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CURRENT ELECTRICITY

PHYSICS REVISION MODULE

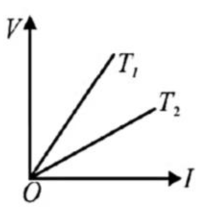
Multiple Choice Questions (MCQs)

DIRECTIONS : *This section contains multiple choice questions. Each question has four choices (a), (b), (c) and (d) out of which only one is correct.*

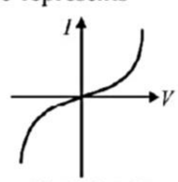
1. In the equation AB = C, A is the current density, C is the electric field, Then B is
(a) resistivity (b) conductivity
(c) potential difference (d) resistance

2. A wire X has 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

3. 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) $T_1 = \frac{1}{T_2}$



4. The I-V characteristics shown in figure represents
(a) ohmic conductors
(b) non-ohmic conductors
(c) insulators
(d) superconductors



5. 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

6. At what temperature will the resistance of a copper wire becomes three times its value at 0°C? (Temperature coefficient of resistance of copper is 4×10^{-3}/°C)
(a) 550°C (b) 500°C
(c) 450°C (d) 400°C

7. A potentiometer can measure emf of a cell because **[CBSE 2020]**
(a) the sensitivity of potentiometer is large.
(b) no current is drawn from the cell at balance.
(c) no current flows in the wire of potentiometer at balance.
(d) internal resistance of cell is neglected.

8. Two resistors R_1 and R_2 of 4 Ω and 6 Ω are connected in parallel across a battery. The ratio of power dissipated in them, $P_1 : P_2$ will be **[CBSE 2020]**
(a) 4 : 9 (b) 3 : 2
(c) 9 : 4 (d) 2 : 3

9. A wire of radius r and another wire of radius 2r, both of same material and length are connected in series to each other. The combination is connected across a battery. The ratio of the heats produced in the two wires will be
(a) 4.00 (b) 2.00
(c) 0.50 (d) 0.25

10. 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.

11. 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

12. 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

13. 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) $\frac{n-1}{n}$

14. 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) $n\varepsilon, nr$

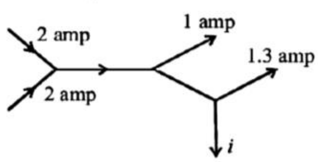
15. Under what condition will the strength of current in a wire of resistance R be the same for connection is series and in parallel of n identical cells each of the internal resistance r? When

(a) $R = nr$ (b) $R = r/n$
(c) $R = r$ (d) $R \to \infty, r \to 0$

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

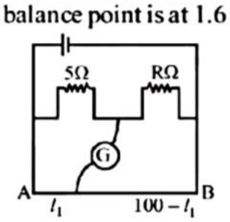
(a) 0.5 Ω (b) 0.8 Ω
(c) 1.0 Ω (d) 0.2 Ω

17. The figure below shows currents in a part of electric circuit. The current i is



(a) 1.7 amp
(b) 3.7 amp
(c) 1.3 amp
(d) 1 amp

18. The resistances in the two arms of the meter bridge are 5Ω and RΩ, respectively. When the resistance R is shunted with an equal resistance, the new balance point is at $1.6\, l_1$. The resistance 'R' is :

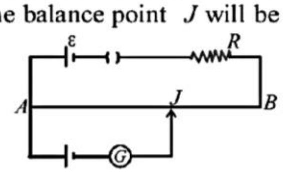


(a) 10Ω
(b) 15Ω
(c) 20Ω
(d) 25Ω

19. Sensitivity of potentiometer can be increased by

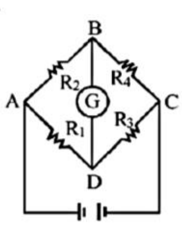
(a) increasing the e.m.f of the cell
(b) increasing the length of the potentiometer
(c) decreasing the length of the potentiometer wire
(d) None of these

20. 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

21. 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.

22. The resistance of an ammeter is 13 Ω and its scale is graduated for a current upto 100 amps. After an additional shunt has been connected to this ammeter it becomes possible to measure currents upto 750 amperes by this meter. The value of shunt-resistance is

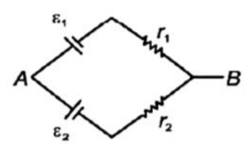
(a) 2 Ω (b) 0.2 Ω (c) 2 kΩ (d) 20 Ω

23. Consider a current carrying wire (current I) in the shape of a circle.

(a) source of emf
(b) electric field produced by charges accumulated on the surface of wire
(c) the charges just behind a given segment of wire which push them just the right way by repulsion
(d) the charges ahead

24. Two batteries of emf ε_1 and $\varepsilon_2 (\varepsilon_2 > \varepsilon_1)$ and internal resistances r_1 and r_2 respectively are connected in parallel as shown in figure.

(a) The equivalent emf ε_{eq} of the two cells is between ε_1 and ε_2, i.e., $\varepsilon_1 < \varepsilon_{eq} < \varepsilon_2$
(b) The equivalent emf ε_{eq} is smaller than ε_1
(c) The ε_{eq} is given by $\varepsilon_{eq} = \varepsilon_1 + \varepsilon_2$ always
(d) ε_{eq} is independent of internal resistances r_1 and r_2



25. A resistance R is to be measured using a meter bridge, student chooses the standard resistance S to be 100Ω. He finds the null point at $l_1 = 2.9$ cm. He is told to attempt to improve the accuracy.
Which of the following is a useful way?

