1. 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

(a) it is rotated about its axis
(b) it is translated
(c) it is rotated about a diameter
(d) None of these

2. 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:

(a) a (b) b
(c) 1/d (d) current in wire

3. 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 :

(a) 0.5A (b) 0.1 A
(c) 2 A (d) 1 A

4. 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 60° is W. Now the torque required to keep the magnet in this new position is :

(a) $\frac{2W}{\sqrt{3}}$ (b) $\frac{W}{\sqrt{3}}$

(c) $\sqrt{3}W$ (d) $\frac{\sqrt{3}W}{2}$

5. 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

(a) 0.138 H (b) 13.89 H
(c) 1.389 H (d) 138.88 H

6. A horizontal straight wire 20 m long extending from east to west falling with a speed of 5.0 m\s, at right angle with the horizontal component of the earth's magnetic field 0.30×10^{-4} Wb \ m². The instantaneous Value of the e.m. f. induced in the wire will be :

(a) 3 mV (b) 4.5 mV
(c) 1.5 mV (d) 6.0mV

7. 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 :

(a) 540 J (b) 740 J
(c) 637.5 J (d) 437.5 J

8. A long solenoid of radius R carries a time(t)- dependent current $I(t) = I_0t(1 - t)$. A ring of radius 2R is placed coaxially near its middle. During the time interval $0 \leq t \leq 1$, the induced current (I_R) and the induced EMF(V_R) in the ring change as :

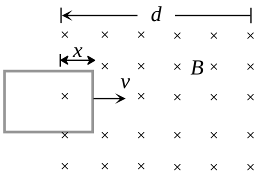
(a) Direction of I_R remains unchanged and V_R is zero at t = 0.25

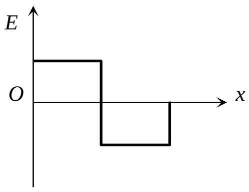
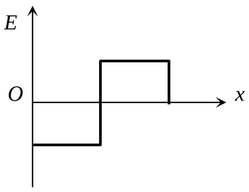
(b) At t = 0.5 direction of I_R reverses and V_R is zero

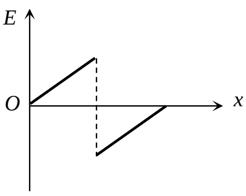
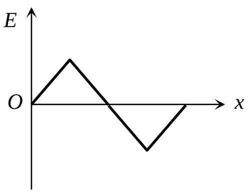
(c) At t = 0.25 direction of I_R reverses and V_R is maximum

(d) Direction of I_R remains unchanged and V_R is maximum at t = 0.5

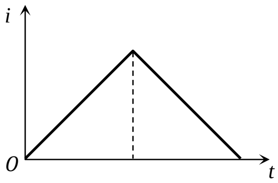
9. A rectangular loop is being pulled at a constant speed v, through a region of certain thickness d, in which a uniform magnetic field B is set up. The graph between position x of the right hand edge of the loop and the induced emf E will be

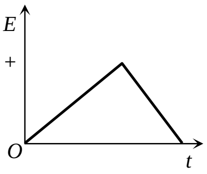
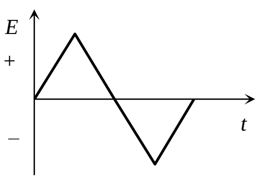


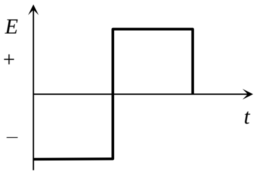
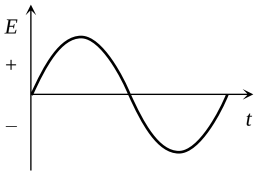
(a)  (b) 

(c)  (d) 

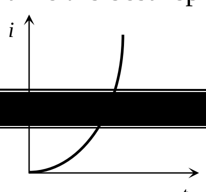
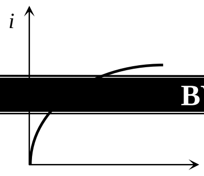
10. The current i in an inductance coil varies with time, t according to the graph shown in fig. Which one of the following plots shows the variation of voltage in the coil with time

