Physics

Chapterwise Practise Problems (CPP) for JEE (Main & Advanced)

Chapter - Current Electricity

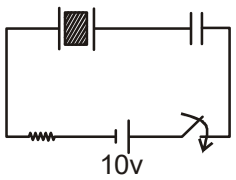
Level-1

SECTION - A

Straight Objective Type

This section contains multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct.

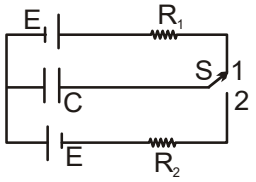
1. Consider the shown arrangement where each capacitor (without dielectric) has capacitance of 2 μF. However, one of the capacitor has got a dielectric of dielectric constant 2. When the system is in equilibrium, the dielectric is suddenly removed. How much charge would flow out of the battery?



(A) $\frac{10}{3}\mu C$ (B) $-\frac{10}{3}\mu C$

(C) Zero (D) $\frac{20}{3}\mu C$

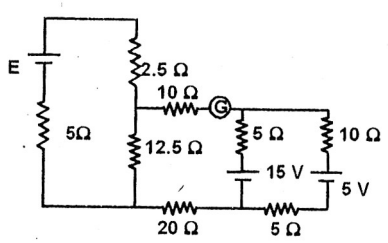
2. In the circuit shown, switch S is placed in position 1 till the capacitor is charged to half of the maximum possible charge in this situation. Now, the switch S is placed in position 2. The maximum energy dissipated by the circuit after switch S is placed in position 2 is



(A) $\frac{1}{2}CE^2$ (B) $\frac{1}{8}CE^2$

(C) $\frac{7}{8}CE^2$ (D) $\frac{9}{8}CE^2$

3. If galvanometer shows no deflection in the given circuit, the value of E is



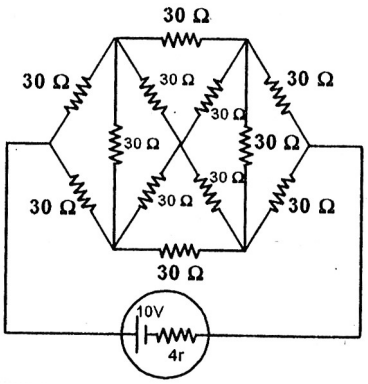
(A) 10 volt

(B) 15 volt

(C) 20 volt

(D) 30 volt

4. Find the value of r so that maximum power is generated in external circuit.



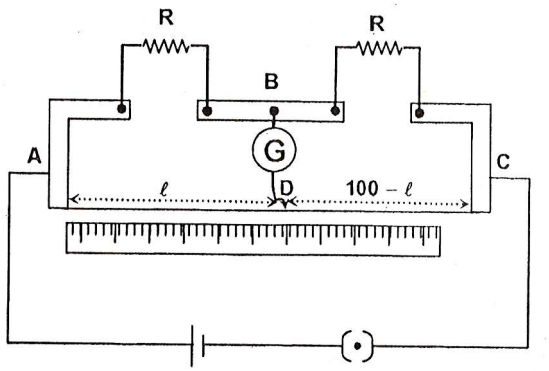
(A) r = 0 Ω

(B) r = 20 Ω

(C) r = 30 Ω

(D) r = 10 Ω

5. In a meter bridge the point D is a neutral point.



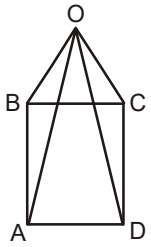
(A) The meter bridge can have other neutral points for this set of resistances

(B) When the jockey contact a point on meter wire left of D, current flows to B in the wire

(C) When the jockey contact a point on the meter wire to the right of D, current flows from B in the wire through galvanometer

(D) When R is increased, the neutral point shifts to left

6. Eight identical resistances each 15 Ω are connected along the edge of a pyramid having square base as shown. The equivalent resistance between A and D is



(A) 7Ω (B) 8Ω

(C) $\frac{15}{2}\Omega$ (D) $\frac{15}{4}\Omega$

7. Current in a resistor R uniformly decreases from some value to zero in time Δt. Total charge that crosses the cross section is q. Heat generated in the resistance during this process is

(A) $\frac{4}{3}\frac{q^2R}{\Delta t}$ (B) $\frac{2}{3}\frac{q^2R}{\Delta t}$

(C) $\frac{3}{4}\frac{q^2R}{\Delta t}$ (D) $\frac{3}{2}\frac{q^2R}{\Delta t}$

8. Which of the following quantities do not change when a resistor connected to a battery is heated due to the current ?

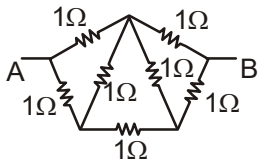
(A) drift speed

(B) resistivity

(C) resistance

(D) number of free electrons in the resistor

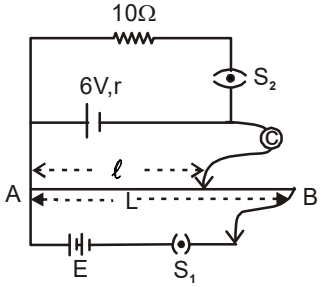
9. Find effective resistance between A and B



(A) 2Ω (B) 1Ω

(C) 8/7Ω (D) 6/5Ω

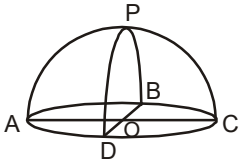
10. In the arrangement shown in the figure when the switch S_2 is open, the galvanometer shows no deflection for ℓ = L/2. When the switch S_2 is closed, the galvanometer shows no deflection for $\ell = \frac{5}{12}L$. The internal resistance (r) of 6 V cell, and the emf E of the other battery are respectively



(A) 3Ω , 8 V (B) 2Ω , 12 V

(C) 2Ω , 24 V (D) 3Ω , 12 V

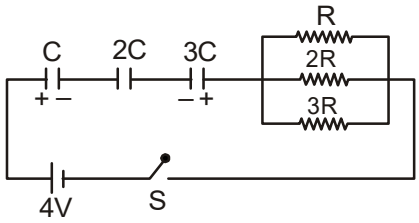
11. A network is made by using a conducting wire of resistance per unit length r as shown. DPB, APC are semicircles and ABCD a circle with common centre O and radius a. The equivalent resistance across OP is



(A) $\frac{ra(\pi+3)}{8}$ (B) $\frac{ra(\pi+2)}{8}$

(C) $\frac{ra(\pi+4)}{8}$ (D) $\frac{ra(\pi+1)}{8}$

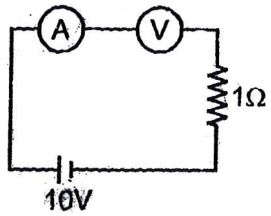
12. Three capacitors (of capacitances C, 2C and 3C) and three resistors (of resistance R, 2R and 3R) are connected with a battery and switch S as shown in the figure. When switch S is open, charges on the capacitors of capacitance C and 3C are CV and 3CV respectively with polarity as shown. Switch S is closed at t = 0 sec. The time constant of the circuit will be



(A) RC (B) $\frac{6RC}{11}$

(C) $\frac{36RC}{121}$ (D) None of these

13. In the shown figure



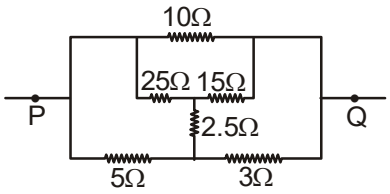
(A) If both ammeter and voltmeter are ideal, then reading of ammeter is zero, reading of voltmeter is less than 10V

(B) If both ammeter and voltmeter are ideal, then reading of ammeter is 10A, reading of voltmeter is 0V

(C) If ammeter is non ideal, voltmeter is ideal, the reading of ammeter is slightly less than 10A, reading of voltmeter is 10V

(D) If ammeter is ideal, voltmeter is non ideal, then reading of ammeter is less than 10A, reading of voltmeter is less than 10V

14. If a battery of emf 8V and negligible internal resistance is connected between terminals P and Q of the circuit shown in figure, calculate the current through 2.5Ω resistance.



