PRACTICE EXERCISES

SINGLE CORRECT CHOICE TYPE QUESTIONS

This section contains Single Correct Choice Type Questions. Each question has four choices (A), (B), (C) and (D), out of which ONLY ONE is correct.

1. A conductor of area of cross-section A having charge carriers, each having a charge q is subjected to a potential V. The number density of charge carriers in the conductor is n and the charge carriers along with their random motion are moving with a velocity v. A current I flows in the conductor. If $\vec{j}$ is the current density, then

(A) $|\vec{j}| = nqV$, in the direction of current flow.

(B) $|\vec{j}| = nqv$, in the direction opposite to current flow.

(C) $|\vec{j}| = nqV$, in the direction perpendicular to current flow.

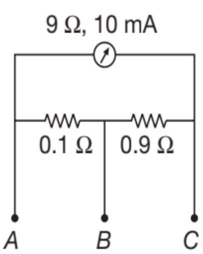
(D) $|\vec{j}| = nqv$, in the direction of current flow.

2. An electron in a hydrogen atom is considered to be revolving around a proton with a velocity $\frac{e^2}{\hbar}$ in a circular orbit of radius $\frac{\hbar^2}{me^2}$. If I is the equivalent current, then

(A) $I = \frac{me^5}{2\pi\hbar^3}$ (B) $I = \frac{me^5}{4\pi\hbar^3}$

(C) $I = \frac{2me^5}{\pi\hbar^3}$ (D) $I = \frac{me^5}{\pi\hbar^3}$

3. A milliammeter of range 10 mA and resistance 9 Ω is joined in a circuit as shown. The meter gives full scale deflection for current I when A and B are used as its terminals, i.e. current enters at A and leaves at B (C is left isolated). The value of I is



(A) 100 mA (B) 900 mA

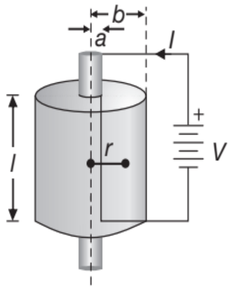
(C) 1 A (D) 1.1 A

4. The charge on a capacitor decreases η times in time t, when it discharges through a circuit with a time constant τ.

(A) $t = \eta\tau$ (B) $t = \tau \log_e \eta$

(C) $t = \tau(\log_e \eta - 1)$ (D) $t = \tau \log_e\left(1 - \frac{1}{\eta}\right)$

5. A metal rod of radius a is concentric with a metal cylindrical shell of radius b and length l. The space between rod and cylinder is tightly packed with a high resistance material of resistivity ρ. A battery having a terminal voltage V is connected across the combination as shown. Neglect resistance of rod and cylinder. If I is the total current in the circuit then,



(A) $I = \frac{lV}{\rho}$ (B) $I = \frac{2\pi lV}{\rho(\ln b - \ln a)}$

(C) $I = \frac{4\pi lV}{\rho(\ln b - \ln a)}$ (D) $I = \frac{lV}{4\pi\rho(\ln b - \ln a)}$

6. N identical light bulbs, each designed to draw P power from a certain voltage supply, are joined in series across that supply. The total power which they will draw is

(A) NP (B) P

(C) $\frac{P}{N}$ (D) $\frac{P}{N^2}$

7. A battery E is connected in series to an ammeter and a voltmeter such that the respective readings are A and V. Now a resistance is joined in parallel with the voltmeter. Then

(A) A increases, V decreases

(B) A decreases, V increases

(C) A and V both decrease

(D) A and V both increase

8. A conductor of area of cross section A having charge carriers, each having a charge q is subjected to a potential V. The number density of charge carriers in the conductor is n and the charge carriers (along with their random motion) are moving with a velocity v. If σ is the conductivity of the conductor and τ is the average relaxation time, then

(A) $\tau = \dfrac{m}{nq^2\sigma}$ (B) $\tau = \dfrac{m\sigma}{nq^2}$

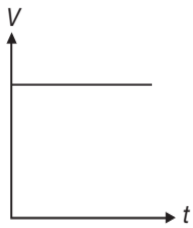
(C) $\tau = \dfrac{2m\sigma}{nq^2}$ (D) $\tau = \dfrac{1}{2}\dfrac{m\sigma}{nq^2}$

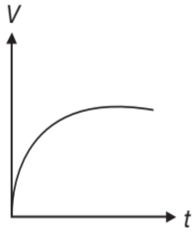
9. A long conductor of charge q, with charge density λ is moving with a velocity $2v$ parallel to its own axis. The conventional current due to motion of conductor is I. Then

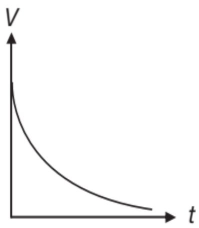
(A) $I = \dfrac{q}{t}$ (B) $I = 2\lambda v$

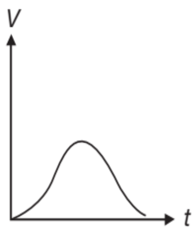
(C) $I = \lambda v$ (D) $I = 3\lambda v$

10. An ideal battery is connected to a capacitor through a voltmeter. The reading V of the voltmeter is plotted against time t. The V-t graph for this is given by

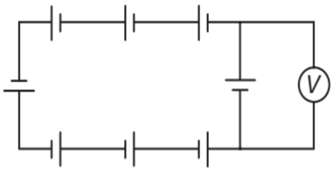
(A)


(B)


(C)


(D)


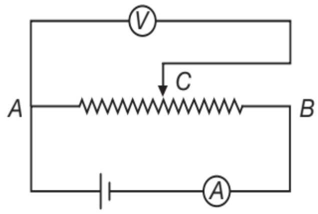
11. In the circuit shown each battery is $5V$ and has an internal resistance of $0.2\,\Omega$. The reading of the voltmeter is V. Then V equals



(A) 5 V (B) 10 V

(C) 15 V (D) ZERO

12. In the given circuit, as the sliding contact C is moved from A to B



(A) the readings of both the ammeter and the voltmeter remain constant

(B) the readings of both the ammeter and the voltmeter increase

(C) the reading of the ammeter remains constant but that of the voltmeter increases

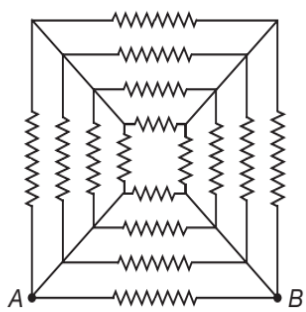
(D) the reading of the ammeter remains constant but that of the voltmeter decreases

13. Two resistances R_1 and R_2 are made of different materials. The temperature coefficient of the material of R_1 is α and that of material of R_2 is $-\beta$. The resistance of the series combination of R_1 and R_2 will not change with temperature if $\dfrac{R_1}{R_2}$ equals

(A) $\dfrac{\alpha}{\beta}$ (B) $\dfrac{\alpha+\beta}{\alpha-\beta}$

(C) $\dfrac{\alpha^2+\beta^2}{2\alpha\beta}$ (D) $\dfrac{\beta}{\alpha}$

14. Sixteen resistors each of resistance $16\,\Omega$ are connected in the circuit as shown. The net resistance between AB is



(A) $1\,\Omega$ (B) $2\,\Omega$

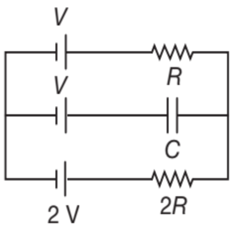
(C) $3\,\Omega$ (D) $4\,\Omega$

15. When an unknown resistance is connected across a series combination of two identical batteries, each of 1.5 V, the current through the resistor is 1.0 A. When it is connected across a parallel combination of the same batteries, the current through it is 0.6 A. The internal resistance of each battery is

(A) $\frac{1}{5}\,\Omega$ (B) $\frac{1}{4}\,\Omega$

(C) $\frac{1}{3}\,\Omega$ (D) $\frac{1}{2}\,\Omega$

16. In the circuit shown in figure, with steady current, the potential drop across the capacitor must be



(A) V (B) $\frac{V}{2}$

(C) $\frac{V}{3}$ (D) $\frac{2V}{3}$

17. A galvanometer with 50 divisions on the scale has a resistance of 25 Ω. A current of 2×10^{-4} A gives a deflection of one scale division. The additional series resistance required to convert it into a voltmeter reading up to 25 V is

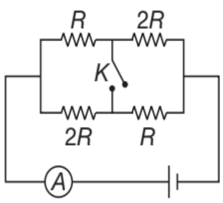
(A) 1200 Ω (B) 1225 Ω
(C) 2475 Ω (D) 2500 Ω

18. A cell has an emf of 1.5 V. When short circuited, it gives a current of 3 A. The internal resistance of the cell is

(A) 0.5 Ω (B) 2.0 Ω

(C) 4.5 Ω (D) $\frac{1}{4.5}\,\Omega$

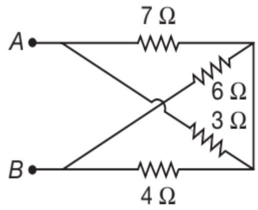
19. The ratio of currents as measured by ammeter in two cases (when the key is open and when the key is closed) is



(A) $\frac{9}{8}$ (B) $\frac{10}{11}$

(C) $\frac{8}{9}$ (D) None of these

20. The equivalent resistance between A and B (of the circuit shown) is



(A) 4.5 Ω (B) 12 Ω

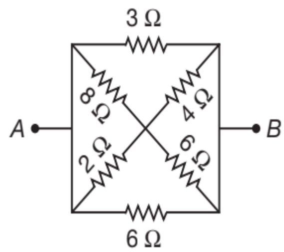
(C) 5.4 Ω (D) 20 Ω

21. When a resistor of 20 Ω is connected across a battery, the current is 0.5 A. When a resistor of 10 Ω is connected across the same battery, the current is 0.8 A. The emf and internal resistance of the battery are

(A) 10 V, $\frac{10}{3}\,\Omega$ (B) 20 V, $\frac{20}{3}\,\Omega$

(C) $\frac{40}{3}$ V, $\frac{10}{3}\,\Omega$ (D) $\frac{40}{3}$ V, $\frac{20}{3}\,\Omega$

22. In the network shown, the equivalent resistance between A and B is



(A) $\frac{4}{3}\,\Omega$ (B) $\frac{3}{4}\,\Omega$

(C) $\frac{24}{17}\,\Omega$ (D) $\frac{17}{24}\,\Omega$

23. A voltmeter of range 1 V has a resistance of 1000 Ω. To extend the range to 10 V, the additional series resistance required is

(A) $\frac{1000}{9}\,\Omega$ (B) 1000 Ω

(C) 9000 Ω (D) 10000 Ω

24. A primary cell has an emf of 1.5 V. When a 5 Ω resistor is connected across it, the current is 0.2 A. The internal resistance of the cell is

(A) 0.5 Ω (B) 1.25 Ω
(C) 2.5 Ω (D) 3.0 Ω

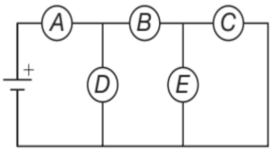
25. Three resistors of 2 Ω, 3 Ω and 5 Ω are connected in parallel across a battery of 10 V and of negligible internal resistance. The potential difference across the 3 Ω resistor is

(A) 2 V (B) 3 V
(C) 5 V (D) 10 V

26. A potentiometer wire of length 100 cm has a resistance of 10 Ω. It is connected in series with a resistance and an accumulator of emf 2 V and of negligible internal resistance. A source of emf 10 mV is balanced against a 40 cm length of the potentiometer wire. The value of the external resistance is

(A) 395 Ω (B) 790 Ω
(C) 405 Ω (D) 810 Ω

27. In the circuit diagram shown in figure, a fuse bulb can cause all other bulbs to go out. Identify the bulb



(A) B (B) C
(C) A (D) D or E

28. Two coils when connected in series have an equivalent resistance of 18 Ω and when connected in parallel have a resistance of 4 Ω. The possible values of resistances for the coils is/are

(A) $R_1 = 4\ \Omega;\ R_2 = 14\ \Omega$

(B) $R_1 = 2\ \Omega,\ R_2 = 16\ \Omega$

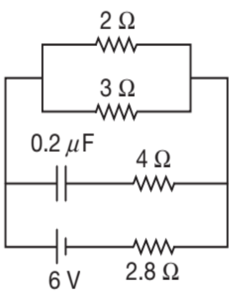
(C) $R_1 = 12\ \Omega;\ R_2 = 6\ \Omega$

(D) $R_1 = 8\ \Omega,\ R_2 = 10\ \Omega$

29. If a wire is stretched to make it 0.1% longer, the percentage change in its resistance would be

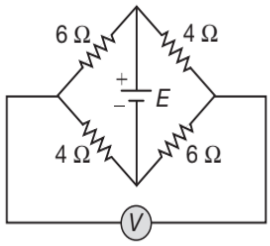
(A) ZERO (B) 0.1%
(C) 0.2% (D) 0.4%

30. In the given circuit the steady state current through the 2 Ω resistor is



(A) 0.6 A (B) 0.9 A
(C) 1.2 A (D) 1.5 A

31. In the circuit shown, the voltmeter has a large resistance. The emf of the cell is E. The reading of the voltmeter is



(A) zero (B) $\frac{E}{10}$

(C) $\frac{E}{5}$ (D) $\frac{E}{2}$

32. N identical cells, each of emf E and internal resistance r, are joined in series to form a closed circuit. The potential difference across any one cell is ΔV. Then

(A) $\Delta V = E$ (B) $\Delta V = \frac{E}{N}$

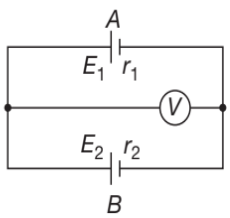
(C) $\Delta V = \left(\frac{N-1}{N}\right)E$ (D) $\Delta V = 0$

33. A non-conducting ring of radius R has two positive point charges lying diametrically opposite to each other, each of magnitude Q. The ring rotates with an angular velocity ω. If I is the equivalent current then,

(A) $I = Q\omega$ (B) $I = \frac{2Q\omega}{\pi}$

(C) $I = \frac{Q\omega}{\pi}$ (D) $I =$ ZERO

34. Two cells A and B of emf 1.3 V and 1.5 V respectively are arranged as shown in figure. The voltmeter reads 1.45 V. The voltmeter is assumed to be ideal. Then



(A) $r_1 = 2r_2$ (B) $r_1 = 3r_2$
(C) $r_2 = 2r_1$ (D) $r_2 = 3r_1$

35. A straight conductor of uniform cross-section carries a time varying current which varies at the rate $\frac{dI}{dt} = \dot{I}$. If s is the specific charge that is carried by each charge carrier of the conductor and l is the length of the conductor then the total force experienced by all the charge carriers per unit length of the conductor due to their drift velocities only is

(A) $F = \dot{I}s$ (B) $F = \dfrac{\dot{I}}{2\sqrt{Is}}$

(C) $F = \dfrac{\dot{I}}{s}$ (D) $F = \dfrac{2I\dot{I}}{s}$

36. A milliammeter of range 10 mA has a coil of resistance $1\,\Omega$. To use it as an ammeter of range 1 A, the required shunt must have a resistance of

(A) $\dfrac{1}{101}\Omega$, connected in series

(B) $\dfrac{1}{100}\Omega$, connected in parallel

(C) $\dfrac{1}{99}\Omega$, connected in parallel

(D) $\dfrac{1}{9}\Omega$, connected in series

37. To use the milliammeter of PROBLEM 36 as a voltmeter of range 10 V, a resistance R is placed in series with it. The value of R is

(A) $9\,\Omega$, connected in parallel

(B) $99\,\Omega$, connected in series

(C) $999\,\Omega$, connected in series

(D) $1000\,\Omega$, connected in parallel

38. N identical cells, each of emf E and internal resistance r, are joined in series to form a closed circuit. It is observed that mistakenly one cell has been joined with its polarity reversed. The potential difference across each cell, except the wrongly connected one is ΔV. Then

(A) $\Delta V = \dfrac{2E}{N}$ (B) $\Delta V = \left(\dfrac{N-1}{N}\right)E$

(C) $\Delta V = \left(\dfrac{N-2}{N}\right)E$ (D) $\Delta V = \left(\dfrac{2N}{N-2}\right)E$

39. A rod of length L has charge distributed on it such that linear charge density $\lambda = kx$, k is a constant and x is the distance of a point from the end of the rod where no charge exists. The rod has a mass m and the mass distribution is uniform. The rod is now rotated about an axis passing through the end of the rod where no charge exists and this axis is perpendicular to the length of the rod. If I is the equivalent current then,

(A) $I = \dfrac{kL^2\omega}{\pi}$ (B) $I = \pi kL\omega$

(C) $I = \dfrac{kL^2\omega}{4\pi}$ (D) $I = \text{zero}$

40. N identical cells, each of emf E_0 and internal resistance r_0, are joined in series. Out of these N cells, n cells are wrongly connected. Assuming $n < \frac{1}{2}N$, E and r to be the respective net emf and internal resistance of the resulting battery, then

(A) $E = (N-n)E_0,\ r = Nr_0$

(B) $E = (N-n)E_0,\ r = (N-n)r_0$

(C) $E = (N-2n)E_0,\ r = (N-2n)r_0$

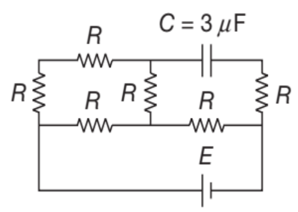
(D) $E = (N-2n)E_0,\ r = Nr_0$

41. A block of metal is made in the cuboid form with all edges of unequal length. The shortest length is one-third the longest one. If R_{max} and R_{min} are the maximum and minimum resistance between parallel faces then,

(A) $\dfrac{R_{max}}{R_{min}} = 4$ (B) $\dfrac{R_{max}}{R_{min}} = 9$

(C) $\dfrac{R_{max}}{R_{min}} = 3$ (D) Data Insufficient

42. In the circuit, the potential difference across the capacitor is 10 V. Each resistance is of $3\,\Omega$. The cell is ideal. The emf of the cell is



(A) 14 V (B) 16 V

(C) 18 V (D) 24 V

43. Three copper wires have their lengths in the ratio $5:3:1$ and their masses are in the ratio $1:3:5$. Their electrical resistance will be in the ratio

(A) $5:3:1$ (B) $1:3:5$

(C) $125:15:1$ (D) $1:15:125$

44. It is observed that a milliammeter of range 10 mA gives full-scale deflection for a current of 100 mA, when a shunt of $0.1\,\Omega$ is connected in parallel to it. The coil of the milliammeter has a resistance of

(A) $0.11\,\Omega$ (B) $1.1\,\Omega$

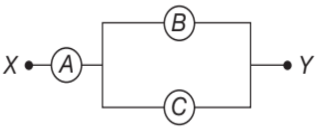
(C) $1\,\Omega$ (D) $0.9\,\Omega$

45. The external resistance of a circuit is η times higher than the internal resistance of the source. The ratio of the potential difference across the terminals of the source to its e.m.f. is

(A) $\frac{1}{\eta}$ (B) η

(C) $\frac{1+\eta}{\eta}$ (D) $\frac{\eta}{1+\eta}$

46. Three voltmeters A, B and C, connected as shown, have resistances R, $\frac{3}{2}R$ and $3R$ respectively. When some potential difference is applied between X and Y, the respective voltmeter readings are V_A, V_B and V_C. Then



(A) $V_A \neq V_B = V_C$ (B) $V_B \neq V_A = V_C$

(C) $V_A = V_B \neq V_C$ (D) $V_A = V_B = V_C$

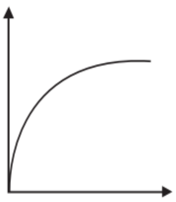
47. The terminal potential difference of a cell is $2.2\ \text{V}$ (when circuit is open) and reduces to $1.8\ \text{V}$ (when the cell is connected to a resistance $R = 5\ \Omega$). The internal resistance of cell (r) is

(A) $\frac{10}{9}\ \Omega$ (B) $\frac{9}{10}\ \Omega$

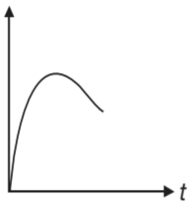
(C) $\frac{11}{9}\ \Omega$ (D) $\frac{5}{9}\ \Omega$

48. The current flowing through a running electric heater, I, is plotted against the time t. Taking into account the variation of resistance with temperature, which of the following curve best represents the variation of I with t?

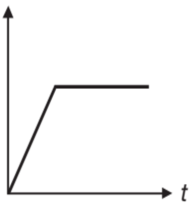
(A)



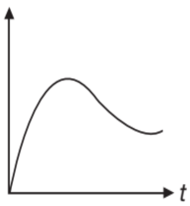
(B)



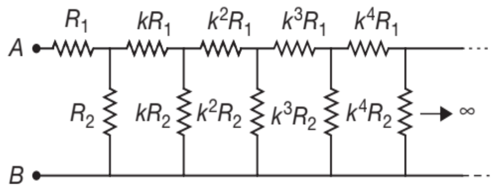
(C)



(D)



49. The circuit diagram shown consists of a large number of elements (each element has two resistors R_1 and R_2). The resistances of the resistors in each subsequent element differs by a factor of $k = \frac{1}{2}$ from the resistances of the resistors in the previous elements. The equivalent resistance between A and B shown in figure is



(A) $\frac{R_1 - R_2}{2}$

(B) $\frac{(R_1 - R_2) + \sqrt{6R_1R_2}}{2}$

(C) $\frac{(R_1 - R_2) + \sqrt{R_1^2 + R_2^2 + 6R_1R_2}}{2}$

(D) None of these

50. A capacitor of capacitance C has charge Q. It is connected to an identical capacitor through a resistance. The heat produced in the resistance is

(A) $\frac{1}{2}\left(\frac{Q^2}{C}\right)$

(B) $\frac{1}{4}\left(\frac{Q^2}{C}\right)$

(C) $\frac{1}{8}\left(\frac{Q^2}{C}\right)$

(D) dependent on the value of the resistance.

51. A and B are two points on a uniform ring of resistance R. The $\angle ACB = \theta$, where C is the centre of the ring. The equivalent resistance between A and B is

(A) $\frac{R}{4\pi^2}(2\pi - \theta)\theta$ (B) $R\left(1 - \frac{\theta}{2\pi}\right)$

(C) $R\left(\frac{\theta}{2\pi}\right)$ (D) $R\left(\frac{2\pi - \theta}{4\pi}\right)$

52. A copper wire of length l and radius r is nickel-plated till its final radius is $2r$. If the resistivities of the copper and nickel are ρ_C and ρ_N, then the equivalent resistance of wire is

(A) $\frac{\rho_C l}{\pi r^2}$ (B) $\frac{\rho_N l}{4\pi r^2}$

(C) $\frac{l}{\pi r^2\left[\frac{1}{\rho_C} + \frac{3}{\rho_N}\right]}$ (D) $\frac{l}{\pi r^2}\left(\rho_C + \frac{\rho_N}{3}\right)$

53. A battery of e.m.f. E, internal resistance r is applied in the circuit in a closed loop. The current I in the circuit goes from the positive terminal of the battery to the negative terminal inside it. The potential drop across the battery is

(A) $V = E - Ir$ (B) $V = E + Ir$

(C) $V = +Ir$ (D) $V = -Ir$

54. Carbon resistors used in electronic circuits are marked for their resistance values and tolerance by a colour scheme. A given resistor has colour scheme brown, black, green and gold. Its value in Ω is

(A) $3.2 \times 10^5 \pm 5\%$ (B) $1.0 \times 10^6 \pm 10\%$

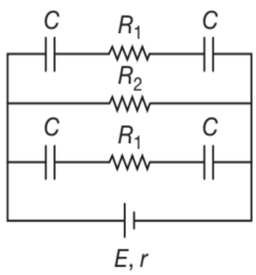
(C) $1.0 \times 10^6 \pm 5\%$ (D) $1.0 \times 10^3 \pm 5\%$

55. Two wires of the same material and the same length are connected to the two gaps of a metre bridge. The balancing length measured from left is 25 cm. The ratio radius of the wire is the left gap to that in the right gap is

(A) 1.73 (B) 3

(C) 0.577 (D) $\frac{1}{3}$

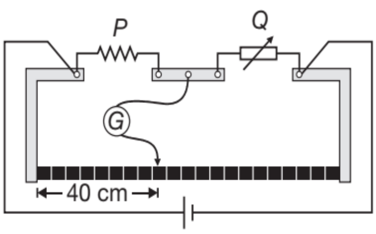
56. In the adjoining circuit $E = 5\text{V}$, $r = 1\,\Omega$, $R_1 = 1\,\Omega$, $R_2 = 4\,\Omega$, $C = 3\,\mu\text{F}$. Then the numerical value of charge on each plate of capacitors is



(A) 3 μC (B) 6 μC

(C) 12 μC (D) 24 μC

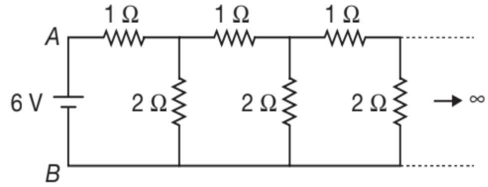
57. In a metre bridge, the gaps are closed by two resistances P and Q and the balance point is obtained at 40 cm. When Q is shunted by a resistance of 10 Ω, the balance point shifts to 50 cm. The values of P and Q are



(A) $\frac{10}{3}\,\Omega, 5\,\Omega$ (B) 20 Ω, 30 Ω

(C) 10 Ω, 15 Ω (D) 5 Ω, $\frac{15}{2}\,\Omega$

58. An infinite ladder network is constructed with 1 Ω and 2 Ω resistors as shown. The effective resistance between A and B is



(A) 1 Ω (B) 2 Ω

(C) 3 Ω (D) 4 Ω

59. In PROBLEM 58, the current through the 2 Ω resistor nearest to the battery is

(A) 1.5 A (B) 2.0 A

(C) 3.0 A (D) 4.0 A

60. Three conductors draw respectively currents of 1 A, 2 A and 4 A when connected in turn across a battery. If they are connected in series across the same battery, The current drawn will be

(A) $\frac{2}{7}$ A (B) $\frac{3}{7}$ A

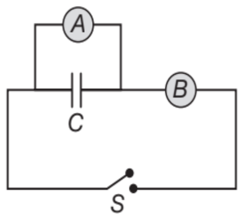
(C) $\frac{4}{7}$ A (D) $\frac{5}{7}$ A

61. Two resistances r_1 and $r_2 (r_1 < r_2)$ are connected in parallel. The equivalent resistance R is

(A) $R > r_1 + r_2$ (B) $r_2 < R < r_1 + r_2$

(C) $r_1 < R < r_2$ (D) $R < r_1$

62. In the circuit shown, the capacitor having capacitance C is connected to two voltmeters A and B. Voltmeter A being ideal, having infinite resistance, while voltmeter B has a resistance R. The capacitor is charged and then the switch S is closed. Both A and B show equal readings at time t. Then this is possible for



(A) $t \to \infty$ (B) $t = RC$

(C) $t = RC\log_e(2)$ (D) all the t values

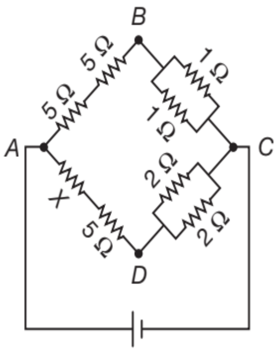
63. The temperature coefficient of resistance of a wire is 0.00125 per °C. At 300 K its resistance is 1 Ω. The resistance of the wire will be 2 Ω at

(A) 1154 K (B) 1100 K
(C) 1400 K (D) 1127 K

64. Two resistors of 500 Ω and 300 Ω are connected in series with a battery of emf 20 V. A voltmeter of resistance 500 Ω is used to measure the potential difference across the 500 Ω resistor. The error in the measurement is

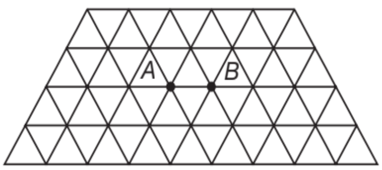
(A) 1.4 V (B) 2.4 V
(C) 3.4 V (D) 4.4 V

65. In the given bridge the value of X for which the potential difference between the points B and D will be zero, is



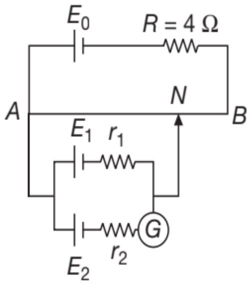
(A) 5 Ω (B) 10 Ω
(C) 15 Ω (D) 20 Ω

66. There is an infinite wire grid with cells in the form of equilateral triangles. The resistance of each wire between neighbouring joint connections is R_0. The net resistance of the whole grid between the points A and B as shown is



(A) R_0 (B) $\frac{R_0}{2}$
(C) $\frac{R_0}{3}$ (D) $\frac{R_0}{4}$

67. A battery of emf $E_0 = 12$ V is connected across a 4 m long uniform wire having resistance $4\ \Omega m^{-1}$. The cell of small emfs $E_1 = 2$ V and $E_2 = 4$ V having internal resistance 2 Ω and 6 Ω respectively are connected as shown in the figure. If galvanometer shows no deflection at the point N, the distance of point N from the point A is equal to



(A) $\frac{5}{3}$m (B) $\frac{4}{3}$m
(C) $\frac{3}{2}$m (D) None of these

68. An ammeter and a voltmeter are joined in series to a cell. Their readings are A and V respectively. If a resistance is now joined in parallel with the voltmeter,

(A) both A and V will increase.
(B) both A and V will decrease.
(C) A will decrease, V will increase.
(D) A will increase, V will decrease.

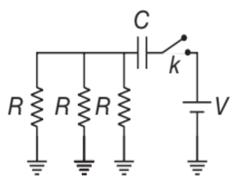
69. A nonconducting ring of radius R has charge Q distributed unevenly over it. If it rotates with an angular velocity ω, the equivalent current will be

(A) ZERO (B) $Q\omega$
(C) $\frac{Q\omega}{2\pi}$ (D) $\frac{Q\omega}{2\pi R}$

70. Two wires of the same metal has the same length but their cross-sections are in the ratio $3:1$. They are joined in series. The resistance of the thicker wire is 10 Ω. The total resistance of the combination will be

(A) 40 Ω (B) $\frac{40}{3}$ Ω
(C) $\frac{5}{2}$ Ω (D) 100 Ω

71. The switch shown in the figure is closed at $t = 0$. The charge on the capacitor as a function of time is given by

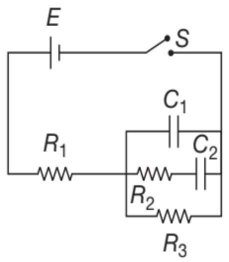


(A) $CV\left(1-e^{-\frac{t}{RC}}\right)$ (B) $3CV\left(1-e^{-\frac{t}{RC}}\right)$
(C) $CV\left(1-e^{-\frac{3t}{RC}}\right)$ (D) $CV\left(1-e^{-\frac{t}{3RC}}\right)$

72. Two electric bulbs A and B having power ratings P_A and P_B, $(<P_A)$ respectively are designed for the same voltage. They are joined in series across a supply of voltage V. Then

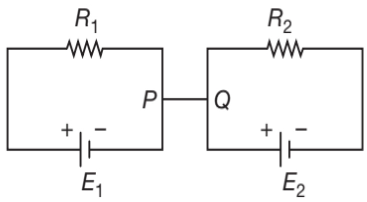
(A) A and B will draw the same power.
(B) A will draw more power than B.
(C) B will draw more power than A.
(D) the ratio of powers drawn by them will depend on V.

