EXERCISE 1

DEFINITION OF CURRENT, CURRENT DENSITIES & DRIFT VELOCITIES

1. The current through a wire depends on time as $i = i_0 + \alpha t$, where $i_0 = 10$ A and $\alpha = 4$ A/s. Find the charge crossed through a section of the wire in 10 seconds, and average current for that interval.

2. A current of 0.50 ampere is passing through a $CuSO_4$ solution. How many Cu^{++} ions will be deposited on cathode in 10 seconds ?

3. Estimate the average drift speed of conduction electrons in a copper wire of cross-sectional area 1.0×10^{-7} m^2 carrying a current of 1.5 A. Assume that each copper atom contributes roughly one conduction electron. The density of copper is 9.0×10^3 kg m^{-3} and its atomic mass is 63.5 u.

4. An electron beam after being accelerated from rest through a potential difference of 500 V in vacuum is allowed to impinge normally on a fixed surface. If the incident current is 100 μA, determine theforce exerted on the surface assuming that it brings the electrons to rest.

5. The drift velocity of electrons in a conducting wire is of the order of 1mm/s, yet the bulb glows very quickly after the switch is put on because

(A) the random speed of electrons is very high, of the order of 10^6 m/s

(B) the electrons transfer their energy very quickly through collisions

(C) electric field is set up in the wire very quickly, producing a current through each cross section, almost intantaneousty

(D) All of above

6. In the presence of an applied electric field ($\vec{E}$) in a metallic conductor.

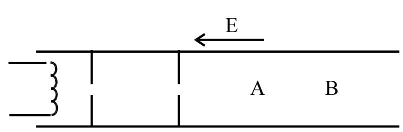
(A) The electrons move in the direction of $\vec{E}$

(B) The electrons move in a direction opposite to $\vec{E}$

(C) The electrons may move in any direction randomly, but slowly drift in the direction of $\vec{E}$.

(D) The electrons move randomly but slowly drift in a direction opposite to $\vec{E}$.

7. Electrons are emitted by a hot filament and are accelerated by an electric field as shown in fig. The two stops at the left ensure that the electron beam has a uniform cross-section.



(A) The speed of the electron is more at B than at A.

(B) The electric current is from left to right

(C) The magnitude of the current is larger at B than at A.

(D) The current density is more at B than at A.

8#. 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 in a given time interval (B) drift speed

(C) current density (D) free-electron density.

9. In a wire of cross section radius *r*, free electrons travel with drift velocity V when a current I flows through the wire. What is the current in another wire of half the radius and of the same material when the drift velocity is 2 V ?

(A) 2 I (B) I (C) I/2 (D) I/4

10. Two wires each of radius of cross section *r* but of different materials are connected together end to end (i.e. in series). If the densities of charge carriers in the two wires are in the ratio 1: 4, the drift velocity of electrons in the two wires will be in the ratio:

(A) 1 : 2 (B) 2 : 1 (C) 4 : 1 (D) 1 : 4

11. A constant current is passed through a uniform conductor. Any given segment of the conductor will have:

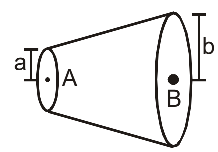
(A) nett negative charge (B) nett positive charge

(C) nett zero charge (D) nett charge proportional to volume of segment.

12. A 150 m long metal wire connects points A and B. The electric potential at point B is 50 V less than that at point A. If the conductivity of the metal is 60×10^6 mho/m, then magnitude of the current density in the wire is equal to :

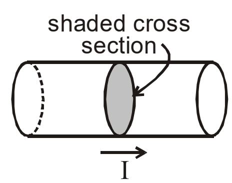
(A) 11×10^{-4} A/m^2 (B) 5.5×10^{-3} A/m^2 (C) 4×10^7 A/m^2 (D) 20×10^6 A/m^2

13. An electric current passes through non uniform cross-section wire made of homogeneous and isotropic material. If the j_A and j_B be the current densities and E_A and E_B be the electric field intensities at A and B respectively, then



(A) $j_A > j_B$; $E_A > E_B$ (B) $j_A > j_B$; $E_A < E_B$ (C) $j_A < j_B$; $E_A > E_B$ (D) $j_A < j_B$; $E_A < E_B$

14. A current I flows through a cylindrical rod of uniform cross-section area A and resistivity ρ. The electric flux through the shaded cross-section of rod as shown in figure is :



(A) $\frac{I}{\rho}$ (B) ρI (C) $\frac{\rho I}{A}$ (D) $\frac{\rho A}{I}$

RESISTANCE

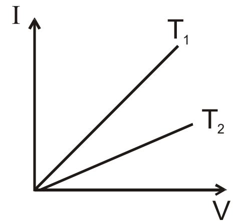
15. A copper wire of radius 0.1 mm and resistance 1 kΩ is connected across a power supply of 20 V. (a) How many electrons are transferred per second between the supply and the wire at one end? (b) Write down the current density in the wire.

16. A wire has a length of 2.0 m and a resistance of 5.0 Ω. Find the electric field existing inside the wire if it carries a current of 10 A.

17. **(i)** A potential difference of 200 volt is applied to a coil at a temperature of 15ºC and the current is 10 A. What will be the mean temperature of the coil when the current has fallen to 9 A, the applied voltage being the same as before? temperature coefficient of resistance $(\alpha) = \frac{1}{234}$ ºC^{-1}.

(ii) A platinum wire has resistance of 10 ohm at 0ºC and 20 ohm at 273 ºC. Find the value of temperature coefficient of resistance.

18. The current-voltage graphs for a given metallic wire at two different temperature T_1 and T_2 are shown in the figure. Which one is higher, T_1 or T_2



19. The current density in a wire is 10 A/cm^2 and the electric field in the wire is 5 V/cm. If ρ = resistivity of material, σ = conductivity of the material then (in S.I. units) :

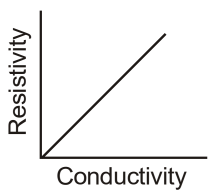
(A) $\rho = 5 \times 10^{-3}$ (B) $\rho = 200$ (C) $\sigma = 5 \times 10^{-3}$ (D) $\sigma = 200$

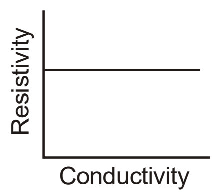
20. A piece of copper and another of germanium are cooled from room temperature to 80 K. The resistance of :

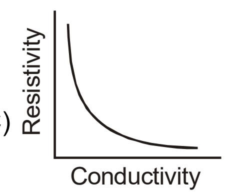
(A) each of the them increases (B) each of them decreases

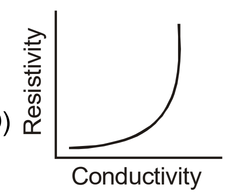
(C) copper increases and germanium decreases (D) copper decreases and germanium increases

21. Which graph best represent the relationship between conductivity and resistivity for a solid ?

(A) 

(B) 

(C) 

(D) 

22#. Consider a resistor of uniform cross section area connected to a battery of internal resistence zero. If the length of the resistor is doubled by stretching it then

(A) current will become four times.

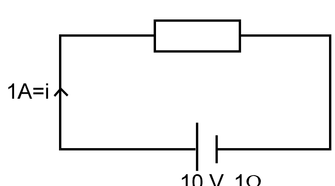
(B) the electric field in the wire wil become half.

(C) the thermal power produced by the resistor will become one fourth.

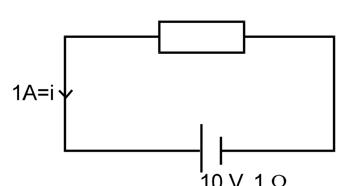
(D) the product of the current density and conductance will become half.

POWER, ENERGY, BATTERY, EMF, TERMINAL VOLTAGE & KIRCHOFF'S LAWS

23. In following diagram boxes may contain resistor or battery or any other element



(A)



(B)

then determine in each case

(a) E.m.f. of battery

(b) Battery is acting as a source or load

(c) Potential difference across each battery

(d) Power input to the battery or output by the battery.

(e) The rate at which heat is generated inside the battery.

(f) The rate at which the chemical energy of the cell is consumed or increased.

(g) Potential difference across box

(h) Electric power output across box.

24. The figure shows the current I in a single-loop circuit with a battery B and resistance R (and wires of negligible resistance).

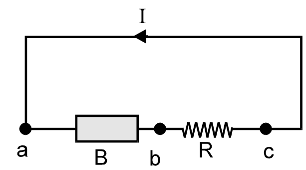
(a) Should the emf arrow at B be drawn leftward or rightward?

At points a, b and c, rank

(b) The magnitude of the current,

(c) The electric potential, and

(d) The electric potential energy of the charge carriers (electron), greatest first.



25. (a) A car has a fresh storage battery of emf 12 V and internal resistance $5.0 \times 10^{-2}\ \Omega$. If the starter draws a current of 90 A, what is the terminal voltage of the battery when the starter is on ?

(b) After long use, the internal resistance of the storage battery increases to 500 Ω. What maximum current can be drawn from the battery? Assume the emf of the battery to remain unchanged.

(c) If the discharged battery is charged by an external emf source, is the terminal voltage of the battery during charging greater or less than its emf 12 V?

26. In following circuit potential at point 'A' is zero then determine

(a) Potential at each point

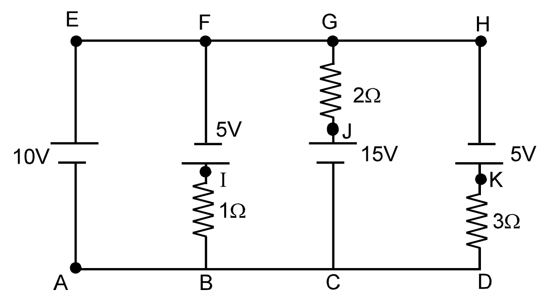
(b) Potential difference across each resistance

(c) Identify the battery which act as a source

(d) Current in each battery

(e) Which resistance consumes maximum power

(f) Which battery consume or gives maximum power.



27. One kilowatt electric heater is to be used with 220 V D.C. supply.

(a) What is the current in the heater.

(b) What is its resistance.

(c) What is the power dissipated in the heater.

(d) How much heat in calories is produced per second.

(e) How many grams of water at 100º C will be converted per minute into steam at 100º C with the heater. (latent heat of vaporisation of water = 540 cal/g)]

28. In an electric circuit containing a battery, the positive charge inside the battery

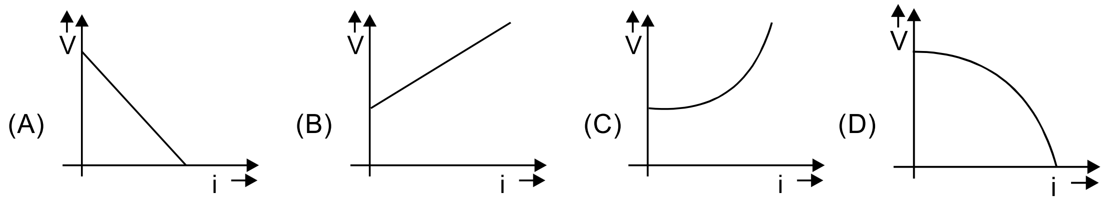
(A) always goes from the positive terminal to the negative terminal

(B) may go from the positive terminal to the negative terminal

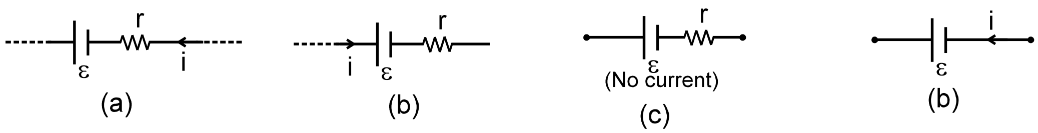
(C) always goes from the negative terminal to the positive terminal

(D) does not move.

29. If internal resistance of a cell is proportional to current drawn from the cell. Then the best representation of terminal potential difference of a cell with current drawn from cell will be:



30.



In which of the above cells, the potential difference between the terminals of a cell exceeds its emf.

(A) a (B) b (C) c (D) d

31.# A resistor of resistance R is connected to a cell of internal resistance 5 Ω. The value of R is varied from 1 Ω to 5 Ω. The power consumed by R:

(A) increases continuously
(B) decreases continuously
(C) first decreases then increases
(D) first increases then decreases.

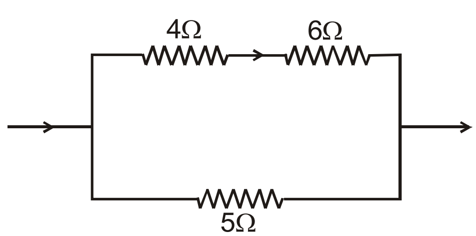
32. A bulb is connected to an ideal battery of emf 10 V so that the resulting current is 10 mA. When the bulb is connected to 220 V mains (ideal), the current is 50 mA. Choose the correct alternative (s)

(A) In the first case, the resistance of the bulb is 1kΩ and in second case, it is 4.4 kΩ.
(B) It is not possible since ohm's law is not followed
(C) the increase in resistance is due to heating of the filament of the bulb when it is connected to 220 V mains
(D) None of these

33.# Choose the correct alternatives

(A) It is easier to start a car engine on a warm day than on a chilly cold day because the internal resistance of battery decreases with rise in temperature
(B) It is more economical to transmit electric power at high voltage and low current rather than at low voltage and high current because heat loss is proportional to square of current.
(C) The heating coil of an electric iron is enclosed in mica sheets because mica is a bad conductor of heat and good conductor of electricity
(D) The heating coil of an electric iron is enclosed in mica sheets because mica is a good conductor of heat and bad conductor of electricity.

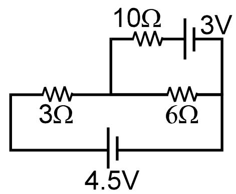
34. In the circuit shown in figure the heat produced in the 5Ω resistor due to the current flowing through it is 10 calories per second.



The heat generated in the 4Ω resistor is :

(A) 1 cal/s (B) 2 cal/s (C) 3 cal/s (D) 4 cal/s

35. Find the current through the 10 Ω resistor shown in figure

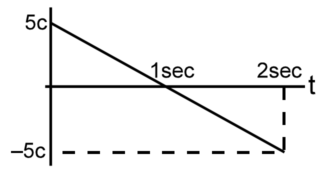


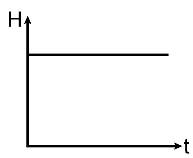
(A) zero (B) 1 A (C) 2A (D) 5 A

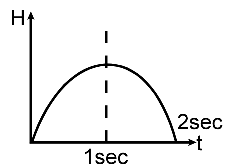
36. The efficiency of a cell when connected to a resistance R is 60%. What will be its efficiency if the external resistance is increased to six times.

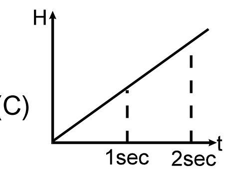
(A) 80 % (B) 90% (C) 55% (D) 95%

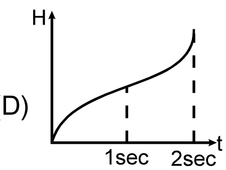
37. A charge passing through a resistor is varying with time as shown in the figure. The amount of heat generated in time ' t ' is best represented (as a function of time) by:



(A) 

(B) 

(C) 

(D) 

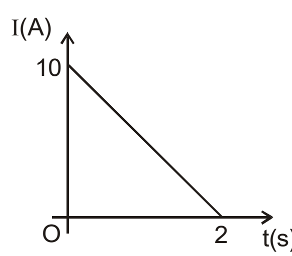
38. The charge flown through a resistance R in time t varies with time according to $Q = at - bt^2$. The total heat produced in R by the time current becomes zero is :

(A) $\frac{a^3R}{6b}$ (B) $\frac{a^3R}{2b}$ (C) $\frac{a^3R}{3b}$ (D) $\frac{a^3R}{b}$

39. A cell of emf ε and internal resistance ' r ' is connected to an external variable resistance R. The total thermal power generated in the circuit is maximum, if R is equal to:

(A) r (B) zero (C) 2 r (D) r/2

40#. A variable current flows through a 1Ω resistor for 2 seconds. Time dependence of the current is shown in the graph.



(A) Total charge flown through the resistor is 10 C.

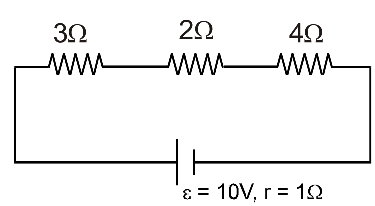
(B) Average current through the resistor is 5A.

(C) Total heat produced in the resistor is 50 J.

(D) Maximum power during the flow of current is 100 W.

EQUIVALENT OF RESISTANCE

41. In given circuit determine



(a) Equivalent resistance (Including internal resistance).

(b) Current in each resistance

(c) Potential difference across each resistance

(d) The rate at which the chemical energy of the cell is consumed

(e) The rate at which heat is generated inside the battery

(f) Electric power output

(g) Potential difference across battery

(h) Which resistance consumes maximum power

(i) Power dissipated in 3 Ω resistance.

42. In given circuit determine

(a) Equivalent resistanace (Including internal resistance).

(b) Current i, i_1, i_2 and i_3

(c) Potential difference across battery and each resistance

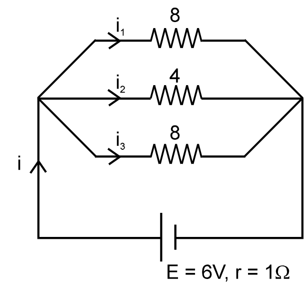
(d) The rate at which the chemical energy of the cell is consumed

(e) The rate at which heat is generated inside the battery

(f) Electric power output

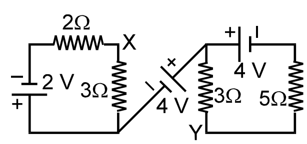
(g) Which resistance consumes maximum power ?

(h) Power dissipated across 4Ω resistance



43. (a) Determine the potential drop between X and Y in the circuit shown in Figure.

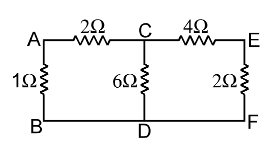
(b) If intermediate cell has internal resistance r = 1Ω then determine the potential difference between x and y.