(A) 2A (B) 3A

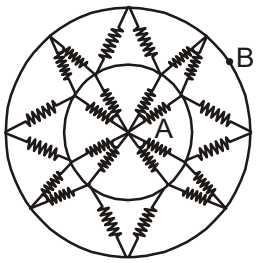
(C) 4A (D) Zero

15. In a potentiometer experiment, two cells connected in series get balanced at 9 cm length on the wire. Now the connections of terminals of the cell of lower emf are reversed, then the balancing length is obtained at 3cm. The ratio of emfs of two cells will be

(A) 1 : 3 (B) 2 : 1

(C) 1 : 4 (D) 4 : 1

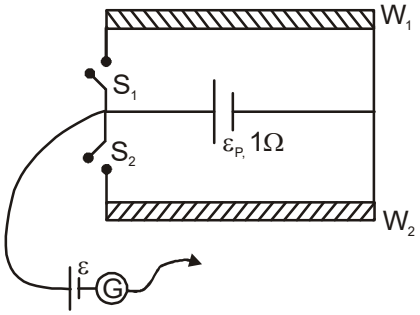
16. Resistance of each part is 'R' and resistance of circumferece is negligible as shown in figure. Find the equivalent resistance across AB (A is the common centre of both circles)



(A) 3R (B) 3R/2

(C) 3R/4 (D) 3R/16

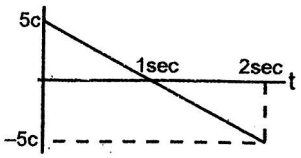
17. Two potentiometer wires w_1 and w_2 of equal length l, connected to a battery of emf ε_p and internal resistance 1Ω through two switches s_1 and s_2. A battery of emf ε is balanced on these potentiometer wires one by one. Potentiometer wire w_1 is of resistance 2Ω and its balancing length is $\ell/2$, when only s_1 is closed and s_2 is open. On closing s_2 and opening s_1 the balancing length on w_2 is found to be $(2\ell/3)$. Then find the resistance (in Ω) of potentiometer wire w_2.

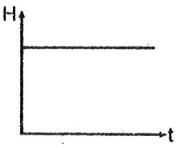


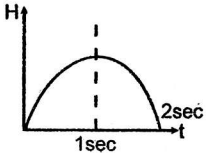
(A) 1 (B) 2

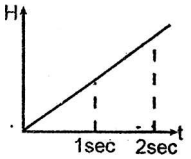
(C) 3 (D) 4

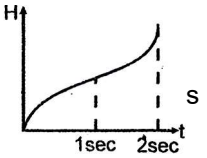
18. A charge passing through a resistor is varying with time as shown in the figure. The amount of heat generated in time 't' is best represented (as a function of time)by:



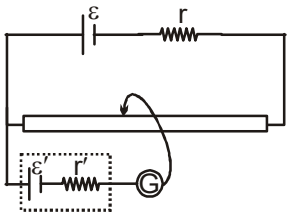
(A) 

(B) 

(C) 

(D) 

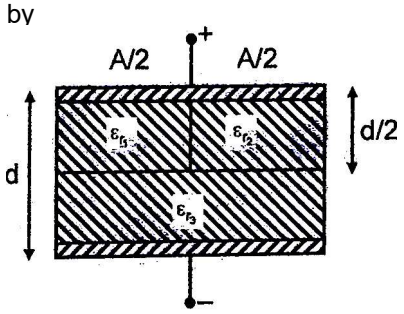
19. In an experiment to measure the internal resistance of a cell by a potentiometer, it is found that the balance point is at a length of 2m when the cell is shunted by a 5Ω resistance and at a length of 3m when the cell is shunted by a 10 Ω resistance. The internal resistance (r′) of the cell is



(A) 1.5 Ω (B) 10 Ω

(C) 15 Ω (D) 1 Ω

20. Two large conducting plates each of area A with small separation d of air has capacitance C_0 and capacitance C when the plates are filled with three different materials having relative permittivity $\varepsilon_{r_1}, \varepsilon_{r_2}, \varepsilon_{r_2}$ as shown in figure. If a single material of relative permittivity ε_r is to be used to have the same capacitance C in this capacitor, then ε_r is given by



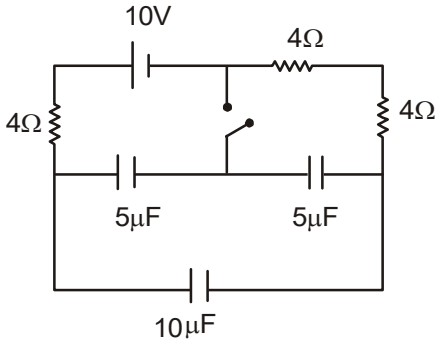
(A) $\varepsilon_r = \dfrac{\varepsilon_{r_1} + \varepsilon_{r_2} + 2\varepsilon_{r_3}}{2\varepsilon_3\left(\varepsilon_{r_1} + \varepsilon_{r_2}\right)}$

(B) $\varepsilon_r = \dfrac{\varepsilon_{r_1}\varepsilon_{r_3}}{\varepsilon_{r_1} + \varepsilon_{r_3}} + \dfrac{\varepsilon_{r_2}\varepsilon_{r_3}}{\varepsilon_{r_2} + \varepsilon_{r_3}}$

(C) $\varepsilon_r = \dfrac{2\varepsilon_{r_1}\varepsilon_{r_2}2\varepsilon_{r_3}}{2\varepsilon_{r_1}\varepsilon_{r_3} + 2\varepsilon_{r_1} + \varepsilon_{r_3} + \varepsilon_{r_1}\varepsilon_{r_3}}$

(D) $\varepsilon_r = \dfrac{\varepsilon_{r_1}\varepsilon_{r_2}}{\varepsilon_{r_1} + \varepsilon_{r_2}} + \dfrac{\varepsilon_{r_2}\varepsilon_{r_3}}{\varepsilon_{r_2} + \varepsilon_{r_3}}$

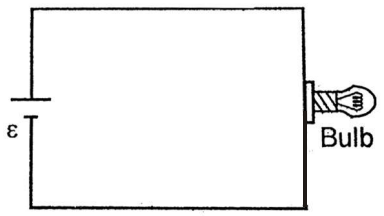
21. Heat produced in the circuit shown in the figure, when switch is closed, is



(A) 125 μJ (B) 250 μJ

(C) 375 μJ (D) 500 μJ

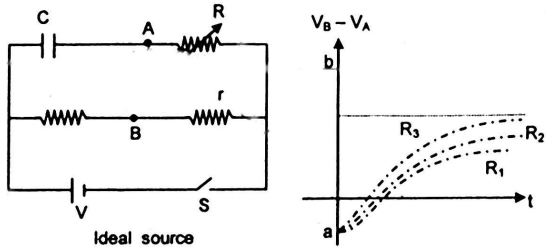
22. When bulb of initial resistance R_0 is switched on, its resistance increases due to heat production. Assuming initial temperature of bulb is 0°C and temperature coefficient of bulb filament's resistance is α, after what time its temperature will become T? (Heat capacity of bulb is c, assume $\alpha T << 1$)



(A) $\dfrac{2\left(e^{\alpha T} - 1\right)R_0C}{\varepsilon^2\alpha}$ (B) $\dfrac{(e^{\alpha T} - 1)R_0C}{\varepsilon^2\alpha}$

(C) $\dfrac{(e^{\alpha T} + 1)R_0C}{2\varepsilon^2\alpha}$ (D) $\dfrac{(e^{\alpha T} + 1)R_0C}{\varepsilon^2\alpha}$

23. An uncharged capacitor C and a variable resistance R are connected to an ideal source and two resistors with the help of a switch at t = 0 as shown in the figure. Initially capacitor is uncharged and switch S is closed at t = 0 sec. The graph between $V_B - V_A$ for variable resistor R for its three different value R_1, R_2 and R_3 versus time is shown in the figure II. Choose the correct statement



