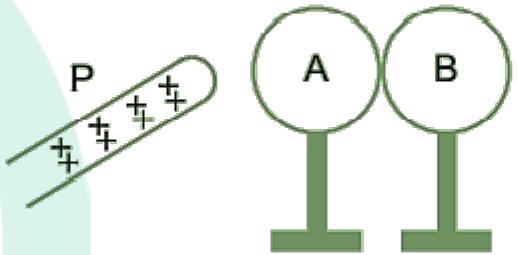
1 Two metallic spheres A and B kept on insulating stands are in contact with each other. A positively charged rod P is brought near the sphere A as shown in the figure. The two spheres are separated from each other, and the rod P is removed. What will be the nature of charges on spheres A and B?



A. Positive and Negative respectively
B. Both Positive
C. Negative and Positive respectively
D. Both Negative

2 Two identical point charges, q(+ve) each, are kept 2 m apart in air. A third point charge Q of unknown magnitude and sign is placed on the line joining the charges such that the system remains in equilibrium. Find the position and nature of Q.

A. 1m from left and only Negative nature
B. 1m from right and only Positive nature
C. 1m from left and can be negative or positive in nature
D. 0.5m from right and can be negative or positive in nature

3 A simple pendulum consists of a small sphere of mass m suspended by a thread of length l. The sphere carries a positive charge q. The pendulum is placed in a uniform electric field of strength E directed vertically downwards. Find the period of oscillation of the pendulum due to the electrostatic force acting on the sphere, neglecting the effect of the gravitational force.

A. $T = 2\pi\sqrt{\frac{ml}{qE}}$

B. $T = 2\pi\sqrt{\frac{ql}{mE}}$

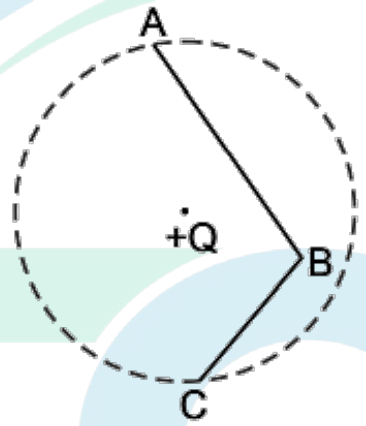
C. $T = 2\pi\sqrt{\frac{El}{mE}}$

D. $T = 2\pi\sqrt{\frac{mE}{ql}}$

4 Calculate the amount of work done in rotating a dipole, of dipole moment 2×10^{-8} cm, from its position of stable equilibrium to the position of unstable equilibrium, in uniform electric field of intensity 5×10^{4} N/C.

A. 0.2×10^{-4} J
B. 10×10^{-4} J
C. 20×10^{-3} J
D. 20×10^{-4} J

5 In the given figure, charge $+Q$ is placed at the centre of a dotted circle. Work done in taking another charge $+q$ from A to B is W_1 and from B to C is W_2. Which one of the following is correct: $W_1 > W_2$, $W_1 = W_2$ and $W_1 < W_2$?

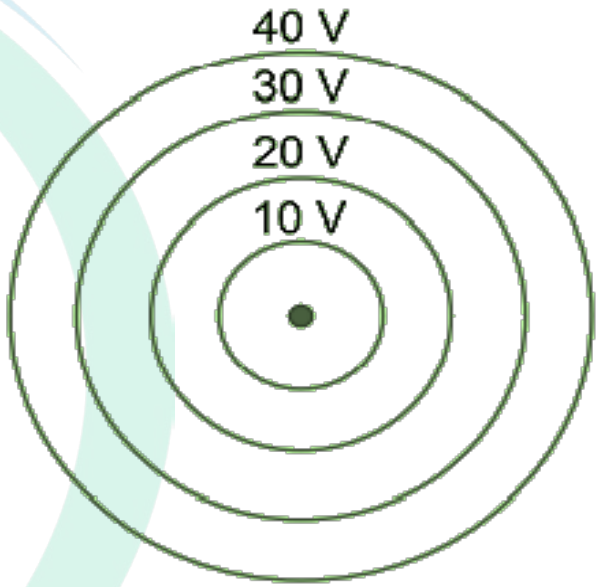


A. $W_1 > W_2$
B. $W_1 = W_2$
C. $W_1 < W_2$
D. None of the above

6 A hollow metal sphere of radius 5 cm is charged such that the potential on its surface is 10 V. What is the potential at the centre of the sphere?

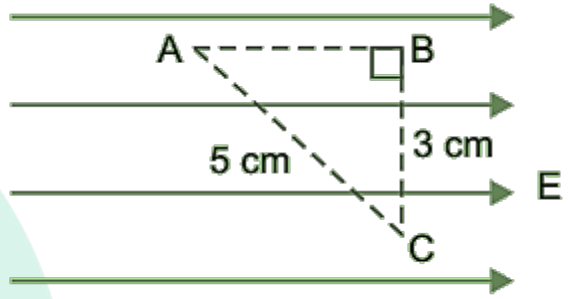
A. 100 V
B. 10 V
C. 50 V
D. 2 V

7 Concentric equipotential surfaces due to a charged body placed at the centre are shown. Identify the polarity of the charge



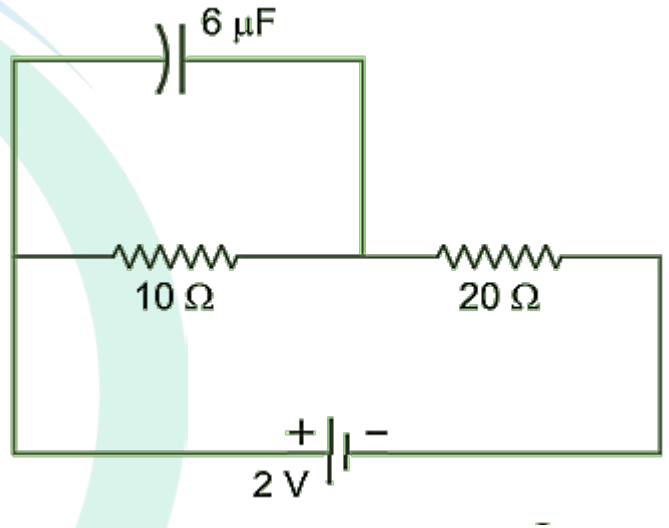
A. Positive
B. Negative
C. Neutral
D. All of the above

8 Three points A, B and C lie in a uniform electric field (E) of 5×10^3 NC^{-1} as shown in the figure. Find the potential difference between A and C.