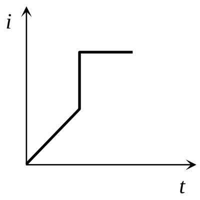


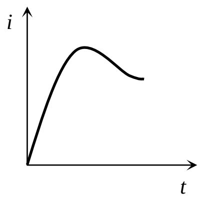
(a)  (b) 

(c)  (d) 

11. When a battery is connected across a series combination of self inductance L and resistance R, the variation in the current i with time t is best represented by

(a)  (b) 

(c) 

(d) 

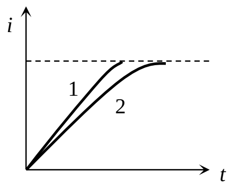
12. When a certain circuit consisting of a constant e.m.f. E an inductance L and a resistance R is closed, the current in, it increases with time according to curve 1. After one parameter (E, L or R) is changed, the increase in current follows curve 2 when the circuit is closed second time. Which parameter was changed and in what direction

(a) L is increased

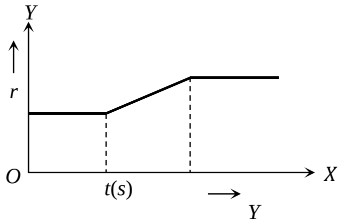
(b) L is decreased

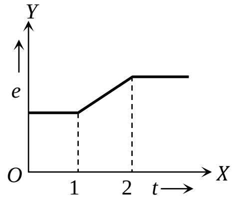
(c) R is increased

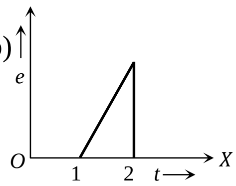
(d) R is decreased

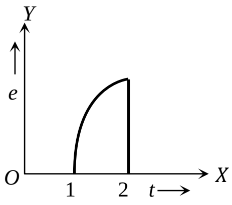


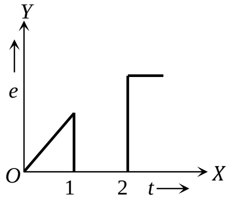
13. A flexible wire bent in the form of a circle is placed in a uniform magnetic field perpendicular to the plane of the coil. The radius of the coil changes as shown in figure. The graph of induced emf in the coil is represented by



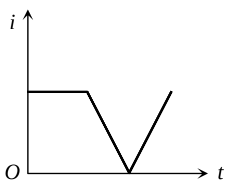
(a) 

(b) 

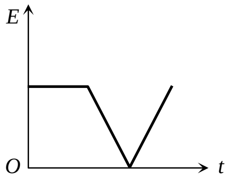
(c) 

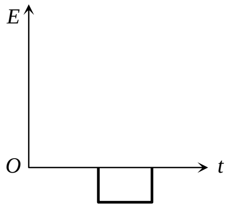
(d) 

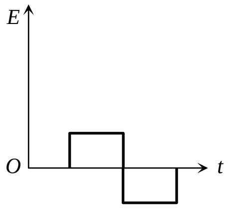
14. The current i in an induction coil varies with time t according to the graph shown

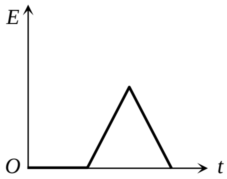


in figure. Which of the following graphs shows the induced emf *(e)* in the coil with time

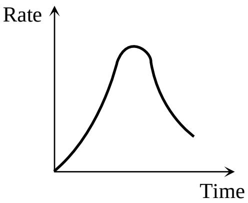
(a) 

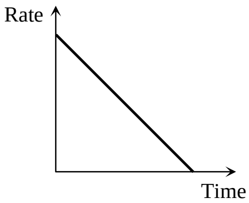
(b) 