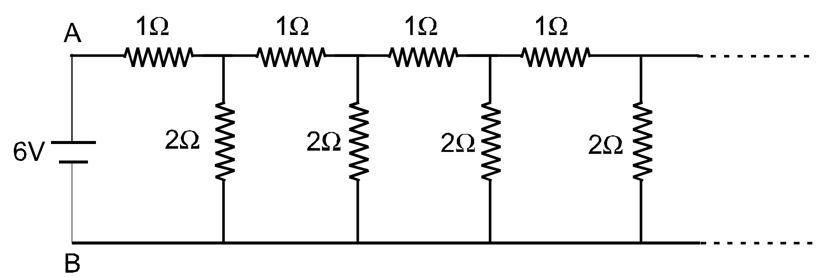
44. Find the equivalent resistance of the circuit given in figure between the following point:

(i) A and B (ii) C and D (iii) E and F

(iv) A and F (v) A and C



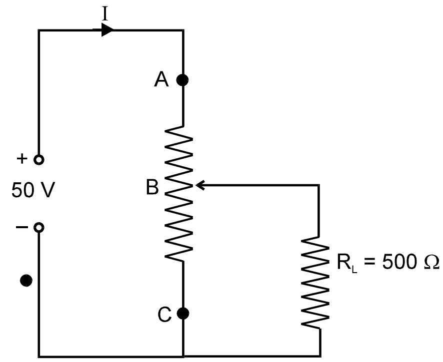
45. An infinite ladder network of resistance is constructed with 1Ω and 2Ω resistance, as shown in figure.



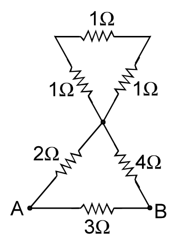
(i) Show that the effective resistance between A and B is 2Ω.

(ii) What is the current that passes through the 2Ω resistance nearest to the battery ?

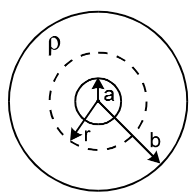
46. As shown in figure a variable rheostat of 2 kΩ is used to control the potential difference across 500 ohm load. (i) If the resistance AB is 500 Ω, what is the potential difference across the load ? (ii) If the load is removed, what should be the resistance at BC to get 40 volt between B and C ?



47. Find the equivalent resistance between the points A and B.



48. Two concentric thin conducting shells of radii a and b are as shown in the figure. The region inside the shells is filled with a medium of resistivity ρ. The conducting spheres are given equal and opposite charges. The electric flux through the surface of a spherical region (indicated by dotted region) of radius r is ϕ. Find the current crossing the dotted spherical surface of radius r.



49. Two coils connected in series have resistances 600 Ω and 300 Ω at 20°C and temperature coefficient of resistivity 0.001 k^{-1} and 0.004 k^{-1} respectively.

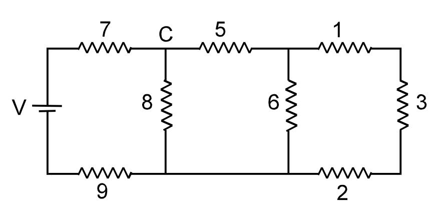
(a) The resistance of the combination at temperature 50°C is

(A) 426 Ω (B) 954 Ω (C) 1806 Ω (D) 214 Ω

(b) The effective temperature coefficient of the combination is

(A) $\frac{1}{1000}$ degree^{-1} (B) $\frac{1}{250}$ degree^{-1} (C) $\frac{1}{500}$ degree^{-1} (D) $\frac{3}{1000}$ degree^{-1}

50. In the ladder network shown, current through the resistor 3 Ω is 0.25 A. The input voltage 'V' is equal to



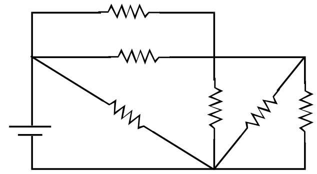
(A) 10 V (B) 20 V (C) 5 V (D) 15/2 V

51. If 2 bulbs rated 2.5 W – 110 V and 100 W – 110 V are connected in series to a 220 V supply then

(A) 2.5 W bulb will fuse (B) 100 W bulb will fuse

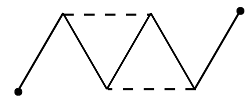
(C) both will fuse (D) both will not fuse

52. In the figure shown each resistor is of 20 Ω and the cell has emf 10 volt with negligible internal resistance. Then rate of joule heating in the circuit is (in watts)



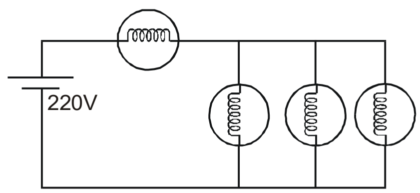
(A) 100/11 (B) 10000/11 (C) 11 (D) None of these

53. Five identical resistor each of resistance 1 Ω are initially arranged as shown in the figure by clear lines. If two similar resistances are added as shown by the dashed lines then change in resistance in final and initial arrangement is



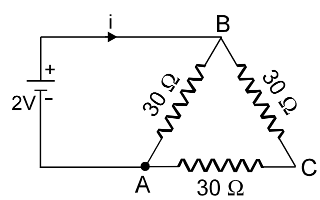
(A) 2 Ω (B) 1 Ω (C) 3 Ω (D) 4 Ω

54. Four identical bulbs each rated 100 watt, 220 volts are connected across a battery as shown. The total electric power consumed by the bulbs is:



(A) 75 watt (B) 400 watt (C) 300 watt (D) 400/3 watt

55. The current i in the circuit of fig. is -

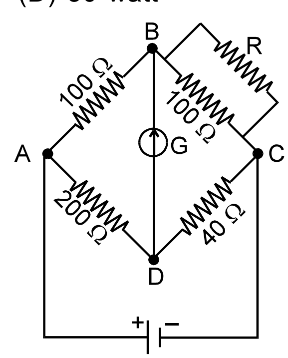


(A) $\frac{1}{45}$ amp. (B) $\frac{1}{15}$ amp. (C) $\frac{1}{10}$ amp. (D) $\frac{1}{5}$ amp.

56. Three equal resistors connected in series across a source of emf together dissipate 10 watts of power. What would be the power dissipated if the same resistors are connected in parallel across the same source of emf ?

(A) 60 watt (B) 90 watt (C) 100 watt (D) 30 watt

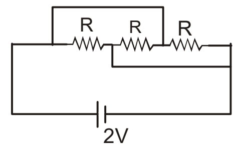
57. The given Wheatstone bridge is showing no deflection in the galvanometer joined between the points B and D (Figure). Calculate the value of R.



(A) 25 Ω (B) 50 Ω

(C) 40 Ω (D) 100 Ω

58. Three equal resistance each of R ohm are connected as shown in figure. A battery of 2 volts of internal resistance 0.1 ohm is connected across the circuit. Calculate the value of R for which the heat generated in the external circuit is maximum.

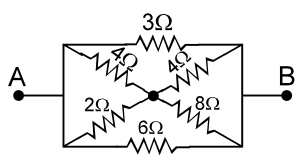


(A) 0.1 Ω (B) 0.2 Ω (C) 0.3 Ω (D) 0.4 Ω

59. A wire of resistance 0.1 ohm cm^{-1} bent to form a square ABCD of side 10 cm. A similar wire is connected between the corners B and D to form the diagonal BD. Find the effective resistance of this combination between corners A and C. IF a 2V battery of neglgible internal resistance is connected across A and C calculate the total power dissipated.

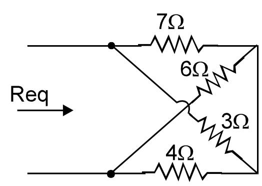
(A) 1 Ω, 3 W (B) 1 Ω, 4 W (C) 2 Ω, 4 W (D) 2 Ω, 4 W

60. The equivalent resistance between A & B is:



(A) $\frac{4}{3}\ \Omega$ (B) $\frac{17}{24}\ \Omega$ (C) 29 Ω (D) $\frac{24}{17}\ \Omega$

61. In the given network of four resistances, the equivalent resistance is

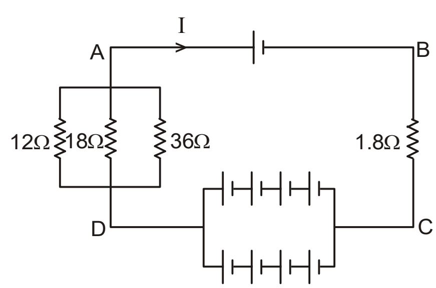


(A) 20 Ω (B) 5.4 Ω (C) 12 Ω (D) 4.5 Ω

COMBINATION OF CELLS

62. Six lead-acid type of secondary cells, each of emf 2.0 V and internal resistance 0.015 Ω, are joined in series to provide a supply to a resistance of 8.5 Ω. Determine : (i) the current drawn from the supply and (ii) its terminal voltage.

63. In the figure each cell has an emf of 1.5 V and internal resistance of 0.40 Ω. Calculate:

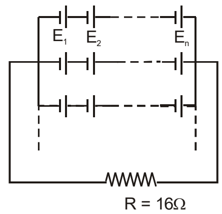


(i) current I

(ii) current in the 36 Ω resistor

(iii) potential difference across A and B.

64. 300 nos. of identical galvanic cells, each of internal resistance 9Ω are arranged as several in–series groups of cells connected in parallel. The arrangement has been laid out so that power output in an externally connected resistance of value 16 Ω is maximum. If n number of cells are connected in every series group that form parallel combination, then find value of n.



65.# Two nonideal batteries are connected in parallel. Consider the following statements

(I) The equivalent emf is smaller than either of the two emfs.

(II) The equivalent internal resistance is smaller than either of the two internal resistance.

(A) Both I and II are correct
(B) I is correct but II is wrong
(C) II is correct but I is wrong
(D) Each of I and II is wrong.

66. 12 cells each having the same emf are connected in series and are kept in a closed box. Some of the cells are wrongly connected. This battery is connected in series with an ammeter and two cells identical with each other and also identical with the previous cells. The current is 3 A when the external cells aid this battery and is 2 A when the cells oppose the battery. How many cells in the battery are wrongly connected?

(A) one (B) two (C) three (D) none

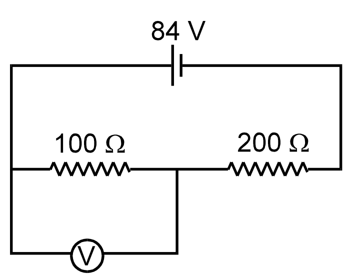
INSTRUMENT

67. A galvanometer has a resistance of 30 ohm and a current of 2 mA is needed to give a full scale deflection. What is the resistance needed and how is it to be connected to convert the galvanometer.

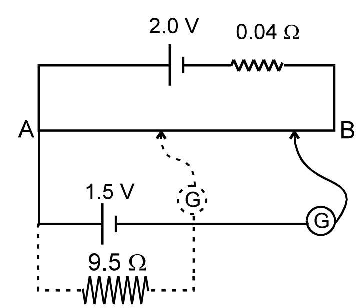
(a) Into an ammeter of 0.3 ampere range

(b) Into a voltmeter of 0.2 volt range ?

68. A voltmeter of resistance 400Ω is used to measure the potential difference across the 100Ω resistor in the circuit shown in the figure. (a) What will be the reading of the voltmeter ? (b) What was the potential difference across 100 Ω before the voltmeter was connected ?



69. Figure shows a 2.0 V potentiometer used for the determination of internal resistance of 1.5 V cell. The balance point of the cell in open circuit is 70 cm. When a resistor of 9.5 Ω is used in the external circuit of the cell, the balance point shifts to 60 cm length of the potentiometer wire. Determine the internal resistance of the secondary cell.



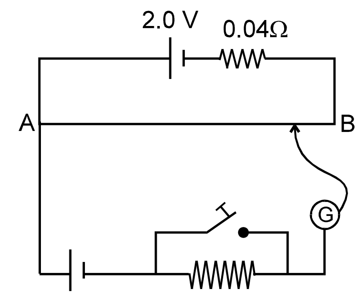
70. A battery of emf 1.4 V and internal resistance 2 Ω is connected to a resistor of 100 Ω through an ammeter. The resistance of the ammeter is 4/3 Ω. A voltmeter has also been connected to find the potential difference across the resistor.

(i) Draw the circuit diagram.

(ii) The ammeter reads 0.02 A. What is the resistance of the voltmeter.

(iii) The voltmeter reads 1.10 V, what is the zero error in the voltmeter.

71. Figure shows a potentiometer with a cell of emf 2.0 V and internal resistance 0.04 Ω maintaining a potential drop across the potentiometer wire AB. A standard cell which maintains a constant emf of 1.02 V (for very moderate currents up to a few ampere) gives a balance point of 67.3 cm length of the wire. To ensure very low currents drawn from the standard cell, a very high resistance of 600 kΩ is put in series with it which is shorted close to the balance point. The standard cell is then replaced by a cell of unknown emf E and the balance point found similarly turns out to be at 82.3 cm length of the wire.



(a) What is the value of E ?

(b) What purpose does the high resistance of 600 kΩ have ?

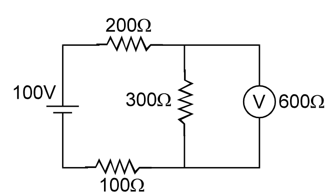
(c) Is the balance point affected by this high resistance?

(d) Is the balance point affected by the internal resistance of the driver cell?

(e) Would the method work in the above situation if the driver cell of the potentiometer had an emf of 1.0 V instead of 2.0 V?

(f) Would the circuit work well for determining extremely small emf, say, of the order of few mV (such typical emf of thermocouple)?

72. The reading of voltmeter is

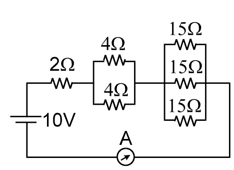


(A) 50V (B) 60 V (C) 40V (D) 80 V

73. A 50 W bulb is in series with a room heater and the combination is connected across the mains. To get max. heater output, the 50 W bulb should be replaced by

(A) 25 W (B) 10 W (C) 100 W (D) 200 W

74. The current through the ammeter shown in figure is 1 A. If each of the 4Ω resistor is replaced by 2Ω resistor, the current in circuit will become nearly :

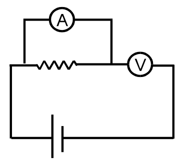


(A) $\frac{10}{9}$ A (B) $\frac{5}{4}$ (C) $\frac{9}{8}$ A (D) $\frac{9}{8}$ A

75.# In a potentiometer wire experiment the emf of a battery in the primary circuit is 20volt and its internal resistance is 5Ω. There is a resistance box (in series with the battery and the potentiometer wire) whose resistance can be varied from 120Ω to 170Ω. Resistance of the potentiometer wire is 75Ω. The following potential differences can be measured using this potentiometer

(A) 5V (B) 6V (C) 7V (D) 8V

76.# By mistake, a voltmeter is placed in series and an ammeter is parallel with a resistance in an electric circuit, with a cell in series.



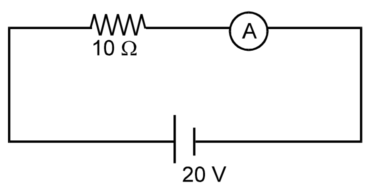
(A) The main current in the circuit will be very low and almost all current will flow through the ammeter, if resistance of ammeter is much smaller than the resistance in parallel.

(B) If the devices are ideal, a large current will flow through the ammeter and it will be damaged

(C) If the devices are ideal, ammeter will read zero current and voltmeter will read the emf of cell

(D) The devices may get damaged if emf of the cell is very high and the meters are nonideal.

77. The ammeter shown in figure consists of a 480 Ω coil connected in parallel to a 20 Ω shunt. Find the reading of the ammeter.

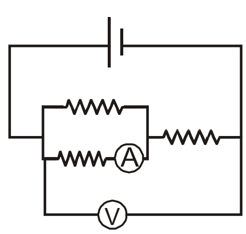


(A) $\frac{50}{73}$A (B) $\frac{40}{53}$A (C) $\frac{50}{93}$A (D) $\frac{73}{50}$A

78. A galvanometer together with an unknown resistance in series is connected across two identical batteries each of 1.5 V. When the batteries are connected in series, the galvanometer records a current of 1A, and when the batteries are in parallel the current is 0.6 A. What is the internal resistance of the battery?

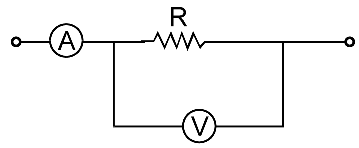
(A) $r = \frac{2}{3}\Omega$ (B) $r = \frac{2}{5}\Omega$ (C) $r = \frac{1}{3}\Omega$ (D) $r = \frac{3}{2}\Omega$

79. In the figure shown, all the resistors have the same resistance. If the ideal ammeter reads 2 A and the ideal voltmeter reads 15 V, what is the resistance of each resistor?



(A) $\frac{5}{2}$ ohm (B) $\frac{15}{4}$ ohm (C) $\frac{15}{2}$ ohm (D) $\frac{5}{3}$ ohm

80. In the circuit shown the readings of ammeter and voltmeter are 4A and 20V respectively. The meters are non-ideal, then R is



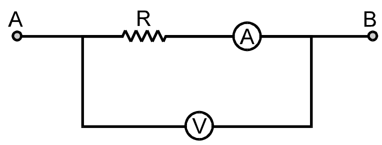
(A) 5 Ω (B) less than 5Ω

(C) greater than 5Ω (D) between 4Ω and 5Ω.

81. The maximum current in a galvanometer can be 10 mA. It's resistance is 10Ω. To convert it into an ammeter of 1 Amp. a resistor should be connected in

(A) series, 0.1Ω (B) parallel, 0.1Ω (C) series, 100Ω (D) parallel, 100Ω.

82. A non-ideal voltmeter and a non-ideal ammeter are connected as shown in the figure. The reading of the voltmeter is 20 V and that of the ammeter is 4 A. The value of R is :



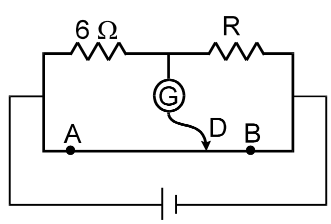
(A) 5 Ω (B) less than 5 Ω

(C) greater than 5 Ω (D) may be less than 5 Ω

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

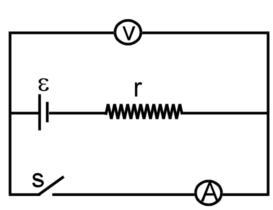
(A) 890 Ω (B) 600 Ω (C) 650 Ω (D) 790 Ω

84. The meter-bridge wire AB shown in figure is 50 cm long. When AD = 30 cm, no deflection occurs in the galvanometer. Find R.