(A) $R_1 < R_2 < R_3$ (B) $R_1 > R_2 > R_3$

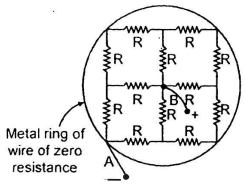
(C) $R_1 < R_3 < R_2$ (D) $|a| < |b|$

24. Two scales on voltmeter measure voltages up to 20V and 30V. The resistance connected in series with galvanometer is 1680 Ω for the 20V scale and 2930 Ω for the 30V scale in the same galvanometer. The resistance of the galvanometer and the full scale current are

(A) 320 Ω and 10 mA (B) 70 Ω and 10 mA

(C) 820 Ω and 10 mA (D) 820 Ω and 8 mA

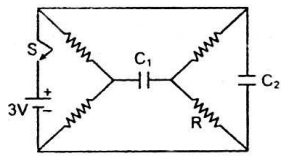
25. In the shown figure a battery (ideal) is joined between terminals A and B having EMF=E. Find the current supplied by the battery



(A) $\frac{8E}{R}$ (B) $\frac{8E}{3R}$

(C) $\frac{4E}{R}$ (D) $\frac{4E}{3R}$

26. What is the potential drop across resistor R in the following circuit a very long time after the switch is closed. Each resistor has resistance of 2MΩ and each capacitor has capacitance of 1μF and initially uncharged.



(A) 1.5V (B) 0.75V

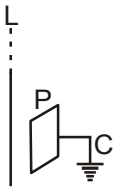
(C) 3V (D) 0V

SECTION - B

Multiple Correct Answer Type

This section contains multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct.

27. L is a long conducting thread and near to it there is a small metal plate P which is earthed through C. Some amount of electricity will flow through C,



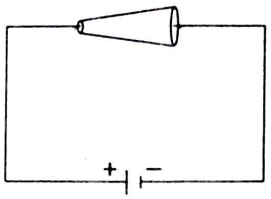
(A) if a current fluctuates in the L

(B) if a current through L is reversed

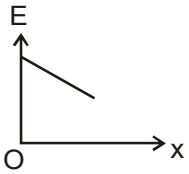
(C) if L is replaced by a fine beam of α-particles

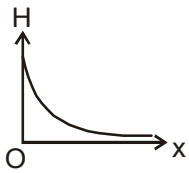
(D) if L is replaced by a narrow beam of electrons

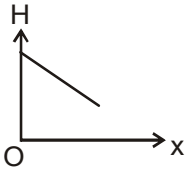
28. A conductor is made of an isotropic material and has the shape of a truncated cone

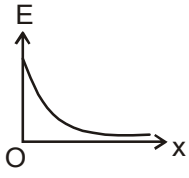


A battery of constant emf is connected across it. If at a distance x from left end, electric field intensity and the rate of generation of heat per unit length are E and H respectively, which of the following graphs is/are correct ?

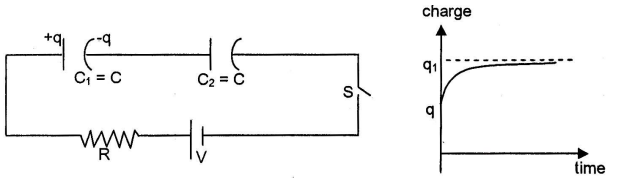
(A) 

(B) 

(C) 

(D) 

29. In the diagram shown, both the capacitors have the same capacitance C. One capacitor has charge +q and other is uncharged. The switch is closed at time t = 0. The graph shows the variation of the charge on C_1 as a function of time. Then



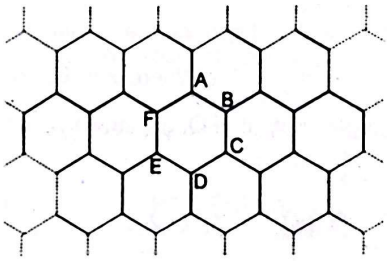
(A) Initial value of current in the circuit is $\frac{\left|V-\frac{q}{C}\right|}{R}$

(B) Charge present in second capacitor in steady state is $\frac{CV-q}{2}$

(C) Value of q_1 in steady state is $\frac{CV+q}{2}$

(D) Heat energy will be generated in the circuit on closing the switch.

30. Consider an infinite mesh as shown in figure. Each side of the mesh has resistance R. Consider hexagonal part ABCDEF of infinite mesh and equivalent resistance between any two points of hexagon is measured. Choose the correct option(s)



(A) Equivalent resistance between A and B is $\frac{2R}{3}$

(B) Equivalent resistance between A and C is R

(C) Equivalent resistance between A and D is $\frac{7R}{6}$

(D) Equivalent resistance between A and E is R

SECTION - C

Linked Comprehension Type

This section contains paragraph. Based upon this paragraph, some multiple choice questions have to be answered. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE OR MORE** is/ are correct.

Paragraph for Questions 31 and 32

Efficiency of a cell can be defined as the ratio of the potential difference across its terminals to its emf. Therefore when a cell has internal resistance, its efficiency will be less than 1. Cell without internal resistance is ideal case, never realised in practice.

31. The efficiency of a battery

(A) Depends on the value of internal resistance

(B) Depends on the value of external resistance

(C) Depends on the emf of cell

(D) Does not depend on the emf of cell

32. Two identical cells of emf ε and internal resistance r are connected across two separate circuits. The currents flowing in circuits being i_1 and i_2 respectively. If their efficiencies are η_1, η_2 and V_1, V_2 are potential difference accross the cells respectively, then

(A) $\frac{V_1}{V_2}=\frac{i_1}{i_2}$ (B) $\frac{V_1}{V_2}=\frac{\varepsilon-i_1r}{\varepsilon-i_2r}$

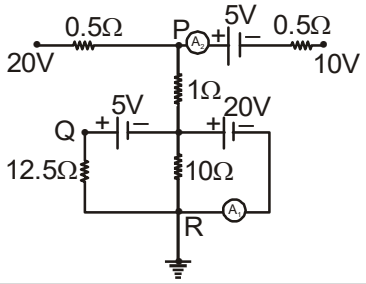
(C) $\frac{\eta_1}{\eta_2}=\frac{i_1}{i_2}$ (D) $\frac{\eta_1}{\eta_2}=\frac{\varepsilon-i_1r}{\varepsilon-i_2r}$

SECTION-D

Matrix-Match Type

This **Section D** have "match the following" type question. Question contains two columns, **Col-I** and **Col-II**. Match the entries in **Col-I** with the entries in **Col-II**. One or more entries in **Col-I** may match with one or more entries in **Col-II**.

33. In the adjacent circuit shown, all ammeters and batteries are ideal. Point R is grounded. Then, match the following.



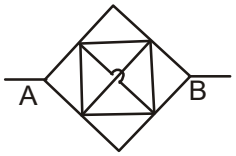
Column-I		Column-II	
(A)	Potential of point P	(p)	6 SI unit
(B)	Potential of point Q	(q)	25 SI unit
(C)	Reading of ammeter A_1	(r)	18 SI unit
(D)	Reading of ammeter A_2	(s)	47 SI unit

SECTION-E

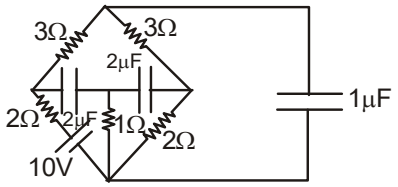
Integer Answer Type

This section contains Integer type questions. The answer to each of the questions is an integer.

34. Identical resistors each of resistance (r = 5Ω) are connected as shown in figure. Calculate equivalent resistance between A and B is



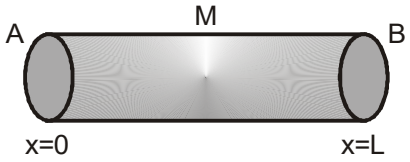
35. The circuit shown in figure is in steady state.



