Exercise-1

ONLY ONE OPTION CORRECT TYPE

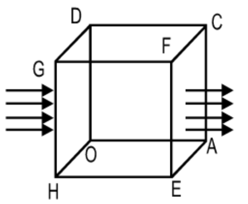
SECTION (A) : FLUX AND FARADAY'S LAWS OF ELECTROMAGNETIC INDUCTION

1. The horizontal component of earth's magnetic field is 3×10^{-5} Wb/m^2. The magnetic flux linked with a coil of area 1 m^2 and having 5 turns, whose plane is normal to the magnetic field, will be -
(1) 3×10^{-5} Wb (2) 5×10^{-5} Wb (3) 15×10^{-5} Wb (4) 1×10^{-5} Wb

2. Tesla is a unit of -
(1) magnetic flux (2) magnetic flux density
(3) electric flux (4) self inductance

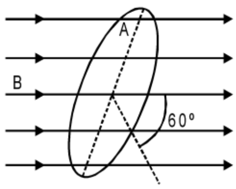
3. The formula of the induced emf due to rate of change of magnetic flux passing through a coil will be-
(1) $e = -\frac{d}{dt}(\vec{B}.\vec{A})$ (2) $e = \frac{d\vec{B}}{dt}$ (3) $e = -\vec{A}.\left(\frac{d\vec{B}}{dt}\right)$ (4) $e = -\vec{B}.\frac{d\vec{A}}{dt}$

4. A cube of side a is placed in a magnetic field of intensity B. The magnetic flux emerging out(outgoing flux only) of the cube will be -



(1) Ba^2 (2) $-Ba^2$ (3) $2Ba^2$ (4) zero

5. The figure represents an area A = 0.5m^2 situated in a uniform magnetic field B = 2.0 weber/m^2 and making an angle of 60º with respect to the magnetic field. The value of the magnetic flux through the area would be equal to-

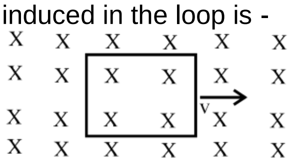


(1) 2.0 weber (2) $\sqrt{3}$ weber (3) $\frac{3}{2}$ weber (4) 0.5 weber

6. If $\phi = 0.02 \cos 100\pi t$ weber/turns and number of turns is 50 in the coil, the maximum induced emf is-
(1) 314 volt (2) 100 volt (3) 31.4 volt (4) 6.28 volt

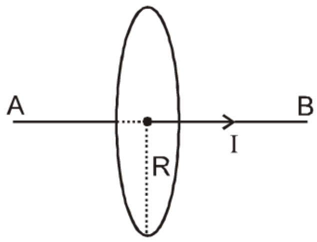
7. The magnetic flux linked with the coil varies with time as $\phi = 3t^2 + 4t + 9$. The magnitude of induced emf at t = 2 second is -
(1) 4 V (2) 3 V (3) 16 V (4) 9 V

8. A conducting square loop of side l and resistance R moves in its plane with a uniform velocity v perpendicular to one of its sides. A uniform and constant magnetic field B exists perpendicular to the plane of the loop in fig. The current induced in the loop is -



(1) $Bl\upsilon/R$ clockwise (2) $Bl\upsilon/R$ anticlockwise
(3) $2Bl\upsilon/R$ anticlockwise (4) zero

9. A long conductor AB lies along the axis of a circular loop of radius R. If the current in the conductor AB varies at the rate of I ampere/second, then the induced emf in the loop is



(1) $\frac{\mu_0 IR}{2}$ (2) $\frac{\mu_0 IR}{4}$ (3) $\frac{\mu_0 \pi IR}{2}$ (4) zero

10. The magnetic flux through a circuit of resistance R changes by an amount $\Delta\phi$ in a time Δt. Then the total quantity of electric charge Q that passes any point in the circuit during the time Δt is represented by : **[AIPMT 2004]**

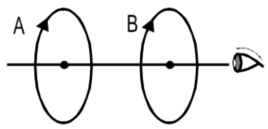
(1) $Q = \frac{\Delta\phi}{R}$ (2) $Q = \frac{\Delta\phi}{\Delta t}$ (3) $Q = R.\frac{\Delta\phi}{\Delta t}$ (4) $Q = \frac{1}{R}.\frac{\Delta\phi}{\Delta t}$

SECTION (B) : LENZ'S LAW

1. Lenz's law is based on the law of conservation of -
(1) charge (2) momentum (3) mass (4) energy

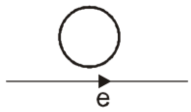
2. A bar magnet is dropped vertically downward through a metal ring held horizontally. The acceleration of falling magnet will be -
(1) equal to g (2) greater than g
(3) less than g (4) dependent on the radius of the ring

3. Two identical coils A and B are arranged coaxially as shown in the figure and the sign convention adopted is that the direction of currents are taken as positive when they flow in the direction of arrows. Which of the following statements is correct-



(1) If A carries a steady positive current and A is moved towards B, than a positive current is induced in B.
(2) If A carries a steady positive current and B is moved towards A, then a negative current is induced in B
(3) If both coils carry positive current, then the coils repel each other.
(4) If a positive current flowing in A is switched off, then a negative current is induced momentarily in B

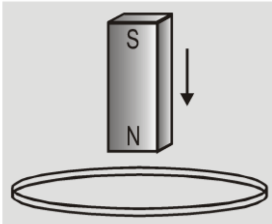
4. An electron is passing near a ring and approaches to ring, then direction of induced current in ring is : **[RPMT 2001]**



(1) clockwise (2) anticlockwise (3) both (1) and (2) (4) no current

5. A magnet is taken towards a coil-
[a] Rapidly [b] Slowly
Then the induced emf is-
(1) More in (a) (2) Less in (a)
(3) Same in both (a) and (b) (4) More or less depends on radius

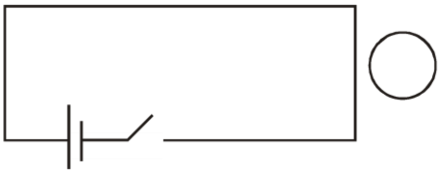
6. The north pole of a magnet is brought near a metallic ring as shown in fig. The direction of induced current in the ring will be-



(1) Anticlock wise from magnet side
(2) Clock wise from magnet side
(3) First anticlock wise and then clock wise from magnet side
(4) First clock wise and then anticlock wise from magnet side

7 When a magnet is moved with its north pole towards a coil placed in a closed circuit, then the nearest face of the coil-
(1) shows south polarity
(2) shows north polarity
(3) shows no polarity
(4) shows some times north and sometimes south polarity

8. Consider the situation shown in fig. If the switch is closed and after some time it is opened again, the closed loop will show

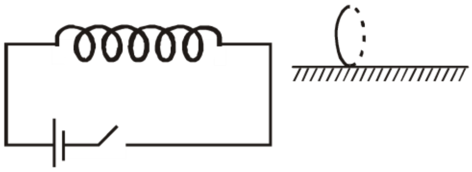


(1) an anticlockwise current-pulse
(2) a clockwise current-pulse
(3) an anticlockwise current-pulse and then a clockwise current-pulse
(4) a clockwise current-pulse and then an anticlockwise current-pulse

9. Solve the previous question if the closed loop is completely enclosed in the circuit containing the switch.
(1) an anticlockwise current-pulse
(2) a clockwise current-pulse
(3) an anticlockwise current-pulse and then a clockwise current-pulse
(4) a clockwise current-pulse and then an anticlockwise current-pulse

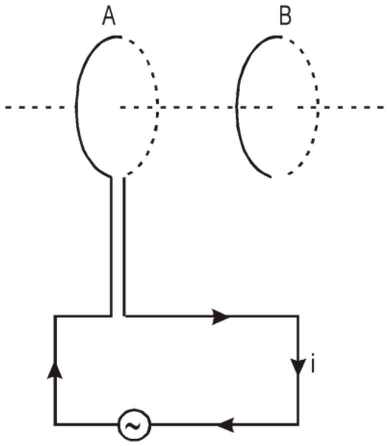
10. A small, conducting circular loop is placed inside a long solenoid carrying a current. The plane of the loop contains the axis of the solenoid. If the current in the solenoid is varied, the current induced in the loop is
(1) clockwise (2) anticlockwise (3) zero
(4) clockwise or anticlockwise depending on whether the resistance in increased or decreased.

11. Fig. shows a horizontal solenoid connected to a battery and a switch. A copper ring is placed on a frictionless track, the axis of the ring being along the axis of the solenoid. As the switch is closed, the ring will



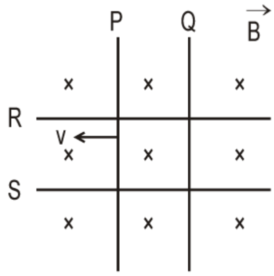
(1) remain stationary
(2) move towards the solenoid
(3) move away from the solenoid
(4) move towards the solenoid or away from it depending on which terminal (positive or negative) of the battery is connected to the left end of the solenoid.