73. In the circuit diagram, the current through the battery immediately after the switch S is closed is



(A) zero
(B) $\dfrac{E}{R_1}$
(C) $\dfrac{E}{R_1+R_2}$
(D) $\dfrac{E}{R_1+\dfrac{R_2R_3}{R_2+R_3}}$

74. In the circuit shown, the conductor PQ is of negligible resistance. Then



(A) current will flow through PQ if $\dfrac{E_1+E_2}{R_1+R_2}\neq\dfrac{|E_1-E_2|}{R_1-R_2}$
(B) current will flow through PQ if $E_1\neq E_2$
(C) no current will flow through PQ
(D) current will flow through PQ if $\dfrac{E_1}{R_1}\neq\dfrac{E_2}{R_2}$

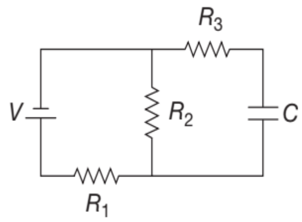
75. A fuse wire of radius r, resistivity ρ, length l has a current I passing through it. If ε is the emissivity of the fuse wire and T is the excess safe temperature above the surroundings then

(A) $T=\dfrac{I^2\rho}{\pi^2\varepsilon r^3}$
(B) $T=\dfrac{I^2\rho}{2\pi^2\varepsilon r^3}$
(C) $T=\dfrac{2I^2\rho}{\pi^2\varepsilon r^3}$
(D) $T=\dfrac{4I^2\rho}{\pi^2\varepsilon r^3}$

76. A battery is formed by connecting N identical cells together. On short circuiting the terminals of the battery a current I flows in the circuit. To maximise the value of I,

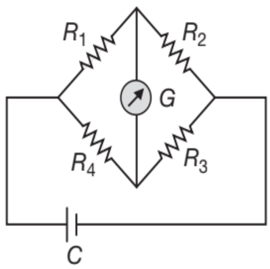
(A) two rows of $\dfrac{N}{2}$ cells each are connected in parallel.
(B) $\sqrt{N}$ rows of $\sqrt{N}$ cells each are connected in parallel, given that $\sqrt{N}$ is an integer.
(C) all the cells are connected in series.
(D) all the cells are connected in parallel.

77. In the circuit shown in figure, the steady state voltage drop across the capacitor is V_C. Then



(A) $V_C=\dfrac{VR_1}{R_2+R_3}$
(B) $V_C=\dfrac{VR_2}{R_1+R_3}$
(C) $V_C=\dfrac{VR_1}{R_1+R_2}$
(D) $V_C=\dfrac{VR_2}{R_1+R_2}$

78. In a balanced Wheatstone bridge shown, if the positions of the battery E and the galvanometer G are interchanged, then G will show zero deflection

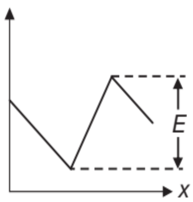


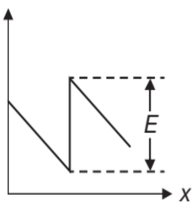
(A) only if $\dfrac{R_1}{R_3}=\dfrac{R_2}{R_4}$.
(B) only if $R_1=R_3$ and $R_2=R_4$.
(C) only if all the resistances are equal.
(D) in all cases.

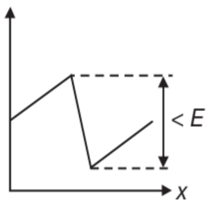
79. A cell develops the same power across two resistors r_1 and r_2 when connected separately. If r is the internal resistance of the cell then

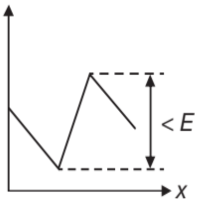
(A) $r=\dfrac{1}{2}\sqrt{r_1r_2}$
(B) $r=\sqrt{r_1r_2}$
(C) $r=\dfrac{1}{2}(r_1+r_2)$
(D) $r=r_1+r_2$

80. A uniform conductor has its two free ends joined to a cell of emf E and some non zero internal resistance. Consider a point P right at the middle of the conductor. Let us now move away from the midpoint of the conductor in the direction of the current and then return to P. During this process we study the variation of the potential V at every point on the path and then plot it against the distance covered (x). The curve that best represents the variation of V with x is

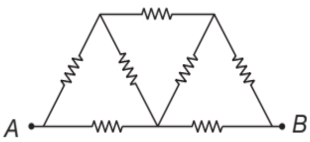
(A) 

(B) 

(C) 

(D) 

81. Seven resistors each of resistance R, are connected as shown in figure. The equivalent resistance between A and B is



(A) $\frac{4}{3}R$ (B) $\frac{3}{2}R$

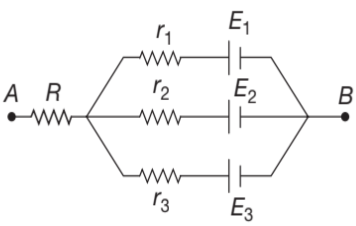
(C) $7R$ (D) $\frac{8}{7}R$

82. A cell of emf E and internal resistance r has its terminals connected to a resistance R such that the potential difference between the terminals is 1.6 V when $R = 4\,\Omega$, and 1.8 V when $R = 9\,\Omega$. Then,

(A) $E = 1\text{ V},\ r = 1\,\Omega$ (B) $E = 2.5\text{ V},\ r = 0.5\,\Omega$

(C) $E = 2\text{ V},\ r = 1\,\Omega$ (D) $E = 2\text{ V},\ = 2\,\Omega$

83. In the network shown the potential difference between A and B for the values $R = r_1 = r_2 = r_3 = 1\,\Omega$, $E_1 = 3\text{ V}$, $E_2 = 2\text{ V}$, $E_3 = 1\text{ V}$ is



(A) 1 V (B) 2 V

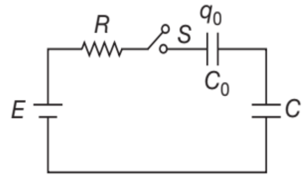
(C) 3 V (D) 4 V

84. The capacitive growth current and the capacitive decay current in series RC circuit are I_g and I_d respectively. If I_0 is the value of growth current as $t \to \infty$ then at any instant of time

(A) $I_g = I_d$ (B) $I_g = I_0$

(C) $I_g = -I_d$ (D) $I_d = -I_0$

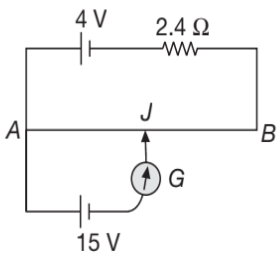
85. In the circuit shown, the switch S is closed initially. The capacitor C is uncharged but C_0 has a charge q_0 at $t = 0$. The capacitive current immediately after switch S is closed is I_C. Then



(A) $I_C = 0$ (B) $I_C \to \infty$

(C) $I_C = \frac{\left(E - \frac{q_0}{C_0}\right)}{R}$ (D) $I_C = \frac{E}{R}$

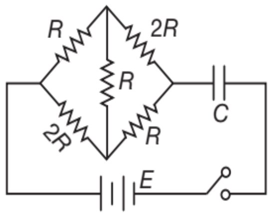
86. A simple potentiometer circuit is shown in figure.



The internal resistance of 4 V battery is negligible. AC is the uniform wire of length 100 cm and resistance 2 Ω. What would be the length of AB for which galvanometer shows zero deflection

(A) 82.5 cm (B) 41.50 cm
(C) 165 cm (D) 50 cm

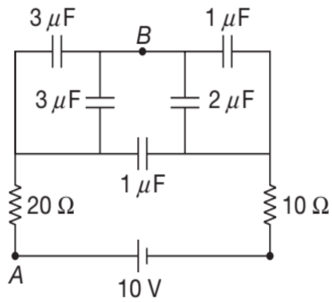
87. In the circuit shown the steady state value is reached at time t_0. Then



(A) $t_0 \to \infty$ (B) $t_0 = 7RC$

(C) $t_0 = \frac{7}{5}RC$ (D) $t_0 = \frac{5}{7}RC$

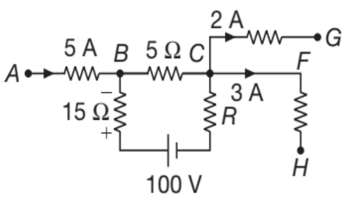
88. In the circuit shown in figure, the potential difference between the points A and B in the steady state is



(A) zero (B) 6 V

(C) 4 V (D) $\frac{10}{3}$ V

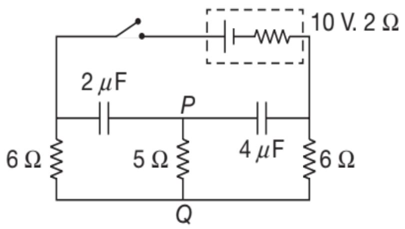
89. In the circuit shown, the voltage drop across the 15 Ω resistor is 30 V having the polarity as indicated. The ratio of potential difference across 5 Ω resistor and resistance R is



(A) $\frac{2}{7}$ (B) 0.4

(C) $\frac{5}{7}$ (D) 1

90. In the circuit shown in figure, the capacitors are initially uncharged. The current through resistor PQ just after closing the switch is



(A) 2 A from P to Q

(B) 2 A from Q to P

(C) 6 A from P to Q

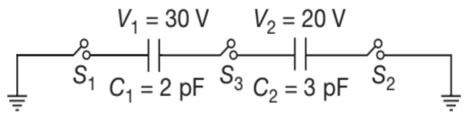
(D) zero

91. In a metre bridge, a standard resistor of R Ω is connected in the left gap and the two wires A and B are connected one after the other in the right gap. The balancing length measured from the left is 50 cm for either of them. If the two wires are connected in series and put in the right gap, balancing length measured from left would be (in cm)

(A) 25 (B) 33.3

(C) 66.7 (D) 75

92. For the circuit shown in figure, which of the following statement(s) is true?



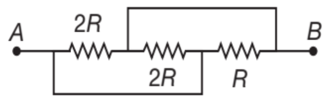
(A) With S_1 closed, $V_1 = 15$ V, $V_2 = 20$ V.

(B) With S_3 closed, $V_1 = V_2 = 25$ V.

(C) With S_1 and S_2 closed $V_1 = V_2 = ZERO$.

(D) With S_1 and S_3 closed $V_1 = 30$ V, $V_2 = 20$ V.

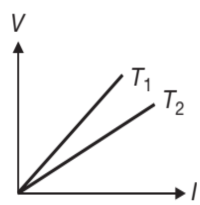
93. The equivalent resistance between points A and B in the circuit shown is



(A) R (B) $\frac{R}{2}$

(C) $\frac{R}{4}$ (D) $\frac{R}{8}$

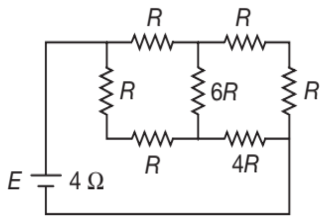
94. The voltage V and current I graph for a conductor at two different temperatures T_1 and T_2 are shown in figure. The relation between T_1 and T_2 is



(A) $T_1 > T_2$ (B) $T_1 < T_2$

(C) $T_1 = T_2$ (D) $T_1 \approx T_2$

95. A battery of internal resistance 4 Ω is connected to a network of resistances as shown. In order that the maximum power can be delivered to the network, the value of R in ohm should be



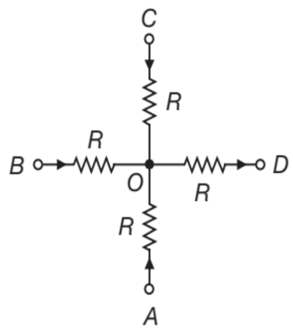
(A) $\frac{4}{9}$ (B) 2

(C) $\frac{8}{3}$ (D) 18

96. Two cells, having emfs E_1 and $E_2 (E_1 > E_2)$, when placed in series produce null deflection at a distance of 204 cm in a potentiometer. When placed in opposition, they produce null deflection at a distance of 36 cm. If $E_2 = 1.4$ V, E_1 is

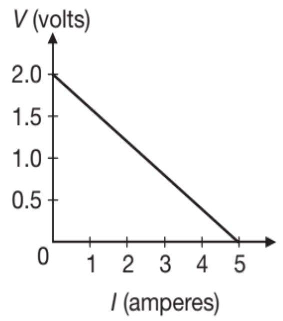
(A) 14 V (B) 10 V
(C) 4.2 V (D) 2 V

97. The given four terminal network is part of a larger circuit. The points A, B, C are at the same potential. The potential difference between any one of A, B or C and D is 40 V. The potential difference between A and O is



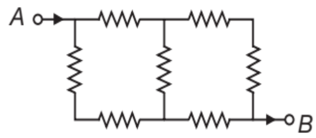
(A) 10 V (B) 15 V
(C) 18 V (D) 20 V

98. For a cell, the graph between the potential difference (*V*) across the terminals of the cell and the current (*I*) drawn from the cell is shown in the figure. The e.m.f. and the internal resistance of the cell are



(A) 2 V, 0.5 Ω (B) 2 V, 0.4 Ω
(C) >2 V, 0.5 Ω (D) >2 V, 0.4 Ω

99. Seven resistors each of value 5 Ω are connected as shown. The equivalent resistance between the points A and B is



(A) 5 Ω (B) 7 Ω
(C) 14 Ω (D) 35 Ω

100. A galvanometer can be converted into a voltmeter or an ammeter by using either of the two resistances R_1 and $R_2 (R_1 \gg R_2)$

(A) R_1 in series with the galvanometer for voltmeter and R_2 in parallel for ammeter

(B) R_1 in parallel with the galvanometer for voltmeter and R_2 in series for ammeter

(C) R_2 in series with the galvanometer for voltmeter and R_1 in parallel for ammeter

(D) R_2 in parallel with the galvanometer for voltmeter and R_1 in series for ammeter

101. All the edges of a block with parallel faces are unequal. Its longest edge is thrice its shortest edge. The ratio of the maximum to minimum resistance between parallel faces is

(A) 3
(B) 6
(C) 9
(D) indeterminate unless the length of the third edge is specified

102. A 2.0 V potentiometer is used to determine the internal resistance of a 1.5 V cell. The balance point of the cell in open circuit is 75 cm. When a resistor of 10 Ω is connected across the cell, the balance point shifts to 60 cm. The internal resistance of the cell is

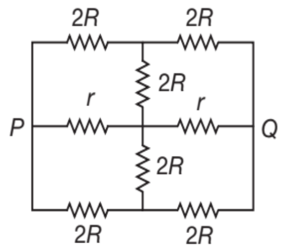
(A) 1.5 Ω (B) 2.5 Ω
(C) 3.5 Ω (D) 4.5 Ω

103. A galvanometer of resistance 50 Ω is connected to a battery of 3 V along with resistance of 2950 Ω in series. A full scale deflection of 30 divisions is obtained in the galvanometer. In order to reduce this deflection to 20 divisions, the above series resistance should be

(A) 4450 Ω (B) 5050 Ω

(C) 5550 Ω (D) 6050 Ω

104. The effective resistance between points P and Q of the electrical circuit shown in figure is



(A) $\frac{2Rr}{R+r}$ (B) $\frac{8R(R+r)}{3R+r}$

(C) $2r+4R$ (D) $\frac{5R}{2}+2r$

105. Five cells, each of e.m.f. E and internal resistance r, are connected in series. If by mistake, one of the cells is connected wrongly, the equivalent e.m.f. and internal resistance of the combination are

(A) $5E$, $5r$ (B) $3E$, $5r$

(C) $5E$, $3r$ (D) $3E$, $3r$

106. The e.m.f. and the internal resistance of a source which is equivalent to two batteries which are connected in parallel having e.m.f.'s E_1 and E_2 and internal resistances r_1 and r_2 respectively are E and r.

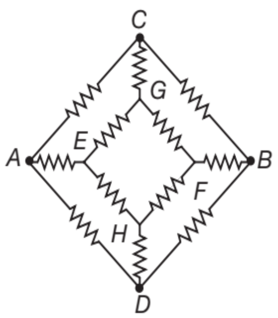
(A) $E=\frac{E_1r_1+E_2r_2}{(r_1+r_2)}$; $r=r_1+r_2$

(B) $E=\frac{E_1r_2+E_2r_1}{(r_1+r_2)}$; $r=r_1+r_2$

(C) $E=\frac{E_1r_2+E_2r_1}{(r_1+r_2)}$; $r=\frac{r_1r_2}{r_1+r_2}$

(D) $E=\frac{E_1r_1+E_2r_2}{(r_1+r_2)}$; $r=\frac{r_1r_2}{r_1+r_2}$

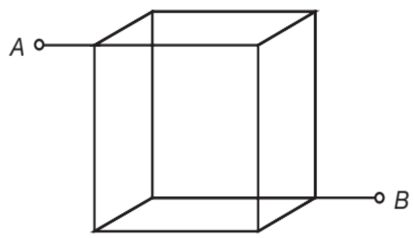
107. Twelve identical resistors each of value $1\,\Omega$ are connected as shown. Net resistance between C and D is R



(A) $R=\frac{7}{6}\,\Omega$ (B) $R=\frac{4}{3}\,\Omega$

(C) $R=1\,\Omega$ (D) $R=\frac{3}{4}\,\Omega$

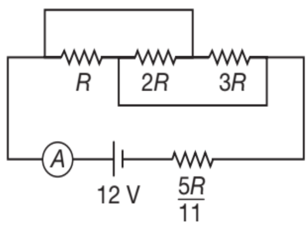
108. Twelve wires, each of resistance R, are connected to form a cube as shown in the figure. The effective resistance between A and B is



(A) $\frac{R}{6}$ (B) $\frac{R}{3}$

(C) $\frac{5R}{3}$ (D) $\frac{5R}{6}$

109. In the circuit shown the reading of ammeter is 2 A. The ammeter has negligible resistance. The value of R equals.



(A) $2\,\Omega$ (B) $4\,\Omega$

(C) $6\,\Omega$ (D) $8\,\Omega$

110. The deflection in a galvanometer falls from 50 divisions to 20 divisions when a $12\,\Omega$ shunt is applied. The galvanometer resistance is

(A) $18\,\Omega$ (B) $24\,\Omega$

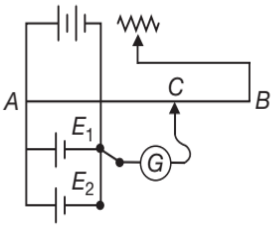
(C) $30\,\Omega$ (D) $36\,\Omega$

111. A straight conductor of uniform cross-section carries a current I. If s be the specific charge of an electron. The momentum of all the free electrons per unit length of the conductor, due to their drift velocities only, is

(A) Is (B) $\frac{I}{s}$

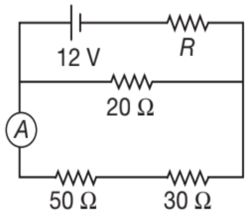
(C) $\sqrt{\frac{I}{s}}$ (D) $\left(\frac{I}{s}\right)^2$

112. The circuit shown here is used to compare the e.m.f.'s of the cells E_1 and $E_2\,(E_1>E_2)$. When the galvanometer is connected to E_1, the null point is at C. When the galvanometer is connected to E_2, the null point will be



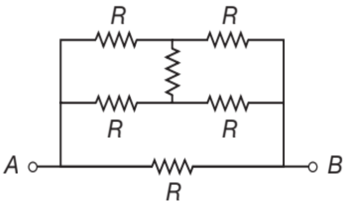
(A) to the left of C (B) to the right of C
(C) at C itself (D) no where on AB

113. In the given circuit, the ammeter A, assumed to have negligible resistance, reads 0.1 A. The value of R is



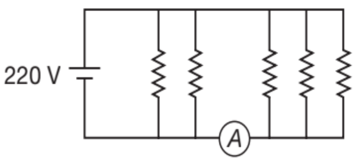
(A) 6 Ω (B) 8 Ω
(C) 16 Ω (D) 20 Ω

114. In the network shown below, the equivalent resistance between A and B is



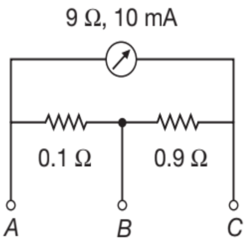
(A) $\frac{R}{2}$ (B) R
(C) $2R$ (D) $4R$

115. Five identical resistors, each of value 1100 Ω, are connected to a 220 V battery as shown. The reading of the ideal ammeter A is



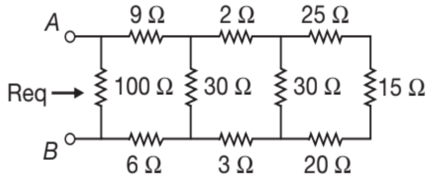
(A) $\frac{1}{5}$ A (B) $\frac{2}{5}$ A
(C) $\frac{3}{5}$ A (D) $\frac{4}{5}$ A

116. A milliammeter of range 10 mA and resistance 9 Ω is joined in a circuit as shown. The metre gives full-scale deflection for current I when A and B are used as its terminals. The value of I is



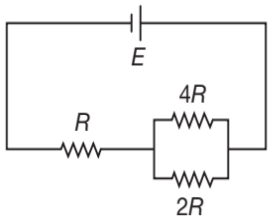
(A) 100 mA (B) 900 mA
(C) 1 A (D) 1.1 A

117. In the given three section network, the equivalent resistance between the points A and B is



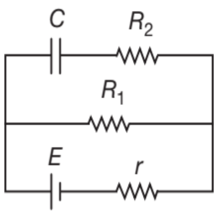
(A) 42.64 Ω (B) 32.42 Ω
(C) 22.26 Ω (D) 12.13 Ω

118. In the network, the current flowing through the resistance $2R$ as shown in the figure is



(A) $\frac{E}{R}$ (B) $\frac{E}{7R}$
(C) $\frac{2E}{7R}$ (D) $\frac{2E}{R}$

119. The numerical value of charge on either plate of capacitor C shown in figure



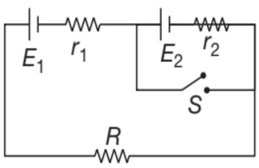
(A) CE (B) $\frac{CER_1}{R_1+r}$
(C) $\frac{CER_2}{R_2+r}$ (D) $\frac{CER_1}{R_2+r}$

120. 24 identical cells, each of internal resistance $0.5\ \Omega$, are arranged in a parallel combination of n rows, each row containing m cells in series. The combination is connected across a resistor of $3\ \Omega$. In order to send maximum current through the resistor, we should have

(A) $m=12$, $n=2$ (B) $m=8$, $n=3$

(C) $m=2$, $n=12$ (D) $m=3$, $n=8$

121. Switch S is closed at time $t=0$. Which one of the following statements is correct?



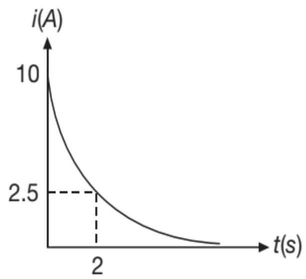
(A) Current in the resistance R increases if $E_1r_2 < E_2(R+r_1)$

(B) Current in the resistance R increases if $E_1r_2 > E_2(R+r_1)$

(C) Current in the resistance R decreases if $E_1r_2 > E_2(R+r_1)$

(D) Current in the resistance R decreases if $E_1r_2 = E_2(R+r_1)$

122. The figure shows a graph of the current in a discharging circuit of a capacitor through a resistor of resistance $10\ \Omega$.



(A) The initial potential difference across the capacitor is 100 V

(B) The capacitance of the capacitor is $\frac{1}{10\ln 2}$ F

(C) The total heat produced in the circuit will be $\frac{500}{\ln 2}$ J

(D) All of the above

123. Two cells of emf E_1 and E_2 are to be compared in a potentiometer $(E_1 > E_2)$. When the cells are used in series correctly, the balancing length obtained is 400 cm. When they are used in series but E_2 is connected with reverse polarities, the balancing length obtained is 200 cm. Ratio of emf of cells is

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

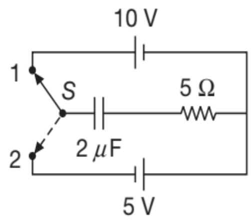
(C) $4:1$ (D) $4:3$

124. The charge flowing through a resistor R varies as $Q(t)=\alpha t-\beta t^2$. The total heat produced in R is

(A) $\frac{\alpha^3 R}{\beta}$ (B) $\frac{\alpha^3 R}{2\beta}$

(C) $\frac{\alpha^3 R}{3\beta}$ (D) $\frac{\alpha^3 R}{6\beta}$

125. In the circuit shown in figure switch S is thrown to position 1 at $t=0$. When the current in the resistor is 1 A, it is shifted to position 2. The total heat generated in the circuit after shifting to position 2 is



(A) zero (B) 625 μJ

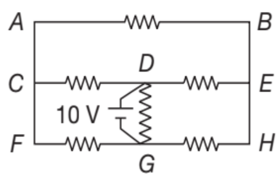
(C) 100 μJ (D) None of these

126. In the metre bridge arrangement, an unknown resistance R_1 is connected in series with or resistance of $10\ \Omega$. When the combination is connected to left gap of the metre bridge and R_2 is connected to right gap, balance point from left end is at 50 cm. When $10\ \Omega$ resistor is removed, the balance point shifts to 40 cm. The value of R_1 is

(A) $20\ \Omega$ (B) $10\ \Omega$

(C) $60\ \Omega$ (D) $40\ \Omega$

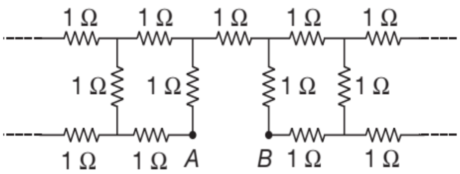
127. All resistances shown in circuit are $2\ \Omega$ each. The current in the resistance between D and E is



(A) 5 A (B) 2.5 A

(C) 1 A (D) 7.5 A

128. Each resistor shown in figure is an infinite network of resistance $1\ \Omega$. The effective resistance between points A and B is



(A) less than 1 Ω
(B) 1 Ω
(C) more than 1 Ω but less than 3 Ω
(D) 3 Ω

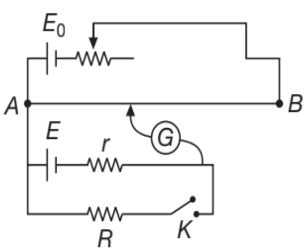
129. Two wires A and B made of same material and having their lengths in the ratio $6:1$ are connected in series. The potential difference across the wires are 3 V and 2 V respectively. If r_A and r_B are the radii of A and B respectively, then $\frac{r_B}{r_A}$ is

(A) $\frac{1}{4}$ (B) $\frac{1}{2}$
(C) 1 (D) 2

130. A leaky parallel capacitor is filled completely with a material having dielectric constant $K=5$ and electrical conductivity $\sigma = 7.4\times10^{-12}\ \Omega^{-1}\text{m}^{-1}$. Charge on the plate at instant $t=0$ is $q=8.885\ \mu\text{C}$. Then, time constant of leaky capacitor is

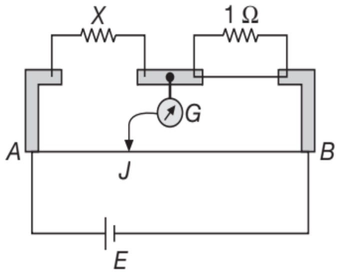
(A) 3 s (B) 4 s
(C) 5 s (D) 6 s

131. The given figure represents an arrangement of potentiometer for the calculation of internal resistance (r) of the unknown battery (E). The balance length is 70.0 cm with the key opened and 60.0 cm with the key closed. R is 132.40 Ω. The internal resistance (r) of the unknown cell will be



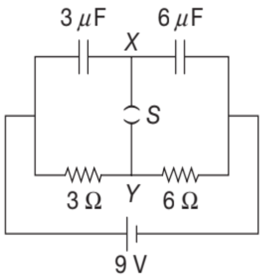
(A) 22.1 Ω (B) 113.5 Ω
(C) 154.5 Ω (D) 10 Ω

132. In the metre bridge, the balancing length $AJ = l = 20$ cm The unknown resistance X is equal to



(A) 0.25 Ω (B) 0.8 Ω
(C) 0.2 Ω (D) 0.16 Ω

133. A circuit is connected as shown in the figure with the switch S open. When the switch is closed, the total amount of charge that flows from Y to X is



(A) zero (B) 54 μC
(C) 27 μC (D) 81 μC

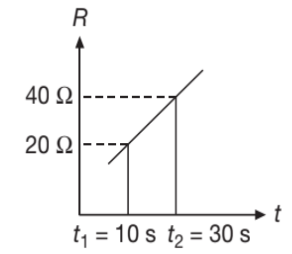
134. Consider a capacitor – charging circuit. Let Q_1 be the charge given to the capacitor in time interval of 20 ms and Q_2 be the charge given in the next time interval of 20 ms. Let 10 μC charge be deposited in a time interval t_1 and the next 10 μC charge is deposited in the next time interval t_2. Then,

(A) $Q_1 > Q_2,\ t_1 > t_2$ (B) $Q_1 > Q_2,\ t_1 < t_2$
(C) $Q_1 < Q_2,\ t_1 > t_2$ (D) $Q_1 < Q_2,\ t_1 < t_2$

135. The temperature coefficient of resistance of a conductor varies as $\alpha(T) = 3T^2 + 2T$. If R_0 is resistance at $T=0$ and R be resistance at T then

(A) $R = R_0(6T+2)$
(B) $R = 2R_0(3+2T)$
(C) $R = R_0(1+T^2+T^3)$
(D) $R = R_0(1-T+T^2+T^3)$

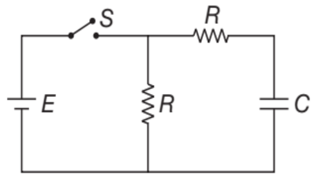
136. A source of emf $E = 10$ V and having negligible internal resistance is connected to a variable resistance. The resistance varies as shown in figure. The total charge that has passed through the resistor R during the time interval from t_1 to t_2 is



(A) $40\log_e 4$ (B) $30\log_e 3$

(C) $20\log_e 2$ (D) $10\log_e 2$

137. A capacitor C is connected to two equal resistances as shown in the figure. Consider the following statements.



(1) At the time of charging of capacitor time constant of the circuit is $2CR$

(2) At the time of discharging of the capacitor the time constant of the circuit is CR

(3) At the time of discharging of the capacitor the time constant of the circuit is $2CR$

(4) At the time of charging of capacitor the time constant of the circuit is CR

(A) Statements (1) and (2) only are correct

(B) Statements (2) and (3) only are correct

(C) Statements (3) and (4) only are correct

(D) Statements (1) and (3) only are correct.

