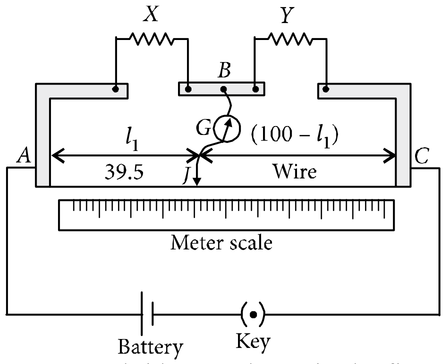
CHAPTER

12 Current Electricity

1. Two batteries with e.m.f. 12 V and 13 V are connected in parallel across a load resistor of 10 Ω. The internal resistances of the two batteries are 1 Ω and 2 Ω 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
(2018)

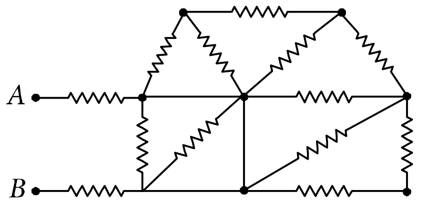
2. On interchanging the resistances, the balance point of a meter bridge shifts to the left by 10 cm. The resistance of their series combinations is 1 kΩ. How much was the resistance on the left slot before the interchange ?
(a) 990 Ω (b) 505 Ω
(c) 550 Ω (d) 910 Ω *(2018)*

3.



In a meter bridge, as shown in the figure, it is given that resistance Y = 12.5 Ω 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 Ω and 60.5 cm (b) 8.16 Ω and 60.5 cm
(c) 8.16 Ω and 39.5 cm (d) 19.15 Ω and 39.5 cm
(Online 2018)

4. In the given circuit all resistances are of value R ohm each. The equivalent resistance between A and B is

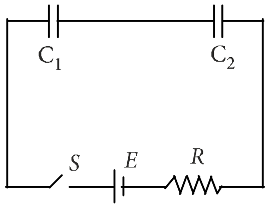


(a) $2R$ (b) $\frac{5R}{2}$ (c) $3R$ (d) $\frac{5R}{3}$
(Online 2018)

5. 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 *(Online 2018)*

6. 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) $\frac{2\rho dA}{IT}$
(Online 2018)

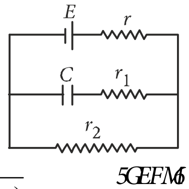
7. In the following circuit, the switch S is closed at t = 0. The charge on the capacitor C_1 as a function of time will be given by $\left(C_{eq} = \frac{C_1C_2}{C_1 + C_2}\right)$



(a) $C_{eq}E$ [1 – exp(–t/RC_{eq})]
(b) C_1E [1–exp(–tR/C_1)]
(c) $C_{eq}E$ exp(–t/RC_{eq})
(d) C_2E [1–exp(–t/RC_2)]
(Online 2018)

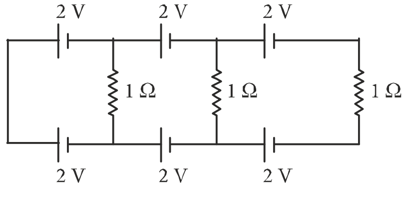
8. A heating element has a resistance of 100 Ω at room temperature. When it is connected to a supply of 220 V, a steady current of 2 A passes in it and temperature is 500°C more than room temperature. What is the temperature coefficient of resistance of the heating element?
(a) 1×10^{-4} °C^{-1} (b) 2×10^{-4} °C^{-1}
(c) 0.5×10^{-4} °C^{-1} (d) 5×10^{-4} °C^{-1}
(Online 2018)

9. 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) $CE\frac{r_1}{(r_1 + r)}$ 5GEFM6

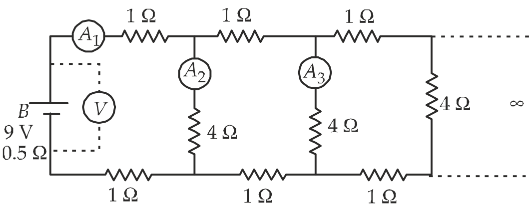
10.



In the above circuit the current in each resistance is
(a) 1 A (b) 0.25 A
(c) 0.5 A (d) 0 A *(2017)*

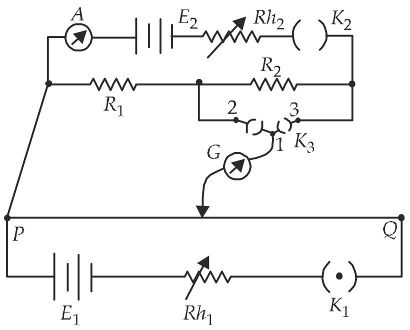
11. Which of the following statement is false ?
(a) Wheatstone bridge is the most sensitive when all the four resistances are of the same order of magnitude.
(b) In a balanced Wheatstone bridge if the cell and the galvanometer are exchanged, the null point is disturbed.
(c) A rheostat can be used as a potential divider.
(d) Kirchhoff's second law represents energy conservation. *(2017)*

12.



A 9 V battery with internal resistance of 0.5 Ω 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
(Online 2017)

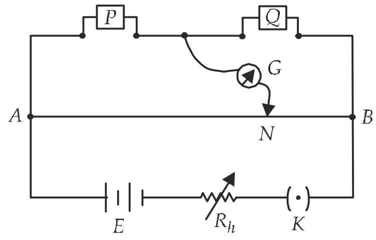
13. A potentiometer PQ is set up to compare two resistances as shown in the figure. The ammeter A in the circuit reads 1.0 A when two way key K_3 is open. The balance point is at a length l_1 cm from P when two way key K_3 is plugged in between 2 and 1, while the balance points is at a length l_2 cm 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) $\frac{l_1}{l_2 - l_1}$

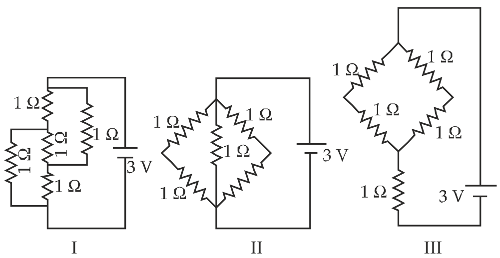
(c) $\frac{l_1}{l_1 + l_2}$ (d) $\frac{l_1}{l_1 - l_2}$
(Online 2017)

14. In a meter bridge experiment resistances are connected as shown in the figure. Initially resistance P = 4 Ω 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) $\frac{20}{3}$ Ω (b) $\frac{33}{5}$ Ω
(c) 6 Ω (d) 7 Ω
(Online 2017)

15. 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

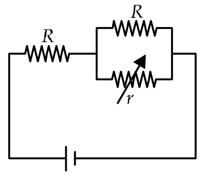


(a) $P_3 > P_2 > P_1$ (b) $P_2 > P_1 > P_3$
(c) $P_1 > P_3 > P_2$ (d) $P_1 > P_2 > P_3$
(Online 2017)

16. A uniform wire of length l and radius r has a resistance of 100 Ω. It is recast into a wire of radius $\frac{r}{2}$. The resistance of new wire will be
(a) 400 Ω (b) 100 Ω
(c) 200 Ω (d) 1600 Ω
(Online 2017)

17. The temperature dependence of resistances of Cu and undoped Si in the temperature range 300-400 K, is best described by :
(a) Linear increase for Cu, linear increase for Si.
(b) Linear increase for Cu, exponential increase for Si.
(c) Linear increase for Cu, exponential decrease for Si.
(d) Linear decrease for Cu, linear decrease for Si.
(2016)

18. 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) $\frac{3}{4}$
(Online 2016)

19. 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 Ω 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 raising the temperature is

(a) $400 \ln\frac{5}{6}$ J (b) $200 \ln\frac{2}{3}$ J

(c) 300 J (d) $400 \ln\frac{1.5}{1.3}$ J

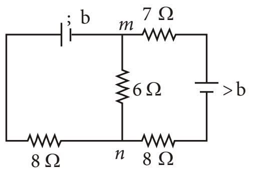
(Online 2016)