(a) He should measure I_1 more accurately
(b) He should change 5 to 1000Ω and repeat the experiment
(c) He should change S to 3Ω and repeat the experiment
(d) He should given up hope of a more accurate measurement with a meter bridge

26. Two cells of emfs approximately 5 V and 10 V are to be accurately compared using a potentiometer of length 400 cm.

(a) The battery that runs the potentiometer should have voltage of 8V
(b) The battery of potentiometer can have a voltage of 15 V and R adjusted so that the potential drop across the wire slightly exceeds 10 V
(c) The first portion of 50 cm of wire itself should have a potential drop of 10 V
(d) Potentiometer is usually used for comparing resistances and not voltages

27. A metal rod of length 10 cm and a rectangular cross-section of 1cm × $\frac{1}{2}$ cm is connected to a battery across opposite faces. The resistance will be

(a) maximum when the battery is connected across 1 cm × $\frac{1}{2}$ cm faces

(b) maximum when the battery is connected across 10 cm × 1 cm faces

(c) maximum when the battery is connected across 10 cm × $\frac{1}{2}$ cm faces

(d) same irrespective of the three faces

28. Which of the following characteristics of electrons determines the current in a conductor?

(a) Drift velocity alone

(b) Thermal velocity alone

(c) Both drift velocity and thermal velocity

(d) Neither drift nor thermal velocity

29. 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

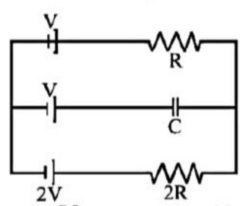
(a) $R = R_2 - R_1$

(b) $R = R_2 \times (R_1 + R_2)/(R_2 - R_1)$

(c) $R = R_1R_2/(R_2 - R_1)$

(d) $R = R_1R_2/(R_1 - R_2)$

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

31. 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

32. Kirchhoff'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

33. 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.

34. 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) $v_d = E$

35. 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

36. 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

37. 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

38. 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) $\frac{Ne^2A}{2m\tau\ell}$

39. The example of non-ohmic resistance is

(a) diode (b) copper wire
(c) filament lamp (d) carbon resistor

40. 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) $k = JE$

41. 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.

42. Two resistors A and B have resistances R_A and R_B respectively with $R_A < R_B$. The resistivities of their materials are ρ_A and ρ_B. Then

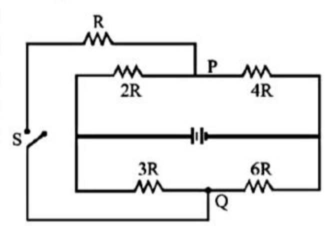
(a) $\rho_A > \rho_B$

(b) $\rho_A = \rho_B$

(c) $\rho_A < \rho_B$

(d) insufficient information to predict relation

43. 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



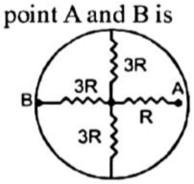
(a) increases

(b) decreases

(c) remains same

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

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



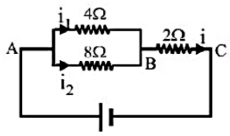
(a) 2R

(b) 4R

(c) 7R

(d) 10R

45. In the circuit shown in Fig, the current in 4 Ω resistance is 1.2 A. What is the potential difference between B and C?



(a) 3.6 volt
(b) 6.3 volt
(c) 1.8 volt
(d) 2.4 volt

46. Kirchhoff's first and second laws for electrical circuits are consequences of
(a) conservation of electric charge and energy respectively
(b) conservation of electric charge
(c) conservation of energy and electric charge respectively
(d) conservation of energy

47. 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.

48. 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

49. 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.

50. 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) $R = r/2$

51. 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) $R = n\,r$ (b) $R = r/n$
(c) $R = r$ (d) $R \to \infty, r \to 0$

52. A capacitor is connected to a cell of emf E having some internal resistance r. The potential difference across the
(a) cell is < E (b) cell is E
(c) capacitor is > E (d) capacitor is < E

53. Two cells of the same emf E have different internal resistances r_1 and r_2. They are connected in series with an external resistance R and the potential difference across the first cell is found to be zero. Therefore, the external resistance R must be
(a) $r_1 - r_2$ (b) $r + r_2$ (c) $2r_1 - r_2$ (d) $r_1 - 2r_2$

54. 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) $\varepsilon,\ nr$ (c) $n\varepsilon,\ \frac{r}{n}$ (d) $n\varepsilon,\ nr$

55. An electric fan and a heater are marked as 100 W, 220 V and 1000 W, 220 V respectively. The resistance of heater is
(a) equal to that of fan (b) lesser than that of fan
(c) greater than that of fan (d) zero

56. Three resistances R, 2R and 3R are connected in parallel to a battery. Then
(a) the potential drop across 3R is maximum
(b) the current through each resistance is same
(c) the heat developed in 3R is maximum
(d) the heat developed in R is maximum.

