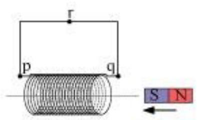
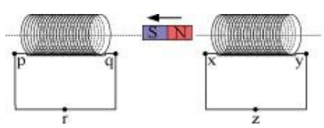
Class: 12
Subject: Physics
Topic: Electromagnetic induction
No. of Questions: 41

1. Predict the direction of induced current in the situations described by the following Figs. 6.18 (a) to (f).

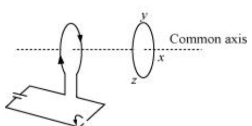
(a)



(b)

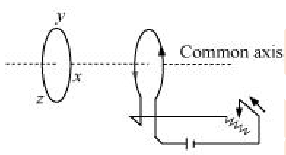


(c)



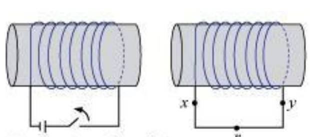
(Tapping key just closed)

(d)



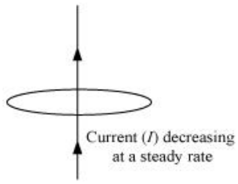
(Rheostat setting being changed)

(e)



(Tapping key just released)

(f)



2. If resistance R in circuit 'a' of Fig. 4(a).29 be decreased, what will be the direction of induced current in the circuit 'b'?

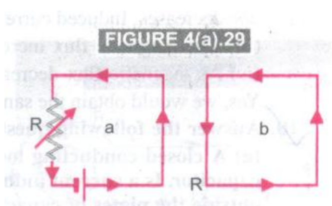


FIGURE 4(a).29

3. A bar magnet falls through a metal ring. Will its acceleration be equal to 'g'?

4. In the above problem, if the ring si cut somewhere, what would be the answer?

5. Answer the following questions:
   (a) A closed conducting loop move normal to the electric field between the plates of large capacitor. Is a current induced in the loop when it is (i) wholly inside the capacitor (ii) partially outside the plates of capacitor. Electric field is normal to the plane of the loop.
   (b) A rectangular loop and a circular loop are moving out of a uniform magnetic field region to a field free region with a constant velocity, Fig. 4(a). 31. In which loop do you expect the induced e.m.f. to be constant during the passage out of the field region, the field is normal to the loops?
   (c) Predict the polarity of the capacitor in the situation described by Fig. 4(a).32:

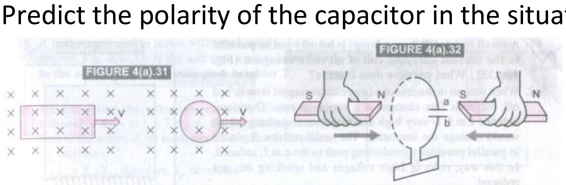


FIGURE 4(a).31
FIGURE 4(a).32

6. A small resistor R (say, a lamp) is usually put in parallel to the current carrying coil of an electromagnet, [Fig. 4(a).35]. What purpose does it serve?

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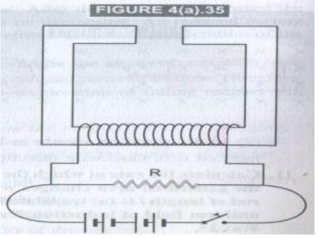
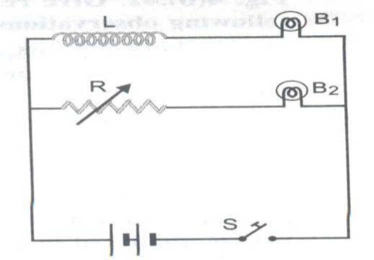
FIGURE 4(a).35



7. In co-axial concentric coils of radius r_1 and r_2 such that $r_1 << r_2$, Fig. 4(a).36, find direction of induced current when K is (i) pressed (ii) released.

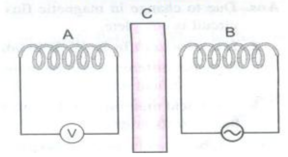
8. Answer the following questions:
   Figure 4(a).38 shows an inductor L and resistance R connected in parallel to a battery through a switch. The resistance of R is the same as that of the coil that makes L. Two identical bulbs are put in each arm of the circuit. (i) Which of the bulb lights up earlier when S is closed? (ii) Will the bulb be equally bright after some time?