20. When 5 V potential difference is applied across a wire of length 0.1 m, the drift speed of electrons is 2.5×10^{-4} m s^{-1}. If the electron density in the wire is 8×10^{28} m^{-3}, the resistivity of the material is close to

(a) $1.6 \times 10^{-6}\ \Omega$ m (b) $1.6 \times 10^{-5}\ \Omega$ m

(c) $1.6 \times 10^{-8}\ \Omega$ m (d) $1.6 \times 10^{-7}\ \Omega$ m *(2015)*

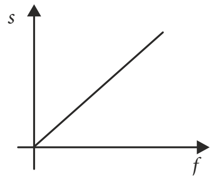
21. In the circuit shown, the current in the 1 Ω resistor is

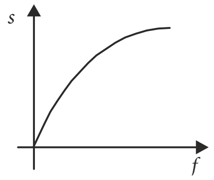


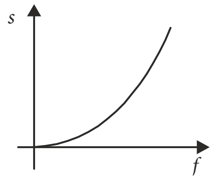
(a) 0.13 A, from Q to P
(b) 0.13 A, from P to Q
(c) 0.3 A, from P to Q
(d) 0 A

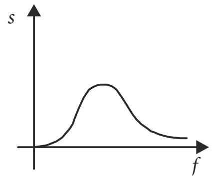
(2015)

22. Suppose the drift velocity v_d in a material varied with the applied electric field E as $V_d \alpha \sqrt{E}$. Then *V-I* graph for a wire made of such a material is best given by

(a) 

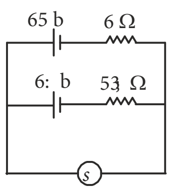
(b) 

(c) 

(d) 

(Online 2015)

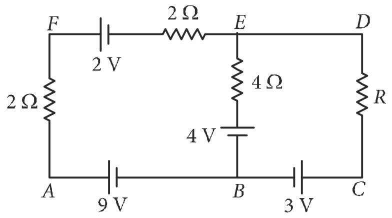
23. A 10 V battery with internal resistance 1 Ω and a 15 V battery with internal resistance 0.6 Ω are connected in parallel to a voltmeter (see figure). The reading in the voltmeter will be close to



(a) 11.9 V
(b) 12.5 V
(c) 13.1 V
(d) 24.5 V

(Online 2015)

24. In the electric network shown, when no current flows through the 4 Ω 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

(Online 2015)

25. 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) 14 A (b) 8 A (c) 10 A (d) 12 A

(2014)

26. The supply voltage to a room is 120 V. The resistance of the lead wires is 6 Ω. 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) 10.04 Volt (b) zero Volt

(c) 2.9 Volt (d) 13.3 Volt *(2013)*

27. 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 *(2012)*

28. 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% *(2011)*

29. 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) $\alpha_1 + \alpha_2, \frac{\alpha_1 \alpha_2}{\alpha_1 + \alpha_2}$ *(2010)*

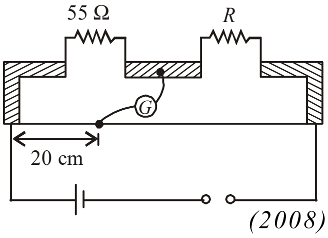
30. This question contains Statement-1 and Statement-2. Of the four choices given after the statements, choose the one that best describes the two statements.

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 $\alpha = 2.5 \times 10^{-3}$/°C

Statement-2: $R = R_0(1 + \alpha\Delta t)$ is valid only when the change in the temperature ΔT is small and $\Delta R = (R - R_0) << R_0$.

(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. *(2009)*

31. Shown in the figure below is a meter-bridge set up with null deflection in the galvanometer. The value of the unknown resistance R is



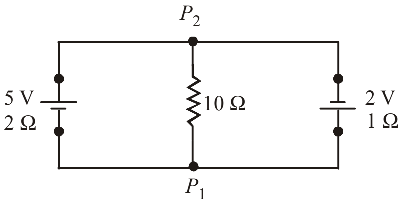
(a) 55 Ω

(b) 13.75 Ω

(c) 220 Ω

(d) 110 Ω *(2008)*

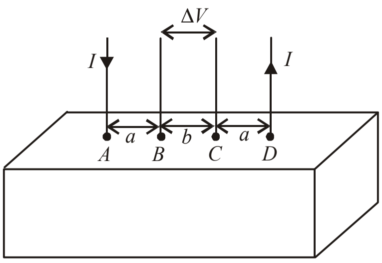
32. A 5 V battery with internal resistance 2 Ω and 2 V battery with internal resistance 1 Ω are connected to a 10 Ω resistor as shown in the figure. The current in the 10 Ω resistor is



(a) 0.27 A P_1 to P_2 (b) 0.27 A P_2 to P_1
(c) 0.03 A P_1 to P_2 (d) 0.03 A P_2 to P_1 *(2008)*

Directions : Questions 33 and 34 are based on the following paragraph.

Consider a block of conducting material of resistivity ρ shown in the figure. Current I enters at A and leaves from D. We apply superposition principle to find voltage ΔV developed between B and C. The calculation is done in the following steps:



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

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

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

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

33. ΔV measured between B and C is

(a) $\dfrac{\rho I}{2\pi(a-b)}$ (b) $\dfrac{\rho I}{\pi a} - \dfrac{\rho I}{\pi(a+b)}$

(c) $\dfrac{\rho I}{a} - \dfrac{\rho I}{(a+b)}$ (d) $\dfrac{\rho I}{2\pi a} - \dfrac{\rho I}{2\pi(a+b)}$

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

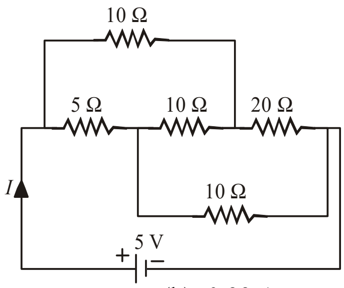
(a) $\dfrac{\rho I}{4\pi r^2}$ (b) $\dfrac{\rho I}{8\pi r^2}$ (c) $\dfrac{\rho I}{r^2}$ (d) $\dfrac{\rho I}{2\pi r^2}$ *(2008)*

35. The resistance of a wire is 5 ohm at 50°C and 6 ohm at 100°C. The resistance of the wire at 0°C will be
(a) 3 ohm (b) 2 ohm
(c) 1 ohm (d) 4 ohm *(2007)*

36. A material B has twice the specific resistance of A. A circular wire made of B has twice the diameter of a wire made of A. Then for the two wires to have the same resistance, the ratio l_B/l_A of their respective lengths must be
(a) 2 (b) 1 (c) 1/2 (d) 1/4 *(2006)*

37. The resistance of a bulb filament is 100 Ω at a temperature of 100ºC. If its temperature coefficient of resistance be 0.005 per ºC, its resistance will become 200 Ω at a temperature of
(a) 200ºC (b) 300ºC (c) 400ºC (d) 500ºC *(2006)*

38. The current I drawn from the 5 volt source will be



(a) 0.17 A (b) 0.33 A
(c) 0.5 A (d) 0.67 A *(2006)*

39. In a Wheatstone's bridge, three resistance P, Q and R connected in the three arms and the fourth arm is formed by two resistance S_1 and S_2 connected in parallel. The condition for bridge to be balanced will be

(a) $\dfrac{P}{Q} = \dfrac{R}{S_1+S_2}$ (b) $\dfrac{P}{Q} = \dfrac{2R}{S_1+S_2}$

(c) $\dfrac{P}{Q} = \dfrac{R(S_1+S_2)}{S_1S_2}$ (d) $\dfrac{P}{Q} = \dfrac{R(S_1+S_2)}{2S_1S_2}$ *(2006)*

40. The Kirchhoff's first law $(\sum i = 0)$ and second law $(\sum iR = \sum E)$, where the symbols have their usual meanings, are respectively based on
(a) conservation of charge, conservation of energy
(b) conservation of charge, conservation of momentum
(c) conservation of energy, conservation of charge
(d) conservation of momentum, conservation of charge. *(2006)*

