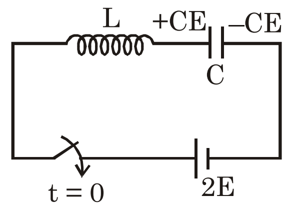
CLASS TEST

SECTION-I

Single Correct Answer Type **10 Q. [3 M (–1)]**

1. Maximum charge on capacitor after switch is closed :-



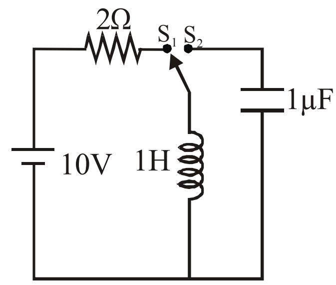
(A) 2CE

(B) 4CE

(C) 3CE

(D) None of these

2. For the circuit shown, the switch was closed at switch S_1 for a long time till steady state condition reached. At time t = 0, the switch S_1 is opened and S_2 is closed. The current through inductor as a function of time will be



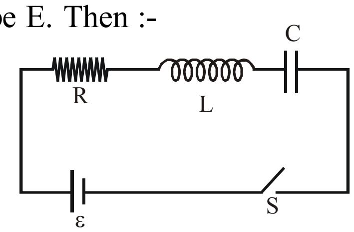
(A) 5 cos 100 t

(B) 10 cos 100 t

(C) 5 cos 1000 t

(D) 10 cos 1000 t

3. A resistor of resistance R, an inductor of inductance L and a capacitor of capacitance C are connected in series and the combination is connected to a battery of emf ε as shown. At t = 0, the switch S is closed. Let, after a very long time, the thermal energy developed in circuit be Q, energy stored in circuit be U and energy supplied by the battery be E. Then :-



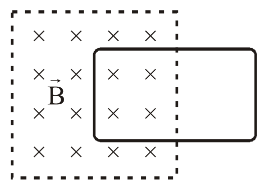
(A) Q : U : E = 1 : 1 : 2

(B) Q : U : E = 1 : 3 : 4

(C) Q : U : E = 3 : 1 : 4

(D) Q : U : E = 1 : 2 : 3

4. A conducting loop is halfway into a magnetic field. Suppose the magnetic field begins to increase rapidly in strength. What happens to the loop ?



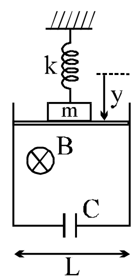
(A) The loop is pushed upward, toward the top of the page.

(B) The loop is pushed downward, toward the bottom of the page.

(C) The loop is pulled to the left, into the magnetic field.

(D) The loop is pushed to the right, out of the magnetic field.

5. A block is attached to the ceiling by a spring that has a force constant k = 200 N/m. A conducting rod is rigidly attached to the block. The combined mass of the block and the rod is m = 0.3 kg. The rod can slide without friction along two vertical parallel rails, which are a distance L = 1 m apart. A capacitor of known capacitance C = 500 μF is attached to the rails by the wires. The entire system is placed in a uniform magnetic field B = 20 T directed as shown. Find the angular frequency (in rad/sec) of the vertical oscillations of the block. Neglect the self-inductance and electrical resistance of the rod and all wires.

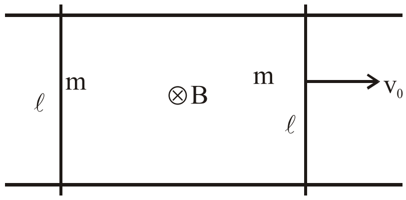


(A) $20\sqrt{5}$ (B) 20 (C) $\frac{20\sqrt{5}}{3}$ (D) none

6. The magnetic field in a region is given by $\vec{B} = \vec{k}\dfrac{B_0}{L}y^2$ where L is a fixed length. A conducting rod of length L lies along the Y-axis between the origin and the point (0, L, 0). If the rod moves with a velocity $V = V_0\hat{i}$, what is the emf induced between the ends of the rod?