12. Two circular coils A and B are facing each other as shown in figure. The current i through A can be altered



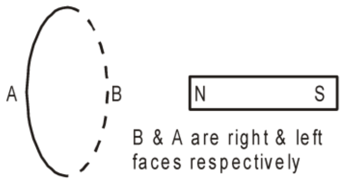
(1) there will be repulsion between A and B if i is increased
(2) there will be attraction between A and B if i is increased
(3) there will be neither attraction nor repulsion when i is changed
(4) attraction or repulsion between A and B depends on the direction of current. It does not depend whether the current is increased or decreased.

13. Two identical conductors P and Q are placed on two frictionless fixed conducting rails R and S in a uniform magnetic field directed into the plane. If P is moved in the direction shown in figure with a constant speed, then rod Q



(1) will be attracted towards P
(2) will be repelled away from P
(3) will remain stationary
(4) may be repelled or attracted towards P

14. In the figure shown, the magnet is pushed towards the fixed ring along the axis of the ring and it passes through the ring.



(1) when magnet goes towards the ring the face B becomes south pole and the face A becomes north pole
(2) when magnet goes away from the ring the face B becomes north pole and the face A becomes south pole
(3) when magnet goes away from the ring the face A becomes north pole and the face B becomes south pole
(4) the face A will always be a north pole.

SECTION (C) : INDUCED EMF IN A MOVING ROD IN UNIFORM MAGNETIC FIELD

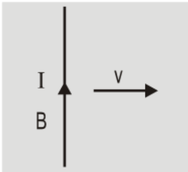
1. A wire of length 2m is moving with a velocity of 1 m/s normal to a magnetic field of 0.5 Wb/m^2. The emf induced in it will be - $(\ell \perp \vec{v})$
(1) 0.5 V (2) 0.1 V (3) 2 V (4) 1 V

2. An aeroplane having a distance of 50 m between the edges of its wings is flying horizontally with a speed of 720 km/hour. If the vertical component of the earth's magnetic field is 2 × 10^{-4} Wb/m^2, then the induced emf will be -
(1) 2mV (2) 2V (3) 200V (4) 0.2mV

3. A straight conductor of length 0.4 m is moved in a magnetic field of 0.9 weber/m^2 with a velocity of 7 m/s. The maximum emf induced in the conductor will be -
(1) 2.52 V (2) 25 V (3) 2.8 V (4) 63 V

4. An athelete runs at a velocity of 30 km/hr. towards east with a 3 meter rod. The horizontal component of the earth is 4×10^{-5} weber/m^2. If he runs, keeping the rod (i) horizontal and (ii) vertical, the p.d. at the ends of the rod in both the cases, will be-
(1) Zero in vertical case and 1×10^{-3} V in the horizontal case.
(2) 1×10^{-3} V in vertical case and zero in the horizontal case.
(3) Zero in both the cases.
(4) 1×10^{-3} V in both the cases.

5. A conducting wire is moving in a magnetic field B towards the right. The direction of induced current is as shown in the figure. The direction of magnitic field will be-

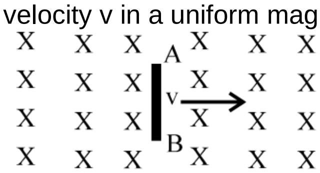


(1) In the plane of paper pointing towards right.
(2) In the plane of paper pointing towards left.
(3) Perpendicular and downwards to the plane of paper.
(4) Perpendicular to the plane of paper and upwards.

6. A conducting rod is moved with a constant velocity $\vec{\upsilon}$ in a magnetic field. A potential difference appears across the two ends
(1) if $\vec{\upsilon} \parallel \vec{\ell}$ (2) if $\vec{\upsilon} \parallel \vec{B}$ (3) if $\vec{\ell} \parallel \vec{B}$ (4) none of these

7. A uniform magnetic field exists in region given by $\vec{B} = 3\hat{i} + 4\hat{j} + 5\hat{k}$. A rod of length 5 m is placed along y − axis is moved along x − axis with constant speed 1 m/sec. Then induced e.m.f. in the rod will be:
(1) zero (2) 25 v (3) 20 v (4) 15 v

8. A rod AB moves with a uniform velocity v in a uniform magnetic field as shown in fig.

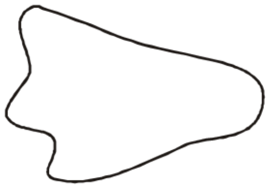


(1) The rod becomes electrically charged (2) The end A becomes positively charged
(3) The end B become positively charged (4) The rod becomes hot because of Joule heating

9. The distance between the ends of wings of an aeroplane is 5m. The aeroplane is moving with velocity of 200 km/sec in a magnetic field of 10T. The emf induced across the ends of wings will be : **[RPMT 2004]**
(1) 10^7 volt (2) 10 volt (3) 10^6 volt (4) none of these

10. A straight conductor of length 4m moves at a speed of 10m/s. When the conductor makes an angle of 30° with the direction of magnetic field of induction of 0.1 wb. per m^2 then induced emf is :**[RPMT 2005]**
(1) 8V (2) 4V (3) 1V (4) 2V

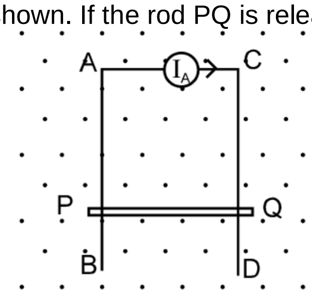
11. As a result of change in the magnetic flux linked to the closed loop shown in the figure, an emf V volt is induced in the loop. The work done (joules) in taking a charge Q coulomb once along the loop is : **[AIPMT 2005]**



(1) QV (2) Zero (3) 2QV (4) 5QV

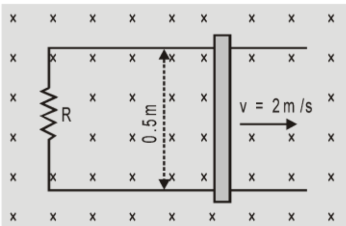
SECTION (D) : CIRCUIT PROBLEMS & MECHANICS

1. AB and CD are fixed conducting smooth rails placed in a vertical plane and joined by a constant current source at its upper end. PQ is a conducting rod which is free to slide on the rails. A horizontal uniform magnetic field exists in space as shown. If the rod PQ is released from rest then,



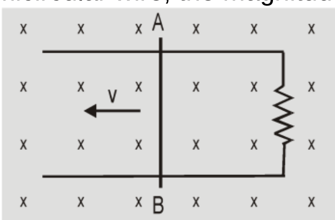
(1) The rod PQ may move downward with constant acceleration
(2) The rod PQ may move upward with constant acceleration
(3) The rod will move downward with decreasing acceleration and finally aquire a constant velocity
(4) either A or B.

2. A metallic rod completes its circuit as shown in the figure. The circuit is normal to a magnetic field of B = 0.15 tesla. If the resistance is 3Ω the force required to move the rod with a constant velocity of 2 m/sec is-



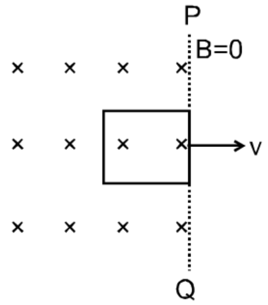
(1) 3.75×10^{-3} N (2) 3.75×10^{-2} N (3) 3.75×10^{2} N (4) 3.75×10^{-4} N

3. Consider the situation shown in the figure. The wire AB is slide on the fixed ralis with a constant velocity. If the wire AB is replaced by a semicircular wire, the magnitude of the induced current will



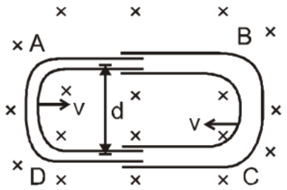
(1) Increase
(2) Remain the same
(3) Decrease
(4) Increase or decrease depending on whether the semicircle bulges towards the resistance or away from it.

4. Figure shows a square loop of side 0.5 m and resistance 10 Ω. The magnetic field on left side of line PQ has a magnitude B = 1.0T. The work done in pulling the loop out of the field uniformly in 2.0 s is



(1) 3.125×10^{-3} J (2) 6.25×10^{-4} J (3) 1.25×10^{-2} J (4) 5.0×10^{-4} J

5. 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, 4/300]**



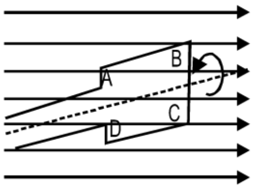
(1) $B\ell v$ (2) $-B\ell v$ (3) zero (4) $2B\ell v$

SECTION (E) : INDUCED EMF IN A ROD, RING, DISC ROTATING IN A UNIFORM MAGNETIC FIELD

1. A metal rod of length L is placed normal to a magnetic field and rotated in a circular path with frequency f. The potential difference between it ends will be -

(1) $\pi L^2 Bf$ (2) BL/f (3) $\pi L^2 B/f$ (4) fBL

2. A rectangular coil ABCD is rotated anti clockwise with a uniform angular velocity about the axis shown in figure. The axis of rotation of the coil as well as the magnetic field B are horizontal. The induced emf in the coil would be maximum when -



(1) the plane of the coil is horizontal
(2) the plane of the coil makes an angles of 45º with the direction of the magnetic field
(3) the plane of the coil is at right angles to the magnetic field
(4) the plane of the coil makes an angle of 30º with the horizontal