57. A current of 30A is registered when the terminals of a dry cell of emf 1.5V are connected through an ammeter. (Neglect the ammeter resistance). The amount of heat produced in the battery in 20s is
(a) 450 J (b) 900 J (c) 1000 J (d) 50 J

58. The powers of two electric bulbs are 100 watt and 200 watt. Both of them are joined with 220 volt. The ratio of resistance of their filament will be
(a) 4 : 1 (b) 1 : 4 (c) 1 : 2 (d) 2 : 1

59. Forty electric bulbs are connected in series across a 220 V supply. After one bulb is fused the remaining 39 are connected again in series across the same supply. The illumination will be
(a) more with 40 bulbs than with 39
(b) more with 39 bulbs than with 40
(c) equal in both the cases
(d) in the ratio $40^2 : 39^2$

60. A heater boils a certain quantity of water in time t_1 Another heater boils the same quantity of water in time t_2. If both heaters are connected in parallel, the combination will boil the same quantity of water in time
(a) $\frac{1}{2}(t_1 + t_2)$ (b) $(t_1 + t_2)$
(c) $\frac{t_1 t_2}{t_1 + t_2}$ (d) $\sqrt{t_1 t_2}$

61. How much heat is developed in 210 watt electric bulb in 5 minutes? (Chemical equivalent of heat = 4.2 J/C)
(a) 30000 cal (b) 22500 cal (c) 15000 cal (d) 7500 cal

62. 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

63. 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

64. 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

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

66. 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

67. 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

68. 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

69. 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

70. 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.

71. The emf developed by a thermocouple is measured with the help of a potentiometer and not by a moving coil millivoltmeter because
(a) the potentiometer is more accurate than the voltmeter
(b) the potentiometer is more sensitive than voltmeter
(c) the potentiometer makes measurement without drawing any current from the thermocouple
(d) measurement using a potentiometer is simpler than with a voltmeter

Case/Passage Based Questions

DIRECTIONS : *Study the given Case/Passage and answer the following questions.*

Case/Passage-I

The motion of free electrons in a conductor are continuous and random. They collide with positive metal ions and change direction during each collision. So thermal velocities are randomly distributed and average velocity is zero.

When a potential difference is applied across the ends of a conductor, electrons are drifted towards the positive terminal of the field, this velocity is called drift velocity (v_d).

$$v_d = -\frac{e\vec{E}\tau}{m} = \frac{i}{neA}$$

72. 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) $\frac{Ne^2A}{2m\tau\ell}$

73. 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) $v_d/4$

74. 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) I s (b) $\sqrt{I/s}$
(c) I/s (d) $(I/s)^2$

75. 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

76. The number of free electrons per 100 mm of ordinary copper wire is 2×10^{21}. Average drift speed of electrons is 0.25 mm/s. The current flowing is
(a) 5 A (b) 80 A
(c) 8 A (d) 0.8 A

Case/Passage-II

Heating Effect of Current: The electric energy consumed in a circuit is defined as *the total work done in maintaining the current in an electric circuit for a given time.*

Electric energy = $VIt = Pt = I^2Rt = V^2t/R$

The **S.I. unit** of electric energy is joule (denoted by J)

where 1 joule = 1 watt × 1 second = 1 volt × 1 ampere × 1 sec.

In **household circuits** the electrical appliances are connected in parallel and the electrical energy consumed is measured in kWh

77 An electric fan and a heater are marked as 100 W, 220 V and 1000 W, 220 V respectively. The resistance of heater is
(a) equal to that of fan
(b) lesser than that of fan
(c) greater than that of fan
(d) zero

78. Which of the following statement is false?
(a) Some of the energy produced by the light bulb takes the form of heat.
(b) The battery is the source of all the electrons flowing around the circuit.
(c) The current entering the light bulb equals the current leaving the light bulb.
(d) The potential in the wire to the left of the light bulb differs from the potential in the wire to the right of that bulb.

79. Resistance of conductor is doubled keeping the potential difference across it constant. The rate of generation of heat will
(a) become one fourth (b) be halved
(c) be doubled (d) become four times

80. The heating element of an electric heater should be made with a material, which should have
(a) high specific resistance and high melting point
(b) high specific resistance and low melting point
(c) low specific resistance and low melting point
(d) low specific resistance and high melting point

81. If R_1 and R_2 are respectively the filament resistances of a 200 watt bulb and a 100 watt bulb designed to operate on the same voltage
(a) R_1 is two times R_2 (b) R_2 is two times R_1
(c) R_2 is four times R_1 (d) R_1 is four times R_2

Case/Passage-III

Terminal potential difference of a cell is defining the potential difference between the two electrodes of a cell when the cell is in closed circuit i.e. current is withdrawn from it.

Electromotive force or e.m.f of a cell is the maximum potential difference between the two electrodes of a cell when the cell is in open circuit i.e. no current is taken from the cell.

$V = E - Ir \leftarrow$ when current is withdrawn from the cell

$V = E + Ir \leftarrow$ when the cell is charged.

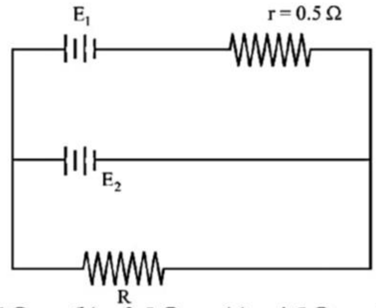
The S.I. unit of emf and potential difference is same i.e., volt.