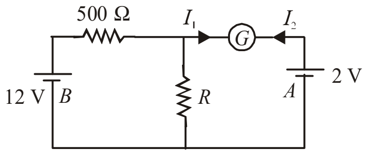
41. An electric bulb is rated 220 volt - 100 watt. The power consumed by it when operated on 110 volt will be
(a) 50 watt (b) 75 watt
(c) 40 watt (d) 25 watt *(2006)*

42. A thermocouple is made from two metals, antimony and bismuth. If one junction of the couple is kept hot and the other is kept cold then, an electric current will
(a) flow from antimony to bismuth at the cold junction
(b) flow from antimony to bismuth at the hot junction
(c) flow from bismuth to antimony at the cold junction
(d) not flow through the thermocouple. *(2006)*

43. In a potentiometer experiment the balancing point with a cell is at length 240 cm. On shunting the cell with a resistance of 2 Ω, the balancing length becomes 120 cm. The internal resistance of the cell is
(a) 4 Ω (b) 2 Ω
(c) 1 Ω (d) 0.5 Ω *(2005)*

44. Two sources of equal emf are connected to an external resistance R. The internal resistances of the two sources are R_1 and R_2 ($R_2 > R_1$). If the potential difference across the source having internal resistance R_2 is zero, then
(a) $R = \frac{R_1R_2}{R_1 + R_2}$ (b) $R = \frac{R_1R_2}{R_2 - R_1}$
(c) $R = R_2\frac{(R_1 + R_2)}{(R_2 - R_1)}$ (d) $R = R_2 - R_1$ *(2005)*

45. In the circuit, the galvanometer G shows zero deflection. If the batteries A and B have negligible internal resistance, the value of the resistor R will be



(a) 500 Ω (b) 1000 Ω
(c) 200 Ω (d) 100 Ω *(2005)*

46. An energy source will supply a constant current into the load if its internal resistance is
(a) zero
(b) non-zero but less than the resistance of the load
(c) equal to the resistance of the load
(d) very large as compared to the load resistance. *(2005)*

47. The resistance of hot tungsten filament is about 10 times the cold resistance. What will be the resistance of 100 W and 200 V lamp when not in use?
(a) 400 Ω (b) 200 Ω
(c) 40 Ω (d) 20 Ω *(2005)*

48. Two voltameters, one of copper and another of silver, are joined in parallel. When a total charge q flows through the voltmeters, equal amount of metals are deposited. If the electrochemical equivalents of copper and silver are z_1 and z_2 respectively the charge which flows through the silver voltammeter is
(a) $q\frac{z_1}{z_2}$ (b) $q\frac{z_2}{z_1}$
(c) $\frac{q}{1+\frac{z_1}{z_2}}$ (d) $\frac{q}{1+\frac{z_2}{z_1}}$ *(2005)*

49. A heater coil is cut into two equal parts and only one part is now used in the heater. The heat generated will now be
(a) one fourth (b) halved
(c) doubled (d) four times *(2005)*

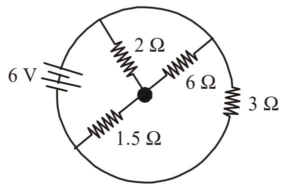
50. The thermistors are usually made of
(a) metals with low temperature coefficient of resistivity
(b) metals with high temperature coefficient of resistivity
(c) metal oxides with high temperature coefficient of resistivity
(d) semiconducting materials having low temperature coefficient of resistivity. *(2004)*

51. In a metre bridge experiment null point is obtained at 20 cm from one end of the wire when resistance X is balanced against another resistance Y. If $X < Y$, then where will be the new position of the null point from the same end, if one decides to balance a resistance of $4X$ against Y?
(a) 50 cm (b) 80 cm (c) 40 cm (d) 70 cm *(2004)*

52. An electric current is passed through a circuit containing two wires of the same material, connected in parallel. If the lengths and radii of the wires are in the ratio of 4/3 and 2/3, then the ratio of the currents passing through the wire will be
(a) 3 (b) 1/3 (c) 8/9 (d) 2 *(2004)*

53. The resistance of the series combination of two resistances is S. When they are joined in parallel the total resistance is P. If $S = nP$, then the minimum possible value of n is
(a) 4 (b) 3 (c) 2 (d) 1 *(2004)*

54. The total current supplied to the circuit by the battery is
(a) 1 A
(b) 2 A
(c) 4 A
(d) 6 A



(2004)

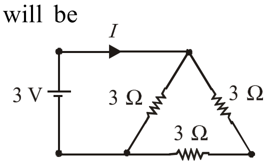
55. The electrochemical equivalent of a metal is 3.3×10^{-7} kg per coulomb. The mass of the metal liberated at the cathode when a 3 A current is passed for 2 second will be
(a) 19.8×10^{-7} kg (b) 9.9×10^{-7} kg
(c) 6.6×10^{-7} kg (d) 1.1×10^{-7} kg *(2004)*

56. The thermo emf of a thermocouple varies with the temperature θ of the hot junction as $E = a\theta + b\theta^2$ in volt where the ratio a/b is 700°C. If the cold junction is kept at 0°C, then the neutral temperature is
(a) 700°C (b) 350°C
(c) 1400°C
(d) no neutral temperature is possible for this thermocouple. *(2004)*

57. Time taken by a 836 W heater to heat one litre of water from 10°C to 40°C is
(a) 50 s (b) 100 s (c) 150 s (d) 200 s *(2004)*

58. The length of a given cylindrical wire is increased by 100%. Due to the consequent decrease in diameter the change in the resistance of the wire will be
(a) 200% (b) 100%
(c) 50% (d) 300% *(2003)*

59. A 3 volt battery with negligible internal resistance is connected in a circuit as shown in the figure. The current I, in the circuit will be



(a) 1 A
(b) 1.5 A
(c) 2 A
(d) (1/3) A *(2003)*

60. The length of a wire of a potentiometer is 100 cm, and the e.m.f. of its standard cell is E volt. It is employed to measure the e.m.f. of a battery whose internal resistance is 0.5 Ω. If the balance point is obtained at l = 30 cm from the positive end, the e.m.f. of the battery is

(a) $\frac{30E}{100.5}$ (b) $\frac{30E}{100-0.5}$

(c) $\frac{30E}{100}-0.5i$, where i is the current in the potentiometer wire.

(d) $\frac{30E}{100}$. *(2003)*

61. A 220 volt, 1000 watt bulb is connected across a 110 volt mains supply. The power consumed will be
(a) 750 watt (b) 500 watt
(c) 250 watt (d) 1000 watt. *(2003)*

62. The negative Zn pole of a Daniell cell, sending a constant current through a circuit, decreases in mass by 0.13 g in 30 minutes. If the electrochemical equivalent of Zn and Cu are 32.5 and 31.5 respectively, the increase in the mass of the positive Cu pole in this time is
(a) 0.180 g (b) 0.141 g
(c) 0.126 g (d) 0.242 g *(2003)*

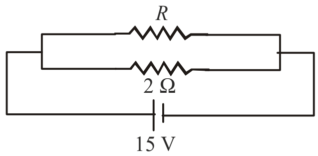
63. The thermo e.m.f. of a thermo-couple is 25 μV/°C at room temperature. A galvanometer of 40 ohm resistance, capable of detecting current as low as 10^{-5} A, is connected with the thermocouple. The smallest temperature difference that can be detected by this system is
(a) 16°C (b) 12°C (c) 8°C (d) 20°C *(2003)*

64. The mass of a product liberated on anode in an electrochemical cell depends on
(a) $(It)^{1/2}$ (b) It (c) I/t (d) I^2t
(where t is the time period for which the current is passed). *(2002)*

65. If θ_i is the inversion temperature, θ_n is the neutral temperature, θ_c is the temperature of the cold junction, then
(a) $\theta_i + \theta_c = \theta_n$ (b) $\theta_i - \theta_c = 2\theta_n$
(c) $\frac{\theta_i + \theta_c}{2} = \theta_n$ (d) $\theta_c - \theta_i = 2\theta_n$ *(2002)*