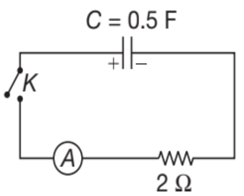
138. The mean free path of charge carriers in a current carrying conductor is

(A) $\dfrac{2I\tau}{nqA}$ (B) $\dfrac{j\tau}{nq}$

(C) $\dfrac{2j\tau}{nq}$ (D) $\dfrac{I\tau}{2nqA}$

(All symbols carry their usual meaning).

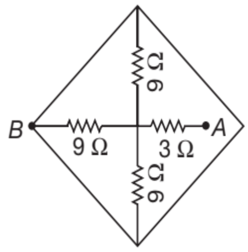
139. A charged capacitor is allowed to discharge through a resistor by closing the key at the instant $t = 0$. At the instant $t = (\ln 4)\,\mu s$, the reading of the ammeter falls half the initial value. The resistance of the ammeter is equal to



(A) 0.5 Ω (B) 1 Ω

(C) 2 Ω (D) 4 Ω

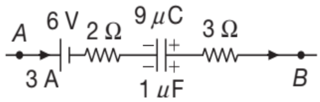
140. The equivalent resistance between the points A and B for the circuit shown in figure is



(A) 3 Ω (B) 6 Ω

(C) 9 Ω (D) 12 Ω

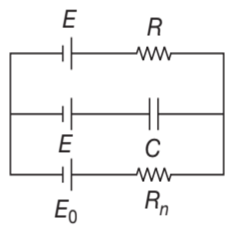
141. The potential difference $V_A - V_B$ between points A and B for the circuit segment shown in figure at the given instant is



(A) 12 V (B) –12 V

(C) 6 V (D) –6 V

142. For the circuit shown in the figure, find the charge stored on capacitor in steady state.



(A) $\dfrac{RC}{R+R_0}E$ (B) $\dfrac{RC}{R_0}(E-E_0)$

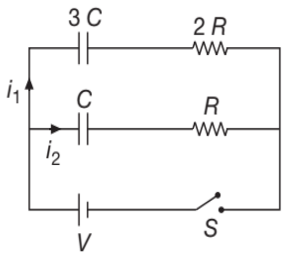
(C) zero (D) $\dfrac{RC}{R+R_0}(E-E_0)$

143. A cell of internal resistance r, when applied across an external resistance R draws a current I. The current drawn in the circuit is maximum when

(A) $R = r$ (B) $R \ll r$

(C) $R \gg r$ (D) $R = 2r$

144. In the circuit shown, switch S is closed at $t = 0$. Let i_1 and i_2 be the current at any finite time t, then the ratio $\dfrac{i_1}{i_2}$



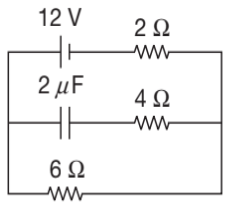
(A) is constant
(B) increases with time
(C) decreases with time
(D) first increases and then decreases

145. 24 cells each of internal resistance $1\,\Omega$ are arranged such that n cells in series are connected in m rows in parallel across a load resistance of $10\,\Omega$. The power consumption across the load is maximum for

(A) $n=24$, $m=1$ (B) $n=12$, $m=2$

(C) $n=8$, $m=3$ (D) $n=6$, $m=4$

146. For the circuit arrangement shown in figure, in the steady state condition charge on the capacitor is



(A) 12 μC (B) 14 μC

(C) 20 μC (D) 18 μC

147. A uniform wire of resistance $4\,\Omega$ is bent into a circle of radius r. A specimen of the same wire is connected along the diameter of the circle. What is the equivalent resistance across the ends of this wire?

(A) $\dfrac{4}{(4+\pi)}\Omega$ (B) $\dfrac{3}{(3+\pi)}\Omega$

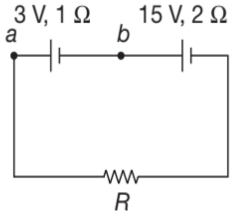
(C) $\dfrac{2}{(2+\pi)}\Omega$ (D) $\dfrac{1}{(1+\pi)}\Omega$

148. 9 identical light bulbs, each designed to extract power P from a certain voltage supply are connected in series across that supply. The total power drawn by them is

(A) $9P$ (B) P

(C) $\dfrac{P}{9}$ (D) $\dfrac{P}{81}$

149. Two batteries one of the emf 3 V, internal resistance $1\,\Omega$ and the other of emf 15 V, internal resistance $2\,\Omega$ are connected in series with a resistance R as shown. If the potential difference between points a and b is zero, the resistance R in Ω is



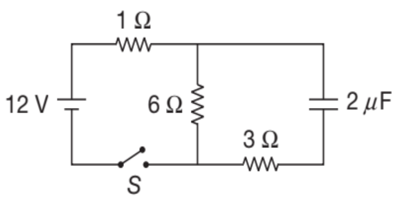
(A) 5 (B) 7
(C) 3 (D) 1

150. Six identical resistors each of value $1\,\Omega$ are joined to form a hexagon. Further six more resistors of the same value are connected between the six vertices and the centre of the hexagon. The equivalent resistance between any two vertices lying opposite to each other is

(A) $\dfrac{5}{4}\Omega$ (B) $\dfrac{4}{5}\Omega$

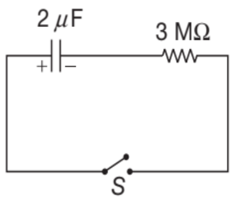
(C) $\dfrac{3}{5}\Omega$ (D) $\dfrac{4}{3}\Omega$

151. When the switch is closed, the initial current through the $1\,\Omega$ resistor is



(A) 2 A (B) 4 A
(C) 3 A (D) 6 A

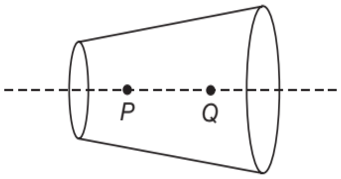
152. In the circuit shown in figure, the capacitor is charged with a cell of 5 V. If the switch is closed at $t=0$, then at $t=12\text{ s}$, charge on the capacitor is



(A) $(0.37)10\ \mu$C (B) $(0.37)^2 10\ \mu$C

(C) $(0.63)10\ \mu$C (D) $(0.63)^2 10\ \mu$C

153. A wire has a non-uniform cross-section as shown in figure. A steady current flows through it. The drift speed of electrons at points P and Q is v_P and v_Q.



(A) $v_P = v_Q$ (B) $v_P < v_Q$

(C) $v_P > v_Q$ (D) Data Insufficient

154. A moving coil galvanometer is converted into an ammeter reading up to 0.03 A by connecting a shunt of resistance $\frac{r}{4}$. What is the maximum current which can be sent through this galvanometer, if no shunt is used. (Here, r = resistance of galvanometer)

(A) 0.004 A (B) 0.005 A

(C) 0.006 A (D) 0.008 A

155. Kirchhoff's junction law and loop law are manifestations of conservation of

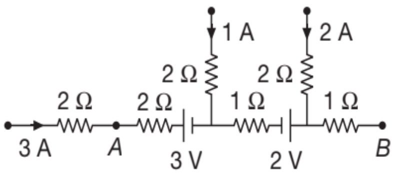
(A) charge only.

(B) energy only.

(C) charge and energy respectively.

(D) energy and charge respectively.

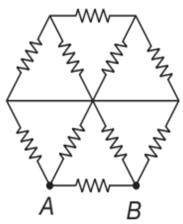
156. The potential difference between points A and B, in a section of a circuit shown, is



(A) 5 volt (B) 1 volt

(C) 10 volt (D) 17 volt

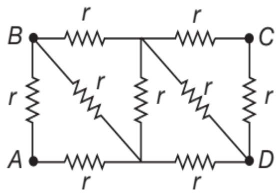
157. In the network shown in figure, each resistance is R. The equivalent resistance between points A and B is



(A) $\frac{20}{11}R$ (B) $\frac{19}{20}R$

(C) $\frac{8}{15}R$ (D) $\frac{R}{2}$

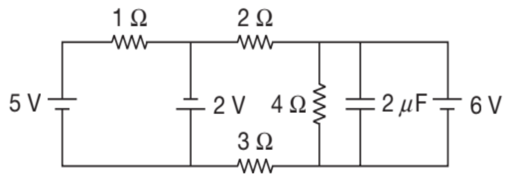
158. For the circuit shown the equivalent resistance between A and C is



(A) $\frac{12}{11}r$ (B) $\frac{13}{11}r$

(C) $\frac{14}{11}r$ (D) $\frac{15}{11}r$

159. The current in $1\,\Omega$ resistance and charge stored in the capacitor are



(A) $4\text{ A}, 6\,\mu\text{C}$ (B) $7\text{ A}, 12\,\mu\text{C}$

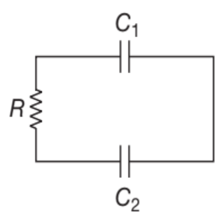
(C) $4\text{ A}, 12\,\mu\text{C}$ (D) $7\text{ A}, 6\,\mu\text{C}$

160. The space between two concentric shells of radii a and b $(a<b)$ is filled with a medium of resistivity ρ. The resistance offered by the medium to the flow of current when a source is connected across the two spheres is

(A) $\frac{\rho}{4\pi a}$ (B) $\frac{\rho}{4\pi b}$

(C) $\frac{\rho}{4\pi(a-b)}$ (D) $\frac{\rho}{4\pi}\left(\frac{1}{a}-\frac{1}{b}\right)$

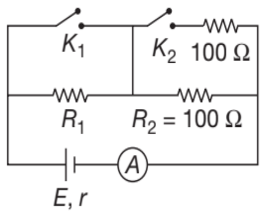
161. A capacitor C_1 is charged to a potential V and connected to another capacitor in series with a resistor R as shown. It is observed that heat H_1 is dissipated across resistance R, till the circuit reaches steady state. Same process is repeated using resistance of $2R$. If H_2 is heat dissipated in this case, then



(A) $\frac{H_2}{H_1}=1$ (B) $\frac{H_2}{H_1}=4$

(C) $\frac{H_2}{H_1}=\frac{1}{4}$ (D) $\frac{H_2}{H_1}=2$

162. In the circuit shown, when keys K_1 and K_2 both are closed, the ammeter reads I_0. But when K_1 is open and K_2 is closed, the ammeter reads $\frac{I_0}{2}$. Assuming that ammeter resistance is much less than R_2, the values of r and R_1 in Ω are



(A) 25, 50 (B) 25, 100
(C) 0, 100 (D) 0, 50

163. In a series RC circuit if we assume that the key K is opened as soon as the steady state is reached in the circuit as a result of which the charge had build up. Due to this a pulse is obtained at a regular interval t_0.

(A) $t_0 \to \infty$ (B) $t_0 = 5\,RC$
(C) $t_0 = 10\,RC$ (D) $t_0 = 15\,RC$

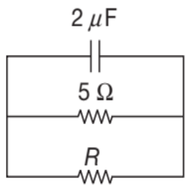
164. Potentiometer wire of length 1 m is connected in series with $490\ \Omega$ resistance and 2 V battery. If 0.2 mVcm^{-1} is the potential gradient, then resistance of the potentiometer wire is approximately

(A) $4.9\ \Omega$ (B) $7.9\ \Omega$
(C) $5.9\ \Omega$ (D) $6.9\ \Omega$

165. In a series RC circuit a steady state charge of $10\ \mu C$ is established in time of 10 ms. If 1 ms is the time constant of the circuit and $3\ \mu C$ is the charge at any instant for the growth part then the decay charge in the circuit is

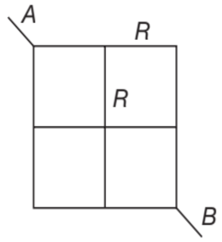
(A) $q_d = 3\ \mu C$ (B) $q_d = 7\ \mu C$
(C) $q_d = -3\ \mu C$ (D) $q_d = -7\ \mu C$

166. A capacitor of capacitance $2\ \mu\text{F}$ is charged to a potential difference of 5 V. Now the charging battery is disconnected and the capacitor is connected in parallel to a resistor of $5\ \Omega$ and another unknown resistor of resistance R as shown in figure. If the total heat produced in $5\ \Omega$ resistance is $10\ \mu\text{J}$, then the unknown resistance R is equal to



(A) $10\ \Omega$ (B) $15\ \Omega$
(C) $\frac{10}{3}\ \Omega$ (D) $7.5\ \Omega$

167. The equivalent resistance between the points A and B is (R is the resistance of each side of smaller square)

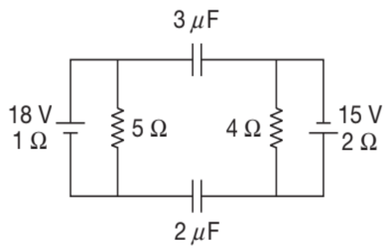


(A) R (B) $\frac{3R}{2}$
(C) $2R$ (D) $\frac{R}{2}$

168. A capacitor is charged from a cell with the help of a resistor. The circuit has a time constant τ. The capacitor collects 10% of the steady charge at time t given by

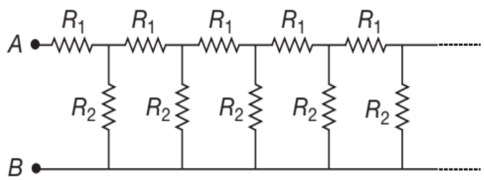
(A) $\tau \ln(1.1)$ (B) $\tau \ln\left(\frac{10}{9}\right)$
(C) $\tau \ln(0.9)$ (D) $\tau \ln(0.1)$

169. Two cells, two resistors and two capacitors are connected as shown in figure, The charge on $2\ \mu\text{F}$ capacitor is



(A) $30\ \mu C$ (B) $20\ \mu C$
(C) $25\ \mu C$ (D) $48\ \mu C$

170. Consider an infinite ladder network shown in figure. A voltage V is applied between the points A and B. This applied value of voltage is halved after each section.



(A) $\frac{R_1}{R_2}=1$ (B) $\frac{R_1}{R_2}=\frac{1}{2}$

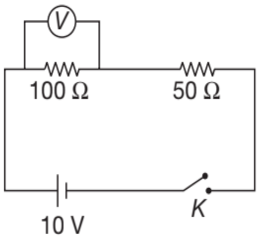
(C) $\frac{R_1}{R_2}=2$ (D) $\frac{R_1}{R_2}=3$

171. In order to increase the resistance of a given wire of uniform cross-section to four times its value, a fraction of its length is stretched uniformly till the full length of the wire becomes $\frac{3}{2}$ times the original length. What is the value of this fraction?

(A) $\frac{1}{4}$ (B) $\frac{1}{8}$

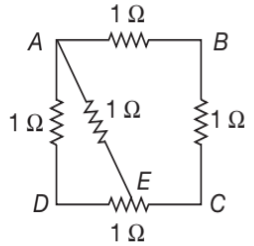
(C) $\frac{1}{16}$ (D) $\frac{1}{6}$

172. In the given circuit, the voltmeter records 5 volt. The resistance of the voltmeter in Ω is



(A) 200 (B) 100
(C) 10 (D) 50

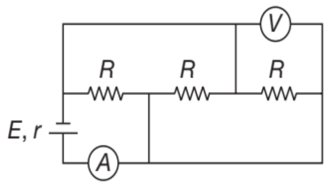
173. ABCD is a square where each side is a uniform wire of resistance $1\,\Omega$. A point E lies on CD such that if a uniform wire of resistance $1\,\Omega$ is connected across AE and constant potential difference is applied across A and C then B and E are equipotential.



(A) $\frac{CE}{ED}=1$ (B) $\frac{CE}{ED}=2$

(C) $\frac{CE}{ED}=\frac{1}{\sqrt{2}}$ (D) $\frac{CE}{ED}=\sqrt{2}$

174. In the circuit shown in the figure ammeter and voltmeter are ideal. If $E=4\text{ V}$, $R=9\,\Omega$ and $r=1\,\Omega$, then readings of ammeter and voltmeter are



(A) $1\text{ A}, 3\text{ V}$ (B) $2\text{ A}, 3\text{ V}$
(C) $3\text{ A}, 4\text{ V}$ (D) $4\text{ A}, 4\text{ V}$

175. A capacitor of capacitance C has a charge Q_0. This capacitor is now connected to another identical capacitor through a resistance R. The heat produced in the resistance is

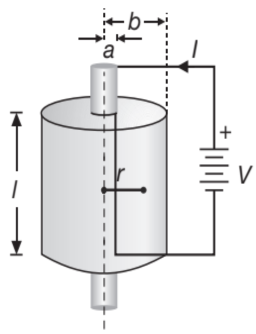
(A) $\frac{Q_0^2}{C}$ (B) $\frac{Q_0^2}{2C}$

(C) $\frac{Q_0^2}{4C}$ (D) $\frac{Q_0^2}{8C}$

MULTIPLE CORRECT CHOICE TYPE QUESTIONS

This section contains Multiple Correct Choice Type Questions. Each question has four choices (A), (B), (C) and (D), out of which ONE OR MORE is/are correct.

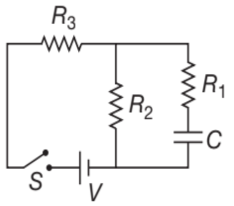
1. A metal rod of radius a is concentric with a metal cylindrical shell of radius b and length l. The space between rod and cylinder is tightly packed with a high resistance material of resistivity ρ. A battery having a terminal voltage V is connected across the combination as shown. Neglect resistance of rod and cylinder. If I is the total current in the circuit then, J is the current density and E is the electric field, then



(A) $J = \dfrac{I}{2\pi rl}$ (B) $E = \dfrac{\rho I}{2\pi rl}$

(C) $J = \dfrac{I}{\pi r^2}$ (D) $E = \text{ZERO}$

2. In the network shown, the capacitor C is initially uncharged. The time constant of the circuit is τ and the charge on C at time t after the switch S is closed is q. Then



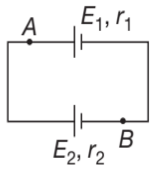
(A) $\tau = CR_1$

(B) $\tau = C\left(R_1 + \dfrac{R_2R_3}{R_2 + R_3}\right)$

(C) $q = \dfrac{CVR_2}{R_2 + R_3}\left(1 - e^{-t/\tau}\right)$

(D) $q = \dfrac{CVR_1}{R_1 + R_2}\left(1 - e^{-t/\tau}\right)$

3. Two batteries of having emfs E_1 and E_2 and internal resistances r_1 and r_2 respectively are joined as shown. V_A and V_B are the potentials at A and B respectively.



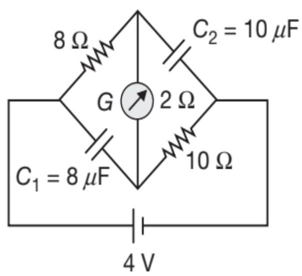
(A) The potential difference across one battery will be greater than its emf.

(B) $V_A - V_B = \dfrac{(E_1r_2 + E_2r_1)}{(r_1 + r_2)}$.

(C) The potential difference across both the battery will be equal.

(D) One battery will continuously supply energy to the other.

4. In the circuit shown,



the battery is ideal and has an emf $E = 2$ V. The resistance of the coil of the galvanometer G is $1\,\Omega$. The current that flows through the galvanometer G is I, the potential difference across the capacitors C_1 and C_2, in steady state is ΔV_1 and ΔV_2 respectively. Then

(A) $I = 0$ (B) $I = \dfrac{1}{5}$ A

(C) $\Delta V_1 = 1.6$ V (D) $\Delta V_2 = 2.4$ V

5. For a metallic conductor

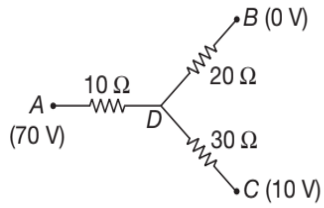
(A) the number density of charge carriers is 10^{28} m^{-3}.

(B) the number density of charge carriers is 10^{26} m^{-3}.

(C) the drift velocity of electrons is 1 cms^{-1}.

(D) the drift velocity of electrons is 10 cms^{-1}.

6. In the network shown, points A, B and C are at potentials $V_A = 70$ V, $V_B = 0$, $V_C = 10$ V and V_D respectively. Then



(A) $V_D = 40$ V

(B) The currents in the sections AD, DB, DC are in the ratio $3:2:1$.

(C) The currents in the sections AD, DB, DC are in the ratio $1:2:3$.

(D) The network draws a total power of 200 W.

7. A long round conductor of cross-sectional area A is made of a material whose resistivity depends on the radial distance r from the axis of the conductor as $\rho = \dfrac{\alpha}{r^2}$, α is a constant. The total resistance per unit length of the conductor is R and the electric field strength in the conductor due to which a current I flows in it is E. Then

(A) $R = \dfrac{2\pi\alpha}{A^2}$ (B) $R = \dfrac{4\pi\alpha}{A^2}$

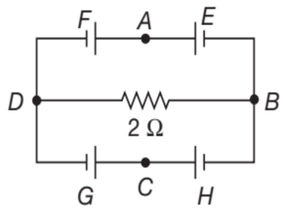
(C) $E = \dfrac{2\pi\alpha I}{A^2}$ (D) $E = \dfrac{4\pi\alpha I}{A^2}$

8. A voltmeter and an ammeter having resistances R_V and R_A respectively are connected in series to an ideal battery of emf E. The voltmeter reading is V, the ammeter reading is I, the potential difference across the ammeter is ΔV_A and the total resistance of the circuit is R. Which of the following statement(s) seem to be correct?

(A) $V < E$ (B) $R_V = \frac{V}{I}$

(C) $\Delta V_A = E - V$ (D) $R_A + R_V = \frac{E}{I}$

9. In the circuit shown E, F, G and H are cells of e.m.f. 2 V, 1 V, 3 V and 1 V respectively and their internal resistances are $2\,\Omega$, $1\,\Omega$, $3\,\Omega$ and $1\,\Omega$ respectively.



(A) $V_D - V_B = -\frac{2}{13}\text{ V}$

(B) $V_D - V_B = \frac{2}{13}\text{ V}$

(C) $V_G = \frac{21}{13}\text{ V}$ = Potential difference across G.

(D) $V_H = \frac{19}{13}\text{ V}$ = Potential difference across H.

10. A uniform wire of resistance R is shaped into a regular, n even sided polygon. 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 $\frac{R}{n}$

11. A voltmeter and an ammeter are joined in series to an ideal battery such that the respective readings shown by them are V and A. A resistance equal to the resistance of the ammeter is now joined in parallel to the ammeter. Then,

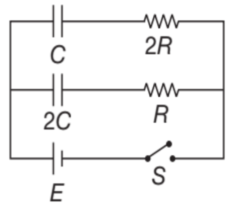
(A) V will not change.

(B) V will increase slightly.

(C) A will become exactly half of its initial value.

(D) A will become slightly more than half of its initial value.

12. In the circuit shown in the figure, switch S is closed at time $t = 0$. Select the correct statements.



(A) Rate of increase of charge is same in both the capacitors

(B) Ratio of charge stored in capacitors C and $2C$ at any time t would be $1:2$

(C) Time constants of both the capacitors are equal

(D) Steady state charges on capacitors C and $2C$ are in the ratio of $1:2$

13. A number of resistors R_1, R_2, R_3, ... are connected in parallel such that R_p is the equivalent resistance of parallel combination. R_2 is the resistance of least magnitude. A current I is flowing in the circuit due to a potential V applied across the circuit. I_1, I_2, I_3, ... are the currents in resistors R_1, R_2, R_3, ... respectively and V_1, V_2, V_3 ..... are potentials across R_1, R_2, R_3 ,.......... respectively.

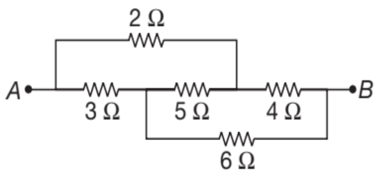
(A) $V_1 = V_2 = V_3 = \ldots\ldots$

(B) $I_1 = \left(\frac{R_p}{R_1}\right)I$; $I_2 = \left(\frac{R_p}{R_2}\right)I$; $I_3 = \left(\frac{R_p}{R_3}\right)I$;........

(C) $R_p > R_2$

(D) $R_p < R_2$

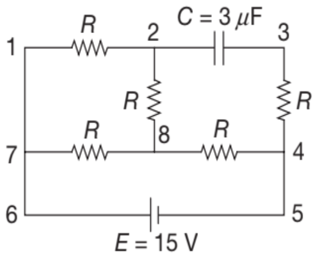
14. In the circuit shown, the points A and B are connected across a battery of emf E. The equivalent resistance between A and B is R_{AB}, the potential difference and the current across the $5\,\Omega$ resistor are ΔV and I respectively.



(A) $I = \frac{5E}{18}$ (B) $\Delta V = 0$

(C) $R_{AB} = \frac{10}{3}\,\Omega$ (D) $R_{AB} = \frac{18}{5}\,\Omega$

15. In the circuit shown, the battery is ideal, with emf $E = 15\ \text{V}$ and it sends a current I in the circuit. All resistors are identical and each resistor has resistance $R = 3\ \Omega$. The potential difference across the capacitor in steady state is V_C, then



(A) $I = 1\ \text{A}$ (B) $V_C = 9\ \text{V}$

(C) $V_C = 12\ \text{V}$ (D) $I = 3\ \text{A}$

16. A number of resistors R_1, R_2, R_3, ... are connected in series such that R_s is the equivalent resistance of series combination. A current I is flowing in the circuit due to a potential V applied across the circuit. V_1, V_2, V_3, ... are potentials across R_1, R_2, R_3, ... respectively.

(A) Same current I will flow through each resistor.

(B) $V_1 + V_2 + V_3 + ... = V$

(C) $V_1 = \left(\frac{R_1}{R_s}\right)V$; $V_2 = \left(\frac{R_2}{R_s}\right)V$; $V_3 = \left(\frac{R_3}{R_s}\right)V$; ......

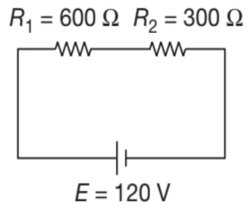
(D) Data Insufficient

17. A vacuum diode consists of plane parallel electrodes separated by a distance d and each having an area A. On applying a potential V to the anode with respect to the cathode a current I flows through the diode. Assume that the electrons are emitted with zero velocity and they do not change the field between the electrodes. The electron velocity is v and the charge density is ρ at any point between the electrodes at a distance x from the cathode . If I is the equivalent current, m is the mass of each charge carrier, then

(A) $v = \sqrt{\frac{2eVx}{md}}$ (B) $\rho = I\sqrt{\frac{md}{2eVxA^2}}$

(C) $v = \sqrt{\frac{eVx}{2md}}$ (D) $\rho = I\sqrt{\frac{2md}{eVxA^2}}$

18. In the circuit, the battery connected is ideal. A voltmeter of resistance $600\ \Omega$ is connected one by one across R_1 and R_2, giving readings of V_1 and V_2 respectively.



(A) $V_2 = 40\ \text{V}$ (B) $V_1 = 80\ \text{V}$

(C) $V_2 = 30\ \text{V}$ (D) $V_1 = 60\ \text{V}$

19. In household electric circuits, the electrical appliance and the usage of the switch with the appliance are governed by the following facts.

(A) All electric appliances drawing power are joined in parallel.

(B) A switch may be either in series or in parallel with the appliance which it controls.

(C) If a switch is in parallel with an appliance, it will draw power when the switch is in the 'off' position (open).

(D) If a switch is in parallel with an appliance, the fuse will blow (burn out) when the switch is put 'on' (closed).

20. A piece of germanium (material used for making semiconductors) and a piece of copper (material used for making conducting wires) are cooled from room temperature to $85\ \text{K}$. R_1 and R_2 be the resistances of the pieces respectively and α_1 and α_2 are the temperature coefficients of resistance of materials respectively.

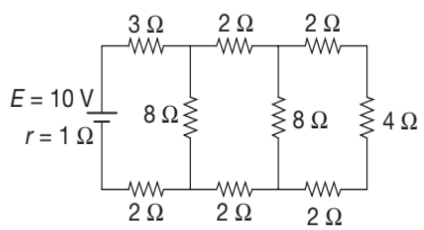
(A) R_1 decreases and R_2 increases

(B) R_1 increases and R_2 decreases

(C) $\alpha_1 < 0$, $\alpha_2 > 0$

(D) $\alpha_1 > 0$, $\alpha_2 > 0$

21. In the circuit shown, the cell has emf $E = 10\ \text{V}$ and internal resistance $= 1\ \Omega$.



(A) The current through the $3\ \Omega$ resistor is 1 A.

(B) The current through the $3\ \Omega$ resistor is 0.5 A.

(C) The current through the $4\ \Omega$ resistor is 0.5 A.

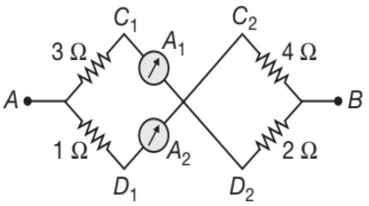
(D) The current through the 4Ω resistor is 0.25 A.

22. Two identical fuses are rated at 10 A. When joined in series the combination acts as a fuse of rating I_1 and when joined in parallel the combination acts as a fuse of rating I_2. Then

(A) $I_1 = 10$ A (B) $I_1 = 20$ A

(C) $I_2 = 20$ A (D) $I_2 = 5$ A

23. The ammeters, A_1 and A_2, each of resistance $5\,\Omega$ are connected as shown. An ideal cell of emf 10 V is applied between A and B, then



(A) the current drawn from the cell is 1 A

(B) the reading of A_1 is 1 A

(C) the reading of A_2 is 1 A

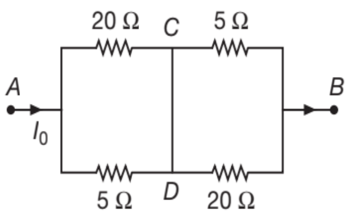
(D) for C_1 joined to C_2 and D_1 joined to D_2, the ammeter readings will become equal

24. A leaky parallel plate capacitor is filled completely with a material having dielectric constant k, electrical conductivity σ. The charge on the plate initially is q_0 and the leakage current at time t is I. The time constant of the circuit is τ. Then

(A) $\tau = \dfrac{\varepsilon_0 k}{\sigma}$ (B) $I = \dfrac{q_0 \sigma}{\varepsilon_0 k}$

(C) $I = I_0 e^{\left(-\frac{t\sigma}{\varepsilon_0 k}\right)}$ (D) $I_0 = -\dfrac{q_0 \sigma}{\varepsilon_0 k}$

25. A current I_0 enters the network at A and leaves at B, when some potential difference is maintained across the points A and B. If R_{AB} is the equivalent resistance between A and B, V_C and V_D be the potentials at the points C and D respectively and I be the current flowing through the branch CD, then which of the following is correct?



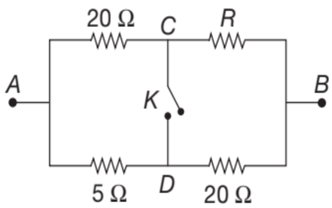
(A) $V_C = V_D$

(B) $R_{AB} = 8\,\Omega$

(C) $I = \dfrac{3}{5} I_0$, from D to C

(D) $I = 0$

26. When the switch K is open, the equivalent resistance between A and B is $20\,\Omega$. Which of the following statement(s) is/are correct?