FIGURE 4(a).38



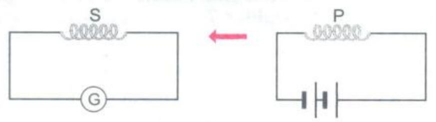
9. A coil A is connected to a voltmeter V and the other coil B to an alternating current source, Fig. 4(a).40. If a large copper sheet is placed between the two coils, how does the induced emf in coil A change due to current in coil B?

FIGURE 4(a).40



10. When primary coil P is moved towards secondary coil S, Fig. 4(b).41, the galvanometer shows momentary deflection. What can be done to have larger deflection in the galvanometer with same battery? State the related law?

FIGURE 4(a).41



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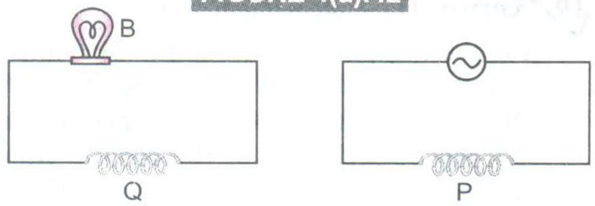
11. A coil Q is connected to low voltage bulb B and placed near another coil P as shown in Fig. 4(b).42. Give reasons to explain the following observations:
   (a) The bulb B lights
   (b) Bulb gets dimmer if coil Q is moved towards left.

FIGURE 4(a).42



12. A uniformly wound solenoid coil of self-inductance 1.8 $\times$ 10^{-4} H and resistance 6 Ω is broken up into two identical coils. These identical coils are then connected across a 12 V battery of negligible resistance. The time constant for the current in the circuit is

A. 0.3 $\times$ 10^{-4} s
B. 0.3 $\times$ 10^{-3} s
C. 0.3 $\times$ 10^{-2} s
D. 0.3 μs

13. A uniformly wound solenoid coil of self-inductance 1.8 $\times$ 10^{-4} H and resistance 6 Ω is broken up into two identical coils. These identical coils are then connected across a 12 V battery of negligible resistance, the steady current through the battery is

A. 8 μA
B. 0.8 A
C. 8 mA
D. 8 A

14. A square loop of side l, mass m and resistance R falls vertically into a uniform magnetic field directed perpendicular to the plane of the coil. The height h through which the loop falls, so that it attains terminal velocity on entering the region of magnetic field is given by

A. $\frac{mgR}{2Bl}$
B. $\frac{m^2gR^2}{2B^2l^2}$
C. $\frac{mgR^2}{4B^3l^3}$
D. $\frac{m^2gR^2}{2B^4l^4}$

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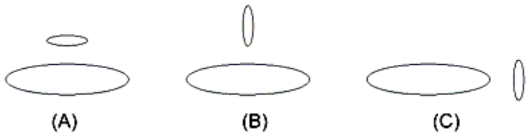
15. The mutual inductance between two planar concentric rings of radii r_1 and r_2 (with $r_1 > r_2$) placed in air is given by

A. $\frac{\mu_0 \pi r_2^2}{2r_1}$
B. $\frac{\mu_0 \pi r_1^2}{2r_2}$
C. $\frac{\mu_0 \pi (r_1 + r_2)^2}{2r_1}$
D. $\frac{\mu_0 \pi (r_1 + r_2)^2}{2r_2}$

16. A small square loop of wire of side l is placed inside a large square loop of wire of side L (L >> l). The loops are coplanar and their centres coincide. The mutual inductance of the system is proportional to

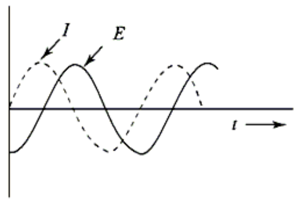
A. $\frac{l}{L}$
B. $\frac{l^2}{L}$
C. $\frac{L}{l}$
D. $\frac{L^2}{l}$

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



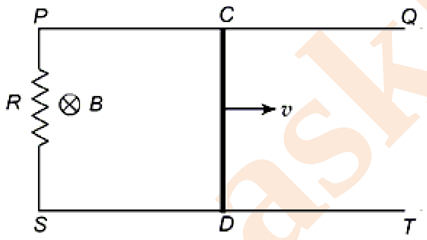
A. maximum in situation (A)
B. maximum in situation (B)
C. maximum in situation (C)
D. the same in all situations

18. When an A.C. source of e.m.f. $E = E_0 \sin(100t)$ is connected across a circuit, the phase difference between the e.m.f. E and the current I in the circuit is observed to be $\pi/4$, as shown in the figure below. If the circuit consists possibly only of R-C or R-L or L-C in series, what will be the relation between the two elements of the circuit?