66. A wire when connected to 220 V mains supply has power dissipation P_1. Now the wire is cut into two equal pieces which are connected in parallel to the same supply. Power dissipation in this case is P_2. Then $P_2 : P_1$ is
(a) 1 (b) 4 (c) 2 (d) 3 *(2002)*

67. If in the circuit, power dissipation is 150 W, then R is



(a) 2 Ω (b) 6 Ω (c) 5 Ω (d) 4 Ω *(2002)*

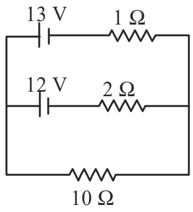
ANSWER KEY

1. (b)	**2.** (c)	**3.** (b)	**4.** (a)	**5.** (a)	**6.** (a)	**7.** (a)	**8.** (b)	**9.** (c)	**10.** (d)	**11.** (b)	**12.** (b)
13. (b)	**14.** (a)	**15.** (b)	**16.** (d)	**17.** (c)	**18.** (a)	**19.** (*)	**20.** (b)	**21.** (a)	**22.** (c)	**23.** (c)	**24.** (c)
25. (d)	**26.** (a)	**27.** (b)	**28.** (b)	**29.** (a)	**30.** (a)	**31.** (c)	**32.** (d)	**33.** (d)	**34.** (d)	**35.** (d)	**36.** (a)
37. (c)	**38.** (c)	**39.** (c)	**40.** (a)	**41.** (d)	**42.** (a)	**43.** (b)	**44.** (d)	**45.** (d)	**46.** (a)	**47.** (c)	**48.** (d)
49. (c)	**50.** (c)	**51.** (a)	**52.** (b)	**53.** (a)	**54.** (c)	**55.** (a)	**56.** (d)	**57.** (c)	**58.** (d)	**59.** (b)	**60.** (c)
61. (c)	**62.** (c)	**63.** (a)	**64.** (b)	**65.** (c)	**66.** (b)	**67.** (b)					

Explanations

1. **(b)** : Equivalent e.m.f. of parallel batteries

$$\varepsilon = \frac{\frac{\varepsilon_1}{r_1}+\frac{\varepsilon_2}{r_2}}{\frac{1}{r_1}+\frac{1}{r_2}} = \frac{\frac{12}{1}+\frac{13}{2}}{\frac{1}{1}+\frac{1}{2}} = \frac{37}{3}\text{ V}$$

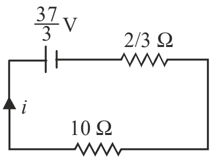


Equivalent resistance of parallel batteries,

$$r_{eq} = \frac{2\times 1}{2+1} = \frac{2}{3}\Omega$$

Now, its equivalent circuit is as drawn.

Current in the circuit, $i = \frac{37/3}{10+(2/3)} = \frac{37}{32}$



Voltage across the load,

$$V_{10\Omega} = i\times 10 = \frac{37}{32}\times 10 = \frac{370}{32} = 11.56\text{ V}$$

2. **(c)** : Let R_1 (left slot) and R_2 (right slot) be two resistances in two slots of a meter bridge.

Initially l be the balancing length

Then, $\frac{R_1}{R_2} = \frac{l}{(100-l)}$ ...(i) $\quad R_1 + R_2 = 1000\ \Omega$ ...(ii)

On interchanging the resistances, balancing length becomes $(l - 10)$, so

$$\frac{R_2}{R_1} = \frac{l-10}{110-l} \quad \text{or} \quad \frac{100-l}{l} = \frac{l-10}{110-l} \qquad \text{(Using eqn (i))}$$

$11000 + l^2 - 210l = l^2 - 10l$

$200\, l = 11000;\ l = 55$ cm

From eqn (i), $\frac{R_1}{R_2} = \frac{55}{45}$ or $R_1 = \frac{55}{45}R_2$

$$R_1 = \frac{55}{45}(1000 - R_1) \qquad \text{(Using eqn (ii))}$$

$$R_1 + \frac{55}{45}R_1 = 1000\times\frac{55}{45} \text{ or } 100\,R_1 = 1000\times 55;\ \therefore R_1 = 550\ \Omega$$

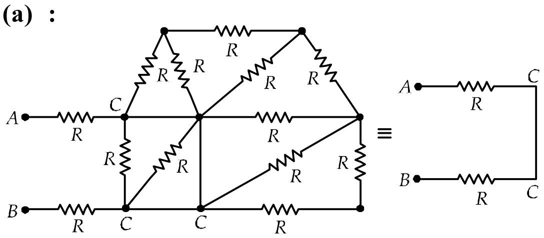
3. **(b)** : For a balanced meter bridge

$Y \times 39.5 = X \times (100 - 39.5)$

$$X = \frac{12.5\times 39.5}{60.5} = 8.16\ \Omega$$

When X and Y are interchanged so l_1 and $(100 - l_1)$ will also interchange; and so $l_2 = 60.5$ cm.

4. **(a)** :



$R_{AB} = R + R = 2R$

5. **(a)** : Rate of heat developed, $P = \frac{V^2}{R}$

For given V, $P \propto \frac{1}{R} = \frac{A}{\rho l} = \frac{\pi r^2}{\rho l}$

Now, $\frac{P_1}{P_2} = \left(\frac{r_1^2}{r_2^2}\right)\left(\frac{l_2}{l_1}\right)$

As per question, $l_2 = l_1/2$ and $r_2 = 2r_1$

$\therefore\ \frac{P_1}{P_2} = \frac{1}{4}\times\frac{1}{2} = \frac{1}{8};\ P_2 = 8P_1$

6. **(a)** : Current flowing through copper rod is given by

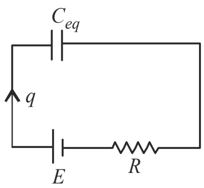
$I = neAv_d = \rho A v_d \qquad (\because\ \rho = ne)$

$v_d = \frac{I}{\rho A}$

Time taken by charges to travel distanced d,

$t = \frac{d}{v_d} = \frac{d}{(I/\rho A)} = \frac{\rho A d}{I}$

7. **(a)** : Equivalent circuit is shown in figure. Charging of capacitor is given by



$q = C_{eq}E\left[1 - e^{-t/RC_{eq}}\right]$

Both capacitors will have same charge as they are connected in series.

8. **(b)** : Resistance after temperature increases by 500°C,

$$R_T = \frac{\text{Voltage applied}}{\text{Current}} = \frac{220}{2} = 110\ \Omega$$

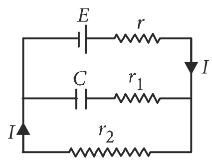
Also, $R_T = R_0\,(1 + \alpha\,\Delta T)$

$110 = 100\,(1 + \alpha\times 500)$

$$\alpha = \frac{10}{100\times 500} = 2\times 10^{-4}\,{}^\circ\text{C}^{-1}$$

9. **(c)** : In the steady state current in the capacitor becomes zero. Therefore, current in the circuit can be shown as below.

Current in the circuit, $I = \frac{E}{r + r_2}$



Charge on the capacitor will be

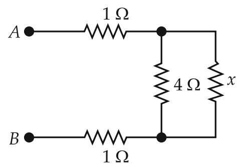
$Q = CV$ or $Q = (Ir_2)C$

or $Q = \frac{Er_2}{r+r_2}C$ or $Q = CE\frac{r_2}{r+r_2}$

10. **(d)** : The potential difference across each loop is zero. Therefore no current will flow in the circuit.

11. **(b)** : In a balanced Wheatstone bridge if the cell and the galvanometer are interchanged the null point remains unchanged.

12. **(b)** : Let equivalent resistance of the infinite network be x. Equivalent resistance between points A and B,



$x = \frac{4x}{4+x} + 2$ or $x^2 - 2x - 8 = 0$

$x = \frac{2 \pm \sqrt{4 - 4(1)(-8)}}{2} = \frac{2 \pm \sqrt{36}}{2}$

$= \frac{2 \pm 6}{2} = 4\,\Omega$

(Since negative value is not accepted)

$I_1 = \frac{9}{4 + 0.5} = 2$ A $\Rightarrow$ Reading of A_1 is 2 A.

