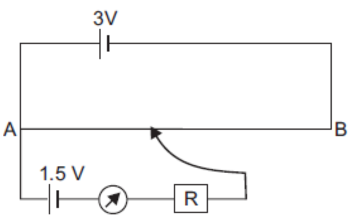
2008 D

1. *Prove that the current density of a metallic conductor is directly proportional to the drift speed of electrons.*
2. *A number of identical cells, n, each of emf* ***E,*** *internal resistance* ***r*** *connected in series are charged by a* ***d.c.*** *source of emf* ***E′****, using a resistor* ***R (i)*** *Draw the circuit arrangement* ***(ii)*** *Deduce the expressions for (a) the charging current and (b) the potential difference across the combination of the cells*
3. *A potentiometer wire of length* ***1 m*** *is connected to a driver cell of emf* ***3 V*** *as shown in the figure. When a cell of* ***1·5 V*** *emf is used in the secondary circuit, the balance point is found to be* ***60 cm.*** *On replacing this cell and using a cell of unknown emf, the balance point shifts to* ***80 cm.***

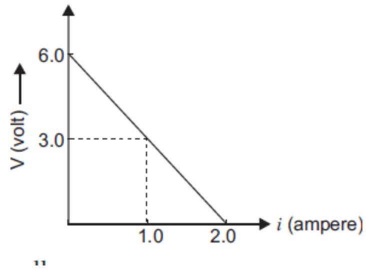


(i) Calculate unknown emf of the cell.
(ii) Explain with reason, whether the circuit works, if the driver cell is replaced with a cell of emf 1 V.
(iii) Does the high resistance R, used in the secondary circuit affect the balance point ? Justify our answer.

4. *Define conductivity of a conductor. Explain the variation of conductivity with temperature in (a) good conductors, (b) ionic conductors.*
5. *Prove that the current density of a metallic conductor is directly proportional to the drift speed of electrons through the conductor.*
6. *Define resistivity of a conductor. Plot a graph showing the variation of resistivity with temperature for a metallic conductor. How does one explain such a behaviour, using the mathematical expression of the resistivity of a material.*

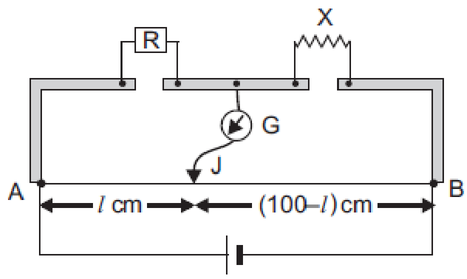
AI 2008

7. *The following graph shows the variation of terminal potential difference* ***V****, across a combination of three cells in series to a resistor, versus the current,* ***i:***

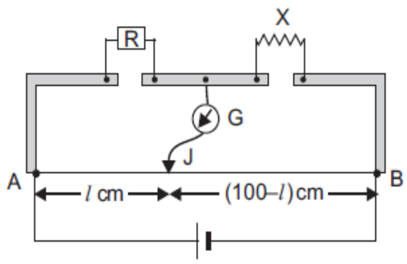


(i) Calculate the emf of each cell.
(ii) For what current i will the power dissipation of the circuit be maximum ?

8. *A resistance R = 2Ω is connected to one of the gaps in a metre bridge, which uses a wire of length 1 m. An unknown resistance X > 2Ω is connected in the other gap as shown in the figure. The balance point is noticed at ' l' from the positive end of the battery. On interchanging R and X, it is found that the balance point further shifts by 20 cm (away from end A). Neglecting the end correction, calculate the value of unknown resistance X used.*

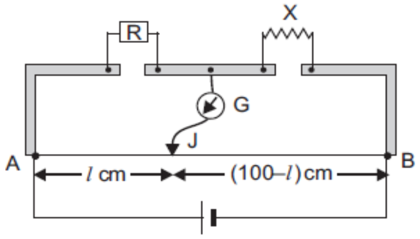


9. *A resistance R =5Ω is connected to one of the gaps in a metre bridge, which uses a wire of length 1 m. An unknown resistance X >5Ω is connected in the other gap as shown in the figure. The balance point is noticed at 'l' cm from the positive end of the battery. On interchanging R and X, it was found that the balance point further shifts by 20 cm away from end A. Neglecting the end correction, calculate the value of unknown resistance X used*



10. *A resistance R = 4Ω is connected to one of the gaps in a metre bridge, which uses a wire of length 1 m. An unknown resistance X > 4Ω is connected in the other gap as shown in the figure. The balance point is noticed at 'l' from the positive end of the battery. On interchanging R and X, it is found that the balance point further shifts by 20 cm (away from end A). Neglecting the end correction, calculate the*

value of unknown resistance X used.