A. 250 V
B. 200 V
C. 150 V
D. 500 V

9 Find the charge on the capacitor as shown in the circuit.



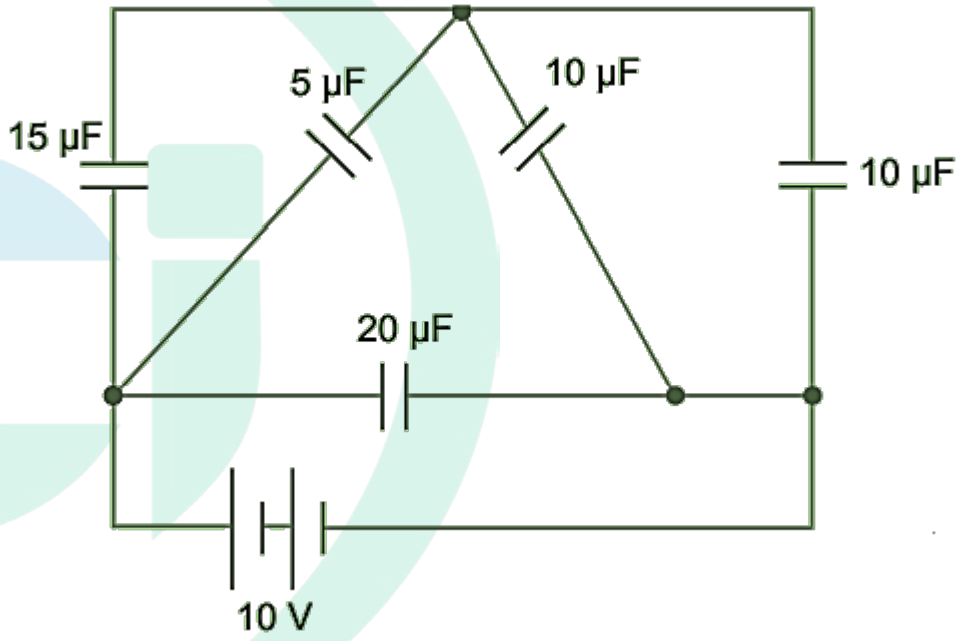
A. $3\ \mu\ C$
B. $4\ \mu\ C$
C. $12\ \mu\ C$
D. $6\ \mu\ C$

10 Net capacitance of three identical capacitors in series is 1 μF. What will be their net capacitance if connected in parallel? Find the ratio of energy stored in the two configurations if they are both connected to the same source.

A. 3 μF and $U_s : U_p = 1 : 9$
B. 1/3 μF and $U_s : U_p = 9 : 1$
C. 1/3 μF and $U_s : Up = 1 : 9$
D. 3 μF and $U_s : Up = 9 : 1$

11 The figure shows a network of five capacitors connected to a 10 V battery. Calculate the charge acquired by the 5 µF capacitor.

A. 15 μ C
B. 25 μ C
C. 10 μ C
D. 20 μ C



12 Consider two conducting spheres of radii R_1 and R_2 with $R_1 > R_2$. If the two are at the same potential, the larger sphere has more charge than the smaller sphere. State whether the charge density of the smaller sphere is more or less than that of the larger one.

A. $\sigma_1 \geq \sigma_2$
B. $\sigma_1 = \sigma_2$
C. $\sigma_1 > \sigma_2$
D. $\sigma_1 < \sigma_2$

13 Two parallel plate capacitors X and Y have the same area of plates and same separation between them are connected in series with a battery of 15 V. X has air between the plates while Y contains a dielectric medium $\varepsilon_r = 4$.

I. Capacitance of each capacitor if equivalent capacitance of the combination is 4 µF

A. 5 μF & 20 μF (boxed)
B. 3 μF & 1 μF
C. 4 μF & 16 μF
D. 3.5 μF & 1.5 μF

II. Calculate the potential difference between the plates of X and Y.

A. 12 V & 3 V (boxed)
B. 3 V & 12 V
C. 10 V & 5 V
D. 5 V & 10 V

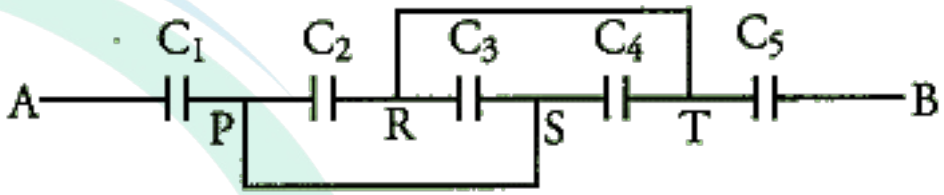
III. Estimate the ratio of electrostatic energy stored in X and Y.

A. 1 : 4
B. 2 : 3
C. 4 : 1 (boxed)
D. 3 : 2

14 Two capacitors of unknown capacitances C_1 and C_2 are connected first in series and then in parallel across a battery of 100 V. If the energy stored in the two combinations is 30 mJ and 125 mJ respectively, the value of C_1 and C_2-

A. 5 μF & 20 μF
B. 12 μF & 13 μF
C. 15 μF & 10 μF
D. 20 μF & 5 μF

15 Find equivalent capacitance between A and B in the combination given below. Each capacitor is of 2μF capacitance.



A. $9/4\ \mu\ F$
B. $4/9\ \mu\ F$
C. $7/6\ \mu\ F$
D. $6/7\ \mu\ F$

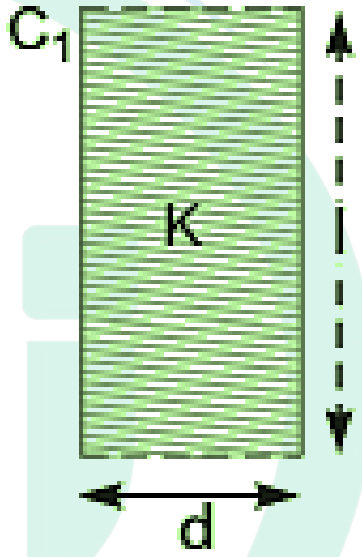
16 Two identical parallel plate (air) capacitors C_1 and C_2 have capacitances C each. The space between their plates is now filled with dielectrics as shown. If the two capacitors still have equal capacitance, obtain the relation between dielectric constants K, K_1 and K_2.