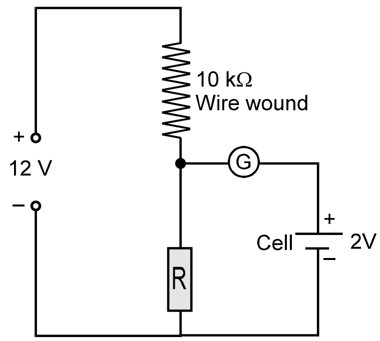


(A) 1 Ω (B) 2 Ω (C) 3 Ω (D) 4 Ω

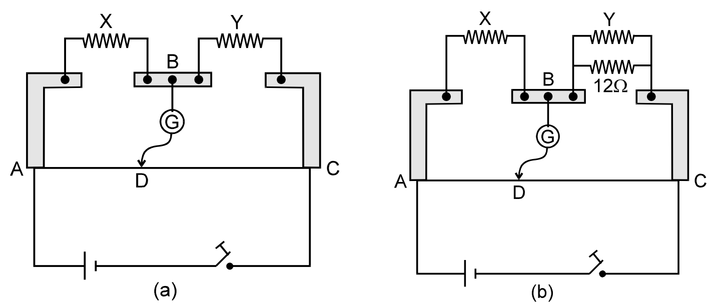
85. In the given figure a battery of emf ε and internal resistance r connected to measure r. The resistance voltmeter is much higher and the resistance of ammeter negligible . When switch is open voltmeter reads 1.52 V and when as closed reading the voltmeter is reduced by 1.45V and ammeter reduced by 1.0A. Find the emf and the internal resistance of the battery ?



86. If the galvanometer in the circuit of Figure reads zero, calculate the value of the resistor R assuming that the 12 V source has negligible internal resistance. If cool air is blown across the wire-wound resistor, what effect will be noticed and why?



87. Figure shows a metre bridge (which is nothing but a practical Wheatstone Bridge) consisting of two resistors X and Y together in parallel with a metre long constantan wire of uniform cross-section. With the help of a movable contact D, one can change the ratio of the resistances of the two segments of the wire until a sensitive galvanometer G connected across B and D shows no deflection. The null point is found to be at a distance of 30 cm from the end A. The resistor Y is shunted by a resistance of 12.0 Ω and the null point is found to shift by a distance of 10 cm. Determine the resistance of X and Y.



88. A potentiometer wire of length 10 m and resistance 10 ohm is connected in series with an ideal cell of E.M.F. 2 V. If a rheostat having range 0 –10 ohm is used in series with the cell then maximum potential gradient of the wire will be :

(A) 2 V/m (B) 0.2 V/m (C) 2 μV/m (D) 0.2 μV/m

89. In a metre bridge experiment null point is obtained at 20 cm from one end of the wire when resistance X is balanced against another resistance Y. If X < Y, then where will be the new position of the null point from the same end, if one decides to balance a resistance of 4X against Y ?

(A) 50 cm (B) 80 cm (C) 40 cm (D) 70 cm

90. In the 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) 4 Ω (B) 2 Ω (C) 1 Ω (D) 0.5 Ω

EXERCISE 2

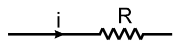
PART - I : SUBJECTIVE QUESTIONS

1. Current flowing through a conducting wire is given by

$$I = (1 + 2t)$$

Where t is in seconds and current I is in amperes. Find the charge (in coulombs) flown through the resistor in the interval from t = 0 to t = 1 second .

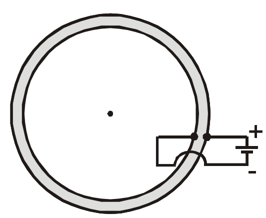
2. A total charge q passes through a resistor of resistance R. The current decreases continuously such that it becomes half after every time T. Find the initial value of the current and its instantaneous value.



3. (a) The current density across a cylindrical conductor of radius R varies according to the equation $J = J_0\left(1 - \frac{r}{R}\right)$, where r = distance from the axis. Thus the current density is a maximum J_0 at the axis r = 0 and decreases linearly to zero at the surface r = R. Calculate the current in terms of J_0 and the conductor's cross-sectional area $A = \pi R^2$.

(b) Suppose that instead the current density is a maximum J_0 at the surface and decreases linearly to zero at the axis so that $J = J_0\frac{r}{R}$. Calculate the current.

4. A spherical shell, made of material of electrical conductivity $\frac{10^9}{\pi}(\Omega\text{-m})^{-1}$, has thickness t = 2 mm and radius R = 10 cm. In an arrangement, its inside surface is kept at a lower potential than its outside surface.



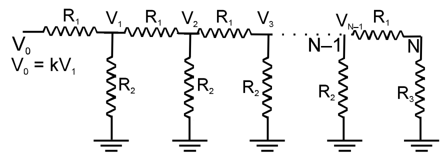
Find The resistance offered by the shell .

5. 1 m long metallic wire is broken into two unequal parts P and Q. P of the wire is uniformly extended into another wire R. Length of R is twice the length of P and the resistance of R is equal to that of Q. Find the ratio of the resistance of P and R and also the ratio of lengths of P and Q. **[REE - 96]**

6. **(a)** A rectangular carbon block has dimensions 1.0 cm x 1.0 cm x 50 cm.
(i) What is the resistance measured between the two square ends?
(ii) Between two opposing rectangular faces?
Resistivity of carbon at 20º C is
$3.5 \times 10^{-5}\ \Omega$m.
(b) A current of 5 A exists in a 10 Ω resistance for 4 minutes.
(i) How many coulombs and
(ii) How many electrons pass through any section of the resistor in this time?
Charge of the electron = 1.6×10^{-19} C.

7. A common flashlight bulb is rated 0.30 A and 2.7 V (the values of the current and voltage under operating conditions). If the resistance of the tungsten bulb filament at room temperature 20°C is 1.0 Ω and its temperature coefficient of resistivity is $4.0 \times 10^{-3}\ °C^{-1}$, then find temperature in centigrade of the filament when the bulb is on. (Consider the variation of ressitance to be linear with temeprature.)

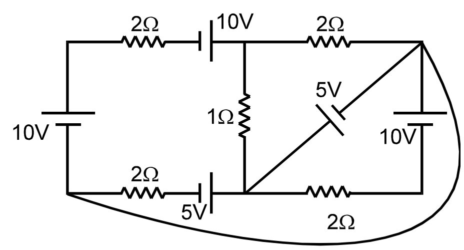
8. A network of resistance is constructed with R_1 and R_2 as shown in the figure. The potential at the points 1, 2, 3,........, N are V_1, V_2, V_3,........., V_n respectively each having a potential K time smaller than previous one. Find:



(i) $\frac{R_1}{R_2}$ and $\frac{R_2}{R_3}$ in terms of K.

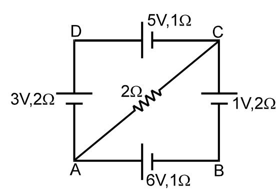
(ii) Current that passes through the resistance R_2 nearest to the V_0 in terms V_0, K and R_3.

9. In the circuit diagram shown find the current through the 1 Ω resistor.



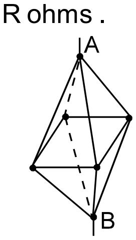
10. A resistor develops 400 J of thermal energy in 10 s when a current of 2 A is passed through it. (a) Find its resistance. (b) If the current is increased to 4 A, what will be the energy developed in 20 s.

11. In the circuit shown:

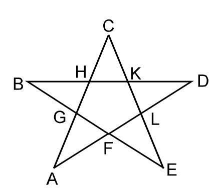


(i) Find the potential difference between points A and C.
(ii) Which battery (s) is (are) acting as source (load).
(iii) Find rate at which energy is delivered (absorbed) by battery of 6 V.

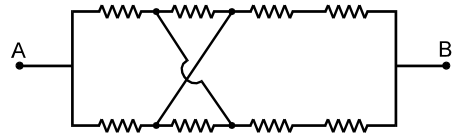
12. Find the equivalent resistance of the circuit as shown in the figure between the junctions A and B. Each of the twelve wires have a resistance R ohms .



13. The figure is made of a uniform wire and represents a regular five pointed star. The resistance of a section EL is 2 ohm. Find the resistance of the star across F and C. ($\sin 18^\circ \simeq \frac{1}{3}$)

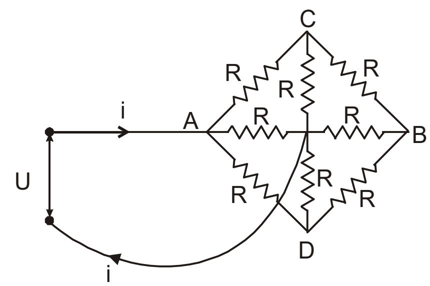


14. Find the equivalent resistance between terminals A and B. Each resistor is of resistance R.

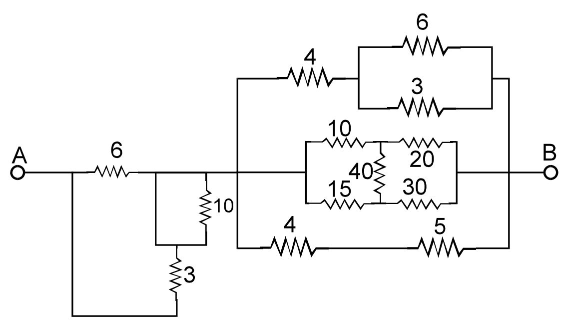


15. ABCD is a square where each side is uniform wire of resistance 1 Ω. Find a point E on CD such that if a uniform wire of resistance 1 Ω is connected across AE and a constant potential difference is applied across A and C, the points B and E will be equipotential.

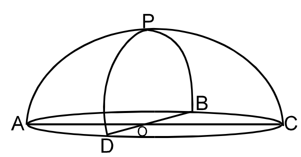
16. The resistance of each resistor in the circuit diagram shown in figure is the same and equal to R. The voltage across the terminals is U. Determine the current I in the leads if their resistance can be neglected.



17. Find the equivalent resistance between point A and B. (all resistors are in ohms)



18. A hemispherical network of radius a is made by using a conducting wire of resistance per unit length 'r'. Find the equivalent resistance across OP.



19. A rod of length L and cross-section area A lies along the x-axis between x = 0 and x = L. The material obeys Ohm's law and its resistivity varies along the rod according to, $\rho(x) = \rho_0 e^{-x/L}$

The end of the rod at x = 0 is at a potential V_0 and it is zero at x = L

(a) Find the total resistance of the rod and the current in the wire.

(b) Find the electric potential V(x) in the rod as a function of x.

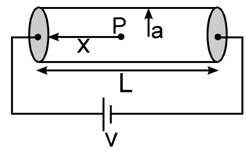
20. The region between two concentric conducting spheres of radii r_a and r_b is filled with a conducting material of resistivity ρ

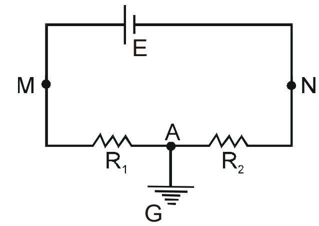
(a) Show that the resistance between the spheres is given by, $R = \frac{\rho}{4\pi}\left(\frac{1}{r_a} - \frac{1}{r_b}\right)$.

(b) Derive an expression for the current density as a function of radius, if the potential difference between the spheres is V_{ab}.

(c) Find the electric field at distance 'r' from the centre in part (b)

21. A cylindrical solid of length L and radius a is connected across a source of emf V and negligible internal resistance shown in figure. The resistivity of the rod at point P distant x from left end is given by $\rho = bx$ (where b is a positive constant). Find the electric field at point P.





22. In the given figure, calculate the potentials at the points M and N if

$E = 12V$, $R_1 = 3\Omega$, $R_2 = 2\Omega$ and $r = 1\,\Omega$.
Also find current in wire AG .

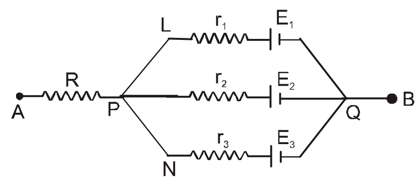
23. Suppose you have three resistors of 20 Ω, 50 Ω and 100 Ω. What minimum and maximum resistances can you obtain from these resistors ?

24. Three bulbs, each having a resistance of 180 Ω, are connected in parallel to an ideal battery of emf 60 V. Find the current delivered by the battery when (a) all the bulbs are switched on, (b) two of the bulbs are switched on and (c) only one bulb is switched on.

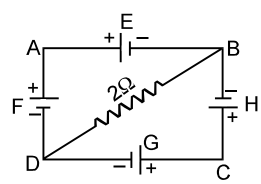
25. In the circuit shown in fig. $E_1 = 3$ volt, $E_2 = 2$ volt, $E_3 = 1$ volt and $R = r_1 = r_2 = r_3 = 1$ ohm. **[JEE - 1981]**

(i) Find potential difference between the points A and B and the currents through each branch.

(ii) If r_2 is short circuited and the point A is connected to point B, find the currents through E_1, E_2, E_3 and the resistor R.

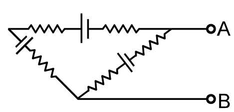


26. In the circuit shown in fig. E, F, G and H are cells of emf 2, 1,3 and 1 volts and their internal resistances are 2, 1, 3 and 1 ohm respectively. Calculate. **[JEE - 1981]**

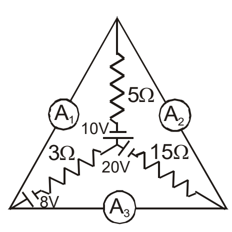


(i) The potential difference between B and D and
(ii) The potential difference across the terminals of each of the cells G and H.

27. In the circuit shown all five resistors have the same value 200 ohms and each cell has an emf 3 volts. Find the open circuit voltage and the short circuit current for the terminals A and B.



28. In the given circuit the ammeter A_1 and A_2 are ideal and the ammeter A_3 has a resistance of $1.9 \times 10^{-3}\ \Omega$. Find the readings of all three meters.



29. 5×10^{-3} A current gives a full scale deflection in a galvanometer of 1Ω resistance. To measure 5 V with this galvanometer, a resistance of ______ is connected in ______ of the galvanometer. **[REE-1996, 1]**

30. A voltmeter of resistance R_V and an ammeter of resistance R_A are connected in series across a battery of emf E and of negligible internal resistance. When a resistance R is connected in parallel to voltmeter, reading of ammeter increases to three times while that of voltmeter reduces to one third. Calculate R_A and R_V is terms of R.

31. A galvanometer having 50 divisions provided with a variable shunt s is used to measure the current when connected in series with a resistance of 90 Ω and a battery of internal resistance 10 Ω. It is observed that when the shunt resistances are 10 Ω & 50 Ω, respectively the deflection are respectively 9 and 30 divisions. What is the resistance of the galvanometer? Further, if the full scale deflection of the galvanometer movement required 200 mA, find the emf of the cell.

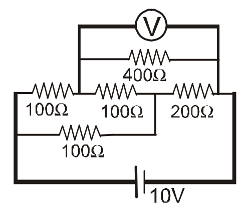
32. In a potentiometer circuit, two wires of same material of resistivity ρ, one of radius of cross-section 'a' and other of radius of cross-section '2a' are joined in series. They are of length ℓ and 2ℓ respectively. This combination acts as the potentiometer wire of length 3ℓ. The emf of the cell in the primary circuit is ε and internal resistance is $\frac{\rho\ell}{2\pi a^2}$. This cell is connected to the potentiometer wire by a conducting wire of negligible resistance with positive terminal of the cell connected to one end (call it A) of longer wire. The negative terminal of the cell is connected to one and of the smaller wire. The remaining ends of the two wires are joined together. Find:

(i) The maximum voltage which can be balanced on the potentiometer wire.

(ii) The balancing length, measured from point A, obtained in measurement of emf of cell of emf $\frac{\varepsilon}{2}$.

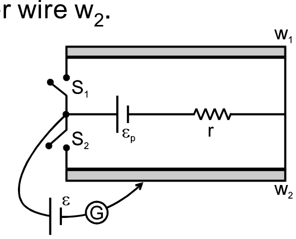
(iii) If positive terminal of cell of emf $\frac{\varepsilon}{2}$ and internal resistance $\frac{\rho\ell}{2\pi a^2}$ is connected to point A and other terminal is joined to the junction of the two wires, then find the current through this cell.

33. An electrical circuit is shown in the figure. Calculate the potential difference across the resistance of 400 ohm, as will be measured by the voltmeter V of resistance 400 ohm, either by applying Kirchhoff's rules or otherwise. **[JEE' 1996, 5]**



34. Two resistors, 400 Ω, and 800 Ω are connected in series with a 6 V battery. It is desired to measure the current in the circuit. An ammeter of 10 Ω resistance is used for this purpose. What will be the reading in the ammeter? Similarly, if a voltmeter of 1000 Ω resistance is used to measure the potential difference across the 400 Ω resistor, what will be the reading in the voltmeter ?

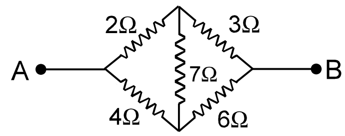
35 Two potentiometer wires w_1 and w_2 of equal length ℓ connected to a battery of emf ε_P and internal resistance 'r' through two switches s_1 and s_2. A battery of emf ε is balanced on these potentiometer wires. If potentiometer wire w_1 is of resistance 2r and balancing length is $\ell/2$ when only s_1 is closed and s_2 is open. On closing s_2 and opening s_1 the balancing length on w_2 is found to be $\left(\frac{2\ell}{3}\right)$, then find the resistance of potentiometer wire w_2.



PART - II : OBJECTIVE QUESTIONS

36. All the edges of a block in cuboidal shape with parallel faces are unequal. Its longest edge is twice its shortest edge. The ratio of the maximum to minimum resistance between parallel faces is:
(A) 2
(B) 4
(C) 8
(D) indeterminate unless the length of the third edge is specified.