3. A coil is placed in a uniform magnetic field such that its plane is parallel to the magnetic field. In time interval Δt its plane becomes perpendicular to the magnetic field, then induced charge q in coil depends on the time interval Δt as-

(1) $q \propto \Delta t$ (2) $q \propto \frac{1}{\Delta t}$ (3) $q \propto (\Delta t)^0$ (4) $q \propto (\Delta t)^2$

4. A metallic conductor of 1 m length is rotated vertically its one end at an angular velocity of 5 rad/sec. If the horizontal component of earth's field is 0.2×10^{-4} T, the voltage generated between ends of the conductor will be-

(1) 5 mV (2) 5×10^{-4} V (3) 50 mV (4) 50 μ V

5. A rectangular coil has 60 turns and its length and width is 20 cm and 10 cm respectively. The coil rotates at a speed of 1800 rotation per minute in a uniform magnetic field of 0.5 tesla. Then the maximum induced emf will be-

(1) 98 V (2) 110 V (3) 113 V (4) 118 V

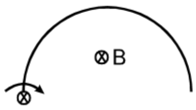
6. The resistance of a coil is 5 ohm and a current of 0.2 A is induced in it due to a varying magnetic field. The rate of change of magnetic flux in it will be -

(1) 0.5 Wb/s (2) 0.05 Wb/s (3) 1 Wb/s (4) 20 Wb/s

7. A rod of length l rotates with a uniform angular velocity ω about its perpendicular bisector. A uniform magnetic field B exists parallel to the axis of rotation. The potential difference between the two ends of the rod is

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

8. A semicircular wire of radius R is rotated with constant angular velocity ω about an axis passing through one end and perpendicular to the plane of the wire. There is a uniform magnetic field of strength B. The induced e.m.f. between the ends is:



(1) $B\omega R^2/2$ (2) $2B\omega R^2$ (3) is variable (4) none of these

9. A coil having n turns and resistance R Ω is connected with a galvanometer of resistance 4RΩ. This combination is moved in time t seconds from a magnetic field W_1 Weber/m^2 to W_2 Weber/m^2. The induced current in the circuit is : **[AIEEE 2004, 4/300]**

(1) $\frac{(W_2 - W_1)A}{5Rnt}$ (2) $-\frac{n(W_2 - W_1)A}{5Rt}$ (3) $-\frac{(W_2 - W_1)A}{Rnt}$ (4) $-\frac{n(W_2 - W_1)A}{Rt}$

10. A metal conductor of length 1 m rotates vertically about one of its ends at angular velocity 5 radians per second. If the horizontal component of earth's magnetic field is 0.2×10^{-4} T, then the emf developed between the two ends of the conductor is : **[AIEEE 2004, 4/300]**

(1) 5 μV (2) 50 μV (3) 5 mV (4) 50 mV

SECTION (F) : FIXED LOOP IN A TIME VARYING MAGNETIC FIELD & INDUCED ELECTRIC FIELD

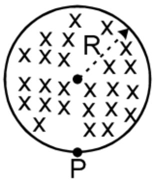
1. A coil of 100 turns having an average area of 100 cm^2 for each turn is held in a uniform field of 50 gauss, the direction of the field being at right angles to the plane of the coil. If the field is removed in 0.01 sec, then average e.m.f induced in coil is -

(1) 0.5 V (2) 10 V (3) 20 V (4) 50 V

2. A coil is placed in transverse magnetic field of 0.02 T. This coil starts shrinking at a rate of 1 mm/sec. When its radius 4 cm, then what is the value of induced emf-

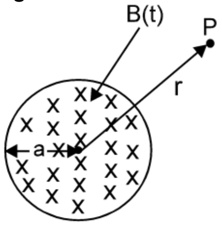
(1) 2 μV (2) 2.5 μV (3) 5 μV (4) 8 μV

3. A uniform magnetic field of induction B is confined to a cylindrical region of radius R. The magnetic field is increasing at a constant rate of $\frac{dB}{dt}$ (tesla/second). An electron of charge q, placed at the point P on the periphery of the field experiences an acceleration :



(1) $\frac{1}{2}\frac{eR}{m}\frac{dB}{dt}$ toward left
(2) $\frac{1}{2}\frac{eR}{m}\frac{dB}{dt}$ toward right
(3) $\frac{eR}{m}\frac{dB}{dt}$ toward left
(4) zero

4. A uniform but time-varying magnetic field B (t) exists in a circular region of radius a and is directed into the plane of the paper, as shown fig. The magnitude of the induced electric field at point P at a distance r from the centre of the circular region.



(1) is zero
(2) decreases as 1/r
(3) increases as r
(4) decreases as $1/r^2$

5. A conducting circular loop is placed in a uniform magnetic field 0.04 T with its plane perpendicular to the magnetic field. The radius of the loop starts shrinking at $2 mms^{-1}$. The induced emf in the loop when the radius is 2 cm is **[AIPMT 2009]**
(1) 3.2 $\pi\mu$V
(2) 4.8 $\pi\mu$V
(3) 0.8 $\pi\mu$V
(4) 1.6 $\pi\mu$V

6. In a uniform magnetic field of induction B, a wire in the form of semicircle of radius r rotates about the diameter of the circle with angular frequency ω. If the total resistance of the circuit is R, the mean power generated per period of rotation is : **[AIEEE 2004, 4/300]**
(1) $\frac{B\pi^2\omega}{2R}$
(2) $\frac{(B\pi r^2\omega)^2}{8R}$
(3) $\frac{(B\pi r\omega)^2}{2R}$
(4) $\frac{(B\pi r\omega^2)^2}{8R}$

SECTION (G) : SELF INDUCTION, SELF INDUCTANCE SELF INDUCED EMF & MAGNETIC ENERGY DENSITY

1. If the length and area of cross-section of an inductor remain same but the number of turns is doubled, its self-inductance will become -
(1) half
(2) four times
(3) double
(4) one-fourth

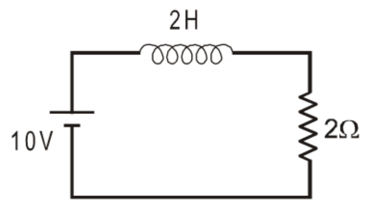
2. Dimensions of coefficient of self-induction are -
(1) $MLT^{-2}A^{-2}$
(2) $ML^{-2}T^{-2}A^{-2}$
(3) $ML^2T^{-2}A^{-2}$
(4) $M^2LT^{-2}A^{-2}$

3. Self-inductance of a solenoid depend on -
(1) the number of turns N of the coil
(2) the area of cross-section A and length ℓ of the coil.
(3) the permeability of the core of the coil
(4) all the above

4. When current flowing in a coil changes from 3A to 2A in one millisecond, 5 volt emf is induced in it. The self-inductance of the coil will be -
(1) zero
(2) 5kH
(3) 5H
(4) 5 mH

5. The equivalent inductance of two inductance is 2.4 henry when connected in parallel and 10 henry, which connected in series. The difference between the two inductance is -
(1) 2 henry
(2) 3 henry
(3) 4 henry
(4) 5 henry

6. In the figure magnetic energy stored in the coil is (in steady state)



(1) 0 (2) ∞ (3) 25 joules (4) none of these

7. The value of self inductance of a coil is 5 henry. The value of current changes from 1 ampere to 2 amperes in 5 seconds. The value of induced emf in it is-
(1) 10 Volt (2) 0.10 Volt (3) 1.0 Volt (4) 100 Volt

8. The self inductance of a solenoid of length L, area of cross section A and having N turns is-
(1) $\frac{\mu_0 N^2 A}{L}$ (2) $\frac{\mu_0 N A}{L}$ (3) $\mu_0 N^2 L A$ (4) $\mu_0 N A L$

9. A long solenoid has 200 turns per cm. and carries a current of 2.5 amps. The magnetic field at its centre is- [$\mu_0 = 4\pi \times 10^{-7}$ Weber/m²]
(1) 3.14×10^{-2} Weber/m² (2) 6.28×10^{-2} Weber/m²
(3) 9.42×10^{-2} Weber/m² (4) 12.56×10^{-2} Weber/m²

10. Energy is stored in the choke coil in the form of-
(1) Heat (2) Electric energy
(3) Magnetic energy (4) Electro-magnetic energy

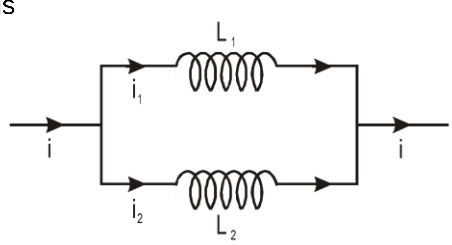
11. For a inductor coil L = 0.04 H then workdone by source to establish a current of 5A in it is-
(1) 0.5 J (2) 1.00 J (3) 100 J (4) 20 J

12. Current passing through a coil is changing at the rate of 1.5 ampere per second. If it induces emf of 45 volt, then the self inductance of the coil will be -
(1) 30 H (2) 67.5 H (3) 60 H (4) 33.3 H