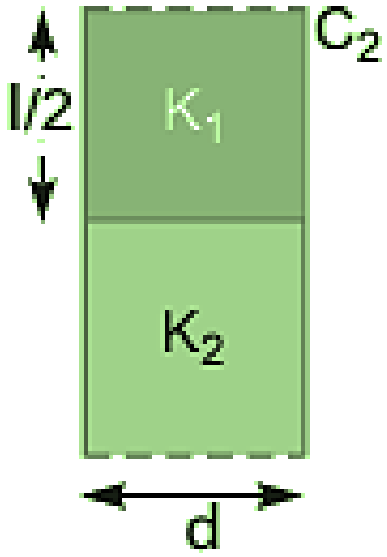
$A.\ K = \frac{1}{2}[K_1 + K_2]$

$B.\ K = [K_1 + K_2]$

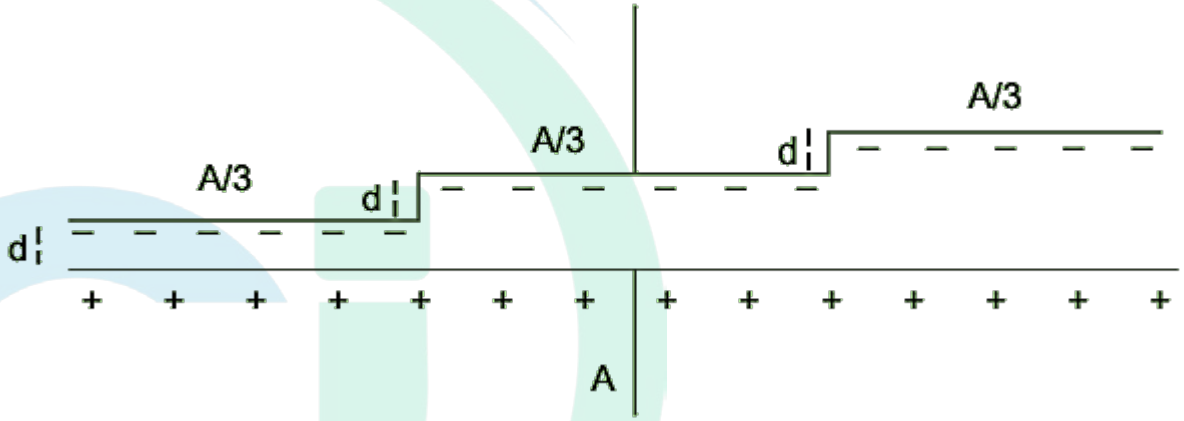
$C.\ K = \frac{1}{2}[\frac{K_1 + K_2}{K_1 K_2}]$

$D.\ K = 2[\frac{K_1 + K_2}{K_1 K_2}]$





17 A capacitor is made of a flat plate of area A and second plate having a stair like structure as shown in figure below. If width of each stair is A/3 and height is d. Find the capacitance of the arrangement.



A. $\frac{11A\epsilon_0}{18d}$

B. $\frac{7A\epsilon_0}{18d}$

C. $\frac{18A\epsilon_0}{d}$

D. $\frac{18A\epsilon_0}{7d}$

18

A wire whose cross-sectional area is increasing linearly from its one end to the other, is connected across a battery of V volts. Which of the following quantities remain constant in the wire ?

A. electric current
B. current density
C. drift speed
D. electric field

19 Nichrome, iron and copper wires of same length and same radius are connected in series. Current I is passed through them. Which wire gets heated up more ?

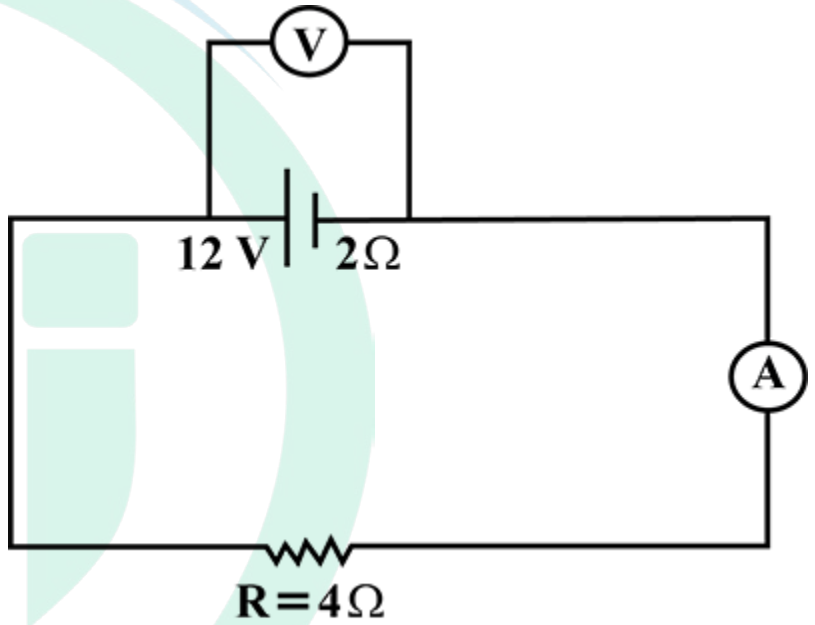
A. Nichrome
B. Iron
C. Copper
D. Same for all of the above

20 The potential difference applied across a given resistor is altered so that the heat produced per second increases by a factor of 9 By what factor does the applied potential difference change ?

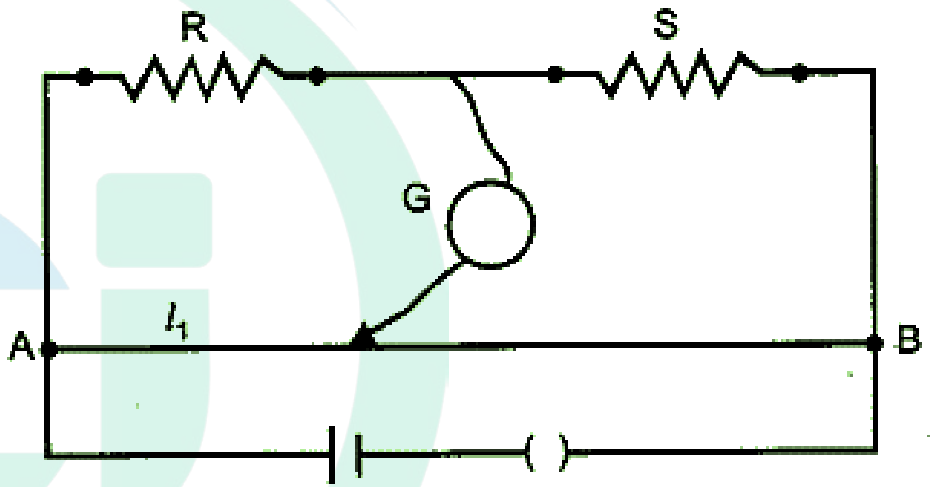
A. Increases by a factor of 9
B. Increases by a factor of 3
C. Decreases by a factor of 3
D. Decreases by a factor of 9

21 An ammeter A and a resistor of 4 Ω are connected to the terminals of the source. The emf of the source is 12 V having the internal resistance of 2Ω . What will be the voltmeter and ammeter readings

A. 12 V & 2 A
B. 8 V & 2 A
C. 8 V & 3 A
D. 12 V & 3 A



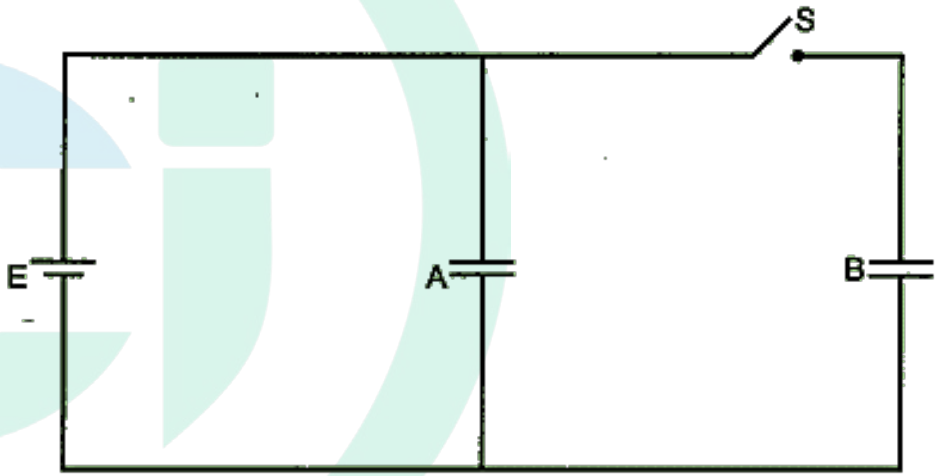
22 In a meter bridge, the balance point is found at a distance $l_1 = 40$ cm with resistances R = 80 Ω and S = 120 Ω as shown in the figure. An unknown resistance X is now connected in parallel to the resistance S and the balance point is found at a distance $l_2 = 50$ cm. then X is -