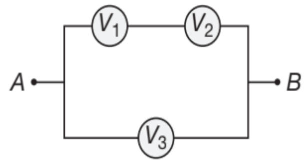
(A) $R = 80\,\Omega$

(B) No current flows through K when it is closed

(C) The powers dissipated in R and in the $5\,\Omega$ resistor are always equal

(D) The powers dissipated in the two $20\,\Omega$ resistors are unequal

27. Three voltmeters V_1, V_2 and V_3, all having different resistances, are connected between two points A and B, such that V_1 and V_2 are in series which in turn fall to be in parallel with V_3. When some potential difference is applied across A and B, the respective readings of the voltmeters are V_1, V_2 and V_3. Which of the following mathematical relations support the argument given here?



(A) $V_1 = V_2$ (B) $V_1 \neq V_2$

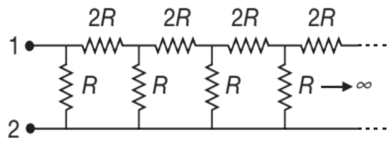
(C) $V_1 + V_2 = V_3$ (D) $V_1 + V_2 > V_3$

28. A battery of emf E, internal resistance r drives a current I through an external resistance R. The battery supplies a power P and produces per second a heat H across the external circuit and a heat h across the internal circuit of the battery. Then

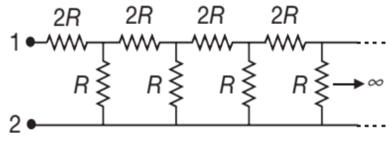
(A) $P = EI$ (B) $P = \dfrac{E^2}{R+r}$

(C) $H = \dfrac{EIR}{R+r}$ (D) $h = \dfrac{E^2 r}{(R+r)^2}$

29. Two circuits (as shown in figure) are called 'Circuit A' and 'Circuit B'. The equivalent resistance of 'Circuit A' is x and that of 'Circuit B' is y between 1 and 2.



Circuit A

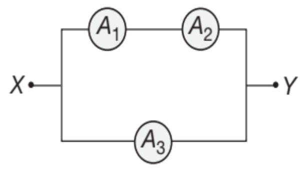


Circuit B

(A) $y > x$ (B) $y = (\sqrt{3}+1)R$

(C) $xy = 2R^2$ (D) $x - y = 2R$

30. Three ammeters A_1, A_2 and A_3 having resistances R_1, R_2 and R_3 respectively are connected between two points X and Y, such that A_1 and A_2 are in series which in turn fall to be in parallel with A_3. When some potential difference is applied across the terminals X and Y, the respective readings of the ammeters are I_1, I_2 and I_3. Which of the following mathematical relations support the argument given here?



(A) $I_1 = I_2$ (B) $I_1R_1 + I_2R_2 = I_3R_3$

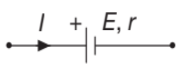
(C) $\frac{I_2}{I_3} = \frac{R_3}{R_1}$ (D) $\frac{I_1}{I_3} = \frac{R_3}{R_1 + R_2}$

31. A circuit has an equivalent resistance R_0. A voltmeter of resistance R_v is applied across the circuit to measure the potential drop across R_0. The new equivalent resistance of the circuit is

(A) R_0 (for $R_0 \ll R_v$) (B) $\frac{R_0R_v}{R_0 + R_v}$

(C) $R_0 + R_v$ (D) Data Insufficient

32. A current I is being driven through a battery of emf E and internal resistance r, as shown. Then which of the following statement(s) best suit the above mentioned condition?



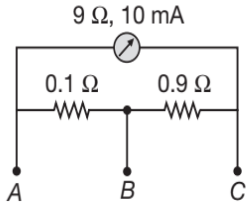
(A) The battery absorbs energy at the rate of EI.

(B) The battery stores chemical energy at the rate of $(EI - I^2r)$.

(C) The potential difference across the battery is $E + Ir$.

(D) Some heat is produced in the battery.

33. A milliammeter of range 10 mA and resistance 9 Ω is joined in a circuit as shown. The milliammeter gives full scale deflection for current I when A and B are used as its terminals. It gives a full scale deflection again for a current I' when A and C are used as terminals. Then



(A) $I' = 111$ mA (B) $I' = 900$ mA

(C) $I = 1$ A (D) $I = 1.1$ A

34. A cube is made of twelve identical wires each of resistance R_0. The equivalent resistance between the two points lying on the diagonal corners of cube is x and the equivalent resistance between the two opposite corners of a face of cube is y.

(A) $\frac{x}{y} = \frac{10}{9}$ (B) $x - y = \frac{R_0}{12}$

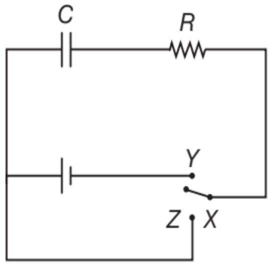
(C) $\frac{x}{y} = \frac{10}{7}$ (D) $x - y = \frac{R_0}{4}$

35. Two electric bulbs, A and B, with respective ratings 25 W, 220 V and 100 W, 220 V are connected in series across a voltage source of 220 V. The bulbs A and B draw powers P_A and P_B respectively. Then

(A) $P_A = 16$ W (B) $P_A = 4$ W

(C) $P_B = 4$ W (D) $P_B = 16$ W

36. In the circuit shown, that contains a capacitor C and a resistor R, the capacitor C is uncharged initially. When the terminal X is joined to the terminal Y for a long time, it is observed that a heat H_1 is produced in the resistor. When the terminal X is joined to the terminal Z, again for a long time, it is observed that a heat H_2 is produced in the resistor. Also, energy supplied by the battery during the process of charging is H. Then



(A) $H_1 = H_2 = \frac{H}{2}$

(B) $H_1 + H_2 = 2H$

(C) $H_1 + H_2 = H$

(D) The maximum energy stored in C at any time is H_1.

37. Two sources of current of equal e.m.f. are connected in series and have different internal resistances r_1 and r_2. An external resistance R is connected in series with two sources of e.m.f.

(A) $R = (r_1 - r_2)$, for terminal potential difference to be zero across source 1.

(B) $R = \sqrt{r_1 r_2}$, for terminal potential difference to be zero across both sources.

(C) $R = (r_2 - r_1)$, for terminal potential difference to be zero across source 2.

(D) Data insufficient to arrive at a conclusion.

38. Two heaters A and B, designed for the same voltage V have different power ratings. When connected individually across a source of voltage V, they produce H amount of heat each in times t_A and t_B respectively. When connected together across the same source, they produce H amount of heat in time T (when in series) and t (when in parallel). Then

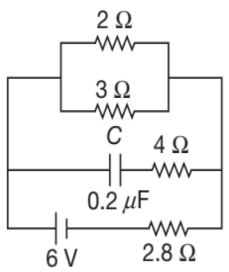
(A) $T = 2(t_A + t_B)$

(B) $T = t_A + t_B$

(C) $t = \frac{t_A t_B}{2(t_A + t_B)}$

(D) $t = \frac{t_A t_B}{t_A + t_B}$

39. In the circuit shown,



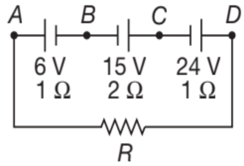
(A) a current of 0.9 A flows through $2\,\Omega$ resistor when steady state is reached.

(B) a potential drop of 4.2 V appears across the resistance of $2.8\,\Omega$.

(C) a potential drop of 1.8 V appears across the capacitor C.

(D) a potential of 4.2 V appears across the capacitor C.

40. In the given circuit the point A is 9 V higher than point B.



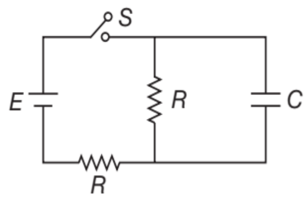
(A) $R = 1\,\Omega$

(B) $R = 7\,\Omega$

(C) Potential difference between B and D is 30 V.

(D) Potential difference between B and C is 15 V.

41. In the circuit shown in figure, the switch S is closed at $t = 0$. The voltage across the capacitor C at time t after the switch S is closed is V. The voltage as $t \to \infty$ is V_0.



(A) $V = \frac{E}{3}\left(1 - e^{-3t/RC}\right)$

(B) $V_0 = \frac{E}{3}$

(C) $V = \frac{E}{2}\left(1 - e^{-2t/RC}\right)$

(D) $V_0 = \frac{E}{2}$

42. Two heaters designed for the same voltage V have different power ratings. When connected individually across a source of voltage V, they produce H amount of heat each in time t_1 and t_2 respectively. When used together across the same source, they produce H amount of heat in time t

(A) If they are in series, $t = t_1 + t_2$

(B) If they are in series, $t = 2(t_1 + t_2)$

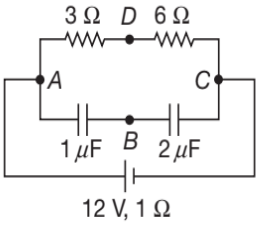
(C) If they are in parallel, $t = \frac{t_1 t_2}{(t_1 + t_2)}$

(D) If they are in parallel, $t = \frac{t_1 t_2}{2(t_1 + t_2)}$

43. The charge, Q flowing in a conductor varies with time in accordance with the relation $Q = at - bt^2$. If I be the current at an instant of time, then I

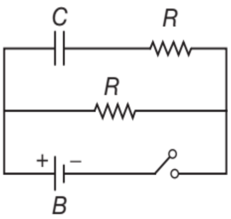
(A) decreases linearly with time.
(B) reaches a maximum and then decreases.
(C) falls to zero after time $t = \frac{1}{2}\frac{a}{b}$.
(D) charges at a rate $-2b$.

44. In the circuit shown in figure, the charge on each capacitor is Q and the potential difference between the points B and D is V.



(A) $Q = 7.2\ \mu C$ (B) $Q = 7.2$ mC
(C) $V = 3.6$ V (D) $V = -3.6$ V

45. In the circuit shown, when the switch is closed, the capacitor charges with a time constant t_1 and when the switch is opened (after the capacitor has been charged) then the capacitor discharges with a time constant t_2. Then



(A) $\frac{t_1}{t_2} = 2$ (B) $t_1 + t_2 = 3RC$
(C) $\frac{t_1}{t_2} = 1$ (D) $t_1 + t_2 = 2RC$

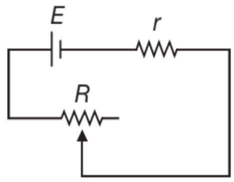
46. A capacitor is charged and then made to discharge through a resistance. The time constant is τ. In time t_1 the potential difference across the capacitor decreases by 10% and in time t_2 the potential difference across the capacitor falls to 10% of its initial value. Then

(A) $t_1 = \tau \log_e\left(\frac{9}{8}\right)$ (B) $t_1 = \tau \log_e\left(\frac{10}{9}\right)$
(C) $t_2 = 2.303\tau$ (D) $t_2 = 0.693\tau$

47. A capacitor charges from a cell through a resistance. The time constant is τ. The capacitor collects 10% of its final charge in a time t_1 and after a time t_2, the charge on the capacitor becomes 10% less than its final charge. Then

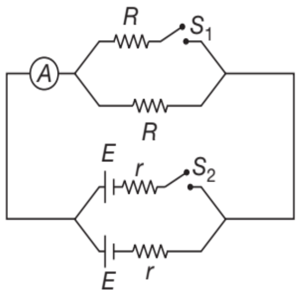
(A) $t_2 - t_1 = \tau \log_e\left(\frac{10}{9}\right)$ (B) $t_1 + t_2 = 2\tau \log_e\left(\frac{10}{3}\right)$
(C) $t_1 + t_2 = 2\tau \log_e(3)$ (D) $t_2 - t_1 = 2\tau \log_e(3)$

48. A battery of e.m.f. E and internal resistance r is connected to a variable resistor R as shown. Which one of the following is true?



(A) Potential difference across the terminals of the battery is maximum where $R = r$
(B) Power delivered to resistor is maximum when $R = r$
(C) Current in the circuit is maximum when $R = r$
(D) Current in the circuit is maximum when $R >> r$

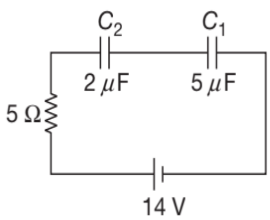
49. In the circuit shown in figure, reading of ammeter will



(A) increase if S_1 is closed
(B) decrease if S_1 is closed
(C) increase if S_2 is closed
(D) decrease if S_2 is closed

50. When a resistance of $9.5\ \Omega$ is connected across a battery, the voltage across the resistance is 11.4 V. If the resistance connected across the same battery is $11.5\ \Omega$, the voltage across the resistance is 11.5 V
(A) The emf of the battery is 12.0 V
(B) The internal resistance of the battery is $0.5\ \Omega$
(C) The internal resistance of the battery is $11.45\ \Omega$
(D) The emf of the battery is 11.5 V

51. In the given circuit is steady state



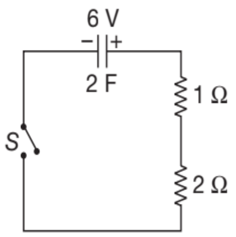
(A) the potential difference across C_1 is 10 V

(B) the potential difference across C_2 is 10 V

(C) the charge on C_1 is 20 μC

(D) the charge on C_2 is 8 μC

52. A capacitor of 2 F (practically not possible to have a capacity of 2 F) is charged by a battery of 6 V. The battery is removed and circuit is made as shown. Switch is closed at time $t = 0$. Choose the correct options.



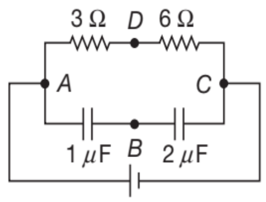
(A) At time $t = 0$ current in the circuit is 2 A

(B) At time $t = (6\ln 2)$ second, potential difference across capacitor is 3 V

(C) At time $t = (6\ln 2)$ second, potential difference across $1\,\Omega$ resistance is 1 V.

(D) At time $t = (6\ln 2)$ second, potential difference across $2\,\Omega$ resistance is 2 V.

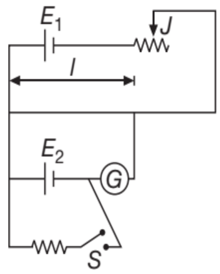
53. In the circuit shown in figure, the charge on each capacitor is Q and the potential difference between the points B and D is V.



(A) $Q = 7.2\ \mu C$ (B) $Q = 7.2\text{ mC}$

(C) $V = 3.6\text{ V}$ (D) $V = -3.6\text{ V}$

54. In the potentiometer experiment shown in figure, the null point length is l. Choose the correct options given below.



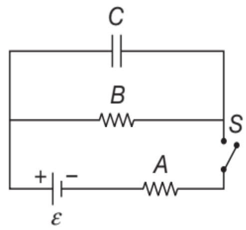
(A) If jockey J is shifted towards right, l will increase

(B) If value of E_1 is increased, l is decreased

(C) If value of E_2 is increased, l is increased

(D) If switch S is closed, l will decrease

55. In the circuit shown, A and B are equal resistances. When S is close, the capacitor C charges from the cell of emf ε and reaches a steady state.



(A) During charging, more heat is produced in A than in B

(B) In steady state, heat is produced at the same rate in A and B

(C) In the steady state, energy stored in C is $\frac{1}{4}C\varepsilon^2$

(D) In the steady state energy stored in C is $\frac{1}{8}C\varepsilon^2$

REASONING BASED QUESTIONS

This section contains Reasoning type questions, each having four choices (A), (B), (C) and (D) out of which ONLY ONE is correct. Each question contains STATEMENT 1 and STATEMENT 2. You have to mark your answer as

Bubble (A) If both statements are TRUE and STATEMENT 2 is the correct explanation of STATEMENT 1.

Bubble (B) If both statements are TRUE but STATEMENT 2 is not the correct explanation of STATEMENT 1.

Bubble (C) If STATEMENT 1 is TRUE and STATEMENT 2 is FALSE.

Bubble (D) If STATEMENT 1 is FALSE but STATEMENT 2 is TRUE.

1. **Statement-1:** In a wire of non-uniform cross-section, the current is same everywhere.
Statement-2: The current in a wire is due to the drift of electrons along the wire.

2. **Statement-1:** A conductor carrying electric current becomes electrically charged.
Statement-2: A conductor carrying electric current contains same number of positive and negative charges and is electrically neutral.

3. **Statement-1:** Electric field outside the conducting wire which carries a constant current is zero.
Statement-2: Net charge on conducting wire is zero.

4. **Statement-1:** Direction of electronic current can not be from negative potential to positive potential.
Statement-2: Direction of current is opposite to flow of electrons.

5. **Statement-1:** Insulators do not allow flow of current through them.
Statement-2: Insulators have no free charge carriers.

6. **Statement-1:** If there is current in a wire potential drop has to be there.
Statement-2: If potential drop is zero, the resistance may be zero.

7. **Statement-1:** Constant potential difference is applied across a conductor. If temperature of conductor is increased, the drift speed of electrons will decrease.
Statement-2: Resistivity increases with increase in temperature.

8. **Statement-1:** When a conductor is stretched to double its length, its resistance will get doubled.
Statement-2: Resistance is directly proportional to the length of a conductor.

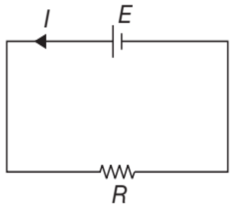
9. **Statement-1:** The drift velocity of electrons in a metallic wire decreases when the temperature of the wire is increased.
Statement-2: On increasing temperature, conductivity of metallic wire decreases.

10. **Statement-1:** Voltmeter always reads the e.m.f. of a cell if it is connected across the terminals of a cell.
Statement-2: Terminal potential of a cell is given by $V = E - Ir$.

11. **Statement-1:** A voltmeter is an inherently inaccurate instrument.
Statement-2: A voltmeter is always connected in parallel in a circuit.

12. **Statement-1:** Potential measured by a voltmeter across a wire is always less than actual potential difference across it.
Statement-2: Finite resistance of voltmeter changes current flowing through the resistance across which potential difference is to be measured.

13. **Statement-1:** In a simple battery circuit, the point at the lowest potential is the positive terminal of the battery.



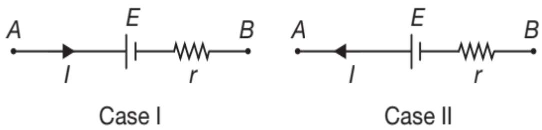
Statement-2: The current flows towards the point of lowest potential of the battery from the outside in the same manner as it flows in a circuit from positive to the negative terminal.

14. **Statement-1:** If potential difference between two points is zero and resistance between those points is zero, current may flow between the points.
Statement-2: Kirchhoff's 1^{st} Law is based on conservation of charge.

15. **Statement-1:** Internal resistance of the battery is connected in parallel to it in an electrical circuit.
Statement-2: Heat generated in battery is due to internal resistance.

16. **Statement-1:** Two bulbs of $25\ \text{W}$ and $100\ \text{W}$ rated at $200\ \text{V}$ are connected in series across $200\ \text{V}$ supply. Ratio of powers of both the bulb in series is $2:1$.
Statement-2: In series, current in both bulbs is same, therefore power depends on resistance of bulb.

17. **Statement-1:** Consider the two situations shown in the figure. Potential difference between points A and B, in Case-1 is more as compared to Case-2.



Statement-2: In Case-1 $V_A - V_B = E + Ir$

In Case-2 $V_A - V_B = E - Ir$

18. **Statement-1:** Since all the current coming to our house returns to power house (Since current travels in a closed loop). So there is no need to pay the electricity bill.
Statement-2: The electricity bill is paid for the electrical energy used and not for the current.

19. **Statement-1:** When current through a bulb is increased by 2% power increases by 4%.

Statement-2: Current passing through the bulb is inversely proportional to its resistance.

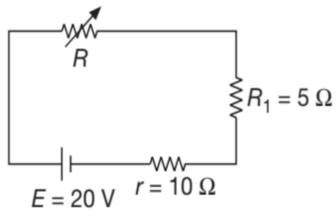
20. **Statement-1:** The e.m.f. of the driver cell in the potentiometer experiment should be greater than the e.m.f. of the cell to be determined.
Statement-2: The fall of potential across the potentiometer wire should not be less than e.m.f. of the cell to be determined.

21. **Statement-1:** When a cell is charged by connecting its positive electrode with positive terminal of the charger battery then potential difference across the electrodes of cell will be smaller than the EMF of cell.
Statement-2: Potential difference across electrodes in a cell providing electric current I is $E - Ir$ where E is the EMF and r internal resistance.

22. **Statement-1:** In metre bridge experiment, a high resistance is always connected in series with a galvanometer.
Statement-2: As resistance increases, current through the circuit increases.

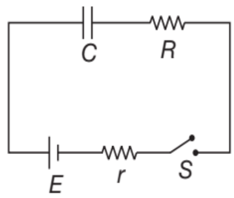
23. **Statement-1:** In a Meter Bridge experiment, null point for an unknown resistance is measured. Now, the unknown resistance is put inside an enclosure maintained at a higher temperature. The null point can be obtained at the same point as before by decreasing the value of the standard resistance
Statement-2: Resistance of a metal increases with increase in temperature.

24. **Statement-1:** For zero value of R in circuit, power transfer in external resistance will be maximum.



Statement-2: Since $R_1 < r$ in the given circuit. So, power transfer in external resistance will be maximum when $R = 0$.

25. **Statement-1:** The switch S shown in the figure is closed at $t = 0$, Initial current flowing through battery is $\frac{E}{R+r}$.



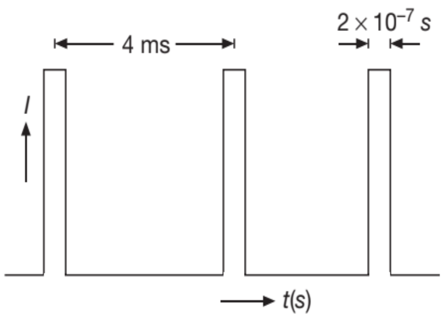
Statement-2: Initially capacitor was uncharged, so resistance offered by capacitor at $t = 0$ is zero.

LINKED COMPREHENSION TYPE QUESTIONS

This section contains Linked Comprehension Type Questions or Paragraph based Questions. Each set consists of a Paragraph followed by questions. Each question has four choices (A), (B), (C) and (D), out of which only one is correct. (For the sake of competitiveness there may be a few questions that may have more than one correct options)

Comprehension I

In a certain particle accelerator, electrons emerge with an energy of 40 MeV. The electrons emerge not in a steady stream but rather in pulses at the rate of 250 pulses/s. This corresponds to a time interval between pulses of 4 ms. Each pulse has a duration of 200 ns and the electrons in the pulse constitute a current of 250 mA. The current is zero between pulses. Based on the information supplied, answer the following questions.



1. How many electrons are delivered by the accelerator per pulse?
(A) 2.12×10^{11} (B) 21.2×10^{10}
(C) 3.13×10^{11} (D) 31.3×10^{10}

2. The average current per pulse delivered by the accelerator is
(A) 0.005% of peak current
(B) 0.05% of peak current
(C) 0.001% of peak current
(D) 0.01% of peak current

3. The peak power delivered by the electron beam is
(A) 1 MW (B) 10 MW (C) 100 MW (D) 100 kW

4. The average power (instead of the peak power) delivered by the electron beam is
(A) 500 MW (B) 50 MW (C) 25 W (D) 500 W

Comprehension 2

A galvanometer (coil resistance $99\ \Omega$) is converted into an ammeter using a shunt of $1\ \Omega$ and connected as shown in figure (a). The ammeter reads 3 A. The same galvanometer is converted into a voltmeter by connecting a resistance of $101\ \Omega$ in series. This voltmeter is connected as shown in figure (b).

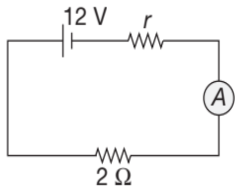


Figure (a)

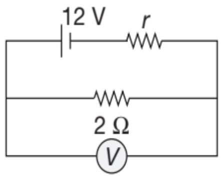


Figure (b)

Its reading is found to be $\frac{4}{5}$ times the full scale reading. Based on the facts and figures provided answer the following questions.

5. The internal resistance r of the cell is

(A) $10.1\ \Omega$ (B) $1\ \Omega$

(C) $1.01\ \Omega$ (D) $11.1\ \Omega$

6. The range of the ammeter and voltmeter respectively is

(A) 5 A, 9 V (B) 50 A, 9 V

(C) 5 A, 9.95 V (D) 5.95 A, 9 V

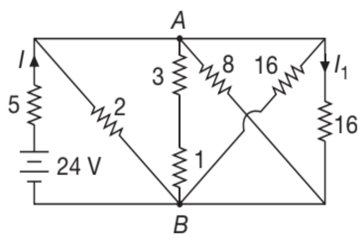
7. The full scale deflection current in the galvanometer is given by

(A) 5 A (B) 0.05 A

(C) 0.5 A (D) 50 A

Comprehension 3

Based on the circuit shown, answer the following questions. Assume that all the resistances have value in ohm.



8. The current I in the circuit is given by

(A) 2 A (B) 4 A

(C) 6 A (D) 8 A

9. The current I_1 is given by

(A) 1 A (B) $\frac{1}{2}$ A

(C) $\frac{1}{4}$ A (D) $\frac{1}{8}$ A

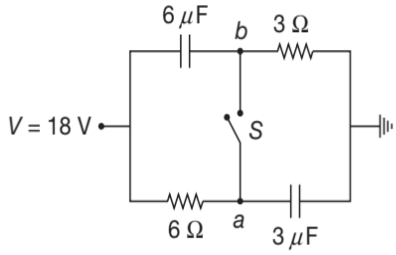
10. The potential difference across the points AB is V_{AB}. Then

(A) $V_{AB} = 4$ V (B) $V_{AB} = 8$ V

(C) $V_{AB} = 6$ V (D) $V_{AB} = 0$

Comprehension 4

Based on the circuit diagram shown, answer the following questions.



11. The potential of point a with respect to point b in figure when switch S is open is

(A) $V_{ab} = 9$ V (B) $V_{ab} = 18$ V

(C) $V_{ab} = -9$ V (D) $V_{ab} = -18$ V

12. The final potential of point b with respect to ground when switch S is closed is

(A) 18 V (B) 9 V

(C) 6 V (D) 3 V

13. The change in the value of charge on $3\ \mu$F capacitor is Δq and on $6\ \mu$F capacitor is $\Delta q'$, when the switch S is closed . Then

(A) $\Delta q = \Delta q' = -36\ \mu$C

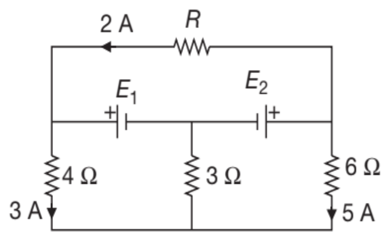
(B) $\Delta q = 36\ \mu$C, $\Delta q' = -36\ \mu$C

(C) $\Delta q = \Delta q' = -18\ \mu$C

(D) $\Delta q' = 18\ \mu$C, $\Delta q = -18\ \mu$C

Comprehension 5

Based on the circuit diagram shown answer the following questions.



14. The current in the $3\ \Omega$ resistor is

(A) 2 A (B) 4 A

(C) 8 A (D) 10 A

15. The respective E_1 and E_2 values, in volt, are given by
(A) 34, 56 (B) 36, 54
(C) 54, 36 (D) 56, 34

16. The resistance R, in ohm is
(A) $3\ \Omega$ (B) $6\ \Omega$
(C) $7.5\ \Omega$ (D) $9\ \Omega$

Comprehension 6

A perfect insulator is filled between the plates of a capacitor. For practical purposes this insulator is assumed to be perfect when its resistance is taken to be very large or infinite. Due to this, if a capacitor is connected to a battery, no current flows through it in steady state. However, an insulator must have some finite resistance which can be calculated by using the relation $R=\dfrac{\rho l}{A}$. So, due to the finite value of the resistance a non zero current must pass through the resistance. This small non zero current is called leakage current. Consider a leaky parallel plate capacitor is filled completely with material having dielectric constant $K=18$ and its resistivity is $(4\pi\times10^3)\,\Omega\text{m}$. The charge on the plate at instant $t=0$ is $2\ \mu\text{C}$. Based on the above facts and the data provided answer the following questions.

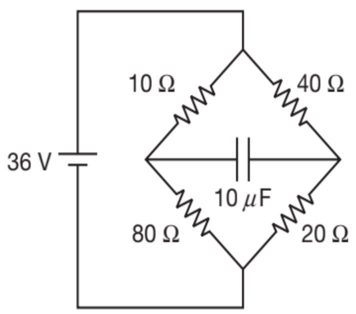
17. Time constant of circuit is
(A) $3\ \mu s$ (B) $2\ \mu s$
(C) $9\ \mu s$ (D) $1\ \mu s$

18. Charge on the capacitor at $t=2\ \mu s$ is
(A) $0.54\ \mu C$ (B) $0.37\ \mu C$
(C) $1\ \mu C$ (D) $0.74\ \mu C$

19. Leakage current at $t=4\ \mu s$ is
(A) $0.48\ \mu A$ (B) $0.36\ \mu A$
(C) $0.24\ \mu A$ (D) $0.13\ \mu A$

Comprehension 7

Consider the circuit shown here. Based on the circuit and the basic knowledge of the Kirchhoff's Laws, answer the following questions.



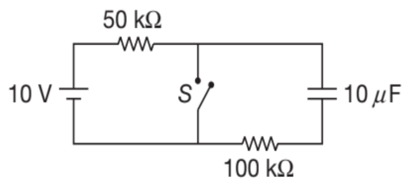
20. In steady state, the potential difference across the capacitor is given by
(A) zero (B) 10 V
(C) 20 V (D) 25 V

21. The capacitor current as a function of time, when the battery is disconnected is given by
(A) $100\ \exp\left(-\dfrac{3t}{1000}\right)$ mC
(B) $100\ \exp\left(-\dfrac{t}{1000}\right)$ μC
(C) $200\ \exp\left(-\dfrac{3t}{1000}\right)$ μC
(D) $200\ \exp\left(-\dfrac{t}{1000}\right)$ mC

22. The time taken by the capacitor to discharge until the potential difference across it is 1 V
(A) 17.66 ms (B) 1.766 ms
(C) 1766 ms (D) 1 ms

Comprehension 8

In the circuit shown, the switch S has been open for a long time. It is then suddenly closed. The time constant of the circuit before the switch is closed is τ_1 and that after the switch is closed τ_2. Assuming the switch to be closed just when $t=0$, give answers to the following questions.