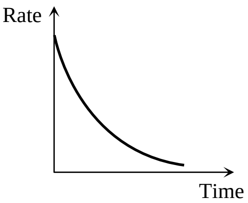
(c) 

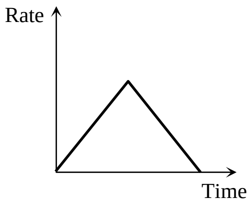
(d) 

15. In an L–R circuit connected to a battery the rate at which energy is stored in the inductor is plotted against time during the growth of the current in the circuit. Which of the following best represents the resulting curve

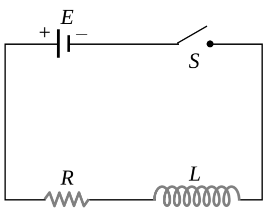
(a) 

(b) 

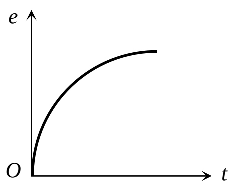
(c) 

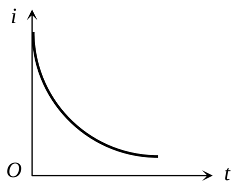
(d) 

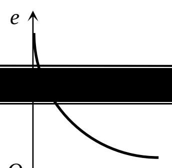
16. Switch S of the circuit shown in figure. is closed at $t = 0$. If e denotes the induced

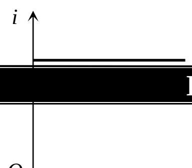


emf in L and i, the current flowing through the circuit at time t, which of the following graphs is correct

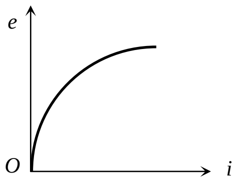
(a) 

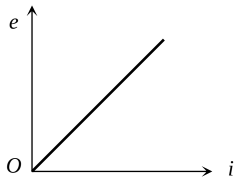
(b) 

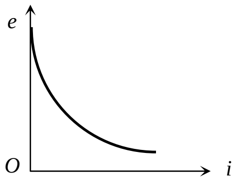
(c) 

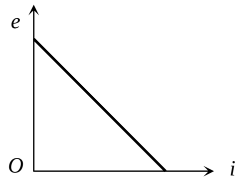
(d) 

17. For previous objective, which of the following graphs is correct

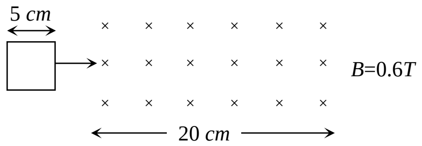
(a)


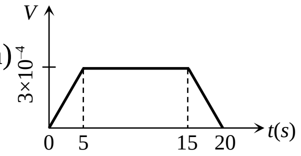
(b)


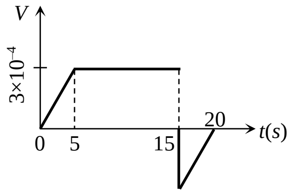
(c)


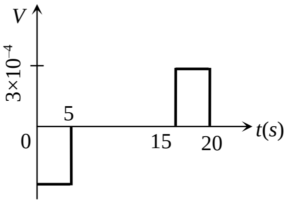
(d)


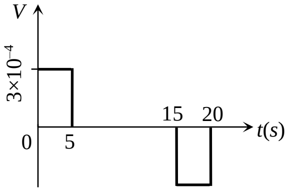
18. A square loop of side 5 *cm* enters a magnetic field with 1 cms^{-1}. The front edge enters the magnetic field at $t = 0$ then which graph best depicts *emf*



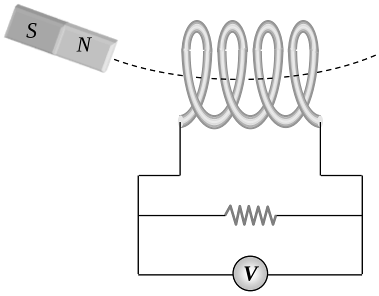
(a)


