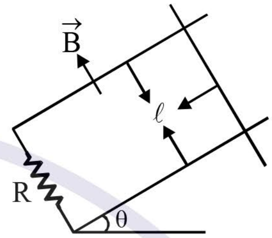
28. An ideal capacitor of capacitance 0.2 μF is charged to a potential difference of 10 V. The charging battery is then disconnected. The capacitor is then connected to an ideal inductor of self inductance 0.5 mH. The current at a time when the potential difference across the capacitor is 5 V, is :

[JEE (Main) – 2018 (On Line)]

(1) 0.34 A (2) 0.17 A
(3) 0.25 A (4) 0.15 A

29. A copper rod of mass m slides under gravity on two smooth parallel rails, with separation ℓ and set at an angle of θ with the horizontal. At the bottom, rails are joined by a resistance R. There is a uniform magnetic field B normal to the plane of the rails, as shown in the figure. The terminal speed of the copper rod is :

[JEE (Main)–2018 (On Line)]

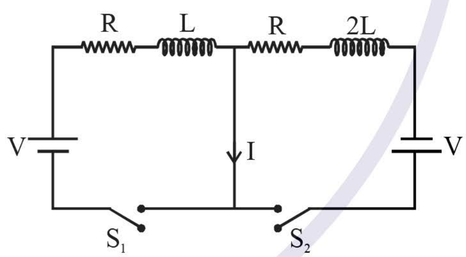


(1) $\dfrac{mgR\sin\theta}{B^2I^2}$ (2) $\dfrac{mgR\cot\theta}{B^2I^2}$

(3) $\dfrac{mgR\tan\theta}{B^2I^2}$ (4) $\dfrac{mgR\cos\theta}{B^2I^2}$

30. In the figure below, the switches S_1 and S_2 are closed simultaneously at t = 0 and a current starts to flow in the circuit. Both the batteries have the same magnitude of the electromotive force (emf) and the polarities are as indicated in the figure. Ignore mutual inductance between the inductors. The current I in the middle wire reaches its maximum magnitude I_{max} at time t = τ. Which of the following statement(s) is (are) true?

[JEE Advance-2018]



(1) $I_{max} = \dfrac{V}{2R}$ (2) $I_{max} = \dfrac{V}{4R}$

(3) $\tau = \dfrac{L}{R}\ell n2$ (4) $\tau = \dfrac{2L}{R}\ell n2$

PREVIOUS YEARS QUESTIONS — ANSWER KEY — Exercise-II

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	4	2	1	4	4	4	2	3	3	2
Que.	11	12	13	14	15	16	17	18	19	20
Ans.	2	4	3	1	1	2	1,3	4	1	2
Que.	21	22	23	24	25	26	27	28	29	30
Ans.	3	3	4	1	3	1,2,3	1,4	2	1	2,4