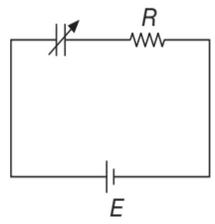
23. The value of τ_1 is
(A) 0.5 s (B) 1 s
(C) 1.5 s (D) 2 s

24. The value of τ_2 is
(A) 0.5 s (B) 1 s
(C) 1.5 s (D) 2 s

25. The current in the switch as a function of time is
(A) $100(2+e^{-t})$ mA (B) $100(2-e^{-t})$ mA
(C) $100(2+e^{-t})$ μA (D) $100(2-e^{-t})$ μA

Comprehension 9

A certain circuit consists of a variable capacitor, a resistor R and an emf source of emf E as shown in figure. Initially the capacitance of the capacitor is $10\ \mu\text{F}$ which is abruptly changed to $5\ \mu\text{F}$ at $t=0$. If $E=10$ V and $R=50\ \Omega$, then answer the following questions



26. The current in the circuit just after the capacitance has been changed is

(A) $\frac{1}{5}$ A (B) $\frac{2}{5}$ A

(C) $\frac{3}{5}$ A (D) $\frac{4}{5}$ A

27. The current in the circuit as function of time is

(A) $0.2\exp(-2000t)$ (B) $0.2\exp(-4000t)$

(C) $0.1\exp(-2000t)$ (D) $0.1\exp(-4000t)$

28. The charge on the capacitor as function of time is

(A) $50\left(1+e^{-2000t}\right)$ (B) $5\left(1+e^{-4000t}\right)$

(C) $50\left(1+e^{-4000t}\right)$ (D) $5\left(1+e^{-2000t}\right)$

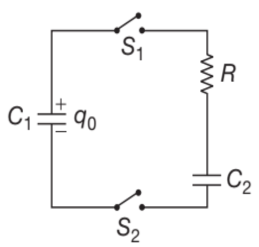
29. The heat produced in the resistor as function of time is

(A) $25\left(1-e^{-8000t}\right)$ mJ (B) $250\left(1-e^{-4000t}\right)$ μJ

(C) $250\left(1-e^{-8000t}\right)$ μJ (D) $25\left(1-e^{-4000t}\right)$ mJ

Comprehension 10

The capacitor C_1 in the figure shown initially carries a charge q_0. When the switches S_1 and S_2 are closed, capacitor C_1 is connected in series to a resistor R and a second capacitor C_2, which is initially uncharged.



30. The charge flown through wires as a function of time t is

(A) $q_0 e^{-\frac{t}{RC}} + \frac{C}{C_2} q_0$ (B) $\frac{q_0 C}{C_1} \times \left[1 - e^{-\frac{t}{RC}}\right]$

(C) $q_0 \frac{C}{C_1} e^{-\frac{t}{CR}}$ (D) $q_0 e^{-\frac{t}{RC}}$

where, $C = \frac{C_1 C_2}{C_1 + C_2}$

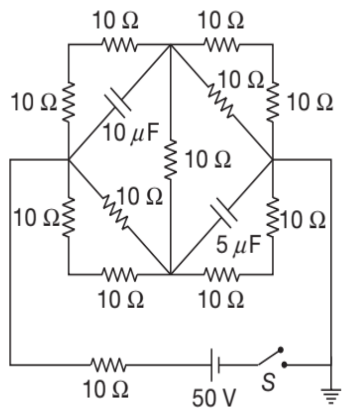
31. The total heat dissipated in the circuit during the discharging process of C_1 is

(A) $\frac{q_0^2}{2C_1^2} \times C$ (B) $\frac{q_0^2}{2C}$

(C) $\frac{q_0^2 C_2}{2C_1^2}$ (D) $\frac{q_0^2}{2C_1 C_2}$

Comprehension 11

In the circuit shown in Figure, the capacitors are initially uncharged. Based on the facts & figure provided, answer the following questions.



32. The initial value of the battery current when the switch S is closed is

(A) 2 A (B) 4 A

(C) 6 A (D) 8 A

33. The battery current after a long time is

(A) $\frac{33}{70}$ A (B) $\frac{73}{30}$ A

(C) $\frac{70}{33}$ A (D) None of these

34. The charges on the 10 μF and 5 μF capacitors after the steady state is reached are q_{10} and q_5 respectively. Then

(A) $q_5 = q_{10} = \frac{2500}{33}$ μC

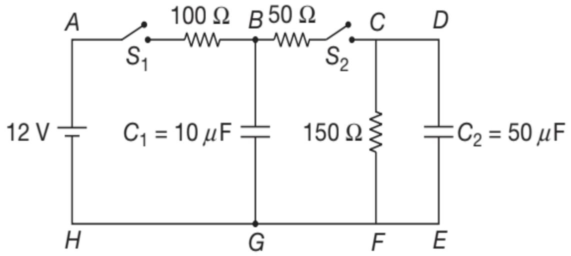
(B) $q_5 = q_{10} = \frac{5000}{33}$ μC

(C) $q_5 = \frac{2500}{33}$ μC, $q_{10} = \frac{5000}{33}$ μC

(D) $q_5 = \frac{5000}{33}$ μC, $q_{10} = \frac{2500}{33}$ μC

Comprehension 12

In the circuit shown the capacitors are initially uncharged. The switch S_2 is closed and then switch S_1 is closed. Based on the facts & figure provided, answer the following questions.



35. What is the battery current immediately after S_1 is closed?
(A) 1.2 A (B) 12 A
(C) 0.12 A (D) None of these

36. What is battery current a long time after both switches are closed?
(A) 0.08 A (B) 0.04 A
(C) 0.02 A (D) 0.01 A

37. What is final voltage across C_1?
(A) 2 V (B) 4 V
(C) 6 V (D) 8 V

38. What is final voltage across C_2?
(A) 2 V (B) 4 V
(C) 6 V (D) 8 V

39. Switch S_2 is opened again after a long time. The current, (in A) in the 150 Ω resistor as a function of time is

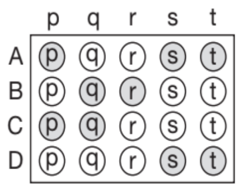
(A) $0.02\exp\left(-\frac{400t}{3}\right)$ (B) $-0.04\exp\left(\frac{200t}{3}\right)$

(C) $-0.04\exp\left(-\frac{400t}{3}\right)$ (D) $-0.02\exp\left(-\frac{400t}{3}\right)$

MATRIX MATCH/COLUMN MATCH TYPE QUESTIONS

Each question in this section contains statements given in two columns, which have to be matched. The statements in **COLUMN-I** are labelled A, B, C and D, while the statements in **COLUMN-II** are labelled p, q, r, s (and t). Any given statement in **COLUMN-I** can have correct matching with **ONE OR MORE** statement(s) in **COLUMN-II**. The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following examples:

If the correct matches are A → p, s and t; B → q and r; C → p and q; and D → s and t; then the correct darkening of bubbles will look like the following:



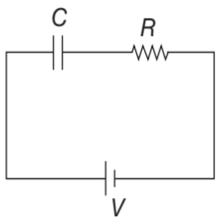
1. **COLUMN-I** contains some of the laws while **COLUMN-II** contains the corresponding expression. Match the Laws in **COLUMN-I** with the expressions in **COLUMN-II**.

COLUMN-I	COLUMN-II
(A) Ohm's Law	(p) $\Sigma V = 0$ in a closed mesh
(B) Kirchhoff's Junction Law	(q) $R = \frac{V}{I}$ under same physical conditions
(C) Kirchhoff's Loop Law	(r) $W = I^2RT$ joule, heat produced in a resistance
(D) Joule's Law	(s) $\Sigma I = 0$ at any junction

2. Three wires of same material are connected in parallel to a battery. The length ratio of wires is $1:2:3$ and the ratio of their area of cross-section is $2:4:1$. Match the ratio of quantities in **COLUMN-I** with their respective answers in **COLUMN-II**

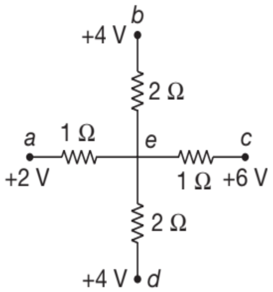
COLUMN-I	COLUMN-II
(A) Resistance	(p) $1:1:1$
(B) Current	(q) $6:6:1$
(C) Power	(r) $1:6:6$
(D) Conductivity	(s) $1:1:6$

3. Consider a series RC circuit. Match the quantities in **COLUMN-I** with the quantities in **COLUMN-II**



COLUMN-I	COLUMN-II
(A) Charging current at time $t = 0$	(p) $\frac{1}{2}CV^2$
(B) Discharging current at $t = 0$	(q) Maximum
(C) While charging energy stored	(r) Capacitor becomes short circuit
(D) While charging energy dissipated as heat	(s) Exponential Law

4. For the circuit shown in figure, match the two columns.



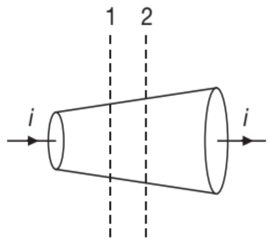
COLUMN-I	COLUMN-II
(A) Current in wire *ae*	(p) 1 A
(B) Current in wire *be*	(q) 2 A
(C) Current in wire *ce*	(r) 0.5 A
(D) Current in wire *de*	(s) None of these

5. Consider two identical cells each of emf E and internal resistance r connected to a load resistance R

COLUMN-I	COLUMN-II
(A) For maximum power transfer to load if cells are connected in series	(p) $\frac{E^2}{4r}$
(B) For maximum power transfer to load if cells are connected in parallel	(q) $\frac{E^2}{2r}$
(C) For series combination of cells	(r) $E_{eq} = E, r_{eq} = \frac{r}{2}$
(D) For parallel connection of cells	(s) $E_{eq} = 2E, r_{eq} = 2r$

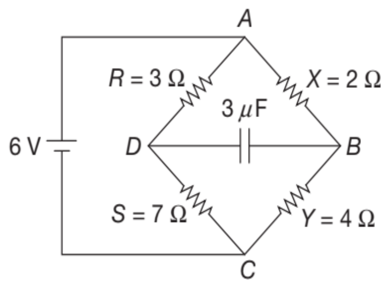
(Continued)

6. Current i is flowing through a wire of non-uniform cross-section as shown. Match the following two columns.



COLUMN-I	COLUMN-II
(A) Current density	(p) is more at 1
(B) Electric field	(q) is more at 2
(C) Resistance per unit length	(r) is same at both sections 1 and 2
(D) Potential difference per unit length	(s) data is insufficient

7. With reference to the circuit diagram shown match the following



COLUMN-I	COLUMN-II
(A) Potential difference, in volt, across A and D	(p) zero
(B) Potential difference, in volt, across capacitor	(q) $\frac{9}{5}$
(C) Value of Y, in ohm, for which no energy is stored across capacitor	(r) $\frac{1}{5}$

(Continued)

COLUMN-I	COLUMN-II
(D) Steady state current, in ampere, in the branch containing the capacitor is	(s) 14
	(t) $\frac{14}{3}$

8. Match the consumption of power given in **COLUMN-II** to the corresponding appliance(s) given in **COLUMN-I**.

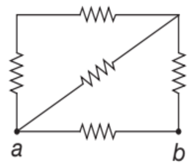
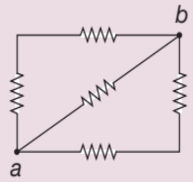
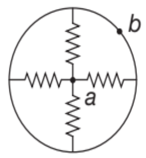
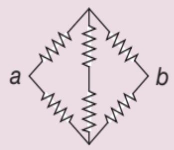
COLUMN-I	COLUMN-II
(A) 100 W, 220 V bulb connected across 220 V supply	(p) 300 W
(B) 200 W, 220 V bulb connected across 220 V supply	(q) 66.7 W
(C) Above 100 W and 200 W bulbs connected in series across a 220 V supply	(r) 100 W
(D) Above 100 W, 200 W bulbs connected in parallel across a 220 V supply	(s) 200 W

9. Two bulbs A and B consume same power P when operated at voltage V_A and V_B respectively. Bulbs can be connected with a dc voltage source. Match the quantities for respective combinations in **COLUMN-I** to their appropriate answers in **COLUMN-II**.

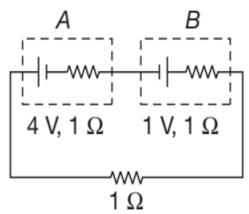
COLUMN-I	COLUMN-II
(A) In series connection, the ratio of potential difference across A and B	(p) $\frac{R_A}{R_B}$
(B) In series connection, the ratio of power consumed by A and B	(q) $\frac{V_A^2}{V_B^2}$
(C) In parallel connection, the ratio of current in A and B	(r) $\frac{R_B}{R_A}$
(D) In parallel connection, the ratio of power consumed in A and B	(s) $\frac{V_B^2}{V_A^2}$

(Continued)

10. **COLUMN-I** represents a combination of resistors of equal identical resistors of resistance r while **COLUMN-II** represents the equivalent resistance across (a) and (b). Match identities in **COLUMN-I** to their corresponding match(es) in **COLUMN-II**.

COLUMN-I	COLUMN-II
(A) 	(p) $\frac{r}{4}$
(B) 	(q) r
(C) 	(r) $\frac{r}{2}$
(D) 	(s) $\frac{5}{8}r$

11. In the circuit shown in figure, match the following two columns

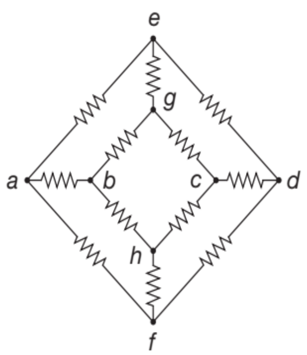


COLUMN-I	COLUMN-II (In SI Units)
(A) Potential difference across battery A	(p) zero

(Continued)

COLUMN-I	COLUMN-II (In SI Units)
(B) Potential difference across battery B	(q) 1
(C) Net power supplied/consumed by A	(r) 2
(D) Net power supplied/consumed by B	(s) 3

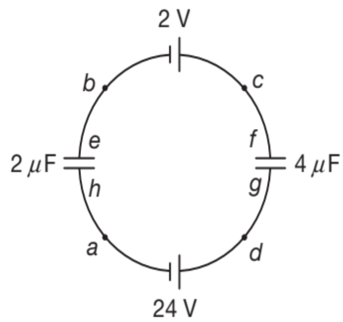
12. For the given network if R_{ij} is the equivalent resistance between the points i, j of the circuit. Then match the resistances in **COLUMN-I** with their respective equivalent values in **COLUMN-II**



COLUMN-I	COLUMN-II
(A) R_{ab}	(p) zero
(B) R_{bc}	(q) $\frac{3R}{4}$
(C) R_{ac}	(r) $\frac{5R}{6}$
(D) R_{ch}, when points c and h are shorted	(s) $\frac{7R}{12}$

(Continued)

13. With reference to the circuit diagram shown match the following



COLUMN-I	COLUMN-II
(A) $v_d - v_c$ (in volt)	(p) –8
(B) $v_a - v_b$ (in volt)	(q) –4
(C) work done by 12 V cell is (in μJ)	(r) –192
(D) work done by 24 V cell is (in μJ)	(s) 384

INTEGER/NUMERICAL ANSWER TYPE QUESTIONS

In this section, the answer to each question is a numerical value obtained after doing series of calculations based on the data given in the question(s).

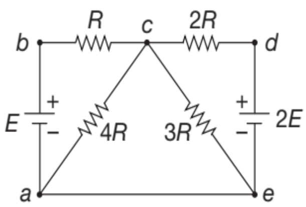
1. An aluminium wire having a cross-sectional area of 4×10^{-6} m^2 carries a current of 5 A. Find the drift speed of the electrons in the wire, in μms^{-1}. The density of aluminium is 2.7 gcm^{-3}. Assume that one conduction electron is supplied by each atom.

2. A carbon wire and a Nichrome wire are connected in series, so that the same current exists in both wires. If the combination has a resistance of 10 kΩ at 0 °C, what is the resistance of each wire, in ohm, at 0 °C, so that the resistance of the combination does not change with temperature?

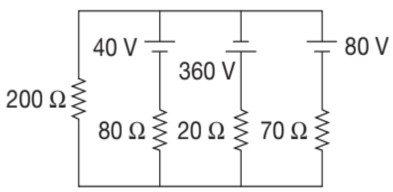
3. A high-voltage transmission line with a diameter of 2 cm and a length of 200 km carries a steady current of 1000 A. If the conductor is copper wire with a free charge density of 8.49×10^{28} electron/m^3, how long does it take one electron to travel the full length of the line? Give your answer in years.

4. The potential difference across the filament of a lamp is maintained at a constant level while equilibrium temperature is being reached. It is observed that the steady-state current in the lamp is only one tenth of the current drawn by the lamp when it is first turned on. If the temperature coefficient of resistivity for the lamp at 20 °C is $0.00450\ (°C)^{-1}$, and if the resistance increases linearly with increasing temperature, what is the final operating temperature, in °C, of the filament?

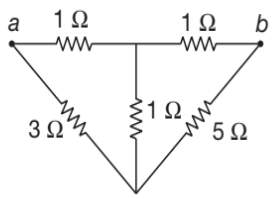
5. Taking $R = 1\ k\Omega$ and $E = 250$ V in figure, determine the direction and magnitude of the current, in mA, in the horizontal wire between a and e.



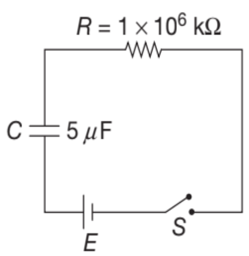
6. In the circuit of figure, determine the current, in ampere, in each resistor and the voltage across the 200 Ω resistor.



7. For the network shown in figure, show that the resistance $R_{ab} = \left(1 + \frac{x}{17}\right)\Omega$. Find x



8. Consider a series RC circuit (see figure) for which $R = 1\ M\Omega$, $C = 5\ \mu F$ and $E = 30$ V. Find



(a) the time constant of the circuit, in second.

(b) the maximum charge, in μC, on the capacitor after the switch is closed.

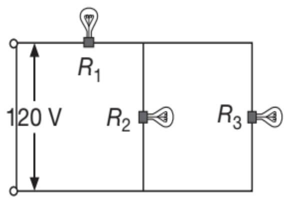
(c) find the current in the resistor 10 s after the switch is closed, in μA to the nearest integer.

9. A capacitor in an RC circuit is charged to 60% of its maximum value in 0.9 s. What is the time constant of the circuit? (Express your result in second to the nearest integer).

10. A $10\ \mu F$ capacitor is charged by a 10 V battery through a resistance R. The capacitor reaches a potential difference of 4 V in a time 3 s after charging begins. Find R, in kΩ.

11. When two unknown resistors are connected in series with a battery, the battery delivers 225 W and carries a total current of 5 A. For the same total current, 50 W is delivered when the resistors are connected in parallel. Determine the values of the two resistors (in ohm).

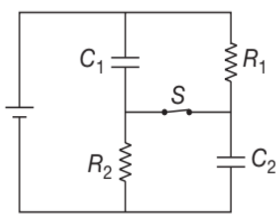
12. Three 60 W, 120 V light bulbs are connected across a 120 V power source, as shown in figure. Find



(a) the total power delivered to the three bulbs (in watt) and

(b) the voltage across each (in volt).
Assume that the resistance of each bulb is constant.

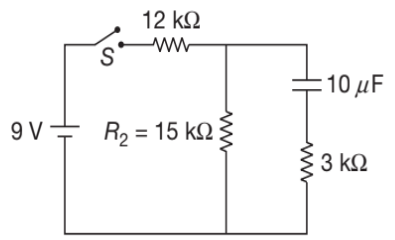
13. Switch S has been closed for a long time, and the electric circuit shown in figure carries a constant current. Take $C_1 = 3\ \mu F$, $C_2 = 6\ \mu F$, $R_1 = 4\ k\Omega$, and $R_2 = 7\ k\Omega$. The power delivered to R_2 is 2.4 W.



(a) Find the charge on C_1, in μC.

(b) Now the switch is left open for a long time. Find the change in the value of charge on C_2, in μC.

14. In figure, suppose the switch has been closed for a time sufficiently long for the capacitor to become fully charged. Find



(a) the steady-state current in each resistor, in μA.
(b) the charge Q on the capacitor, in μC.
(c) the switch is now opened at $t = 0$. Write an equation for the current I through R_2 as a function of time.
(d) the time interval required for the charge on the capacitor to fall to one-fifth its initial value, in millisecond.

15. A 75 W tungsten light bulb has a resistance of 190 Ω when switched on and 15 Ω when switched off. Estimate the temperature, in kelvin of the filament when the bulb is switched on. Given $\alpha = 4.5 \times 10^{-3}\ ^{\circ}C^{-1}$

16. Two wires of different materials x and y have resistances per unit lengths, $100\ \Omega(\text{km})^{-1}$, $50\ \Omega(\text{km})^{-1}$ and temperature coefficients $0.0025\ (^{\circ}C)^{-1}$, $0.00075\ (^{\circ}C)^{-1}$ respectively. It is desired to make a coil having 1000 Ω resistance and a temperature coefficient of $0.001(^{\circ}C)^{-1}$ by using suitable lengths of the two wires in series. Calculate their respective lengths in metre.

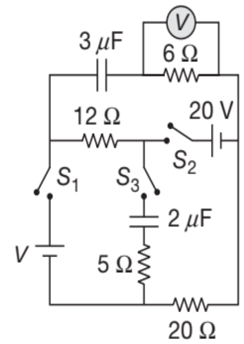
17. A block of metal is heated directly by dissipating power in the internal resistance of block. Because of temperature rise, the resistance increases exponentially with time and is given by $R(t) = 0.5e^{2t}$, where t is in second. The block is connected across a 110 V source and dissipates 7644 J heat energy over a certain period of time. Calculate this period of time (in millisecond).

18. An electric kettle has two coil. When one coil is switched on, it takes 15 minutes to boil water and when the second coil is switched on it takes double the time for the same job to be done. How long, in minutes will it take to boil water when both the coils are used in

(a) series?
(b) parallel?

19. A wire of length 1 m and radius 10^{-3} m is carrying a heavy current and is assumed to radiate as a black body. At equilibrium its temperature is 900 K while that of the surroundings is 300 K. The resistivity of the material of the wire at 300 K is $\pi^2 \times 10^{-8}\ \Omega\text{m}$ and its temperature coefficient of resistance is 7.8×10^{-3} per °C. Find the current, in ampere in the wire. Stefan's constant, $\sigma = 5.68 \times 10^{-8}\ \text{Wm}^{-2}\text{K}^{-4}$

20. With only switch S_1 closed in the circuit shown,

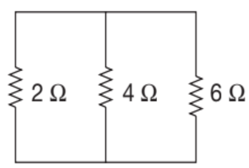


(a) what is the steady state reading of the voltmeter (in volt)?
(b) what is the charge on the 3 μF capacitor (in μC)?
(c) how much power does the 12 V battery supply in the steady state after all the switches are closed (in watt)?
(d) what is the charge on 2 μF capacitor (in μC)?

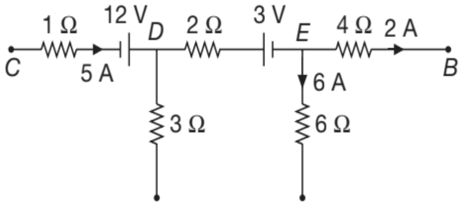
21. 200 identical electrical bulbs, each having resistance 300 Ω, are connected in parallel to a current source of emf 200 V and internal resistance 0.5 Ω.

(a) What is the power expended, in watt on each bulb?
(b) The fractional change in power expended on each bulb when one bulb burns out is f. Find $10000f$.

22. In which branch of the circuit shown in figure, an 11 V battery be inserted so that it dissipates minimum power. What will be the current, in ampere, through the 2 Ω resistance for this position of the battery?



23. Figure shows part of a circuit. Calculate the power, in ohm, dissipated in $3\ \Omega$ resistance. What is the potential difference $V_C - V_B$?

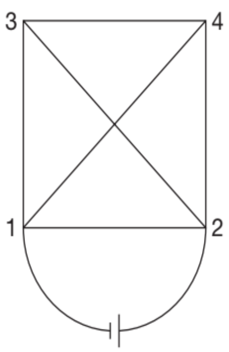


24. An ammeter and a voltmeter are connected in series to a battery with an emf $E = 6$ V. When a certain resistance is connected in parallel with the voltmeter, the reading of the latter decreases two times, whereas the reading of the ammeter increase the same number of times. Find the voltmeter reading, in volt, after the connection of the resistance.

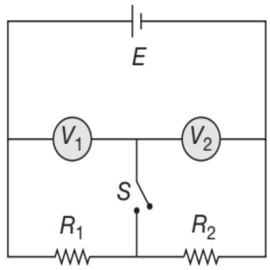
25. A voltmeter of resistance R_1 and an ammeter of resistance R_2 are connected in series across a battery of negligible internal resistance. When a resistance R is connected in parallel to voltmeter, reading of ammeter increases three times while that of voltmeter reduces to one third. Find R_1 and R_2 when $R = 3\ \Omega$.

26. The emf of a storage battery is 90 V before charging and 100 V after charging. When charging began the current was 10 A. What is the current, in ampere, at the end of charging if the internal resistance of the storage battery during the whole process of charging may be taken as constant and equal to $2\ \Omega$?

27. The circuit shown in figure is made of a homogeneous wire of uniform cross-section. 1234 is a square. The ratio $\dfrac{Q_{12}}{Q_{34}}$ of the amounts of heat liberated per unit time in conductor 1-2 and 3-4 is found to be $11x + y\sqrt{2x}$, where x and y are non zero positive integers. Find the values of x and y.



28. In the circuit shown in figure, V_1 and V_2 are two voltmeters having resistances $6000\ \Omega$ and $4000\ \Omega$ respectively. E.M.F. of the battery is 250 V, having negligible internal resistance. Two resistances R_1 and R_2 are $4000\ \Omega$ and $6000\ \Omega$ respectively. Find the reading of the voltmeters V_1 and V_2, in volt, when

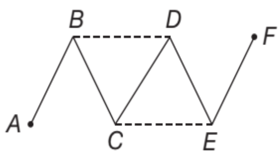


(a) the switch S is open and

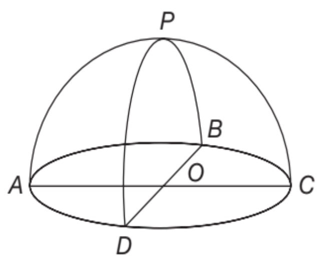
(b) the switch S is closed.

29. It is required to send a current of 8 A through a circuit whose resistance is $5\ \Omega$. What is the least number of cells which must be used for this purpose and how should they be connected? The emf of each cell is 2 V and the internal resistance is $0.5\ \Omega$.

30. What will be the change in the resistance, in ohm, of a circuit between A and F consisting of five identical conductors each of resistance $2\ \Omega$ if two similar conductors added as shown by the dashed line in figure.

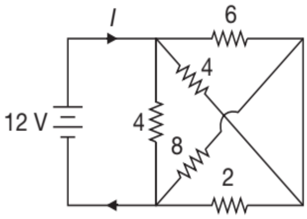


31. A hemispherical network of radius a is made by using a conducting wire of resistance per unit length $\lambda = \left(\dfrac{64}{2+\pi}\right)\dfrac{1}{a}$. Find the equivalent resistance, in ohm, across OP.



32. Find the velocity of charge leading to 1 A current which flows in a copper conductor of cross-section $1\ \text{cm}^2$ and length 10 km. Free electron density of copper is $n = 8.5 \times 10^{28}$ per m^3. How long will it take the electric charge to travel from one end of the conductor to the other. Give your answer in years.

33. Compute the value of battery current I, in ampere, shown in figure. All resistances are in ohm.



34. Calculate the potential, in volt, of points A, B, C and D shown in Figure 1. What would be the new potential values, in volt, if polarity of 6 V battery is reversed as shown in Figure 2? All resistances are in Ω.

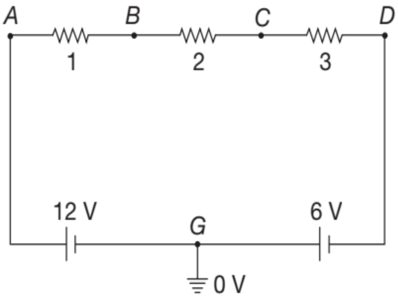


Figure 1

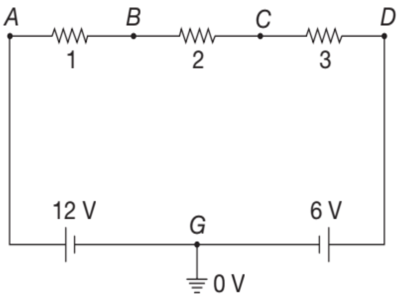


Figure 2

35. Twelve cells each having the same e.m.f. are connected in series and are kept in a closed box. Some of the cells are wrongly connected. This battery is connected in series with an ammeter and two cells identical with the others. The current 3 A when the cells and battery aid each other and 2 A when the cells and battery oppose each other. How many cells in the battery are wrongly connected?

36. A parallel plate capacitor has plate of area $10\ \text{cm}^2$ separated by a distance of 1 mm. It is filled with the dielectric mica the resistivity of mica is $1\times10^3\ \Omega\text{m}$, the leakage current through the capacitor is found to be $*\times10^{-13}$ ampere, where $*$ is not readable. Find the value of $*$.

37. The gap between the plates of a parallel plate capacitor is filled up with an inhomogeneous poorly conducting medium whose conductivity varies linearly in a direction perpendicular to the plates from $\sigma = 10^{-12}\ \Omega^{-1}\text{m}^{-1}$ to $2\times10^{-12}\ \Omega^{-1}\text{m}^{-1}$. Each plate has an area $230\ \text{cm}^2$ and the separation between the plates is $d = 2$ mm. Find the current, in nanoampere, flowing through the capacitor due to a voltage $V = 300$ V.

38. An electric bulb rated for 500 W at 100 V is used in a circuit having a 200 V supply. Calculate the resistance R that one must be put in series with the bulb, so that the bulb delivers 500 W. Give your answer in ohm.

39. A fuse of lead wire has an area of cross-sectional $0.2\ \text{mm}^2$. On short circuiting, the current in the fuse wire reaches 30 A. How long after the short-circuiting, will fuse begin to melt? Give your answer in millisecond.

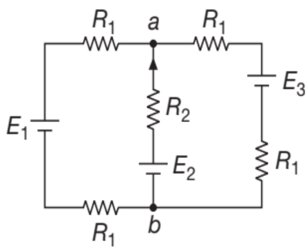
For lead, specific heat $0.032\ \text{cal}\,\text{g}^{-1}(°\text{C})^{-1}$, melting point is $327\ °\text{C}$, density is $11.34\ \text{gcm}^{-3}$ and resistivity is $22\times10^{-6}\ \Omega\text{cm}$. The initial temperature of wire is $20°\text{C}$. Neglect heat losses.