A. 120 Ω
B. 240 Ω
C. 60 Ω
D. 100 Ω

23 Two identical parallel plate capacitors A and B are connected to battery of V volts with the switch S closed. The switch is now opened and the free space between the plates of the capacitors is filled with a dielectric of dielectric constant 3. Find the ratio of the total electrostatic energy stored in both capacitors before and after the introduction of the dielectric.

A. 0.6
B. 0.8
C. 0.4
D. 0.3



24 What is the relation between mobility and relaxation time?

A. $\mu = \frac{m\tau}{e}$

B. $\mu = \frac{e\tau}{m}$

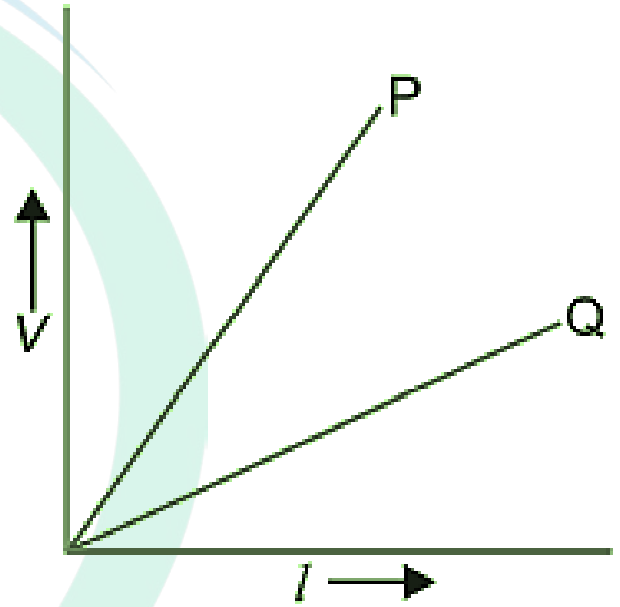
C. $\mu = \frac{em}{\tau}$

D. $\mu = \frac{\tau}{em}$

25 Under what condition will the current in a wire be the same when connected in series and in parallel of n identical cells each having internal resistance r and external resistance R ?

A. R = r/2
B. R = 2r
C. R = r
D. R = r/3

26 The variation of potential difference V with length l in the case of two potentiometer P and Q is as shown. Which of these two will you prefer for comparing the emfs of two primary cells



A. P
B. Q
C. Both
D. None

27 Two cells of emfs 1.5 V and 2.0 V having internal resistances 0.2 Ω and 0.3 Ω respectively are connected in parallel. Calculate the emf and internal resistance of the equivalent cell.

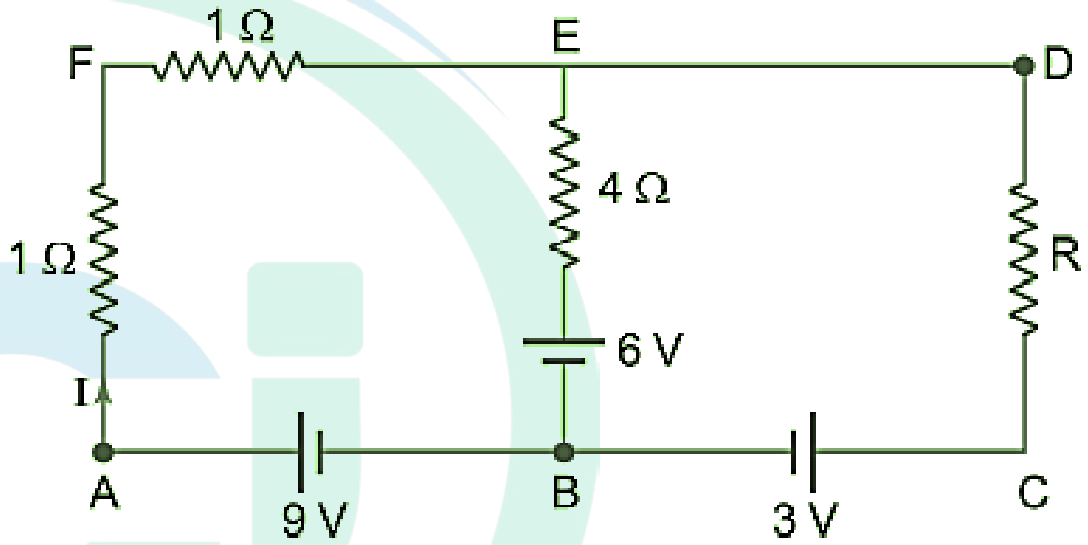
A. 1.4 V & 0.12 Ω
B. 1.7 V & 0.12 Ω
C. 1.7 V & 0.50 Ω
D. 2.1 V & 0.50 Ω

28 Two conducting wires X and Y of same diameter but different materials are joined in series across a battery. If the number density of electrons in X is twice that in Y, find the ratio of drift velocity of electrons in the two wires

A. 2 : 1
B. 1 : 2
C. 1 : 4
D. 4 : 1

29 Using Kirchoff's rules determine the value of unknown resistance R in the circuit so that no current flows through 4 Ω resistance.

A. 1 Ω
B. 2 Ω
C. 4 Ω
D. 3 Ω



30 A wire of 20Ω resistance is gradually stretched to double its original length. It is then cut into two equal parts. These parts are then connected in parallel across a 4.0 volt battery. Find the current drawn from the battery.

A. 0.2 A
B. 0.3 A
C. 0.4 A
D. 0.5 A

31

A straight current carrying conductor is placed inside a uniform magnetic field. The force per unit length acting on the conductor is

(*a*) maximum when the conductor is perpendicular to the direction of magnetic field.

(*b*) maximum when the conductor is along the direction of magnetic field.

(*c*) minimum when the conductor is perpendicular to the direction of magnetic field.

(*d*) minimum when the conductor makes an angle of 45° with the direction of magnetic field.