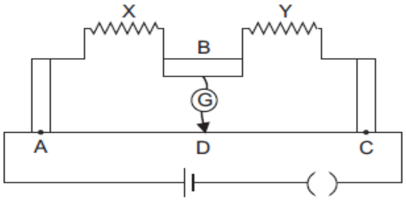


11. A cell of emf 'E' and internal resistance 'r' is connected across a variable resistor 'R'. Plot a graph showing the variation of terminal potential 'V' with resistance R. Predict from the graph the condition under which 'V' becomes equal to 'E'.

2009 D

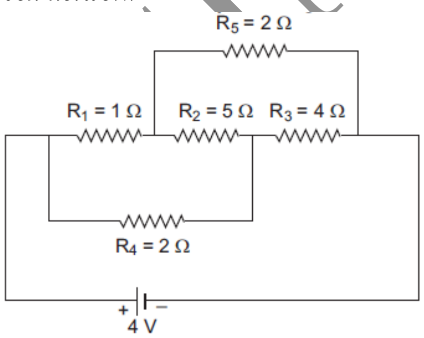
12. Derive an expression for drift velocity of free electrons in a conductor in terms of relaxation time.

13. The figure shows experimental set up of a meter bridge. When the two unknown resistances X and Y are inserted, the null point D is obtained 40 cm from the end A. When a resistance of 10 W is connected in series with X, the null point shifts by 10 cm. Find the position of the null point when the 10 W resistance is instead connected in series with resistance 'Y'. Determine the values of the resistances X and Y.



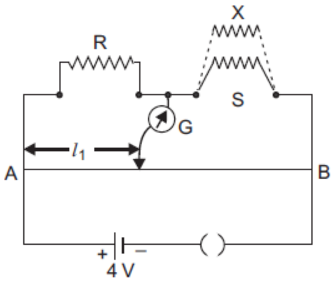
2009 AI

14. Calculate the current drawn from the battery in the given network



15. A wire of 15 W resistance is gradually stretched to double its original length. It is then cut into two equal parts. These parts are then connected in parallel across a 3. 0 volt battery. Find the current drawn from the battery.

16. (i) State the principle of working of a meter bridge. (ii) In a meter bridge balance point is found at a distance l_1 with resistance R and S as shown in the figure. When an unknown resistance X is connected in parallel with the resistance S, the balance point shifts to a distance l_2. Find the expression for X in terms of l_1, l_2 and S. **(3)**

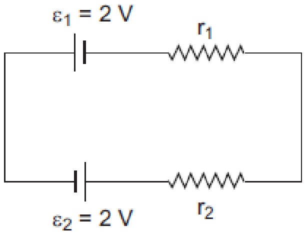


17. A wire of 20 W resistance is gradually stretched to double its original length. It is then cut into two equal parts. These parts are then connected in parallel across a 4 × 0 volt battery. Find the current drawn from the battery. **(2)**

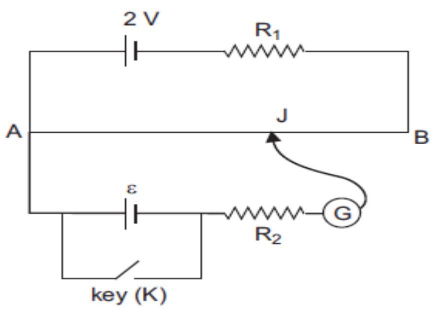
2009 F

18. A steady current flows in a metallic conductor of non-uniform cross-section. Which of these quantities is constant along the conductor: Current, current density, drift speed, electric field? **(1)**

19. State Kirchhoff's rules. Use Kirchhoff's rules to show that no current flows in the given circuit.

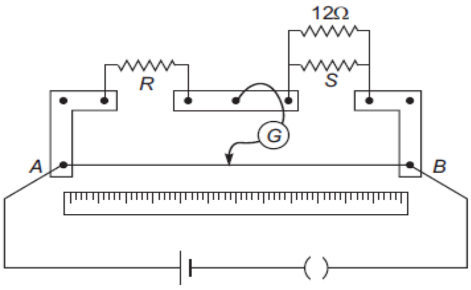


20. (a) State the Principle of working of a potentiometer. (b) Figure shows the circuit diagram of a potentiometer for determining the emf 'e' of a cell of negligible internal resistance. (i) What is the purpose of using high resistance R_2 ? (ii) How does the position of balance point (J) change when the resistance R_1 is decreased? (iii) Why cannot the balance point be obtained (1) when the emf e is greater than 2 V, and (2) when the key (K)i s closed? **(3)**



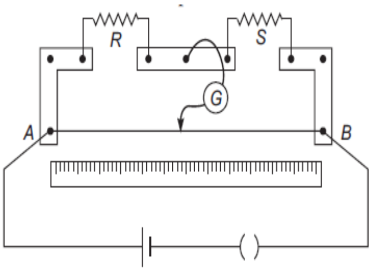
2010 D

21. *In a meter bridge, the null point is found at a distance of 40 cm from A. If a resistance of 12 W is connected in parallel with S, the null point occurs at 50×0 cm from A. Determine the values of R and S* .