13. (b) : When key is plugged between 2 and 1,
$V_1 = iR_1 = Xl_1$ ...(i)
When key is plugged between 3 and 1,
$V_2 = i(R_1 + R_2) = Xl_2$ ...(ii)
On dividing eqn. (ii) by eqn. (i)

$$\frac{R_1}{R_1 + R_2} = \frac{l_1}{l_2} \Rightarrow \frac{R_1}{R_2} = \frac{l_1}{l_2 - l_1}$$

14. (a) : For $P = 4\ \Omega$, $l_1 = 60$ cm $\therefore \frac{P}{Q} = \frac{l_1}{100 - l_1} = \frac{60}{40} = \frac{3}{2}$

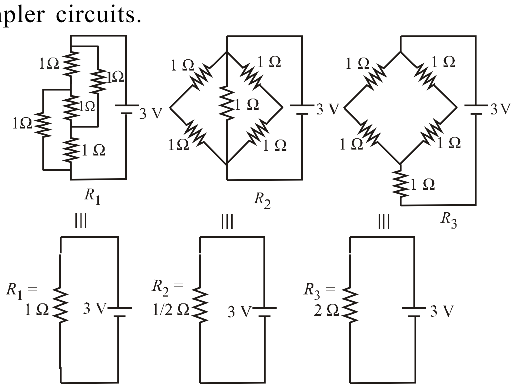
$Q = \frac{2}{3}P = \frac{8}{3}\Omega$

Now, $P' = P + R$, $l'_1 = 80$ cm

$\frac{P'}{Q} = \frac{l'_1}{100 - l'_1} = \frac{80}{20} = 4$

$\frac{P+R}{Q} = 4 \Rightarrow \frac{4+R}{\frac{8}{3}} = 4$; $4 + R = \frac{32}{3}$ $\therefore$ $R = \frac{32}{3} - 4 = \frac{20}{3}\Omega$

15. (b) : The given three circuits are equivalent to the following three simpler circuits.



$P_1 = \frac{3^2}{1} = 9$ W, $P_2 = \frac{3^2}{1/2} = 18$ W, $P_3 = \frac{3^2}{2} = 4.5$ W

Hence, clearly, $P_2 > P_1 > P_3$

16. (d) : Resistance of a wire of length l and radius r is given by

$$R = \frac{\rho l}{A} = \frac{\rho l}{A} \times \frac{A}{A} = \frac{\rho V}{A^2} = \frac{\rho V}{\pi^2 r^4} \qquad (\because V = Al)$$

i.e., $R \propto \frac{1}{r^4}$ $\therefore$ $\frac{R_1}{R_2} = \left(\frac{r_2}{r_1}\right)^4$

Here, $R_1 = 100\ \Omega$, $r_1 = r$, $r_2 = \frac{r}{2}$, $R_2 = ?$

$\therefore$ $R_2 = R_1\left(\frac{r_1}{r_2}\right)^4 = 16R_1 = 1600\ \Omega$

17. (c) : Resistivity of Cu increases linearly with increase in temperature because relaxation time decreases.
Resistivity of semiconductor decreases exponentially with increase in temperature, as $\rho_q = \rho$ -b 4 xq.

18. (a) : Let the source voltage be V.
Equivalent resistance of the circuit when $r = fR$,

$R_{eq} = R + \frac{r \times R}{r + R} = R + \frac{fR}{f+1} = \frac{(2f+1)R}{(f+1)}$

$\therefore$ Current in the circuit, $I = \frac{V}{R_{eq}} = \frac{V(f+1)}{R(2f+1)}$

Current in the resistance $r(= fR)$

$I_2 = \frac{I}{f+1} = \frac{V}{R(2f+1)}$

Now, heat generated per unit time in r

$H = I_2^2 r = \frac{V^2 f}{R(2f+1)^2}$

For maximum H, $\frac{dH}{df} = 0 \Rightarrow \frac{V^2}{R}\left[\frac{1}{(2f+1)^2} - \frac{4f}{(2f+1)^3}\right] = 0$

or $2f + 1 - 4f = 0 \Rightarrow f = \frac{1}{2}$

19. (*) : Here, $R(T) = R_0[1 + \alpha(T - T_0)]$
At $T_0 = 300$ K, $R_0 = 100\ \Omega$
$T = 500$ K, $R = 120\ \Omega$ $\therefore$ $120 = 100(1 + \alpha(200))$

$\Rightarrow 200\alpha = \frac{6}{5} - 1 = \frac{1}{5} \Rightarrow \alpha = 10^{-3}\ °C^{-1}$

Temperature of the toaster is raised at constant rate from 300 K to 500 K is 30 s.

So, increment in the temperature in time $t = \frac{(500 - 300)}{30}t$

$\Delta T = \frac{20}{3}t$

Total work done in raising the temperature

$= \int_0^t \frac{V^2}{R(t)}dt = \int_0^t \frac{V^2}{R_0(1 + \alpha\Delta T)}dt$

$= \int_0^{30} \frac{(200)^2}{100\left(1 + 10^{-3} \times \frac{20}{3}t\right)}dt = 400\int_0^{30} \frac{dt}{\left(1 + \frac{1}{150}t\right)}$

$= 400 \times 150\left[\ln\left(1 + \frac{t}{150}\right)\right]_0^{30}$

$= 60000\left[\ln\left(1 + \frac{30}{150}\right) - \ln 1\right] = 60000 \ln\left(\frac{6}{5}\right)$ J

* (None of the given options is correct)

20. (b) : $V = IR$

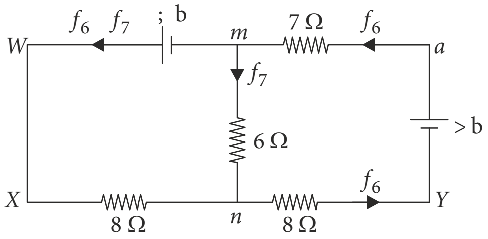
As $I = neAv_d$ and $o = \frac{\rho}{W}$ $\therefore$ $s = W \times \frac{\rho}{W}$ {~ $\rho = \frac{s}{\ }$

Here, $V = 5$ V, $n = 8 \times 10^{28}$ m^{-3}, $v_d = 2.5 \times 10^{-4}$ m s^{-1}, $l = 0.1$ m, $e = 1.6 \times 10^{-19}$ C

$\therefore$ $\rho = \frac{:}{= \times 65^{7=} \times 63 \times 65^{-6>} \times 73 \times 65^{-9} \times 536}$

$= 0.156 \times 10^{-4}\ \Omega$ m $\simeq 1.6 \times 10^{-5}\ \Omega$ m

21. (a) :



Applying KVL in loop *PQCDP*

$-1I_2 - 3I_1 + 9 - 2I_1 = 0 \Rightarrow 5I_1 + I_2 = 9$ ...(i)

Applying KVL in loop *PQBAP*

$-1I_2 + 3(I_1 - I_2) - 6 = 0 \Rightarrow 3I_1 - 4I_2 = 6$ ...(ii)

Solving eqns. (i) and (ii), we get $I_1 = 1.83$ A, $I_2 = -0.13$ A

∴ The current in the 1 Ω resistor is 0.13 A, from Q to P.

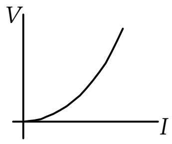
22. (c) : Given, $v_d \propto \sqrt{b}$

We know,

$I = neAv_d$

and $E = \frac{s}{}$ or, $E \propto V$

so $I \propto \sqrt{s}$; $I^2 \propto V$



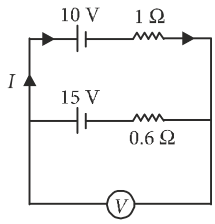
23. (c) : Current in the circuit, $f = \frac{:}{63}$

$= \frac{:5}{6;} = \frac{7:}{=}$ H

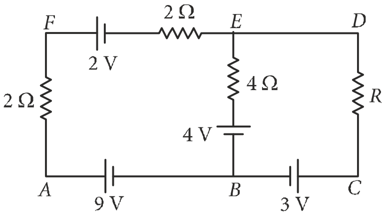
Reading of the voltmeter

$s = 6: - \frac{7:}{=} \times 53$

$= 6: - \frac{6:}{=} = 683 6$ b



24. (c) :



Current in 4 Ω is zero.