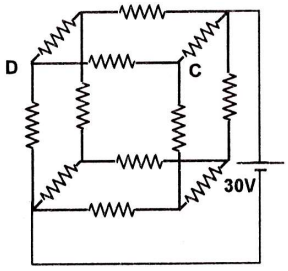
Rate at which energy is supplied is x × 10 W. Then the value of x is

36. AB is a solid cylinder of radius a_0 and length L. Resistivity of the material varies with x-coordinate from end a as $\rho = \frac{\rho_0 x}{L}$. M is the mid point of AB.

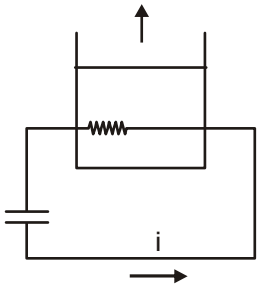
Find the ratio of resistances between AB and between AM.



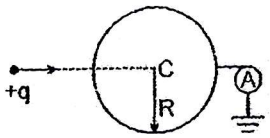
37. A resistor circuit is constructed such that 12 resistance are to form a cube. Each resistor is of 2Ω. A battery of 30 Volt is applied across the body diagonal of the cube. Find the current flowing through DC.



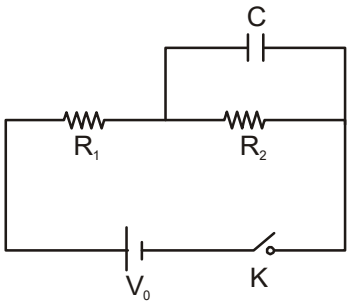
38. In figure, a resistance coil, wired to an external battery is placed inside a thermally insulated cylinder fitted with a frictionless piston and containing an ideal diatomic gas. A current i = 200 mA exists in the coil, which has a resistance R = 350Ω. If the pressure of the gas remains constant, what should be the speed v(in cm/s)of the piston, of mass m = 10kg? (Take P_{atm} =10^5Pa, A=10cm^2 = cross-section area of cylinder)



39. If a charge q (1 milli columb) is moving towards the centre of an earthed conducting sphere of radius 1m with a velocity 2 cm/s, find the current (in μA) flowing in the ammeter shown in figure when q is at a distance 2m from centre of sphere



40. In the connection shown in the figure the switch K is open and the capacitor is uncharged. Then we close the switch and let the capacitor charge up to the maximum and open the switch again. Then



(a) the current through R_1 be I_1 immediately after closing the switch

(b) the current through R_2 be I_2 a long time after the switch was closed

(c) The current through R_2 be I_3 immediately after reopening the switch

Find $\frac{I_1}{150 I_2 I_3}$ (in ampere^{-1}) (Use the following data : V_0 = 30 V, R_1 = 10 kΩ, R_2 = 5kΩ).

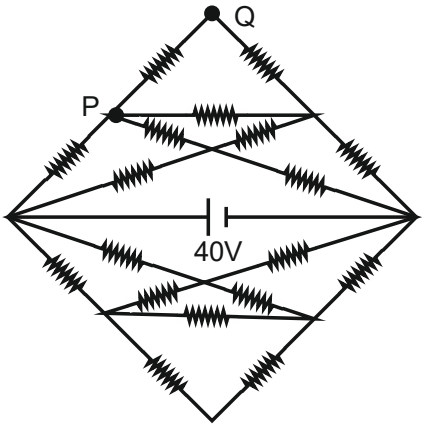
❑ ❑ ❑

SECTION - A

Straight Objective Type

This section contains multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct.

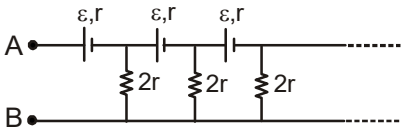
1. Each resistance in the given circuit is 10Ω. Power dissipated across PQ will be



(A) 1.6 watt (B) 6.4 watt

(C) 12.8 watt (D) 25.6 watt

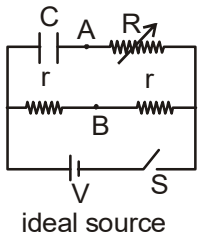
2. In the infinite circuit shown in the diagram, each battery has emf ε and internal resistance r. Each resistor has resistance 2r. Find the emf and the internal resistance of the equivalent battery across terminals A and B.

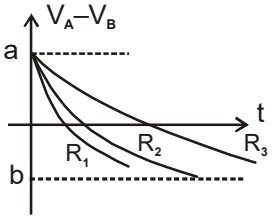


(A) ε, r (B) 2ε, 2r

(C) 2ε, r (D) ε, 2r

3. An uncharged capacitor C and a variable resistance R are connected to an ideal source and two resistors with the help of a switch at t = 0 as shown in the figure. Initially capacitor is uncharged and switch S is closed at t = 0 sec. The graph between V_A - V_B for variable Resistor R for its three different values R_1, R_2 and R_3 versus time is shown in the figure II. Choose the correct statement

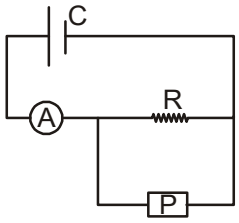




(A) $R_1 < R_2 < R_3$ (B) $R_1 > R_2 > R_3$

(C) |a| < |b| (D) |a| > |b|

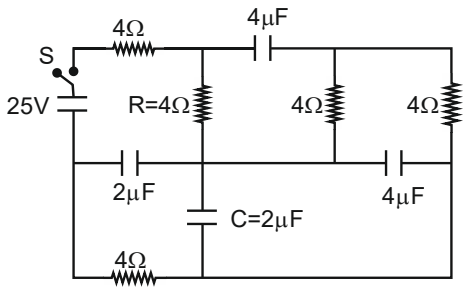
4. An ammeter A of finite resistance, and a resistor R are joined in series to an ideal cell C. A potentiometer P is joined in parallel to R. The ammeter reading is I_0 and the potentiometer reading is V_0. P is now replaced by a voltmeter of finite resistance. The ammeter reading now is I and the voltmeter reading is V.



(A) $I > I_0$, V, $< V_0$ (B) $I > I_0$, $V = V_0$

(C) $I = I_0$, $V < V_0$ (D) $I < I_0$, $V < V_0$

5. The capacitor C shown in figure is charged by closing switch S for a long time. Find the charge on it in steady state

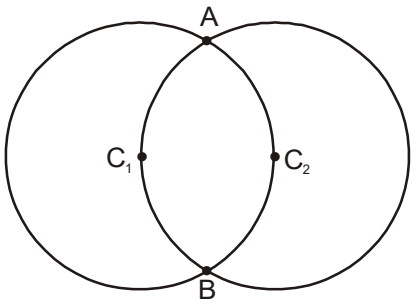


(A) 8μC (B) 10μC

(C) 16μC (D) 20μC

6. Two circular rings of identical radii and resistance of

36Ω each are placed in such a way that they cross each other's centre C_1 and C_2 as shown in figure. Conducting joints are made at intersection points A and B of the rings. An ideal cell of emf 20 volt is connected across AB. The power delivered by cell is



(A) 80 watt (B) 100 watt
(C) 120 watt (D) 200 watt

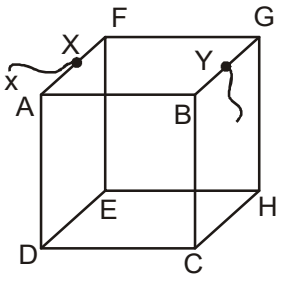
7. If each resistance is 'r' along the 12 edges of a cubical skeleton of uniform wires, then find equivalent resistance between X and Y, where X and Y are the mid points of two opposite edges of a face of cube

(A) $\frac{7r}{8}$

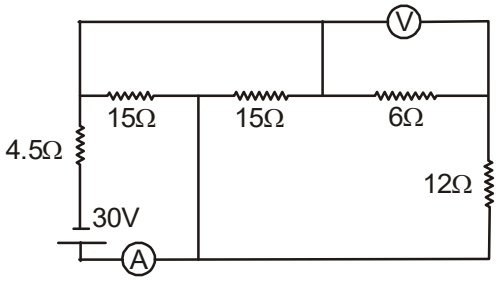
(B) $\frac{r}{2}$

(C) $\frac{4r}{5}$

(D) $\frac{7r}{5}$

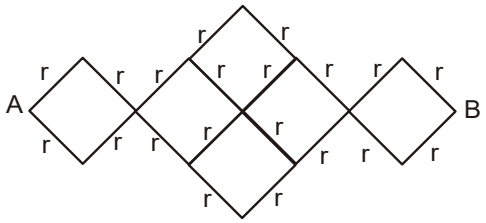


8. A galvanometer of coil resistance 1 Ω is converted into voltmeter by using a resistance of 5 Ω. in series and same galvanometer is converted into ammeter by using a shunt of 1 Ω. Now ammeter and voltmeter are connected in circuit as shown. Find the reading of voltmeter and ammeter.