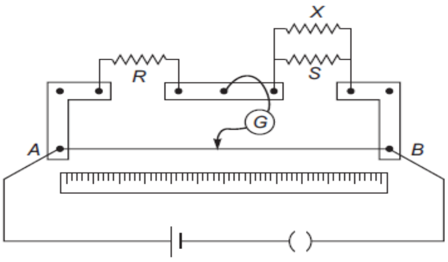


22. *Write the principle of working of a potentiometer. Describe briefly, with the help of a circuit diagram, how a potentiometer is used to determine the internal resistance of a given cell*

23. *In a meter bridge, the null point is found at a distance of 60.0 cm from A. If now a resistance of 5Ω is connected in series with S, the null point occurs at 50 cm. Determine the values of R and S.*



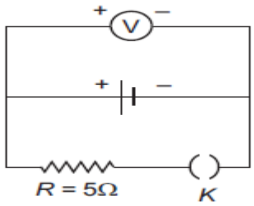
24. *In a metre bridge, the null point is found at a distance of l1 cm from A. If now a resistance of X is connected in parallel with S, the null point occurs at l2 cm. Obtain a formula for X in terms of l1, l2 and S.*



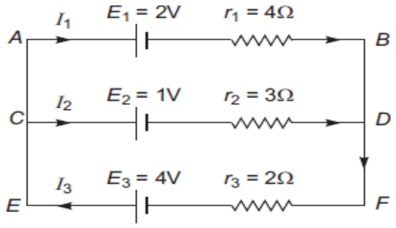
2010 AI

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

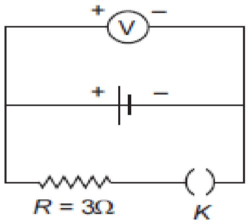
26. *Write any two factors on which internal resistance of a cell depends. The reading on a high resistance voltmeter, when a cell is connected across it, is 2·2 V. When the terminals of the cell are also connected to a resistance of 5Ω as shown in the circuit, the voltmeter reading drops to 1·8 V. Find the internal resistance of the cell.*



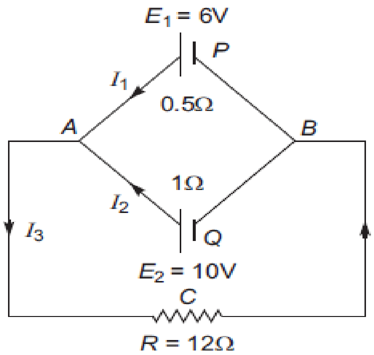
27. *State Kirchhoff's rules. Use these rules to write the expressions for the currents I1, I 2 and I 3 in the circuit diagram shown.*



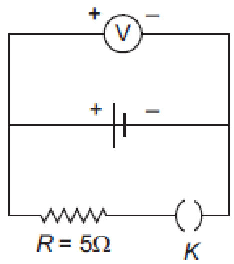
28. *Write any two factors on which internal resistance of a cell depends. The reading on a high resistance voltmeter, when a cell is connected across it, is 2·0 V. When the terminals of the cell are also connected to a resistance of 3Ω as shown in the circuit, the voltmeter reading drops to 1·5 V. Find the internal resistance of the cell.*



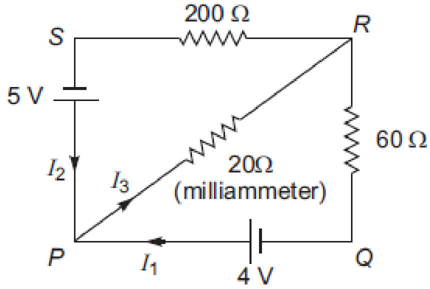
State Kirchhoff's rules. Apply Kirchhoff's rules to the loops ACBPA and ACBQA to write the expressions for the currents I1, I 2 and I 3 in the network



29. *Write any two factors on which internal resistance of a cell depends. The reading on a high resistance voltmeter, when a cell is connected across it, is 2·5 V. When the terminals of the cell are also connected to a resistance of 5Ω are shown in the circuit, the voltmeter reading drops to 2·0 V. Find* the internal resistance of the cell.