37. Five resistance are connected as shown in fig. The effective resistance between the points A and B is - **[JEE - 1976]**



(A) 10/3 Ω (B) 20/3 Ω (C) 15 Ω (D) 6 Ω

38. A series parallel combination battery consisting of a large number N = 300 of identical cells, each with an internal resistances r = 0.3 Ω, is loaded with an external resistance R = 10 Ω. The number 'n' of parallel groups consisting of an equal number of cells connected in series, at which the external resistance generates the highest thermal power is

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

39. A silver wire of length 10 metre and cross-sectional area 10^{-8} m^2 is suspended vertically and a weight of 10 N is attached to it. Young's modulus of silver and its resistivity are 7×10^{10} N/m^2 and 1.59×10^{-8} Ω-m respectively. The increase in its resistance is equal to (keeping volume constant)

(A) 0.0455 Ω (B) 0.455 Ω (C) 0.91 Ω (D) 0.091 Ω

40#. When no current is passed through a conductor

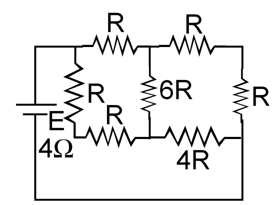
(A) the free electrons do not move

(B) the average speed of a free electron over a large period of time is zero

(C) the average velocity of a free electron over a large period of time is zero

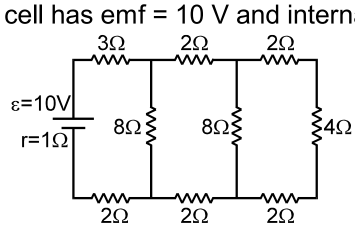
(D) the average of the velocities of all the free electrons at an instant is zero

41. A battery of internal resistance 4 ohm is connected to the network of resistance as shown. In the order that the maximum power can be delivered to the network, the value of R in ohm should be :**[JEE - 2011]**



(A) 4/9 (B) 2 (C) 8/3 (D) 18

42#. In the circuit shown, the cell has emf = 10 V and internal resistance = 1 Ω



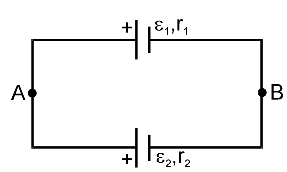
(A) The current through the 3 – Ω resistor is 1 A.

(B) The current though the 3 – Ω resistor is 0.5 A

(C) The current through the 4 – Ω resistor is 0.5 A.

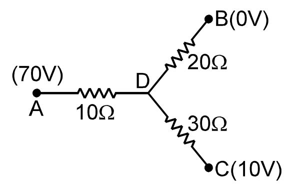
(D) The current through the 4 – Ω resistor is 0.25 A

43#. Two cells of unequal emfs ε_1 and ε_2, and internal resistances r_1 and r_2 are joined as shown. V_A and V_B are the potentials at A and B respectively.



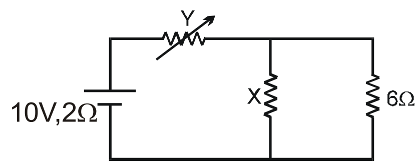
(B) The potential difference across both the cells will be equal
(C) The potential difference across one cell will be greater than its emf.
(D) $V_A - V_B = \frac{(\varepsilon_1 r_2 + \varepsilon_2 r_1)}{r_1 + r_2}$

44#. In the network shown, points A, B and C are potentials of 70 V, zero and 10 V respectively.



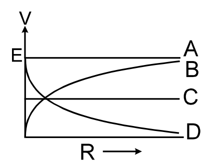
(A) Point D is at a potential of 40 V
(B) The currents in the sections AD, DB, DC are in the ratio 3: 2: 1
(C) The currents in the sections AD, DB, DC are in the ratio 1: 2: 3
(D) The network draws a total power of 200 W.

45. In the figure shown the thermal power generated in ' y ' is maximum when y = 4 Ω. Then X is:



(A) 2 Ω (B) 3 Ω (C) 1 Ω (D) 6 Ω

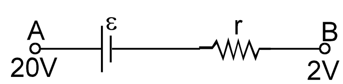
46. A cell of emf E having an internal resistance r is connected to an external resistance R. The potential difference V across the resistance R varies with R as shown in figure by the curve :



(A) A (B) B (C) C (D) D

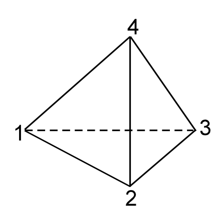
47. When a galvanometer is shunted with a 4Ω resistance, the deflection is reduced to one - fifth. If the galvanometer is further shunted with a 2Ω wire, determine current in galvanometer now if initially current in galvanometer is I_0 (given main current remain same) .
(A) $I_0/13$ (B) $I_0/5$ (C) $I_0/8$ (D) $5I_0/13$

48. The figure shown is a part of circuit :



(A) current will flow from A to B
(B) current may flow from A to B
(C) current will flow from B to A
(D) the direction of current will depend on *r*.

49. A wire is in the form of a tetrahedron. The resistance of each edge is r. The equivalent resistances between corners 1–2 and 1–3 are respectively



(A) $\frac{r}{\ }, \frac{r}{\ }$ (B) r, r (C) $\frac{r}{\ }$, r (D) r, $\frac{r}{\ }$

50. N cells each of e.m.f. E & identical resistance r are grouped into sets of K cells connected in series. The (N/K) sets are connected in parallel to a load of resistance R, then;

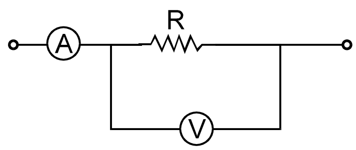
(A) Maximum power is delivered to the load if $K = \sqrt{\frac{NR}{r}}$.

(B) Maximum power is delivered to the load if $K = \sqrt{\frac{r}{NR}}$

(C) Maximum power delivered to the load is $\frac{NE^2}{4r}$

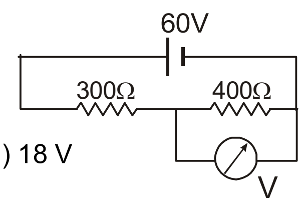
(D) Maximum power delivered to the load is $\frac{E^2}{4Nr}$

51. In the circuit shown the readings of ammeter and voltmeter are 4A and 20V respectively. The meters are non-ideal, then R is



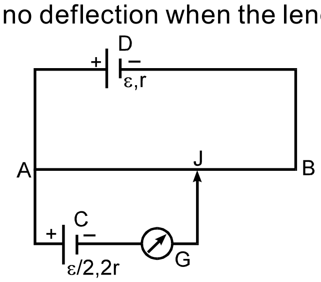
(A) 5 Ω
(B) less than 5Ω
(C) greater than 5Ω
(D) between 4Ω and 5Ω.

52. In the circuit shown, reading of the voltmeter connected across 400 Ω resistance is 30 V. If it is connected across 300 Ω resistance then reading will be



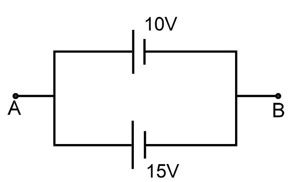
(A) 45 V
(B) 32.5 V
(C) 22.5 V
(D) 18 V

53. In the fig. the potentiometer wire AB of length L & resistance 9 r is joined to the cell D of e.m.f. $\mathcal{E}$ & internal resistance r. The cell C's e.m.f. is $\mathcal{E}/2$ and its internal resistance is 2 r.
The galvanometer G will show no deflection when the length AJ is:



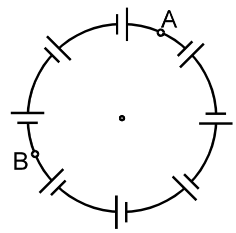
(A) 4L/9
(B) 5L/9
(C) 7L/18
(D) 11L/18

54. Two cells of e.m.f. 10 V & 15 V are connected in parallel to each other between points A & B. The cell of e.m.f. 10 V is ideal but the cell of e.m.f. 15 V has internal resistance 1 Ω. The equivalent e.m.f. between A and B is:



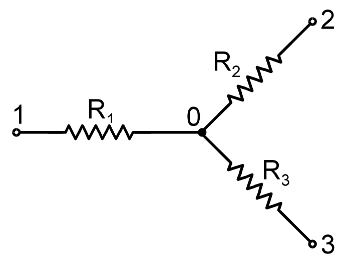
(A) $\frac{25}{2}$ V
(B) not defined
(C) 15 V
(D) 10 V

55. N sources of current with different emf's are connected as shown in figure. The emf's of the sources are proportional to their internal resistances, i.e. $E = \alpha R$, where α is an assigned constant. The connecting wire resistance is negligible. The potential difference between points A and B dividing the circuit in n and N – n links



(A) 0 (B) nE/2 (C) NE (D) (N – n)E

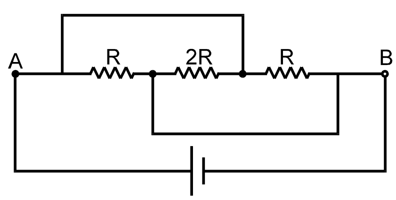
56. Find the current flowing through the resistance R_1 of the circuit shown in figure if the resistances are equal to $R_1 = 10\ \Omega$, $R_2 = 20\ \Omega$, and $R_3 = 30\ \Omega$, and the potentials of points 1, 2 and 3 are equal to $\varphi_1 = 10$ V, $\varphi_2 = 6$ V, and $\varphi_3 = 5$ V.



(A) 0.1 A (B) 0.2 A (C) 0.3 A (D) 0.4 A

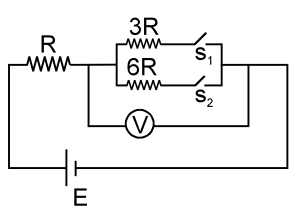
57. In the previous question potential at point 0 is
(A) 15 V (B) 20 V (C)25 V (D) 8 V

58. In the figure shown the current flowing through 2 R is



(A) from left to right (B) from right to left
(C) no current (D) None of these

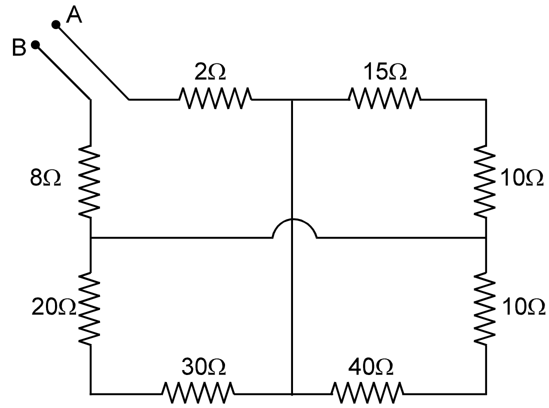
59. In the circuit shown in figure reading of voltmeter is V_1 when only S_1 is closed, reading of voltmeter is V_2 when only S_2 is closed and reading of voltmeter is V_3 when both S_1 and S_2 are closed. Then



(A) $V_3 > V_2 > V_1$ (B) $V_2 > V_1 > V_3$ (C) $V_3 > V_1 > V_2$ (D) $V_1 > V_2 > V_3$

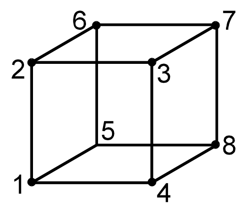
60. The equivalent resistance between points A and B is :

:



(A) $\frac{65}{2}\ \Omega$ (B) $\frac{45}{2}\ \Omega$ (C) $\frac{5}{2}\ \Omega$ (D) $\frac{91}{2}\ \Omega$

61. Find the resistance of a wire frame shaped as a cube (figure) when measured between points 1-7

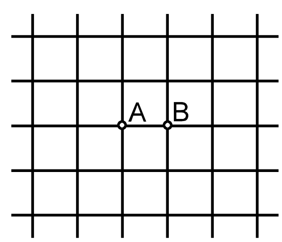


(A) $\frac{5}{3}R$ (B) $\frac{5}{6}R$ (C) $\frac{3}{5}R$ (D) $\frac{6}{5}R$

62. In the previous question find the resistance between points 1 - 3.

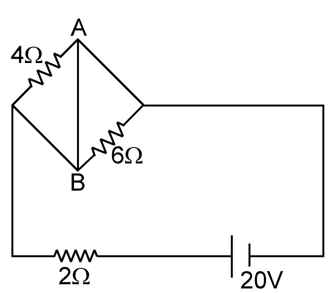
(A) $\frac{3}{4}R$ (B) $\frac{5}{6}R$ (C) $\frac{3}{5}R$ (D) $\frac{6}{5}R$

63. There is an infinite wire grid with square cells (figure). The resistance of each wire between neighbouring joint connections is equal to R_0. Find the resistance R of the whole grid between points A and B.



(A) R_0 (B) $R_0/2$ (C) $R_0/4$ (D) $R_0/8$

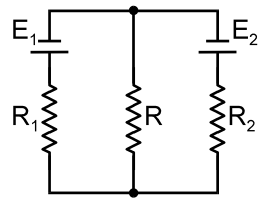
64#. In the circuit shown in figure



(A) power supplied by the battery is 200 watt
(B) current flowing in the circuit is 5 A
(C) potential difference across 4 Ω resistance is equal to the potential difference across 6Ω resistance
(D) current in wire AB is zero

65#. Potential difference across the terminals of a non ideal battery is
(A) zero when it is short circuited
(B) less than its emf when current flows from negative terminal to positive terminal inside the battery
(C) zero when no current is drawn from the battery
(D) greater than its emf when current flows from positive terminal to negative inside the battery.

66. In a circuit shown in figure resistances R_1 and R_2 are known, as well as emf's E_1 and E_2. The internal resistances of the sources are negligible. At what value of the resistance R will the thermal power generated in it be the highest ?

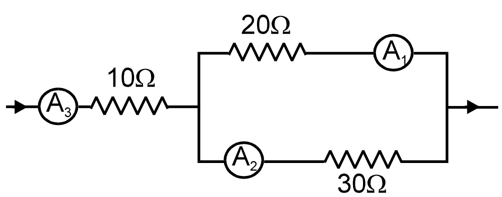


(A) $R_1 + R_2$ (B) $R_1 - R_2$ (C) $\sqrt{R_1R_2}$ (D) $\frac{R_1R_2}{R_1+R_2}$

67. The potential difference between the terminals of a battery of emf 6.0 V and internal resistance 1Ω drops to 5.8 V when connected across an external resistor. The residences of the external resistor is
(A) $29\ \Omega$ (B) $25\ \Omega$ (C) $31\ \Omega$ (D) $43\ \Omega$

68#. A microammeter has a resistance of $100\ \Omega$ and full scale range of $50\ \mu A$. It can be used as a voltmeter of as a higher range ammeter provided a resistance is added to it. Pick the correct range and resistance combination (s) :
(A) 50 V range with $10\ k\Omega$ resistance is series
(B) 10 V range with $200\ k\Omega$ resistance in series
(C) 5 mA range with $1\ \Omega$ resistance in parallel
(D) 10 mA range with $1\ \Omega$ resistance in parallel

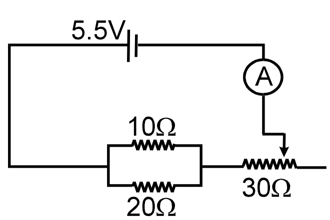
69. If the reading of ammeter A_1 in figure is 2.4 A. Neglecting the resistances of the ammeters, the reading of ammeter A_2 will be :



(A) 1.6 A (B) 1.2 A (C) 1 A (D) 2 A

70. In the previous question the reading of ammeter A_3 will be :
(A) 1.6 A (B) 1.2 A (C) 4 A (D) 2 A

71. The resistance of the rheostat shown in figure is $30\ \Omega$. Neglecting the meter resistance, the ratio of minimum and maximum currents through the ammeter, as the rheostat is varied, will be :



(A) $\frac{2}{11}$A (B) $\frac{83}{15}$A (C) $\frac{9}{43}$A (D) $\frac{19}{43}$A

72#. A cell of emf ε and internal resistance r drives a current i through an external resistance R.

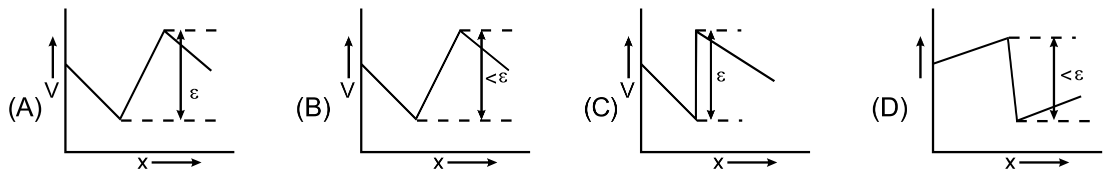
(A) The cell generating εi power

(B) Heat is produced in R at the rate εi

(C) Heat is produced in R at the rate $\varepsilon i \left(\frac{R}{R+r}\right)$

(D) Heat is produced in the cell at the rate $\varepsilon i \left(\frac{r}{R+r}\right)$

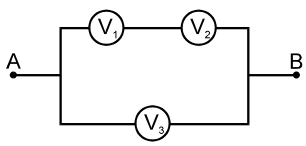
73. The two ends of a uniform conductor are joined to a cell of emf ε and some internal resistance. Starting from the midpoint P of the conductor, we move in the direction of the current and return to P. The potential V at every point on the path is plotted against the distance covered (x). Which of the following best represents the resulting curve?



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

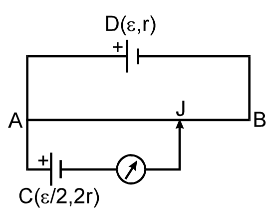
(A) both A and V will increase
(B) both A and V will decrease
(C) A will decrease, V will increase
(D) A will increase, V will decrease

75#. Three voltmeters, all having different resistances, are joined as shown. When some potential difference is applied across A and B, their readings are V_1, V_2, V_3 :



(A) $V_1 = V_2$ (B) $V_1 \neq V_2$ (C) $V_1 + V_2 = V_3$ (D) $V_1 + V_2 > V_3$

76#. In the potentiometer arrangement shown, the driving cell D has emf ε and internal resistance r. The cell C, whose emf is to be measured, has emf $\varepsilon/2$ and internal resistance 2r. The potentiometer wire is 100-cm long. If balance is obtained, the length AJ = ℓ.



(A) ℓ = 50 cm

(B) ℓ> 50 cm

(C) Balance will be obtained only if resistance of AB is > r.

(D) Balance cannot be obtained.

EXERCISE 3

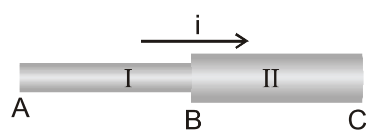
PART - I : MATRIX MATCH

1. **Match the following :**
The following table gives the lengths of four copper rods at the same temperature, their diameters, and the potential differences between their ends.

Rod	Length	Diameter	Potential Difference
1	L	3d	V
2	2L	d	3V
3	3L	2d	2V
4	3L	d	V

Correctly match the physical quantities mentioned in the left column with the rods as marked.
(A) Greatest Drift speed of the electrons. (p) Rod 1
(B) Greatest Current (q) Rod 2
(C) Greatest rate of thermal energy produced (r) Rod 3
(D) Greatest Electric field (s) Rod 4

2. Column I gives physical quantities of a situation in which a current i passes through two rods I and II of equal length that are joined in series. The ratio of free electron density (n), resistivity (ρ) and cross-section area (A) of both are in ratio $n_1 : n_2 = 2 : 1$, $\rho_1 : \rho_2 = 2 : 1$ and $A_1 : A_2 = 1 : 2$ respectively. Column II gives corresponding results. Match the ratios in Column I with the values in Column II and indicate your answer by darkening appropriate bubbles in the 4 × 4 matrix given in the OMR.

