CURRENT ELECTRICITY

FACT/DEFINITION TYPE QUESTIONS

1. In a current carrying conductor the net charge is
   (a) 1.6×10^{-19} coulomb (b) 6.25×10^{-18} coulomb
   (c) zero (d) infinite
2. The current which is assumed to be flowing in a circuit from positive terminal to negative, is called
   (a) direct current (b) pulsating current
   (c) conventional current (d) alternating current
3. When no current is passed through a conductor,
   (a) the free electrons do not move
   (b) the average speed of a free electron over a large period of time is not zero
   (c) the average velocity of a free electron over a large period of time is zero
   (d) the average of the velocities of all the free electrons at an instant is non zero
4. A current passes through a wire of nonuniform cross-section. Which of the following quantities are independent of the cross-section?
   (a) The charge crossing (b) Drift velocity
   (c) Current density (d) Free-electron density
5. In the equation AB = C, A is the current density, C is the electric field, Then B is
   (a) resistivity (b) conductivity
   (c) potential difference (d) resistance
6. Drift velocity of electrons is due to
   (a) motion of conduction electrons due to random collisions.
   (b) motion of conduction electrons due to electric field $\vec{E}$.
   (c) repulsion to the conduction electrons due to inner electrons of ions.
   (d) collision of conduction electrons with each other.
7. The speed at which the current travels, in conductor, is nearly equal to
   (a) 3×10^4 m/s (b) 3×10^5 m/s
   (c) 4×10^6 m/s (d) 3×10^8 m/s
8. In the absence of an electric field, the mean velocity of free electrons in a conductor at absolute temperature (T) is
   (a) zero (b) independent of T
   (c) proportional to T (d) proportional to T^2
9. When a potential difference V is applied across a conductor at a temperature T, the drift velocity of electrons is proportional to
   (a) $\sqrt{V}$ (b) V
   (c) $\sqrt{T}$ (d) T
10. For which of the following dependence of drift velocity v_d on electric field E, is Ohm's law obeyed?
    (a) $v_d \propto E^2$ (b) $v_d = E^{1/2}$
    (c) v_d = constant (d) $v_d = E$
11. The current density (number of free electrons per m^3) in metallic conductor is of the order of
    (a) 10^{22} (b) 10^{24}
    (c) 10^{26} (d) 10^{28}
12. A current passes through a resistor. If K_1 and K_2 represent the average kinetic energy of the conduction electrons and the metal ions respectively then
    (a) $K_1 < K_2$
    (b) $K_1 = K_2$
    (c) $K_1 > K_2$
    (d) any of these three may occur
13. A metal wire is subjected to a constant potential difference. When the temperature of the metal wire increases, the drift velocity of the electron in it
    (a) increases, thermal velocity of the electron increases
    (b) decreases, thermal velocity of the electron increases
    (c) increases, thermal velocity of the electron decreases
    (d) decreases, thermal velocity of the electron decreases
14. The electric field intensity E, current density J and specific resistance k are related to each other through the relation
    (a) $E = J/k$ (b) $E = Jk$
    (c) $E = k/J$ (d) $k = JE$
15. The relaxation time in conductors
    (a) increases with the increases of temperature
    (b) decreases with the increases of temperature
    (c) it does not depends on temperature
    (d) all of sudden changes at 400 K

16. We are able to obtain fairly large currents in a conductor because
(a) the electron drift speed is usually very large
(b) the number density of free electrons is very high and this can compensate for the low values of the electron drift speed and the very small magnitude of the electron charge
(c) the number density of free electrons as well as the electron drift speeds are very large and these compensate for the very small magnitude of the electron charge
(d) the very small magnitude of the electron charge has to be divided by the still smaller product of the number density and drift speed to get the electric current

17. In conductor when electrons move between two collisons, their paths are ... *A*... when external fields are absent and ... *B*...when external filed is present. Here, *A* and *B* refer to
(a) straight lines, straight lines
(b) straight lines, curved lines
(c) curved lines, straight lines
(d) curved lines, curved lines

18. If N, e, τ and m are representing electron density, charge, relaxation time and mass of an electron respectively, then the resistance of wire of length ℓ and cross-sectional area A is given by
(a) $\frac{m\ell}{Ne^2A^2\tau}$ (b) $\frac{2m\tau A}{Ne^2\ell}$
(c) $\frac{Ne^2\tau A}{2m\ell}$ (d) $\frac{Ne^2A}{2m\tau\ell}$

19. The unit of specific resistance is
(a) Ωm^{-1} (b) $\Omega^{-1}m^{-1}$
(c) Ω^{-1} (d) $2.5\Omega m^2$

20. The example of non-ohmic resistance is
(a) diode (b) copper wire
(c) filament lamp (d) carbon resistor

21. Constantan wire is used for making standard resistance, because it has
(a) high melting point
(b) low specific resistance
(c) high specific resistance
(d) negligible temperature coefficient of resistance

22. At temperature 0K, the germanium behaves as a / an
(a) conductor (b) insulator
(c) super-conductor (d) ferromagnetic

23. Which of the following is used for the formation of thermistor?
(a) Copper oxide (b) Nickel oxide
(c) Iron oxide (d) All of the above

24. What is the suitable material for electric fuse?
(a) Cu (b) Constantan
(c) Tin-lead alloy (d) Nichrome

25. A strip of copper and another of germanium are cooled from room temperature to 80 K. The resistance of
(a) each of these increases
(b) each of these decreases
(c) copper strip increases and that of germanium decreases
(d) copper strip decreases and that of germanium increases

26. The electric resistance of a certain wire of iron is R. If its length and radius are both doubled, then
(a) the resistance and the specific resistance, will both remain unchanged
(b) the resistance will be doubled and the specific resistance will be halved
(c) the resistance will be halved and the specific resistance will remain unchanged
(d) the resistance will be halved and the specific resistance will be doubled

27. Nichrome or Manganin is widely used in wire bound standard resistors because of their
(a) temperature independent resistivity
(b) very weak temperature dependent resistivity.
(c) strong dependence of resistivity with temperature.
(d) mechanical strength.

28. With increase in temperature the conductivity of
(a) metals increases and of semiconductor decreases.
(b) semeconductors increases and metals decreases.
(c) in both metals and semiconductors increases.
(d) in both metal and semiconductor decreases.

29. The resistance of a metal increases with increasing temperature because
(a) the collisions of the conducting electrons with the electrons increase
(b) the collisions of the conducting electrons with the lattice consisting of the ions of the metal increase
(c) the number of conduction electrons decreases
(d) the number of conduction electrons increases

30. To minimise the power loss in the transmission cables connecting the power stations to homes and factories, the transmission cables carry current
(a) at a very low voltage.
(b) at a very high voltage
(c) at 220 volt
(d) neither at a very high voltage nor at a very low voltage.

31. Appliances based on heating effect of current work on
(a) only a.c. (b) only d.c.
(c) both a.c. and d.c. (d) None of these

32. In the series combination of two or more than two resistances
(a) the current through each resistance is same
(b) the voltage through each resistance is same
(c) neither current nor voltage through each resistance is same
(d) both current and voltage through each resistance are same.

33. Two or more resistors are said to be in ...*A*... if one end of all resistors is joined together and similarly the other ends joined together, Here, *A* refers to
(a) series (b) parallel
(c) either (a) or (b) (d) None of these

34. Emf of a cell is
(a) the maximum potential difference between the terminals of a cell when no current is drawn from the cell.
(b) the force required to push the electrons in the circuit.
(c) the potential difference between the positive and negative terminal of a cell in a closed circuit.
(d) less than terminal potential difference of the cell.

35. When potential difference is applied across an electrolyte, then Ohm's law is obeyed at
(a) zero potential (b) very low potential
(c) negative potential (d) high potential

36. To draw a maximum current from a combination of cells, how should the cells be grouped?
(a) Parallel
(b) Series
(c) Mixed grouping
(d) Depends upon the relative values of internal and external resistances.

37. Under what condition will the strength of current in a wire of resistance R be the same for connection is series and in parallel of n identical cells each of the internal resistance r? When
(a) $R = nr$ (b) $R = r/n$
(c) $R = r$ (d) $R \to \infty, r \to 0$

38. A cell of internal resistance r is connected to an external resistance R. The current will be maximum in R, if
(a) $R = r$ (b) $R < r$
(c) $R > r$ (d) $R = r/2$

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

40. The resistance of the coil of an ammeter is R. The shunt required to increase its range n-fold should have a resistance
(a) $\frac{R}{n}$ (b) $\frac{R}{n-1}$
(c) $\frac{R}{n+1}$ (d) nR

41. A cell of internal resistance r is connected across an external resistance nr. Then the ratio of the terminal voltage to the emf of the cell is
(a) $\frac{1}{n}$ (b) $\frac{1}{n+1}$
(c) $\frac{n}{n+1}$ (d) $\frac{n-1}{n}$

42. If n cells each of emf ε and internal resistance *r* are connected in parallel, then the total emf and internal resistances will be
(a) $\varepsilon, \frac{r}{n}$ (b) ε, nr
(c) $n\varepsilon, \frac{r}{n}$ (d) $n\varepsilon, nr$

43. The internal resistance of dry cell is ...*A*..., than the internal resistance of common electrolytic cell. Here, A refers to
(a) much lower (b) much higher
(c) slightly lower (d) slightly higher

44. Kirchoff's first law, i.e., $\Sigma i = 0$ at a junction, deals with the conservation of
(a) charge (b) energy
(c) momentum (d) angular momentum

45. The Kirchhoff's second law ($\Sigma iR = \Sigma E$), where the symbols have their usual meanings, is based on
(a) conservation of momentum
(b) conservation of charge
(c) conservation of potential
(d) conservation of energy

46. Why is the Wheatstone bridge better than the other methods of measuring resistances?
(a) It does not involve Ohm's law
(b) It is based on Kirchoff's law
(c) It has four resistor arms
(d) It is a null method

47. If in the experiment of Wheatstone's bridge, the positions of cells and galvanometer are interchanged, then balance point will
(a) change
(b) remain unchanged
(c) depend on the internal resistance of cell and resistance of galvanometer
(d) None of these

48. In a wheatstone bridge in the battery and galvanometer are interchanged then the deflection in galvanometer will
(a) change in previous direction
(b) not change
(c) change in opposite direction
(d) none of these.