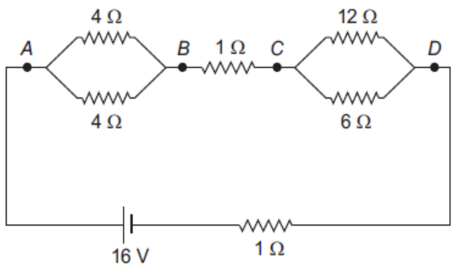
30. *State Kirchhoff's rules. Apply these rules to the loops PRSP and PRQP to write the expressions for the currents I_1, I_2 and I_3 in the given circuit.*



2010 F

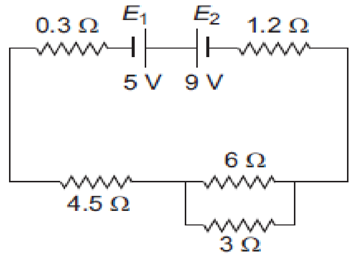
31. *Define drift velocity. Write its relationship with relaxation time in terms of the electric field E applied to a conductor. A potential difference V is applied to a conductor of length L. How is the drift velocity affected when V is doubled and L is halved?*

32. *State the principle of working of a potentiometer. Define potential gradient and write its S.I. unit. A network of resistors is connected to a 16 V battery of internal resistance of 1 Ω as shown in the figure. (a) Compute the equivalent resistance of the network.(b) Obtain the voltage drops* $\mathbf{V_{AB}}$ *and* $\mathbf{V_{CD}}$.

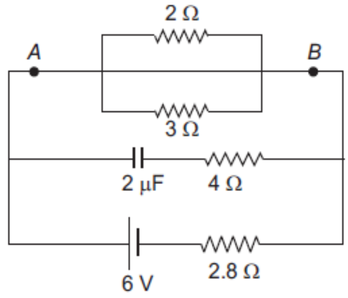


33. *State the principle on which the working of a meter bridge is based. Under what condition is the error in determining the unknown resistance minimized?*

34. *Two cells E_1 and E_2 of EMF's 5 V and 9 V and internal resistances of 0.3 Ω and 1.2 Ω respectively are connected to a network of resistances as shown in the figure. Calculate the value of current flowing through the 3 Ω resistance.*



35. *Calculate the steady current through the 2Ω resistor in the circuit shown below.*

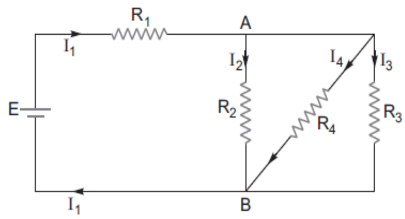


2011 D

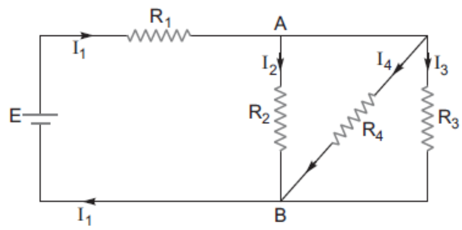
36. *A resistance R is connected across a cell of emf ε and internal resistance r. A potentiometer now measures the potential difference between the terminals of the cell as V. Write the expression for 'r' in terms of ε, V and R.*

37. *Define the terms (i) drift velocity, (ii) relaxation time.A conductor of length L is connected to a dc source of emf ε. If this conductor is replaced by another conductor of same material and same area of cross-section but of length 3L, how will the drift velocity change?*

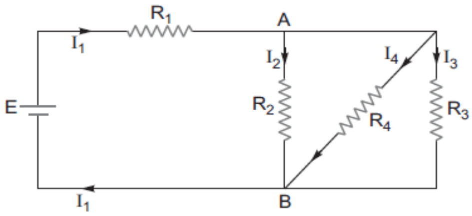
38. *In the circuit shown, R_1 = 4 Ω, R_2 = R_3 = 15 Ω, R_4 = 30 Ω and E = 10 V. Calculate the equivalent resistance of the circuit and the current in each resistor.*



39. *In the circuit shown, R_1 = 4 Ω, R_2 = R_3 = 5 Ω, R_4 = 10 Ω and E = 6 V. Work out the equivalent resistance of the circuit and the current in each resistor.*

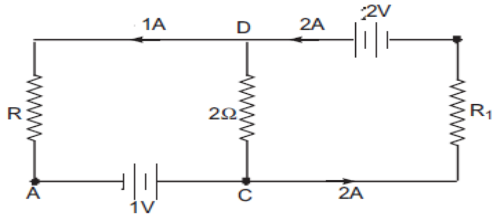


40. *In the circuit shown, R_1 = 2Ω, R_2 = R_3 = 10Ω, R_4 = 20Ω and E = 6 V. Work out the equivalent resistance of the circuit and the current in each* resistor.