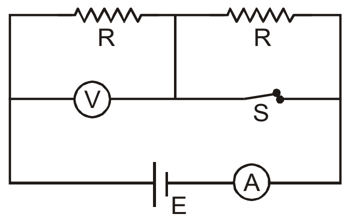


Column I	Column II
(A) $\dfrac{\text{Drift velocity of free electron in rod I}}{\text{Drift velocity of free electron in rod II}}$	(p) 0.5
(B) $\dfrac{\text{Electric field in rod I}}{\text{Electric field in rod II}}$	(q) 1
(C) $\dfrac{\text{Potential difference across rod I}}{\text{Potential difference across rod II}}$	(r) 2
(D) $\dfrac{\text{Average time taken by free electron to move from A to B}}{\text{Average time taken by free electron to move from B to C}}$	(s) 4

3. Match the statements in Column I with the current element in Column II

Column - I	Column - II
(A) Current always flows from higher potential to lower potential	(p) A Resistor
(B) Energy dissipated in an element is always zero	(q) Ideal cell/Battery
(C) Current flow through the element is always zero	(r) Non-Ideal cell/Battery
(D) Potential difference may be zero	(s) Short-circuited resistor

4. In the circuit shown, battery, ammeter and voltmeter are ideal and the switch S is initially closed as shown. When switch S is opened, match the parameter of column **I** with the effects in column **II** and indicate your answer by darkening appropriate bubbles in the 4 × 4 matrix given in the OMR.

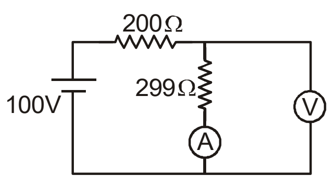


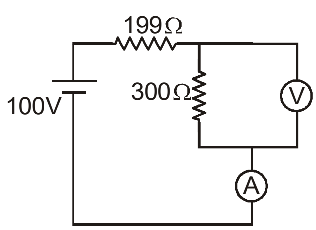
(A) Equivalent resistance across the battery
(B) Power dissipated by left resistance R
(C) Voltmeter reading
(D) Ammeter reading

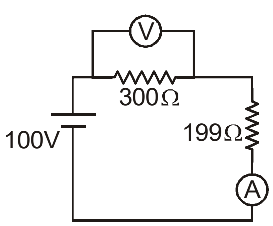
(p) Remains same
(q) Increases
(r) decreases
(s) Becomes zero.

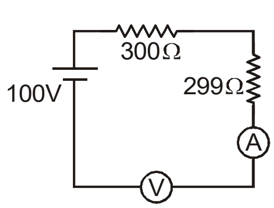
5. In the circuit shown in each situation of column-I, all cells are ideal, resistance of ammeter is 1Ω and resistance of voltmeter is $600\,\Omega$. Match each situation in column-I with corresponding voltmeter and ammeter reading given in column-II.

Column I

(A) 

(B) 

(C) 

(D) 

Column II

(p) ammeter reading is $\frac{1}{6}$ A

(q) voltmeter reading is 50 V.

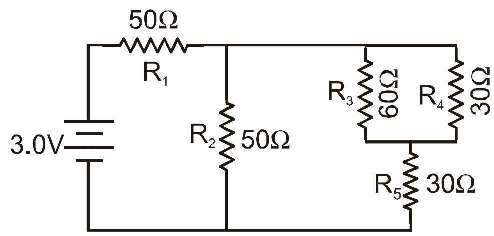
(r) voltmeter reading is $\frac{600}{11}$ V.

(s) ammeter reading is $\frac{1}{4}$ A.

PART - II : COMPREHENSIVE

Paragraph for Question Nos. 6 to 8

In the circuit shown, the resistances are given in ohms and the battery is assumed ideal with emf equal to 3.0 volts.



6. The resistor that dissipates maximum power.

(A) R_1 (B) R_2 (C) R_4 (D) R_5

7. The potential difference across resistor R_3 is

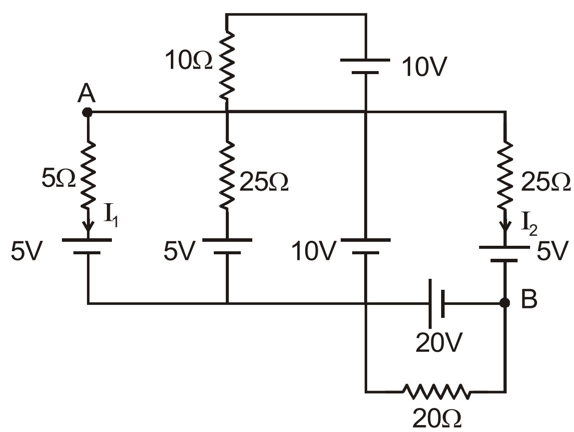
(A) 0.4 V (B) 0.6 V (C) 1.2 V (D) 1.5 V

8. The current passing through 3V battery is

(A) 10 mA (B) 30 mA (C) 40 mA (D) 60 mA

Paragraph for Question Nos. 9 to 11

The circuit consists of resistors and ideal cells. I_1 and I_2 are current through branches indicated in the figure. V_A and V_B is the potential at points A and B on the circuit.



9. The value of $\frac{I_2}{I_1}$ is :

(A) 1 (B) 2 (C) 3 (D) 4

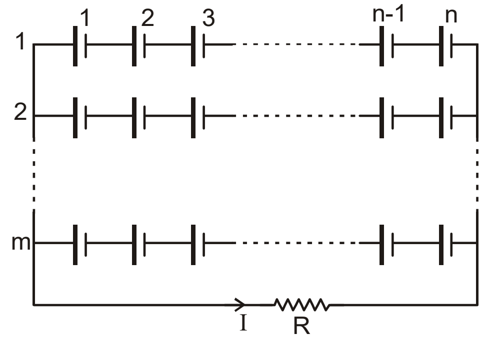
10. The value of $V_A - V_B$ in volts is :

(A) 5 (B) 10 (C) 15 (D)30

11. The net power dissipated in the circuit in watts is :

(A) 55 (B) 15 (C) 62 (D) 61

m rows of n identical cells are connected across a resistor of resistance R as shown. EMF of each cell is E and its internal resistance is r. I is the current through R as shown.



12. If n, m are fixed; then for I to be maximum, the value of R is :

(A) 0 (B) r (C) $\frac{nr}{m}$ (D) $\frac{mr}{n}$

13. If n, m are fixed; then for power consumed by R to be maximum, the value of R is :

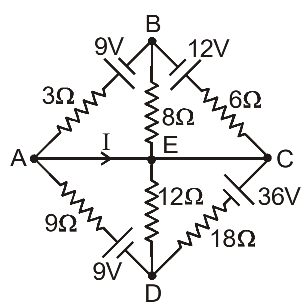
(A) 0 (B) r (C) $\frac{nr}{m}$ (D) $\frac{mr}{n}$

14. Now R is fixed but n and m can be varied keeping total numbers of cells in the circuit fixed. Then for power consumed by R to be maximum, the value of R will be :

(A) 0 (B) r (C) $\frac{nr}{m}$ (D) $\frac{mr}{n}$

Paragraph for Question Nos. 15 to17

In the shown circuit all cells are ideal.



15. The magnitude of current through 8Ω resistor connected between points B and E is equal to :
(A) 0.25 A (B) 0.5 A (C) 1 A (D) 2 A

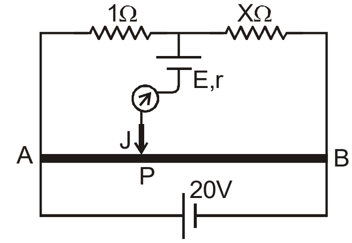
16. The magnitude of current I through conducting wire connected between A and E is equal to :

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

17. Let potential at points B and D be V_B and V_D respectively. Then $V_B - V_D$ is equal to :
(A) 4V (B) – 4V (C) 20 V (D) – 20 V

Paragraph for Question Nos. 18 to 20

AB is a uniform wire of meter bridge, across which an ideal 20 volt cell is connected as shown. Two resistor of 1 Ω and X Ω are inserted in slots of metre bridge. A cell of emf E volts and internal resistance r Ω and a galvanometer is connected to jockey J as shown.



18. If E = 16 volts, r = 4 Ω and distance of balance point P from end A is 90 cm, then the value of X is :

(A) 3 Ω (B) 6 Ω (C) 9 Ω (D) 12 Ω

19. If E = 16 volts, r = 8 and X = 9 , then the distance of balance point P from end A is :
(A) 10 cm (B) 30 cm (C) 60 cm (D) 90 cm

20. If E = 12 volts, X = 9 Ω, then distance of balance point P from end A is
(A) 20 cm (B) 50 cm (C) 70 cm (D) Data insufficient

PART - III: ASSERTION REASON

21. **STATEMENT-1 :** The current density $\vec{J}$ at any point in ohmic resistor is in direction of electric field $\vec{E}$ at that point.

STATEMENT-2 : A point charge when released from rest in a region having only electrostatic field always moves along electric lines of force.

(A) Statement-1 is True, Statement-2 is True; Statement-2 **is** a correct explanation for Statement-1
(B) Statement-1 is True, Statement-2 is True; Statement-2 **is NOT** a correct explanation for Statement-1
(C) Statement-1 is True, Statement-2 is False
(D) Statement-1 is False, Statement-2 is True.

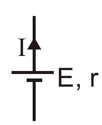
22. **STATEMENT-1 :** A wire of uniform cross section and uniform resitivity is connected across an ideal cell. Now the length of the wire is doubled keeping volume of wire constant. The drift velocity of electrons after stretching the wire becomes one fourth of what it was before stretching the wire.

STATEMENT-2 : Drift velocity of electrons in a current carrying wire is directly proportional to electric field.

(A) Statement-1 is True, Statement-2 is True; Statement-2 **is** a correct explanation for Statement-1
(B) Statement-1 is True, Statement-2 is True; Statement-2 **is NOT** a correct explanation for Statement-1
(C) Statement-1 is True, Statement-2 is False
(D) Statement-1 is False, Statement-2 is True.

23. **STATEMENT–1 :** Magnitude of potential difference across the terminals of a non-ideal battery in a circuit cannot be greater than its emf.

STATEMENT–2 : When a current of magnitude I is passing through a battery of emf E and internal resistance r as shown, the magnitude of potential difference (V) across the battery is given by V = E– I r



(A) Statement-1 is True, Statement-2 is True; Statement-2 **is** a correct explanation for Statement-1
(B) Statement-1 is True, Statement-2 is True; Statement-2 **is NOT** a correct explanation for Statement-1
(C) Statement-1 is True, Statement-2 is False
(D) Statement-1 is False, Statement-2 is True.

24. **STATEMENT–1 :** The electrostatic field inside a cell is always in direction of current flow through the cell, when cell is connected in a closed circuit.

STATEMENT–2 : Inside a resistor the direction of drift current and electric field is same.

(A) Statement-1 is True, Statement-2 is True; Statement-2 **is** a correct explanation for Statement-1
(B) Statement-1 is True, Statement-2 is True; Statement-2 **is NOT** a correct explanation for Statement-1
(C) Statement-1 is True, Statement-2 is False
(D) Statement-1 is False, Statement-2 is True.

25. **STATEMENT–1** : When nonzero current flows through a conducting wire, the electric field inside the conducting wire must be zero.

STATEMENT–2 : Electric field inside a solid conductor is always zero.

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1

(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1

(C) Statement-1 is True, Statement-2 is False

(D) Statement-1 is False, Statement-2 is True.

(E) Statement-1 is False, Statement-2 is False

26. **STATEMENT-1 :** When an external resistor of resistance R (connected across a cell of constant internal resistance r) is varied, power consumed by resistance R is maximum when R = r.

STATEMENT-2 : Power consumed by a resistor of constant resistance R is maximum when current through it is maximum.

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.

(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1

(C) Statement-1 is True, Statement-2 is False

(D) Statement-1 is False, Statement-2 is True

27. **STATEMENT-1 :** The rate at which energy is being delivered to a light bulb is higher after it has been on for a few seconds than just after it is turned on.

STATEMENT-2 : As the filaments warms up, its resistance rises and the current falls.

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1

(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1

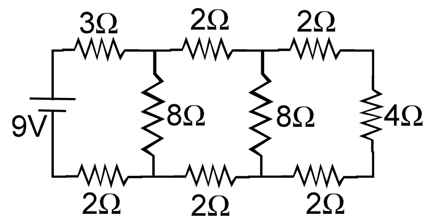
(C) Statement-1 is True, Statement-2 is False

(D) Statement-1 is False, Statement-2 is True.

EXERCISE 4

JEE PROBLEMS

1. In the circuit shown in the figure, the current through: **[JEE - 1998, 2/200]**



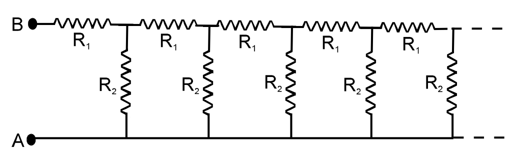
(A) The 3 Ω resistor is $\frac{1}{2}$ A

(B) The 3 Ω resistor is $\frac{1}{4}$ A

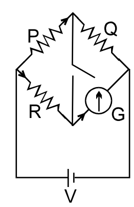
(C) The 4 Ω resistor is $\frac{1}{2}$ A

(D) The 4 Ω resistor is $\frac{1}{4}$ A **[JEE - 1998, 2/200]**

2. Consider an infinite ladder network shown in fig. A voltage is applied between points A and B. If the voltage is halved after each section, find the ratio R_1/R_2. Suggest a method to terminate it after a few sections without introducing much error in attenuation. **[REE - 1998]**



3. In the circuit shown, P ≠ R, the reading of the galvanometer is same with switch S open or closed. Then **[JEE - 1999, 2/100]**



(A) $I_R = I_G$ (B) $I_P = I_G$ (C) $I_Q = I_G$ (D) $I_Q = I_R$

4. A nichrome wire of uniform cross-sectional area is bent to form a rectangular loop ABCD. Another nichrome wire of the same cross-section is connected to form the diagonal AC. Find out the ratio of the resistances across BD and AC if AB = 0.4 m and BC = 0.3 m. **[REE - 2000]**

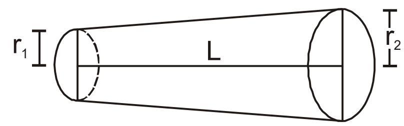
5. An electric kettle has coils A and B, when coil A is switched on, the water boils in 10 minute, and when coil B is switched on the water boils in 20 minute. Calculate the time taken by water, to boil if the coils connected in **[REE - 2000]**

(a) Series and
(b) Parallel all switched on.

6. A quantity X is given by $\varepsilon_0 L \frac{\Delta V}{\Delta t}$ where ε_0 is the permittivity of free space, L is a length, ΔV is a potential difference and Δt is a time interval. The dimensional formula for X is the same as that of : **[JEE - 2001, 3/105]**

(A) Resistance (B) Charge (C) Voltage (D) Current

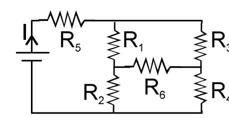
7. A portion of length L is cut out of a conical solid wire. The two ends of this portion have circular cross-section of radii r_1 and r_2 ($r_2 > r_1$). It is connected lengthwise to a circuit and a current I is flowing in it. The resistivity of the material of the wire is ρ. Calculate the resistance of the considered portion and the voltage developed across it. **[REE - 2001, 7]**



8. A wire of length L and 3 identical cells of negligible internal resistances are connected in series. Due to the current the temperature of the wire is raised by ΔT in a time t. A number N of similar cells is now connected in series with a wire of the same material and cross-section but of length 2 L. The temperature of the wire is raised by the same amount ΔT in the same time t. The value of N is: **[JEE - 2001,3/105]**

(A) 4 (B) 6 (C) 8 (D) 9

9. In the given circuit, it is observed that the current I is independent of the value of the resistance R_6. Then the resistance values must satisfy: **[JEE - 2001,3/105]**



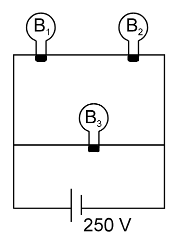
(A) $R_1 R_2 R_5 = R_3 R_4 R_6$

(B) $\frac{1}{R_5} + \frac{1}{R_6} = \frac{1}{R_1 + R_2} + \frac{1}{R_3 + R_4}$

(C) $R_1 R_4 = R_2 R_3$

(D) $R_1 R_3 = R_2 R_4 = R_5 R_6$

10. A 100 W bulb B_1 and two 60 W bulbs B_2 and B_3 are connected to a 250 V source as shown in the figure. Now W_1, W_2 and W_3 are the output powers of the bulbs B_1, B_2 and B_3 respectively. Then:



(A) $W_1 > W_2 = W_3$

(B) $W_1 > W_2 > W_3$

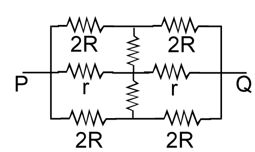
(C) $W_1 < W_2 = W_3$

(D) $W_1 < W_2 < W_3$ **[JEE - 2002, 3/105]**

11. The potential difference applied to an X-ray tube is 5 kV and the current through it is 3.2 mA. Then the number of electrons striking the target per second is **[JEE - 2002,3/105]**

(A) 2×10^{16} (B) 5×10^{16} (C) 1×10^{17} (D) 4×10^{15}

12. The effective resistance between points P and Q of the electrical circuit shown in the figure is: **[JEE - 2002, 3/105]**



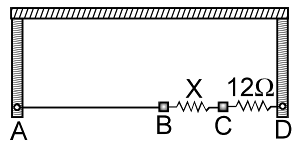
(A) $\frac{2Rr}{R+r}$

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

(C) $2r + 4R$

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

13. A thin uniform wire AB of length 1 m, an unknown resistance X and a resistance of 12 are connected by thick conducting strips, as shown in the figure. A battery and a galvanometer (with a sliding jockey connected to it) are also available. Connections are to be made to measure the unknown resistance X using the principle of Wheatstone bridge. Answer the following question. **[JEE - 2002; 5/100]**

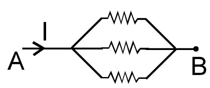


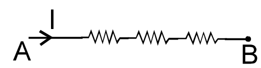
(a) Are there positive and negative terminals on the galvanometer?

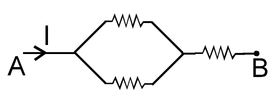
(b) Copy the figure in your answer book and show the battery and the galvanometer (with jockey) connected at appropriate points.