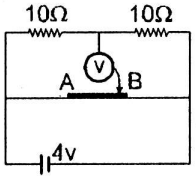
(A) 3 volt, 3 amp (B) 2 volt, 2 amp
(C) 4 volt, 3 amp (D) 3 volt, 4 amp

9. The resistance of each straight section is r. Find the equivalent resistance between A and B



(A) 3r (B) 3.5 r
(C) 4 r (D) 4.5 r

10. A potentiometer wire as shown is 40 cm long of resistance 50 Ω/m. Free end of an ideal voltmeter is touching the potentiometer wire. What should be the velocity of the jockey as a function of time so that reading in voltmeter is varying with time as (2 sin πt) volts where t is in sec?



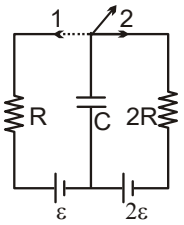
(A) 10 π sin πt cm/s (B) 10 π cos πt cm/s
(C) 20 π sin πt cm/s (D) 20 π cos πt cm/s

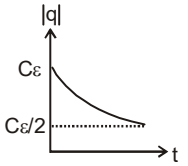
11. In a meter bridge experiment the resistance of resistance box is 16 Ω, which is inserted in right gap. The null point is obtained at 36 cm from the left end. The least count of meter scale is 1 mm. What is the value of unknown resistance? (Error = L.C.)

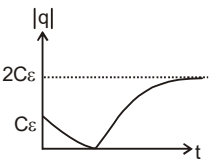
(A) $9 \pm \frac{5}{128}\Omega$ (B) $9 \pm \frac{5}{256}\Omega$

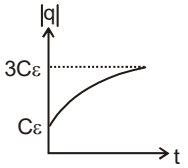
(C) $9 \pm \frac{5}{512}\Omega$ (D) $\frac{128}{9} \pm \frac{5}{2560}\Omega$

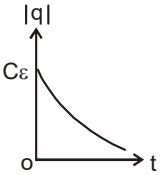
12. In the circuit shown, the switch is shifted from position 1 $\rightarrow$ 2 at t = 0. The switch was initially in position 1 for a long time. The graph between the magnitude of charge on capacitor C and time 't' is



(A)


(B)


(C)


(D)


13. Three uniform copper wires have their lengths in the ratio 1 : 4 : 5 and their masses are in the ratio 5 : 2 : 1 their electrical resistance will be in the ratio

(A) 5 : 3 : 1 (B) 1 : 8 : 25

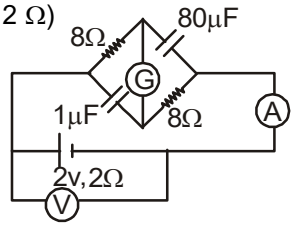
(C) 1 : 40 : 125 (D) 8 : 5 : 1

SECTION - B

Multiple Correct Answer Type

This section contains multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct.

14. The ammeter (A) and voltmeter (V) in the given circuit are ideal but the galvanometer has a resistance of 2 Ω . In steady state (Internal resistance of the battery is 2 Ω)



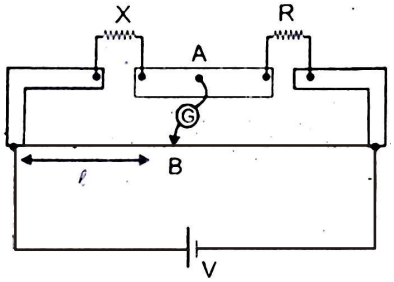
(A) no current flows in (G)

(B) 0.1 A current flows in (G)

(C) charge on 1 μF capacitor is 1 μC

(D) terminal potential difference across battery is 1.8 V

15. A meter bridge is used to predict the value of unknown resistance X, it is observed that current is flowing from A to B initially (when jockey is fixed at a point B). If the temperature of X is increased, then select possible option/s



(A) current reduces in magnitude

(B) current remain constant (for any raise in temperature)

(C) current become zero

(D) current flows in opposite direction

16. In the shown figure (1) and (2) capacitors are in steady state. Charging batteries are removed and switches S_1 and S_2 are closed at time t = 0. The plot of ln I (I is the current in the resistor) against time t in the resistor R_1 and R_2 are shown by the graphs 1 and 2 respectively in the figure (3). Choose the correct option(s).

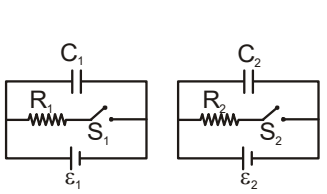


figure - 1 figure - 2

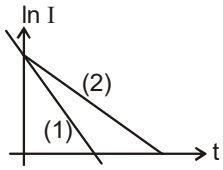


figure - 3

(A) If $\varepsilon_1 = 2\varepsilon_2$, R_1 must be equal to $2R_2$

(B) If $R_1 = R_2$, C_2 must be less than C_1

(C) If $C_1 = C_2$, R_1 must be less than R_2

(D) R_1C_1 is equal to R_2C_2

17. A uniform wire of resistance R is shaped into a regular n-sided polygon (n is even). The equivalent resistance between any two corners can have

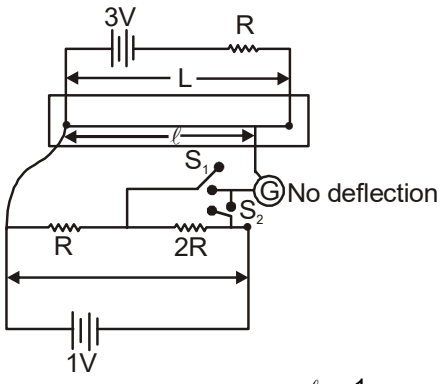
(A) The maximum value $\frac{R}{4}$

(B) The maximum value $\frac{R}{n}$

(C) The minimum value $R\left(\frac{n-1}{n^2}\right)$

(D) The minimum value $\frac{R}{n}$

18. Figure shows a potentiometer circuit. The length of potentiometer wire is L and its resistance is 2R. Neglect the internal resistance of the cells. Select the correct alternative (ℓ is the distance of balance point from left end of potentiometer wire)



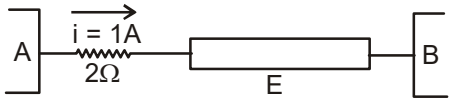
(A) When only S_1 is closed, $\frac{\ell}{L} = \frac{1}{6}$

(B) When only S_2 is closed, $\frac{\ell}{L} = \frac{1}{2}$

(C) When both S_1 and S_2 are closed, $\frac{\ell}{L} = \frac{1}{6}$

(D) When both S_1 and S_2 are closed, $\frac{\ell}{L} = \frac{1}{2}$

19. AB is part of a circuit as shown, that absorbs electric energy at a rate of 50W. E is a lead-acid battery that has no internal resistance



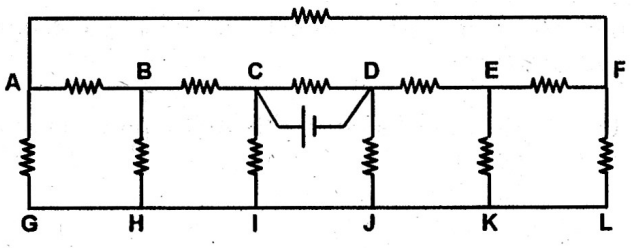
(A) Potential difference across AB is 48 V