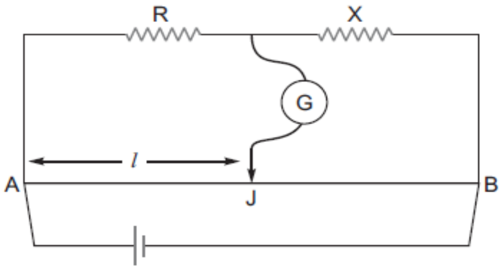


2011 AI

41. *In the given circuit, assuming point A to be at zero potential, use Kirchhoff's rules to determine the potential at point B.*

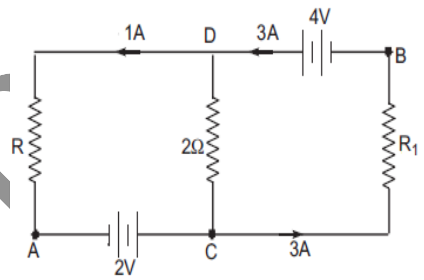


42. *In the meter bridge experiment, balance point was observed at J with AJ = l. (i) The values of R and X were doubled and then interchanged. What would be the new position of balance point? (ii) If the galvanometer and battery are interchanged at the balance position, how will the balance point get affected?*

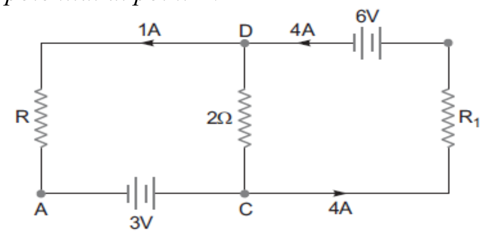


43. *Two heating elements of resistance R_1 and R_2 when operated at a constant supply of voltage, V, consume powers P_1 and P_2 respectively. Deduce the expressions for the power of their combination when they are, in turn, connected in (i) series and (ii) parallel across the same voltage supply.*

44. *In the given circuit, assuming point A to be at zero potential, use Kirchhoff's rules to determine the potential at point B.*



45. *In the given circuit, assuming point A to be at zero potential, use Kirchhoff's rules to determine the potential at point B.*



2011 F

46. *Plot a graph showing temperature dependence of resistivity for a typical semiconductor. How is this behaviour explained?*

47. *State the underlying principal of potentiometer. Describe briefly, giving the necessary circuit diagram, how a potentiometer is used to measure the internal resistance of a given cell.*

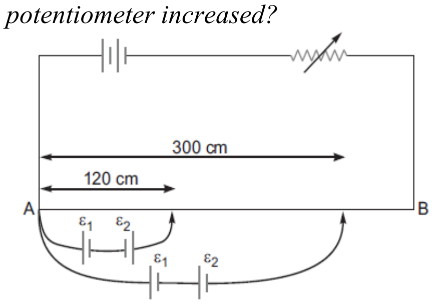
2012 D

48. *When electrons drift in a metal from lower to higher potential, does it mean that all the free electrons of the metal are moving in the same direction?*

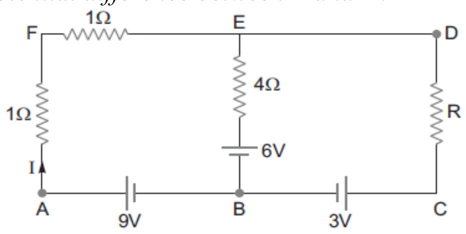
49. *Show on a graph, the variation of resistivity with temperature for a typical semiconductor.*

50. *A cell of emf E and internal resistance r is connected to two external resistances R_1 and R_2 and a perfect ammeter. The current in the circuit is measured in four different situations:*
(i) without any external resistance in the circuit.
(ii) with resistance R_1 only
(iii) with R_1 and R_2 in series combination
(iv) with R_1 and R_2 in parallel combination.
The currents measured in the four cases are 0.42 A, 1.05 A, 1.4 A and 4.2 A, but not necessarily in that order. Identify the currents corresponding to the four cases mentioned above.