82. 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

83. A capacitor is connected to a cell of emf E having some internal resistance r. The potential difference across the
(a) cell is < E (b) cell is E
(c) capacitor is > E (d) capacitor is < E

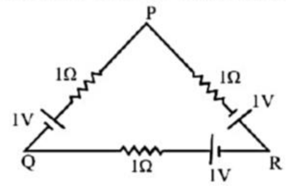
84. A primary cell has an e.m.f. of 1.5 volt. When short-circuited it gives a current of 3 ampere. The internal resistance of the cell is
(a) 4.5 ohm (b) 2 ohm
(c) 0.5 ohm (d) (1/4.5) ohm

85. A dc source of emf E_1 = 100 V and internal resistance $r = 0.5\ \Omega$, a storage battery of emf E_2 = 90 V and an external resistance R are connected as shown in figure. For what value of R no current will pass through the battery ?



(a) 5.5 Ω (b) 3.5 Ω (c) 4.5 Ω (d) 2.5 Ω

86. Three batteries of emf 1 V and internal resistance 1 Ω each are connected as shown. Effective emf of combination between the points PQ is



(a) zero
(b) 1V
(c) 2V
(d) (2/3) V

Case/Passage-IV

Potentiometer: A potentiometer is an ideal voltmeter since a voltmeter draws some current through the circuit while potentiometer needs no current to work. A potentiometer works on the principle of emf comparison. In working condition, a constant current flows throughout the wire of a potentiometer using standard cell of emf e_1. The wire of potentiometer is made of uniform material and cross-sectional area, and it has uniform resistance per unit length. The potential gradient depends upon the current in the wire.
A potentiometer with a cell of emf 2 V and internal resistance 0.4 Ω is used across the wire *AB*. A standard cadmium cell of emf 1.02 V gives a balance point at 66 cm length of wire. The standard cell is then replaced by a cell of unknown emf *e* (internal resistance *r*), and the balance point found similarly turns out to be 88 cm length of the wire. The length of potentiometer wire *AB* is 1 m.

87. The value of *e* is
(a) 1.36 V (b) 2.63 V
(c) 1.83 V (d) None of these

88. The reading of the potentiometer, if a 4 V battery is used instead of *e*, is
(a) 88.3 cm (b) 47.3 cm
(c) 95 cm (d) cannot be calculated

89. If the resistance is connected across the cell *e*, the balancing length will
(a) increase (b) decrease
(c) remain same (d) None of these

90. The length of a wire of a potentiometer is 100 cm, and the emf of its standard cell is *E* volt. It is employed to measure the emf of a battery whose internal resistance is 0.5 Ω. If the balance point is obtained at l = 30 cm from the positive end, the emf of the battery is
(a) $\dfrac{30E}{100}$ (b) $\dfrac{30E}{100.5}$
(c) $\dfrac{30E}{(100-0.5)}$ (d) $\dfrac{30(E-0.5i)}{100}$
where i is the current in the potentiometer wire.

91. In a potentiometer experiment, the balancing with a cell is at length 240 cm. On shunting the cell with a resistance of 2 Ω, the balancing length becomes 120 cm. The internal resistance of the cell is

(a) 2 Ω (b) 4 Ω (c) 0.5 (d) 1 Ω

Case/Passage-V

It an instrument based on wheatstone bridge.

Principle:– The fall of potential across any portion of the wire is directly proportional to the length of that portion provided the wire of uniform cross-section and a constant current is flowing through it.

Theory : If A be the area of cross-section of the wire,

ρ be the specific resistance of the material of the wire.

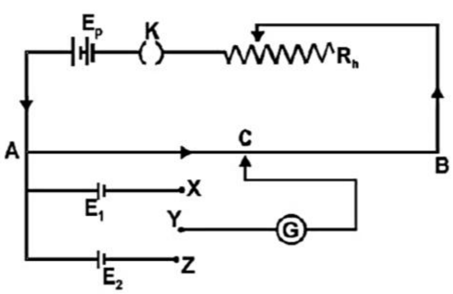
V be the potential difference across the portion of the wire whose length is ℓ and resistance R.

I be the current flowing through the wire then by Ohm's law,

$$V = IR = I\frac{\ell\rho}{A} = \left(\frac{I\rho}{A}\right)\ell = k\ell \quad \left[\text{where } k = \frac{\rho\ell}{A}\right]$$

∴ $V \propto \ell$ if A and I are constants

or, $\frac{V}{\ell} = k$ = Potential gradient or fall of potential/length of the wire.



92. If specific resistance of a potentiometer wire is 10^{-7}Ωm 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

93. 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

94. 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

95. 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

96. 125 cm of potentiometer wire balances the emf. of a cell and 100 cm of the wire is required for balance, if the poles of the cell are joined by a 2Ω resitor. Then the internal resistance of the cell is

(a) 0.25Ω (b) 0.5Ω (c) 0.75Ω (d) 1.25Ω

Assertion & Reason

DIRECTIONS : *Each of these questions contains an assertion followed by reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.*

(a) If both **Assertion** and **Reason** are **correct** and the Reason is the **correct explanation** of the Assertion.
(b) If both **Assertion** and **Reason** are correct but Reason is **not the correct explanation** of the Assertion.
(c) If the **Assertion** is **correct** but **Reason** is **incorrect**.
(d) If the **Assertion** is **incorrect** but the **Reason** is **correct**.

97. Assertion : The electric bulbs glows immediately when switch is on.

Reason : The drift velocity of electrons in a metallic wire is very high.

98. 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.

99. Assertion : The current density $\vec{J}$ at any point in ohmic resistor is in direction of electric field $\vec{E}$ at that point.