(B) EMF of the device is 48 V

(C) Point B is connected to the positive terminal of E

(D) Rate of conversion from electrical to chemical energy is 48 W in device E

20. In the figure shown resistance of each resistor are same. If current in AG is 5A then



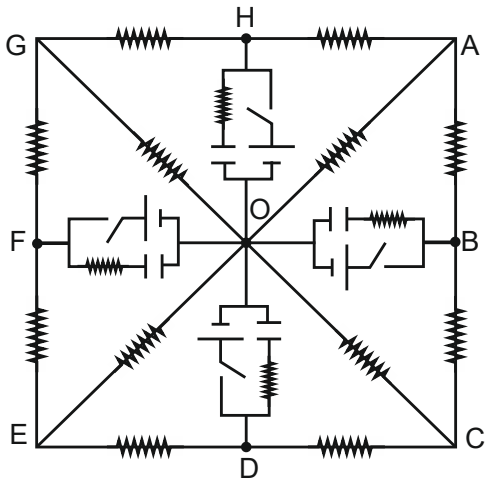
(A) Current in FL is 5A

(B) Current in BA is 15 A

(C) Current in AF is 10 A

(D) Current in BH is 20 A

21. In the figure resistance of each resistor is 10 Ω, capacitance of each capacitor is 5μF, emf of each cell is 10V. All the switches are closed for a long time and opened at t = 0. At t = 0 mark the correct option.



(A) Current through resistor in arm AO is 0.4A

(B) Rate of loss of field energy of each capacitor is 4 W

(C) Rate of loss of heat energy through resistor in arm AB is 0.4 W

(D) Rate of loss of heat energy through resistor in arm OB is 1.6 W

22. When a galvanometer is shunted with 4Ω resistance, the deflection is reduced to one fifth. If the galvanometer is further shunted with 2Ω wire, the deflection will be (the main current remains the same)

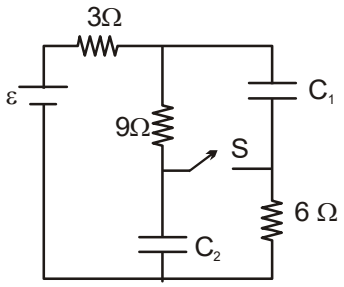
(A) $\frac{5}{9}$ of the deflection when shunted with 4Ω only

(B) $\frac{5}{13}$ of deflection when shunted with 4Ω only

(C) $\frac{1}{13}$ of the original deflection only

(D) $\frac{1}{9}$ of the original deflection only

23. In the circuit shown there is steady state with the switch closed. The switch is opened at t = 0. Choose the correct option(s). (Given: ε=24V, C_1=3F and C_2=2F)



(A) The voltage across C_1 before the switch is open is 12V

(B) The voltage across C_1 after a long time after the switch is open is 12V

(C) The voltage across C_2 after a long time after the switch is open is 24 V

(D) The voltage across C_2 before the switch is open is 8V

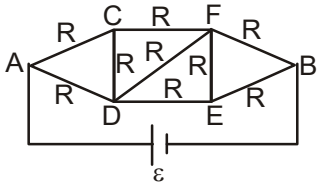
SECTION - C

Linked Comprehension Type

This section contains paragraph. Based upon this paragraph, some multiple choice questions have to be answered. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE OR MORE** is/ are correct.

Paragraph for Question Nos. 24 and 25

A frame is formed by nine identical wires of resistance R each as shown in the figure.



24. The equivalent resistance between A and B is

(A) $\frac{5}{11}R$ (B) $\frac{1}{11}R$

(C) $\frac{15}{11}R$ (D) $\frac{6}{11}R$

25. Choose the incorrect statement.

(A) the ratio of current through CF and DE is 1

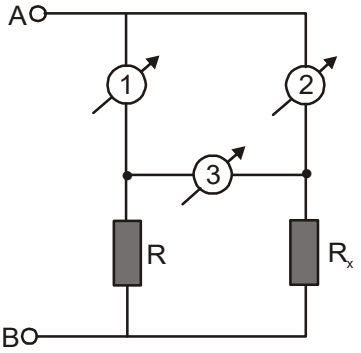
(B) the ratio of current through CD and FE is 1

(C) the ratio of current through AC and AD is 6/5

(D) the ratio of current through AC and AD is 5/6

Paragraph for Question Nos. 26 and 27

In the circuit shown the three ammeters (marked as 1, 2, 3) are identical, each have a resistance $R_0 = 2\Omega$. Between points A and B there is a constant potential difference of 19V. The first and second ammeter read $I_1 = 2.5A$ and $I_2 = 1.5A$ respectively.



26. What is the reading of third ammeter ?

(A) 1A (B) 1/2A

(C) 2A (D) 3A

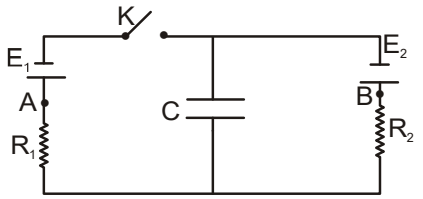
27. Calculate value of resistance R

(A) 2Ω (B) 3Ω

(C) 4Ω (D) 5Ω

Paragraph for Question Nos. 28 to 30

In the circuit shown, switch K is initially open. Both the cells are ideal and C = 30 μF, $E_1 = 1V$, $R_1 = 2\Omega$, $E_2 = 3V$, $R_2 = 4\Omega$. At t = 0 second, the switch K is closed. A and B are two points on circuit as shown



28. Just after the switch K is closed, the magnitude of current (in amperes) through resistance R_1 is (in A)

(A) $\frac{1}{3}$ (B) $\frac{4}{3}$

(C) 1 (D) 2

29. V_A and V_B are potentials of points A and B respectively. After the switch K is closed, the potential difference $V_B - V_A$

(A) Remains constant

(B) Decreases

(C) Increases and then becomes constant after long time

(D) Decreases and then becomes constant after long time

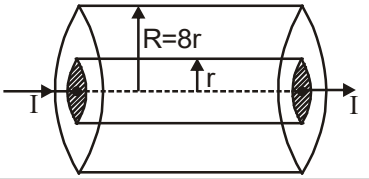
30. Long time after the switch K is closed, the magnitude of charge on the capacitor in steady state is

(A) 10 μC (B) 30 μC

(C) 50 μC (D) 90 μC

Paragraph for Question Nos. 31 to 33

A long uniform solid metallic cylinder has cross sectional radius r. Surface of the cylinder is painted by black body material. Resistivity of the material of inner cylinder is ρ. Another long hollow coaxial cylinder of black body material has cross sectional radius R = 8r. Electric current I continuously passes through the axis of inner cylinder. Whole arrangement lies in vacuum when steady state is reached. Temperature of outer shell is 500 K. Then answer the following questions. (σ is Stefan's constant)



31. Temperature of surface of inner cylinder is

(A) 1000 K (B) 500 K

(C) $500\sqrt{2}$ K (D) 250 K

32. Current through the inner cylinder is

(A) $\sqrt{\frac{\sigma}{\rho}16\pi^2r^3(500)^4}$ (B) $\sqrt{\frac{\sigma}{\rho}32\pi^2r^3(500)^4}$

(C) $\sqrt{\frac{\rho}{\sigma}16\pi^2r^3(500)^4}$ (D) None of these

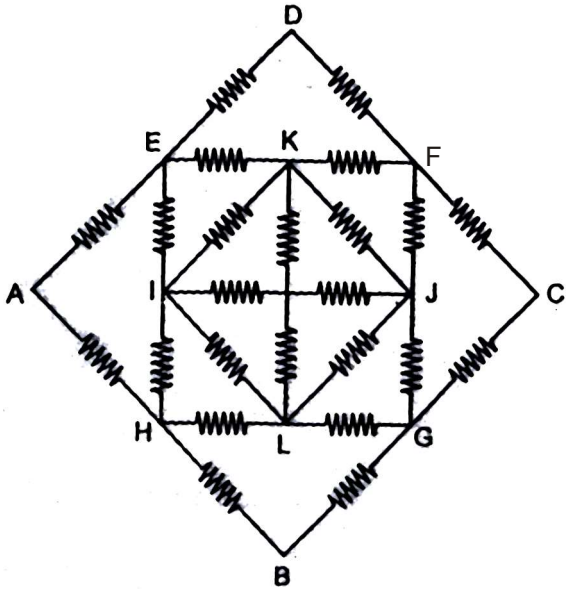
33. Intensity of emitted radiation at distance 16r from axis is