49. In meter bridge or Wheatstone bridge for measurement of resistance, the known and the unknown resistance are interchanged. The error so removed is
(a) end correction
(b) index error
(c) due to temperature effect
(d) random error

50. Potentiometer is based on
(a) deflection method
(b) zero deflection method
(c) both (a) and (b)
(d) None of these

51. In potentiometer a balance point is obtained, when
(a) the e.m.f. of the battery becomes equal to the e.m.f of the experimental cell
(b) the p.d. of the wire between the +ve end of battery to jockey becomes equal to the e.m.f. of the experimental cell
(c) the p.d. of the wire between +ve point of cell and jockey becomes equal to the e.m.f. of the battery
(d) the p.d. across the potentiometer wire becomes equal to the e.m.f. of the battery

52. In the experiment of potentiometer, at balance point, there is no current in the
(a) main circuit
(b) galvanometer circuit
(c) potentiometer circuit
(d) both main and galvanometer circuits

53. Sensitivity of potentiometer can be increased by
(a) increasing the e.m.f of the cell
(b) increasing the length of the potentiometer
(c) decreasing the length of the potentiometer wire
(d) None of these

54. Potentiometer measures potential more accurately because
(a) it measures potential in open circuit
(b) it uses sensitive galvanometer for null deflection
(c) it uses high resistance potentiometer wire
(d) it measures potential in closed circuit

55. For measuring voltage of any circuit, potentiometer is preferred to voltmeter because
(a) the potentiometer is cheap and easy to handle.
(b) calibration in the voltmeter is sometimes wrong .
(c) the potentiometer almost draws no current during measurement.
(d) range of the voltmeter is not as wide as that of the potentiometer.

STATEMENT TYPE QUESTIONS

56. Consider the following statements and select the correct statement(s).
I. Current is the time rate of flow of charge through any cross-section
II. For a given conductor current does not change with change in cross-sectional area
III. The net charge in a current carrying conductor is infinite
(a) I and II (b) II and III
(c) I and III (d) I, II and III

57. Which of the following statements are incorrect ?
I. The order of magnitude of current flowing in household appliances is one ampere.
II The order of magnitude of current in lightening is about one ampere.
III. The order of magnitude of current in nerves in human body is one ampere.
(a) II and III (b) I and II
(c) I and III (d) I, II and III

58. Ohm's law fails in which of the following cases
I. Potential V depends on I non-linearly.
II. The relation between V and I depends on the sign of V for the same absolute value of V.
III. V depends on I linearly.
(a) I only (b) II only
(c) I and III (d) I and II

59. When no electric field is present.
I. The electrons will be moving due to thermal motion during which they collide with the fixed ions.
II. An electron colliding with an ion emerges with the same speed as before the collision. However the direction of its velocity after the collision is completely random.
III. At a given time, there is no preferential direction for the velocities of the electrons. Thus, on an average, the number of electrons travelling in any direction will be equal to the number of electrons travelling in the opposite direction. So, there will be no net electric current.
Which of the above statements are correct?
(a) I and II (b) II and III
(c) I and III (d) I, II and III

60. What should be the characteristic of fuse wire?
I. High melting point, high specific resistance
II. Low melting point, low specific resistance
III. Low melting point, high specific resistance
(a) I only (b) I and II
(c) I and III (d) III only

61. In household electric circuit
I. all electric appliances drawing power are joined in parallel
II. a switch may be either in series or in parallel with the appliance which it controls
III. if a switch is in parallel with an appliance, it will draw power when the switch is in the 'off' position (open)
IV. if a switch is in parallel with an appliance, the fuse will blow (burn out) when the switch is put 'on' closed.
Which of the above statements are correct?
(a) I and IV (b) I, III and IV
(c) II, III and IV (d) I, II and IV

62. Consider the following statements and select the correct option.
I. When resistances are connected in parallel the equivalent resistance is less than the smallest resistance.
II. When resistances are connected in parallel, current distributes in the inverse ratio of resistances.
III. When resistances are connected in series maximum current flows through the resistance having least value.
(a) I only (b) II only
(c) I and II (d) I, II and III

MATCHING TYPE QUESTIONS

63. Match the Column I and Column II.

Column I	Column II
(A) Ohm's law is applicable to	(1) Metals
(B) Ohm's law is not applicable to	(2) Greater resistivity
(C) Alloys have	(3) Diodes, electrolytes semiconductors
(D) A heat sensitive resistor	(4) Thermistors

(a) (A) $\rightarrow$ (2); (B) $\rightarrow$ (1); (C) $\rightarrow$ (3); (D) $\rightarrow$ (4)
(b) (A) $\rightarrow$ (1); (B) $\rightarrow$ (3); (C) $\rightarrow$ (2); (D) $\rightarrow$ (4)
(c) (A) $\rightarrow$ (4); (B) $\rightarrow$ (3); (C) $\rightarrow$ (2); (D) $\rightarrow$ (1)
(d) (A) $\rightarrow$ (2); (B) $\rightarrow$ (1); (C) $\rightarrow$ (4); (D) $\rightarrow$ (3)

64.

Column I	Column II
(A) Silver	(1) Wire bound resistor
(B) Semiconductor	(2) Resistor of higher range
(C) Carbon resistor	(3) Negative temperature coefficient of resistivity
(D) Manganin	(4) Least resistivity

(a) (A) $\rightarrow$ (2); (B) $\rightarrow$ (1); (C) $\rightarrow$ (3); (D) $\rightarrow$ (4)
(b) (A) $\rightarrow$ (2); (B) $\rightarrow$ (2); (C) $\rightarrow$ (4); (D) $\rightarrow$ (3)
(c) (A) $\rightarrow$ (4); (B) $\rightarrow$ (3); (C) $\rightarrow$ (2); (D) $\rightarrow$ (1)
(d) (A) $\rightarrow$ (4); (B) $\rightarrow$ (3); (C) $\rightarrow$ (2); (D) $\rightarrow$ (1)

65. Match the physical quantities in Column I and their mathematical expressions in Column II.

Column I	Column II
(A) Current	(1) $\frac{ne^2\tau}{m}$
(B) Conductivity	(2) $\frac{1}{p}\left(\frac{dp}{dT}\right)$
(C) Current density	(3) $\vec{j}\cdot\overrightarrow{\Delta S}$
(D) Temperature coefficient of resistivity	(4) $nq\,\vec{v}_d$

(a) (A) $\rightarrow$ (2); (B) $\rightarrow$ (1); (C) $\rightarrow$ (3); (D) $\rightarrow$ (4)
(b) (A) $\rightarrow$ (2); (B) $\rightarrow$ (2); (C) $\rightarrow$ (4); (D) $\rightarrow$ (3)
(c) (A) $\rightarrow$ (3); (B) $\rightarrow$ (1); (C) $\rightarrow$ (4); (D) $\rightarrow$ (2)
(d) (A) $\rightarrow$ (2); (B) $\rightarrow$ (1); (C) $\rightarrow$ (4); (D) $\rightarrow$ (3)

66. Match the Column I and Column II.

Column I	Column II
(A) Smaller the resistance greater the current	(1) If the same voltage is applied and resistance are in series
(B) Greater or smaller the resistance the current is same	(2) If the same current is passed
(C) Greater the resistance smaller the power	(3) When resistances are connected in series
(D) Greater the resistance greater the power	(4) When resistances are connected in parallel

(a) (A) $\rightarrow$ (3); (B) $\rightarrow$ (1); (C) $\rightarrow$ (2); (D) $\rightarrow$ (4)
(b) (A) $\rightarrow$ (1); (B) $\rightarrow$ (3); (C) $\rightarrow$ (2); (D) $\rightarrow$ (4)
(c) (A) $\rightarrow$ (2); (B) $\rightarrow$ (1); (C) $\rightarrow$ (4); (D) $\rightarrow$ (2)
(d) (A) $\rightarrow$ (4); (B) $\rightarrow$ (3); (C) $\rightarrow$ (1); (D) $\rightarrow$ (2)

67.

Column I	Column II
(A) Junction rule	(1) Another statement of Ohm's law.
(B) Loop rule	(2) Magnitude of drift velocity per unit electric field.
(C) $\vec{j}=\sigma\vec{E}$	(3) Based on law of conservation of charge
(D) Mobility	(4) Based on law of conservation of energy.

(a) (A) $\rightarrow$ (1); (B) $\rightarrow$ (2); C $\rightarrow$ (3); (D) $\rightarrow$ (4)
(b) (A) $\rightarrow$ (1); (B) $\rightarrow$ (3); C $\rightarrow$ (2); (D) $\rightarrow$ (4)
(c) (A) $\rightarrow$ (4); (B) $\rightarrow$ (2); C $\rightarrow$ (1); (D) $\rightarrow$ (3)
(d) (A) $\rightarrow$ (3); (B) $\rightarrow$ (4); C $\rightarrow$ (1); (D) $\rightarrow$ (2)

68. Column I gives certain situations in which a straight metallic wire of resistance R is used and Column II gives some resulting effects.