Reason : A point charge when released from rest in a region having only electrostatic field always moves along electric lines of force.

100. Assertion : Free electrons always keep on moving in a conductor even then no magnetic force act on them in magnetic field unless a current is passed through it.

Reason : The average velocity of free electron is zero.

101. Assertion : Drift speed v_d is the average speed between two successive collisions.

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

102. Assertion : Fuse wire must have high resistance and low melting point.

Reason : Fuse is used for voltage stablisation only.

103. Assertion : The (100w, 220 v) bulb glow with more brightness than, (50w, 220v) bulb.

Reason : 100w bulb has more resistance than 50w bulb.

104. Assertion : When current through a bulb decreases by 0.5%, the glow of bulb decreases by 1%.

Reason : Glow (Power) which is directly proportional to square of current.

105. Assertion : Long distance power transmission is done at high voltage.
Reason : At high voltage supply power losses are less.

106. Assertion : A larger dry cell has higher emf.
Reason : The emf of a dry cell is proportional to its size.

107. Assertion : In a simple battery circuit, the point of the lowest potential is negative terminal of the battery.
Reason : The current flows towards the point of the higher potential, as it does in such a circuit from the negative to the positive terminal.

108. Assertion : Kirchoff's junction 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.

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.

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

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

112. Assertion : Bending a wire does not effect electrical resistance.
Reason : Resistance of wire is proportional to resistivity of material.

Match the Following

DIRECTIONS : *Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in column-I have to be matched with statements (1, 2, 3, 4) in column-II.*

113. 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) $(A)\to(3)$; $(B)\to(1)$; $(C)\to(2)$; $(D)\to(4)$
(b) $(A)\to(1)$; $(B)\to(3)$; $(C)\to(2)$; $(D)\to(4)$
(c) $(A)\to(2)$; $(B)\to(1)$; $(C)\to(4)$; $(D)\to(3)$
(d) $(A)\to(4)$; $(B)\to(3)$; $(C)\to(1)$; $(D)\to(2)$

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

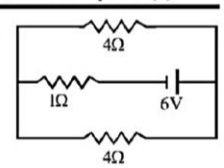
	Column I		Column II
(A)	Balanced condition of wheatstone bridge	(1)	$\frac{R_1}{R_2}=\frac{R_3}{R_4}$
(B)	Comparison of emf of two cells.	(2)	$\frac{R}{S}=\frac{l_1}{100-l_1}$
(C)	Determination of internal resistance of a cell	(3)	$\frac{E_1}{E_2}=\frac{l_1}{l_2}$
(D)	Determination of unknown resistance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

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

Fill in the Blanks

DIRECTIONS : *Complete the following statements with an appropriate word / term to be filled in the blank space(s).*

115. The current in the 1Ω resistor shown in the circuit is _______ A.



116 A primary cell has an e.m.f. of 6. volt, when short-circuited it gives a current of 3 ampere. The internal resistance of the cells is _______ ohm.

117. A 5–ampere fuse wire can withstand a maximum power of 1 watt in the circuit. The resistance of the fuse wire is _______ ohm.

118. A heater of 220 V heats a volume of water in 5 minutes. The same heater when connected to 110 V heats the same volume of water in _______ minutes.

119. A battery of 10 V and internal resistance 0.5Ω is connected across a variable resistance R. The value of R for which the power delivered is maximum is equal to _______ Ω.

True / False

DIRECTIONS : *Read the following statements and write your answer as true or false.*

120. Voltmeter is connected in parallel with the circuit.

121. Resistance of a voltmeter is very small.

122. The drift velocity of electrons in a metallic wire will decrease, if the temperature of the wire is increased.

123. On increasing temperature, conductivity of metallic wire increases.

ANSWER KEY & SOLUTIONS

1. **(a)** $J = \sigma E \Rightarrow J\rho = E$
J is current density, E is electric field
so B = ρ = resistivity.

2. **(c)** $R = \frac{\rho\ell}{A} \Rightarrow R = \frac{\rho\ell}{\pi r^2}$

Given, $\ell_x = \frac{\ell_y}{2}$

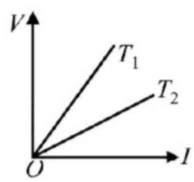
$r_x = \frac{r_y}{2}$

So, ratio of resistance of x to that of Y is,

$$\Rightarrow \frac{R_x}{R_y} = \frac{\ell_x}{\ell_y} \times \frac{r_y^2}{r_x^2} \Rightarrow \frac{(\ell_y/2)}{\ell_y} \times \frac{r_y^2}{\left(\frac{r_y^2}{2}\right)^2}$$

$$\Rightarrow \frac{\ell_y}{2\ell_y} \times \frac{\ell_y^2}{\ell_y^2} \times 4 \Rightarrow \frac{2}{1}$$

3. **(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_2 As the resistance of a conductor is more at higher temperature and less at lower temperature, hence $T_1 > T_2$.