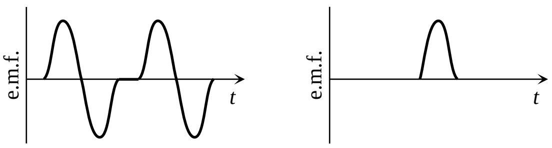
(b)


(c)


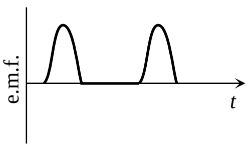
(d)


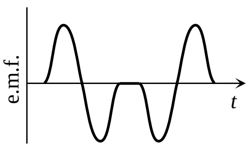
19. A magnet is made to oscillate with a particular frequency, passing through a coil as shown in figure. The time variation of the magnitude of e.m.f. generated across the coil during one cycle is



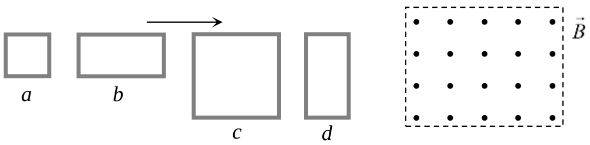


(a) (b)

(c) 

(d) 

20. The figure shows four wire loops, with edge lengths of either L or $2L$. All four loops will move through a region of uniform magnetic field $\vec{B}$ (directed out of the page) at the same constant velocity. Rank the four loops according to the maximum magnitude of the e.m.f. induced as they move through the field, greatest first



(a) $(e_c = e_d) < (e_a = e_b)$ (b) $(e_c = e_d) > (e_a = e_b)$

(c) $e_c > e_d > e_b > e_a$ (d) $e_c < e_d < e_b < e_a$

21. A circular coil and a bar magnet placed near by are made to move in the same direction. The coil covers a distance of 1 *m* in 0.5 *sec* and the magnet a distance of 2 *m* in 1 *sec*. The induced emf produced in the coil

(a) Zero

(b) 1 *V*

(c) 0.5 *V*

(d) Cannot be determined from the given information

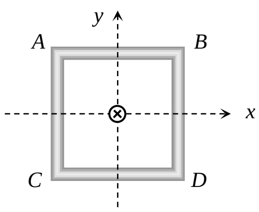
22. A square coil *ABCD* lying in *x*-*y* plane with it's centre at origin. A long straight wire passing through origin carries a current $i = 2t$ in negative *z*-direction. The induced current in the coil is

(a) Clockwise

(b) Anticlockwise

(c) Alternating

(d) Zero



23. A short magnet is allowed to fall along the axis of a horizontal metallic ring. Starting from rest, the distance fallen by the magnet in one second may be

(a) 4 m (b) 5 m
(c) 6 m (d) 7 m

24. The horizontal component of the earth's magnetic field at a place is $3 \times 10^{-4}\ T$ and the dip is $\tan^{-1}\left(\frac{4}{3}\right)$. A metal rod of length 0.25 m placed in the north-south position and is moved at a constant speed of 10 cm/s towards the east. The emf induced in the rod will be

(a) Zero (b) 1 μV
(c) 5 μV (d) 10 μV

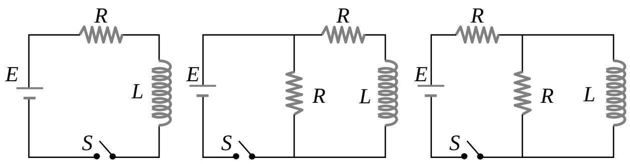
25. A copper disc of radius 0.1 m rotates about its centre with 10 revolutions per second in a uniform magnetic field of 0.1 *Tesla*. The emf induced across the radius of the disc is

(a) $\frac{\pi}{10} V$ (b) $\frac{2\pi}{10} V$
(c) $10\ \pi\ mV$ (d) $20\ \pi\ mV$

26. A coil of *Cu* wire (radius-*r*, self inductance-*L*) is bent in two concentric turns each having radius $\frac{r}{2}$. The self inductance now