Column I	Column II
(A) A charged capacitor is connected to the ends of the wire	(1) A constant current flows through the wire
(B) The wire is moved perpendicular to its length with a constant velocity in a uniform magnetic field perpendicular to the plane of motion	(2) Thermal energy is generated in the wire
(C) The wire is placed in a constant electric field that has a direction along the length of the wire	(3) A constant potential difference develops between the ends of the wire
(D) A battery of constant emf is connected to the ends of the wire.	(4) charges of constant magnitude appear at ends of the wire

(a) (A) $\rightarrow$ (2); (B) $\rightarrow$ (3); (C) $\rightarrow$ (4); (D) $\rightarrow$ (1, 2, 3)
(b) (A) $\rightarrow$ (1); (B) $\rightarrow$ (2, 3); (C) $\rightarrow$ (4); (D) $\rightarrow$ (3)
(c) (A) $\rightarrow$ (1); (B) $\rightarrow$ (2); (C) $\rightarrow$ (1, 3); (D) $\rightarrow$ (4)
(d) (A) $\rightarrow$ (1); (B) $\rightarrow$ (2); (C) $\rightarrow$ (3); (D) $\rightarrow$ (4)

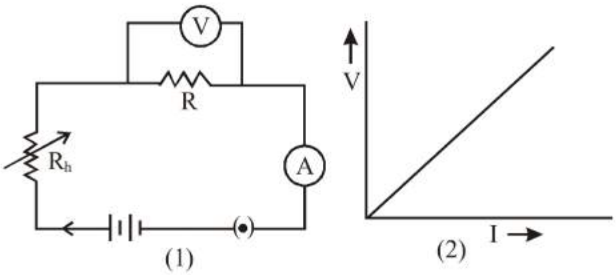
69. Match the entries of Column I with their correct mathematical expressions in Column II

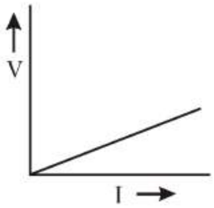
Column I	Column II
(A) Balanced condition of wheatstone bridge	(1) $\frac{R_1}{R_2}=\frac{R_3}{R_4}$
(B) Comparison of emf of two cells field.	(2) $\frac{R}{S}=\frac{l_1}{100-l_1}$
(C) Determination of internal resistance of a cell	(3) $\frac{E_1}{E_2}=\frac{l_1}{l_2}$
(D) Determination of unknown resistance by meter bridge	(4) $r=R\left(\frac{l_1}{l_2}-1\right)$

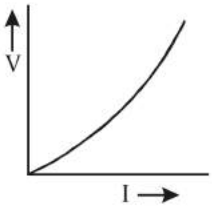
(a) (A) → (4); (B) → (2); C → (3); (D) → (1)
(b) (A) → (1); (B) → (3); C → (4); (D) → (2)
(c) (A) → (3); (B) → (4); C → (2); (D) → (1)
(d) (A) → (4); (B) → (3); C → (2); (D) → (1)

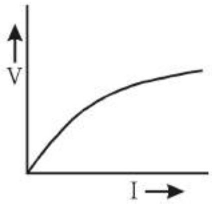
DIAGRAM TYPE QUESTIONS

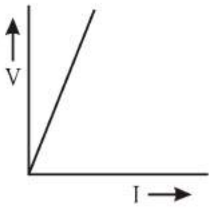
70. The figure (1) shows the experimental set up for verification of Ohm's law. Graph obtained for this set up is shown in figure (2). If the resistance R is changed with a new reistance of value 2R and the experiment is repeated again then which of the following will be the correct V-I graph?



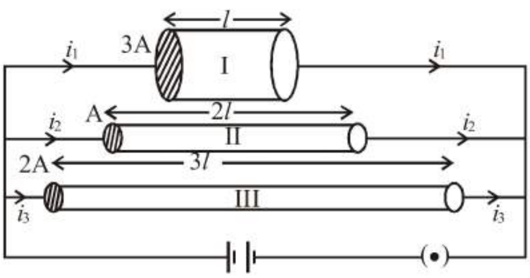
(a)


(b)


(c)


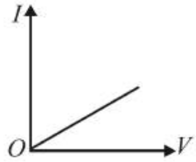
(d)


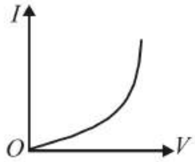
71. The figure shows three conductors I, II and III of same material, different lengths l, $2l$ and $3l$ and of different areas of cross-section 3A, A and 2A respectively. Arrange them in the increasing order of current drawn from battery.

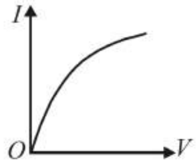


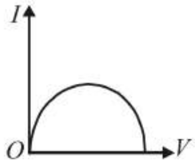
(a) $i_1 < i_2 < i_3$
(b) $i_3 < i_2 < i_1$
(c) $i_2 < i_1 < i_3$
(d) $i_2 < i_3 < i_1$

72. Which of the following I-V graph represents ohmic conductors ?

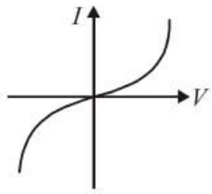
(a)


(b)


(c)


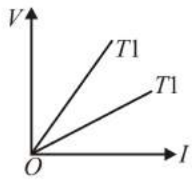
(d)


73. The I-V characteristics shown in figure represents



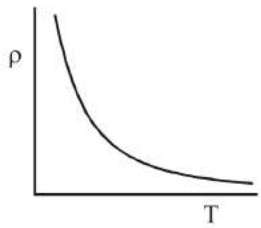
(a) ohmic conductors
(b) non-ohmic conductors
(c) insulators
(d) superconductors

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



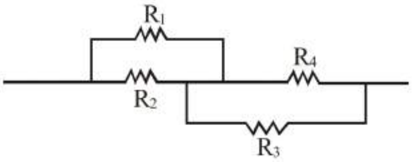
(a) $T_1 > T_2$
(b) $T_1 < T_2$
(c) $T_1 = T_2$
(d) $T_1 = \frac{1}{T_2}$

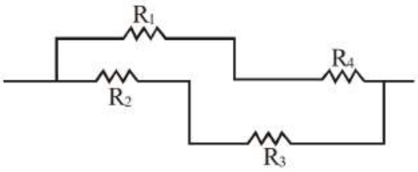
75. The graph shows the variation of resistivity with temperature T. The graph can be of

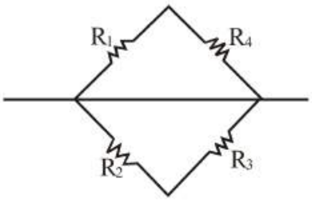


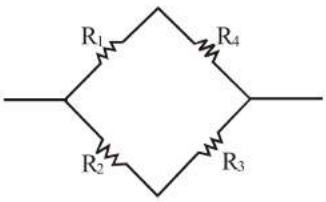
(a) copper
(b) nichrome
(c) germanium
(d) silver

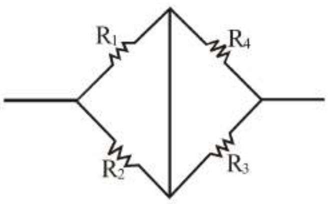
76. Choose the correct circuit diagram which is equivalent to the circuit diagram given in the figure.



(a) 

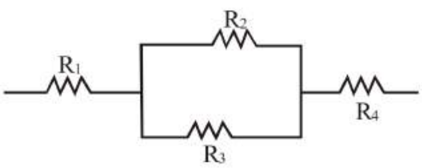
(b) 

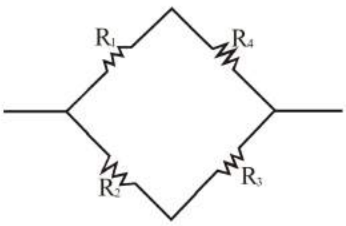
(c) 

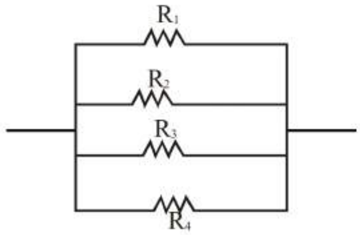
(d) 

77. Four resistors R_1, R_2, R_3 and R_4 are connected in different ways. Which of the following combinations will draw the maximum current when connected to a battery?

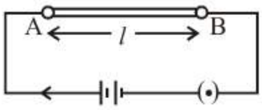
(a) 

(b) 

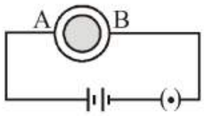
(c) 

(d) 

78. A wire of length l is connected to a battery between point A and B as shown in fig (1). The same wire is bent in the form of a circle and then connected to the battery between the points A and B as shown in fig. (2). The current drawn from the battery



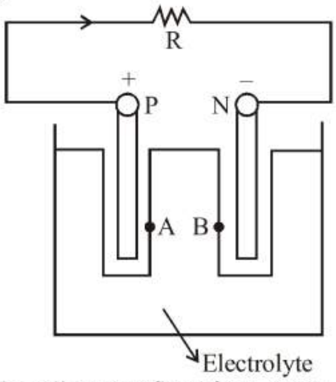
(1)



(2)

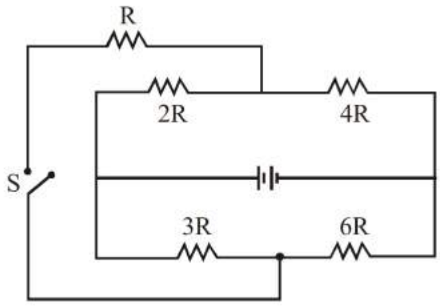
(a) increases
(b) decreases
(c) remains same
(d) increases if upper part of wire between A and B is a major arc and decreases if it is minor arc.

79. Figure shows a cell in which electrodes P and N are dipped in electrolyte. Points A and B are just adjacent to the electrodes. P is positive electrode and N is negative electrode. Which of the following is true?



(a) Inside the cell current flows from A to B.
(b) Inside the cell current flows from B to A.
(c) Current does not flow inside the cell.
(d) Inside the cell current flows in both the directions A to B and B to A.

80. The figure shows the circuit diagram of five resistors, a battery and a switch. If the switch S is closed then current drawn from the battery



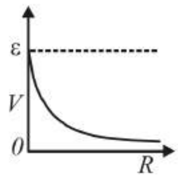
(a) increases

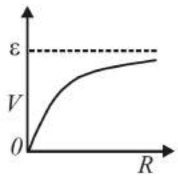
(b) decreases

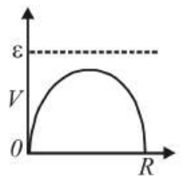
(c) remains same

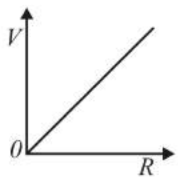
(d) initially increases and when the resistance R gets heated then decreases.

81. A cell having an emf ε and internal resistance r is connected across a variable external resistance R. As the resistance R is increased, the plot of potential difference V across R is given by

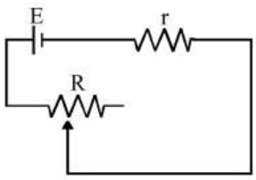
(a)


(b)


(c)


(D)


82. 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 ?