A. R = 1 kΩ, C = 10 μF
B. R = 1 kΩ, C = 1 μF
C. R = 1 kΩ, L = 10 H
D. R = 1 kΩ, L = 1 H

19. Two parallel wires PQ and ST, placed a distance w apart are connected by a resistor R as shown in the figure and placed in a magnetic field B which is perpendicular to the plane containing the wires. A rod CD connects the two wires. The power spent to slide the rod CD with a velocity v along the wires is (neglect the resistance of the wires and the rod)



A. $\frac{Bwv}{R}$
B. $\frac{Bwv}{R^2}$
C. $\frac{(Bwv)^2}{R}$
D. $\left(\frac{Bwv}{R}\right)^2$

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20. An air plane, with 20 m wingspread is flying at 250 ms^{-1} parallel to the earth's surface at a place where the horizontal component of earth's magnetic field is 2 × 10^{-5} T and angle of dip is 60°. The magnitude of the induced emf between the tips of the wings is

A. $\frac{1}{10}$ V
B. $\frac{\sqrt{2}}{10}$ V
C. $\frac{\sqrt{3}}{10}$ V
D. $\frac{1}{5}$ V

21. A coil of metal wire is kept stationary with its plane perpendicular to a uniform magnetic field directed along the positive x-axis. The current induced in the coil

A. circulates in anti-clockwise direction when viewed from the x-axis
B. circulates in clockwise direction when viewed from the x-axis
C. is perpendicular to the direction of the magnetic field
D. is zero

22. In a car spark coil, an emf of 40,000 volts is induced in its secondary windings when the current in its primary winding changes from 4 A to zero in 10 μs. The mutual inductance between the primary and the secondary windings of the spark coil is

A. 0.1 H
B. 0.3 H
C. 0.2 H
D. 0.4 H

23. In a plane electromagnetic wave, the electric field oscillates sinusoidally at a frequency of 2.0 × 10^{10} Hz. What is the wavelength of the wave?

A. cm
B. 1.5 cm
C. cm
D. cm

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24. In Q. 12, if the peak value of the electric field is 60 Vm^{-1}, the average energy density (in Jm^{-3}) of the magnetic field of the wave will be (given $\mu_0 = 4\pi\times10^{-7}$ Fm^{-1})

A. $2\pi\times10^{-7}$
B. $4\pi\times10^{-7}$
C. $\frac{1}{2\pi}\times10^{-7}$
D. $\frac{1}{4\pi}\times10^{-7}$

25. An electromagnetic wave is produced by oscillating electric and magnetic fields **E** and **B**. Choose the only incorrect statement from the following.

A. **E** is perpendicular to **B**.
B. **E** is perpendicular to the direction of propagation of the wave.
C. **B** is perpendicular to the direction of propagation of the wave.
D. **E** is parallel to **B**.

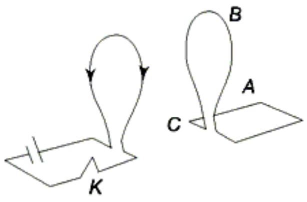
26. . Which of the following pairs of space and time varying **E** = ($\hat{i}E_x + \hat{j}E_y + \hat{k}E_z$) and **B** = ($\hat{i}B_x + \hat{j}B_y + \hat{k}E_z$) would generate a plane electromagnetic wave travelling in the z-direction?

A. E_x, B_z
B. E_y, B_z
C. E_z, B_x
D. E_x, B_y

27. What is the self inductance of an air – core solenoid, 3.14 m long, cross-sectional area 10^{-3} m^2 and having 500 turns?