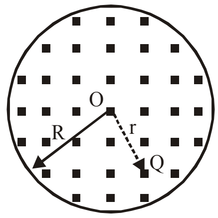
(A) $\dfrac{B_0 v_0 \ell^2}{3}$ (B) $\dfrac{B_0 v_0 \ell^2}{2}$ (C) $\dfrac{2B_0 v_0 \ell^2}{3}$ (D) $\dfrac{B_0 v_0 \ell^2}{6}$

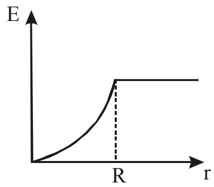
7. Two parallel conducting rails, separated by a distance ℓ, are placed horizontally in a region of uniform magnetic field $\vec{B}$, perpendicular to the plane of the rails as shown in the figure. Two conducting wires, each of length ℓ are placed so as to slide on parallel conducting rails without friction. One of the wires is given a velocity v_0 parallel to the rails. Loss in kinetic energy of the system till the steady state is achieved will be :

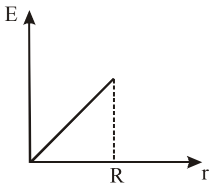


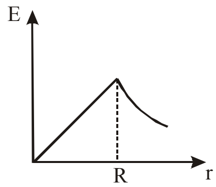
(A) 0 (B) $\dfrac{3}{4}mv_0^2$ (C) $\dfrac{3}{8}mv_0^2$ (D) $\dfrac{1}{4}mv_0^2$

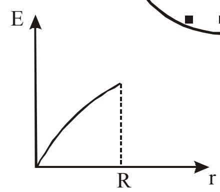
8. A uniform magnetic field exists in cylindrical region of radius R with axis passing through O. The field is made to vary at a constant rate. The variation of the induced electric field E with distance r from the axis is given by :



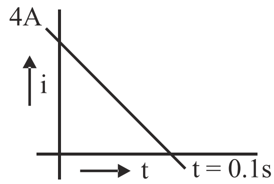
(A)


(B)


(C)


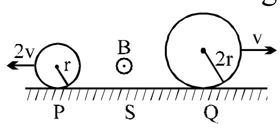
(D)


9. Some magnetic flux is changed from a coil of resistance 10Ω. As a result an induced current is developed in it which varies with time as shown in figure. The magnitude of change in flux through the coil in weber is :-



(A) 2 (B) 4
(C) 6 (D) None of these

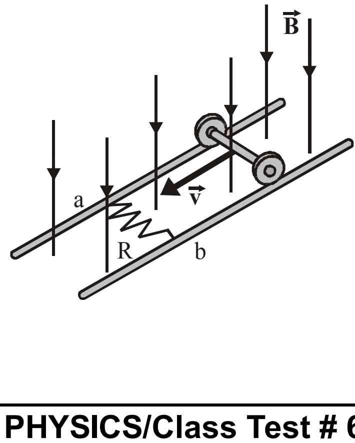
10. Two conducting rings P and Q of radii r and 2r rotate uniformly in opposite directions with centre of mass velocities 2v and v respectively on a conducting surface S. There is a uniform magnetic field of magnitude B perpendicular to the plane of the rings. The potential difference between the highest points of the two rings is



(A) 0 (B) 4 Bvr
(3) 8 Bvr (D) 16 Bvr

Multiple Correct Answer Type 4 Q. [4 M (–1)]

11. In figure the rolling axle, of length ℓ is pushed along horizontal rails at a constant speed v. A resistor R is connected to the rails at points a and b, directly opposite each other. The wheels make good electrical contact with the rails, so the axle, rails, and R form a closed-loop circuit. The only significant resistance in the circuit is R. A uniform magnetic field B is vertically downward. Mark the **CORRECT** statement(s)



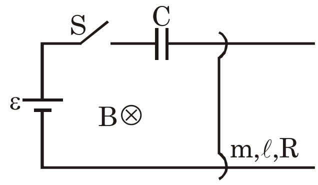
(A) The induced current I in the resistor is $\frac{B\ell v}{R}$.

(B) Horizontal force F is required to keep the axle rolling at constant speed is $\frac{B^2\ell^2v^2}{R}$.

(C) End of the resistor, a is at the higher electric potential than b.

(D) After the axle rolls past the resistor, the current in R reverse direction.