51. *In the figure a long uniform potentiometer wire AB is having a constant potential gradient along its length. The null points for the two primary cells of emfs ε_1 and ε_2 connected in the manner shown are obtained at a distance of 120 cm and 300 cm from the end A. Find (i) $\varepsilon_1 / \varepsilon_2$ and (ii) position of null point for the cell ε_1. How is the sensitivity of a potentiometer increased?*

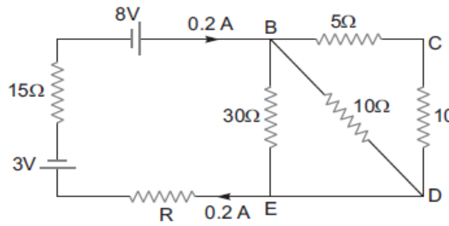


52. *Using Kirchoff's rules determine the value of unknown resistance R in the circuit so that no current flows through 4 Ω resistance. Also find the* *potential difference between A and D.*



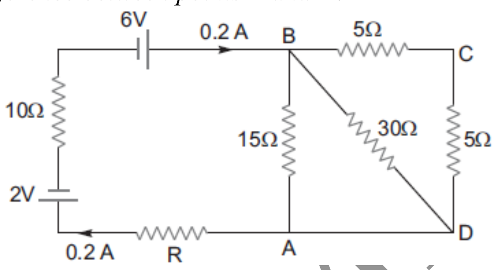
2012 AI

53. *Calculate the value of the resistance R in the circuit shown in the figure so that the current in the circuit is 0.2 A. What would be the potential difference between points B and E?*

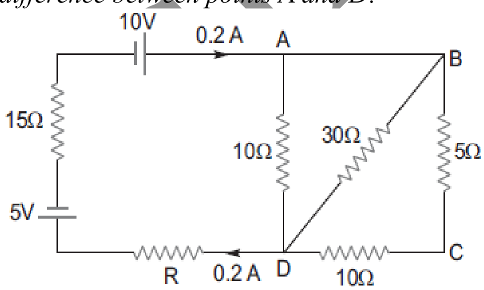


54. *Define relaxation time of the free electrons drifting in a conductor. How is it related to the drift velocity of free electrons? Use this relation to deduce the expression for the electrical resistivity of the material.*

55. *Calculate the value of the resistance R in the circuit shown in the figure so that the current in the circuit is 0.2 A. What would be the potential difference between points A and B?*



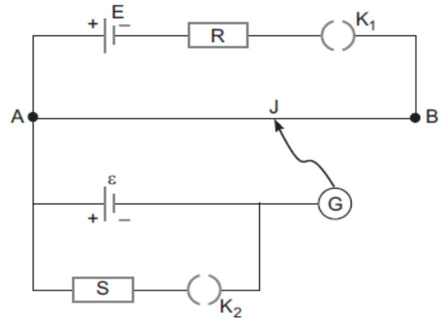
56. *Calculate the value of the resistance R in the circuit shown in the figure so that the current in the circuit is 0.2 A. What would be the potential difference between points A and D?*



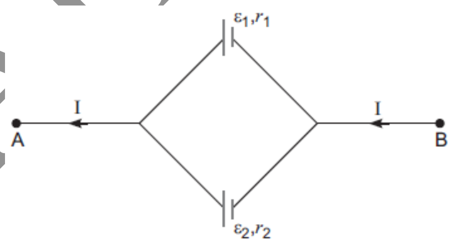
2012 F

57. *A conductor of length 'l' is connected to a dc source of potential 'V'. If the length of the conductor is tripled by gradually stretching it, keeping 'V' constant, how will (i) drift speed of electrons and (ii) resistance of the conductor be affected? Justify your answer.*

58. *Two students 'X' and 'Y' perform an experiment on potentiometer separately using the circuit given: Keeping other parameters unchanged, how will the position of the null point be affected it (i) 'X' increases the value of resistance R in the set-up by keeping the key K_1 closed and the key K_2 open? (ii) 'Y' decreases the value of resistance S in the set-up, while the key K_2 remain open and the key K_1 closed? Justify.*

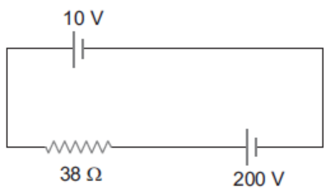


59. *Two cells of emfs* **ε1, ε2** *and internal resistance* **r_1** *and* **r_2** *respectively are connected in parallel as shown in the figure. Deduce the expressions for*
(i) the equivalent e.m.f. of the combination,
(ii) the equivalent resistance of the combination,
and (iii) the potential difference between the points A and B.



2013 D

60. *A 10 V battery of negligible internal resistance is connected across a 200 V battery and a resistance of 38 Ω as shown in the figure. Find the value of the current in circuit.*

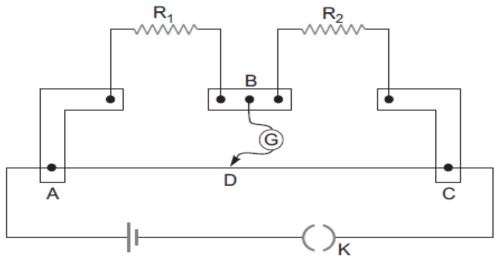


61. *The emf of a cell always greater than its terminal voltage. Why? Give reason.*

62. *(a) State the working principle of a potentiometer. With the help of the circuit diagram, explain how a potentiometer is used to compare the emf's of two primary cells. Obtain the required expression used for comparing the emfs.*
(b) Write two possible causes for one sided deflection in a potentiometer experiment.