32

A region has a uniform magnetic field in it. A proton enters into the region with velocity making an angle of 45° with the direction of the magnetic field. In this region the proton will move on a path having the shape of a

(*a*) straight line
(*b*) circle
(*c*) spiral
(*d*) helix

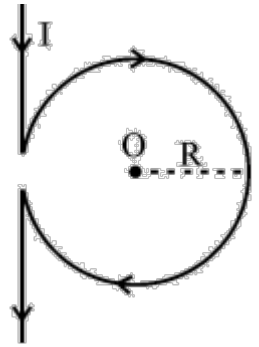
33 The magnetic dipole moment of a current carrying coil does not depend upon

A. number of turns of the coil.
B. cross-sectional area of the coil.
C. current flowing in the coil.
D. material of the turns of the coil.

34 An electron is released from rest in a region of uniform electric and magnetic fields acting parallel to each other. The electron will

A. move in a straight line.
B. move in a circle
C. remain stationary
D. move in a helical path.

35 A current I flows through a long straight conductor which is bent into a circular loop of radius R in the middle as shown in the figure.
The magnitude of the net magnetic field at point O will be



A. Zero

B. $\frac{\mu_0 I}{2R}(1+\pi)$

C. $\frac{\mu_0 I}{4\pi R}$

D. $\frac{\mu_0 I}{2R}\left(1-\frac{1}{\pi}\right)$

36 A charge particle after being accelerated through a potential difference 'V' enters in a uniform magnetic field and moves in a circle of radius r. If V is doubled, the radius of the circle will become

A. $2r$

B. $\sqrt{2}r$

C. $4\,r$

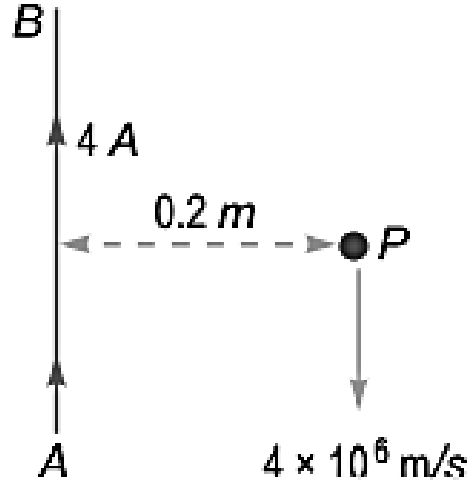
D. $\frac{r}{\sqrt{2}}$

37 An electron does not suffer any deflection while passing through a region of uniform magnetic field. What is the direction of the magnetic field?

A. Magnetic field is parallel or antiparallel to velocity of electron
B. Magnetic field is perpendicular to velocity of electron
C. Magnetic field at some angle Ø(not equals to 0 or 180°) to velocity of electron
D. None of the above

38

A long straight wire AB carries a current of 4 A. A proton P travels at 4×10^6 ms^{-1} parallel to the wire 0.2 m from it and in a direction opposite to the current as shown in the figure. Calculate the force which the magnetic field due to the current carrying wire exerts on the proton. Also specify its direction.



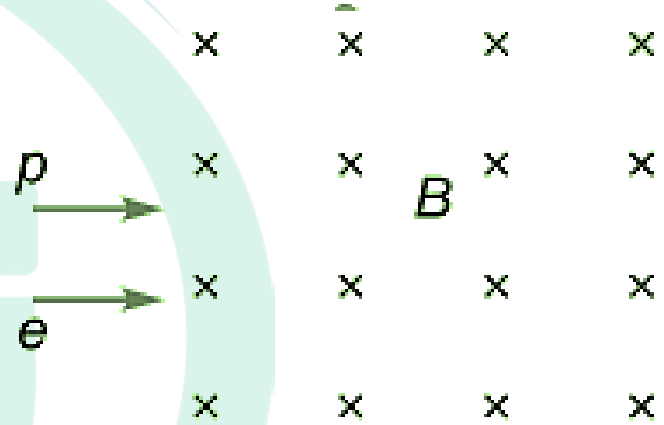
39

A magnetised needle of magnetic moment 4.8×10^{-2} J T^{-1} is placed at 30° with the direction of uniform magnetic field of magnitude 3×10^{-2} T. Calculate the torque acting on the needle.

A. 7.2×10^{-3} N-m
B. 7.2×10^{-4} N-m
C. 3.6×10^{-4} N-m
D. 14.4×10^{-4} N-m

40 An electron and a proton enter a region of uniform magnetic field B with uniform speed v in a perpendicular direction (fig.). What is the ratio of the radii of the circular paths of electron to proton?

A. $m_p : m_e$
B. $m_e : m_p$
C. $q_p : q_e$
D. $q_p : q_e$



41 A circular coil of ‘N’ turns and diameter ‘d’ carries a current ‘I’. It is unwound and rewound to make another coil of diameter ‘2d’, current ‘I’ remaining the same. Calculate the ratio of the magnetic moments of the new coil and the original coil.

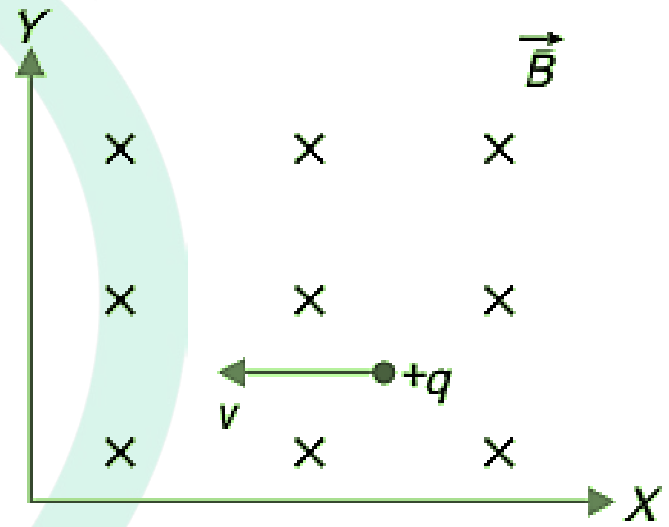
A. 1 : 2
B. 2 : 1
C. 4 : 3
D. 3 : 1

42 A wire AB is carrying a steady current of 12 A and is lying on the table. Another wire CD carrying 5 A is held directly above AB at a height of 1 mm. Find the mass per unit length of the wire CD so that it remains suspended at its position when left free.

A. 1.2×10^{-2} kg/m
B. 1.2×10^{-3} kg/m
C. 1.2×10^{-4} kg/m
D. 1.2×10^{-1} kg/m

43 A point charge is moving with a constant velocity perpendicular to a uniform magnetic field as shown in the figure. What should be the magnitude and direction of the electric field so that the particle moves undeviated along the same path?