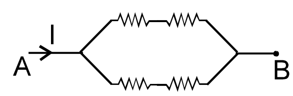
(c) After appropriate connections are made, it is found that no deflection takes place in the galvanometer when the sliding jockey touches the wire at a distance of 60 cm from A. Obtain the value of the resistance X.

14. Arrange the order of power dissipated in the given circuits, if the same current is passing through the system. The resistance of each resistor is 'r'. **[JEE - 2003, 3/90]**

(i) 

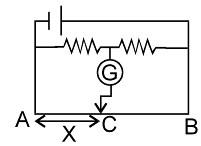
(ii) 

(iii) 

(iv) 

(A) $P_2 > P_3 > P_4 > P_1$ (B) $P_1 > P_4 > P_3 > P_2$ (C) $P_1 > P_2 > P_3 > P_4$ (D) $P_4 > P_3 > P_2 > P_1$

15. In the given circuit, no current is passing through the galvanometer. If the cross-sectional diameter of the wire AB is doubled, then for null point of galvanometer, the value of AC would be:



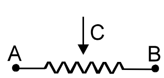
(A) 2 X

(B) X

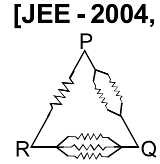
(C) $\frac{X}{2}$

(D) None **[JEE - 2003, 3/90]**

16. Connect a battery to the terminals and complete the circuit diagram so that it works as a potential divider meter. Indicate the output terminals also. **[JEE - 2003, 2/60]**



17. In the given circuit all resistors are of equal value then equivalent resistance will be maximum between the points. **[JEE - 2004, 4/84]**



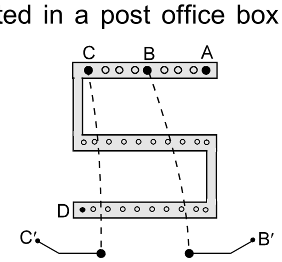
(A) PR

(B) PQ

(C) RQ

(D) same for all

18. Between which points should the terminals of unknown resistance be connected in a post office box arrangement to get its value



(A) A and B

(B) B and C

(C) C and D

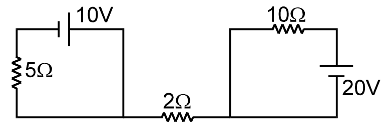
(D) A and D

[JEE - 2004, 4/84]

19. Draw the circuit diagram for the verification of ohm's law using resistance R = 100Ω. Using galvanometers, and resistances of 10^{-3} and 10^{+6} Ω, clearly indicating the position of ammeter & voltmeter.

[JEE - 2004, 4/60]

20. In the figure shown the current through 2Ω resistor is



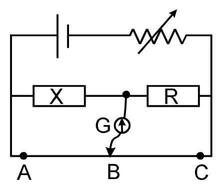
(A) 2A
(B) 0 A
(C) 4 A
(D) 6A

[JEE (Scr.) - 2005, 3/84]

21. A galvanometer has resistance 100Ω and it requires current 100μA for full scale deflection. A resistor 0.1Ω is connected in parallel to make it an ammeter. The smallest current required in the circuit to produce the full scale deflection is **[JEE (Scr.) - 2005, 3/84]**

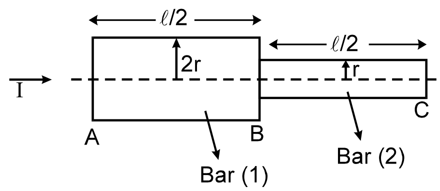
(A) 1000.1 mA
(B) 1.1 mA
(C) 10.1 mA
(D) 100.1 mA

22. For the three values of resistances R namely R_1, R_2 and R_3 the balanced positions of jockey are at A, B and C respectively. Which position will show most accurate result for calculation of X. Give reason. B is near the mid point of the wire.



[JEE (Mains)' 2005, 2/60]

23. Two bars of equal resistivity ρ and radii 'r' and '2r' are kept in contact as shown. An electric current I is passed through the bars. Which one of the following is correct?



(A) Heat produced in bar (1) is 2 times the heat produced in bar (2)
(B) Electric field in both halves is equal
(C) Current density across AB is double that of across BC.
(D) Potential difference across BC is 4 times that of across AB. **[JEE' 2006 ; 3/184]**

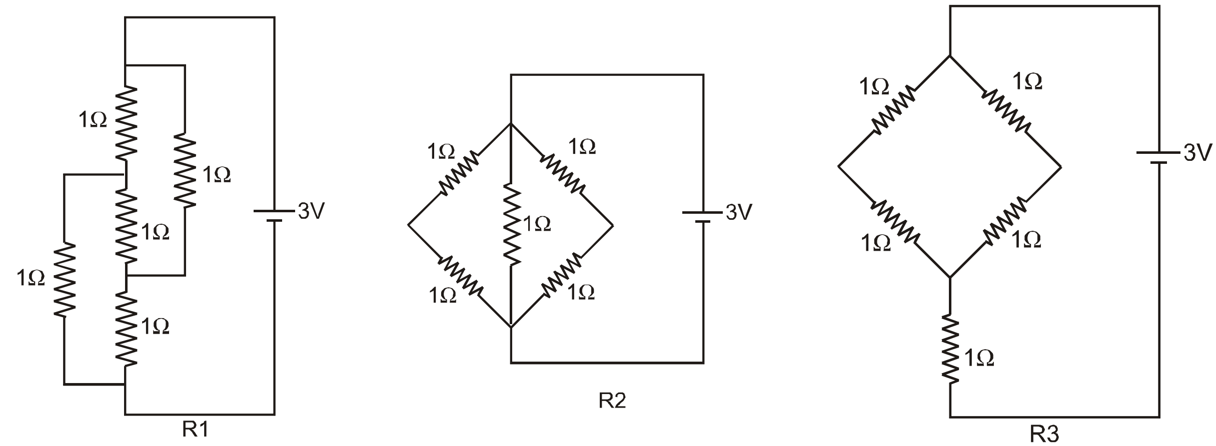
24. A resistance of 2 Ω is connected across one gap of a metre-bridge (the length of the wire is 100 cm) and an unknown resistance, greater than 2 Ω, is connected across the other gap. When these resistances are interchanged, the balance point shifts by 20 cm. Neglecting any corrections, the unknown resistance is

[JEE' 2007_Paper-1, 3/81]

(A) 3 Ω
(B) 4 Ω
(C) 5 Ω
(D) 6 Ω

25. Figure shows three resistor configurations R1, R2 and R3 connected to 3 V battery. If the power dissipated by the configuration R1, R2 and R3 is P1, P2 and P3, respectively, then
Figure : **[JEE' 2008_, 3/163]**

:

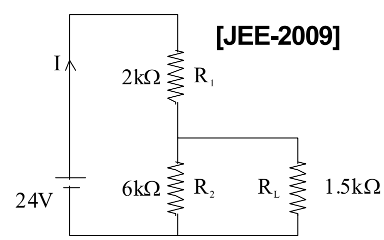


(A) P1 > P2 > P3 (B) P1 > P3 > P2
(C) P2 > P1 > P3 (D) P3 > P2 > P1

26. **STATEMENT -1 :** In a Meter Bridge experiment, null point for an unknown resistance is measured. Now, the unknown resistance is put inside an enclosure maintained at a higher temperature. The null point can be obtained at the same point as before by decreasing the value of the standard resistance.
and **[JEE' 2008, 3/163]**
STATEMENT -2 : Resistance of a metal increases with increase in temperature.

(A) STATEMENT -1 is True, STATEMENT -2 is True; STATEMENT -2 is a correct explanation for STATEMENT -1
(B) STATEMENT -1 is True, STATEMENT -2 is True; STATEMENT -2 is NOT a correct explanation for STATEMENT -1
(C) STATEMENT -1 is True, STATEMENT -2 is False
(D) STATEMENT -1 is False, STATEMENT -2 is True.

27. For the circuit shown in figure **[JEE-2009]**

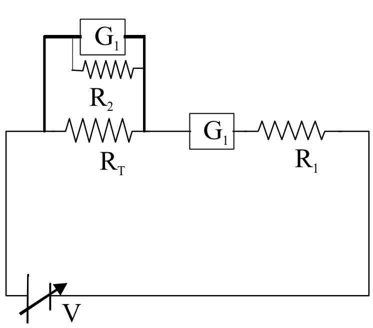


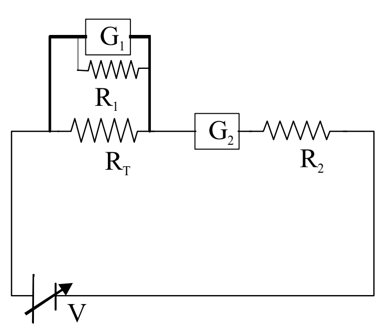
(a) the current I through the battery is 7.5 mA
(b) the potential difference across R_L is 18V
(c) ratio of powers dissipated in R_1 and R_2 is 3.
(d) if R_1 and R_2 are interchanged , magnitude of the power dissipated in R_L will decrease by a factor or 9.

28. Incandescent bulbs are designed by keeping in mind that the resistance of their filament increases with the increase in temperature. If at room temperate, 100W, 60W and 40W bulbs have filament resistance R_{100}, R_{60} and R_{40}, respectively, the relation between these resistance is **[JEE-2010]**

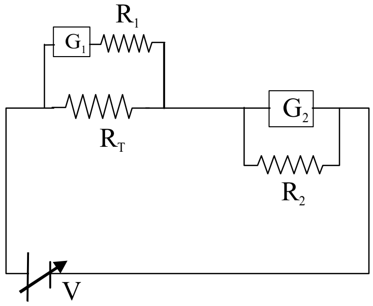
(A) $\frac{1}{R_{100}} = \frac{1}{R_{40}} + \frac{1}{R_{60}}$ (B) $R_{100} = R_{40} + R_{60}$ (C) $R_{100} > R_{60} > R_{40}$ (D) $\frac{1}{R_{100}} > \frac{1}{R_{60}} > \frac{1}{R_{40}}$

29. Two verify ohm's law, a student is provided with a test resistor R_T, a high resistance R_1, a small resistance R_2, two identical galvanometers G_1 and G_2, and a variable voltage source V. The correct circuit to carry out the experiment is **[JEE-2010]**

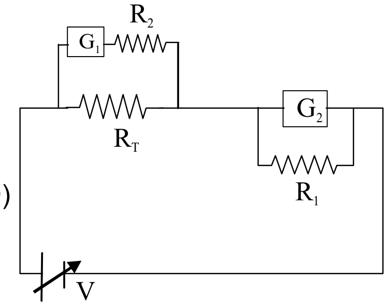
(A)


(B)


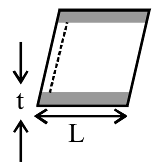
(C)



(D)

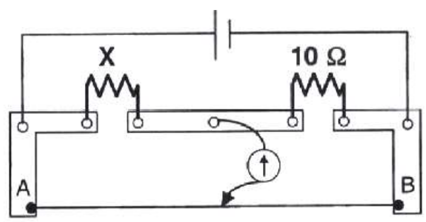


30. Consider a thin square sheet of side L and thickness t, made a material of resistivity ρ. The resistance between two opposite faces, shown by the shaded areas in the figure is **[JEE-2010]**



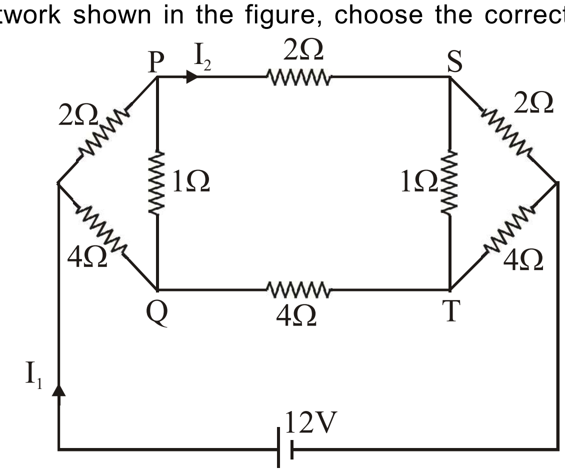
(A) directly proportional to L
(B) directly proportional to t
(C) independent of L
(D) independent of t

31. 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 52cm mark. The end-corrections are 1cm and 2cm respectively for the ends A and B. The determined value of 'X' is. **[JEE-2011]**



(A) 10.2 ohm
(B) 10.6 ohm
(C) 10.8 ohm
(D) 11.1 ohm

32. For the resistance network shown in the figure, choose the correct option(s). **[JEE-2012]**



(A) The current through PQ is zero
(B) I_1 =3A
(C) The potential at S is less than that at Q.
(D) I_2 =2A

Questions marked with an aestrick are based on thermocouple which is not in JEE Syllabus.

1. If an ammeter is to be used in place of a voltmeter, then we must connected with the ammeter a

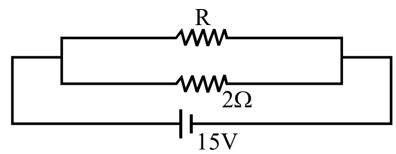
(A) low resistance is parallel (B) high resistance in parallel **[AIEEE 2002]**

(C) high resistance in series (D) low resistance in series

2. A wire when connected to 220 V mains supply has power dissipation P_1. Now the wire is cut into two equal pieces which are connected in parallel to the same supply. Power dissipation in this case is P_2. Then $P_2 : P_1$ is **[AIEEE 2002]**

(A) 1 (B) 4 (C) 2 (D) 3

3. If in the circuit, power dissipation is 150 W, then R is **[AIEEE 2002]**



(A) 2Ω (B) 6Ω (C) 5Ω (D) 4Ω

4. The mass of product liberated on anode in an electrochemical cell depends on **[AIEEE 2002]**

(A) $(It)^{1/2}$ (B) It (C) I/t (D) I^2t

(where t is the time period for which the current is passed).

5. If θ_i, is the inversion temperature, θ_n is the neutral temperature, θ_c is the temperature of the cold junction, then **[AIEEE 2002]**

(A) $\theta_i + \theta_c = \theta_n$ (B) $\theta_i - \theta_c = 2\theta_n$ (C) $\frac{\theta_i + \theta_c}{2} = \theta_n$ (D) $\theta_c - \theta_i = 2\theta_n$

6. The length of a wire of a potentiometer is 100 cm, and the e.m.f. of its standard cell is E volt. It is employed to measure the e.m.f. of a battery whose internal resistance is 0.5Ω. If the balance point is obtained at $l = 30$cm from the positive end, the e.m.f. of the battery is **[AIEEE 2002]**

(A) $\frac{30E}{100.5}$ (B) $\frac{30E}{(100-0.5)}$ (C) $\frac{30(E-0.5i)}{100}$ (D) $\frac{30E}{100}$

where i is the current in the potentiometer wire.

7. The thermo e.m.f. of a thermo-couple is 25 $\mu V / °C$ at room temperature. A galvanometer of 40 ohm resistance, capable of detecting current as low as 10^{-5}A, is connected with the thermo couple. The smallest temperature difference that can be detected by this system is **[AIEEE 2003]**

(A) 16°C (B) 12°C (C) 8°C (D) 20°C

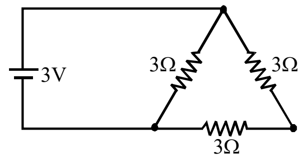
8. The negative Zn pole of a Daniell cell, sending a constant current through a circuit, decreases in mass by 0.13g in 30 minutes. If the electrochemical equivalent of Zn and Cu are 32.5 and 31.5 respectively, the increase in the mass of the positive Cu pole in this time is **[AIEEE 2003]**

(A) 0.180 g (B) 0.141 g (C) 0.126 g (D) 0.242 g

9. An ammeter reads upto 1 ampere. Its internal resistance is 0.81 ohm. To increase the range to 10 A the value of the required shunt is

(A) 0.03Ω (B) 0.3Ω (C) 0.9Ω (D) 0.09Ω

10. 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 [AIEEE 2003]

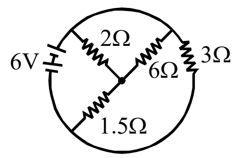


(A) 1A (B) 1.5A
(C) 2 A (D) 1/3A

11. A 220 volt, 1000 watt bulb is connected across a 110 volt mains supply. The power consumed will be **[AIEEE 2003]**

(A) 750 watt (B) 500 watt (C) 250 watt (D) 1000 watt

12. The total current supplied to the circuit by the battery is **[AIEEE 2004]**



(A) 4A (B) 2A (C) 1A (D) 6A

13. The resistance of the series combination of two resistances is S, when they are joined in parallel the total resistance is P. If S = nP then the minimum possible value of n is **[AIEEE 2004]**

(A) 2 (B) 3 (C) 4 (D) 1

14. An electric current is passed through a circuit containing two wires of the same material, connected in parallel. If the lengths and radii are in the ratio of $\frac{4}{3}$ and $\frac{2}{3}$, then the ratio of the current passing through the wires will be **[AIEEE 2004]**

(A) 8/9 (B) 1/3 (C) 3 (D) 2

15. In a meter bridge experiment null point is obtained at 20 cm from one end of the wire when resistance X is balanced against another resistance Y. If X < Y, then where will be the new position of the null point from the same end, if one decides to balance a resistance of 4X against Y **[AIEEE 2004]**

(A) 40 cm (B) 80 cm (C) 50 cm (D) 70 cm

16. The thermistors are usually made of **[AIEEE 2004]**

(A) metal oxides with high temperature coefficient of resistivity
(B) metal with high temperature coefficient of resistivity
(C) metals with low temperature coefficient of resistivity
(D) semiconducting materials having low temperature coefficient of resistivity

17. Time taken by a 836 W heater to heat one litre of water from 10°C to 40°C is **[AIEEE 2004]**

(A) 150 s (B) 100 s (C) 50 s (D) 200 s

18. The thermo emf of a thermocouple varies with the temperature θ of the hot junction as $E = a\theta + b\theta^2$ in volts where the ratio a/b is 700°C. If the cold junction is kept at 0°C, then the neutral temperature is **[AIEEE 2004]**

(A) 1400°C (B) 350°C
(C) 700°C (D) No neutral temperature is possible for this termocouple

19. The electrochemical equivalent of a metal is 3.35109^{-7} kg per Coulomb. The mass of the metal liberated at the cathod when a 3A current is passed for 2 seconds will be **[AIEEE 2004]**

(A) 6.6×10^{57} kg (B) 9.9×10^{-7} kg (C) 19.8×10^{-7} kg (D) 1.1×10^{-7} kg

20. Two thin, long, parallel wires, separated by a distance 'd' carry a current of 'i' A in the same direction. They will **[AIEEE 2005]**