63. *State Kirchhoff's rules for an electric network. Using Kirchhoff's rules, obtain the balance condition in terms of the resistances of four arms of Wheatsone bridge. (b) In the meterbridge experimental set up, shown in the figure, the null point 'D' is obtained at a distance of 40 cm from end A of the meterbridge wire. If a resistance of 10 Ω is connected in series with R_1, null point is obtained at AD = 60 cm. Calculate the value of R_1*

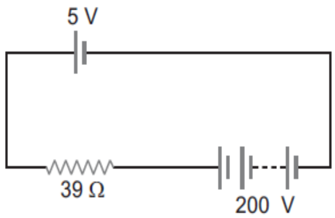
and R_2.



64. *A cell of emf 'E' and internal resistance 'r' draws a current 'I'. Write the relation between terminal voltage 'V' in terms of E, I and r.*

65. *A heating element is marked 210 V, 630 W. What is the value of the current drawn by the element when connected to a 210 V dc source?*

66. *A 5 V battery of negligible internal resistance is connected across a 200 V battery and a resistance of 39 Ω as shown in the figure. Find the value of the current .*



2013 AI

67. *Two identical cells, each of emf E, having negligible internal resistance, are connected in parallel with each other across an external resistance R. What is the current through this resistance?*

68. *Explain the term 'drift velocity' of electrons in a conductor. Hence obtain the expression for the current through a conductor in terms of 'drift velocity'.*

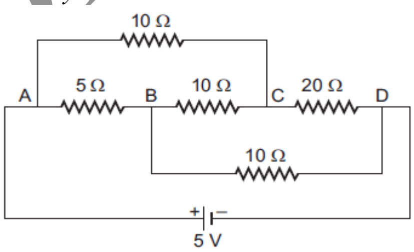
69. *Describe briefly, with the help of a circuit diagram, how a potentiometer is used to determine the internal resistance of a cell*

2013 F

70. *Plot a graph showing the variation of resistance of a conducting wire as a function of its radius, keeping the length of the wire and its temperature as constant.*

71. *Two materials Si and Cu, are cooled from 300 K to 60 K. What will be the effect on their resistivity?*

72. *Calculate the value of the current drawn from a 5 V battery in the circuit as shown.*

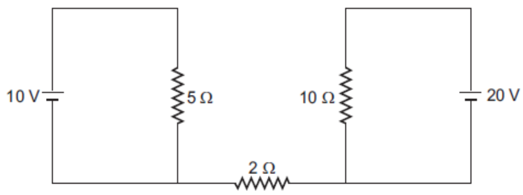


73. *(a) State, with the help of a suitable diagram, the principle on which the working of a meter bridge is based.*

(b) Answer the following: (i) Why are the connections between resistors in a meter bridge made of thick copper strips? (ii) Why is it generally preferred to obtain the balance point near the middle of the bridge wire in meter bridge experiments?

74. *Two materials, Ge and Al, are cooled from 300K to 60 K. What will be the effect on their resistivity?*

75. *What will be the value of current through the 2 Ω resistance for the circuit shown in the figure? Give reason to support your answer.*



2014 D

76. *Define the term 'Mobility' of charge carries in a conductor. Write its SI unit.*

77. *Show variation of resistivity of copper as a function of temperature in a graph.*

78. *A potentiometer wire of length 1 m has a resistance of 10 Ω. It is connected to a 6 V battery in series with a resistance of 5 Ω. Determine the emf of the primary cell which gives a balance point at 40 cm.*

79. *Define the term 'electrical conductivity' of a metallic wire. Write its S.I. unit.*

80. *Show variation of resistivity of Si with temperature in a graph.*

81. *A potentiometer wire of length 1.0 m has a resistance of 15 Ω. It is connected to a 5 V battery in series with a resistance of 5 Ω. Determine the emf of the primary cell which gives a balance point at 60 cm.*

82. *Define the term 'drift velocity' of charge carriers in a conductor and write its relationship with the current flowing through it.*

83. *Plot a graph showing variation of current versus voltage for the material GaAs.*

84. *A potentiometer wire of length 1 m has a resistance of 5 Ω. It is connected to a 8 V battery in series with a resistance of 15 Ω. Determine the emf of the primary cell which gives a balance point at 60 cm*