13. An inductor coil stores energy U when a current i is passed through it and dissipates heat energy at the rate of P. The time constant of the circuit when this coil is connected across a battery of zero internal resistance is :
(1) $\frac{4U}{P}$ (2) $\frac{U}{P}$ (3) $\frac{2U}{P}$ (4) $\frac{2P}{U}$

14. L, C and R represent the physical quantities inductance, capacitance and resistance.Which of the following combinations have dimensions of time ?
(1) $\frac{1}{RC}$ (2) $\frac{R}{L}$ (3) $\frac{1}{\sqrt{LC}}$ (4) $\sqrt{LC}$

15. Two inductors L_1 and L_2 are connected in parallel and a time varying current i flows as shown. The ratio of currents i_1/i_2 at any time t is

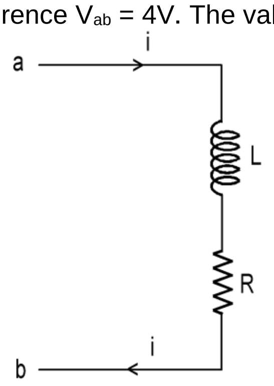


(1) L_1/L_2 (2) L_2/L_1 (3) $\frac{L_1^2}{(L_1+L_2)^2}$ (4) $\frac{L_2^2}{(L_1+L_2)^2}$

16. An LR circuit with a battery is connected at t =0. Which of the following quantities is not zero just after the connection ?

(1) current in the circuit
(2) magnetic field energy in the inductor
(3) power delivered by the battery
(4) emf induced in the inductor

17. When the current in the portion of the circuit shown in the figure is 2A and increasing at the rate of 1A/s, the measured potential difference V_{ab} = 8V. However when the current is 2A and decreasing at the rate of 1A/s, the measured potential difference V_{ab} = 4V. The values of R and L are :

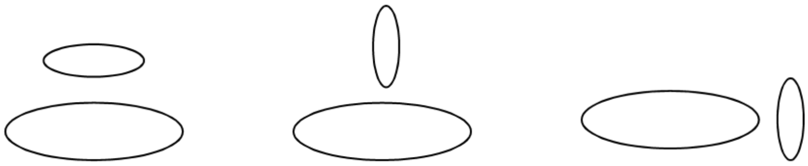


(1) 3 ohm and 2 henry respectively
(2) 2 ohm and 3 henry respectively
(3) 10 ohm and 6 henry respectively
(4) 6 ohm and 1 henry respectively

18. When the current changes from +2A to –2A in 0.05s, an emf of 8V is induced in a coil. The coefficient of self induction of the coil is : **[RPMT 2008]**
(1) 0.2 H (2) 0.4H (3) 0.8H (4) 0.1H

19. A coil of resistance R and inductance L is connected to a battery of emf E volt. The final current in the coil is **[RPMT 2009]**
(1) E/R (2) E/L (3) $\sqrt{E/(R^2+L^2)}$ (4) $\sqrt{\dfrac{EL}{(R^2+L^2)}}$

20. Two circular coils can be arranged in any of the three situations shown in the figure. Their mutual inductance will be:



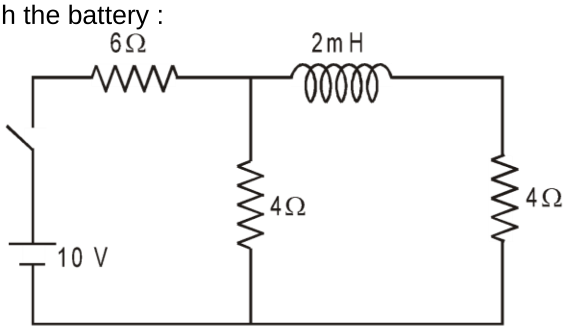
(1) (2) (3)

(1) maximum in situation (1)
(2) maximum in situation (2)
(3) maximum in situation (3)
(4) the same in all situations

21. Which of the following is proportional to energy density in magnetic field B : **[RPMT 2002]**
(1) $\dfrac{1}{B}$ (2) $\dfrac{1}{B^2}$ (3) B (4) B^2

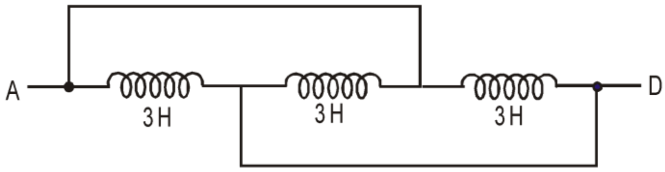
22. Which of the following is proportional to energy density in magnetic field B : **[RPMT 2002]**
(1) $\dfrac{1}{B}$ (2) $\dfrac{1}{B^2}$ (3) B (4) B^2

23. In the given circuit find the ratio of i_1 to i_2. Where i_1 is the initial (at t = 0) current, and i_2 is steady state (at t = ∞) current through the battery :



(1) 1.0 (2) 0.8 (3) 1.2 (4) 1.5

24. The inductance between A and D is : **[AIEEE 2002, 4/300]**

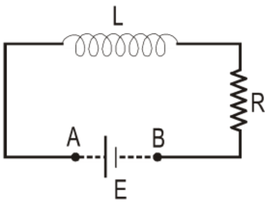


(1) 3.66 H (2) 9 H (3) 0.66 H (4) 1 H

25. In an oscillating LC circuit the maximum charge on the capacitor is Q. The charge on the capacitor when the energy is stored equally between the electric and magnetic field is : **[AIEEE 2003, 4/300]**

(1) Q/2 (2) $Q/\sqrt{3}$ (3) $Q/\sqrt{2}$ (4) Q

26. 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, 4½/180]**



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

SECTION (H) : MUTUAL INDUCTION & MUTUAL INDUCTANCE

1. The unit of mutual inductance is -
(1) volt (2) weber (3) tesla (4) henry

2. The self-inductances of two identical coils are 0.1 H. They are wound over each other. Mutual inductance will be -
(1) 0.1 H (2) 0.2 H (3) 0.01 H (4) 0.05 H

3. Two conducting loops of radi R_1 and R_2 are concentric and are placed in the same plane. If $R_1 >> R_2$, the mutual inductance M between them will be directly proportional to-
(1) $\frac{R_1}{R_2}$ (2) $\frac{R_2}{R_1}$ (3) $\frac{R_1^2}{R_2}$ (4) $\frac{R_2^2}{R_1}$

4. The mutual inductance between a primary and secondary circuits is 0.5H. The resistance of the primary and the seconday circuits are 20 Ω and 5 Ω respectively. To generate a current of 0.4 A in the secondary, current in the primary must be changed at the rate of-
(1) 4.0 amp./sec. (2) 16.0 amp./sec. (3) 1.6 amp./sec. (4) 8.0 amp./sec.

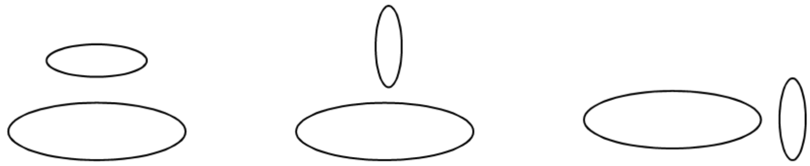
5. Two coils A and B having turns 300 and 600 respectively are placed near each other, on a passing a current of 3.0 A in A, the flux linked with A is 1.2×10^{-4} weber and with B it is 9.0×10^{-5} weber. The mutual inductance of the system is-
(1) 2×10^{-5} henry (2) 3×10^{-5} henry (3) 4×10^{-5} henry (4) 6×10^{-5} henry

6. A steel wire of length *l* has magnetic moment M. It is bent into a semi-circle. Now its magnetic moment is **[MP PET-2002]**
(1) $\frac{2M}{\pi}$ (2) $\frac{3M}{2\pi}$ (3) $\frac{M}{\pi}$ (4) $\frac{M}{2\pi}$

7. Two coils are placed close to each other. The mutual inductance of the pair of coils depends upon : **[RPMT 2008]**
(1) the rates at which currents are changing in the two coils
(2) relative position and orientation of the two coils
(3) the materials of the wires of the coils
(4) the currents in the two coils

8. Two inductance coils of inductance L_1 and L_2 are kept at sufficiently large distance apart. On connecting them in parallel their equivalent inductance will be **[RPMT-2014]**
(1) $\frac{L_1+L_2}{L_1L_2}$ (2) $\frac{L_1L_2}{L_1+L_2}$ (3) L_1+L_2 (4) $\sqrt{L_1L_2}$

9. Two circular coils can be arranged in any of the three situations shown in the figure. Their mutual inductance will be:



(1) maximum in situation (1) (2) maximum in situation (2)
(3) maximum in situation (3) (4) the same in all situations

10. Two coils of self inductances 2 mH and 8mH are located so close together that the effective flux in one coil is completely linked with the other. The mutual inductance between these coils is :- **[AIPMT 2006]**
(1) 10 mH (2) 6 mH (3) 4 mH (4) 16 mH