A. +y axis & -y axis respectively
B. -y axis & +y axis respectively
C. +x axis & -x axis respectively
D. -x axis & +x axis respectively



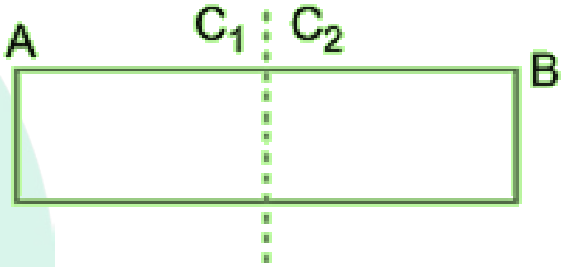
44 SI unit of magnetic pole strength is

A. Ampere – meter^2
B. Ampere / meter
C. Ampere/meter^2
D. Ampere – meter

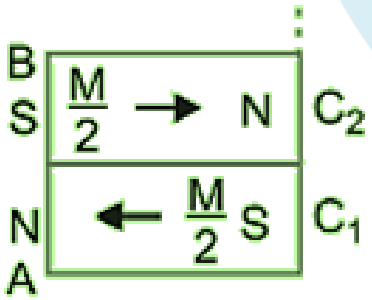
45 At a place, the horizontal component of earth's magnetic field is B and angle of dip is 60°. What is the value of horizontal component of the earth's magnetic field at equator?

A. 2B
B. B/2
C. $2B/\sqrt{3}$
D. $\sqrt{3}$ B/2

46 A hypothetical bar magnet (AB) is cut into two equal parts. One part is now kept over the other, so that the pole C_2 is above C_1. If M is the magnetic moment of the original magnet, what would be the magnetic moment of the combination, so formed?



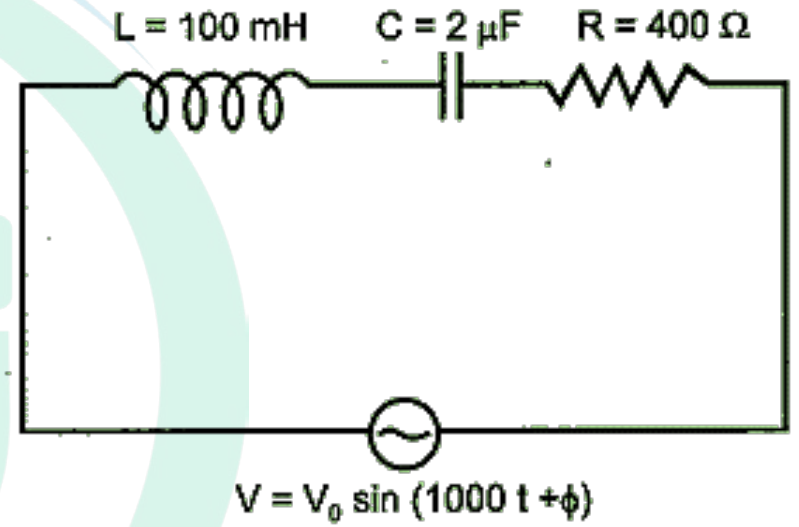
A. M
B. M/4
C. 0
D. M/2



47 A long straight current carrying wire passes normally through the center of circular loop. If the current through the wire increases, then induced emf in the loop -

A. Increase
B. Decrease
C. Zero
D. None of the above

48 Find the value of the phase difference between the current and the voltage in the series LCR circuit shown below. Which one leads in phase current or voltage ?



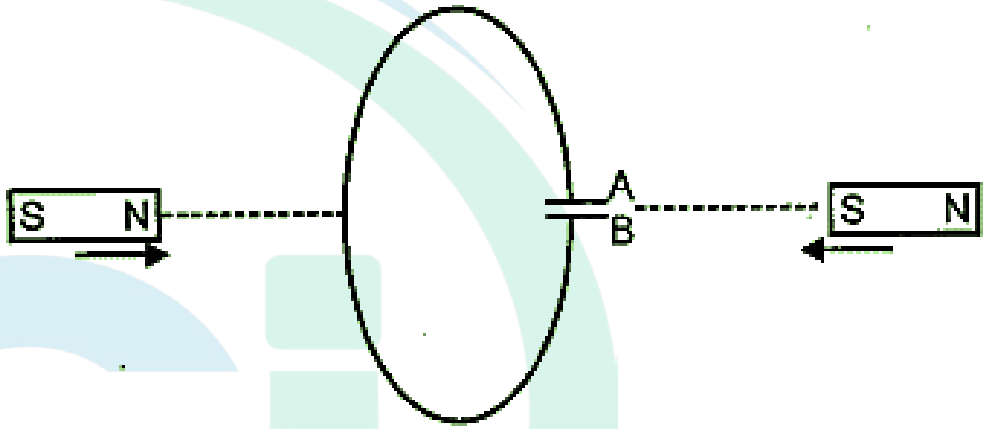
A. Voltage
B. Current
C. Both are in same phase
D. None of these

49 A power transmission line feeds input power at 2200 V to a step-down transformer with its primary winding's having 3000 turns. Find the number of turns in the secondary to get the power output at 220 V.

A. 30000
B. 300
C. 30
D. 3000

50 Predict the polarity of the capacitor in the situation described below

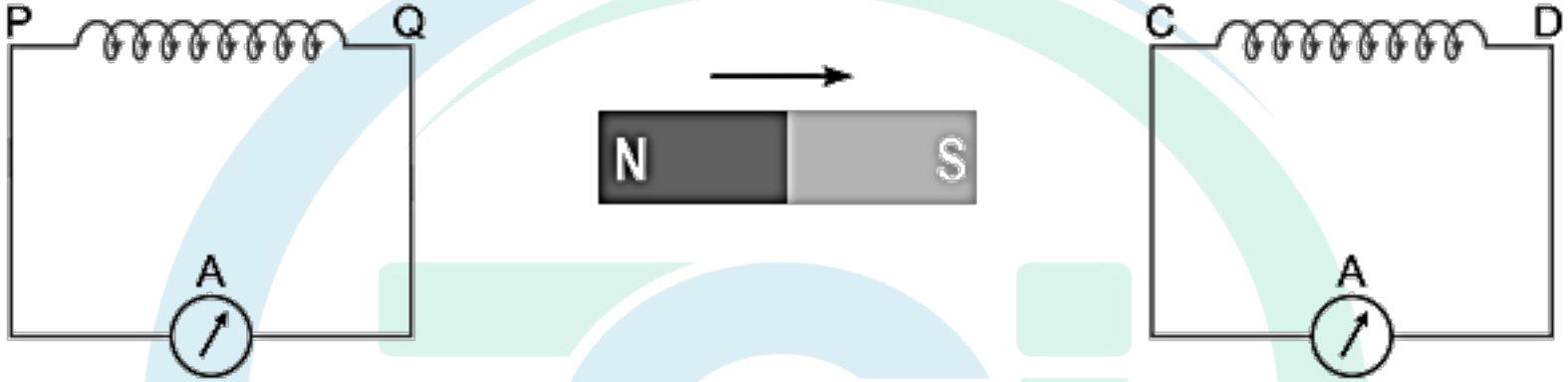
A. A will be positive w.r.t. B
B. B will be positive w.r.t. A
C. No polarization
D. None of the above



51 Two spherical bobs, one metallic and the other of glass, of the same size are allowed to fall freely from the same height above the ground. Which of the two would reach earlier