Applying KVL in loop *EBCDE*,

$V_{EB} + V_{BC} + V_{CD} + V_{DE} = 0$

$-4 + 3 + V_{CD} + 0 = 0$

$V_{CD} = 1$ volt

∴ $V_A - V_D = 9 - 3 - 1 = 5$ V

25. (d) : Power of 15 bulbs of 40 W = 15 × 40 = 600 W

Power of 5 bulbs of 100 W = 5 × 100 = 500 W

Power of 5 fan of 80 W = 5 × 80 = 400 W

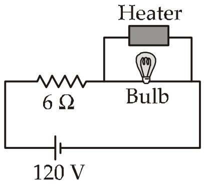
Power of 1 heater of 1 kW = 1000 W

∴ Total power, $P = 600 + 500 + 400 + 1000 = 2500$ W

When these combination of bulbs, fans and heater are connected to 220 V mains, current in the main fuse of building is given by

$$I = \frac{P}{V} = \frac{2500}{220} = 11.36 \text{ A} \approx 12 \text{ A}$$

26. (a) : As $P = \frac{V^2}{R}$



Here, the supply voltage is taken as rated voltage.

∴ Resistance of bulb

$$R_B = \frac{120 \text{ V} \times 120 \text{ V}}{60 \text{ W}} = 240\ \Omega$$

Resistance of heater, $R_H = \frac{120 \text{ V} \times 120 \text{ V}}{240 \text{ W}} = 60\ \Omega$

Voltage across bulb before heater is switched on,

$$V_1 = \frac{120 \text{ V} \times 240\ \Omega}{240\ \Omega + 6\ \Omega} = 117.07 \text{ V}$$

As bulb and heater are connected in parallel. Their equivalent resistance is

$$R_{eq} = \frac{(240\ \Omega)(60\ \Omega)}{240\ \Omega + 60\ \Omega} = 48\ \Omega$$

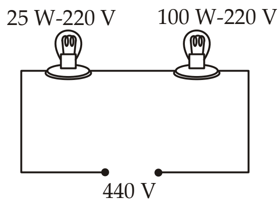
∴ Voltage across bulb after heater is switched on

$$V_2 = \frac{120 \text{ V} \times 48\ \Omega}{48\ \Omega + 6\ \Omega} = 106.66 \text{ V}$$

Decrease in the voltage across the bulb is

$\Delta V = V_1 - V_2 = 10.41$ V $\simeq$ 10.04 V

27. (b) :



As $R = \frac{(\text{Rated voltage})^2}{\text{Rated power}}$

∴ Resistance of 25 W-220 V bulb is $R_1 = \frac{(220)^2}{25}\ \Omega$

Resistance of 100 W-220 V bulb is $R_2 = \frac{(220)^2}{100}\ \Omega$

When these two bulbs are connected in series, the total resistance is

$$R_s = R_1 + R_2 = (220)^2\left[\frac{1}{25} + \frac{1}{100}\right] = \frac{(220)^2}{20}\ \Omega$$

$$\text{Current, } I = \frac{440}{(220)^2/20} = \frac{2}{11} \text{ A}$$

Potential difference across 25 W bulb $= IR_1 = \frac{2}{11} \times \frac{(220)^2}{25} = 352$ V

Potential difference across 100 W bulb $= IR_2 = \frac{2}{11} \times \frac{(220)^2}{100} = 88$ V

Thus the bulb 25 W will be fused, because it can tolerate only 220 V while the voltage across it is 352 V.

28. (b) : Resistance of wire $R = \frac{\rho l}{A}$ ...(i)

On stretching, volume (V) remains constant.

So $V = Al$ or $A = \frac{V}{l}$ ∴ $R = \frac{\rho l^2}{V}$ (Using (i))

Taking logarithm on both sides and differentiating we get,

$$\frac{\Delta R}{R} = \frac{2\Delta l}{l} \qquad (\because V \text{ and } \rho \text{ are constants})$$

or $\frac{\Delta R}{R}\% = \frac{2\Delta l}{l}\%$

Hence, when wire is stretched by 0.1% its resistance will increase by 0.2%.

29. (a) : Let R_0 be the resistance of both conductors at 0°C. Let R_1 and R_2 be their resistance at t°C. Then

$R_1 = R_0(1 + \alpha_1 t)$

$R_2 = R_0(1 + \alpha_2 t)$

Let R_s is the resistance of the series combination of two conductors at t°C. Then

$R_s = R_1 + R_2$

$R_{s_0}(1 + \alpha_s t) = R_0(1 + \alpha_1 t) + R_0(1 + \alpha_2 t)$

where, $R_{s_0} = R_0 + R_0 = 2R_0$

$\therefore \quad 2R_0(1 + \alpha_s t) = 2R_0 + R_0 t(\alpha_1 + \alpha_2)$

$2R_0 + 2R_0\alpha_s t = 2R_0 + R_0 t(\alpha_1 + \alpha_2) \;\therefore\; \alpha_s = \frac{\alpha_1 + \alpha_2}{2}$

Let R_p is the resistance of the parallel combination of two conductors at t°C. Then $R_p = \frac{R_1 R_2}{R_1 + R_2}$

$$R_{p_0}(1 + \alpha_p t) = \frac{R_0(1 + \alpha_1 t)\, R_0(1 + \alpha_2 t)}{R_0(1 + \alpha_1 t) + R_0(1 + \alpha_2 t)}$$

where, $R_{p_0} = \frac{R_0 R_0}{R_0 + R_0} = \frac{R_0}{2}$

$$\therefore \quad \frac{R_0}{2}(1 + \alpha_p t) = \frac{R_0^2(1 + \alpha_1 t)(1 + \alpha_2 t)}{2R_0 + R_0(\alpha_1 + \alpha_2)t}$$

$$\frac{R_0}{2}(1 + \alpha_p t) = \frac{R_0^2(1 + \alpha_1 t + \alpha_2 t + \alpha_1\alpha_2 t^2)}{R_0(2 + (\alpha_1 + \alpha_2)t)}$$

$$\frac{1}{2}(1 + \alpha_p t) = \frac{(1 + \alpha_1 t + \alpha_2 t + \alpha_1\alpha_2 t^2)}{(2 + (\alpha_1 + \alpha_2)t)}$$

As α_1 and α_2 are small quantities $\therefore$ $\alpha_1\alpha_2$ is negligible

$$\therefore \quad \frac{1}{2}(1 + \alpha_p t) = \frac{1 + (\alpha_1 + \alpha_2)t}{2 + (\alpha_1 + \alpha_2)t} = \frac{1 + (\alpha_1 + \alpha_2)t}{2\left[1 + \frac{(\alpha_1 + \alpha_2)t}{2}\right]}$$

$$= \frac{1}{2}[1 + (\alpha_1 + \alpha_2)t]\left[1 + \frac{(\alpha_1 + \alpha_2)t}{2}\right]^{-1}$$

$$= \frac{1}{2}[1 + (\alpha_1 + \alpha_2)t]\left[1 - \frac{(\alpha_1 + \alpha_2)t}{2}\right] \quad \text{[By binomial expansion]}$$

$$= \frac{1}{2}\left[1 - \frac{(\alpha_1 + \alpha_2)t}{2} + (\alpha_1 + \alpha_2)t - \frac{(\alpha_1 + \alpha_2)^2 t^2}{2}\right]$$

As $(\alpha_1 + \alpha_2)^2$ is negligible $\therefore$ $\frac{1}{2}(1 + \alpha_p t) = \frac{1}{2}\left[1 + \frac{1}{2}(\alpha_1 + \alpha_2)t\right]$

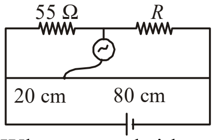
$$\alpha_p t = \frac{(\alpha_1 + \alpha_2)}{2}t \quad \text{or} \quad \alpha_p = \frac{\alpha_1 + \alpha_2}{2}$$

30. (a) : From the statement given, $\alpha = 2.5 \times 10^{-3}$/°C.