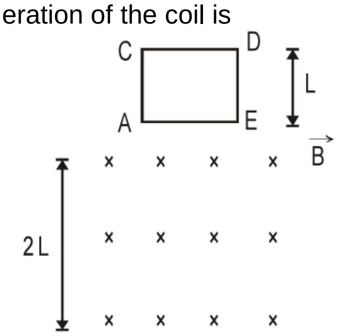
11. A long solenoid has 500 turns. When a current of 2 A is passed through it, the resulting magnetic flux linked with each turn of the solenoid is 4×10^{-3} Wb. The self-inductance of the solenoid is **[AIPMT 2008]**
(1) 2.5 H (2) 2.0 H (3) 1.0 H (4) 4.0 H

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

Exercise-2

1. A circular loop of radius R, carrying current I, lies in x-y plane with its centre at origin. The total magnetic flux through x-y plane is
(1) directly proportional to I (2) directly proportional to R
(3) directly proportional to R^2 (4) zero

2. A square coil ACDE with its plane vertical is released from rest in a horizontal uniform magnetic field $\vec{B}$ of length 2L. The acceleration of the coil is



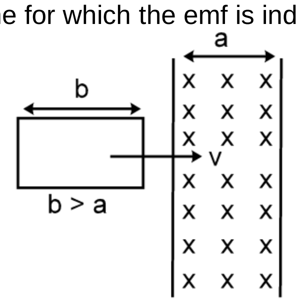
(1) less than g for all the time till the loop crosses the magnetic field completely
(2) less than g when it enters the field and greater than g when it comes out of the field
(3) g all the time

(4) less than g when it enters and comes out of the field but equal to g when it is within the field

3. A conducting ring lies fixed on a horizontal plane. If a charged nonmagnetic particle is released from a point (on the axis) at some height from the plane, then :
(1) an induced current will flow in clockwise or anticlockwise direction in the loop depending upon the nature of the charge
(2) the acceleration of the particle will decrease as it comes down
(3) the rate of production of heat in the ring will increase as the particle comes down
(4) no heat will be produced in the ring.

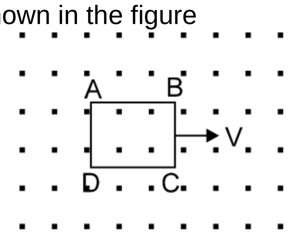
4. A bar magnet is released from rest coaxially along the axis of a very long, vertical copper tube. After some time the magnet
(1) will stop in the tube (2) will move with almost constant speed
(3) will move with an acceleration g (4) will oscillate

5. In the given arrangement, the loop is moved with constant velocity v in a uniform magnetic field B in a restricted region of width a. The time for which the emf is induced in the circuit is:



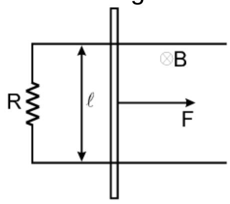
(1) $\frac{2b}{v}$ (2) $\frac{2a}{v}$ (3) $\frac{(a+b)}{v}$ (4) $\frac{2(a-b)}{v}$

6. A metallic square loop ABCD is moving in its own plane with velocity v in a uniform magnetic field perpendicular to its plane as shown in the figure



An electric field is induced **[JEE 2001 (Screening) 1/35]**
(1) in AD, but not in BC (2) in BC, but not in AD
(3) neither in AD nor in BC (4) in both AD and BC

7. A constant force F is being applied on a rod of length 'ℓ' kept at rest on two parallel conducting rails connected at ends by resistance R in uniform magnetic field B as shown.

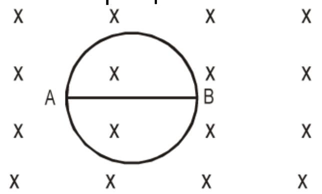


(1) the power delivered by force will be constant with time
(2) the power delivered by force will be increasing first and then will decrease
(3) the rate of power delivered by the external force will be increasing continuously
(4) the rate of power delivered by external force will be decreasing continuously.

8. A metal rod of resistance 20 Ω is fixed along a diameter of conducting ring of radius 0.1 m and lies in x-y plane. There is a magnetic field $\vec{B} = (50T)\hat{k}$. The ring rotates with an angular velocity ω = 20 rad/s about its axis. An external resistance of 10 Ω is connected across the centre of the ring and rim. The current through external resistance is

(1) $\frac{1}{4}$A (2) $\frac{1}{2}$A (3) $\frac{1}{3}$A (4) zero

9. The radius of the circular conducting loop shown in figure is R. Magnetic field is decreasing at a constant rate α. Resistance per unit length of the loop is ρ. Then current in wire AB is (AB is one of the diameters)



(1) $\frac{R\alpha}{2\rho}$ from A to B (2) $\frac{R\alpha}{2\rho}$ from B to A (3) $\frac{2R\alpha}{\rho}$ from A to B (4) Zero

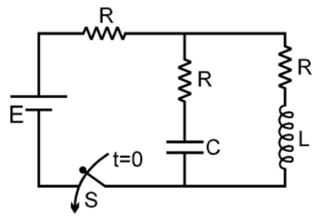
10. Two different coils have self-inductance L_1 = 8 mH, L_2 = 2 mH. The current in one coil is increased at a constant rate. The current in the second coil is also increased at the same rate. At a certain instant of time, the power given to the two coils is the same. At that time the current, the induced voltage and the energy stored in the first coil are i_1, V_1 and W_1 respectively. Corresponding values for the second coil at the same instant are i_2, V_2 and W_2 respectively. Then which is incorrect :

(1) $\frac{i_1}{i_2} = \frac{1}{4}$ (2) $\frac{i_1}{i_2} = 4$ (3) $\frac{W_2}{W_1} = 4$ (4) $\frac{V_2}{V_1} = \frac{1}{4}$

11. In an LR circuit current at t = 0 is 20 A. After 2s it reduces to 18 A. The time constant of the circuit is (in second):

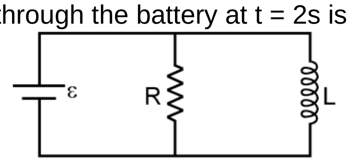
(1) $\ln\left(\frac{10}{9}\right)$ (2) 2 (3) $\frac{2}{\ln\left(\frac{10}{9}\right)}$ (4) $2\ln\left(\frac{10}{9}\right)$

12. In the circuit shown in figure, switch S is closed at t = 0. Then:



(1) after a long time interval potential difference across capacitor and inductor will be equal.
(2) after a long time interval charge on capacitor will be E C.
(3) after a long time interval current in the inductor will be E /R.
(4) after a long time interval current through battery will be same as the current through it initially.

13. The battery shown in the figure is ideal. The values are ε = 10 V, R = 5Ω, L = 2H . Initially the current in the inductor is zero. The current through the battery at t = 2s is



(1) 12 A (2) 7 A (3) 3 A (4) none of these

14. Two coils are at fixed locations. When coil 1 has no current and the current in coil 2 increases at the rate 15.0 A/s the e.m.f. in coil 1 is 25.0 mV, when coil 2 has no current and coil 1 has a current of 3.6 A, flux linkage in coil 2 is

(1) 16 mWb (2) 10 mWb (3) 4.00 mWb (4) 6.00 mWb

15. A long straight wire is placed along the axis of a circular ring of radius R. The mutual inductance of this system is

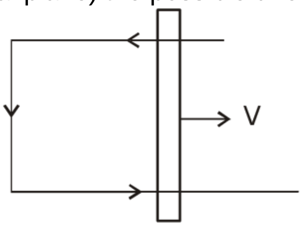
(1) $\frac{\mu_0 R}{2}$ (2) $\frac{\mu_0 \pi R}{2}$ (3) $\frac{\mu_0}{2}$ (4) 0

16. Two identical circular loops of metal wire are lying on a table without touching each other. Loop-A carries a current which increases with time. In response, the loop-B **[JEE 99, 2/200]**

(1) remains stationary
(2) is attracted by the loop-A
(3) is repelled by the loop-A
(4) rotates about its CM, with CM fixed

17. When two co-axial coils having same current in same direction are bring to each other, then the value of current in both coils : **[RPMT 2002]**
(1) increases
(2) decreases
(3) first increases and then decreases
(4) remain same

18. For given arrangement (in horizontal plane) the possible direction of magnetic field : **[RPMT 2002]**



(1) towards right
(2) towards left
(3) vertically upward
(4) vertically downward

19. A magnetic field can be produced by :- **[RPMT 2003]**
(1) A moving charge
(2) A changing electric field
(3) A stationary charge
(4) Both (1) and (2)

20. A coil of inductance 300 mH and resistance 2Ω is connected to a source of voltage 2V. The current reaches half of its steady state value in **[RPMT 2008]**
(1) 0.05 s
(2) 0.1 s
(3) 0.15s
(4) 0.3 s

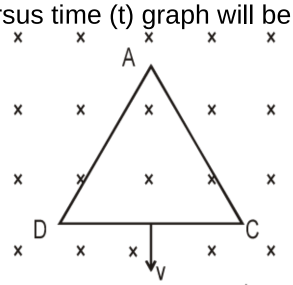
21. If a bar magnet is dropping through the copper ring, then its velocity (gravity free space): **[RPMT 2009]**
(1) decreases
(2) increases
(3) remain unaffected
(4) None of these