(A) repel each other with a force of $\mu_0 i^2/(2\pi d)$

(B) attract each other with a force of $\mu_0 i^2/(2\pi d)$

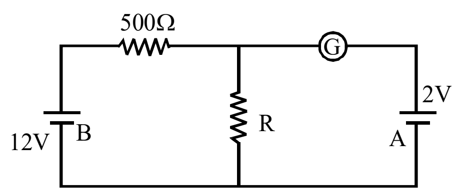
(C) repel each other with a force of $\mu_0 i^2/(2\pi d^2)$

(D) repel each other with a force of $\mu_0 i^2/(2\pi d^2)$

21. A heater coil is cut into two equal parts and only one part is now used in the heater. The heat generated will now be **[AIEEE 2005]**

(A) four times (B) doubled (C) halved (D) one fourth

22. In the circuit, the galvanometer G shows zero deflection. If the batteries A and B have negligible internal resistance, the value of the resistor R will be - **[AIEEE 2005]**



(A) 100Ω (B) 200Ω (C) 1000Ω (D) 500Ω

23. A moving coil galvanometer has 150 equal divisions. Its current sensitivity is 10 - divisions per milliampere and voltage sensitivity is 2 divisions per millivolt. In order that each division reads 1 volt, the resistance in ohms needed to be connected in series with the coil will be **[AIEEE 2005]**

(A) 10^5 (B) 10^3 (C) 9995 (D) 99995

24. 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 resistnace R_2 is zero, then **[AIEEE 2005]**

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

25. Two voltameter, one of copper and another of silver, are joined in parallel. When a total charge q flows through the voltameters, equal amount of metals are deposited. If the electrochemical equivalents of copper and silver are z_1 and z_2 respectively the charge which flows through the silver voltameter is **[AIEEE 2005]**

(A) $\dfrac{q}{1+\dfrac{z_2}{z_1}}$ (B) $\dfrac{q}{1+\dfrac{z_1}{z_2}}$ (C) $q\dfrac{z_2}{z_1}$ (D) $q\dfrac{z_1}{z_2}$

26. In a potentiometer experiment the balancing with a cell is at length 240 cm. On shunting the cell with a resistance of 2Ω, the balancing length becomes 120 cm. The internal resistance of the cell is **[AIEEE 2005]**

(A) 0.5Ω (B) 1Ω (C) 2Ω (D) 4Ω

27. The resistance of hot tungsten filament is about 10 times the cold resistance. What will be the resistance of 100 W and 200 V lamp when not in use? **[AIEEE 2005]**

(A) 20Ω (B) 40Ω (C) 200Ω (D) 400Ω

28. An energy source will supply a constant current into the load if its internal resistance is **[AIEEE 2005]**

(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

29. The Kirchhoff's first law $(\sum i = 0)$ and second law $(\sum iR = \sum E)$, where the symbols have their usual meanings, are respectively based on **[AIEEE 2006]**

(A) conservation of charge, conservation of momentum

(B) conservation of energy, conservation of charge

(C) conservation of momentum, conservation of charge

(D) conservation of charge, conservation of energy

30. A material 'B' has twice the specific resistance of 'A'. A circular wire made of 'B' has twice the diameter of a wire made of 'A'. then for the two wires to have the same resistance, the ratio l_B/l_A of their respective lengths must be **[AIEEE 2006]**

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

31. A thermocouple is made from two metals, Antimony and Bismuth. If one junction of the couple is kept hot and the other is kept cold, then, an electric current will **[AIEEE 2006]**

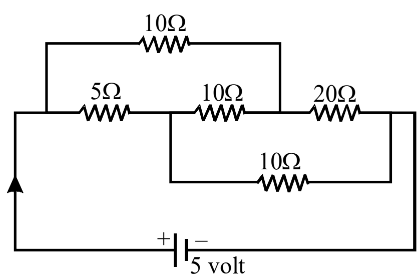
(A) flow from Antimony to Bismuth at the hot junction

(B) flow from Bismuth to Antimony at the cold junction

(C) now flow through the thermocouple

(D) flow from Antimony to Bismuth at the cold junction

32. The current I drawn from the 5 volt source will be **[AIEEE 2006]**



(A) 0.33 A (B) 0.5 A (C) 0.67 A (D) 0.17 A

33. The resistance of a bulb filmanet is 100Ω at a temperature of 100°C. If its temperature coefficient of resistance be 0.005 per °C, its resistance will become 200 Ω at a temperature of **[AIEEE 2006]**

(A) 300°C (B) 400°C (C) 500°C (D) 200°C

34. In a Wheatsone's bridge, three resistances P, Q and R connected in the three arms and the fourth arm is formed by condition for the bridge to be balanced will be **[AIEEE 2006]**

(A) $\frac{P}{Q} = \frac{2R}{S_1 + S_2}$ (B) $\frac{P}{Q} = \frac{R(S_1 + S_2)}{S_1 S_2}$ (C) $\frac{P}{Q} = \frac{R(S_1 + S_2)}{2S_1 S_2}$ (D) $\frac{P}{Q} = \frac{R}{S_1 + S_2}$

35. An electric bulb is rated 220 volt - 100 watt. The power consumed by it when operated on 110 volt will be **[AIEEE 2006]**

(A) 75 watt (B) 40 watt (C) 25 watt (D) 50 watt

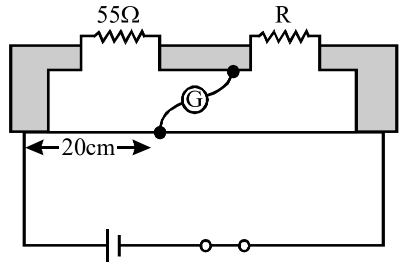
36. A battery is used to charge a parallel plate capacitor till the potential difference between the plates becomes equal to the electromotive force of the battery. The ratio of the energy stored in the capacitor and the work done by the battery will be **[AIEEE 2007]**

(A) 1/2 (B) 1 (C) 2 (D) 1/4

37. The resistance of a wire is 5 ohm at 50°C and 6 ohm at 100°C. The resistance of the wire at 0°C will be **[AIEEE 2007]**

(A) 3 ohm (B) 2 ohm (C) 1 ohm (D) 4 ohm

38. Shown in the figure below is a meter-bridge set up with null deflection in the galvanometer.



The value of the unknown resistor R is **[AIEEE 2008]**

(A) 13.75Ω (B) 220Ω (C) 110Ω (D) 55Ω

Directions: Question No. 39 to 41 are based on the following paragraphs.

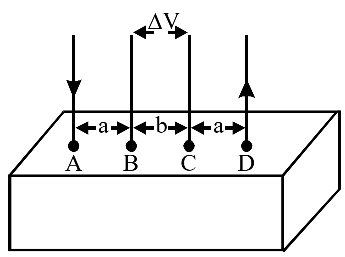
Consider a block of conducting material of resistivity 'ρ' shown in the figure. Current 'I' enters at 'A' and leaves from 'D'. We apply superposition principle to find voltage 'ΔV' developed between 'B' and 'C'. The calculation is done in the following steps:

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

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

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

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



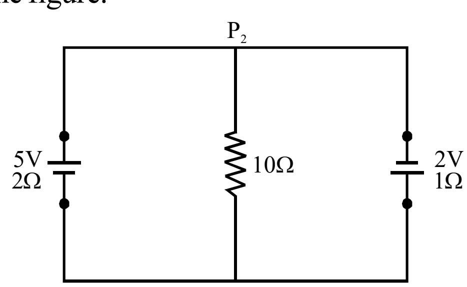
39. ΔV measured between B and C is **[AIEEE 2008]**

(A) $\frac{\rho I}{\pi a} - \frac{\rho I}{\pi(a+b)}$ (B) $\frac{\rho I}{a} - \frac{\rho I}{(a+b)}$ (C) $\frac{\rho I}{2\pi a} - \frac{\rho I}{2\pi(a+b)}$ (D) $\frac{\rho I}{2\pi(a-b)}$

40. For current entering at A, the electric field at a distance 'r' from A is **[AIEEE - 2008]**

(A) $\frac{\rho I}{8\pi r^2}$ (B) $\frac{\rho I}{r^2}$ (C) $\frac{\rho I}{2\pi r^2}$ (D) $\frac{\rho I}{4\pi r^2}$

41. A 5V battery with internal resistance 2Ω a 2V battery with internal resistance 1Ω are connected to a 10Ω resistor as shown in the figure. **[AIEEE 2008]**



The current in the 10Ω resistor is

(A) 0.27A P_2 to P_1 (B) 0.03A P_1 to P_2 (C) 0.03A P_2 to P_1 (D) 0.27A P_1 to P_2

42. Statement-1 The temperature dependence of resistance is usually given as $R = R_0(1 + \alpha\Delta t)$. The resistance of a wire changes from 100Ω to 150Ω when its temperature is increased from 27ºC to 227ºC. This implies that $\alpha = 2.5 \times 10^{-3}$ /ºC.

Statement-2 $R = R_0(1 + \alpha\Delta t)$ is valid only when the change in the temperature ΔT is small and $\Delta R = (R - R_0) << R_0$. **[AIEEE-2009]**

(A) Statement - 1 is True , Statement - 2 is True ; Statement - 2 is a CORRECT explanation for Statement - 1

(B) Statement - 1 is True , Statement - 2 is True ; Statement - 2 is a NOT CORRECT explanation for Statement - 1

(C) Statement - 1 is True , Statement - 2 is False

(D) Statement - 1 is False , Statement - 2 is True

43. Two conductors have the same resistance at 0ºC but their temperature coefficient of resistance are α_1 and α_2. The respective temperature coefficients of their series and parallel combinations are nearly. **[AIEEE-2010]**

(A) $\frac{\alpha_1+\alpha_2}{2}, \frac{\alpha_1+\alpha_2}{2}$ (B) $\frac{\alpha_1+\alpha_2}{2}, \alpha_1+\alpha_2$ (C) $\alpha_1+\alpha_2, \frac{\alpha_1+\alpha_2}{2}$ (D) $\alpha_1+\alpha_2, \frac{\alpha_1\alpha_2}{\alpha_1+\alpha_2}$

44. If a wire is stretched to make it 0.1% longer, its resistance will be- **[AIEEE-2011]**

(A) increase by 0.05% (B) increase by 0.2%

(C) decrease by 0.2% (D) decrease by 0.05%

45. Two electric bulbs marked 25W - 220V and 100W - 200V are connected an series to a 440V supply. Which of the bulbs will fuse ? **[AIEEE 2012]**

(A) 25W (B) neither (C) both (D) 100W

EXERCISE 5

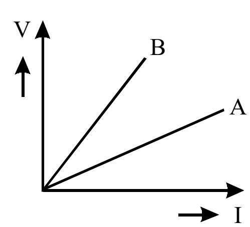
CBSE

1. How does drift velocity of electrons in a metallic conductor vary with rise of temperature?
2. How does the resistivity of (i) a conductor (ii) a semiconductor vary with temperature. Give reasons for each case.
3. State kirchoff's laws for electrical circuits
4. Define relaxation time of electrons in a conductor. Explain how it varies with increase in temperature. State the relation between resistivity and relaxation time.
5. Sketch a graph showing variation of resistivity of carbon with temperature.
6. Draw V-I graphs for ohmic and non-ohmic materials Give one example of each.
7. What is change in resistance of an eureka wire when its radius is halved and length is reduced to one fourth of its original value?
8. A potential difference V is applied across the ends of copper wire of length and diameter D. What is the effect on drift velocity of electrons if :

   (i) V is doubled? (ii) I is doubled? (iii) D is doubled?
9. A peice of copper and other of germanium are cooled from room temperature to 100K. What will happen to their conductivities ?
10. What is the ratio of initial and final resistance when a metallic wire of length l is stretched to double its length, assuming no change in density on stretching?
11. A student has two wires. By connecting them individually or combinedly he can obtain resistances 3, 4, 12 and 16Ω. What are the resistances of wires?
12. Two electric bulbs have following specifications

    (i) 100 W at 220 V (B) 1000 W at 220 V

    Which bulb has higher resistance? What is the ratio of their resistances?
13. The element of heater is very hot while the wires carrying are cold, why?
14. Name the carriers of electric current in
    (a) A wire made of silver
    (b) a hydrogen discharged tube
    (c) a germanium semi conductor
    (d) a wire made of nichrome alloy
    (e) a superconductor.
15. V-I graphs for parallel and series combination of two metallic resistors are shown. Which graph represents parallel combination? Justify your answers.



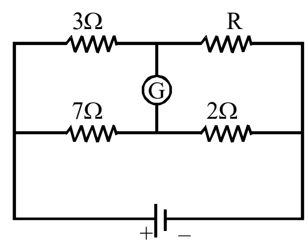
16. The length of three conducting wires are in the ratio 1 : 2 : 3. All its wires are of same metal and their radii are also equal. If we join them in parallel across a battery, what will be ratio of currents in them?

17. A wire of uniform cross section and length l has a resistance 16Ω. It is cut with four equal parts. Each part is stretched uniformly in length l and all the four stretched parts are connected in parallel. Calculate the total resistance of the combination so formed. Assume that stretching of wire does not cause any charge in the density of its material.

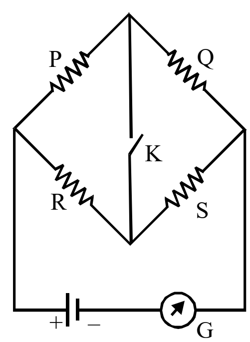
18. A nichrome heating element across 230V supply consumes 1.5 kw of power and heats up to a temperature of 750°C. A tungsten bulb across the same supply operates at a much highest temp of 1600°C in order to be able to emit light. Does it mean that the tungsten bulb necessarily consume greater power?

19. Two heater coils made of same material are connected in parallel across the mains. The length and diameter of the wire of one of the coils is double that of the other. Which one of them will produce more heat?

20. In the adjoining figure, there is no deflection in galvanometer. What is the value of resistance R?

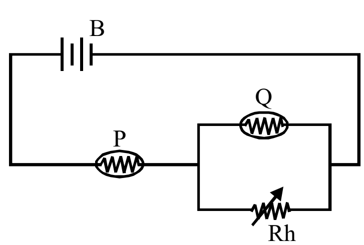


21. In a Wheatstone's bridge experiment, a student by mistake, connects key(K) in place of galvanometer and galvanometer (G) in place of key (K), How will we test for the balance of the bridge?

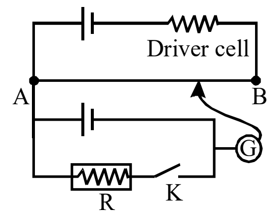


22. How can three resistances of 2Ω, 3Ω and 6Ω can be connected to give an equivalent resistance of 4Ω?

23. The circuit shown in the diagram contains a battery 'B' a rheostat 'Rh' and identical lamps P and Q. What will happen to the brightness of the lamps, if the resistance through the rheostat is increased? Give reason



24. The following circuit shows the use of potentiometer to measure the internal resistance of a cell.



(i) When the key K is open, how does the balance point change, if the current from the driver cell decreases?

(ii) When the key K is closed how does the balance point change if R is increased keeping current from the driver cell constant?

25. Deduce ohm's law using the concept of drift velocity.

OR

Show that the resistance of a conductor is given by $R = \frac{m}{ne^2 q} \frac{\ell}{A}$ symbols have their usual significance.

26. Establish a relation between electric current and drift velocity.

27. Deduce expresion for drift velocity of electrons in a good conductor in terms of relaxation time of electrons.

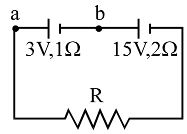
28. State the principle of potentiometer. Draw a circuit diagram to compare the emf's of two primary cells. How can the sensitivity of a potentiometer be increased?

29. Explain with the help of a circuit diagram how the value of unknown resistance can be determined using a Wheatstone bridge. Give the formula used.

30. Using the principle of Wheatstone bridge, describe the method to determine the specific resistance of a wire in the laboratory. Draw circuit diagram and write formula used. Write any two important precautions you would observe while performing the experiment.

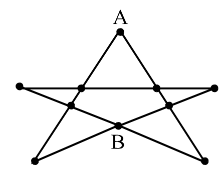
EXERCISE 6

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

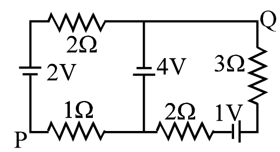


2. A wire of length L and 3 identical cells of negligible internal resistances are connected in series. Due to the current, the temperature of the wire is raised by ΔT in time t. N number of similar cells is now connected in series with a wire of the same material and cross section but of length 2L. The temperature of the wire is raised by the same amount ΔT in the same time t. Find the value of N is :

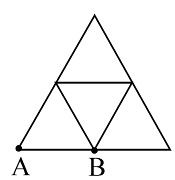
3. The resistance of all the wires between any two adjacent dots is R. If the equivalent resistance between A and B is given by $\frac{NR}{6}$. Then find the value of N.



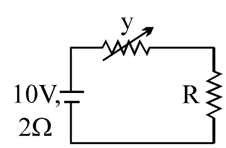
4. In the circuit shown, find the the potential difference V_{PQ} (in volt)



5. In the diagram resistance between any two junctions is $\frac{18}{11}$ ohm. Find the equivalent resistance across terminals A and B is

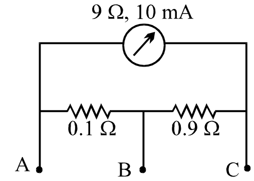


6. In the figure shown the power generated in y is maximum when y = 5Ω. Then find the value of R. (in ohm)

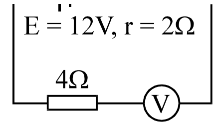


7. When the current in the coil decreases to zero uniformly during a time interval Δt, then $\frac{4}{N}\frac{q^2R}{\Delta t}$ amount of heat will be generated in a coil of resistance R due to a charge q passing through it. Find the value of N.

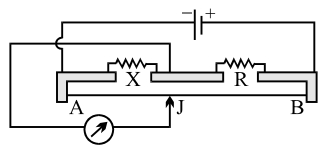
8. A milliammeter of range 10 mA and resistance 9 Ω is joined in a circuit as shown. The metre gives full-scale deflection for current I when A and B are used as its terminals, i.e., current enters at A and leaves at B (C is left isolated). Find the value of I (in amp)



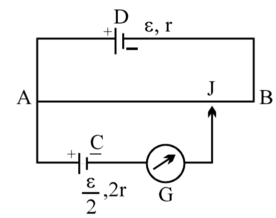
9. By error, a student places moving-coil voltmeter V (nearly ideal) in series with the resistance in a circuit in order to read the current, as shown. If the voltmeter reading is N × 3 volt. Find N.