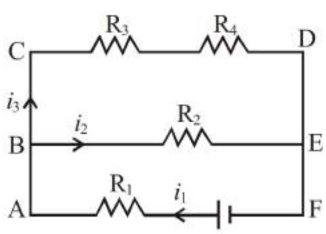
(a) Potential difference across the terminals of the battery is maximum when R = r

(b) Power delivered to resistor is maximum when R = 2r

(c) Current in the circuit is maximum when R = r

(d) Current in the circuit is maximum when R >> r

83. Which of the following is the correct equation when kirchhoff's loop rule is applied to the loop BCDEB in clockwise direction?



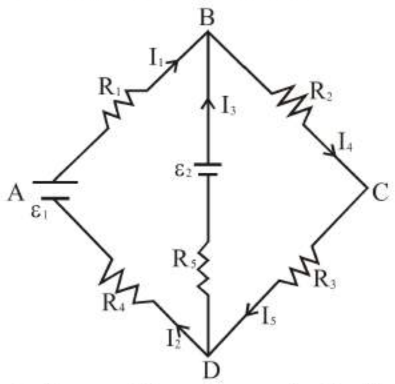
(a) $-i_3 R_3 - i_3 R_4 - i_2 R_2 = 0$

(b) $-i_3 R_3 - i_3 R_4 + i_2 R_2 = 0$

(c) $-i_3 R_3 + i_3 R_4 + i_2 R_2 = 0$

(d) $-i_3 R_3 + i_3 R_4 + i_2 R_2 = 0$

84. For the circuit diagram shown in the figure the value of I_1 comes out to be negative. It implies that



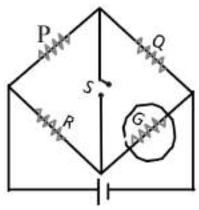
(a) the actual current flows in opposite direction of arrow

(b) the actual current flows in the direction of arrow.

(c) Kirchhoff's junction rule is wrongly applied to find current.

(d) Kirchhoff's loop rule is wrongly applied to find the current.

85. The figure shows a circuit diagram of a Wheatstone Bridge' to measure the resistance G of the galvanometer. The relation $\frac{P}{Q} = \frac{R}{G}$ will be satisfied only when



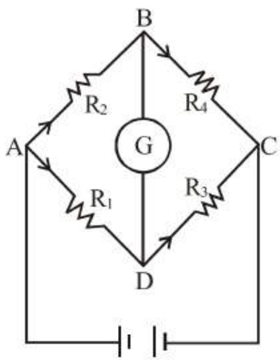
(a) the galvanometer shows a deflection when switch S is closed

(b) the galvanometer show a deflection when switch S is open

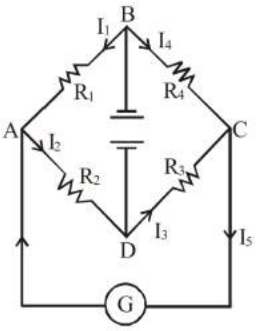
(c) the galvanometer shows no change in deflection whether S is open or closed

(d) the galvanometer shows no deflection

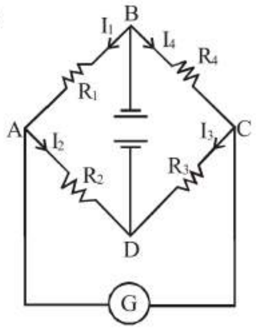
86. The bridge is at balanced condition in figure. Now the battery and galvanometer are interchanged. Which of the following figures show the correct direction of flow of current?



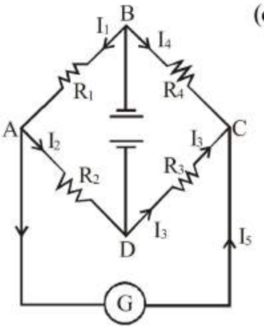
(a)



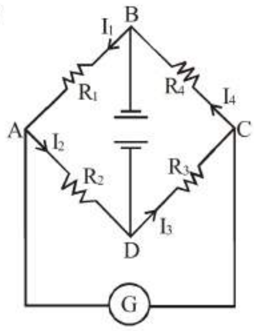
(b)



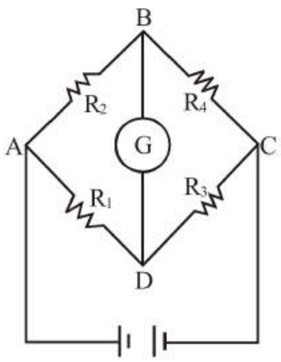
(c)



(d)

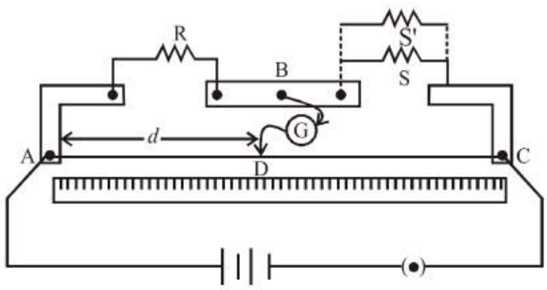


87. In the figure in balanced condition of wheatstone bridge



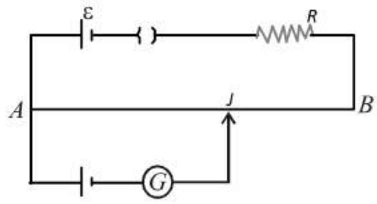
(a) B is at higher potential
(b) D is at higher potential
(c) Any of the two B or D can be at higher potential than other arbitrarily.
(d) B and D are at same potential.

88. The figure shows a meter bridge in which null point is obtained at a length AD = l. When a resistance S' is connected in parallel with resistance S the new position of null point is obtained



(a) to the left of D
(b) to the right of D
(c) at the same point D
(d) to the left of D if S' has lesser value than S and to the right of D if S' has more value than S.

89. AB is a wire of potentiometer with the increase in value of resistance R, the shift in the balance point J will be



(a) towards B
(b) towards A
(c) remains constant
(d) first towards B then back towards A

ASSERTION- REASON TYPE QUESTIONS

Directions : Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

90. **Assertion:** Current is a vector quantity.
Reason: Current has magnitude as well as direction.

91. **Assertion :** A stream of positively charged particle produces an electric field E at a centrain distance from it.
Reason : A current currying conductor produces an electric field 2E at the same distance.

92. **Assertion :** Electric field outside the conducting wire which carries a constant current is zero.
Reason : Net charge on conducting wire is zero.

93. **Assertion:** The statement of Ohm's law is V = IR.
Reason: V = IR is the equation which defines resistance.

94. **Assertion :** A current flows in a conductor only when there is an electric field within the conductor.
Reason : The drift velocity of electron in presence of electric field decreases.

95. **Assertion :** Drift speed v_d is the average speed between two successive collisions.
Reason : If $\Delta\ell$ is the average distance moved between two collision and Δt is the corresponding time, then $v_d = \lim_{\Delta t \to 0} \frac{\Delta \ell}{\Delta t}$.

96. **Assertion :** When a current is established in a wire, the free electrons drift in the direction opposite to the current and so the number of free electrons in the wire continuously decrease.
Reason : Charge is a conserved quantity.

97. **Assertion :** The electric bulb glows immediately when switch is on.
Reason : The drift velocity of electrons in a metallic wire is very high.

98. **Assertion:** $\vec{E} = \rho\,\vec{j}$ is the statement of Ohm's law.
Reason: If the resistivity of the conducting material is independent of the direction and magnitude of applied field then the material obeys Ohm's law.

99. **Assertion:** For a conductor resistivity increases with increase in temperature.
Reason: Since $\rho = \frac{m}{ne^2\tau}$, when temperature increases the random motion of free electrons increases and vibration of ions increases which decreases τ.

100. **Assertion :** The drift velocity of electrons in a metallic wire will decrease, if the temperature of the wire is increased.
Reason : On increasing temperature, conductivity of metallic wire decreases.

101. **Assertion :** Bending a wire does not effect electrical resistance.
Reason: Resistance of wire is proportional ot resistivity of material.

102. **Assertion :** Two non ideal batteries are connected in parallel. The equivalent emf is smaller than either of the two emfs.
Reason : The equivalent internal resistance is smaller than either of the two internal resistances.

103. **Assertion :** Kirchoff's juction rule can be applied to a junction of several lines or a point in a line.
Reason : When steady current is flowing, there is no accumulation of charges at any junction or at any point in a line.

104. **Assertion :** Kirchoff's junction rule follows from conservation of charge.
Reason : Kirchoff's loop rule follows from conservation of momentum.

105. **Assertion :** In meter bridge experiment, a high resistance is always connected in series with a galvanometer.
Reason : As resistance increases current through the circuit increases.

106. **Assertion :** 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.
Reason : Resistance of a metal increases with increase in temperature.

107. **Assertion :** In meter bridge experiment, a high resistance is always connected in series with a galvanometer.
Reason : As resistance increase current more accurately then ammeter.

108. **Assertion :** The e.m.f of the driver cell in the potentiometer experiment should be greater that the e.m.f of the cell to be determined.
Reason : The fall of potential across the potentiometer wire should not be less than the e.m.f of the cell to be determined.

109. **Assertion :** A potentiometer of longer length is used for accurate measurement.
Reason : The potential gradient for a potentiometer of longer length with a given source of e.m.f becomes small.