ARCHIVE: JEE MAIN

1. **[Online April 2019]**
A 200 Ω resistor has a certain colour code. If one replaces the red colour by green in the code, the new resistance will be

(A) 400 Ω (B) 500 Ω
(C) 300 Ω (D) 100 Ω

2. **[Online April 2019]**
For the circuit shown, with $R_1 = 1.0\ \Omega$, $R_2 = 2.0\ \Omega$, $E_1 = 2$ V and $E_2 = E_3 = 4$ V, the potential difference between the points a and b is approximately (in V)

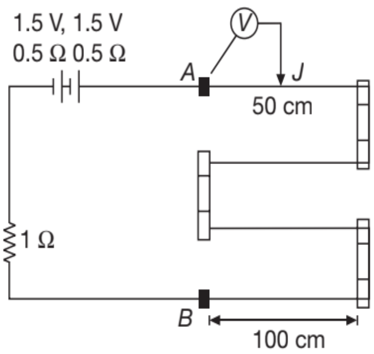


(A) 2.7 (B) 3.7
(C) 2.3 (D) 3.3

3. [Online April 2019]
A cell of internal resistance r drives current through an external resistance R. The power delivered by the cell to the external resistance will be maximum when

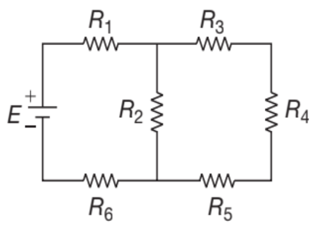
(A) $R = 1000r$ (B) $R = r$
(C) $R = 2r$ (D) $R = 0.001r$

4. [Online April 2019]
In the circuit shown, a four-wire potentiometer is made of a 400 cm long wire, which extends between A and B. The resistance per unit length of the potentiometer wire is $r = 0.01\ \Omega\text{cm}^{-1}$. If an ideal voltmeter is connected as shown with jockey J at 50 cm from end A, the expected reading of the voltmeter will be



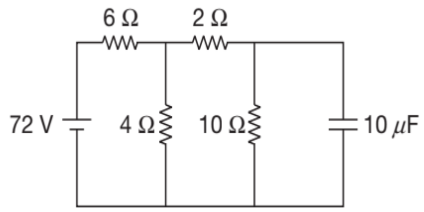
(A) 0.75 V (B) 0.50 V
(C) 0.20 V (D) 0.25 V

5. [Online April 2019]
In the figure shown, what is the current (in Ampere) drawn from the battery? You are given
$R_1 = 15\ \Omega,\ R_2 = 10\ \Omega,\ R_3 = 20\ \Omega,\ R_4 = 5\ \Omega,\ R_5 = 25\ \Omega,$
$R_6 = 30\ \Omega,\ E = 15\text{ V}$



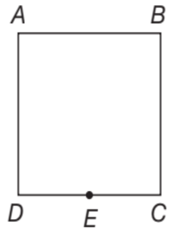
(A) $\frac{13}{24}$ (B) $\frac{9}{32}$
(C) $\frac{20}{3}$ (D) $\frac{7}{18}$

6. [Online April 2019]
Determine the charge on the capacitor in the following circuit



(A) 200 μC (B) 60 μC
(C) 10 μC (D) 2 μC

7. [Online April 2019]
A wire of resistance R is bent to form a square $ABCD$ as shown in the figure. The effective resistance between E and C is (E is mid-point of arm CD)



(A) $\frac{3}{4}R$ (B) R
(C) $\frac{1}{16}R$ (D) $\frac{7}{64}R$

8. [Online April 2019]
A moving coil galvanometer has resistance $50\ \Omega$ and it indicates full deflection at 4 mA current. A voltmeter is made using this galvanometer and a 5 kΩ resistance. The maximum voltage, that can be measured using this voltmeter, will be close to

(A) 10 V (B) 20 V
(C) 15 V (D) 40 V

9. [Online April 2019]
A metal wire of resistance $3\ \Omega$ is elongated to make a uniform wire of double its previous length. This new wire is now bent and the ends joined to make a circle. If two points on this circle make an angle 60° at the centre, the equivalent resistance between these two points will be

(A) $\frac{5}{3}\ \Omega$ (B) $\frac{5}{2}\ \Omega$
(C) $\frac{7}{2}\ \Omega$ (D) $\frac{12}{5}\ \Omega$

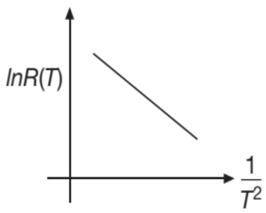
10. [Online April 2019]
The resistance of a galvanometer is $50\ \Omega$ and the maximum current which can be passed through it is 0.002 A. What resistance must be connected to it in order to convert it into an ammeter of range 0 – 0.5 A?

(A) 0.2 Ω (B) 0.002 Ω
(C) 0.5 Ω (D) 0.02 Ω

11. [Online April 2019]
In a conductor, if the number of conduction electrons per unit volume is $8.5\times10^{28}\ \text{m}^{-3}$ and mean free time is 25 fs (femto second), its approximate resistivity is $\left(m_e = 9.1\times10^{-31}\ \text{kg}\right)$

(A) $10^{-5}\ \Omega\text{m}$ (B) $10^{-6}\ \Omega\text{m}$
(C) $10^{-7}\ \Omega\text{m}$ (D) $10^{-8}\ \Omega\text{m}$

12. [Online April 2019]
In an experiment, the resistance of a material is plotted as a function of temperature (in some range). As shown in the figure, it is a straight line. One may conclude that



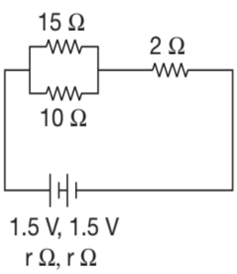
(A) $R(T) = \dfrac{R_0}{T^2}$ (B) $R(T) = R_0 e^{-\frac{T_0^2}{T^2}}$

(C) $R(T) = R_0 e^{-\frac{T^2}{T_0^2}}$ (D) $R(T) = R_0 e^{\frac{T^2}{T_0^2}}$

13. [Online April 2019]
A moving coil galvanometer allows a full scale current of 10^{-4} A. A series resistance of $2\ \text{M}\Omega$ is required to convert the above galvanometer into a voltmeter of range $0-5$ V. Therefore, the value of shunt resistance required to convert the above galvanometer into an ammeter of range $0-10$ mA is

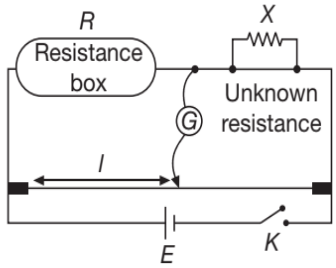
(A) 200 Ω (B) 500 Ω
(C) 100 Ω (D) 10 Ω

14. [Online April 2019]
In the given circuit, an ideal voltmeter connected across the 10 Ω resistance reads 2 V. The internal resistance r, of each cell is



(A) 0.5 Ω (B) 0 Ω
(C) 1.5 Ω (D) 1 Ω

15. [Online April 2019]
In a meter bridge experiment, the circuit diagram and the corresponding observation table are shown in figure.



S. No.	$R(\Omega)$	l(cm)
1.	1000	60
2.	100	13
3.	10	1.5
4.	1	1.0

Which of the readings is inconsistent?
(A) 1 (B) 2
(C) 3 (D) 4

16. [Online April 2019]
A current of 5 A passes through a copper conductor (resistivity $= 1.7\times10^{-8}\ \Omega\text{m}$) of radius of cross-section 5 mm. Find the mobility of the charges if their drift velocity is $1.1\times10^{-3}\ \text{ms}^{-1}$.

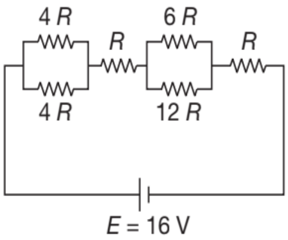
(A) $1.3\ \text{m}^2\text{V}^{-1}\text{s}^{-1}$ (B) $1.8\ \text{m}^2\text{V}^{-1}\text{s}^{-1}$
(C) $1.5\ \text{m}^2\text{V}^{-1}\text{s}^{-1}$ (D) $1.0\ \text{m}^2\text{V}^{-1}\text{s}^{-1}$

17. [Online April 2019]
Space between two concentric conducting spheres of radii a and $b\,(b > a)$ is filled with a medium of resistivity ρ. The resistance between the two spheres will be

(A) $\dfrac{\rho}{4\pi}\left(\dfrac{1}{a}-\dfrac{1}{b}\right)$ (B) $\dfrac{\rho}{2\pi}\left(\dfrac{1}{a}-\dfrac{1}{b}\right)$

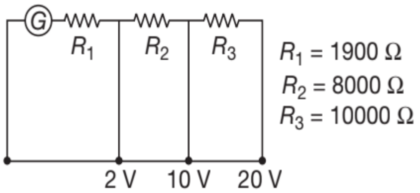
(C) $\dfrac{\rho}{2\pi}\left(\dfrac{1}{a}+\dfrac{1}{b}\right)$ (D) $\dfrac{\rho}{4\pi}\left(\dfrac{1}{a}+\dfrac{1}{b}\right)$

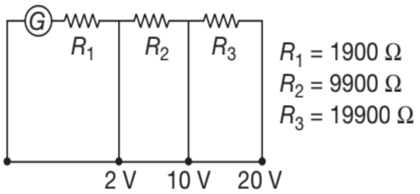
18. [Online April 2019]
The resistive network shown below is connected to a D.C. source of 16 V. The power consumed by the network is 4 W. The value of R is

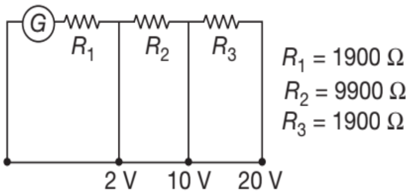


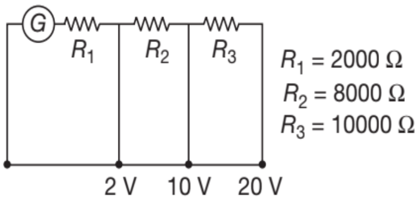
(A) 8 Ω (B) 1 Ω
(C) 16 Ω (D) 6 Ω

19. [Online April 2019]
A galvanometer of resistance 100 Ω has 50 divisions on its scale and has sensitivity of 20 μA/division. It is to be converted to a voltmeter with three ranges, of 0-2 V, 0-10 V and 0-20 V. The appropriate circuit to do so is

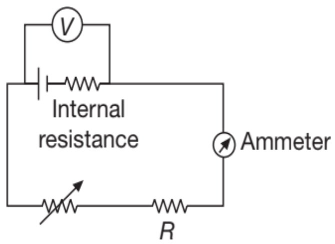
(A)


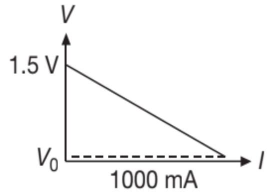
(B)


(C)


(D)


20. [Online April 2019]
To verify Ohm's law, a student connects the voltmeter across the battery as, shown in the figure. The measured voltage is plotted as a function of the current, and the following graph is obtained





If V_0 is almost zero, identify the correct statement

(A) The emf of the battery is 1.5 V and its internal resistance is 1.5 Ω
(B) The emf of the battery is 1.5 V and the value of R is 1.5 Ω
(C) The value of the resistance R is 1.5 Ω
(D) The potential difference across the battery is 1.5 V when it sends a current of 1000 mA

21. [Online April 2019]
A moving coil galvanometer, having a resistance G, produces full scale deflection when a current I_g flows through it. This galvanometer can be converted into (i) an ammeter of range 0 to $I_0 (I_0 > I_g)$ by connecting a shunt resistance R_A to it and (ii) into a voltmeter of range 0 to $V (V = GI_0)$ by connecting a series resistance R_V to it. Then,

(A) $R_A R_V = G^2$ and $\frac{R_A}{R_V} = \left(\frac{I_g}{I_0 - I_g}\right)^2$

(B) $R_A R_V = G^2\left(\frac{I_g}{I_0 - I_g}\right)$ and $\frac{R_A}{R_V} = \left(\frac{I_0 - I_g}{I_g}\right)^2$

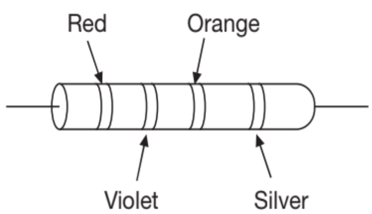
(C) $R_A R_V = G^2$ and $\frac{R_A}{R_V} = \frac{I_g}{(I_0 - I_g)}$

(D) $R_A R_V = G^2\left(\frac{(I_0 - I_g)}{I_g}\right)$ and $\frac{R_A}{R_V} = \left(\frac{I_g}{(I_0 - I_g)}\right)^2$

22. [Online January 2019]
A copper wire is stretched to make it 0.5% longer. The percentage change in its electrical resistance if its volume remains unchanged is

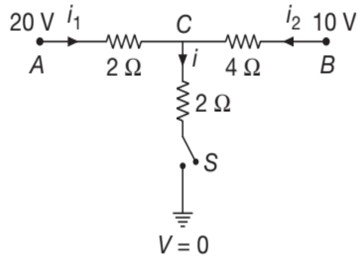
(A) 0.5% (B) 2.0%
(C) 2.5% (D) 1.0%

23. [Online January 2019]
A resistance is shown in the figure. Its value and tolerance are given respectively by



(A) 27 kΩ, 20% (B) 270 Ω, 5%
(C) 27 kΩ, 10% (D) 270 Ω, 10%

24. [Online January 2019]
When the switch S, in the circuit shown, is closed, then the value of current i will be

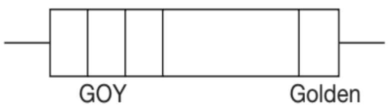


(A) 2 A (B) 5 A
(C) 4 A (D) 3 A

25. [Online January 2019]
Drift speed of electrons, when 1.5 A of current flows in a copper wire of cross section $5\ \text{mm}^2$, is v. If the electron density in copper is $9\times10^{28}\ \text{m}^{-3}$ the value of v in mms^{-1} is close to (Take charge of electron to be $=1.6\times10^{-19}$ C)

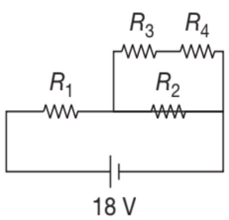
(A) 0.02 (B) 0.2
(C) 3 (D) 2

26. [Online January 2019]
A carbon resistance has a following colour code. What is the value of the resistance?



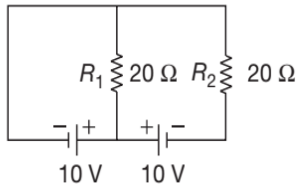
(A) 6.4 MΩ ± 5% (B) 5.3 MΩ ± 5%
(C) 64 kΩ ± 10% (D) 530 kΩ ± 5%

27. [Online January 2019]
In the given circuit the internal resistance of the 18 V cells is negligible. If $R_1 = 400\ \Omega$, $R_3 = 100\ \Omega$ and $R_4 = 500\ \Omega$ and the reading of an ideal voltmeter across R_4 is 5 V, then the value of R_2 will be



(A) 230 Ω (B) 450 Ω
(C) 550 Ω (D) 300 Ω

28. [Online January 2019]
In the given circuit the cells have zero internal resistance. The currents (in amperes) passing through resistance R_1 and R_2 respectively, are



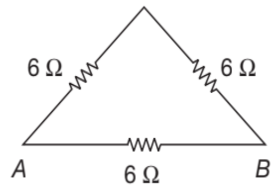
(A) 1, 2 (B) 0, 1
(C) 0.5, 0 (D) 2, 2

29. [Online January 2019]
A 2 W carbon resistor is colour coded with green, black, red and brown respectively. The maximum current which can be passed through this resistor is

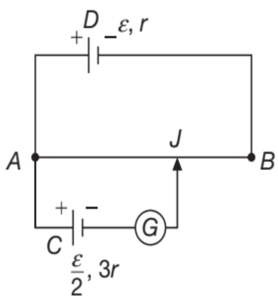
(A) 20 mA (B) 0.4 mA
(C) 100 mA (D) 63 mA

30. [Online January 2019]
A uniform metallic wire has a resistance of 18 Ω and is bent into an equilateral triangle. Then, the resistance between any two vertices of the triangle is

(A) 4 Ω (B) 12 Ω
(C) 8 Ω (D) 2 Ω



31. [Online January 2019]
A potentiometer wire AB having length L and resistance $12r$ is joined to a cell D of emf ε and internal resistance r. A cell C having emf $\frac{\varepsilon}{2}$ and internal resistance $3r$ is connected. The length AJ at which the galvanometer as shown in figure shows no deflection is

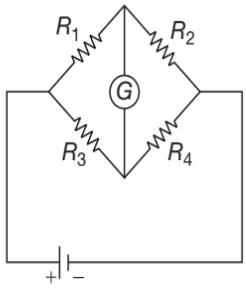


(A) $\frac{11}{12}L$ (B) $\frac{11}{24}L$

(C) $\frac{5}{12}L$ (D) $\frac{13}{24}L$

32. [Online January 2019]

The Wheatstone bridge shown in figure here, gets balanced when the carbon resistor used as R_1 has the colour code (Orange, Red, Brown). The resistors R_2 and R_4 are $80\ \Omega$ and $40\ \Omega$ respectively. Assuming that the colour code for the carbon resistors gives their accurate values, the colour code for the carbon resistor, used as R_3, would be

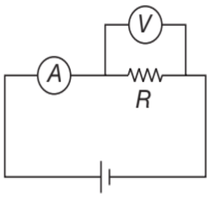


(A) Brown, Blue, Black (B) Red, Green, Brown

(C) Grey, Black, Brown (D) Brown, Blue, Brown

33. [Online January 2019]

The actual value of resistance R, shown in the figure is $30\ \Omega$. This is measured in an experiment as shown using the standard formula $R = \frac{V}{I}$, where V and I are the readings of the voltmeter and ammeter, respectively. If the measured value of R is 5% less, then the internal resistance of the voltmeter is



(A) $570\ \Omega$ (B) $600\ \Omega$

(C) $350\ \Omega$ (D) $35\ \Omega$

34. [Online January 2019]

A current of 2 mA was passed through an unknown resistor which dissipated a power of 4.4 W. Dissipated power when an ideal power supply of 11 V is connected across it is

(A) 11×10^{-5} W (B) 11×10^{5} W

(C) 11×10^{-3} W (D) 11×10^{-4} W

35. [Online January 2019]

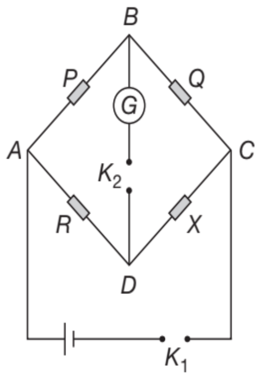
Two equal resistances when connected in series to a battery, consume electric power of 60 W. If these resistances are now connected in parallel combination to the same battery, the electric power consumed will be

(A) 60 W (B) 30 W

(C) 120 W (D) 240 W

36. [Online January 2019]

In a Wheatstone bridge (see figure), resistances P and Q are approximately equal. When $R = 400\ \Omega$, the bridge is balanced. On interchanging P and Q, the value of R, for balance, is $405\ \Omega$. The value of X is close to

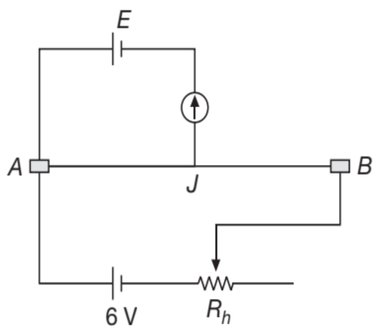


(A) $404.5\ \Omega$ (B) $401.5\ \Omega$

(C) $402.5\ \Omega$ (D) $403.5\ \Omega$

37. [Online January 2019]

The resistance of the metre bridge AB in given figure is $4\ \Omega$. With a cell of emf $E = 0.5$ V and rheostat resistance $R_h = 2\ \Omega$ the null point is obtained at some point J. When the cell is replaced by another one of emf $E = E_2$ the same null point J is found for $R_h = 6\ \Omega$. The emf E_2 is



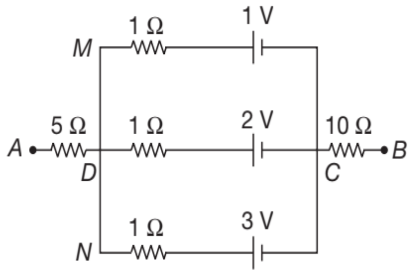
(A) 0.6 V (B) 0.5 V

(C) 0.3 V (D) 0.4 V

38. [Online January 2019]
A galvanometer having a resistance of $20\,\Omega$ and 30 divisions on both sides has figure of merit 0.005 ampere/division. The resistance that should be connected in series such that it can be used as a voltmeter upto 15 volt, is:

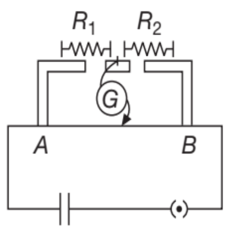
(A) $100\,\Omega$ (B) $125\,\Omega$
(C) $80\,\Omega$ (D) $120\,\Omega$

39. [Online January 2019]
In the circuit shown, the potential difference between A and B is:



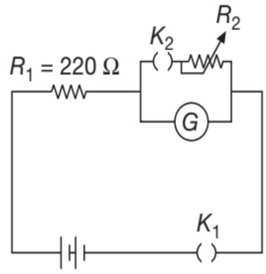
(A) 6 V (B) 3 V
(C) 2 V (D) 1 V

40. [Online January 2019]
In the experimental set up of metre bridge shown in the figure, the null point is obtained at a distance of 40 cm from A. If a $10\,\Omega$ resistor is connected in series with R_1, the null point shifts by 10 cm. The resistance that should be connected in parallel with $(R_1+10)\,\Omega$ such that the null point shifts back to its initial position is:



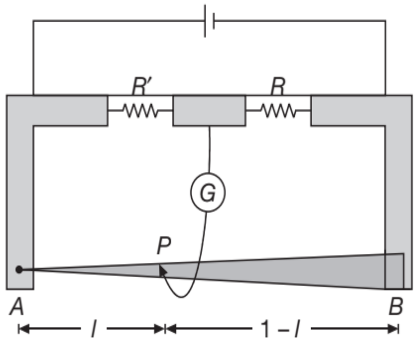
(A) $60\,\Omega$ (B) $30\,\Omega$
(C) $40\,\Omega$ (D) $20\,\Omega$

41. [Online January 2019]
The galvanometer deflection, when key K_1 is closed but K_2 is open, equal θ_0 (see figure). On closing K_2 also and adjusting R_2 to $5\,\Omega$, the deflection in galvanometer becomes $\frac{\theta_0}{5}$. The resistance of the galvanometer is, then given by (neglect the internal resistance of battery)



(A) $22\,\Omega$ (B) $25\,\Omega$
(C) $5\,\Omega$ (D) $12\,\Omega$

42. [Online January 2019]
In a meter bridge, the wire of length 1 m has a non-uniform cross-section such that, the variation $\frac{dR}{dl}$ of its resistance R with length l is $\frac{dR}{dl} \propto \frac{1}{\sqrt{l}}$. Two equal resistances are connected as shown in the figure. The galvanometer has zero deflection when the jockey is at point P. What is the length AP?



(A) 0.2 m (B) 0.35 m
(C) 0.25 m (D) 0.3 m

43. [Online January 2019]
An ideal battery of 4 V and resistance R are connected in series in the primary circuit of a potentiometer of length 1 m and resistance $5\,\Omega$. The value of R, to give a potential difference of 5 mV across 10 cm of potentiometer wire, is

(A) $480\,\Omega$ (B) $490\,\Omega$
(C) $495\,\Omega$ (D) $395\,\Omega$

44. [Online January 2019]
Two electric bulbs, rated at (25 W, 220 V) and (100 W, 220 V), are connected in series across a 220 V voltage source. If the 25 W and 100 W bulbs draw powers P_1 and P_2 respectively, then

(A) $P_1 = 9$ W, $P_2 = 16$ W (B) $P_1 = 4$ W, $P_2 = 16$ W
(C) $P_1 = 16$ W, $P_2 = 9$ W (D) $P_1 = 16$ W, $P_2 = 4$ W

45. [Online January 2019]

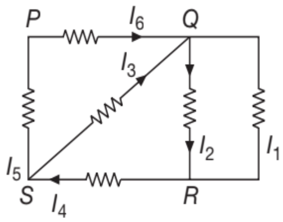
A galvanometer, whose resistance is $50\,\Omega$, has 25 divisions in it. When a current of 4×10^{-4} A passes through it, its needle (pointer) deflects by one division. To use this galvanometer as a voltmeter of range 2.5 V, it should be connected to a resistance of

(A) $6250\,\Omega$ (B) $250\,\Omega$

(C) $200\,\Omega$ (D) $6200\,\Omega$

46. [Online January 2019]

In the given circuit diagram, the currents, $I_1 = -0.3$ A, $I_4 = 0.8$ A and $I_5 = 0.4$ A, are flowing as shown. The currents I_2, I_3 and I_6, respectively, are:



(A) 1.1 A, 0.4 A, 0.4 A

(B) 1.1 A, –0.4 A, 0.4 A

(C) 0.4 A, 1.1 A, 0.4 A

(D) –0.4 A, 0.4 A, 1.1 A

47. [2018]

Two batteries with e.m.f. 12 V and 13 V are connected in parallel across a load resistor of $10\,\Omega$. The internal resistances of the two batteries are $1\,\Omega$ and $2\,\Omega$ respectively. The voltage across the load lies between

(A) 11.6 V and 11.7 V (B) 11.5 V and 11.6 V

(C) 11.4 V and 11.5 V (D) 11.7 V and 11.8 V

48. [2018]

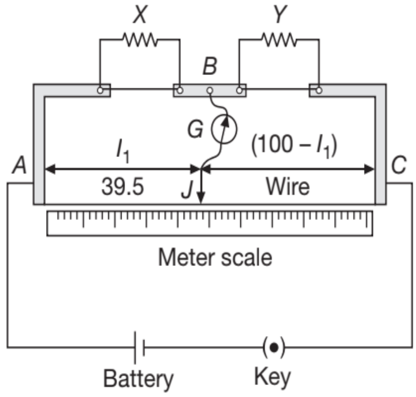
On interchanging the resistances, the balance point of a meter bridge shifts to the left by 10 cm. The resistance of their series combinations is $1\,k\Omega$. How much was the resistance on the left slot before the interchange?

(A) $990\,\Omega$ (B) $505\,\Omega$

(C) $550\,\Omega$ (D) $910\,\Omega$

49. [Online 2018]

In a meter bridge, as shown in the figure, it is given that resistance $Y = 12.5\,\Omega$ and that the balance is obtained at a distance 39.5 cm from end *A* (by Jockey *J*). After interchanging the resistances X and Y, a new balance point is found at a distance l_2 from end A. What are the values of X and l_2?



(A) $19.15\,\Omega$ and 60.5 cm

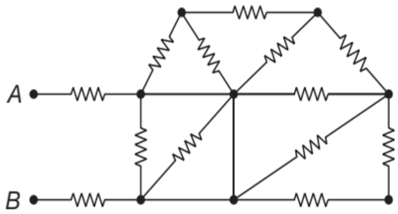
(B) $8.16\,\Omega$ and 60.5 cm

(C) $8.16\,\Omega$ and 39.5 cm

(D) $19.15\,\Omega$ and 39.5 cm

50. [Online 2018]

In the given circuit all resistances are of value R ohm each. The equivalent resistance between A and B is



(A) $2R$ (B) $\frac{5R}{2}$

(C) $3R$ (D) $\frac{5R}{3}$

51. [Online 2018]

A constant voltage is applied between two ends of a metallic wire. If the length is halved and the radius of the wire is doubled, the rate of heat developed in the wire will be

(A) Increased 8 times (B) Unchanged

(C) Doubled (D) Halved

52. [Online 2018]

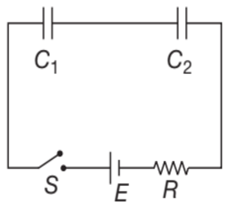
A copper rod of cross-sectional area A carries a uniform current I through it. At temperature T, if the volume charge density of the rod is ρ, how long will the charges take to travel a distance d?

(A) $\frac{\rho dA}{I}$ (B) $\frac{\rho dA}{IT}$

(C) $\frac{2\rho dA}{I}$ (D) $\frac{2\rho dA}{IT}$

53. [Online 2018]

In the following circuit, the switch S is closed at $t = 0$. The charge on the capacitor C_1 as a function of time will be given by $\left(C_{eq} = \frac{C_1 C_2}{C_1 + C_2}\right)$



(A) $C_{eq}E\left[1 - \exp\left(-\frac{t}{RC_{eq}}\right)\right]$

(B) $C_1E\left[1 - \exp\left(-\frac{tR}{C_1}\right)\right]$

(C) $C_{eq}E\exp\left(-\frac{t}{RC_{eq}}\right)$

(D) $C_2E\left[1 - \exp\left(-\frac{t}{RC_2}\right)\right]$

54. [Online 2018]

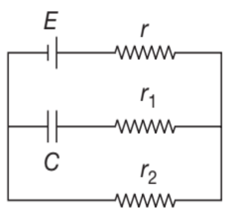
A heating element has a resistance of $100\ \Omega$ at room temperature. When it is connected to a supply of 220 V, a steady current of 2 A passes in it and temperature is 500 °C more than room temperature. What is the temperature coefficient of resistance of the heating element?

(A) $1 \times 10^{-4}\ °C^{-1}$ (B) $2 \times 10^{-4}\ °C^{-1}$

(C) $0.5 \times 10^{-4}\ °C^{-1}$ (D) $5 \times 10^{-4}\ °C^{-1}$

55. [2017]

In the given circuit diagram when the current reaches steady state in the circuit, the charge on the capacitor of capacitance C will be

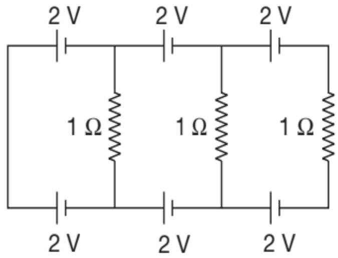


(A) CE (B) $CE\frac{r_1}{(r_2 + r)}$

(C) $CE\frac{r_2}{(r + r_2)}$ (D) $CE\frac{r_1}{(r_1 + r)}$

56. [2017]

In the following circuit the current in each resistance is



(A) 1 A (B) 0.25 A

(C) 0.5 A (D) 0 A

57. [2017]

Which of the following statement is false?

(A) Wheatstone bridge is the most sensitive when all the four resistances are of the same order of magnitude.

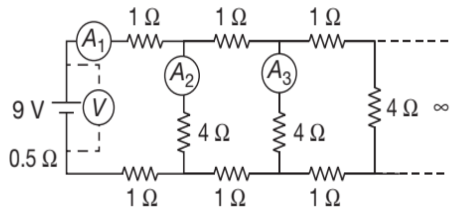
(B) In a balanced Wheatstone bridge if the cell and the galvanometer are exchanged, the null point is disturbed.

(C) A rheostat can be used as a potential divider.

(D) Kirchhoff's second law represents energy conservation.

58. [Online 2017]

A 9 V battery with internal resistance of $0.5\ \Omega$ is connected across an infinite network as shown in the figure. All ammeters A_1, A_2, A_3 and voltmeter V are ideal. Choose correct statement.