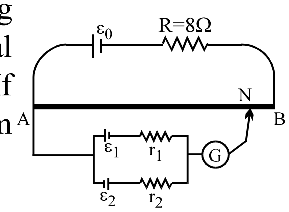
10. The figure shows a metre-bridge circuit, with AB = 100 cm, X = 12Ω and R = 18Ω, and the jockey J in the position of balance. If R is now made 8Ω, then Jockey J will move 10 × N cm for obtain balancing point. Find the value of N.



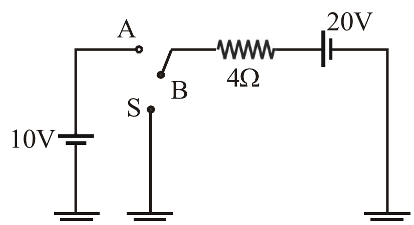
11. In the figure, the potentiometer wire AB of length $\frac{9}{5}$ metre and resistance 9r is joined to the cell D of emf ε and internal resistance r. The cell C's emf is ε/2 and its internal resistance is 2r. The galvanometer G will show no deflection when the length AJ (in metre)



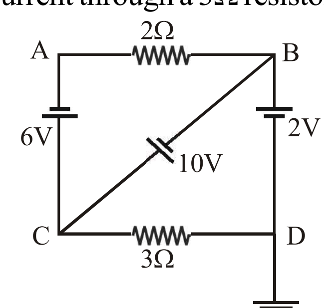
12. A battery of emf $E_0 = 12$ V is connected across a 4m long uniform wire having resistance 4Ω/m. The cells of small emfs $\varepsilon_1 = 2$V and $\varepsilon_2 = 4$V having internal resistance 2Ω and 6Ω respectively, are connected as shown in the figure. If galvanometer shows no deflection at the point N, the distance of point N from the point A is equal to P^2 (in cm). Find the value of P.



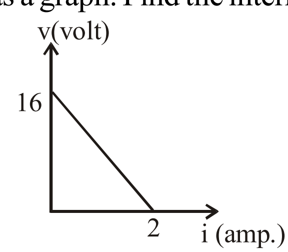
13. In the circuit as shown, find the current through resistance when switch is in position B (in amp).



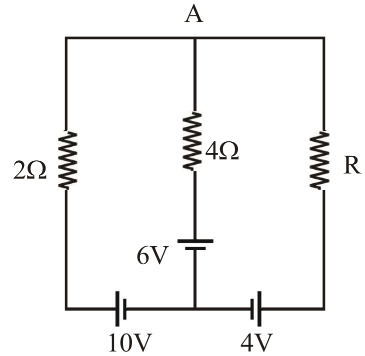
14. In the circuit as shown, find the current through a 3Ω resistor (in Amp).



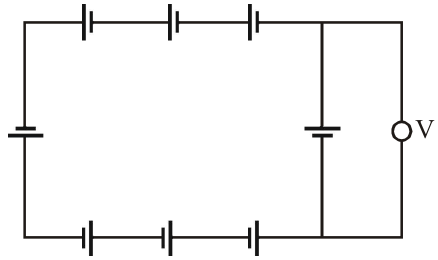
15. A battery is connected across a resistance R. Current passing through the resistance (i) and potential difference (V) across it is plotted as a graph. Find the internal resistance of the battery (in Ω).



16. In the given circuit, find the value of R (in   ) for which the current through the 4   resistor is zero.



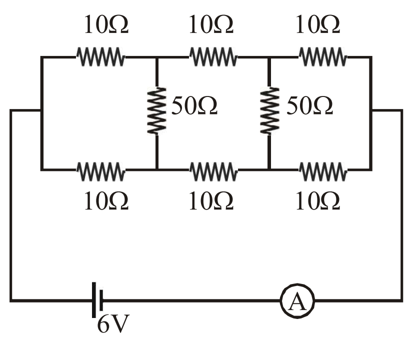
17. In the circuit shown below, each battery is 5V and has an internal resistance of 0.2Ω. The reading in the ideal voltmeter V is (in volt)



18. A uniform wire of resistance 100Ω is melted and recast into a wire of length double that of the original. What should be the resistance of the wire (in $\times 10^2\Omega$).

19. An ideal battery sends a current of 5A in a resistor. When another resistor of a value of 10Ω is connected in parallel, the current through the battery is increased to 6A. Find the resistance of the first resistor.

20. Find the current measured by the ammeter in the circuit shown in figure (in $\times 10^{-1}$A)



ANSWER KEY

EXERCISE -1

1. 300 C, 30 A **2.** $\frac{0.5\times10}{1.6\times10^{-19}}\times\frac{1}{2}=\frac{25}{16}\times10^{19}$ **3.** $\frac{1.5\times63.5\times10^{-3}}{1.6\times6\times9}$ = 1.1×10^{-3} ms^{-1} or 1.1 mm s^{-1}

4. 7.5×10^{-9} N **5.** (C) **6.** (D) **7.** (A) **8.** (A) (D) **9.** (C)

10. (C) **11.** (C) **12.** (D) **13.** (A) **14.** (B)

15. (a) n = $\frac{2}{1.6}\times10^{17}$ = 1.25×10^{17} (b) $\frac{2}{\pi}\times10^{6}$ = 6.37×10^{5} A/m^2 . **16.** 25 V/m.

17. **(i)** 41ºC **(ii)** $\frac{\ell n2}{273}$ ºC^{-1} . **18.** $T_2 > T_1$ **19.** (A) (D)

20. (D) **21.** (C) **22.** (B) (C)

23. (a) E = 10 V each (b) (A) act as a source and (B) act as load (c) V_A = 9V, V_B = 11 V
(d) P_A = 9 W, P_B = 11 W (e) Heat rate = 1 W each (f) 10 watt. each (g) 9V, 11V (h) -9W, 11 W

24. (a) rightward (b) all equal (c) b, then a and c equal (d) a, c equal, b

25. (a) 7.5 V, (b) 24 mA (c) greater than 12 V.

26. (a) $V_A = V_B = V_C = V_D = 0$ V, $V_E = 10$ V $= V_F = V_G = V_H$ V_I = 15 V, V_J = 15 V, V_K = 15 V
(b) V_1 = 15 V, V_2 = 5V, V_3 = 15 V
(c) each act as a source
(d) 17.5 A (↑), 15A(↓) 2.5 A (↑), 5A (↓) from left to right in given circuit.
(e) 1 Ω resistance
(f) left most battery.

27. (a) $\frac{50}{11}$ = 4.55 A (b) $\frac{22\times11}{5}$ = 48.4 Ω (c) 1000 W (d) 240 cal s^{-1} (e) 80/3 gm

28. (B) **29.** (D) **30.** (B) **31.** (A) **32.** (A) (C) **33.** (A) (B) (D)

34. (B) **35.** (A) **36.** (B) **37.** (C) **38.** (A) **39.** (B)

40. (A) (B) (D)

41. (a) R = 10 Ω (b) 1A in each (c) V_3 = 3V, V_2 = 2V, V_4 = 4V (d) 10 W (e) 1 W (f) 9W
(g) 9V (h) 4 Ω resistance (i) 3 W.

42. (a) R = 3 (b) i = 2A, $i_1 = \frac{1}{2}$ A i_2 = 1A $i_3 = \frac{1}{2}$ A (c) V = 4V in each (d) 12 W (e) 4W (f) 8 W
(g) 4Ω (h) 4W

43. (a) 3.7 V (b) 3.7 V

44. (i) R_{AB} = 5/6 Ω (ii) R_{CD} = 1.5 Ω (iii) R_{EF} = 1.5 Ω (iv) R_{AF} = 5/6 Ω (v) R_{AC} = 4/3 Ω

45. **(ii)** 1.5 A **46.** (i) $\frac{150}{7}$ = 21.43 V, (ii) 1600 Ω **47.** $R_{AB} = \frac{(2+4)\times3}{2+4+3} = \frac{18}{9}$ = 2Ω

48. Consider a thin shell of radius r, thickness dr. $i = \frac{dv}{R} = \frac{Edr}{\frac{\rho dr}{4\pi r^2}} = \frac{E4\pi r^2}{\rho} = \frac{\phi}{\rho}$. **49.** **i.** (B) **ii.** (C)

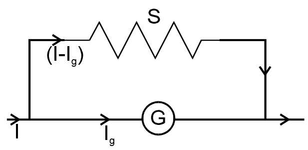
50. (B) **51.** (A) **52.** (C) **53.** (A) **54.** (A) **55.** (C) **56.** (B)

57. (A) **58.** (C) **59.** (B) **60.** (A) **61.** (D)

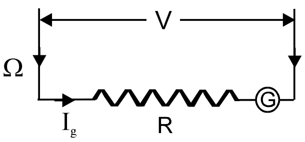
62. (i) $\frac{12}{8.59}$ = 1.4 A, (ii) $\frac{12 \times 8.5}{8.59}$ = 11.9 V

63. (i) $\frac{1}{2}$ = 0.5 A (ii) $\frac{1}{12}$ = 0.0833 A (iii) $1.5 + \frac{1}{2} \times 0.4$ = 1.7 V **64.** 25 **65.** (C) **66.** (A)

67.

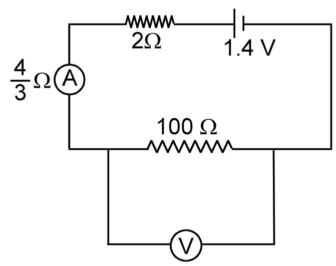


(a) $S = \frac{30 \times 2 \times 10^{-3}}{0.3 - 2 \times 10^{-3}} = 0.2013\,\Omega$ (b) $R = 70\,\Omega$



68. (a) 24 V, (b) 28 V **69.** $\left(\frac{70}{60} - 1\right) \times 9.5 = \frac{9.5}{6}$ ohm

70. (i)



(ii) 200 Ω (iii) $\frac{4}{3} - 1.1 = 0.23$ V

71. (a) $\frac{82.3}{67.3} \times 1.02 = 1.25$ V

(b) The high resistance to keep the initial current low when null point is being located. This saves the standard cell from damage.

(c) This high resistance does not affect the balance point because then there is no flow of current through the standard cell branch.

(d) The internal resistance of driver cell affects the current through the potentiometer wire. Since potential gradient is changed, therefore, the balance point must be affected.

(e) No. It is necessary that the emf of the driver cell is more than the emf of the cells.

(f) This circuit will not work well for meaurement of small emf. (mV) because the balanced point will be very near to end A, and percentage error in EMF measured due to length measument would be very large $E = \frac{V}{100}\ell \Rightarrow \frac{dE}{E} = \frac{d\ell}{\ell}$ will be large if ℓ is very small.

72. (C) **73.** (D) **74.** (A) **75.** (A) (B) (C) **76.** (A) (C) (D) **77.** (A)

78. (C) **79.** (A) **80.** (C) **81.** (B) **82.** (B) **83.** (D)

84. (D) **85.** 1.52 V, 0.07 W

86. 2 kΩ, galvanometer will show deflection, as the temperature of wire wound decreases, resistor decreases

87. $x = \frac{20}{7}\,\Omega$, $Y = \frac{20}{3}\,\Omega$ **88.** (B) **89.** (A) **90.** (B)

EXERCISE -2

1. 2 coulombs

2. $i_0 = \frac{q}{T}$ ln 2 Ans. initial value of the current

   Instantaneous value = $i_0\, e^{-t/T \ln 2}$

3. (a) $J_0 A/3$ (b) $2 J_0 A/3$

4. $5 \times 10^{-11}\ \Omega$ 5. $\frac{1}{4}, \frac{1}{4}$

6. (a) (i) $R = \frac{0.35}{2} = 0.175$ W

   (ii) $R = 7 \times 10^{-5}\ \Omega$

   (b) (i) $Q = 1200$ C (ii) $n = 75 \times 10^{20}$

7. T = 2000°C + 20°C = 2020°C

8. (i) $\frac{(K-1)^2}{K}; \frac{K}{(K-1)}$ (ii) $\left[\frac{(K-1)}{K^2}\right]\frac{V_0}{R_3}$

9. $i = \frac{5/2}{1} = \frac{5}{2}$ amp. Ans.

10. (a) $10\ \Omega$. (b) 3200 J

11. (i) 3.5 V ; (ii) 6 V, 1Ω, 5V, 1Ω ; (iii) 6 Watt.

12. $R_{eq} = \frac{2R}{4} = \frac{R}{2}$ Ans.

13. $2\ \Omega$

14. [balanced wheat-stone bridge] then equivalent resistance, $= \frac{3R}{2} = 1.5$ R

15. CE: ED = $\sqrt{2}$: 1 16. $i = \frac{15}{7}\frac{U}{R}$ 17. [Ans. 5Ω]

18. $\frac{(2+\pi)ar}{8}$

19. (a) $R = \rho_o \frac{L}{A}\left(\frac{e-1}{e}\right)$, $i = \frac{V_0}{R}$, (b) $V(x) = \frac{V_o(e^{-x/L} - e^{-1})}{1-e^{-1}}$

20. (b) $\left[\frac{V_{ab} r_a r_b}{\rho r^2 (r_b - r_a)}\right]$ (c) $\left[\frac{V_{ab} r_a r_b}{r^2 (r_b - r_a)}\right]$

21. $E = \frac{2V}{L^2} x$

22. 6V and – 4V, zero '

23. $12.5\ \Omega$, $170\ \Omega$.

24. (a) 1 A (b) 2/3 A (c) 1/3 A

25. (i) 2 volt, $i_1 = 1$ A, $i_2 = 0$ A, $i_3 = 1$ A, (ii) $i_1 = 1$ A, $i_2 = 2$ A, $i_3 = 1$ A, $i_R = 2$A

26. (i) $\frac{2}{13}$ volt. (ii) $v_g = \frac{21}{13}$, $v_H = \frac{19}{13}$

27. $V_B - V_A = 21/5 = 4.2$ V, $I = 35/2 = 17.5$ mA (B to A)

28. $I_1 = 82/27$, $I_2 = 34/27$, $I_3 = 0$

29. 999Ω, Series

30. $R_A = \frac{8}{3}R, R_V = 8R$

31. $R_g = \frac{700}{3}\Omega$, $\varepsilon = 96$ volt.

32. (i) $v_0 = \frac{3\varepsilon}{4}$ (ii) $\frac{5\ell}{2}$ (iii) $\frac{\varepsilon}{7R}$, where $R = \frac{\rho\ell}{A}$ and $A = 2\pi a^2$

33. $\frac{20}{3}$ V

34. 4.96 mA, 1.58 volt

35 R = r. Ans.

PART - II : OBJECTIVE QUESTIONS

36.	B	37.	A	38.	B	39.	B	40.	CD
41.	B	42.	AD	43.	ABCD	44.	ABD	45.	B
46.	B	47.	A	48.	B	49.	A	50.	AC
51.	C	52.	C	53.	B	54.	D	55.	A
56.	B	57.	D	58.	B	59.	B	60.	B
61.	B	62.	A	63.	B	64.	AC	65.	ABD
66.	D	67.	A	68.	BC	69.	A	70.	C
71.	A	72.	ACD	73.	B	74.	D	75.	BC
76.	BC								

EXERCISE -3

1. (A) q, (B) p , (C) p, (D) q

2. *(A) q (B) s (C) s (D) q*

3. (A) p ; (B) q, s ; (C) s ; (D) p, r, s

4. (A) q, (B) r, (C) r , (D) r

5. (A) p,q (B) q,s (C) q,s (D) q

6.	A	7.	A	8.	C	9.	A	10.	D
11.	D	12.	A	13.	C	14.	C	15.	C
16.	D	17.	A	18.	C	19.	D	20.	C
21.	C	22.	D	23.	D	24.	D	25.	E
26.	B	27.	D						

EXERCISE - 4

1. D

2. $\frac{1}{2}$

3. A

4. $\frac{R_{BD}}{R_{AC}} = \frac{59}{35}$

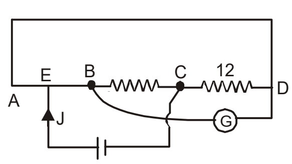
5. (a) $t_s = 30$ min. (b) $t_p = \frac{20}{3}$ min.

6. D

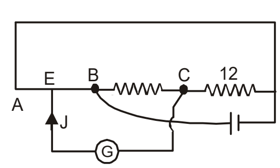
7. $R = \frac{\rho L}{\pi r_1 r_2}$; V = IR

8. (B) 9. (C) 10. (D) 11. (A) 12. (A)

13. (a) No (b)



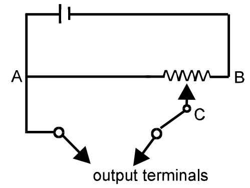
or



(c) 8 Ω

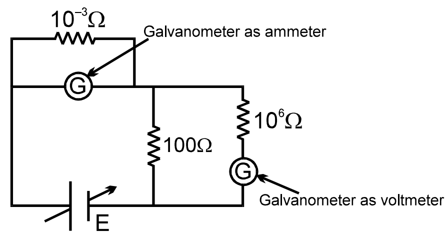
14. A 15. (B)

16.



17.	B	18.	(D)				

19.



20.	B	21.	D	22.	Position B,	23.	D
24.	A	25.	C	26.	D	27.	A,D
28.	D	29.	C	30.	C	31.	B
32.	ABCD						

AIEEE FLASH BACK

1.	(C)	**2.**	(B)	**3.**	(B)		
4.	(B)	**5.**	(C)	**6.**	(D)	**7.**	(A)
8.	(C)	**9.**	(D)	**10.**	(B)	**11**.	(C)
12.	(A)	**13.**	(C)	**14**.	(B)	**15.**	(C)
16.	(A)	**17.**	(A)	**18.**	(D)	**19**.	(C)
20.	(B)	**21.**	(B)	**22.**	(A)	**23.**	(C)
24.	(A)	**25.**	(A)	**26.**	(C)	**27**.	(B)
28.	(D)	**29.**	(D)	**30**.	(D)	**31.**	(D)
32.	(B)	**33.**	(B)	**34.**	(B)	**35.**	(C)
36.	(A)	**37.**	(D)	**38.**	(B)	**39.**	(A)
40.	(C)	**41.**	(C)	**42.**	(D)	**43.**	(A)
44.	(B)	**45.**	(A)				

EXERCISE - 6

1.	3	2.	6	3.	7	4.	2
5.	1	6.	3	7.	3	8.	1
9.	4	10.	2	11.	1	12.	5
13.	5	14.	4	15.	8	16.	1
17.	0	18.	4	19.	2	20.	4