(A) $\frac{\sigma}{8}(500)^4$ (B) $\frac{\sigma}{2}(500)^4$

(C) $\frac{\sigma}{4}(500)^4$ (D) $\frac{\sigma}{16}(500)^4$

Paragraph for Question Nos. 34 and 35

Each resistance in the circuit is R = 13 Ω then, answer the following questions



34. If a battery of 18 volt is connected across A and C, then the current in branch AE is

(A) 1 amp (B) 0.5 amp

(C) 2 amp (D) 0.25 amp

35. From previous problem power developed in resistance across GB

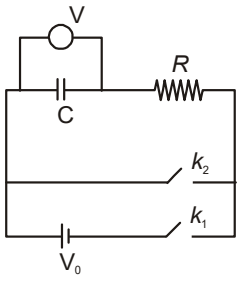
(A) 25/52 watt (B) 50/32 watt

(C) 15/26 watt (D) 25/26 watt

Paragraph for Question Nos 36 and 37

Consider the given R-C circuit with the ideal voltmeter, while charging (i.e., K_1 closed) at t = 0, initial voltmeter reading is $V_0/4$. During charging when voltmeter reading approaches to $\frac{3V_0}{4}$, switch K_1 is opened and K_2 is closed. The switch K_2 is kept closed till the reading of voltmeter again drops to $\frac{V_0}{4}$. This cycle is continuously repeated (i.e, charging from $\frac{V_0}{4}$ to $\frac{3V_0}{4}$ and then discharging from $\frac{3V_0}{4}$ to $\frac{V_0}{4}$). Answer the following questions for this set up

36. Time period of the cycle is



(A) RC ℓn 3

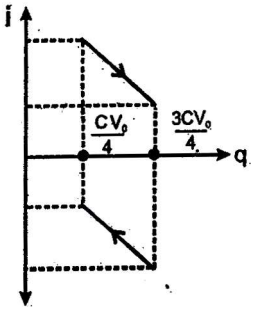
(B) RC ℓn 2

(C) 2 RC ℓn 3

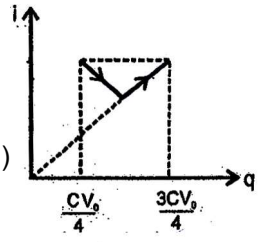
(D) RC ℓn 6

37. The graph of the current in the resistance R vs charge of on the capacitor in one complete cycle is (Assume the voltmeter to be ideal)

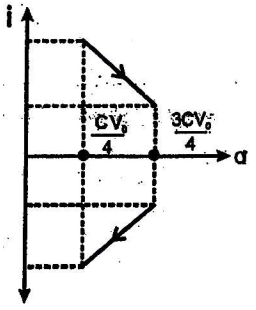
(A)



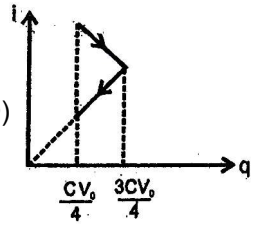
(B)



(C)

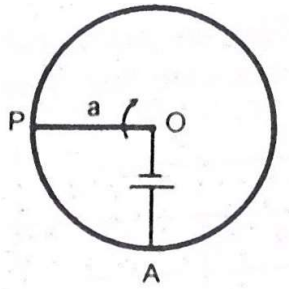


(D)



Paragraph for Question Nos. 38 to 40

Figure shows a metallic ring of uniform cross section and radius 'a'. The resistance per unit length of the ring is r. A rod (OP) of same material and same thickness is rotating with uniform angular velocity ω about O. An ideal cell of emf ε is connected between O and the ring. Initially the point P coincides with A. The resistance of wire used to connect the battery is zero



38. The maximum current through cell is

(A) $\frac{\varepsilon}{\pi ar}$ (B) $\frac{2\varepsilon}{\pi ar}$

(C) $\frac{\varepsilon}{ar}$ (D) $\frac{\varepsilon}{2ar}$

39. The minimum current through cell is

(A) $\frac{2\varepsilon}{ar(1+\pi)}$ (B) $\frac{2\varepsilon}{ar(2+\pi)}$

(C) $\frac{\varepsilon a}{2ar(1+\pi)}$ (D) $\frac{\varepsilon}{ar(1+\pi)}$

40. The minimum time interval between two instants when current is half of the maximum current

(A) $\left[\frac{2\pi-\sqrt{4\pi(\pi-2)}}{2\omega}\right]$

(B) $\left[\frac{2\pi-\sqrt{4\pi(\pi-2)}}{3\omega}\right]$

(C) $\left[\frac{2\pi+\sqrt{4\pi(\pi-2)}}{\omega}\right]$

(D) $\left[\frac{2\pi-\sqrt{4\pi(\pi-2)}}{\omega}\right]$

Paragraph for Question Nos. 41 and 42

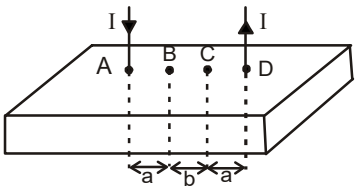
Consider a very large block of conducting material of resistivity 'ρ'. Figure shows a small part of it current 'I' enters at 'A' and leaves from 'D'. We apply superposition principle to find voltage 'ΔV' deveoloped between 'B' and 'C'. The calculation is done in the following steps

(i) Take current 'I' entering from 'A' and assume it to spread over a hemispherical surface in the block

(ii) Calculate field E(r) at distance 'r' from A by usingOhm's law $E = \rho J$, where J is the current per unit area at 'r'

(iii) From the 'r' dependence of E(r), obtain the potential V(r) at r

(iv) Repeat (i), (ii) and (iii) for current 'I' leaving 'D' and superpose results for 'A' and 'D'



41. ΔV measured between B and C is

(A) $\frac{\rho I}{\pi a}-\frac{\rho I}{\pi(a+b)}$ (B) $\frac{\rho I}{a}-\frac{\rho I}{\pi(a+b)}$

(C) $\frac{\rho I}{2\pi a}-\frac{\rho I}{2\pi(a+b)}$ (D) $\frac{\rho I}{2\pi(a-b)}$

42. For current entering at A, the electric field at a distance 'r' from A is

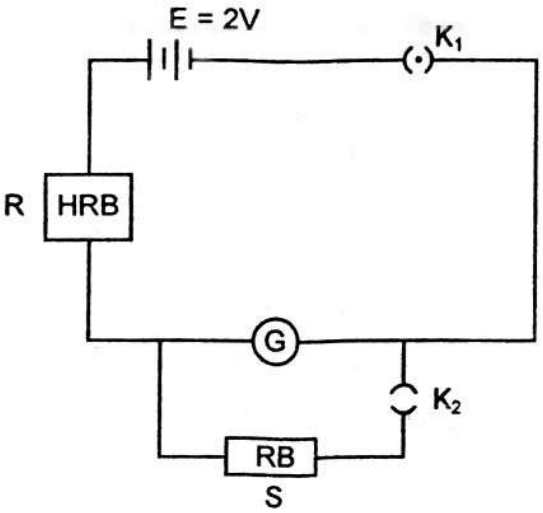
(A) $\frac{\rho I}{8\pi r^2}$ (B) $\frac{\rho I}{r^2}$

(C) $\frac{\rho I}{2\pi r^2}$ (D) $\frac{\rho I}{4\pi r^2}$

Paragraph for Questions 43 and 44

The given circuit is used to find resistance of a galvanometer. First key K_1 is closed and K_2 is kept open. A high resistance R = 5000Ω is used from HRB such that galvanometer shows 20 divisions deflection.