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

5. **(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 $\alpha = \frac{2}{150} = 0.0133/°C$

6. **(b)** $R_t = R_0(1 + \alpha t)$ at t°C $R_t = 3R_0$

$\alpha = 4 \times 10^{-3}/°C$
$3R_0 = R_0(1 + 4 \times 10^{-3} \times t)$
$\therefore \quad 3 - 1 = 4 \times 10^{-3} t$

$\therefore \quad t = \frac{2}{4 \times 10^{-3}} = 500°C$

7. **(b)**

8. **(b)** $P_1 = \frac{V^2}{R_1}$ and $P_2 = \frac{V^2}{R_2}$ $\quad \therefore \frac{P_1}{P_2} = \frac{R^2}{R_1} = \frac{6}{4} = \frac{3}{2}$

9. **(a)** $H = I^2 Rt$. Here $R_1 = \rho\frac{\ell}{\pi r^2}$ and

$R_2 = \rho\frac{\ell}{\pi(2r)^2}$.

That is, $R_1 = 4R_2$. Hence, $\frac{H_1}{H_2} = 4$.

10. **(a)**

11. **(d)** $I = \frac{E}{R + r}$, Internal resistance (r) is zero,

$I = \frac{E}{R}$ = constant.

12. **(d)**

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

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

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

14. **(a)** In the parallel combination,

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

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

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

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

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

From (i) and (ii)

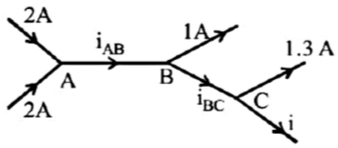
$$\varepsilon_{eq} = n\frac{\varepsilon}{r_{eq}} \times r_{eq} = n \times \frac{\varepsilon}{r} \times \frac{\varepsilon}{r} = \varepsilon$$

15. **(c)**

16. **(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 $0.2r = 0.1$ $\quad \Rightarrow r = \dfrac{0.1}{0.2} = 0.5\Omega$

17. (a) According to Kirchhoff's first law
At junction A, $i_{AB} = 2 + 2 = 4$ A
At junction B, $i_{AB} = i_{BC} + 1 \Rightarrow i_{BC} = 4 - 1 \Rightarrow 3A$



At junction C, $i = i_{BC} - 1.3 = 3 - 1.3 = 1.7$ A

18. (b) This is a balanced wheatstone bridge condition,
$\dfrac{5}{R} = \dfrac{\ell_1}{100 - \ell_1}$ and $\dfrac{5}{R/2} = \dfrac{1.6\ell_1}{100 - 1.6\ell_1} \Rightarrow R = 15\,\Omega$

19. (b)

20. (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*.

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

22. (a) We know

$$\frac{I}{I_S} = 1 + \frac{G}{S}$$

$$\frac{750}{100} = 1 + \frac{13}{S}$$

$S \Rightarrow 2\Omega$

23. (b) As we know, electric current per unit area I/A, is called current density j i.e., $j = \dfrac{I}{A}$
The SI units of the current density are A/m^2.
The current density is also directed along E and is also a vector and the relationship is
$j = \sigma E$
Current density changes due to electric field produced by charges accumulated on the surface of wire.

24. (a) As we know the equivalent emf (ε_{eq}) in the parallel combination

$$\varepsilon_{eq} = \frac{\varepsilon_2 r_1 + \varepsilon_1 r_2}{r_1 + r_2}$$

So according to formula the equivalent emf ε_{eq} of the two cells in parallel combination is between ε_1 and ε_2. Thus $(\varepsilon_1 < \varepsilon_{eq} < \varepsilon_2)$.

25. (c) Adjusting the blance point near the middle of the bridge, i.e.. when l_1 is close to 50 cm. requires a suitable choice of S, R is unknown resistance :

Since, $\dfrac{R}{S} = \dfrac{Rl_1}{R(100 - l_1)}$

$\dfrac{R}{S} = \dfrac{l_1}{100 - l_1}$ or $R = S\left[\dfrac{l_1}{100 - l_1}\right]$

$$R = S\left[\frac{2.9}{97.1}\right]$$

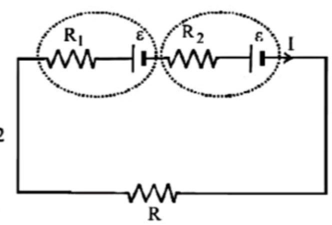
So, here, R : S = 2.9 : 97.1 implies that the S is nearly 33 times to that of R. In orded to make this ratio 1 : 1 it is necessary to reduce the value of S nearly $\dfrac{1}{33}$ times i.e., nearly 3Ω.

26. (b) The potential drop across wires of potentiometer should be more than emfs of primary cells. Here, values of emfs of two cells are given as 5V and 10V, so the potential drop along the potentiometer wire must be more than 10V. So battery should be of 15V and about 4V potential is droped by using variable resistance.

27. (a) As we known that the resistance of wire is $R = \rho\dfrac{l}{A}$
For maximum value of R, *l* must be higher and A should be lower and it is possible only when the battery is connected across area of cross section $= 1\text{cm} \times \left(\dfrac{1}{2}\right)$cm.

28. (a) We know that the relationship between current and drift speed is
$I = neAv_d$
Where, I is the current and V_d is the drift velocity.
So, $I \propto V_d$
Hence, only drift velocity determines the current in a conductor.