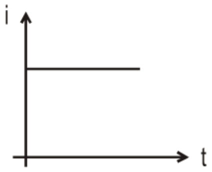
22. Lenz's law gives : **[RPMT 2009]**
(1) the magnitude of the induced emf
(2) the direction of the induced current
(3) both the magnitude and direction of the induced current
(4) the magnitude of the induced current

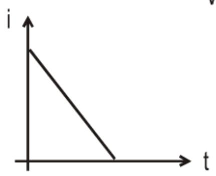
23. The unit of mutual inductance of a coil can be expressed as : **[RPMT 2011]**
(1) weber . amp
(2) weber/amp.
(3) weber meter
(4) weber / meter

24. A conducting ring is placed in a uniform magnetic field with its plane perpendicular to the field. An emf is induced in the ring if
(1) it is rotated about its axis
(2) it is translated
(3) it is rotated about a diameter
(4) None of these

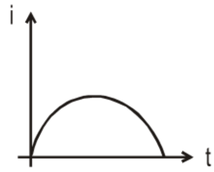
25. An equilateral triangular loop ADC having some resistance is pulled with a constant velocity v out of a uniform magnetic field directed into the paper. At time t = 0, side DC of the loop is at edge of the magnetic field. The induced current (i) versus time (t) graph will be as



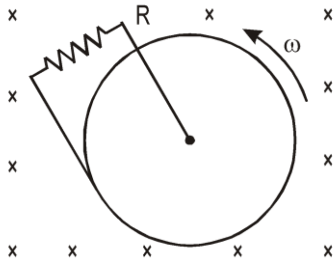
(1)


(2)


(3)


(4)


26. Figure shows a conducting disc rotating about its axis in a perpendicular magnetic field B. A resistor of resistance R is connected between the centre and the rim. The radius of the disc is 5.0 cm, angular speed ω = 40 rad/s, B = 0.10 T and R = 1 Ω. The current through the resistor is

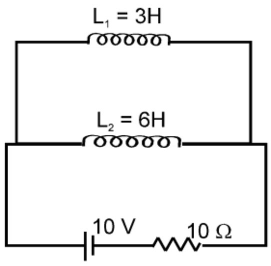


(1) 5 mA (2) 50 A (3) 5 A (4) 10 mA

27. A rectangular loop of sides 'a' and 'b' is placed in xy plane. A very long wire is also placed in xy plane such that side of length 'a' of the loop is parallel to the wire. The distance between the wire and the nearest edge of the loop is 'd'. The mutual inductance of this system is proportional to:

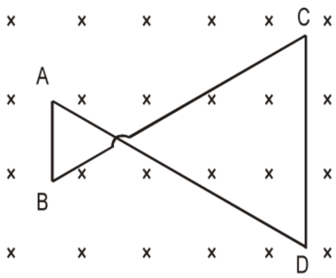
(1) a (2) b (3) 1/d (4) current in wire

28. Two inductor coils of self inductance 3H and 6H respectively are connected with a resistance 10Ω and a battery 10 V as shown in figure. The ratio of total energy stored at steady state in the inductors to that of heat developed in resistance in 10 seconds at the steady state is(neglect mutual inductance between L_1 and L_2):



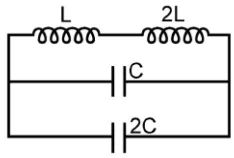
(1) $\frac{1}{10}$ (2) $\frac{1}{100}$ (3) $\frac{1}{1000}$ (4) 1

29. A conducting wire frame is placed in a magnetic field which is directed into the paper. The magnetic field is increasing at a constant rate. The directions of induced currents in wires AB and CD are :



(1) B to A and D to C (2) A to B and C to D (3) A to B and D to C (4) B to A and C to D

30. The frequency of oscillation of current in the inductor is:



(1) $\frac{1}{3\sqrt{LC}}$ (2) $\frac{1}{6\pi\sqrt{LC}}$ (3) $\frac{1}{\sqrt{LC}}$ (4) $\frac{1}{2\pi\sqrt{LC}}$

31. A short circuited coil is placed in a time-varying magnetic field. Electrical power is dissipated due to the current induced in the coil. If the number of turns were to be four times and the wire radius halved keeping the radius of the loop unchanged, the electrical power dissipated would be: **[JEE Screening 2002, 3/90, –1]**

(1) halved (2) the same (3) doubled (4) quadrupled

Exercise-3

PART - I : NEET / AIPMT QUESTION (PREVIOUS YEARS)

1. A rectangular, a square, a circular and an elliptical loop, all in the (x-y) plane, are moving out of a uniform magnetic field with a constant velocity $\vec{v} = v\hat{i}$. The magnetic field is directed along the negative z-axis direction. The induced emf, during the passage of these loops, out of the field region, will not remain constant for **[AIPMT 2009]**

(1) the rectangular, circular and elliptical loops

(2) the circular and the elliptical loops

(3) only the elliptical loop

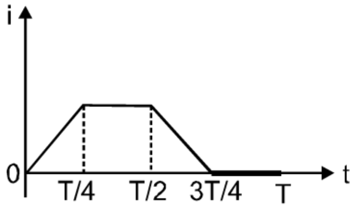
(4) any of the four loops

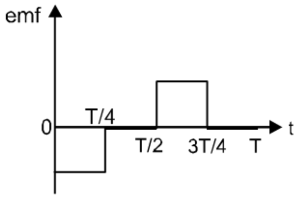
2. A condenser of capacity C is charged to a potential difference of V_1. The plates of the condenser are then connected to an ideal inductor of inductance L. The current through the inductor when the potential difference across the condenser reduces to V_2 is **[AIPMT Mains-2010]**

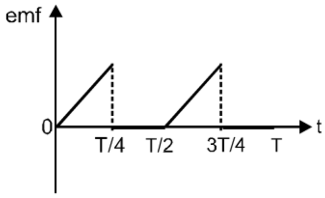
(1) $\left(\frac{C(V_1 - V_2)^2}{L}\right)^{\frac{1}{2}}$ (2) $\frac{C(V_1^2 - V_2^2)}{L}$

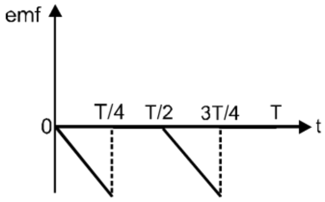
(3) $\frac{C(V_1^2 + V_2^2)}{L}$ (4) $\left(\frac{C(V_1^2 - V_2^2)}{L}\right)^{\frac{1}{2}}$

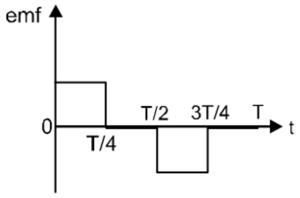
3. The current i in a coil varies with time as shown in the figure. The variation of induced emf with time would be: **[AIPMT (Screening) 2011]**



(1)


(2)


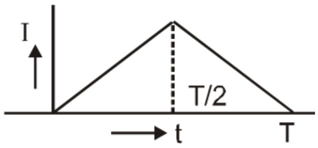
(3)


(4)


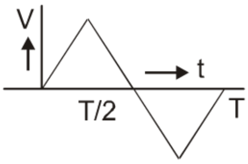
4. A coil of resistance 400Ω is placed in a magnetic field. If the magnetic flux ϕ (wb) linked with the coil varies with time t (sec) as $\phi = 50t^2 + 4$. The current in the coil at t = 2 sec is : **[AIPMT_Pre_2012]**

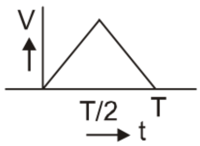
(1) 0.5A (2) 0.1 A (3) 2 A (4) 1 A

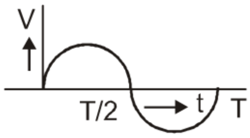
5. The current (I) in the inductance is varying with time according to the plot shown in figure. **[AIPMT_Pre_2012]**

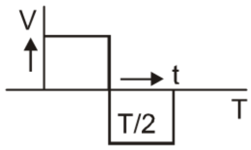


Which one of the following is the correct variation of voltage with time in the coil ?