The resistance of a wire change from 100 Ω to 150 Ω when the temperature is increased from 27°C to 227°C.

It is true that α is small. But (150 – 100) Ω or 50 Ω is not very much less than 100 Ω *i.e.*, $R - R_0 << R_0$ is not true.

31. (c) :

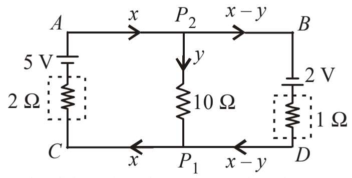


This is a Wheatstone bridge.

If ρ_l is the resistance per unit length (in cm)

$$\frac{20\rho_l}{55} = \frac{80\rho_l}{R} \quad \text{or} \quad R = \frac{80 \times 55}{20} = 220\,\Omega$$

32. (d) :



Applying Kirchhoff's law for the loops AP_2P_1CA and $P_2BDP_1P_2$, one gets $-10y - 2x + 5 = 0$

$\Rightarrow \quad 2x + 10y = 5 \qquad$ ...(i)

$+ 2 - 1(x - y) + 10 \cdot y = 0$

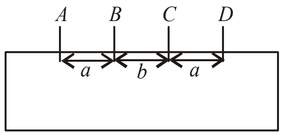
$+x - 11y = 2 \qquad$ ...(ii)

$\Rightarrow 2x - 22y = 4 \qquad$ ...(iii) = (ii) × 2

(i) – (iii) gives $32y = 1$

$\Rightarrow \quad y = \frac{1}{32}$ A = 0.03 A from P_2 to P_1.

33. (d) : Current is spread over an area $2\pi r^2$. The current I is a surface current.



Current density, $j = \frac{I}{2\pi r^2}$

Resistance $= \frac{\rho l}{\text{area}} = \frac{\rho r}{2\pi r^2}$

$E = I\rho/2\pi r^2$

$$V_B - V_C = \Delta V = \int_{a+b}^{a} -E\,dr \;\Rightarrow \Delta V = \frac{-I\rho}{2\pi}\int_{a+b}^{a}\frac{1}{r^2}dr = \frac{-I\rho}{2\pi}\left[-\frac{1}{r}\right]_{a+b}^{a}$$

$$\Delta V = \frac{I\rho}{2\pi}\left[\frac{1}{a} - \frac{1}{a+b}\right]$$

34. (d) : $j \times \rho = E \quad \therefore \quad E = \frac{I\rho}{2\pi r^2}$

35. (d) : Given : $R_{50} = 5\,\Omega$, $R_{100} = 6\,\Omega$

$R_t = R_0(1 + \alpha t)$

where R_t = resistance of a wire at t°C, R_0 = resistance of a wire at 0°C, α = temperature coefficient of resistance.

$\therefore \quad R_{50} = R_0\,[1 + \alpha\, 50]$ and $R_{100} = R_0\,[1 + \alpha\, 100]$

or $\quad R_{50} - R_0 = R_0\alpha(50) \quad$ ...(i); $\quad R_{100} - R_0 = R_0\alpha\,(100) \quad$ ...(ii)

Divide (i) by (ii), we get $\frac{5 - R_0}{6 - R_0} = \frac{1}{2}$ or $10 - 2R_0 = 6 - R_0$

or $\quad R_0 = 4\,\Omega$

36. (a) : Resistance of a wire $R = \frac{\rho l}{\pi r^2} = \frac{\rho l \times 4}{\pi D^2}$

$\because \quad R_A = R_B$

$$\therefore \quad \frac{4\rho_A l_A}{\pi D_A^2} = \frac{4\rho_B l_B}{\pi D_B^2} \quad \text{or} \quad \frac{l_B}{l_A} = \left(\frac{\rho_A}{\rho_B}\right)\left(\frac{D_B}{D_A}\right)^2$$

$$= \left(\frac{\rho_A}{2\rho_A}\right)\left(\frac{2D_A}{D_A}\right)^2 = \frac{4}{2} = \frac{2}{1}$$

37. (c) : Given : $R_{100} = 100\ \Omega$

$\alpha = 0.005°C^{-1}$

$R_t = 200\ \Omega \quad \therefore R_{100} = R_0[1 + 0.005 \times 100]$

or $\quad 100 = R_0[1 + 0.005 \times 100]$ ...(i)

$R_t = R_0[1 + 0.005t] \Rightarrow 200 = R_0[1 + 0.005t]$ ...(ii)

Divide (i) by (ii), we get $\dfrac{100}{200} = \dfrac{[1+0.005\times 100]}{[1+0.005t]}$

$1 + 0.005t = 2 + 1$ or $t = 400°C$

38. (c) : The equivalent circuit is a balanced Wheatstone's bridge. Hence no current flows through arm BD.

AB and BC are in series

$\therefore \quad R_{ABC} = 5 + 10 = 15\ \Omega$

AD and DC are in series

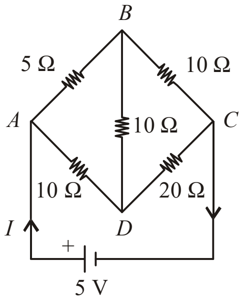
$\therefore \quad R_{ADC} = 10 + 20 = 30\ \Omega$

ABC and ADC are in parallel

$\therefore \quad R_{eq} = \dfrac{(R_{ABC})(R_{ADC})}{(R_{ABC} + R_{ADC})}$

or $\quad R_{eq} = \dfrac{15\times 30}{15+30} = \dfrac{15\times 30}{45} = 10\ \Omega$

$\therefore$ Current $I = \dfrac{E}{R_{eq}} = \dfrac{5}{10} = 0.5$ A



39. (c) : For balanced Wheatstone's bridge, $\dfrac{P}{Q} = \dfrac{R}{S}$

$\because \quad S = \dfrac{S_1 S_2}{S_1 + S_2}$ $\quad$ ($\because S_1$ and S_2 are in parallel)

$\therefore \quad \dfrac{P}{Q} = \dfrac{R(S_1 + S_2)}{S_1 S_2}$

40. (a) : Kirchhoff's first law $[\Sigma\, i = 0]$ is based on conservation of charge

Kirchhoff's second law $(\Sigma iR = \Sigma E)$ is based on conservation of energy.

41. (d) : Resistance of the bulb

$(R) = \dfrac{V^2}{P} = \dfrac{(220)^2}{100} = 484\ \Omega$

Power across 110 volt $= \dfrac{(110)^2}{484}$

$\therefore \quad$ Power $= \dfrac{110\times 110}{484} = 25$ W

42. (a) : Antimony-bismuth couple is ABC couple. It means that current flows from A to B at cold junction.

43. (b) : The internal resistance of a cell is given by

$r = R\left(\dfrac{l_1}{l_2} - 1\right) = R\left(\dfrac{l_1 - l_2}{l_2}\right) \quad \therefore r = 2\left[\dfrac{240-120}{120}\right] = 2\ \Omega$

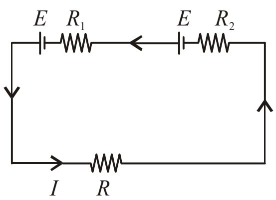
44. (d) : $I = \dfrac{2E}{R_1 + R_2 + R}$

$\because \quad E - IR_2 = 0$ Given)

$\therefore \quad E = IR_2$

or $\quad E = \dfrac{2ER_2}{R_1 + R_2 + R}$

or $\quad R_1 + R_2 + R = 2R_2$ or $R = R_2 - R_1$



45. (d) : For zero deflection in galvanometer, $I_1 = I_2$

or $\quad \dfrac{12}{500 + R} = \dfrac{2}{R} \Rightarrow 12R = 1000 + 2R \Rightarrow R = 100\ \Omega$

46. (a) : If internal resistance is zero, the energy source will supply a constant current.