(A) Reading of V is 9 V

(B) Reading of A_1 is 2 A

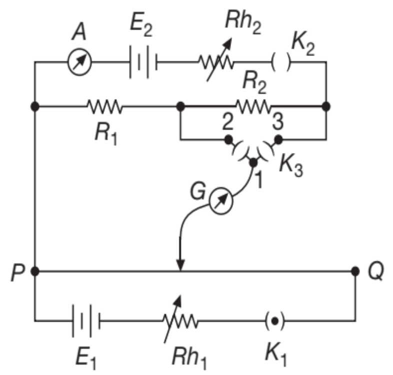
(C) Reading of V is 7 V

(D) Reading of A_1 is 18 A

59. [Online 2017]

A potentiometer PQ is set up to compare two resistances as shown in the figure. The ammeter A in the circuit reads 1 A when two way key K_3 is open. The balance point is at a length l_1 cm from P when two way key K_3 is plugged in between 2 and 1, while the balance points is at a length l_2 cm from P when key K_3

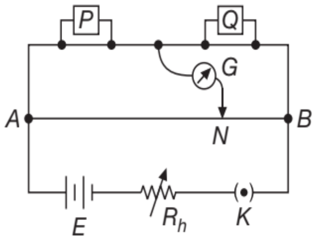
is plugged in between 3 and 1. The ratio of two resistances $\frac{R_1}{R_2}$, is found to be



(A) $\frac{l_2}{l_2 - l_1}$ (B) $\frac{l_1}{l_2 - l_1}$

(C) $\frac{l_1}{l_1 + l_2}$ (D) $\frac{l_1}{l_1 - l_2}$

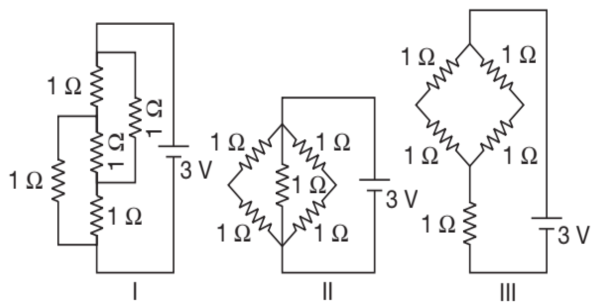
60. [Online 2017]
In a meter bridge experiment resistances are connected as shown in the figure. Initially resistance $P = 4\ \Omega$ and the neutral point N is at 60 cm from A. Now an unknown resistance R is connected in series to P and the new position of the neutral point is at 80 cm from A. The value of unknown resistance R is



(A) $\frac{20}{3}\ \Omega$ (B) $\frac{33}{5}\ \Omega$

(C) $6\ \Omega$ (D) $7\ \Omega$

61. [Online 2017]
The figure shows three circuits I, II and III which are connected to a 3 V battery. If the powers dissipated by the configurations I, II and III are P_1, P_2 and P_3 respectively, then



(A) $P_3 > P_2 > P_1$ (B) $P_2 > P_1 > P_3$

(C) $P_1 > P_3 > P_2$ (D) $P_1 > P_2 > P_3$

62. [Online 2017]
A uniform wire of length l and radius r has a resistance of $100\ \Omega$. It is recast into a wire of radius $\frac{r}{2}$. The resistance of new wire will be

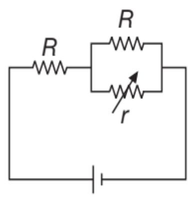
(A) $400\ \Omega$ (B) $100\ \Omega$

(C) $200\ \Omega$ (D) $1600\ \Omega$

63. [2016]
The temperature dependence of resistances of Cu and undoped Si in the temperature range 300-400 K, is best described by

(A) Linear decrease for Cu, linear decrease for Si.
(B) Linear increase for Cu, linear increase for Si.
(C) Linear increase for Cu, exponential increase for Si.
(D) Linear increase for Cu, exponential decrease for Si.

64. [Online 2016]
In the circuit shown, the resistance r is a variable resistance. If for $r = fR$, the heat generation in r is maximum then the value of f is



(A) $\frac{1}{2}$ (B) 1

(C) $\frac{1}{4}$ (D) $\frac{3}{4}$

65. [Online 2016]
The resistance of an electrical toaster has a temperature dependence given by $R(T) = R_0[1 + \alpha(T - T_0)]$ in its range of operation. At $T_0 = 300$ K, $R = 100\ \Omega$ and at $T = 500$ K, $R = 120\ \Omega$. The toaster is connected to a voltage source at 200 V and its temperature is raised at a constant rate from 300 to 500 K in 30 s. The total work done (in kJ) in raising the temperature is

(A) $40\ln\left(\frac{6}{5}\right)$ (B) $20\ln\left(\frac{3}{2}\right)$

(C) $60\ln\left(\frac{6}{5}\right)$ (D) $40\ln\left(\frac{15}{13}\right)$

66. [2015]
When $5V$ potential difference is applied across a wire of length 0.1 m, the drift speed of electrons is

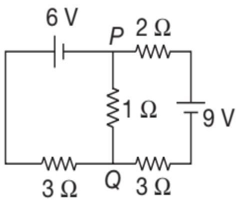
$2.5\times10^{-4}\ ms^{-1}$. If the electron density in the wire is $8\times10^{28}\ m^{-3}$, the resistivity of the material is close to

(A) $1.6\times10^{-8}\ \Omega m$ (B) $1.6\times10^{-7}\ \Omega m$

(C) $1.6\times10^{-6}\ \Omega m$ (D) $1.6\times10^{-5}\ \Omega m$

67. [2015]

In the circuit shown, the current in the $1\ \Omega$ resistor is



(A) 1.3 A, from P to Q

(B) 0 A

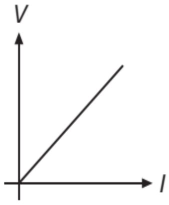
(C) 0.13 A, from Q to P

(D) 0.13 A, from P to Q

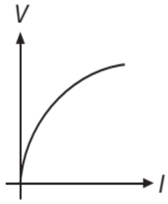
68. [Online 2015]

Suppose the drift velocity v_d in a material varied with the applied electric field E as $V_d \propto \sqrt{E}$. Then V-I graph for a wire made of such a material is best given by

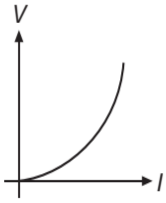
(A)



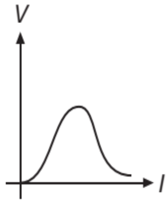
(B)



(C)

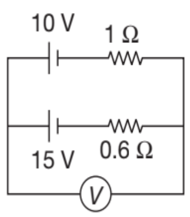


(D)



69. [Online 2015]

A 10 V battery with internal resistance $1\ \Omega$ and a 15 V battery with internal resistance $0.6\ \Omega$ are connected in parallel to a voltmeter (shown in figure). The reading in the voltmeter will be close to

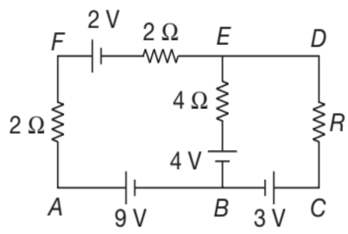


(A) 11.9 V (B) 12.5 V

(C) 13.1 V (D) 24.5 V

70. [Online 2015]

In the electric network shown, when no current flows through the $4\ \Omega$ resistor in the arm EB, the potential difference between the points A and D will be



(A) 3 V (B) 4 V

(C) 5 V (D) 6 V

71. [2014]

In a large building, there are 15 bulbs of 40 W, 5 bulbs of 100 W, 5 fans of 80 W and 1 heater of 1 kW. The voltage of the electric mains is 220 V. The minimum capacity of the main fuse of the building will be

(A) 8 A (B) 10 A

(C) 12 A (D) 14 A

72. [2013]

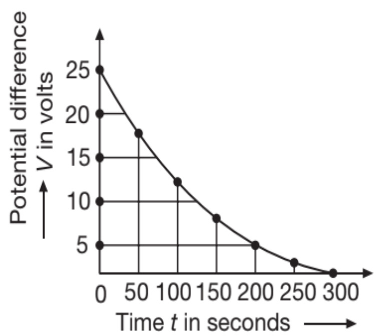
The supply voltage to a room is 120 V. The resistance of the lead wires is $6\ \Omega$. A 60 W bulb is already switched on. What is the decrease of voltage across the bulb, when a 240 W heater is switched on in parallel to the bulb?

(A) zero volt (B) 2.9 volt

(C) 13.3 volt (D) 10.04 volt

73. [2012]

The figure shows an experimental plot for discharging of a capacitor in an R-C circuit. The time constant t of this circuit lies between



(A) 0 and 50 sec (B) 50 sec and 100 sec

(C) 100 sec and 150 sec (D) 150 sec and 200 sec

74. [2012]

Two electric bulbs marked 25 W – 220 V and 100 W – 220 V are connected in series to a 440 V supply. Which of the bulbs will fuse?

(A) 100 W (B) 25 W
(C) neither (D) Both

75. [2011]
If a wire is stretched to make it 0.1% longer, its resistance will
(A) increase by 0.05% (B) increase by 0.2%
(C) decrease by 0.2% (D) decrease by 0.05%

76. [2010]
Two conductors have the same resistance at 0 °C but their temperature coefficients of resistance are α_1 and α_2. The respective temperature coefficients of their series and parallel combinations are nearly

(A) $\frac{\alpha_1+\alpha_2}{2}, \frac{\alpha_1+\alpha_2}{2}$ (B) $\frac{\alpha_1+\alpha_2}{2}, \alpha_1+\alpha_2$

(C) $\alpha_1+\alpha_2, \frac{\alpha_1+\alpha_2}{2}$ (D) $\alpha_1+\alpha_2, \frac{\alpha_1\alpha_2}{\alpha_1+\alpha_2}$

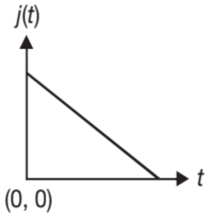
77. [2009]
This question contains Statement 1 and Statement 2. Of the four choices given after the statements, choose the one that best describes the two statements.
Statement 1: The temperature dependence of resistance is usually given as $R=R_0(1+\alpha\Delta t)$. The resistance of a wire changes from 100 Ω to 150 Ω when its temperature is increased from 27 °C to 227 °C. This implies that $\alpha = 2.5\times10^{-3}\ °C^{-1}$.
Statement 2: $R=R_0(1+\alpha\Delta t)$ is valid only when the change in the temperature ΔT is small and $\Delta R=(R-R_0)\ll R_0$.
(A) Statement 1 is true, Statement 2 is false.
(B) Statement 1 is true, Statement 2 is true; Statement 2 is the correct explanation of Statement 1.
(C) Statement 1 is true, Statement 2 is true; Statement 2 is not the correct explanation of Statement 1.
(D) Statement 1 is false, Statement 2 is true.

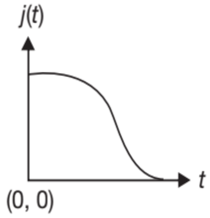
ARCHIVE: JEE ADVANCED

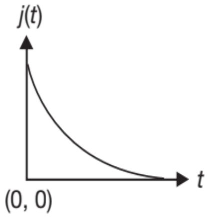
Single Correct Choice Type Problems

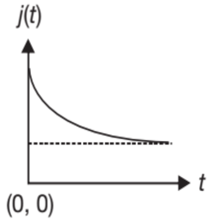
In this section each question has four choices (A), (B), (C) and (D), out of which ONLY ONE is correct.

1. [JEE (Advanced) 2016]
An infinite line charge of uniform electric charge density λ lies along the axis of an electrically conducting infinite cylindrical shell of radius R. At time $t=0$, the space inside the cylinder is filled with a material of permittivity ε and electrical conductivity σ. The electrical conduction in the material follows Ohm's law. Which one of the following graphs best describes the subsequent variation of the magnitude of current density $j(t)$ at any point in the material?

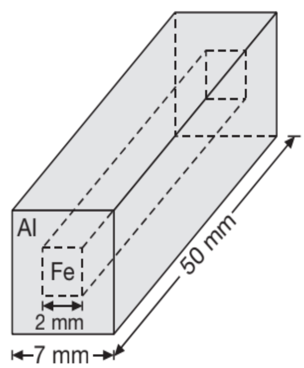
(A)


(B)


(C)


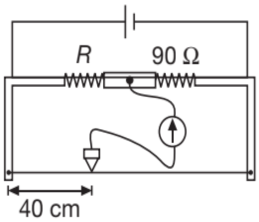
(D)


2. [JEE (Advanced) 2015]
In an aluminium (Al) bar of square cross section, a square hole is drilled and is filled with iron (Fe) as shown in the figure. The electrical resistivities of Al and Fe are 2.7×10^{-8} Ωm and 10×10^{-7} Ωm, respectively. The electrical resistance between the two faces P and Q of the composite bar is



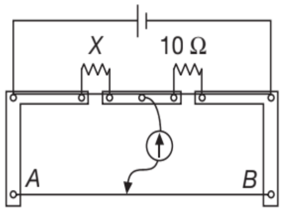
(A) $\frac{2475}{64}\ \mu\Omega$ (B) $\frac{1875}{64}\ \mu\Omega$
(C) $\frac{1875}{49}\ \mu\Omega$ (D) $\frac{2475}{132}\ \mu\Omega$

3. [JEE (Advanced) 2014]
During an experiment with a meter bridge, the galvanometer shows a null point when the jockey is pressed at 40 cm using a standard resistance of 90 Ω, as show in the scale used in the meter bridge is 1 mm. The unknown resistance is



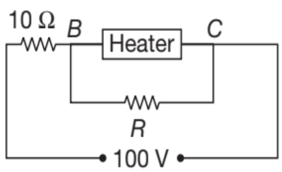
(A) $60 \pm 0.15\ \Omega$ (B) $135 \pm 0.56\ \Omega$
(C) $60 \pm 0.25\ \Omega$ (D) $135 \pm 0.23\ \Omega$

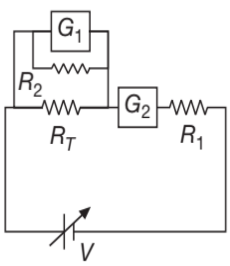
4. [IIT-JEE 2011]
A meter bridge is set-up as shown in figure, to determine an unknown resistance X using a standard $10\ \Omega$ resistor. The galvanometer shows null point when tapping key is at 52 cm mark. The end-corrections are 1 cm and 2 cm respectively for the ends A and B. The determined value of X is

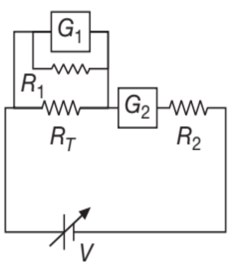


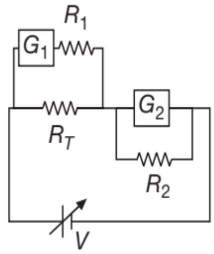
(A) $10.2\ \Omega$ (B) $10.6\ \Omega$
(C) $10.8\ \Omega$ (D) $11.1\ \Omega$

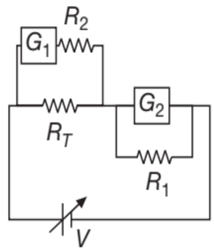
5. [IIT-JEE 2010]
To verify Ohm's law, a student is provided with a test resistor R_T, a high resistance R_1, a small resistance R_2, two identical galvanometers G_1 and G_2 and a variable voltage source V. The correct circuit to carry out the experiment is



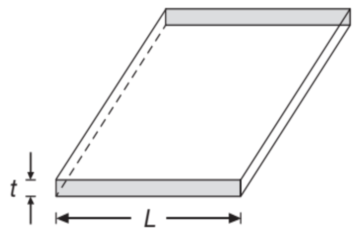
(A)


(B)


(C)


(D)


6. [IIT-JEE 2010]
Consider a thin square sheet of side L and thickness t, made of a material of resistivity ρ. The resistance between two opposite faces, shown by the shaded areas in the figure is



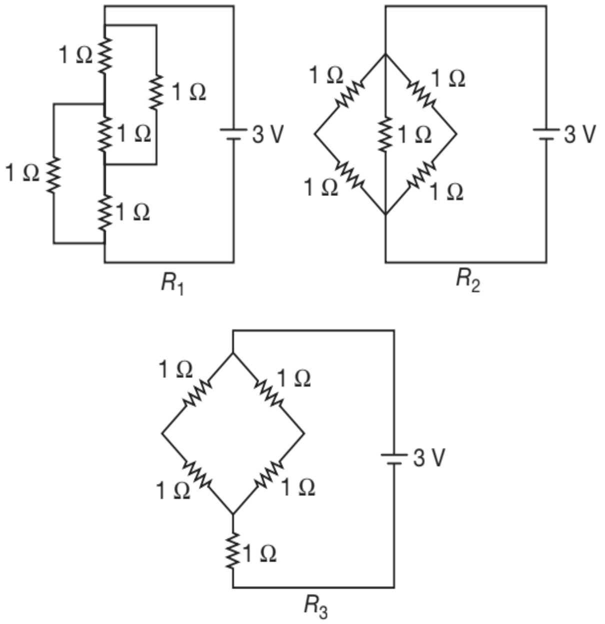
(A) directly proportional to L
(B) directly proportional to t
(C) independent of L
(D) independent of t

7. [IIT-JEE 2010]
Incandescent bulbs are designed by keeping in mind that the resistance of their filament increases with the increase in temperature. If at room temperature, 100 W, 60 W and 40 W bulbs have filament resistances R_{100}, R_{60} and R_{40}, respectively, the relation between these resistances is

(A) $\dfrac{1}{R_{100}} = \dfrac{1}{R_{40}} + \dfrac{1}{R_{60}}$ (B) $R_{100} = R_{40} + R_{60}$

(C) $R_{100} > R_{60} > R_{40}$ (D) $\dfrac{1}{R_{100}} > \dfrac{1}{R_{60}} > \dfrac{1}{R_{40}}$

8. [IIT-JEE 2008]
Figure shows three resistor configurations R_1, R_2 and R_3 connected to 3 V battery. If the power dissipated by the configuration R_1, R_2 and R_3 is P_1, P_2 and P_3, respectively, then



(A) $P_1 > P_2 > P_3$ (B) $P_1 > P_3 > P_2$

(C) $P_2 > P_1 > P_3$ (D) $P_3 > P_2 > P_1$

9. [IIT-JEE 2007]

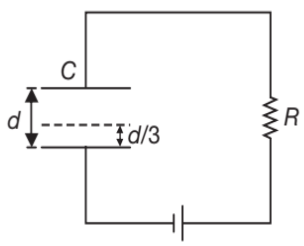
A resistance of $2\,\Omega$ is connected across one gap of a metre bridge (the length of the wire is 100 cm) and an unknown resistance, greater than $2\,\Omega$, is connected across the other gap. When these resistances are interchanged, the balance point shifts by 20 cm. Neglecting any corrections, the unknown resistance is

(A) $3\,\Omega$ (B) $4\,\Omega$

(C) $5\,\Omega$ (D) $6\,\Omega$

10. [IIT-JEE 2007]

A parallel plate capacitor C with plates of unit area and separation d is filled with a liquid of dielectric constant $K = 2$. The level of liquid is $\frac{d}{3}$ initially. Suppose the liquid level decreases at a constant speed V, the time constant as a function of time is

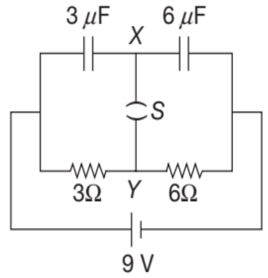


(A) $\dfrac{6\varepsilon_0 R}{5d+3Vt}$ (B) $\dfrac{(15d+9Vt)\varepsilon_0 R}{2d^2-3dVt-9V^2t^2}$

(C) $\dfrac{6\varepsilon_0 R}{5d-3Vt}$ (D) $\dfrac{(15d-9Vt)\varepsilon_0 R}{2d^2+3dVt-9V^2t^2}$

11. [IIT-JEE 2007]

A circuit is connected as shown in the figure with the switch S open. When the switch is closed, the total amount of charge that flows from Y to X is

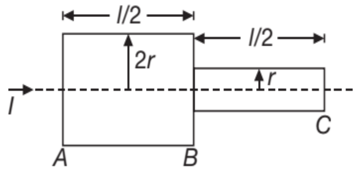


(A) zero (B) $54\,\mu$C

(C) $27\,\mu$C (D) $81\,\mu$C

12. [IIT-JEE 2006]

Two bars of radius r and $2r$ are kept in contact as shown. An electric current I is passed through the bars. Which one of the following is correct?



(A) Heat produced in bar BC is 4 times the heat produced in bar AB

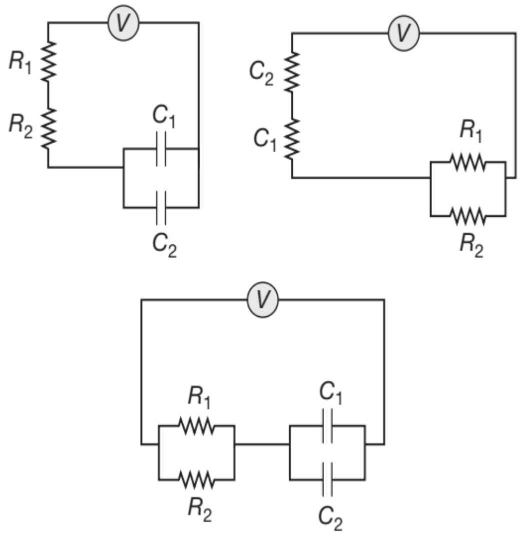
(B) Electric field in both halves is equal

(C) Current density across AB is double that of across BC

(D) Potential difference across AB is 4 times that of across BC

13. [IIT-JEE 2006]

Find the time constant for the given RC circuits in correct order



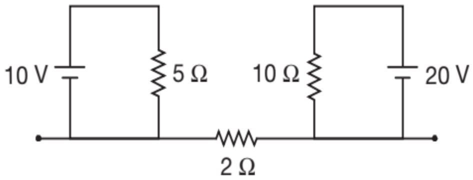
$R_1 = 1\,\Omega$, $R_2 = 2\,\Omega$, $C_1 = 4\,\mu$F, $C_2 = 2\,\mu$F

(A) 18, 4, $\frac{8}{9}$ (B) 18, $\frac{8}{9}$, 4
(C) 4, 18, $\frac{8}{9}$ (D) 4, $\frac{8}{9}$, 18

14. [IIT-JEE 2005]
A moving coil galvanometer of resistance $100\ \Omega$ is used as an ammeter using a resistance $0.1\ \Omega$. The maximum deflection current in the galvanometer is $100\ \mu A$. Find the minimum current in the circuit, so that the ammeter shown maximum deflection
(A) 100.1 mA (B) 1000.1 mA
(C) 10.01 mA (D) 1.01 mA

15. [IIT-JEE 2005]
A rigid container with thermally insulated walls contains a coil of resistance $100\ \Omega$, carrying current 1 A. Change in internal energy after 5 minute will be
(A) zero (B) 10 kJ
(C) 20 kJ (D) 30 kJ

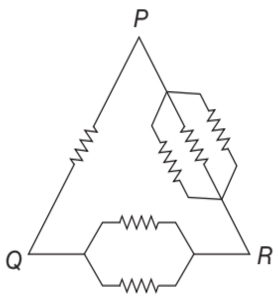
16. [IIT-JEE 2005]
Find out the value of current through $2\ \Omega$ resistance for the given circuit.



(A) 5 A (B) 2 A
(C) zero (D) 4 A

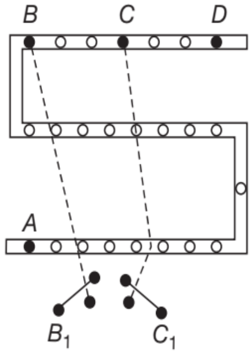
17. [IIT-JEE 2005]
A $4\ \mu F$ capacitor, a resistance of $2.5\ M\Omega$ is in series with 12 V battery. Find the time after which the potential difference across the capacitor is 3 times the potential difference across the resistor: $\left[\text{Given } \log_e(2) = 0.693\right]$
(A) 13.86 s (B) 6.93 s
(C) 7 s (D) 14 s

18. [IIT-JEE 2004]
Six equal resistances are connected between points P, Q and R as shown in the figure. Then, the net resistance will be maximum between



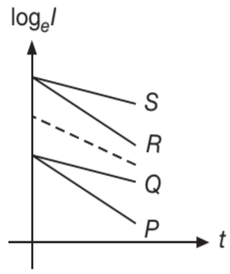
(A) P and Q (B) Q and R
(C) P and R (D) any two points

19. [IIT-JEE 2004]
For the post office box arrangement to determine the value of unknown resistance, the unknown resistance should be connected between



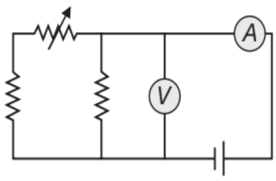
(A) B and C (B) C and D
(C) A and D (D) B_1 and C_1

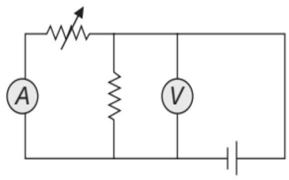
20. [IIT-JEE 2004]
A capacitor is charged using an external battery with a resistance x in series. The dashed line shows the variation of $\log_e I$ with respect to time. If the resistance is changed to $2x$, the new graph will be



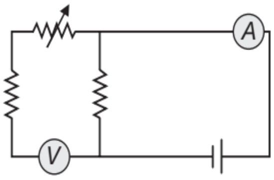
(A) P (B) Q
(C) R (D) S

21. [IIT-JEE 2003]
Express which of the following set-up can be used to verify Ohm's Law?

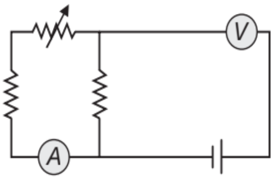
(A)


(B)


(C)

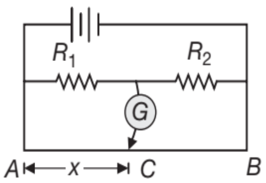


(D)



22. [IIT-JEE 2003]

In the shown arrangement of the experiment of the meter bridge if AC corresponding to null deflection of galvanometer is x, what would be its value if the radius of the wire AB is doubled?

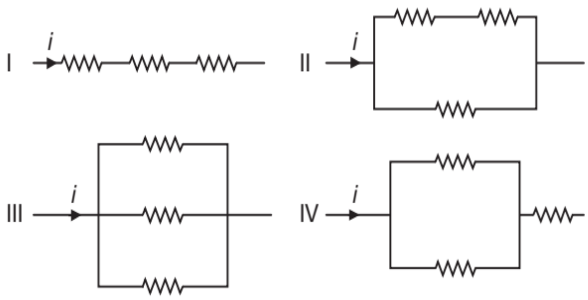


(A) x (B) $\frac{x}{4}$

(C) $4x$ (D) $2x$

23. [IIT-JEE 2003]

The three resistances of equal value are arranged in the different combinations shown below. Arrange them in increasing order of power dissipation

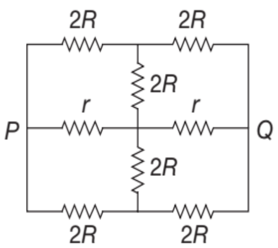


(A) III < II < IV < I (B) II < III < IV < I

(C) I < IV < III < II (D) I < III < II < IV

24. [IIT-JEE 2002]

The effective resistance between points P and Q of the electrical circuit shown in figure is

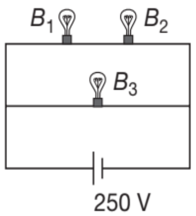


(A) $\frac{2Rr}{R+r}$ (B) $\frac{8R(R+r)}{3R+r}$

(C) $2r+4R$ (D) $\frac{5R}{2}+2r$

25. [IIT-JEE 2002]

A 100 W bulb B_1, and two 60 W bulbs B_2 and B_3, are connected to a 250 V source, as shown in the figure. Now W_1, W_2 and W_3 are the output powers of the bulbs B_1, B_2 and B_3 respectively. Then

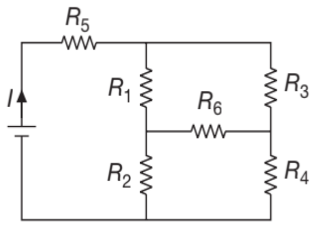


(A) $W_1 > W_2 = W_3$ (B) $W_1 > W_2 > W_3$

(C) $W_1 < W_2 = W_3$ (D) $W_1 < W_2 < W_3$

26. [IIT-JEE 2001]

In the given circuit, it is observed that the current I is independent of the value of the resistance R_6. Then, the resistance values must satisfy



(A) $R_1R_2R_5 = R_3R_4R_6$

(B) $\frac{1}{R_5}+\frac{1}{R_6}=\frac{1}{R_1+R_2}+\frac{1}{R_3+R_4}$

(C) $R_1R_4 = R_2R_3$

(D) $R_1R_3 = R_2R_4$

27. [IIT-JEE 2001]

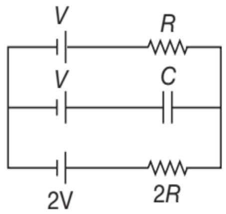
A wire of length L and 3 identical cells of negligible internal resistances are connected in series. Due to the current, the temperature of the wire is raised by ΔT in time t. A number N of similar cells is now connected in series with a wire of the same material and cross section but of length $2L$. The temperature of the wire is raised by the same amount ΔT in the same time t. The value of N is

(A) 4 (B) 6

(C) 8 (D) 9

28. [IIT-JEE 2001]

In the circuit shown in figure, with steady current, the potential drop across the capacitor must be

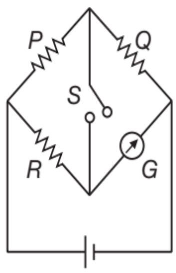


(A) V (B) $\frac{V}{2}$

(C) $\frac{V}{3}$ (D) $\frac{2V}{3}$

29. [IIT-JEE 1999]

In the circuit shown $P \neq R$, the reading of galvanometer is same with switch S open or closed. Then

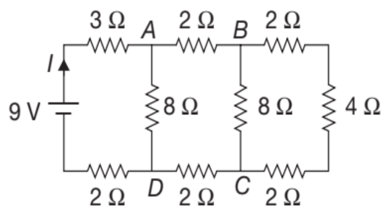


(A) $I_R = I_G$ (B) $I_P = I_G$

(C) $I_R = I_P$ (D) $I_Q = I_R$

30. [IIT-JEE 1998]

In the circuit shown in figure, the current through



(A) the $3\ \Omega$ resistor is 0.5 A.

(B) the $3\ \Omega$ resistor is 0.25 A.

(C) the $4\ \Omega$ resistor is 0.5 A.

(D) the $4\ \Omega$ resistor is 0.25 A.