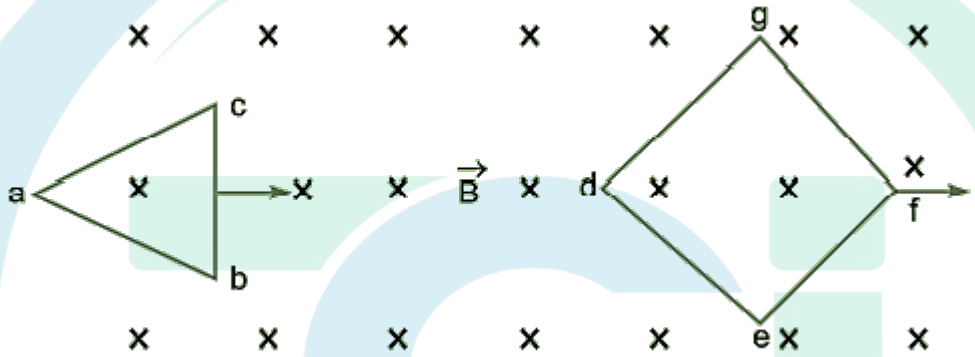
A. Metallic bob
B. Glass bob
C. Both will reach on same time
D. None of the above

52 **A bar magnet is moved in the direction indicated by the arrow between two coils *PQ* and *CD*. Predict the directions of induced current in each coil.**



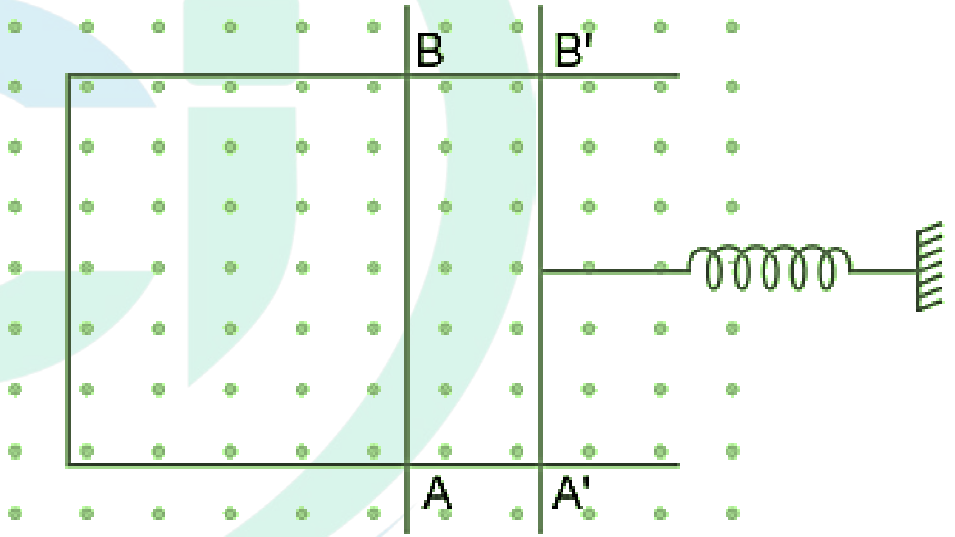
A. Clockwise for PQ and anticlockwise for CD
B. Anticlockwise for PQ and anticlockwise for CD
C. Clockwise for PQ and clockwise for CD
D. Anticlockwise for PQ and clockwise for CD

53 Two loops of different shapes are moved in the region of a uniform magnetic field pointing downward. The loops are moved in the directions shown by arrows. What is the direction of induced current in each loop?



A. Anticlockwise for loop abc and clockwise for loop defg
B. Anticlockwise for loop abc and anti-clockwise for loop defg
C. Clockwise for loop abc and anti-clockwise for loop defg
D. Clockwise for loop abc and clockwise for loop defg

54 A rectangular wire frame, shown below, is placed in a uniform magnetic field directed upward and normal to the plane of the paper. The part AB is connected to a spring. The spring is stretched and released when the wire AB has come to the position A′ B′ (t = 0) How would the induced emf vary with time?



55 A solenoid is connected to a battery so that a steady current flows through it. If an iron core is inserted into the solenoid, will the current increase or decrease?

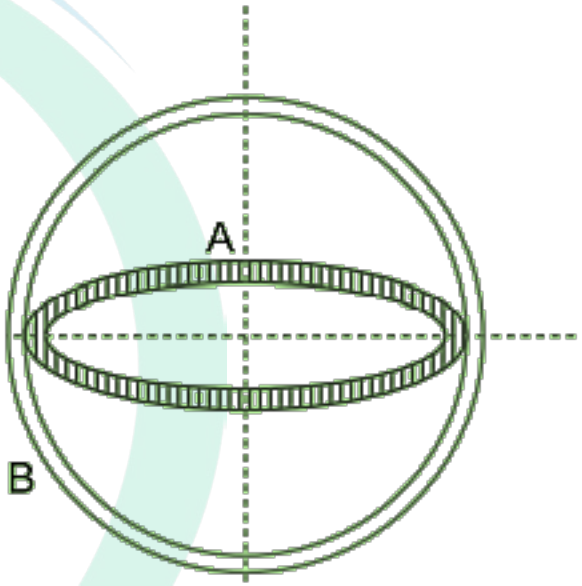
A. Increase
B. Decrease
C. Remains constant
D. Can't determine

56 A pair of adjacent coils has a mutual inductance of 1.5 H. If the current in one coil changes from 0 to 20 A in 0.5 s, what is the change of flux linkage with the other coil?

A. 60 Weber
B. 30 Weber
C. 15 Weber
D. 20 Weber

57 Two coils of wire A and B are placed mutually perpendicular as shown in figure. When current is changed in any one coil, will the current induce in another coil?

A. Yes
B. No



58 A light bulb and a solenoid are connected in series across an ac source of voltage. how the glow of the light bulb will be affected when an iron rod is inserted in the solenoid.

A. Increase
B. Decrease
C. No change
D. Can’t determine

59 What is the average value of ac voltage

$$V = V_0 \sin \omega t$$

over the time interval $t = 0$ to $t = \frac{\pi}{\omega}$.