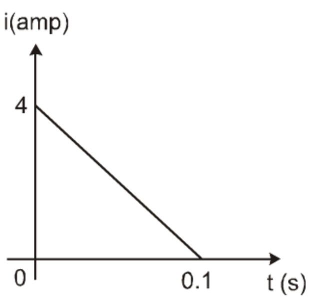
(1)


(2)


(3)


(4)


6. In a coil of resistance 10 Ω, the induced current developed by changing magnetic flux through it, is shown in figure as a function of time. The magnitude of change in flux through the coil in Weber is : **[AIPMT 2012 (Mains)]**



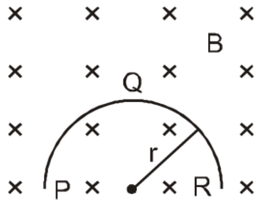
(1) 8 (2) 2 (3) 6 (4) 4

7. A wire loop is rotated in a magnetic field. The frequency of change of direction of the induced e.m.f. is : **[NEET-2013]**

(1) twice per revolution (2) four times per revolution

(3) six times per revolution (4) once per revolution

8. A thin semicircular conducting ring (PQR) of radius 'r' is falling with its plane vertical in a horizontal magnetic field B, as shown in figure. The potential difference developed across the ring when its speed is v, is : **[AIPMT-2014]**

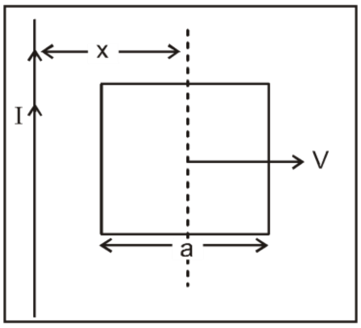


(1) Zero
(2) $Bv\pi r^2/2$ and P is at higher potential
(3) πrBv and R is at higher potential
(4) 2rBv and R is at higher potential

9. A transformer having efficiency of 90% is working on 200 V and 3 kW power supply. If the current in the secondary coil is 6 A the voltage across the secondary coil and the current in the primary coil respectively are : **[AIPMT-2014]**

(1) 300 V, 15 A (2) 450 V, 15 A (3) 450 V, 13.5 A (4) 600 V, 15A

10. A conducting square frame of side 'a' and a long straight wire carrying current I are located in the same plane as shown in the figure. The frame moves to the right with a constant velocity 'V'. The emf induced in the frame will be proportional to : **[AIPMT-2015]**

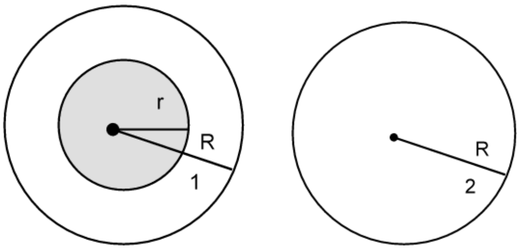


(1) $\frac{1}{(2x-a)^2}$ (2) $\frac{1}{(2x+a)^2}$ (3) $\frac{1}{(2x-a)(2x+a)}$ (4) $\frac{1}{x^2}$

11. A bar magnet is hung by a thin cotton thread in a uniform horizontal magnetic field and is in equilibrium state. The energy required to rotate it by 60º is W. Now the torque required to keep the magnet in this new position is : **[NEET 2016]**

(1) $\frac{2W}{\sqrt{3}}$ (2) $\frac{W}{\sqrt{3}}$ (3) $\sqrt{3}W$ (4) $\frac{\sqrt{3}W}{2}$

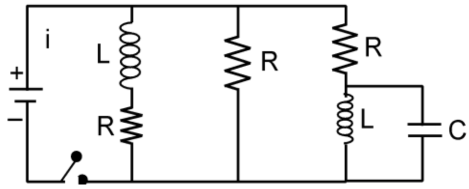
12. A uniform magnetic field is restricted within a region of radius r. The magnetic field changes with time at a rate $\frac{d\vec{B}}{dt}$. Loop 1 of radius R > r encloses the region r and loop 2 of radius R is outside the region of magnetic field as shown in the figure below. Then the e.m.f. generated is : **[NEET 2016]**



(1) $-\frac{d\vec{B}}{dt}\pi r^2$ in loop 1 and zero in loop 2 (2) zero in loop 1 and zero in loop 2

(3) $-\frac{d\vec{B}}{dt}\pi r^2$ in loop 1 and $-\frac{d\vec{B}}{dt}\pi r^2$ in loop 2 (4) $-\frac{d\vec{B}}{dt}\pi R^2$ in loop 1 and zero in loop 2

13. Figure shows a circuit that contains three identical resistors with resistance R = 9.0 Ω each, two identical inductors with inductance L = 2.0 mH each and an ideal battery with emf ε = 18 V. The current 'i' through the battery just after the switch closed is. **[NEET 2017]**



(1) 2 mA (2) 0.2 A (3) 2 A (4) 4 ampere

14. A long solenoid of diameter 0.1 m has 2×10^4 turn per meter. At the centre of the solenoid, a coil of 100 turns and radius 0.01 m is placed with its axis coinciding with the solenoid axis. The current in the solenoid reduces at a constant rate to 0A from 4 A in 0.05 s. If the resistance of the coil is $10\pi^2\Omega$, the total charge flowing through the coil during this time is : **[NEET 2017]**

(1) 32 πμC (2) 16 μC (3) 32 μC (4) 16 πμC

15. The magnetic potential energy stored in a certain inductor is 25 mJ then the current in the inductor is 60 mA. This inductor is of inductance **[NEET 2018]**

(1) 0.138 H (2) 13.89 H (3) 1.389 H (4) 138.88 H

16. In which of the following devices, the eddy current effect is not used? **[NEET 2019]**

(1) electric heater (2) induction furnace

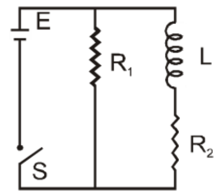
(3) magnetic braking in train (4) electromagnet

17. A 800 turn coil of effective area 0.05 m^2 is kept perpendicular to a magnetic field 5×10^{-5} T. When the plane of the coil is rotated by 90º around any of its coplanar axis in 0.1 s, the emf induced in the coil will be : **[NEET 2019]**

(1) 0.02 V (2) 2 V (3) 0.2 V (4) 2×10^{-3}V

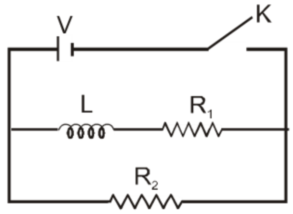
PART - II : JEE (MAIN) / AIEEE PROBLEMS (PREVIOUS YEARS)

1. An inductor of inductance L = 400 mH and resistors of resistances R_1 = 2 Ω and R_2 = 2 Ω are connected to a battery of emf 12 V 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) $\frac{12}{t}e^{-3t}V$ (2) $6\left(1-e^{-t/0.2}\right)V$ (3) $12\ e^{-5t}$ V (4) $6\ e^{-5t}$ V

2. In the circuit shown below, the key K is closed at t = 0. The current through the battery is : **[AIEEE 2010, 4/144, –1]**



(1) $\frac{VR_1R_2}{\sqrt{R_1^2+R_2^2}}$ at t = 0 and $\frac{V}{R_2}$ at t = ∞ (2) $\frac{V}{R_2}$ at t = 0 and $\frac{V(R_1+R_2)}{R_1R_2}$ at t = ∞

(3) $\frac{V}{R_2}$ at t = 0 and $\frac{VR_1R_2}{\sqrt{R_1^2+R_2^2}}$ at t = ∞ (4) $\frac{V(R_1+R_2)}{R_1R_2}$ at t = 0 and $\frac{V}{R_2}$ at t = ∞

3. In a series LCR circuit R = 200 Ω and the voltage and the frequency of the main supply is 220 V and 50 Hz respectively. On taking out the capacitance from the circuit the current lags behind the voltage by 30º. On taking out the inductor from the circuit the current leads the voltage by 30º. The power dissipated in the LCR circuit is **[AIEEE 2010; 4/144, –1]**

(1) 305 W (2) 210 W (3) Zero W (4) 242 W

4. A fully charged capacitor C with initial 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, 4/120, –1]**

(1) $\pi\sqrt{LC}$ (2) $\frac{\pi}{4}\sqrt{LC}$ (3) $2\pi\sqrt{LC}$ (4) $\sqrt{LC}$

5. A boat is moving due east in a region where the earth's magnetic field is 5.0 × 10^{-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, 4/120, –1]**

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

6. A horizontal straight wire 20 m long extending from east to west falling with a speed of 5.0 M\s, at right angles to the horizontal component of the earth's magnetic field 0.30 ×10^{-4} Wb \ m^2. The instantaneous Value of the e.m. f. induced in the wire will be : **[AIEEE 2011, 11 May; 4, –1]**

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

7. 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 ; 4, –1]**

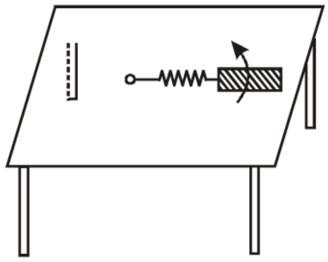
(1) developement of air current when the plate is placed.

(2) induction of electrical charge on the plate

(3) shielding of magnetic lines of force as aluminium is a paramagnetic material.