CRITICALTHINKING TYPE QUESTIONS

110. The amount of charge Q passed in time t through a cross-section of a wire is $Q = 5t^2 + 3t + 1$. The value of current at time t = 5 s is
(a) 9 A (b) 49 A
(c) 53 A (d) None of these

111. A conductor carries a current of 50 μ A. If the area of cross-section of the conductor is 50 mm^2, then value of the current density in Am^{-2} is
(a) 0.5 (b) 1
(c) 10^{-3} (d) 10^{-6}

112. Two wires A and B of the same material, having radii in the ratio 1 : 2 and carry currents in the ratio 4 : 1. The ratio of drift speed of electrons in A and B is
(a) 16 : 1 (b) 1 : 16
(c) 1 : 4 (d) 4 : 1

113. When a current I is set up in a wire of radius r, the drift velocity is v_d. If the same current is set up through a wire of radius 2 r, the drift velocity will be
(a) $4\,v_d$ (b) $2\,v_d$
(c) $v_d/2$ (d) $v_d/4$

114. A straight conductor of uniform cross-section carries a current I. If s is the specific charge of an electron, the momentum of all the free electrons per unit length of the conductor, due to their drift velocity only is
(a) Is (b) $\sqrt{I/s}$
(c) I/s (d) $(I/s)^2$

115. When the current *i* is flowing through a condutor, the drift velocity is *v*. If 2*i* current flows through the same metal but having double the are of cross-section, then the drift velocity will be
(a) $v \setminus 4$ (b) $v / 2$
(c) v (d) $4v$

116. If the resistance of a conductor is 5Ω at 50° C & 7Ω at 100° C, then mean temperature coefficient of resistance (of material) is
(a) 0.013/°C (b) 0.004/°C
(c) 0.006/°C (d) 0.008/°C

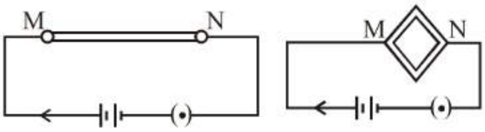
117. If negligibly small current is passed though a wire of length 15 m and resistance of 5Ω, having uniform cross section of 6×10^{-7} m^2, then coefficient of resistivity of material is

(a) $1\times10^{-7}\Omega$–m (b) $2\times10^{-7}\Omega$–m
(c) $3\times10^{-7}\Omega$–m (d) $4\times10^{-7}\Omega$–m

118. The resistance of a wire at room temperature 30°C is found to be 10 Ω. Now to increase the resistance by 10%, the temperature of the wire must be [The temperature coefficient of resistance of the material of the wire is 0.002 per °C]

(a) 36°C (b) 83°C
(c) 63°C (d) 33°C

119. A wire is connected to a battery between the point *M* and *N* as shown in the figure (1). The same wire is bent in the form of a square and then connected to the battery between the points *M* and *N* as shown in the figure (2). Which of the following quantities increases ?



(1) (2)

(a) Heat produced in the wire and resistance offered by the wire.
(b) Resistance offered by the wire and current through the wire.
(c) Heat produced in the wire, resistance offered by the wire and current through the wire.
(d) Heat produced in the wire and current through the wire.

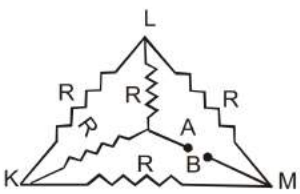
120. When a piece of aluminium wire of finite length is drawn through a series of dies to reduce its diameter to half its original value, its resistance will become

(a) two times (b) four times
(c) eight times (d) sixteen times

121. A wire X is half the diameter and half the length of a wire Y of similar material. The ratio of resistance of X to that of Y is

(a) 8 : 1 (b) 4 : 1
(c) 2 : 1 (d) 1 : 1

122. Each of the resistance in the network shown in fig. is equal to R. The resistance between the terminals A and B is

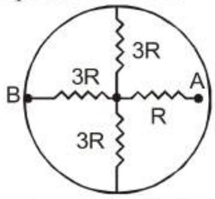


(a) R (b) 5 R
(c) 3 R (d) 6 R

123. A wire has a resistance 12 Ω. It is bent in the form of a circle. The effective resistance between two points on any diameter is

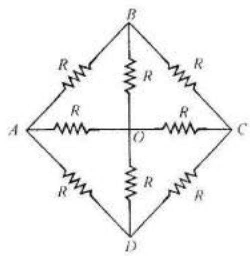
(a) 6 Ω (b) 3 Ω
(c) 12 Ω (d) 24 Ω

124. In the network shown below, the ring has zero resistance. The equivalent resistance between the point A and B is



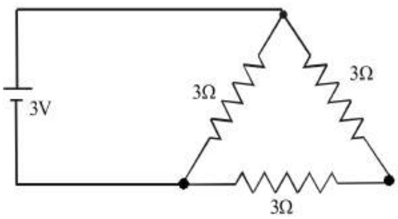
(a) 2R
(b) 4R
(c) 7R
(d) 10R

125. In the network shown, each resistance is equal to R. The equivalent resistance between adjacent corners A and D is



(a) R
(b) $\frac{2}{3}$R
(c) $\frac{3}{7}$R
(d) $\frac{8}{15}$R

126. 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

127. Two sources of equal emf are connected to an external resistance R. The internal resistance 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) $R = R_2 - R_1$
(b) $R = R_2 \times (R_1 + R_2)/(R_2 - R_1)$
(c) $R = R_1R_2/(R_2 - R_1)$
(d) $R = R_1R_2/(R_1 - R_2)$

128. In the series combination of *n* cells each cell having emf ε and internal resistance *r*. If three cells are wrongly connected, then total emf and internal resistance of this combination will be

(a) $n\varepsilon$, $(nr - 3r)$ (b) $(n\varepsilon - 2\varepsilon)$ nr
(c) $(n\varepsilon - 4\varepsilon)$, nr (d) $(n\varepsilon - 6\varepsilon)$, nr

129. The internal resistance of a 2.1 V cell which gives a current of 0.2 A through a resistance of 10 Ω is

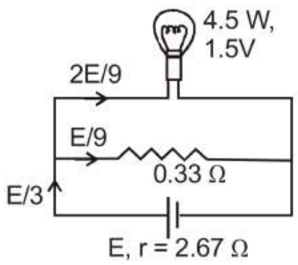
(a) 0.5 Ω (b) 0.8 Ω
(c) 1.0 Ω (d) 0.2 Ω

130. A primary cell has an e.m.f. of 1.5 volt. When short-circuited it gives a current of 3 ampere. The internal resistance of the cell is

(a) 4.5 ohm (b) 2 ohm

(c) 0.5 ohm (d) (1/4.5) ohm

131. A torch bulb rated as 4.5 W, 1.5 V is connected as shown in fig. The e.m.f. of the cell, needed to make the bulb glow at full intensity is



(a) 4.5 V (b) 1.5 V

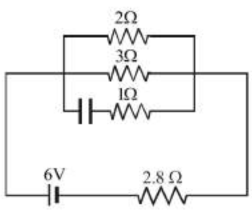
(c) 2.67 V (d) 13.5 V

132. A battery of e.m.f. 10 V and internal resistance 0.5 Ω is connected across a variable resistance R. The value of R for which the power delivered in it is maximum is given by

(a) 0.5 Ω (b) 1.0 Ω

(c) 2.0 Ω (d) 0.25 Ω

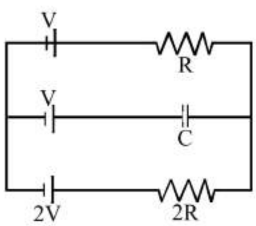
133. Determine the current in 2Ω resistor.



(a) 1 A (b) 1.5 A

(c) 0.9 A (d) 0.6 A

134. 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) $\frac{2V}{3}$

135. The resistance of the four arms P, Q, R and S in a Wheatstone's bridge are 10 ohm, 30 ohm, 30 ohm and 90 ohm, respectively. The e.m.f. and internal resistance of the cell are 7 volt and 5 ohm respectively. If the galvanometer resistance is 50 ohm, the current drawn from the cell will be

(a) 0.2 A (b) 0.1 A

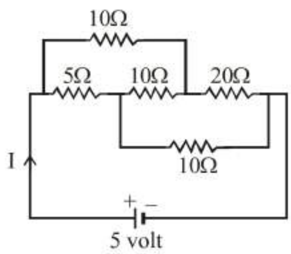
(c) 2.0 A (d) 1.0 A

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

(a) $\frac{P}{Q}=\frac{2R}{S_1+S_2}$ (b) $\frac{P}{Q}=\frac{R(S_1+S_2)}{S_1S_2}$

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

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



(a) 0.33 A (b) 0.5 A

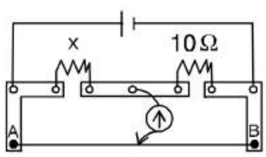
(c) 0.67 A (d) 0.17 A

138. In a Wheatstone bridge all the four arms have equal resistance R. If the resistance of galvanometer arm is also R, the equivalent resistance of combination is

(a) 2R (b) R/4

(c) R/2 (d) R

139. A meter bridge is set up as shown, to determine an unknown resistance 'X' using a standard 10 ohm 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 ohm (b) 10.6 ohm

(c) 10.8 ohm (d) 11.1 ohm

140. In a metre bridge, the balancing length from the left end (standard resistance of one ohm is in the right gap) is found to be 20 cm. The value of the unknown resistance is

(a) 0.8 Ω (b) 0.5 Ω
(c) 0.4 Ω (d) 0.25 Ω

141. If specific resistance of a potentiometer wire is $10^{-7}\Omega$m current flowing through it, is 0.1 amp and cross sectional area of wire is 10^{-6} m^2, then potential gradient will be

(a) 10^{-2} volt/m (b) 10^{-4} volt/m
(c) 10^{-6} volt/m (d) 10^{-8} volt/m

142. The current in the primary circuit of a potentiometer wire is 0.5 A, ρ for the wire is 4×10^{-7} Ω–m and area of cross-section of wire is 8×10^{-6} m^2. The potential gradient in the wire would be

(a) 25 mV/meter (b) 2.5 mV/meter
(c) 25 V/meter (d) 10 V/meter

143. A cell when balanced with potentiometer gave a balance length of 50 cm. 4.5 Ω external resistance is introduced in the circuit, now it is balanced on 45 cm. The internal resistance of cell is

(a) 0.25 Ω (b) 0.5 Ω
(c) 1.0 Ω (d) 1.5 Ω

144. A potentiometer consists of a wire of length 4m and resistance 10Ω. It is connected to a cell of e.m.f. 3V. The potential gradient of wire is

(a) 5V/m (b) 2V/m
(c) 5V/m (d) 10V/m

145. Potentiometer wire of length 1 m is connected in series with 490Ω resistance and 2 V battery. If 0.2 mV/cm is the potential gradient, then resistance of the potentiometer wire is

(a) 4.9 Ω (b) 7.9 Ω
(c) 5.9 Ω (d) 6.9 Ω

146. A potentiometer wire, 10 m long, has a resistance of 40Ω. It is connected in series with a resistance box and a 2 V storage cell. If the potential gradient along the wire is 0.1 m V/cm, the resistance unplugged in the box is