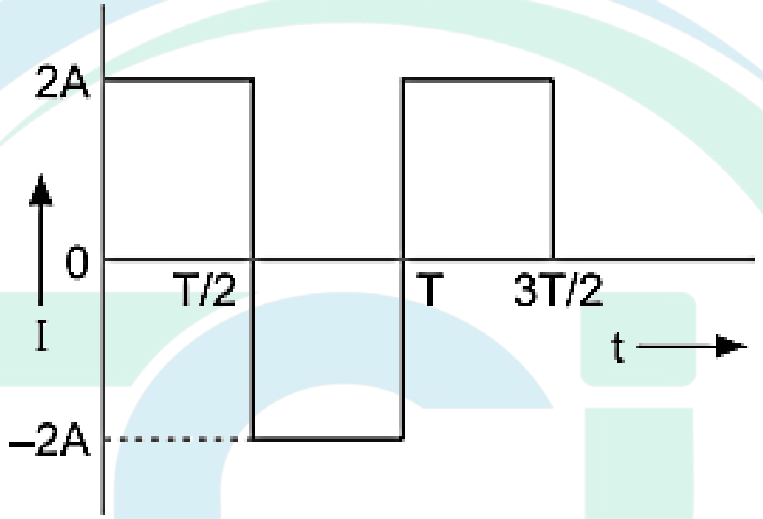
A. $\frac{2VO}{\pi}$

B. $\frac{V_o}{\pi}$

C. $\frac{V_o}{2\pi}$

D. πV_O

60 What is the rms value of alternating current shown in figure?



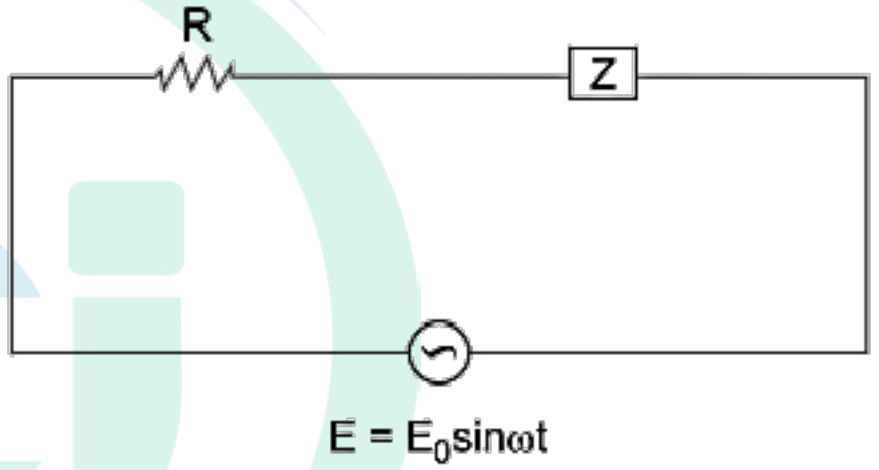
A. 2 A
B. 1 A
C. 3 A
D. 2/3 A

61

An alternating voltage $E = E_0 \sin \omega t$ is applied to a circuit containing a resistor R connected in series with a black box. The current in the circuit is found to be $I = I_0 \sin (\omega t + \pi/4)$.

(*i*) State whether the element in the black box is a capacitor or inductor.

(*ii*) Draw the corresponding phasor diagram and find the impedance in terms of R.



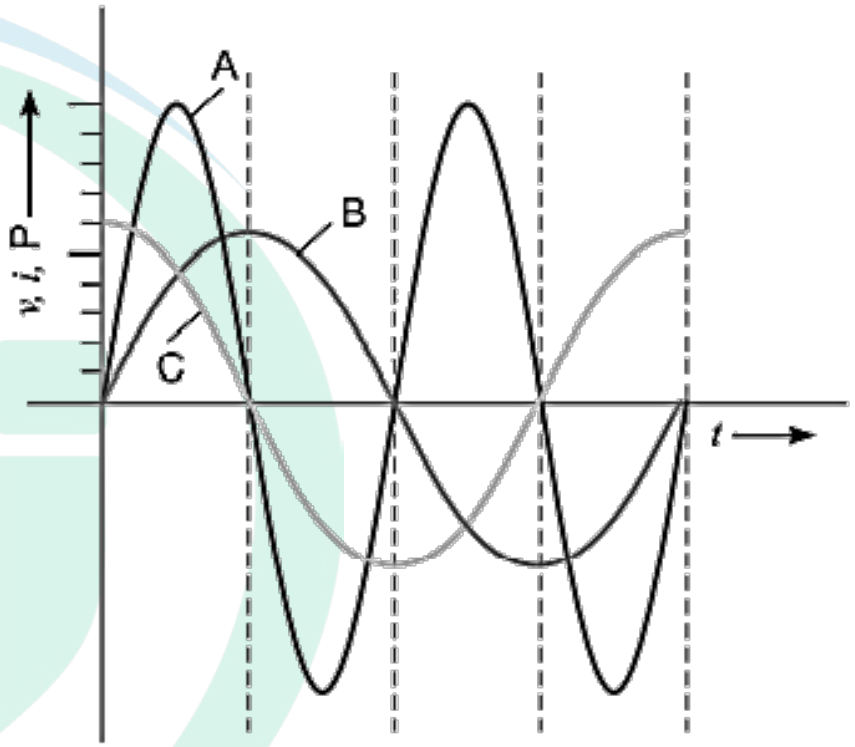
62 Calculate the quality factor of a series LCR circuit with L = 2.0 H, C = 2 μF and R = 10 Ω. Mention the significance of quality factor in LCR circuit.

A. 500
B. 100
C. 400
D. 200

63

A device 'X' is connected to an *ac* source. The variation of voltage, current and power in one complete cycle is shown in the figure.

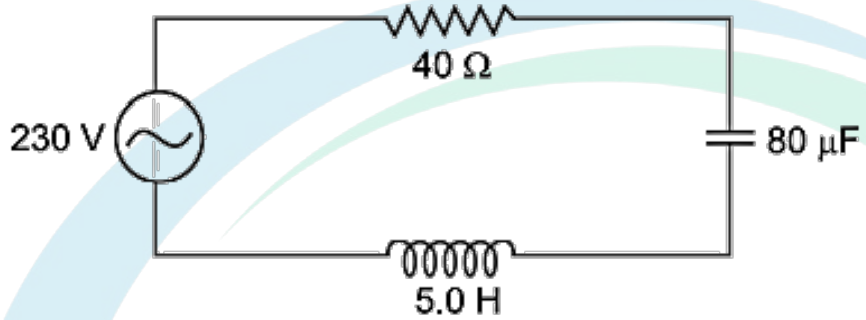
Which curve shows power consumption over a full cycle?



A. B
B. C
C. A
D. None

64

The figure shows a series LCR circuit connected to a variable frequency 230 V source.



(*a*) Determine the source frequency which drives the circuit in resonance.

(*b*) Calculate the impedance of the circuit and amplitude of current at resonance.

(*c*) Show that potential drop across LC combination is zero at resonating frequency.

(a) $\omega = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{5\times80\times10^{-6}}} = \frac{1}{\sqrt{400\times10^{-6}}}$

$\omega = \frac{1000}{20} = 50 \text{ rad/s} \Rightarrow f = \frac{\omega}{2\pi} = \frac{50}{2\pi} = \frac{\mathbf{25}}{\pi}$ **Hz**

(b) At resonance, $Z = R = \mathbf{40\ \Omega}$

$I_{max} = \frac{230\sqrt{2}}{R} = \frac{230\sqrt{2}}{40} = \mathbf{8.1\ A}$

(c) $V_C = I_{max}X_C = \frac{230\sqrt{2}}{40} \times \frac{1}{50\times80\times10^{-6}} = 2025 \text{ V}$ $\left[\because X_C = \frac{1}{\omega C}\right]$

$V_L = I_{max}X_L = \frac{230\sqrt{2}}{40} \times 50 \times 5 = 2025 \text{ V}$ $[\because X_L = \omega L]$

$V_C - V_L = 0$