12. In the figure shown a conducting rod of mass m, length 'ℓ' and resistance 'R' can smoothly move along parallel rails in horizontal plane. Initially the rod is at rest. A uniform magnetic field $\vec{B}$ perpendicular to the plane of motion exists in the region. Now switch S is closed at t = 0, then :



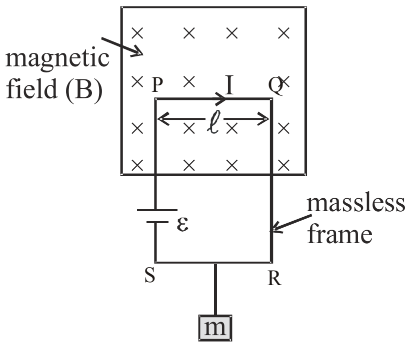
(A) The charge on the capacitor in steady state is $mc\varepsilon/(m + cB^2\ell^2)$

(B) The charge on the capacitor in steady state is $2mc\varepsilon/(m + cB^2\ell^2)$

(C) Velocity of conducting rod in steady state is $2B\ell c\varepsilon/(m + cB^2\ell^2)$

(D) Velocity of conducting rod in steady state is $B\ell c\varepsilon/(m + cB^2\ell^2)$

13. A massless frame is present in uniform magnetic field and a block of mass m hangs on the frame as shown in figure. When a constant current $I > \frac{mg}{\ell B}$ is mantained in the frame, it gets displaced by 'h' in some time interval. If ε is the emf of battery then which of the following is/are **CORRECT** ?



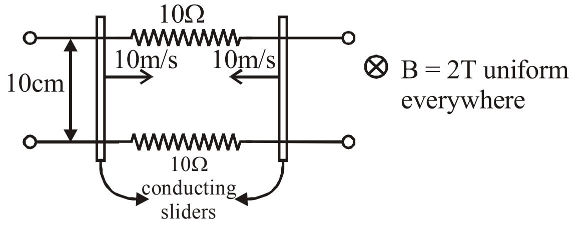
(A) Work done by magnetic force is $I\ell Bh$

(B) Work done by battery is $I\ell Bh$

(C) Velocity of block when it gets displacement by h is $\sqrt{\frac{2(I\ell B - mg)h}{m}}$

(D) Force on charges in the segment PQ while the frame moves up is in the vertical direction

14. The circuit below shows two parallel rails separated by distance of 10 cm. The rails has 10 Ω resistor each at its middle. The region of space contains magnetic field which is uniform throughout the space. There are two conducting wires on the parallel rails moving towards each other with speed of 10 m/s.



(A) Current in the circuit is 0.2 A.

(B) Power lost in the circuit is 0.8 W.

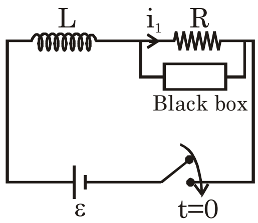
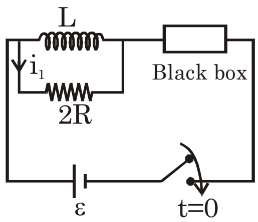
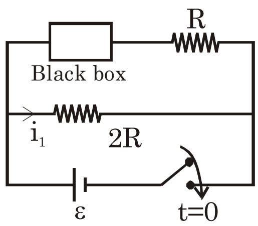
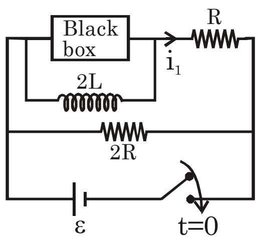
(C) The electric field inside the wires is non-conservative in nature.

(D) The electric field inside the wires is conservative in nature.

Matching list based comprehension Type (4 × 4 × 4) **1 Table × 3 Q. [3(–1)]**
Single option correct **(Three Columns and Four Rows)**

Answer Q.15, Q.16 and Q.17 by appropriately matching the information given in the three columns of the following table.

Column-1 gives various circuit diagram with a black box which can contain either inductor or resistor. Column-2 lists time constant for the various circuit while column-3 lists the value of current (i_1) at either t = 0 or t → ∞. Initially before switching on inductor does not carry any energy.

Column–1		Column-2		Column-3	
(I)		(i)	$\frac{L}{2R}$	(P)	$i_1 = 0$ at t = 0
(II)		(ii)	$\frac{2L}{3R}$	(Q)	$i_1 = \frac{\varepsilon}{R}$ at $t \to \infty$
(III)		(iii)	$\frac{3L}{R}$	(R)	$i_1 = \frac{\varepsilon}{2R}$ at t = 0
(IV)		(iv)	$\frac{3L}{2R}$	(S)	$i_1 = \frac{\varepsilon}{3R}$ at t = 0

15. If the black box consists of , then correct matching will be :
(A) (I) (iv) (Q) (B) (II) (i) (P) (C) (I) (iv) (R) (D) (IV) (iii) (P)