(a) 260 Ω (b) 760 Ω
(c) 960 Ω (d) 1060 Ω

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

(a) 1.5 Ω (b) 10 Ω
(c) 15 Ω (d) 1 Ω

HINTS AND SOLUTIONS

FACT/DEFINITION TYPE QUESTIONS

1. **(c)** In a current carrying conductor, the net charge is zero.
2. **(c)** **3. (d)** **4. (d)**
5. **(a)** $J = \sigma E \Rightarrow J\rho = E$

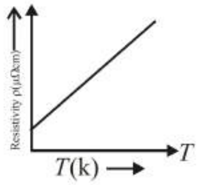
   J is current density, E is electric field

   so $B = \rho$ = resistivity.
6. **(b)** Motion of conduction electrons due to random collisions has no preffered direction and average to zero. Drift velocity is caused due to motion of conduction electrons due to applied electric field $\vec{E}$.
7. **(d)** **8. (a)** **9. (b)**
10. **(d)** **11. (d)** **12. (c)**
13. **(b)** When the temperature increases, resistance increases. As the e.m.f. applied is the same, the current density decreases the drift velocity decreases. But the rms velocity of the electron due to thermal motion is proportional to $\sqrt{T}$. The Thermal velocity increases.
14. **(b)**
15. **(b)** Because as temperature increases, the resistivity increases and hence the relaxation time decreases for conductors $\left(\tau \propto \frac{1}{\rho}\right)$
16. **(b)**
17. **(a)** In conductor when electrons move between two collisions, their paths are **straight lines** when external fields are absent and paths are **curved in general** when external field is present.
18. **(a)** **19. (c)** **20. (a)** **21. (d)** **22. (b)**
23. **(d)** **24. (c)** **25. (d)**
26. **(c)** $R = \frac{\rho \ell_1}{A_1}$, now $\ell_2 = 2\ell_1$

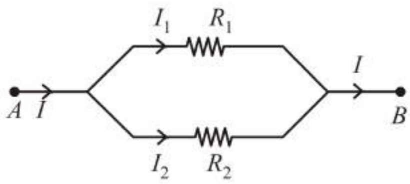
   $A_2 = \pi(r_2)^2 = \pi(2r_1)^2 = 4\pi r_1^2 = 4A_1$

   $\therefore \quad R_2 = \frac{\rho(2\ell_1)}{4A_1} = \frac{\rho\ell}{2A} = \frac{R}{2}$

   $\therefore$ Resistance is halved, but specific resistance remains the same.
27. **(b)** These materials exhibit a very weak dependence of resistivity on temperature. Their resistance values would be changed very little with temperature as shown in figure. Hence these materials are widely used as heating element.



28. **(b)** Semiconductors having negative temperature coefficient of resistivity whereas metals are having positive temperature coefficient of resistivity with increase in temperature the resistivity of metal increases where a resistivity of semiconductor decreases.
29. **(a)** The conduction electrons collides with each other more. the specific resistance of a conductor increases with temperature according to the reaction $\rho_T = \rho_0{}^{eEg/kgT}$ where ρ_0 is the specific resistance at 0° C, E_g = energy of the gap between the valence and the conduction band, k_B is the Boltzmann constant and T, the temperature of the resistor.
30. **(b)** The power dissipated in the transmission cables is inversely proportional to the square of voltage at which current is transmitted through the cables. Therefore to minimize the power loss the transmission cables carry current at a very high voltage.
31. **(c)**
32. **(a)** In series combination, current across its circuit components is always constant and in parallel combination the voltage across the circuit components in constant.
33. **(b)** Two or more resistors are said to be in parallel, if one end of all resistors is joined together and similarly the other ends joined together.



Two resistors R_1 and R_2 connected in parallel.

34. **(a)** **35. (d)** **36. (d)** **37. (c)** **38. (a)**
39. **(d)** $I = \frac{E}{R + r}$, Internal resistance (r) is zero,

   $I = \frac{E}{R}$ = constant.
40. **(b)** $S = \frac{I_g R}{nI_g - I_g} \Rightarrow S = \frac{I_g}{(n-1)I_g} R$

41. (c) Internal resistance = r, External resistance = nr.
Let terminal voltage = V

then $V = E - Ir \Rightarrow V = E - \frac{Er}{(n+1)r}$

$$V = \frac{nE}{n+1} \Rightarrow \frac{V}{E} = \frac{n}{n+1}$$

42. (a) : In the parallel combination,

$$\frac{\varepsilon_{eq}}{r_{eq}} = \frac{\varepsilon_1}{r_1} + \frac{\varepsilon_2}{r_2} + ... + \frac{\varepsilon_n}{r_n}$$

$$\frac{1}{r_{eq}} = \frac{1}{r_1} + \frac{1}{r_2} + ... + \frac{1}{r_n}$$

$(\because \varepsilon_1 = \varepsilon_2 = \varepsilon_3 = ... = \varepsilon_n = \varepsilon \text{ and } r_1 = r_2 = r_3 = ... r)$

$$\therefore \frac{\varepsilon_{eq}}{r_{eq}} = \frac{\varepsilon}{r} + \frac{\varepsilon}{r} + ... + \frac{\varepsilon}{r} = n\frac{\varepsilon}{r} \quad .... (i)$$

$$\frac{\varepsilon}{r_{eq}} = \frac{1}{r} + \frac{1}{r} + ... + \frac{1}{r} = \frac{n}{r} \quad r_{eq} = r/n \quad ...(ii)$$

From (i) and (ii)

$$\varepsilon_{eq} = n\frac{\varepsilon}{r_{eq}} \times r_{eq} = n \times \frac{\varepsilon}{r} \times \frac{\varepsilon}{r} = \varepsilon$$

43. (b) The internal resistance of dry cells, is much higher than the common electrolytic cells.

44. (a)

45. (d) Kirchhoff's first law is based on conservation of charge and Kirchhoff's second law is based on conservation of energy.

46. (d) 47. (b)

48. (b) The deflection in galvanometer will not be changed due to interchange of battery and the galvanometer.

49. (a) In meter bridge experiment, it is assumed that the resistance of the *L* shaped plate is negligible, but actually it is not so. The error created due to this is called end error. To remove this the resistance box and the unknown resistance must be interchanged and then the mean reading must be taken.

50. (b) Potentiometer is based on zero deflection method.

51. (b) 52. (b) 53. (b) 54. (a) 55. (c)

STATEMENT TYPE QUESTIONS

56. (a)

57. (a) The order of magnitude of current in lightening is very high approx 10,000 of amperes. The order of magnitude of current in human body and galvanometer is also not one ampere.

58. (d) According to Ohm's law, the plot of I versus V is linear so how can it fail if V depends on I linearly.

59. (d) Consider the case when no electric field is present. The electrons will be moving due to thermal motion during which they collide with the fixed ions. An electron colliding with an ion emerges with the same speed as before the collision. However, the direction of its velocity after the collision is completely random. At a given time, there is no preferential direction for the velocities of the electrons. Thus, on the average, the number of electrons travelling in any direction will be equal to the number of electrons travelling in the opposite direction. So, there will be no net electric current.

60. (d) 61. (b)

62. (c) When resistances are connected in series the same current flows through each resistance.

MATCHING TYPE QUESTIONS

63. (b) (A) → (1) if the temperature is not very high.
(B) → (3)
(C) → (2)
(D) → (4)

64. (d) A - (4) as silver has least resistivity. B - (3) because the resistivity of semiconductor decreases with temperature so they have negative temperature coefficient of resistivity. C-(2) as carbon resistors have high range. D-(1) because wires of alloys like managanin, constantan, nichrome etc are used to make wire bound resistors.

65. (c) 66. (c)

67. (d) A-(3) Kirchhoff's junction rule is based on law of conservation of charge. B-(4) Kirchhoff's loop rule is based on law of conservation of energy. C-(1) $\vec{j} = \sigma \vec{E}$ is also an equivalent form of Ohm's law. D-(2) as mobility is defined as the magnitude of drift velocity per unit electric field.

68. (a) A-2 : Energy stored in capacitor will convert into thermal energy.
B-3 : Induced emf, $e = Bv\ell$.
C-4 : Because of electric force ends of wire will have opposite charges.
D-1, 2, 3 : When battery is connected to wire a constant current flows in the wire which produces heating effect.

69. (b)

DIAGRAM TYPE QUESTIONS

70. (d) Even if resistance R is changed with $2R$, according to Ohm's law V is still proportional to I i.e., the graph between V and I is a straight line. Then why option (a) is not correct? Because the slope of $V.I.$ graph gives the value of resistance. As the value of resistance is increased from R to $2R$, the slope of given graph must also increase which is shown in fig. (d).

71. (d) As we know, resistance $R = \rho\frac{l}{A}$. The resistance of conductor l is given by

$$R_l = \rho\frac{l}{3A} = \frac{R}{3} \qquad \left(\text{where } R = \rho\frac{l}{A}\right)$$

Similarly, $R_{II} = \rho\frac{2l}{A} = 2R$

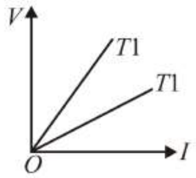
and $R_{III} = \rho\frac{3l}{2A} = \frac{3}{2}R$

From this we conclude that $R_{II} > R_{III} > R_I$. Since in parallel combination of resistances current distributes in inverse ratio of resistances, therefore $i_2 < i_3 < i_1$

72. **(a)** Ohm's law $V = IR$ is an equation of straight line Hence I - V characteristics for ohmic conductors is also a straight line and its slope gives resistance of the conductor.

73. **(b)** The figure is showing $I - V$ characteristics of non ohmic or non linear conductors.

74. **(a)**



The slope of $V - I$ graph gives the resistance of a conductor at a given temperature.
From the graph, it follows that resistance of a conductor at temperature T_1 is greater than at temperature T_1 As the resistance of a conductor is more at higher temperature and less at lower temperature, hence $T_1 > T_2$

75. **(c)** The resistivity of semiconductor decreases with increase in temperature.

76. **(d)** This is a balanced Wheatstone bridge condition.

77. **(d)** When all the resistances are connected in parallel the equivalent resistance is minimum so, current drawn will be maximum.