(a) $2L$ (b) L
(c) $4L$ (d) $L/2$

27. In which of the following circuit is the current maximum just after the switch *S* is closed



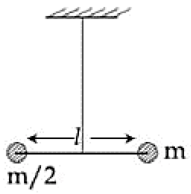
(i) (ii) (iii)

(a) (i) (b) (ii)
(c) (iii) (d) Both (ii) and (iii)

28. A conducting circular loop made a thin wire, has area $3.5 \times 10^{-3} m^2$ and resistance 10Ω. It is placed perpendicular to a time dependent magnetic field $B(t) = (0.4T)\sin(50\pi t)$. The field is uniform in space. Then the net charge flowing through the loop during $t = 0s$ and $t = 10ms$ is close to:

(a) 14 mC (b) 7 mC
(c) 1.4×10^{-4} cM (d) 6 mC

29. Two masses m and $\frac{m}{2}$ are connected at the two ends of a massless rigid rod of length l. The road he rod is suspended by a thin wire of torsional constant k at the centre of mass of the rod-mass system (see figure). Because of torsional constant k, the restoring torque is $\tau = k\theta$ for angular displacement θ. If the rod is rota ted by θ_0 and released, the tension in it when it passes through its mean position will be:



(a) $\frac{3k\theta_0^2}{l}$ (b) $\frac{2k\theta_0^2}{l}$ (c) $\frac{k\theta_0^2}{l}$ (d) $\frac{k\theta_0^2}{2l}$

30. A power transmission line feeds input power at 2300 V a step down transformer with its primary windings having 4000 turns. The output power is delivered at 230 V by the transformer. If the current in the primary of the transformer is 5A and its efficiency is 90%, the output current would be :

(a) 50 A (b) 45A
(c) 35 A (d) 25 A

1. (c)EMF is induced in the ring if there is change in flux which occurs either due to rotation about a diameter or due to its deformation.

2. (a) $\phi = M \times I$

$$\frac{\int_{d}^{d+b} B.ds}{I} = M$$

$$M = \frac{\mu_0 a}{2\pi} \ell n \frac{b+d}{d}$$

Hence $M \propto a$.

3. (a)Induced e.m.f. $\varepsilon = -\frac{d\phi}{dt} = -(100t)$

induced current i at t = 2 sec. $= \left|\frac{\varepsilon}{R}\right| = +\frac{100 \times 2}{400} = +0.5 \text{ Amp}$

4. (c)$W_{ext} = U_f - U_i$

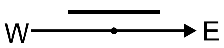
$= -MB\cos 60° - (-MB)$

$= MB(1 - \cos 60°) = MB/2 = W$

$r = MB\sin 60° = MB\,\frac{\sqrt{3}}{2} = \sqrt{3}W$

5. (b)$U = \frac{1}{2}Li^2$

$25 \times 10^{-3} = \frac{1}{2}L(60 \times 10^{-3})^2 \quad \Rightarrow \quad L = \frac{500}{36} = 13.89H$

6. **(a)** 

$\varepsilon_{ind} = Bv\ell$

$= 0.3 \times 10^{-4} \times 5 \times 20$

$= 3 \times 10^{-3}$ v

= 3 mv.

7. **(d)**$|\varepsilon| = \frac{Ldi}{dt}$

$25 = L \times \frac{(25-10)}{1}$

$L = \frac{5}{3}$ H

energy of inductor $E = \frac{1}{2}Li^2$

$\Rightarrow \Delta E = \frac{1}{2} \times \frac{5}{3}$ [625 – 100] J

$\Delta E = 437.5$ J

8. (b)$I = I_0 t - I_0 t^2$

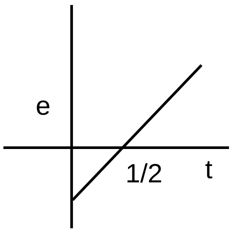
$\phi = BA$

$\phi = \mu_0 nIA$

$V_R = -\dfrac{d\phi}{dt} = -\mu_0 nAI_0 (1 - 2t)$

$V_R = 0$ at $t = \dfrac{1}{2}$

and $= \dfrac{V_R}{\text{Resistance of loop}}$



9. (b) As x increases so $\dfrac{dB}{dt}$ increases *i.e.* induced emf (e) is negative. When loop completely entered in the magnetic field, emf = 0

When it exit out x increases but $\dfrac{dB}{dt}$ decreases *i.e.* e is positive.