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

8. 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-Mains 2013, 4/120]**



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

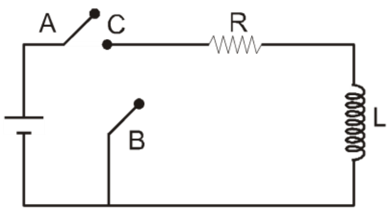
9. A circular loop of radius 0.3 cm lies parallel to a much bigger circular loop of radius 20 cm. The centre of the small loop is on the axis of the bigger loop. The distance between their centres is 15 cm. If a current of 2.0 A flows through the smaller loop, then the flux linked with bigger loop is :

[JEE-Mains 2013, 4/120]

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

10. In the circuit shown here, the point 'C' is kept connected to point 'A' till the current flowing through the circuit becomes constant. Afterward, suddenly point 'C' is disconnected from point 'A' and connected to point 'B' at time t = 0. Ratio of the voltage across resistance and the inductor at t = L/R will be equal to :

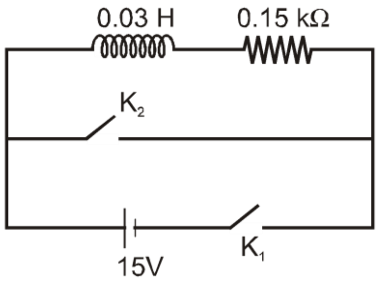
[JEE-Mains 2014]



(1) $\frac{e}{1-e}$ (2) 1 (3) –1 (4) $\frac{1-e}{e}$

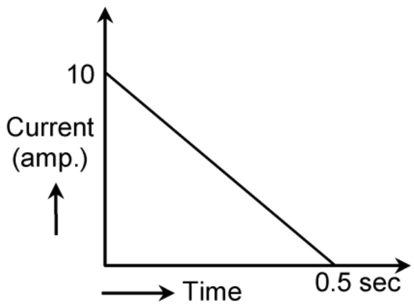
11. An inductor (L = 0.03H) and a resistor (R = 0.15 kΩ) are connected in series to a battery of 15V EMF in a circuit shown below. The key K_1 has been kept closed for a long time. Then at t = 0, K_1 is opened and key K_2 is closed simultaneously. At t = 1ms, the current in the circuit will be : ($e^5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

[JEE(Main)-2015; 4/120, –1]



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

12. In a coil resistance 100Ω, 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) 275 Wb (2) 200 Wb (3) 225 Wb (4) 250 Wb

13. A conducting circular loop made of a thin wire, has area 3.5×10^{-3} m^2 and resistance 10Ω. It is placed perpendicular to a time dependent magnetic field B(t) = (0.4T)sin(50πt). The field is uniform in space. Then the net charge flowing through the loop during t = 0 s and t = 10 ms is close to : **[JEE Main 2019]**

(1) 7 mC (2) 14 mC (3) 21 mC (4) 6 mC

14. A solid metal cube of edge length 2 cm is moving in a positive y-direction at a constant speed of 6 m/s. There is a uniform magnetic field of 0.1 T in the positive z-direction. The potential difference between the two faces of the cube perpendicular to the x-axis, is : **[JEE Main 2019]**

(1) 6 mV (2) 2 mV (3) 12 mV (4) 1 mV

15. The self induced emf of a coil is 25 volts. When the current in it is changed at uniform rate from 10A to 25A in 1s, the change in the energy of the inductance is : **[JEE Main 2019]**

(1) 540 J (2) 740 J (3) 637.5 J (4) 437.5 J

16. A copper wire is wound on a wooden frame, whose shape is that of each side of the frame is increased by a factor of 3, keeping the number of turns of the coil per unit length of the frame the same, then the self inductance of the coil : **[JEE Main 2019]**

(1) increases by a factor of 3 (2) decreases by a factor of $9\sqrt{3}$

(3) increases by a factor of 27 (4) decreases by a factor of 9

17. The region between y = 0 and y = d contains a magnetic field $\vec{B} = B\hat{z}$. A particle of mass m and charge q enters the region from point (0, d) with a velocity $\vec{v} = v\hat{i}$. If $d = \frac{mv}{2qB}$, the acceleration of the charged particle at the point of its emergence at the other side is : **[JEE Main 2019]**

(1) $\frac{qvB}{m}\left(\frac{1}{2}\hat{i} - \frac{\sqrt{3}}{2}\hat{j}\right)$ (2) $\frac{qvB}{m}\left(\frac{\hat{i}+\hat{j}}{\sqrt{2}}\right)$

(3) $\frac{qvB}{m}\left(\frac{-\hat{j}+\hat{i}}{\sqrt{2}}\right)$ (4) $\frac{qvB}{m}\left(\frac{\sqrt{3}}{2}\hat{i} + \frac{1}{2}\hat{j}\right)$

18. In an experiment, electrons are accelerated, from rest, by applying a voltage of 500 V. Calculate the radius of the path if a magnetic field 100 mT is then applied. [Charge of the electron = 1.6×10^{-19} C Mass of the electron = 9.1×10^{-31} kg] **[JEE Main 2019]**

(1) 7.5×10^{-2} m (2) 7.5 m (3) 7.5×10^{-4} m (4) 7.5×10^{-3} m

19. There are two long co–axial solenoids of same length ℓ. The inner and outer coils have radii r_1 and r_2 and number of turns per unit length n_1 and n_2, respectively. The ratio of mutual inductance to the self-inductance of the inner-coil is : **[JEE Main 2019]**

(1) $\frac{n_2}{n_1}.\frac{r_2^2}{r_1^2}$ (2) $\frac{n_2}{n_1}$ (3) $\frac{n_1}{n_2}$ (4) $\frac{n_2}{n_1}.\frac{r_1}{r_2}$

20. A 10 m long horizontal wire extends from North East to South West. It is falling with a speed of 5.0 ms^{-1}, at right angles to the horizontal component of the earth's magnetic field, of 0.3×10^{-4} Wb/m^2. The value of the induced emf in wire is : **[JEE Main 2019]**

(1) 1.1×10^{-3} V (2) 2.5×10^{-3} V (3) 0.3×10^{-3} V (4) 1.5×10^{-3} V

Answers

EXERCISE # 1

SECTION (A)

1.	(3)	**2.**	(2)	**3.**	(1)	**4.**	(1)	**5.**	(4)	**6.**	(1)	**7.**	(3)
8.	(4)	**9.**	(4)	**10.**	(1)								

SECTION (B)

1.	(4)	**2.**	(3)	**3.**	(2)	**4.**	(2)	**5.**	(1)	**6.**	(1)	**7**	(2)
8.	(4)	**9.**	(3)	**10.**	(3)	**11.**	(3)	**12.**	(1)	**13.**	(1)	**14.**	(3)

SECTION (C)

1.	(4)	**2.**	(2)	**3.**	(1)	**4.**	(2)	**5.**	(3)	**6.**	(4)	**7.**	(2)
8.	(2)	**9.**	(1)	**10.**	(4)	**11.**	(1)						

SECTION (D)

1.	(4)	**2.**	(1)	**3.**	(2)	**4.**	(1)	**5.**	(4)

SECTION (E)

1.	(1)	**2.**	(1)	**3.**	(3)	**4.**	(4)	**5.**	(3)	**6.**	(3)	**7.**	(1)
8.	(2)	**9.**	(2)	**10.**	(2)								

SECTION (F)

1.	(1)	**2.**	(3)	**3.**	(1)	**4.**	(2)	**5.**	(1)	**6.**	(2)

SECTION (G)

1.	(2)	**2.**	(3)	**3.**	(4)	**4.**	(4)	**5.**	(1)	**6.**	(3)	**7.**	(3)
8.	(1)	**9.**	(2)	**10.**	(3)	**11.**	(2)	**12.**	(1)	**13.**	(3)	**14.**	(4)
15.	(2)	**16.**	(4)	**17.**	(1)	**18.**	(4)	**19.**	(1)	**20.**	(1)	**21.**	(4)
22.	(4)	**23.**	(2)	**24.**	(4)	**25.**	(3)	**26.**	(2)				

SECTION (H)

1.	(4)	**2.**	(1)	**3.**	(4)	**4.**	(1)	**5.**	(2)	**6.**	(1)	**7.**	(2)
8.	(2)	**9.**	(1)	**10.**	(3)	**11.**	(3)	**12.**	(3)				

EXERCISE # 2

1.	(4)	**2.**	(4)	**3.**	(4)	**4.**	(2)	**5.**	(2)	**6.**	(4)	**7.**	(4)
8.	(3)	**9.**	(4)	**10.**	(2)	**11.**	(3)	**12.**	(4)	**13.**	(1)	**14.**	(4)
15.	(4)	**16.**	(3)	**17.**	(2)	**18.**	(4)	**19.**	(4)	**20.**	(2)	**21.**	(1)
22.	(2)	**23.**	(2)	**24.**	(3)	**25.**	(2)	**26.**	(1)	**27.**	(1)	**28.**	(2)
29.	(1)	**30.**	(2)	**31.**	(2)								

EXERCISE # 3

PART-I

1.	(2)	**2.**	(4)	**3.**	(1)	**4.**	(1)	**5.**	(4)	**6.**	(2)	**7.**	(1)
8.	(4)	**9.**	(2)	**10.**	(3)	**11.**	(3)	**12.**	(1)	**13.**	(4)	**14.**	(3)
15.	(2)	**16.**	(1)	**17.**	(1)								

PART - II

1.	(3)	**2.**	(2)	**3.**	(4)	**4.**	(2)	**5.**	(4)	**6.**	(1)	**7.**	(4)
8.	(4)	**9.**	(1)	**10.**	(3)	**11.**	(4)	**12.**	(4)				

13. (Bonus, correct ans. is 140 μC) **14.** (3) **15.** (4) **16.** (1)

17. (Bonus, correct ans. is $\frac{qvB}{m}\left(-\frac{\sqrt{3}}{2}\hat{i}-\frac{1}{2}\hat{j}\right)$) **18.** (3) **19.** (2) **20.** (1)