78. **(a)** In figure (2) the upper and lower part of the wire between A and B are in parallel. Therefore the equivalent resistance of these two parts is less than the resistance of each of the upper and lower part. Since the resistance between A and B decreases in fig. (2) therefore the current drawn from the battery increases.

79. **(b)** Current does flow through the electrolyte inside the cell and it flows from negative electrode to positive electrode.

80. **(c)** No current flows through the resistor R as A and C are at same potential. Hence current drawn from battery will remain same on closing the switch.

81. **(b)** Current in the circuit,

$$I = \frac{\varepsilon}{R+r}$$

Potential difference across R,

$$V = IR = \left(\frac{\varepsilon}{R+r}\right)R = \frac{\varepsilon}{1+\frac{r}{R}}$$

When $R = 0$, $V = 0$
$R = \infty$, $V = \varepsilon$

82. **(c)** $I = \frac{E}{R+r} = \frac{E}{(\sqrt{R}-\sqrt{r})^2 + 2\sqrt{R}\sqrt{r}}$

I is maximum when R = r

$P = I^2R$, when I is max, P is also max.

$P_{max} = I_{max}^2 R$.

83. **(b)** If we apply Kirchhoff's loop rule to the loop BCDEB in clockwise direction the changes in potential across R_3 and R_4 are negative. Therefore $i_3 R_3$ and $i_3 R_4$ should have negative sign. But for this clockwise direction we are moving in a direction opposite to i_2 across R_2. Current flows from higher potential to lower potential but we are moving from lower potential to higher potential i.e., potential is increasing. So the change in potential is positive. Therefore $i_2 R_2$ has positive sign.

84. **(a)** If the value of current comes out positive then actual current is in the direction of arrow and if it comes out negative then actual current is in opposite direction of the arrow.

85. **(c)** In balances condition, no current will flow through the branch containing S.

86. **(b)** In the balance condition if the battery and galvanometer are interchanged even then no current flows through the galvanometer as A and C are at same potential.

87. **(d)** In balance condition, since no current flows through the galvanometer therefore B and D are at the same potential.

88. **(b)** The working principle of meter bridge is

$$\frac{R}{S} = \frac{l}{100-l} \quad \ldots\text{(i)}$$

When S' is connected in parallel with S we obtain equivalent resistance S_{eq} of S and S' which is less than S. Thus if the value of denominator of L.H.S. of eq. (i) decreases then value of denominator of R.H.S. of eq. (i) also decreases. For this to happen the null point shifts to the right of D.

89. **(a)** Due to increases in resistance R the current through the wire will decrease and hence the potential gradient also decreases, which results in increase in balancing length. So. J will shift towards B.

ASSERTION- REASON TYPE QUESTIONS

90. **(d)** We call those quantities as vector quantities which have magnitude and direction and obey laws of vector addition. Though current has magnitude as well as direction but it does not obey laws of vector addition. Hence it is not a vector quantity.

91. **(c)** The net charge on current carrying conductor is zero, and so its electric field is also zero.

92. **(a)**

93. **(d)** A diode does not obey Ohm's law while a resistor obeys. But the equation $V = IR$ can be applied to both. In fact the equation $V = IR$ can be applied to all the conducting devices whether they obey Ohm's law or not. So $V = IR$

is not a statement of Ohm's law. Ohm's law states that V is directly proportional to I i.e.. $V \propto I$. The proportionality sign is changed to equality sign in the equation $V = IR$ with R as constant of proportionality know as resistance of conductor. Thus the equation $V = IR$ defines resistance.

94. (c) Before the presence of electric field, the free electrons move randomly in the conductor, so their drift velocity is zero and therefore there is no current in the conductor. In the presence of electric field, each electron in the conductor experience a force in a direction opposite to the electric field. Now the free electrons are accelerated from negative and to the positive end of the conductor and hence a current starts to flow from the conductor.

95. (c) Drift speed is the average speed between two successive collision.

96. (d) The free electron density in any part of the conductor remains constant.

97. (c) The drift velocity of electrons in metals is order of 10^{-4} m/s.

98. (a) We know that $V = IR$

Since $R = \rho \frac{l}{A}$

Therefore $V = I\rho \frac{l}{A}$ ...(i)

Now $\frac{I}{A} = j$ is the current density.

Therefore eq. (i) becomes

$V = j\rho l$ or $\frac{V}{l} = j\rho$

Now $\frac{V}{l} = E$, where E is magnitude of electric field.

Therefore $E = j\rho$ ...(ii)

Current density $\vec{j}$ is also a vector which is directed along $\vec{E}$. Therefore the relation (ii) can also be written in vector form $\vec{E} = \rho\vec{j}$.

99. (a) When temperature increases the random motion of electrons and vibration of ions increases which results in more frequent collisions of electrons with the ions. Due to this the average time between the successive collisions, denoted by τ, decreases which increases ρ.

100. (b) On increasing temperature of wire the kinetic energy of free electrons increase and so they collide more rapidly with each other and hence their drift velocity decreases. Also when temperature increases, resistivity increases and resistivity is inversely proportional to conductivity of material.

101. (a) Resistance wire $R = \rho\frac{l}{A}$, where ρ is resistivity of material which does not depend on the geometry of wire. Since when wire is bent resistivity, length and area of cross-section do not change, therefore resistance of wire also remain same.

102. (d) The equivalent *emf* of the two batteries in parallel,

$$e = \left(\frac{e_1 r_2 + r_2 r_1}{r_1 + r_2}\right).\ e \text{ may be; } e_1 \le e \le e_2.$$

Internal resistance, $r = \left(\frac{r_1 r_2}{r_1 + r_2}\right)$. This value is smaller than either of r_1 and r_2.

103. (a)

104. (c) Kirchoff's loop rule follows from conservation of energy.

105. (c) The resistance of the galvanometer is fixed. In meter bride experiments, to protect the galvanometer from a high current, high resistance is connected to the galvanometer.

106. (d) With increase in temperature, resistance of metal wire increases, but balance conduction will not change.

107. (c) The resistance of the galvanometer is flexed. In meter bridge experiments, to protect the galvanometer from a high current, high resistance is conneted to the galvanometer in order to protect it from damage.

108. (a) If either e.m.f. of the driver cell or potential difference across the whole potentiometer wire is lesser than the e.m.f. of then experimental cell, then balance point will not obtained.

109. (a) Sensitivity $\propto \frac{1}{\text{Potential gradient}} \propto$ (Length of wire)

CRITICALTHINKING TYPE QUESTIONS

110. (c) $I = \frac{dQ}{dt} = 10t + 3$

At $t = 5s$, $I = 10 \times 5 + 3 = 53$ A

111. (b) Current density $J = I/A$

$= 50 \times 16^{-6} / 50 \times 10^{-6} = 1\ Am^{-2}$

112. (a) Current flowing through the conductor,
$I = n\,e\,v\,A$. Hence

$$\frac{4}{1} = \frac{nev_{d_1}\pi(1)^2}{nev_{d_2}\pi(2)^2} \text{ or } \frac{v_{d_1}}{v_{d_2}} = \frac{4 \times 1}{1} = \frac{16}{1}.$$

113. (d) $I = n\,A\,e\,v_d$ or $v_d \propto 1/\pi r^2$

114. (c)

115. (c) $v_d = \frac{J}{ne} \Rightarrow v_d \propto J$ [current density]

$$J_1 = \frac{i}{A} \text{ and } J_2 = \frac{2i}{2A} = \frac{1}{A} J_1;$$

$\therefore\ (v_d)_1 = (v_d)_2 = v$

116. (a) [Hint $\Rightarrow R_t = R_0(1 + \alpha t)$]

$5\Omega = R_0(1 + \alpha \times 50)$ and $7\Omega = R_0(1 + \alpha \times 100)$

or $\frac{5}{7} = \frac{1 + 50\alpha}{1 + 100\alpha}$ or $\alpha = \frac{2}{150} = 0.0133/°C$

117. (b) (Hint $\Rightarrow \rho = \frac{R.A}{\ell}$ = Coefficient of resistivity)

118. (b) $R_t = R_0(1+\alpha t)$
Initially, $R_0(1+30\alpha) = 10\,\Omega$
Finally, $R_0(1+\alpha t) = 11\,\Omega$

$$\therefore \frac{11}{10} = \frac{1+\alpha t}{1+30\alpha}$$

or, $10 + (10 \times 0.002 \times t) = 11 + 330 \times 0.002$

or, $0.02t = 1 + 0.66 = 1.066$ or $t = \frac{1.66}{0.02} = 83°C$.

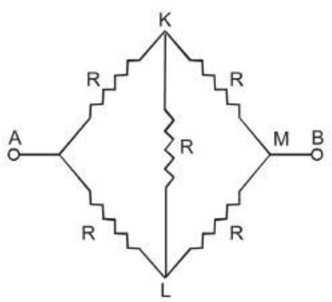
119. (d) When the wire is bent in the form of a square and connected between *M* and *N* as shown in fig. (2), the effective resistance between *M* and *N* decreases to one fourth of the value in fig. (1). The current increases four times the initial value according to the relation $V = IR$. Since $H = I^2Rt$, the decrease in the value of resistance is more than compensated by the increases in the value of current. Hence heat produced increases.

120. (d)

121. (c) $R = \frac{\rho \ell}{(\pi D^2/4)}$ or $R \propto \frac{\ell}{D^2}$.

$$\frac{R_x}{R_y} = \frac{\ell_x}{D_x^2} \times \frac{D_y^2}{\ell_y} = \frac{\ell_y/2}{(D_y/2)^2} \times \frac{D_y^2}{\ell_y} = \frac{2}{1}$$

122. (a) The equivalent circuit is shown in fig. Since the Wheatstone's bridge is balanced, therefore no current will flow through the arm KL. Equivalent resistance between
AKM = R + R = 2 R
Equivalent resistance between ALM = R + R = 2 R
The two resistances are in parallel. Hence equivalent resistance between A and B is given by



$$\frac{1}{R'} = \frac{1}{2R} + \frac{1}{2R} = \frac{2}{2R} = \frac{1}{R}$$

i.e., $R' = R$

123. (b) Resistance of the wire of a semicircle = 12/2 = 6Ω
For equivalent resistance between two points on any diameter, 6Ω and 6Ω are in parallel.

or

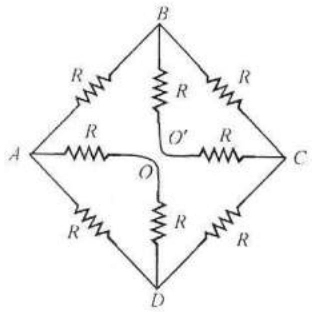
If a wire of resistance R is bent in the form of a circle, the effective resistance between the ends of a diameter = R/4.