10. (c) According to $i - t$ graph, in the first half current is in-creasing uniformly so a constant negative emf induces in the circuit.

In the second half current is decreasing uniformly so a constant positive emf induces

Hence graph (c) is correct

11. (b) $i = i_0\left(1 - e^{-\frac{R}{L}t}\right)$

12. (a) $\dfrac{di}{dt}$ = slope of $i - t$ graph slope of graph (2) < slope of graph (1) so $\left(\dfrac{di}{dt}\right)_2 < \left(\dfrac{di}{dt}\right)_1$

Also $L \propto \dfrac{1}{(di/dt)} \Rightarrow L_2 > L_1$

13. (b) $\phi = BA = B \times \pi r^2$

$\therefore \phi \propto r^2 \Rightarrow \phi = kr^2$ (k = constant)

$\therefore e = \dfrac{d\phi}{dt} = k.2r\dfrac{dr}{dt}$

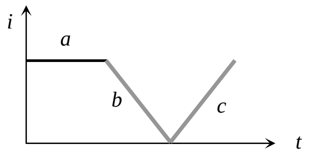
From 0 – 1, r is constant, $\therefore \dfrac{dr}{dt} = 0$ hence, $e = 0$

From 1 – 2, $r = \alpha t$, $\therefore \dfrac{dr}{dt} = \alpha$ hence $e \propto r \Rightarrow e \propto t$

From 2 – 3, again r is constant, $\therefore \frac{dr}{dt} = 0$ hence $e = 0$

14. (c) Emf induces during 'a' = 0

emf induced during 'b' is constant throughout emf induced during 'c' is constant throughout magnitude of emf induced during 'b' is equal to the magnitude of emf induced during 'c'. But the direction opposite.



15. (a) $U = \frac{1}{2}Li^2$

$\therefore$ Rate $= \frac{dU}{dt} = Li\left(\frac{di}{dt}\right)$

At $t = 0, i = 0$ $\therefore$ rate $= 0$

At $t = \infty, i = i_0$ but $\frac{di}{dt} = 0$, therefore rate = 0

16. (c) At the time t = 0, e is max and is equal to E, but current i is zero.

As the time passes, current through the circuit increases but induced emf decreases.

17. (d) If at any instant, current through the circuit is i then applying Kirchoffs voltage law, $iR + e = E \Rightarrow e = E - iR$. Therefore, graph between e and i will be a straight line having negative slope and having a positive intercept.

18. (c) When loop is entering in the field, magnetic flux ($i.e.$ $\times$) linked with the loop increases so induced emf in it $e = Bvl$ $= 0.6 \times 10^{-2} \times 5 \times 10^{-2} = 3 \times 10^{-4} V$ (Negative) .

When loop completely entered in the field (after 5 sec) flux linked with the loop remains constant so e = 0.

After 15 sec, loop begins to exit out, linked magnetic flux decreases so induced emf $e = 3 \times 10^{-4} V$ (Positive).

19. (a)

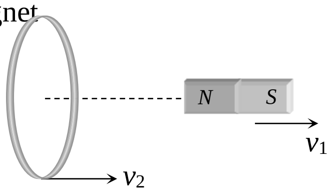
20. (b) Emf induces across the length of the wire which cuts the magnetic field. (Length of c = Length d) > (Length of a = b). So $(e_c = e_d) > (e_a = e_b)$

21. (a) Speed of the magnet

$v_1 = \frac{2}{1} = 2\, m/s$

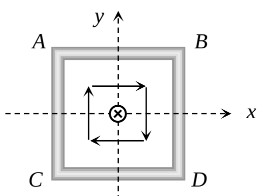
Speed of the coil

$v_2 = \frac{1}{0.5} = 2\, m/s$



Relative speed between coil and magnet is zero, so there is no induced emf in the coil.