47. (c) : Resistance of hot tungsten $= \dfrac{V^2}{P} = \dfrac{(200)^2}{100} = 400\ \Omega$

Resistance when not in use $= \dfrac{400}{10} = 40\ \Omega$

48. (d) : The voltameters are joined in parallel.

Mass deposited $= z_1 q_1 = z_2 q_2$

$\therefore \quad \dfrac{q_1}{q_2} = \dfrac{z_2}{z_1} \Rightarrow \dfrac{q_1 + q_2}{q_2} = \dfrac{z_1 + z_2}{z_1} \Rightarrow \dfrac{q}{q_2} = \left(1 + \dfrac{z_2}{z_1}\right)$ or $q_2 = \dfrac{q}{\left(1 + \dfrac{z_2}{z_1}\right)}$

49. (c) : Resistance of full coil $= R$

Resistance of each half piece $= R/2$

$\therefore \quad \dfrac{H_2}{H_1} = \dfrac{V^2 t}{R/2} \times \dfrac{R}{V^2 t} = \dfrac{2}{1} \quad \therefore H_2 = 2H_1$

Heat generated will now be doubled.

50. (c) : Thermistors are made of metal oxides with high temperature co-efficient of resistivity.

51. (a) : For meter bridge experiment, $\dfrac{R_1}{R_2} = \dfrac{l_1}{l_2} = \dfrac{l_1}{(100 - l_1)}$

In the first case, $\dfrac{X}{Y} = \dfrac{20}{100-20} = \dfrac{20}{80} = \dfrac{1}{4}$

In the second case, $\dfrac{4X}{Y} = \dfrac{l}{(100-l)} \Rightarrow \dfrac{4}{4} = \dfrac{l}{100-l} \Rightarrow l = 50$ cm.

52. (b) : Potential difference is same when the wires are put in parallel

$V = I_1 R_1 = I_1 \times \dfrac{\rho l_1}{\pi r_1^2}$ $\quad$ Again $V = I_2 R_2 = I_2 \times \dfrac{\rho l_2}{\pi r_2^2}$

$\therefore \quad \dfrac{I_1 \times \rho l_1}{\pi r_1^2} = \dfrac{I_2 \times \rho l_2}{\pi r_2^2} \Rightarrow \dfrac{I_1}{I_2} = \left(\dfrac{l_2}{l_1}\right)\left(\dfrac{r_1}{r_2}\right)^2$

or $\quad \dfrac{I_1}{I_2} = \left(\dfrac{3}{4}\right)\left(\dfrac{2}{3}\right)^2 = \dfrac{3\times 4}{4\times 9} = \dfrac{1}{3}$

53. (a) : In series combination, $S = (R_1 + R_2)$

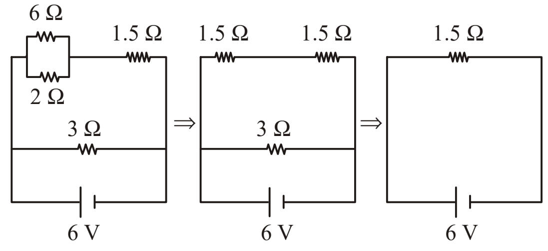
In parallel combination, $P = \dfrac{R_1 R_2}{(R_1 + R_2)} \quad \because S = nP$

$\therefore \quad (R_1 + R_2) = n\dfrac{R_1 R_2}{(R_1 + R_2)} \quad \therefore (R_1 + R_2)^2 = nR_1 R_2$

For minimum value, $R_1 = R_2 = R$

$\therefore \quad (R + R)^2 = n(R \times R) \Rightarrow 4R^2 = nR^2$ or $n = 4$

54. (c) : The equivalent circuits are shown below :



$I = \dfrac{6}{1.5} = 4$ A

55. (a) : $m = Zit$

or $m = (3.3 \times 10^{-7}) \times (3) \times (2) = 19.8 \times 10^{-7}$ kg

56. (d) : $E = a\theta + b\theta^2 \therefore \frac{dE}{d\theta} = a + 2b\theta$

At neutral temperature (θ_n), $\frac{dE}{d\theta} = 0$

or $0 = a + 2b\theta_n$ or $\theta_n = -\frac{a}{2b} = -\frac{1}{2} \times (700) = -350°C$

Neutral temperature is calculated to be –350°C

Since temperature of cold junction is 0°C, no neutral temperature is possible for this thermocouple.

57. (c) : Electrical energy is converted into heat energy

$\therefore$ $836 \times t = 1000 \times 1 \times (40 - 10) \times (4.18)$ [$\because$ 4.18 J = 1cal]

or $t = \frac{1000 \times 30 \times 4.18}{836} = 150$ seconds

58. (d) : Let the length of the wire be l, radius of the wire be r

$\therefore$ Resistance $R = \rho\frac{l}{\pi r^2}$; ρ = resistivity of the wire

Now l is increased by 100% $\therefore l' = l + \frac{100}{100}l = 2l$

As length is increased, its radius is going to be decreased in such a way that the volume of the cylinder remains constant.

$\pi r^2 \times l = \pi r'^2 \times l' \Rightarrow r'^2 = \frac{r^2 \times l}{l'} = \frac{r^2 \times l}{2l} = \frac{r^2}{2}$

$\therefore$ The new resistance $R'^2 = \rho\frac{l'}{\pi r'^2} = \rho\frac{2l}{\pi \times \frac{r^2}{2}} = 4R$

$\therefore$ Change in resistance $= R' - R = 3R$

$\therefore$ % change = $\frac{3R}{R} \times 100\% = 300\%$

59. (b) : Equivalent resistance $= \frac{(3+3)\times 3}{(3+3)+3} = \frac{18}{9} = 2\ \Omega$

$\therefore$ Current $I = \frac{V}{R} = \frac{3}{2} = 1.5$ A

60. (c) : Potential gradient along wire, $K = \frac{E}{100}\frac{\text{volt}}{\text{cm}}$

For battery $V = E' - ir$, where E' is emf of battery.

or $K \times 30 = E' - ir$, where current i is drawn from battery

or $\frac{E \times 30}{100} = E' + 0.5i$ or $E' = \frac{30E}{100} - 0.5i$

61. (c) : Resistance of bulb $= \frac{V^2}{P} = \frac{(220)^2}{1000} = 48.4\ \Omega$

Required power $= \frac{V^2}{R} = \frac{(110)^2}{48.4} = \frac{110 \times 110}{48.4} = 250$ W.

62. (c) : According to Faraday's laws of electrolysis,

$\frac{m_{Zn}}{m_{Cu}} = \frac{Z_{Zn}}{Z_{Cu}}$ when i and t are same

$\therefore \frac{0.13}{m_{Cu}} = \frac{32.5}{31.5} \Rightarrow m_{Cu} = \frac{0.13 \times 31.5}{32.5} = 0.126$ g

63. (a) : Let the smallest temperature be θ°C

$\therefore$ Thermo emf = $(25 \times 10^{-6})\ \theta$ volt

Potential difference across galvanometer = IR

$= 10^{-5} \times 40 = 4 \times 10^{-4}$ volt

$\therefore (25 \times 10^{-6})\theta = 4 \times 10^{-4} \therefore \theta = \frac{4 \times 10^{-4}}{25 \times 10^{-6}} = 16°C$

64. (b) : According to Faraday's laws, $m \propto It$.

65. (c) : $\theta_c + \theta_i = 2\theta_n \Rightarrow \frac{\theta_i + \theta_c}{2} = \theta_n$

66. (b) : $P_1 = \frac{V^2}{R}$ when connected in parallel,

$R_{eq} = \frac{(R/2)\times(R/2)}{\frac{R}{2} + \frac{R}{2}} = \frac{R}{4} \quad \therefore P_2 = \frac{V^2}{R/4} = 4\frac{V^2}{R} = 4P_1$

$\therefore \frac{P_2}{P_1} = 4$

67. (b) : Power $= \frac{V^2}{R}$

$\therefore 150 = \frac{(15)^2}{R} + \frac{(15)^2}{2} = \frac{225}{R} + \frac{225}{2} \Rightarrow R = 6\ \Omega$