2014 AI

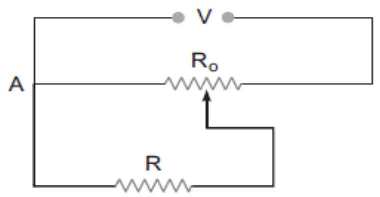
85. *A cell of emf 'E' and internal resistance 'r' is connected across a variable resistor 'R'. Plot a graph showing variation of terminal voltage 'V' of the cell versus the current 'I'. Using the plot, show how the emf of the cell and its internal resistance can be determined.*

86. *Estimate the average drift speed of conduction electrons in a copper wire of cross-sectional area* $\mathbf{1.0 \times 10^{-7}\ m^2}$ *carrying a current of* **1.5 A**. *Assume the density of conduction electrons to be* $\mathbf{9 \times 10^{28}\ m^{-3}}$.

87. *Answer the following:*
(a) Why are the connections between the resistors in a meter bridge made of thick copper strips?

(b) *Why is it generally preferred to obtain the balance point in the middle of the meter bridge wire?*
(c) *Which material is used for the meter bridge wire and why?*

88. *A resistance of R Ω draws current from a potentiometer as shown in the figure. The potentiometer has a total resistance R_0 Ω. A voltage V is supplied to the potentiometer. Derive an expression for the voltage across R when the sliding contact is in the middle of the potentiometer.*

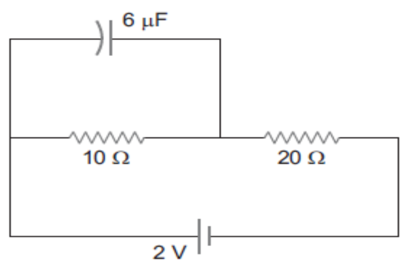


89. *Estimate the average drift speed of conduction electrons in a copper wire of cross-sectional area 2.5×10^{-7} m^2 carrying a current of 1.8 A. Assume the density of conduction electrons to be 9×10^{28} m^{-3}.*

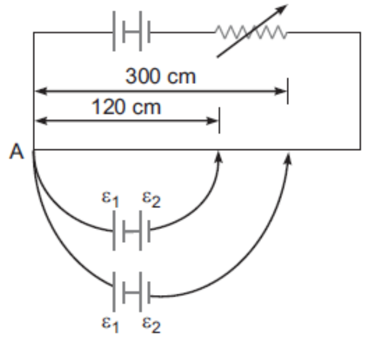
90. *Estimate the average drift speed of conduction electrons in a copper wire of cross-sectional area 2.5×10^{-7} m^2 carrying a current of 2.7 A. Assume the density of conduction electrons to be 9×10^{28} m^{-3}.*

2014 F

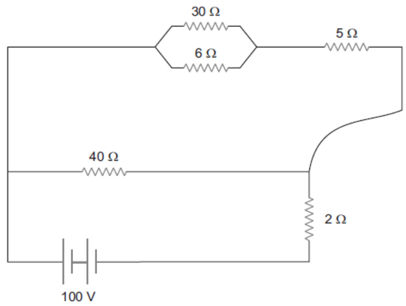
91. *Find the charge on the capacitor as shown in the circuit.*



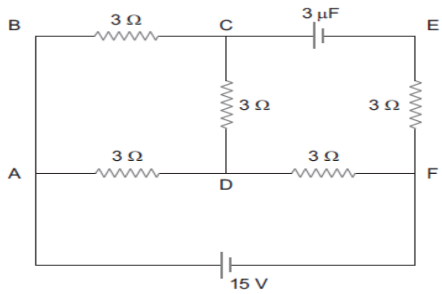
92. **(a)** *State the principle of a potentiometer. Define potential gradient. Obtain an expression for potential gradient in terms of resistivity of the potentiometer wire.*
(b) *Figure shows a long potentiometer wire AB having a constant potential gradient. The null points for the two primary cells of emfs ε_1 and ε_2 connected in the manner shown are obtained at a distance of $l_1 = 120$ cm and $l_2 = 300$ cm from the end A. Determine (i) $\varepsilon_1/\varepsilon_2$ and (ii) position of null point for the cell ε_1 only.*



93. **(a)** *Define the term 'drift velocity' of charge carriers in a conductor. Obtain the expression for the current density in terms of relaxation time.*
(b) *A 100 V battery is connected to the electric network as shown. If the power consumed in the 2Ω resistor is 200 W, determine the power dissipated in the 5Ω resistor.*



94. *In the circuit shown in the figure, find the total resistance of the circuit and the current in the arm CD*



95. *In the circuit shown in the figure, find the total resistance of the circuit and the current in the arm AD*