22. (d) Magnetic lines are tangential to the coil as shown in figure. Thus net magnetic flux passing through the coil is always zero or the induced current will be zero.



23. (a) We know that in this case acceleration of falling magnet will be lesser than g. If 'g' would have been acceleration, then distance covered $=\frac{1}{2}gt^2 = 5m$.

Now the distance covered will be less than 5 m. hence only option (a) is correct.

24. (d) Rod is moving towards east, so induced emf across it's end will be $e = B_V vl = (B_H \tan\phi)vl$

$\therefore e = 3\times10^{-4}\times\frac{4}{3}\times(10\times10^{-2})\times0.25 = 10^{-5}\,V = 10\,\mu V$

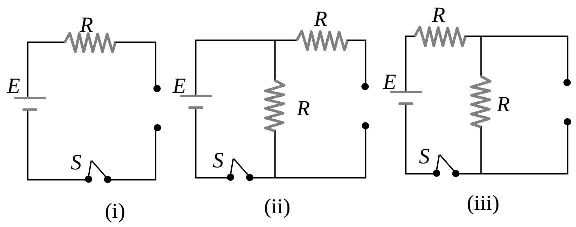
25. (c) The induced emf between centre and rim of the rotating disc is

$E=\frac{1}{2}B\omega R^2 = \frac{1}{2}\times0.1\times2\pi\times10\times(0.1)^2 = 10\pi\times10^{-3}\,volt$

26. (a) $\because\ L\propto N^2 r;\ \ \frac{L_1}{L_2}=\left(\frac{N_1}{N_2}\right)^2\times\frac{r_1}{r_2}$

$\Rightarrow\ \frac{L}{L_2}=\left(\frac{1}{2}\right)^2\times\left(\frac{r}{r/2}\right)=\frac{1}{2};\ \ L_2 = 2L$

27. (b) At $t = 0$ current through L is zero so it acts as open circuit. The given figures can be redrawn as follow.



$i_1 = 0$ $\quad i_2=\frac{E}{R}$ $\quad i_3=\frac{E}{2R}$

Hence $i_2 > i_3 > i_1$.

28. (c)JEE MAIN 2019

Net charge,

$Q=\frac{\Delta\phi}{R}=\frac{1}{10}A(B_f-B_i)=\frac{1}{10}\times3.5\times10^{-3}\left(0.4\sin\frac{\pi}{2}-0\right)$

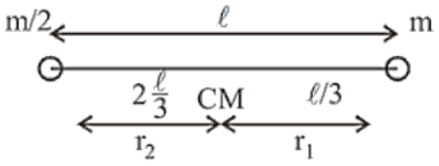
$=\frac{1}{10}(3.5\times10^{-3})(0.4-0)$

$=1.4\times10^{-4}$

29. (c) **JEE MAIN 2019**

As we know that, $\omega=\sqrt{\frac{k}{I}}$

$\omega=\sqrt{\frac{3k}{m\ell^2}}\left[\because I_{rod}=\frac{1}{3}m\ell^2\right]$



Tension when it passes through the mean position,

$= m\omega^2\theta_0^2\frac{\ell}{3} = m\frac{3k}{m\ell^2}\theta_0^2\frac{\ell}{3} = \frac{k\theta_0^2}{\ell}$

30. (b) **JEE MAIN 2019**

Efficiency, $\eta = \frac{P_{out}}{P_{in}} = \frac{V_s I_s}{V_p I_p}$

$\Rightarrow 0.9 = \frac{230 \times I_s}{2300 \times 5}$

$\Rightarrow I_s = 0.9 \times 50 = 45A$

Output current $= 45A$