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



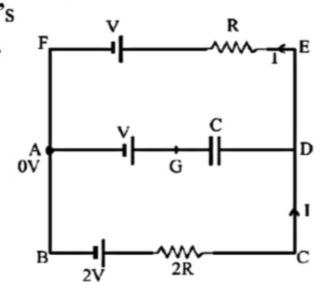
Pot. difference across second cell $= V = \varepsilon - IR_2$
$= 0$

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

$R + R_1 + R_2 - 2R_2 = 0$
$R + R_1 - R_2 = 0 \quad \therefore R = R_2 - R_1$

30. (c) Applying Kirchhoff's law in BCDEFAB we get,

$I = \dfrac{V}{3R}$



Let A be at 0 V. Then potential at G is V.
Applying Krichhoff's law for AFED, we get
$0 + V + IR = V_D$
$\Rightarrow 0 + V + \dfrac{V}{3R} \times R = V_D \Rightarrow V_D = \dfrac{4V}{3}$

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

31. (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 $\frac{V}{\ell}=\frac{4\times10^{-7}}{8\times10^{-6}}\times0.5=25mV/meter$

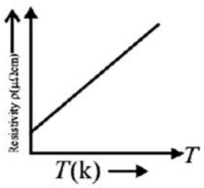
32. (a)

33. (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 $\vec{E}$.

34. (d) **35.** (b) **36.** (a) **37.** (d) **38.** (a)

39. (a) **40.** (b)

41. (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.

42. (d) Resistivity depends on various other factors like temp.

43. (c) No current flows through the resistor R as P and Q are at same potential. Hence current drawn from battery will remain same on closing the switch.

44. (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 $=R+R=2R$

45. (a) The potential difference across 4Ω resistance is given by $V=4\times i_1=4\times1.2=4.8$ volt

So, the potential across 8Ω resistance is also 4.8 volt.

Current $i_2=\frac{V}{8}=\frac{4.8}{8}=0.6$ amp

Current in 2Ω resistance $i=i_1+i_2$

$\therefore i=1.2+0.6=1.8$ amp

Potential difference across 2Ω resistance

$V_{BC}=1.8\times2=3.6$ volts

46. (a) Kirchhoff ' s first law deals with conservation of electrical charge & the second law deals with conservation of electrical energy.

47. (a) Because of internal resistance of cell.

48. (d) **49.** (d) **50.** (a) **51.** (c)

52. (b) In the given case cell is in open circuit (i = 0) so voltage across the cell is equal to its e.m.f.

53. (a)

54. (a) In the parallel combination,

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

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

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

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

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

From (i) and (ii)

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

55. (b) As $R\propto V^2/P$ or $R\propto 1/P$, so resistance of heater is less than that of fan.

56. (d) $H\propto\frac{1}{R}$ [as V = constant in parallel connection]

57. (b) $i=\frac{E}{r}\Rightarrow30=\frac{1.5}{r}$

$r=0.05\,\Omega\Rightarrow H=i^2rt=(30)^2\times0.05\times20=900\,J$

58. (d) As $R\times\frac{1}{\text{Power}}$ $\quad\therefore R_1:R_2=2:1$

59. (b) Since, the voltage is same for the two combinations, therefore $H\propto\frac{1}{R}$. Hence, the combination of 39 bulbs will glow more.

60. (c) If a heater boils m kg water in time t_1 and another heater boils the same water in t_2, then both connected in series will boil the same water in time $t_s=t_1+t_2$ and if in parallel $t_p=\frac{t_1t_2}{t_1+t_2}$ [Use time taken $\propto$ Resistance]

61. (c) $H=P\times t=\frac{210\times5\times60}{4.2}=15000$ cal.

62. (d)

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

64. (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.

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

66. (b) **67.** (b) **68.** (b) **69.** (a) **70.** (c)

71. (c) **72.** (a)

73. (d) $I=nAev_d$ or $v_d\propto1/\pi r^2$

74. (c)

75. **(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 $t = \frac{1.66}{0.02} = 83°C.$

76. **(d)** $I = neAv_d = 2\times10^{21} \times 1.6 \times 10^{-19} \times 10 \times 0.25 \times 10^{-3}$

$$= 2 \times 1.6 \times 0.25 = \frac{8}{10} = 0.8\text{ A}$$

77. **(b)** As $R \propto V^2/P$ or $R \propto 1/P$, so resistance of heater is less than that of fan.

78. **(b)** Most of the charges flowing around the circuit are valence electrons stripped off the metal atoms in the wires and light bulbs. A battery doesn't "supply" all of the charges. It merely pushes around charges already present in the circuit.
Statements (c) and (d) are both true. All charges flowing into the light bulb also flow back out; no current gets " used up" But inside the bulb, those charges lose energy. This lost electrical energy converts into light and heat. So, the current has lower "potential" after flowing through the bulb.

79. **(b)** The rate of generation of heat, for a given potential difference is, $P = V^2/R$

80. **(a)** A heating wire should be such that it produces more heat when current is passed through it and also does not melt. It will be so if it has high specific resistance and high melting point.

81. **(b)** $R_1 = \frac{V^2}{P_1}$ and $R_2 = \frac{V^2}{P_2}$

$$\therefore \frac{R_2}{R_1} = \frac{P_1}{P_2} = \frac{200}{100} = 2 \quad (\because V = \text{constant})$$

$R_2 = 2R_1$

82. **(a)**

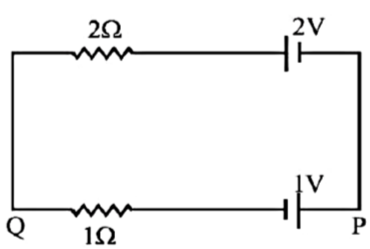
83. **(b)** In the given case cell is in open circuit (i = 0) so voltage across the cell is equal to its e.m.f.