31. [IIT-JEE 1997]

A steady current flows in a metallic conductor of non-uniform cross-section. The quantity/quantities constant along the length of the conductor is/are

(A) current, electric field and drift speed
(B) drift speed only
(C) current and drift speed
(D) current only

32. [IIT-JEE 1997]

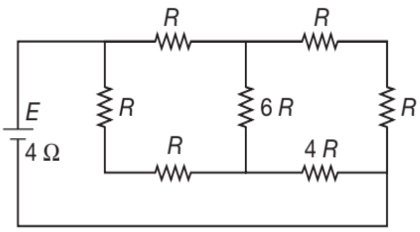
A parallel combination of $0.1\ \text{M}\Omega$ resistor and a $10\ \mu\text{F}$ capacitor is connected across a 1.5 V source of negligible resistance. The time required for the capacitor to get charged upto 0.75 V is approximately (in second)

(A) ∞ (B) $\log_e 2$

(C) $\log_{10} 2$ (D) zero

33. [IIT-JEE 1995]

A battery of internal resistance $4\ \Omega$ is connected to the network of resistances as shown. In order that the maximum power can be delivered to the network, the value of R in Ω should be



(A) $\frac{4}{9}$ (B) 2

(C) $\frac{8}{3}$ (D) 18

34. [IIT-JEE 1993]

Read the following statements carefully :

Y: The resistivity of semiconductor decreases with increase of temperature.

Z: In a conducting solid, the rate of collisions between free electrons and ions increases with increase of temperature

Select the correct statement(s) from the following :

(A) Y is true but Z is false

(B) Y is false but Z is true

(C) Both Y and Z are true

(D) Y is true and Z is the correct reason for Y

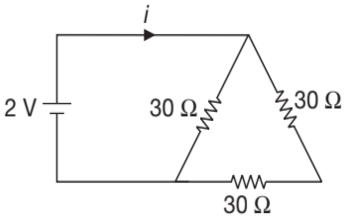
35. [IIT-JEE 1988]

A piece of copper and another of germanium are cooled from room temperature to 80 K. The resistance of

(A) each of them increases.
(B) each of them decreases.
(C) copper increases and that of germanium decreases.
(D) copper decreases and that of germanium increases.

36. [IIT-JEE 1983]

The current i in the circuit (see figure) is

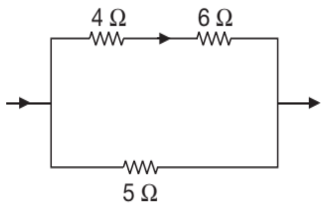


(A) $\frac{1}{45}$ A (B) $\frac{1}{15}$ A

(C) $\frac{1}{10}$ A (D) $\frac{1}{5}$ A

37. [IIT-JEE 1981]

In the circuit shown in figure the heat produced in the $5\ \Omega$ resistor due to the current flowing through it is 10 calories per second.



The heat generated in the $4\ \Omega$ resistor is

(A) $1\ \text{cals}^{-1}$ (B) $2\ \text{cals}^{-1}$

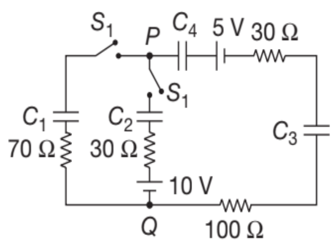
(C) $3\ \text{cals}^{-1}$ (D) $4\ \text{cals}^{-1}$

Multiple Correct Choice Type Problems

(In this section each question has four choices (A), (B), (C) and (D), out of which ONE OR MORE is/are correct)

1. [JEE (Advanced) 2019]

In the circuit shown, initially there is no charge on capacitors and keys S_1 and S_2 are open. The values of the capacitors are $C_1 = 10\ \mu\text{F}$, $C_2 = 30\ \mu\text{F}$ and $C_3 = C_4 = 80\ \mu\text{F}$. Which of the following statement(s) is/are correct?



(A) If key S_1 is kept closed for long time such that capacitors are fully charged, the voltage across the capacitor C_1 will be $4\ \text{V}$.

(B) The key S_1 is kept closed for long time such that capacitors are fully charged. Now key S_2 is closed, at this time, the instantaneous current across $30\ \Omega$ resistor (between points P and Q) will be $0.2\ \text{A}$ (round off to 1st decimal place).

(C) At time $t = 0$, the key S_1 is closed, the instantaneous current in the closed circuit will be $25\ \text{mA}$.

(D) If key S_1 is kept closed for long time such that capacitors are fully charged, the voltage difference between point P and Q will be $10\ \text{V}$.

2. [JEE (Advanced) 2019]

Two identical moving coil galvanometers have $10\ \Omega$ resistance and full scale deflection at $2\ \mu\text{A}$ current. One of them is converted into a voltmeter of $100\ \text{mV}$ full scale reading and the other into an Ammeter of $1\ \text{mA}$ full scale current using appropriate resistors. These are then used to measure the voltage and current in the Ohm's law experiment with $R = 1000\ \Omega$ resistor by using an ideal cell. Which of the following statement(s) is/are correct?

(A) The measured value of R will be $978\ \Omega < R < 982\ \Omega$

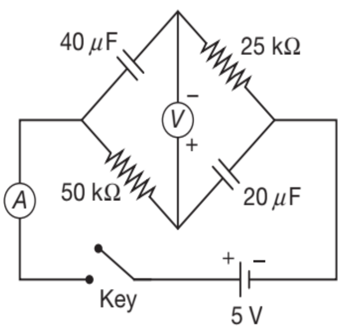
(B) The resistance of the ammeter will be $0.02\ \Omega$ (round off to 2nd decimal place)

(C) If the ideal cell is replaced by a cell having internal resistance of $5\ \Omega$ then the measured value of R will be more than $1000\ \Omega$

(D) The resistance of the voltmeter will be $100\ \text{k}\Omega$

3. [JEE (Advanced) 2016]

In the circuit shown below, the key is pressed at time $t = 0$. Which of the following statement(s) is (are) true?



(A) The voltmeter display $-5\ \text{V}$ as soon as the key is pressed and displays $+5\ \text{V}$ after a long time.

(B) The voltmeter will display $0\ \text{V}$ at time $t = \ln 2$ seconds.

(C) The current in the ammeter becomes $\frac{1}{e}$ of the initial value after 1 second.

(D) The current in the ammeter becomes zero after a long time.

4. [JEE (Advanced) 2016]

An incandescent bulb has a thin filament of tungsten that is heated to high temperature by passing an electric current. The hot filament emits black-body radiation. The filament is observed to break up at random locations after a sufficiently long time of operation due to non-uniform evaporation of tungsten from the filament. If the bulb is powered at constant voltage, which of the following statement(s) is(are) true?

(A) The temperature distribution over the filament is uniform.

(B) The resistance over small sections of the filament decreases with time.

(C) The filament emits more light at higher band of frequencies before it breaks up.

(D) The filament consumes less electrical power towards the end of the life of the bulb.

5. [JEE (Advanced) 2016]

Consider two identical galvanometers and two identical resistors with resistance R. If the internal resistance of the galvanometers $R_C < \frac{R}{2}$, which of the following statement(s) about any one of the galvanometers is(are) true?

(A) The maximum voltage range is obtained when all the components are connected in series.

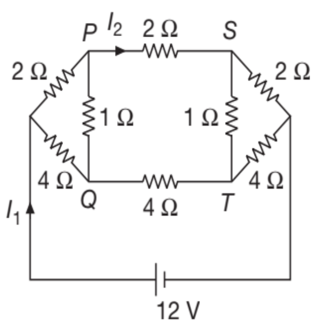
(B) The maximum voltage range is obtained when the two resistors and one galvanometer are connected in series, and the second galvanometer is connected in parallel to the first galvanometer.

(C) The maximum current range is obtained when all the components are connected in parallel.

(D) The maximum current range is obtained when the two galvanometers are connected in series and the combination is connected in parallel with both the resistors.

6. [IIT-JEE 2012]

For the resistance network shown in the figure, choose the **correct** option(s)



(A) The current through PQ is zero

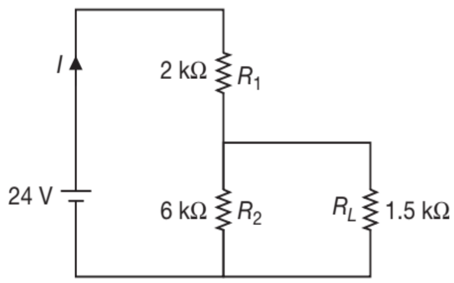
(B) $I_1 = 3$ A

(C) The potential at S is less than that at Q

(D) $I_2 = 2$ A

7. [IIT-JEE 2009]

For the circuit shown in the figure



(A) the current I through the battery is 7.5 mA

(B) the potential difference across R_L is 18 V

(C) ratio of powers dissipated in R_1 and R_2 is 3

(D) if R_1 and R_2 are interchanged, magnitude of the power dissipated in R_L will decrease by a factor of 9

8. [IIT-JEE 1999]

When a potential difference is applied across, the current passing through

(A) an insulator at 0 K is zero

(B) a semiconductor at 0 K is zero

(C) a metal at 0 K is finite

(D) a p-n diode at 300 K is finite, if it is reverse biased

9. [IIT-JEE 1991]

A microammeter has a resistance of $100\ \Omega$ and full scale range of $50\ \mu A$. It can be used as a voltmeter or as a higher range ammeter provided a resistance is added to it. Pick the correct range and resistance combination(s)

(A) 50 V range with $10\ k\Omega$ resistance in series

(B) 10 V range with $200\ k\Omega$ resistance in series

(C) 5 mA range with $1\ \Omega$ resistance in parallel

(D) 10 mA range with $1\ \Omega$ resistance in parallel

10. [IIT-JEE 1989]

Capacitor C_1 of capacitance 1 μF and capacitor C_2 of capacitance 2 μF are separately charged fully by a common battery. The two capacitors are then separated allowed to discharge through equal resistors at time $\tau = 0$

(A) the current in each of the two discharging circuits is zero at $t = 0$

(B) the currents in the two discharging circuits at $t = 0$ are equal but not zero

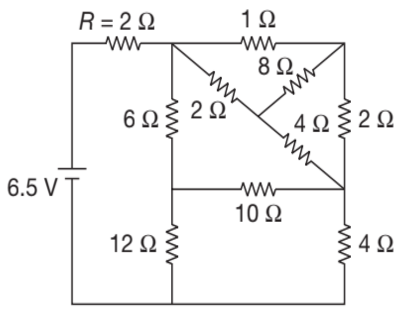
(C) the currents in the two discharging circuits at $t = 0$ are unequal

(D) the capacitors C_1 and C_2 lose their 50% charge in same duration

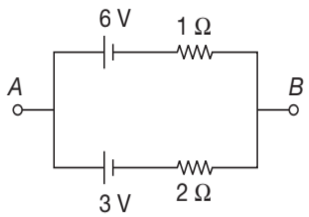
Integer/Numerical Answer Type Questions

In this section, the answer to each question is a numerical value obtained after doing series of calculations based on the data given in the question(s).

1. **[JEE (Advanced) 2015]**
In the following circuit, the current through the resistor $R(=2\ \Omega)$ is I amperes. The value of I is



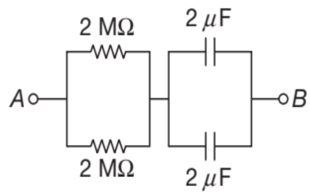
2. **[IIT-JEE 2011]**
Two batteries of different emfs and different internal resistances are connected as shown. The voltage across AB in volt is



3. **[JEE (Advanced) 2014]**
A galvanometer gives full scale deflection with 0.006 A current. By connecting it to a $4990\ \Omega$ resistance, it can be converted into a voltmeter of range $0-30$ V. If connected to a $\dfrac{2n}{249}\ \Omega$ resistance, it becomes an ammeter of range 0-1.5 A. The value of n is

4. **[IIT-JEE 2010]**
When two identical batteries of internal resistance $1\ \Omega$ each are connected in series across a resistor R, the rate of heat produced in R is J_1. When the same batteries are connected in parallel across R, the rate is J_2. If $J_1 = 2.25\, J_2$ then the value of R in Ω is

5. **[IIT-JEE 2010]**
At time $t = 0$, a battery of 10 V is connected across points A and B in the given circuit. If the capacitors have no charge initially, at what time (in second) does the voltage across them become 4 V? [Take: $\ln 5 = 1.6$, $\ln 3 = 1.1$]



Assertion and Reasoning Type Problems

For the following Assertion-Reason type questions given below, choose the correct option:

(A) Both statement I & II are correct and statement II is correct explanation of statement I.
(B) Both statement I & II are correct and statement II is not correct explanation of statement I.
(C) Statement I is true and statement II is false.
(D) Statement II is correct and statement I is false.

1. **[IIT-JEE 2008]**
Statement-1: In a Meter Bridge experiment, null point for an unknown resistance is measured. Now, the unknown resistance is put inside an enclosure maintained at a higher temperature. The null point can be obtained at the same point as before by decreasing the value of the standard resistance
Statement-2: Resistance of a metal increases with increase in temperature.

ANSWER KEYS–TEST YOUR CONCEPTS AND PRACTICE EXERCISES

Test Your Concepts-I (Based on Current Definition)

1. (b) 1.05 mA
2. (a) 17 A
   (b) 85 kAm^{-2}
3. 0.265 C
4. $I(t)=\begin{cases}-v\left(\dfrac{q_1}{a}+\dfrac{q_2}{b}\right), & t<\dfrac{a}{v},\\ -v\dfrac{q_2}{b}, & \dfrac{a}{v}\le t<\dfrac{b}{v},\\ 0, & t\ge\dfrac{b}{v}.\end{cases}$
5. (a) 40 C
   (b) 10 A
6. $en_0e^{\alpha d}$
7. $2\lambda v$

Test Your Concepts-II (Based on Resistance, Resistivity and Ohm's Law)

1. $\sigma A\left|\dfrac{dV}{dx}\right|$
2. $\dfrac{\rho L}{w(y_2-y_1)}\log_e\left(\dfrac{y_2}{y_1}\right)$
3. 4 Ω
4. (a) 0.2%
   (b) 4%
6. (b) $\dfrac{abV_{ab}}{\rho(b-a)r^2}$

Test Your Concepts-III (Based on Variation of Resistance with Temperature)

1. $(2+0.115t)$ Ω
2. $\dfrac{\alpha_0}{1+\alpha_0 T}$
3. $\dfrac{\alpha_1}{1+\alpha_1(T_2-T_1)}$
4. $1+\alpha_0(T_1-T_2)$
5. $\rho_2=\rho_1\left[1+\dfrac{m}{\rho_1}(T_2-T_1)\right]$
6. Percentage change in Length = 0.0017%
   Percentage change in Area = 0.0034%
   Percentage change in Resistance = 0.39%
7. 0.002 $(°C)^{-1}$

Test Your Concepts-IV (Based on Series and Parallel Combination of Resistances)

1. 29.5 V
2. (a) 227 mA
   (b) 5.68 V
3. $R_1=1$ kΩ, $R_2=2$ kΩ, $R_3=3$ kΩ
4. 470 Ω and 220 Ω
5. (i) –75 V
   (ii) –50 V
   (iii) 125 V
   (iv) 175 V
   (v) –25 V and
   (vi) –200 V
6. 22.5 Ω
7. 5 A
8. $\dfrac{8}{5}$ Ω; 15 A
9. $\dfrac{8}{3}$ Ω; 9 A
10. 6 A
11. (a) $\dfrac{42}{31}$ Ω
    (b) 4 Ω
12. $(R_{AD})_{\text{MAX}}=\dfrac{R_d(R_d+2R_b)(R_a+2R_c)}{4R_d(R_a+R_b+R_c)+(R_a+2R_b)(R_a+2R_c)}$
13. 48 V
15. 4 A; 10 A
16. zero

Test Your Concepts-V (Based on Series and Parallel Combination of Resistances)

1. (a) $\frac{1}{2\pi\sigma L}\log_e\left(\frac{b}{a}\right)$

   (b) $\frac{b-a}{2\pi L\sigma_0}$

2. (a) $1\ \Omega$

   (b) $\frac{2R}{n}$

3. (a) $\frac{2R}{5}$

   (b) $\frac{2R}{3}$

4. $\frac{(2+\pi)a\lambda}{8}$

5. 0.833 A

6. (a) $\frac{E}{8R}$

   (b) $\frac{E}{2R}$

7. $\left(\frac{\sqrt{2}}{2\sqrt{2}+1}\right)\lambda a$

8. (a) 2Ω

   (b) $1.5\ A$

9. (a) $\frac{8}{15}r$

   (b) $\frac{3}{5}r$

11. $\frac{3r}{2}$

12. $1\ \Omega$

13. $\frac{7R}{2}$

14. (a) $\frac{5}{6}R$

    (b) $R_{AB'}=\frac{3R}{4}$

    (c) $\frac{7}{12}$ R

15. The new equivalent resistance in the circuit has become 0.6 times.

16. $\frac{25}{6}\ \Omega$

17. $\frac{5R}{4}$

18. $\frac{5}{7}\ \Omega$

19. (a) $\frac{\rho}{2\pi L}\log_e\left(\frac{r_b}{r_a}\right)$

    (b) $\rho=\frac{2\pi L\Delta V}{I\log_e\left(\frac{r_b}{r_a}\right)}$

20. (a) $\frac{2\sqrt{\ell}}{3A\sigma_0}$

    (b) $\frac{3V_0\sqrt{x}}{2\ell^{\frac{3}{2}}}$

21. $R_{AB}=\left(\frac{\sqrt{7}-1}{3}\right)R_0$

22. 1.2 A , 7.2 V

23. zero

Test Your Concepts-VI (Based on Kirchhoff's Laws and Nodal Analysis)

1. 0.283 A, in the dead battery

   171 A, in the starter

2. (a) 909 mA

   (b) −1.82 V

3. 4 V and a is at the higher potential.

4. $\frac{\left(\frac{V_1}{R_1}+\frac{V_2}{R_2}+\frac{V_3}{R_3}\right)}{\left(\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}\right)}$

5. $I_1=\frac{108}{77}$ A, $I_2=\frac{212}{77}$ A and $I_3=\frac{10}{77}$ A

   $\frac{404}{77}$ V, $-\frac{354}{77}$ V

6. Current through $1\ \Omega$ and $5\ \Omega$ is $I_1=2$ A

   Current through $6\ \Omega$ is $I_1-I_2=1.5$ A

   Current through $8\ \Omega$ is $I_2-I_3=0.25$ A

   Current through $4\ \Omega$ is $I_2=0.5$ A and

   Current through $16\ \Omega$ is $I_3=0.25$ A

7. 20 V

8. $\frac{122}{21}\ \Omega$

9. (a) 2 V, 1 A, 0, 1 A

(b) 1 A, 2 A, 1 A, 2 A

10. 0.9 A

11. (a) $\frac{2}{13}$ V

(b) $\frac{21}{13}$ V, $\frac{19}{13}$ V

12. 0.288 mJ

13. 0.2 A, 1.44×10^{-5} J

14. 846 mA, 462 mA, 1.31 A

Test Your Concepts-VII (Based on Emf, Internal Resistance and Combination of Cells)

1. (a) 12.4 V

(b) 9.65 V

3. $(r_1 - r_2)$

4. 110 V, 5 A

7. 10 V and 0.5 Ω

8. $(k-1)^2 : k : (k-1)$

Test Your Concepts-VIII (Based on Galvanometer, Voltmeter and Ammeter)

1. 0.302 Ω

4. 145 Ω, 0.756 mA

5. (a) $\frac{V_{\text{meas}}}{\left(I_{\text{meas}} - \frac{V_{\text{meas}}}{R_v}\right)}$

(b) $R = \frac{V_{\text{meas}}}{I_{\text{meas}}}$

6. (a) $\left(\frac{V_{\text{meas}}}{I_{\text{meas}}} - R_A\right)$

(b) $R \simeq \frac{V_{\text{meas}}}{I_{\text{meas}}}$

7. 0.408 Ω

8. $(n-1)G$

9. $\frac{R_1 n_2 N_1}{n_1 N_2}$

10. $\frac{R_0}{R + R_0}$

11. $\frac{R}{R + R_0}$

12. 204 Ω

13. 2 V

14. Increase

15. 3.2 V, 3.238 V

16. (a) 100 V

(b) 125 V

17. (a) 4 V

(b) 4.2 V, 0.08 A

18. 79.995 Ω

19. $\frac{G^2}{G + S}$

20. 20.16 Ω

21. 4.96 mA, 1.58 V

Test Your Concepts-IX (Based on Heating Effects and Power Consumption)

1. 14.2 W in 2 Ω, 1.33 W in 3 Ω, 4 W in 1 Ω

2. (a) $\frac{2\Delta t}{3}$

(b) $3\Delta t$

3. $\frac{P_s + \sqrt{P_s^2 - 4P_sP_p}}{2I^2}$, $\frac{P_s - \sqrt{P_s^2 - 4P_sP_p}}{2I^2}$

4. (a) $\frac{IR_2}{R_1 + R_2}$, $\frac{IR_1}{R_1 + R_2}$

5. In parallel

6. (a) 4

(b) $\frac{1}{4}$

7. $I_{20} = 9.82$ A

$I_{2000} = 0.91$ A

8. (b) 0.16 mm

10. (a) VI

(b) $P = 2P_c$

11. (a) 20 W

(b) 8 W

(c) 12 W

12. 40 J

13. 13.5 W, 1 W, 2 W

14. 2 Ω, 4.5 W

15. (a) 5 Ω

(b) 5 Ω

16. 2 W, 0.6 W

17. (a) By 4 V battery −222 J

By 12 V battery 1.88 kJ

(b) By 8 Ω resistor 687 J

By 5 Ω resistor 128 J

By 1 Ω resistor 25.6 J

By 3 Ω resistor 616 J

By 1 Ω resistor 205 J

(c) 1.66 kJ from chemical to electrical

1.66 kJ from electrical to internal

Test Your Concepts-X (Based on Wheatstone Bridge and Potentiometer)

1. (a) 1.25 V

(c) no effect

(d) no effect

(e) (i) not work

(ii) not work

2. 1.1 Ω

3. $6.3\times10^{-4}\ \text{K}^{-1}$

4. 1.5 Ω

5. $\frac{16}{3}\ \Omega$

6. (a) no

(c) 8 Ω

7. B

8. $\dfrac{V_0Rx}{RL+R_0x\left(1-\dfrac{x}{L}\right)}$, $V=\dfrac{V_0x}{L}$ for $R\gg R_0$

Test Your Concepts-XI (Based on RC Circuit)

1. (a) $(0.632)I_0\tau$

(b) $(0.99995)I_0\tau$

(c) $I_0\tau$

2. (b) $1.79\times10^{15}\ \Omega$

3. (a) −61.6 mA

(b) 0.235 μC

(c) 1.96 A

4. $\frac{1}{4}U_0$

5. (a) 6 V

(b) 8.29 μs

6. $240\left(1-e^{-\frac{1000t}{6}}\right)\mu\text{C}$, $360\left(1-e^{-\frac{1000t}{6}}\right)\mu\text{C}$

7. 0.693τ

8. 0.693τ

9. 0.34τ

10. (a) $\dfrac{V^2}{R}e^{-\frac{2t}{RC}}$

11. 0.198 μA

12. SITUATION 1: $t=0.693$ s

SITUATION 2: Charged instantaneously

13. $RC\log_e\left(\dfrac{V_0-V_e}{V_0-V_f}\right)$

14. $\begin{bmatrix} 40e^{-4000t} & 0<t<250\ \mu s \\ -286e^{-4000t} & t>250\ \mu s \end{bmatrix}$

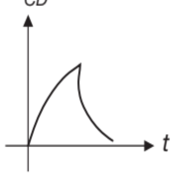
15. 40 mJ

16. (a) $2CE^2$

(b) CE^2

17. $\left(0.03e^{-10^4t}\right)$ A

18. V_{CD}



19. $\dfrac{E}{R}(\eta-1)e^{-\frac{\eta t}{CR}}$

20. 1.5 μA

Single Correct Choice Type Questions

1. D	2. A	3. C	4. B	5. B	6. C	7. A	8. B	9. B	10. C
11. D	12. C	13. D	14. C	15. C	16. C	17. C	18. A	19. C	20. A
21. D	22. A	23. C	24. C	25. D	26. B	27. C	28. C	29. C	30. B
31. C	32. D	33. C	34. B	35. C	36. C	37. C	38. A	39. C	40. D
41. B	42. A	43. C	44. D	45. D	46. D	47. A	48. D	49. C	50. B
51. A	52. C	53. B	54. C	55. A	56. B	57. A	58. B	59. A	60. C
61. D	62. D	63. B	64. C	65. C	66. C	67. D	68. D	69. C	70. A
71. C	72. C	73. B	74. C	75. B	76. D	77. D	78. D	79. B	80. D
81. D	82. C	83. B	84. C	85. C	86. A	87. B	88. D	89. D	90. D
91. B	92. B	93. B	94. A	95. B	96. D	97. A	98. B	99. B	100. A
101. C	102. B	103. A	104. A	105. B	106. C	107. D	108. D	109. C	110. A
111. B	112. A	113. B	114. A	115. C	116. C	117. C	118. C	119. B	120. A
121. B	122. D	123. B	124. D	125. C	126. A	127. B	128. C	129. B	130. D
131. A	132. A	133. C	134. B	135. C	136. D	137. C	138. B	139. C	140. B
141. A	142. D	143. A	144. B	145. B	146. D	147. A	148. C	149. C	150. B
151. B	152. B	153. C	154. C	155. C	156. D	157. D	158. D	159. B	160. D
161. A	162. D	163. C	164. A	165. B	166. C	167. B	168. B	169. A	170. B
171. B	172. B	173. D	174. A	175. C					

Multiple Correct Choice Type Questions

1. A, B	2. B, C	3. A, B, C, D	4. B, D	5. A, C
6. A, B, D	7. A, C	8. A, B, C, D	9. A, C	10. A, C
11. B, D	12. B, C, D	13. A, B, D	14. B, D	15. C, D
16. A, B, C	17. A, B	18. C, D	19. A, C, D	20. B, C
21. A, D	22. A, C	23. B, C, D	24. A, C, D	25. A, B, C
26. A, B, C, D	27. B, C	28. A, B, C, D	29. A, B, C, D	30. A, B, D
31. A, B	32. A, B, C, D	33. A, C	34. A, B	35. A, C
36. A, C, D	37. A, C	38. B, D	39. A, B, D	40. B, C
41. C, D	42. A, C	43. A, C, D	44. A, D	45. A, B
46. B, C	47. B, D	48. B, C	49. A, C	50. A, B
51. B, C	52. A, B, C, D	53. A, D	54. A, B, C, D	55. A, B, D

Reasoning Based Questions

1. B	2. D	3. A	4. D	5. A	6. D	7. B	8. D	9. B	10. D
11. B	12. A	13. D	14. B	15. D	16. D	17. A	18. D	19. B	20. A
21. D	22. C	23. D	24. C	25. A					

Linked Comprehension Type Questions

1. C	2. A	3. B	4. D	5. C	6. C	7. B	8. B	9. C	10. A
11. B	12. C	13. A	14. C	15. B	16. D	17. B	18. D	19. D	20. C

21. C	**22.** B	**23.** C	**24.** B	**25.** C	**26.** A	**27.** B	**28.** C	**29.** C	**30.** B
31. A	**32.** B	**33.** C	**34.** C	**35.** C	**36.** B	**37.** D	**38.** C	**39.** C	

Matrix Match/Column Match Type Questions

1. A → (q)	B → (s)	C → (p)	D → (r)
2. A → (s)	B → (q)	C → (q)	D → (p)
3. A → (q, r, s)	B → (q, s)	C → (p, s)	D → (p, s)
4. A → (q)	B → (s)	C → (q)	D → (s)
5. A → (q)	B → (q)	C → (s)	D → (r)
6. A → (p)	B → (p)	C → (p)	D → (p)
7. A → (q)	B → (r)	C → (t)	D → (p)
8. A → (r)	B → (s)	C → (q)	D → (p)
9. A → (p, q)	B → (p, q)	C → (r, s)	D → (r, s)
10. A → (s)	B → (r)	C → (p)	D → (q)
11. A → (s)	B → (r)	C → (s)	D → (r)
12. A → (s)	B → (q)	C → (r)	D → (p)
13. A → (q)	B → (p)	C → (r)	D → (s)

Integer/Numerical Answer Type Questions

1. 130	**2.** 5560, 4440	**3.** 27	**4.** 2020	**5.** 50
6. 1 in 200 Ω, 4 in 70 Ω, 3 in 80 Ω, 8 in 20 Ω		**7.** 10	**8.** (a) 5 (b) 150 (c) 4	**9.** 1
10. 587	**11.** 6, 3	**12.** (a) 240, 360, 40 (b) 80, 40, 40		**13.** (a) 222 (b) 444
14. (a) 333 (b) 50 (c) 278 (d) 290		**15.** 2885	**16.** 6250, 7500	**17.** 500
18. (a) 45 (b) 10	**19.** 36	**20.** (a) zero (b) 36 (c) 2 (d) 30		**21.** (a) 75 (b) 25
22. 1	**23.** 20	**24.** 2	**25.** 24, 8	**26.** 5
27. 1, 6	**28.** (a) 100 (b) 125	**29.** 160	**30.** 4	**31.** 8
32. 431	**33.** 6	**34.** (a) 12, 9, 3, −6 (b) 12, 11, 9, 6		**35.** 1
36. 6	**37.** 5	**38.** 20	**39.** 95	

ARCHIVE: JEE MAIN

1. B	**2.** D	**3.** B	**4.** D	**5.** B	**6.** A	**7.** D	**8.** B	**9.** A	**10.** A
11. D	**12.** B	**13.** (*)	**14.** A	**15.** D	**16.** D	**17.** A	**18.** A	**19.** A	**20.** A
21. A	**22.** D	**23.** C	**24.** B	**25.** A	**26.** D	**27.** D	**28.** C	**29.** A	**30.** A
31. D	**32.** D	**33.** A	**34.** A	**35.** D	**36.** C	**37.** C	**38.** C	**39.** C	**40.** A
41. A	**42.** C	**43.** D	**44.** D	**45.** C	**46.** A	**47.** B	**48.** C	**49.** B	**50.** A
51. A	**52.** A	**53.** A	**54.** B	**55.** C	**56.** D	**57.** B	**58.** B	**59.** B	**60.** A
61. B	**62.** D	**63.** D	**64.** A	**65.** C	**66.** D	**67.** C	**68.** C	**69.** C	**70.** C
71. C	**72.** D	**73.** C	**74.** B	**75.** B	**76.** A	**77.** A			

(*) None of the options given in exam is correct

ARCHIVE: JEE ADVANCED

Single Correct Choice Type Problems

1. C	**2.** B	**3.** C	**4.** B	**5.** C	**6.** C	**7.** D	**8.** C	**9.** A	**10.** A
11. C	**12.** A	**13.** B	**14.** A	**15.** D	**16.** C	**17.** A	**18.** A	**19.** C	**20.** B
21. A	**22.** A	**23.** A	**24.** A	**25.** D	**26.** C	**27.** B	**28.** C	**29.** A	**30.** D
31. D	**32.** D	**33.** B	**34.** C	**35.** D	**36.** C	**37.** B			

Multiple Correct Choice Type Problems

1. A, C	**2.** A, B	**3.** A, B, C, D	**4.** C, D	**5.** B, C
6. A, B, C, D	**7.** A, D	**8.** A, B, D	**9.** B, C	**10.** B

Integer/Numerical Answer Type Questions

1. 1	**2.** 5	**3.** 5	**4.** 4	**5.** 2

Assertion and Reasoning Type Problems

1. D