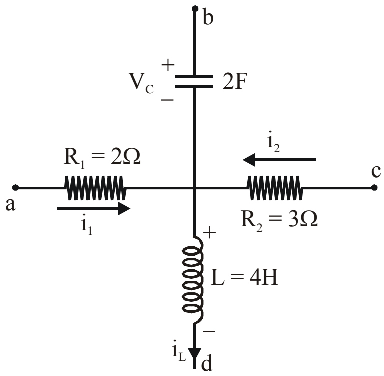
16. If the black box consists of , then correct matching will be :
(A) (I) (ii) (P) (B) (IV) (i) (Q) (C) (II) (iv) (S) (D) (II) (iii) (R)

17. If the black box consists of ______________ (connecting wire), then correct matching will be :
(A) (II) (iii) (Q) (B) (II) (i) (R) (C) (II) (i) (P) (D) (II) (ii) (Q)

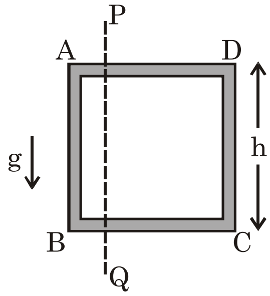
SECTION-III

Numerical Grid Type (Ranging from 0 to 9) 2 Q. [4 M (0)]

1. In the figure shown $i_1 = 10e^{-2t}$ A, $i_2 = 4$A and $V_C = 3e^{-2t}$ V. If $V_L = ae^{-bt}$ then find $\left|\frac{a}{b}\right|$:-



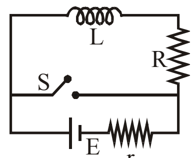
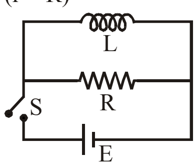
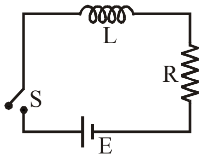
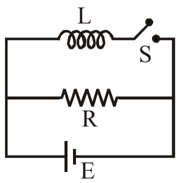
2. ABCD is a square frame of conductor of electrical resistivity ρ. The frame lies in a vertical plane. PQ is an imaginary boundary separating space into two parts. Left of PQ, a uniform gravitational field $\vec{g}$ exists (figure) whereas no gravitational field is present right of PQ. The electrical potential difference between A and B will be $\frac{k}{4}\frac{mgh}{e}$. e is charge on an electron and m is mass of electron. Find k.



SECTION-IV

Matrix Match Type (4 × 5) 1 Q. [8 M (for each entry +2(0)]

1. In column–I some circuit are given. In all the circuits except in (A) switch S remains closed for long time and then it is opened at t = 0 while for (A), the situation is reversed. Column–II tells something about the circuit quantities. Match the entries of column–I with the entries of column–II.

Column-I	Column-II
(A)  (r < R)	(P) Voltage across inductor can be greater than E at t =0.
(B) 	(Q) Voltage across inductor would be less than E at t =0.
(C) 	(R) After long time, energy stored in inductor is zero.
(D) 	(S) After long time, energy sotred in inductor is non-zero
	(T) Voltage across inductor increases as time progress.

CLASS TEST # 61 **ANSWER KEY**

SECTION-I

Single Correct Answer Type **10 Q. [3 M (–1)]**

1. Ans. (C) 2. Ans. (C) 3. Ans. (A) 4. Ans. (D) 5. Ans. (B) 6. Ans. (A)
7. Ans. (D) 8. Ans. (C) 9. Ans. (A) 10. Ans. (C)

Multiple Correct Answer Type **4 Q. [4 M (–1)]**

11. Ans. (A D) 12. Ans. (A,D) 13. Ans. (B,C,D) 14. Ans. (A,B.D)

Matching list based comprehension Type (4 × 4 × 4) **1 Table × 3 Q. [3(–1)]**

Single option correct **(Three Columns and Four Rows)**

15. Ans. (A) 16. Ans. (C) 17. Ans. (B)

SECTION-III

Numerical Grid Type (Ranging from 0 to 9) **2 Q. [4 M (0)]**

1. Ans. 8 2. Ans. 3

SECTION-IV

Matrix Match Type (4 × 5) **1 Q. [8 M (for each entry +2(0)]**

1. Ans. (A) QR (B) S, (C) S (D) S