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

85. **(c)** $\frac{100}{R+r} = \frac{90}{R} \Rightarrow \frac{R+r}{R} = \frac{10}{9}$

$$\Rightarrow 1 + \frac{0.5}{R} = \frac{10}{9} \Rightarrow \frac{0.5}{R} = \frac{1}{9} \Rightarrow R = 4.5\,\Omega$$

86. **(a)**



$$E_{net} = \frac{E_1 r_2 - E_2 r_1}{r_1 + r_2} \quad \text{or} \quad E_{net} = \frac{2-2}{2+1} = 0$$

87 **(a)** $\frac{e}{1.02} = \frac{88}{66}$
or $e = 1.36$ V

88. **(d)** 4 V is greater than applied emf 2 V, hence no balance point is obtained. On connecting the resistance across e, current will flow in e due to which terminal potential difference will be less than emf and the balancing length will decrease.

89. **(b)**

90. **(a)** $\because V \propto l \quad \therefore \frac{V}{E} = \frac{l}{L}$ or $V = \frac{l}{L}E = \frac{30}{100}E$

91. **(a)** $r = \frac{l_1 - l_2}{l_2}R = \frac{240-120}{120} \times 2 = 2\Omega$

92. **(a)** Potential gradient $= \frac{V_A - V_B}{\ell} = \frac{i \times \rho}{A} = \frac{0.1 \times 10^{-7}}{10^{-6}}$
$= 10^{-2}$ V/m

93. **(a)**

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

95. **(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 $R_2 = 10\Omega$

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

96. **(b)** $r = \frac{\ell_1 - \ell_2}{\ell_2} \times R\Omega$

Here, $\ell_1 = 125$ cm, $\ell_2 = 100$ cm, $R = 2\Omega$.
$\therefore \quad r = 0.5\Omega$

97. **(c)**

98. **(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.

99. **(c)** From relation $\vec{J} = \sigma\vec{E}$, the current density $\vec{J}$ at any point in ohmic resistor is in direction of electric field $\vec{E}$ at that point. In space having non-uniform electric field, charges released from rest may not move along ELOF. Hence Assertion is correct while Reason is incorrect.

100. **(a)** In the absence of the electric current, the free electrons in a conductor are in a state of random motion, like molecule in a gas. Their average velocity is zero. i.e. they do not have any net velocity in a direction. As a result, there is no net magnetic force on the free electrons in the magnetic field. On passing the current, the free electrons acquire drift velocity in a definite direction, hence magnetic force acts on them, unless the field has no perpendicular component.

101. **(c)** Drift speed is the average speed between two successive collisions.

102. **(c)**

103. **(c)**

104. **(a)** Glow = Power (P) = I^2R

$\therefore \frac{dP}{P} = 2\left(\frac{dI}{I}\right) = 2 \times 0.5 = 1\%$

105. **(a)** Power loss $= i^2R = \left(\frac{P}{V}\right)^2 R$

[P = Transmitted power]

106. **(d)** The e.m.f. of a dry cell is dependent upon the electrode potential of cathode and anode which in turn is dependent upon the reaction involved as well as concentration of the electrolyte. It has nothing to do with size of the cell.

107. **(c)** Positive terminal of a battery is point of highest potential and current flows from highest to lowest potential i.e. from +ve to –ve potential.

108. **(a)**

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

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

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

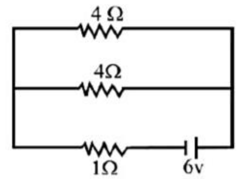
112. **(a)** Resistance wire $R = \rho\frac{\ell}{A}$, where ρ is resistivity of material which does not depend on the geometry of wire. Since when wire is bent resistivity, length and area of cross-section do not change, therefore resistance of wire also remain same.

113. **(c)** $A \to (2); B \to (1); C \to (4); D \to (3)$

114. **(b)** $A \to (1); B \to (3); C \to (4); D \to (2)$

115. (2A) Two 4Ω resistors are in parallel combination. Their equivalent resistance

$= \frac{4 \times 4}{4+4} = \frac{16}{8} = 2\Omega$



$\therefore$ Total resistance of the network $= 2 + 1 = 3\Omega$

$\therefore$ Current through 1Ω resistor $= \frac{6}{3} = 2A$

116. (2Ω) Short circuit current

$i_{SC} = \frac{E}{r} \Rightarrow 3 = \frac{6}{r} \Rightarrow r = 2\Omega$

117. (0.04 Ω) $R = \frac{P}{I^2} = \frac{1}{25} = 0.04\Omega$

118. (20 min) W = Power × time $= \frac{V^2 t}{R}$ R is the same.

$\therefore V^2 t$ = constant. $V_1^2 t_1 = V_2^2 t_2 \Rightarrow 220^2 \times 5 = 110^2 t_2$

$\therefore t_2 = 20$ min.

119. (0.5 Ω) Power is maximum when $r = R$, $R = r = 0.5\Omega$.

120. (True) Voltmeter is a galvanometer with high resistance. It measures potential drop across any part of an electrical circuit. It is connected in parallel so that it does not draw any current itself (due to high resistance) and does not affect net resistance of the circuit.

121. (False)

122. (True) 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.

123. (False) Also when temperature increases, resistivity increases and resistivity is inversely proportional to conductivity of material.