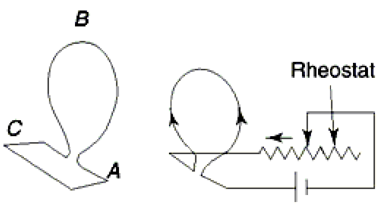
A. 0.1 mH
B. 0.2 mH
C. 0.3 mH
D. 0.4 mH

28. The figure below shows two coils placed close to each other. When the key K is pressed so that a current starts building up in one of the coils, then



A. a current flows along ABC in the other coil
B. a current flows along CBA in the other coil
C. no current flows in the other coil
D. an alternating current flows in the other coil

29. The figure below shows two coils placed close to each other. When the current through one coil is decreased gradually by shifting the position of the rheostat, then



A. a current flows along ABC in the other coil
B. a current flows along CBA in the other coil
C. no current flows in the other coil
D. an alternating current flows in the other coil

30. If the flux of magnetic induction through a coil of resistance R and having n turns changes from ϕ_1 to ϕ_2, then the magnitude of the charge that passes through the coil is

A. $\frac{(\phi_2 - \phi_1)}{R}$
B. $\frac{n(\phi_2 - \phi_1)}{R}$
C. $\frac{(\phi_2 - \phi_1)}{nR}$
D. $\frac{nR}{(\phi_2 - \phi_1)}$

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31. A metallic wheel with 8 metallic spokes, each of length r, is rotating at an angular frequency w in a plane perpendicular to the magnetic field B. The magnitude of the induced emf between the axle and the rim of the wheel is

A. $\frac{1}{2}\omega r^2 B$
B. $2\omega r^2 B$
C. $4\omega r^2 B$
D. $8\omega r^2 B$

32. A uniformly wound solenoid coil of self-inductance 1.8 $\times$ 10^{-4} H and resistance 6 Ω is broken up into two identical coils. These identical coils are then connected across a 12 V battery of negligible resistance. The time constant for the current in the circuit is

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34. A square loop of side l, mass m and resistance R falls vertically into a uniform magnetic field directed perpendicular to the plane of the coil. The height h through which the loop falls, so that it attains terminal velocity on entering the region of magnetic field is given by

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35. The mutual inductance between two planar concentric rings of radii r_1 and r_2 (with $r_1 > r_2$) placed in air is given by

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36. A small square loop of wire of side l is placed inside a large square loop of wire of side L (L >> l). The loops are coplanar and their centres coincide. The mutual inductance of the system is proportional to

A. $\frac{l}{L}$

B. $\frac{l^2}{L}$

C. $\frac{L}{l}$

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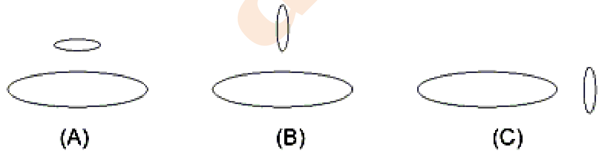

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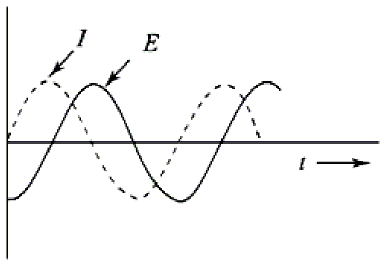
38. When an A.C. source of e.m.f. $E = E_0 \sin(100t)$ is connected across a circuit, the phase difference between the e.m.f. E and the current I in the circuit is observed to be $\pi/4$, as shown in the figure below. If the circuit consists possibly only of R-C or R-L or L-C in series, what will be the relation between the two elements of the circuit?



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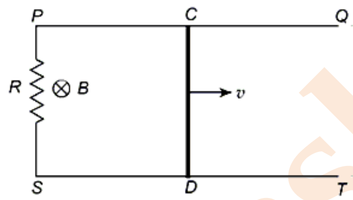

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B. $\frac{Bwv}{R^2}$
C. $\frac{(Bwv)^2}{R}$
D. $\left(\frac{Bwv}{R}\right)^2$

40. An air plane, with 20 m wingspread is flying at 250 ms^{-1} parallel to the earth's surface at a place where the horizontal component of earth's magnetic field is 2×10^{-5} T and angle of dip is 60°. The magnitude of the induced emf between the tips of the wings is

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B. $\frac{\sqrt{2}}{10}$ V
C. $\frac{\sqrt{3}}{10}$ V
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41. A coil of metal wire is kept stationary with its plane perpendicular to a uniform magnetic field directed along the positive x-axis. The current induced in the coil

A. circulates in anti-clockwise direction when viewed from the x-axis
B. circulates in clockwise direction when viewed from the x-axis
C. is perpendicular to the direction of the magnetic field
D. is zero