124. (a) As the ring has no resistance, the three resistances of 3R each are in parallel.

$$\Rightarrow \frac{1}{R'} = \frac{1}{3R} + \frac{1}{3R} + \frac{1}{3R} = \frac{1}{R} \Rightarrow R' = R$$

$\therefore$ between point A and B equivalent resistance = R + R = 2R

125. (d) The equivalent circuit is as shown in figure.
The resistance of arm AOD (= R + R) is in parallel to the resistance R of arm AD.



Their effective resistance $R_1 = \frac{2R \times R}{2R \times R} = \frac{2}{3}R$

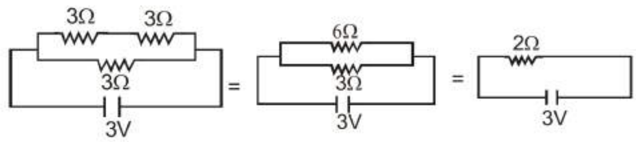
The resistance of arms AB, BC and CD is

$$R_2 = R + \frac{2}{3}R + R = \frac{8}{3}R$$

The resistance R_1 and R_2 are in parallel. The effective resistance between A and D is

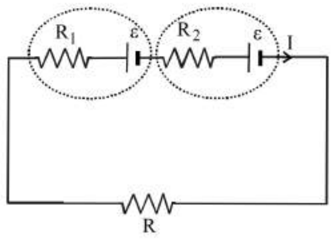
$$R_3 = \frac{R_1 \times R_2}{R_1 + R_2} = \frac{\frac{2}{3}R \times \frac{8}{3}R}{\frac{2}{3}R + \frac{8}{3}R} = \frac{8}{15}R.$$

126. (b)



$$\Rightarrow I = \frac{3}{2} = 1.5\,A$$

127. (c) $I = \frac{2\varepsilon}{R + R_1 + R_2}$



Pot. difference across second cell $= V = \varepsilon - IR_2 = 0$

$$\varepsilon = \frac{2\varepsilon}{R + R_1 + R_2} . R_2 = 0$$

$$R + R_1 + R_2 - 2R_2 = 0$$

$$R + R_1 - R_2 = 0 \qquad \therefore\ R = R_2 - R_1$$

128. (d) Since due to wrong connection of each cell the total emf reduced to 2ε then for wrong connection of three cells the total emf will reduced to ($n\varepsilon - 6\varepsilon$) whereas the total or equivalent resistance of cell combination will be nr.

129. (a) Given : emf $\varepsilon = 2.1$ V

$I = 0.2$ A, $R = 10\Omega$

Internal resistance r = ?

From formula.

$\varepsilon - Ir = V = IR$

$2.1 - 0.2r = 0.2 \times 10$

$2.1 - 0.2r = 2$ or $0.2r = 0.1$

$$\Rightarrow\ r = \frac{0.1}{0.2} = 0.5\,\Omega$$

130. (c) $r = E/I = 1.5/3 = 0.5$ ohm.

131. (d) Resistance of bulb $R_b = \frac{(1.5)^2}{4.5} = 0.5\Omega$

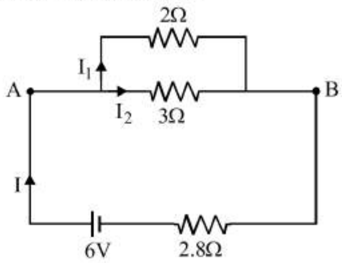
Current drawn from battery $= \frac{E}{2.67 + 0.33} = \frac{E}{3}$

Share of bulb $= \frac{2}{3} \times \frac{E}{3} = \frac{2E}{9}$

$$\therefore\ \left(\frac{2E}{9}\right)^2 \times 0.5 = 4.5 \text{ or } E = 13.5\text{ V.}$$

132. (a) According to maximum power theorem, the power in the circuit is maximum if the value of external resistance is equal to the internal resistance of battery.

133. (c) At steady state the capacitor will be fully charged and thus there will be no current in the 1Ω resistance. So the effective circuit becomes



Net current from the 6V battery,

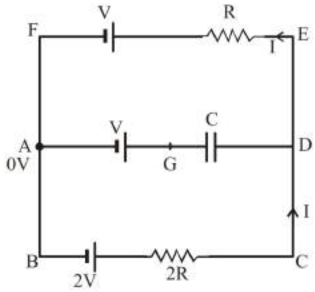
$$I = \frac{6}{\left(\frac{2 \times 3}{2+3}\right) + \frac{2.8}{1}} = \frac{6}{1.2 + 2.8} = \frac{3}{2} = 1.5\text{A}$$

Between A and B, voltage is same in both resistances,

$2I_1 = 3I_2$ where $I_1 + I_2 = I = 1.5$

$$\Rightarrow\quad 2I_1 = 3(1.5 - I_1) \Rightarrow I_1 = 0.9\text{A}$$

134. (c)



Applying Kirchhoff's law in BCDEFAB we get, $I = \frac{V}{3R}$

Let A be at 0 V. Then potential at G is V.

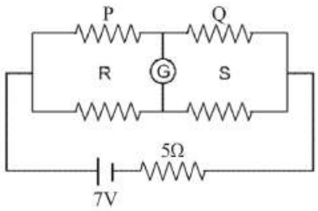
Applying Krichhoff's law for AFED, we get

$$0 + V + IR = V_D \Rightarrow 0 + V + \frac{V}{3R} \times R = V_D \Rightarrow V_D = \frac{4V}{3}$$

$$\therefore \text{ potential different across capacitor } = \frac{4V}{3} - V = \frac{V}{3}$$

135. (a) Given : V = 7 V

$r = 5\Omega$



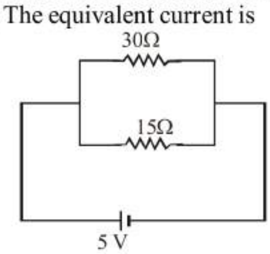
$$R_{eq} = \frac{40 \times 120}{40 + 120}\ \Omega$$

$$I = \frac{V}{R} = \frac{7}{5 + \frac{40 \times 120}{40 + 120}}$$

$$= \frac{7}{5 + 30} = \frac{1}{5} = 0.2\text{ A.}$$

136. (b) $\frac{P}{Q} = \frac{R}{S}$ where $S = \frac{S_1 S_2}{S_1 + S_2}$

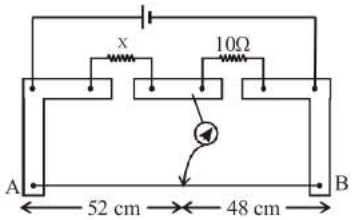
137. (b) The network of resistors is a balanced wheatstone bridge. The equivalent current is



$$R_{eq} = \frac{15\times30}{15+30} = 10\ \Omega \Rightarrow I = \frac{V}{R} = \frac{5}{10} = 0.5\ A$$

138. (d)

139. (b) At Null point



$$\frac{X}{\ell_1} = \frac{10}{\ell_2}$$

Here $\ell_1 = 52 + \text{End correction} = 52 + 1 = 53$ cm

$\ell_2 = 48 + \text{End correction} = 48 + 2 = 50$ cm

$$\therefore \frac{X}{53} = \frac{10}{50} \qquad \therefore X = \frac{53}{5} = 10.6\Omega$$

140. (d) $\frac{P}{Q} = \frac{l}{(100-l)}$ or $P = \frac{l}{100-l} \times Q = \frac{20}{80} \times 1 = 0.25\Omega.$

141. (a) Potential gradient $= \frac{V_A - V_B}{\ell} = \frac{i\times\rho}{A} = \frac{0.1\times10^{-7}}{10^{-6}}$

$$= 10^{-2}\ V/m$$

142. (a) Potential gradient of wire $= \frac{V}{\ell} = \left(\frac{\rho}{A}\right) \times I$

where ℓ & A are the length and cross-section of wire

so $\frac{V}{\ell} = \frac{4\times10^{-7}}{8\times10^{-6}} \times 0.5 = 25$ mV / meter

143. (a)

144. (a) **Hint :** Potential gradient $= \frac{\text{Pot. Difference}}{\text{length of wire}} = \frac{V_A - V_B}{\ell}$

145. (a) Pot. gradient = 0.2mV/cm

$$= \frac{0.2\times10^{-3}}{10^{-2}} = 2\times10^{-2}\ V/m$$

Emf of cell $= 2\times10^{-2}\times1m = 2\times10^{-2}\ V = 0.02\ V$

As per the condition of potentiometer

$0.02\,(R+490) = 2\,(R)$ or $1.98\,R = 9.8$

$$\Rightarrow \quad R = \frac{9.8}{1.98} = 4.9\ \Omega$$

146. (b) Potential gradient along wire

$$= \frac{\text{potential difference along wire}}{\text{length of wire}}$$

or, $0.1\times10^{-3} = \frac{I\times40}{1000}$ V / cm

or, Current in wire, $I = \frac{1}{400}$ A

or, $\frac{2}{40+R} = \frac{1}{400}$ or $R = 800 - 40 = 760\,\Omega$

147. (b) In case of internal resistance measurement by potentiometer,

$$\frac{V_1}{V_2} = \frac{\ell_1}{\ell_2} = \frac{\{ER_1/(R_1+r)\}}{\{ER_2/(R_2+r)\}} = \frac{R_1(R_2+r)}{R_2(R_1+r)}$$

Here $\ell_1 = 2$m, $\ell_2 = 3$m, $R_1 = 5\Omega$ and $R_2 = 10\Omega$

$$\therefore \frac{2}{3} = \frac{5(10+r)}{10(5+r)} \text{ or } 20 + 4r = 30 + 3r \text{ or } r = 10\,\Omega$$