Now Key K_2 is closed and a resistance 'S' = 50Ω is drawn from RB such that deflection in galvanometer becomes half (i.e.10 division). The internal resistance of the battery is negligible. Total number division in galvanometer is 30.



43. Select correct alternatives(s) :

(A) Resistance of galvanometer is 50.50Ω

(B) Current required for one division deflection is 19.8μA

(C) Minimum voltage across galvanometer for full deflection is 12.2mV

(D) Minimum current through galvanometer for full deflection is 60μA

44. To convert given galvanometer to

(A) an ammeter of range 6mA a resistance of 5.55Ω should be connected in parallel with the galvanometer

(B) an ammeter of range 6mA a resistance of 10.1Ω should be connected in parallel with the galvanometer

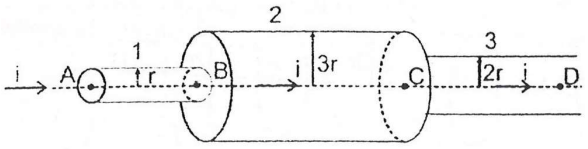
(C) a voltmeter of range 6V a resistance of 9565Ω should be connected in series with the galvanometer

(D) a voltmeter of range 6V a resistance of 10050.5Ω should be connected in series with the galvanometer

SECTION-D
Matrix-Match Type

This **Section D** have "match the following" type question. Question contains two columns, **Col-I** and **Col-II**. Match the entries in **Col-I** with the entries in **Col-II**. One or more entries in **Col-I** may match with one or more entries in **Col-II**.

45. Three metallic bars 1, 2, 3 are arranged as shown in figure with density of free charge carriers in ratio $N_1 : N_2 : N_3 = 1 : 3 : 2$; resistivity ratio $\rho_1 : \rho_2 : \rho_3 = 2 : 1 : 3$; lengths in ratio $l_1 : l_2 : l_3 = 2 : 2 : 3$ for 1, 2, and 3 bars respectively (radius of cross-section shown in figure), carry current i as shown. Match Column-I with Column - II and select the correct answer using the codes given below the lists:

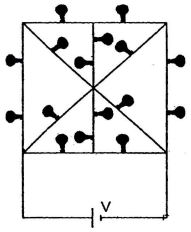


Column I	Column II
(A) If P_1, P_2 and P_3 are power dissipated across AB, BC, and CD, then $\frac{P_2P_3}{P_1^2}$	(p) $\frac{81}{32}$
(B) If E_1, E_2 and E_3 are magnitude of Electric-fields across AB, BC, and CD, then $\frac{E_3^2}{E_1E_2}$	(q) $\frac{1}{32}$
(C) If $v_{d_1}, v_{d_2}, v_{d_3}$ are drift speeds in bar AB, BC and CD, respectively, then $\frac{v_{d_2}v_{d_3}}{v_{d_1}^2}$	(r) $\frac{1}{216}$

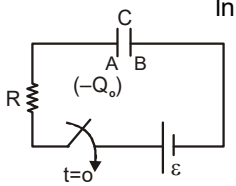
SECTION-E
Integer Answer Type

This section contains Integer type questions. The answer to each of the questions is an integer.

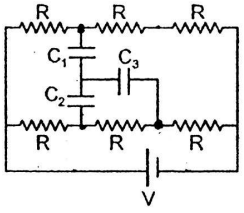
46. Standard rating of each bulb is P, V. If total power consumption by combination is $\frac{3XP}{5}$ then calculate 'X'.



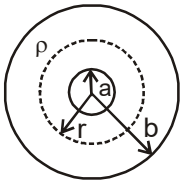
47. The figure shows an RC circuit with a parallel plate capacitor. Before switching on the circuit plate A of the capacitor has a charge $-Q_0$ while plate B has no net charge. Now at t = 0, the circuit is switched on. How much time (in second) will elapse before the net charge on plate A becomes zero (Given C = 1μF, Q_0 = 1mC, ε = 1000 V and R = $\frac{2\times10^{+6}}{\ln 3}\Omega$)



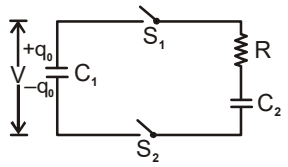
48. In the shown circuit, all three capacitor are identical and have capacitance C μF each. Each resistor has resistance of R Ω.An ideal cell of emf V volts is connected as shown. If the magnitude of potential difference across capacitor C_3 in steady state is $\frac{a}{b}$ V then value of (b–a) is (where a and b are co-primes)



49. Two concentric thin conducting shells of radii a = 0.5 m and b = 2 m are as shown in the figure. The region inside the shells is filled with a medium of specific resistance ρ = 5 Ωm. The conducting spheres are given equal and opposite charges. The electric flux through the surface of a spherical region (indicated by dotted region) of radius r is ϕ = 40 V-m. Find the current in amperes crossing the dotted spherical surface of radius r = 1m

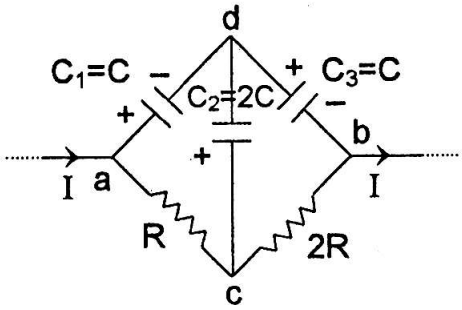


50. The capacitor C_1 in the figure initially carries a charge q_0. When the switches S_1 and S_2 are simultaneously closed, capacitor C_1 is connected in series to a resistor R and a second capacitor C_2, which initially does not carry any charge. If the heat lost in the circuit after a long time of simultaneously closing the switches is $\frac{q_0^2 C_2}{kC_1(C_1+C_2)}$, then find the value of k.



51. An ammeter and a voltmeter are connected in series to a battery of emf 6V. When a certain resistance is connected in parallel with the voltmeter, the reading of the latter decreases two times, whereas the reading of the ammeter increases the same number of times. Find the voltmeter reading after the connection

52. In the network of capacitor and resistances as shown in the figure, steady current I enters at juction 'a' and same current leaves junction b. Charge on capacitor C_3 with shown polarity is $\frac{KIRC}{4}$. Find K.



❑ ❑ ❑

ANSWERS

LEVEL-1

1. (B)	2. (D)	3. (C)	4. (A)	5. (C)	6. (B)
7. (A)	8. (D)	9. (C)	10. (B)	11. (B)	12. (C)
13. (D)	14. (D)	15. (B)	16. (D)	17. (A)	18. (C)
19. (B)	20. (B)	21. (A)	22. (B)	23. (B)	24. (D)
25. (B)	26. (A)	27. (C,D)	28. (B,D)	29. (A,B,C,D)	30. (A,B,C,D)
31. (A,B,D)	32. (B,D)	33. (A-r, B-q ,C-p, D-p)		34. (6)	35. (1)
36. (4)	37. (3)	38. (2)	39. (5)	40. (5)	

LEVEL-2

1. (A)	2. (B)	3. (A)	4. (A)	5. (D)	6. (B)
7. (A)	8. (A)	9. (B)	10. (D)	11. (A)	12. (B)
13. (C)	14 (B,C,D)	15. (A,C,D)	16. (A,C)	17. (A,C)	18. (A,B,D)
19. (B,D)	20. (A,B,C,D)	21. (A,B,C,D)	22. (B,C)	23. (A,C,D)	24. (C)
25. (C)	26. (A)	27. (C)	28.(C)	29. (A)	30. (C)
31. (A)	32. (A)	33. (B)	34. (B)	35. (A)	36. (C)
37. (A)	38. (C)	39. (B)	40. (D)	41. (A)	42. (C)
43. (A,B)	44. (A,D)	45. (A-q, B-p ,C-r)	46. (2)	47. (2)	48. (7)
49. (8)	50. (2)	51. (2)	52. (7)		

❑ ❑ ❑