Date: 25/9/2021

Q1. What is the SI unit of electric charge?

Q2. Define electric current.

Q3. State the SI unit of electric currnet and define it.

Q4. In an electric circuit, state the relationship between the direction of conventional current and the direction of flow of electrons.

Q5. Define potential difference between two points in a conductor.

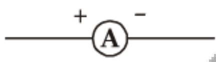
Q6. What is the SI unit of electric potential?

Q7. What is meant by the statement "potential difference between points *A* and *B* in an electric field is 1 volt"?

Q8. Give symbols of (a) an electric cell, (b) battery of cells.

Q9. Identify the following symbols of commonly used components in a circuit diagram:

(a)



(b)

Q10. What is an ammeter?

Q11. Name the instrument/device used to measure electric current in a circuit.

Q12. How is an ammeter connected in a circuit to measure current flowing through it?

Q13. What is a voltmeter?

Q14. Name the instrument used to measure (a) electric current in a circuit, (b) potential difference between two points in a circuit.

Q15. Draw a schematic diagram of an electric circuit consisting of a battery of two cells each of 1.5 Ω, 5 Ω, 10 Ω and 15 Ω resistors and a plug key, all connected in series.

Q16. What is the unit of electrical resistance?

Q17. What is the name of physical quantity which is equal to $\frac{V}{I}$?

Q18. What is meant by electric resistance of a conductor?

Or

Define resistance of a conductor.

Q19. The following table gives the value of electrical resistivity of some materials:

Material	*Copper*	*Silver*	*Constanton*
Electrical resistivity (in Ω-m)	1.62×10^{-8}	1.6×10^{-8}	49×10^{-8}

Which one is the best conductor of electricity out of them?

Q20. Which material is the best conductor?

Q21. A current of 0.2 A passes through a resistance of 20 Ω, what is the potential difference across it?

Q22. Keeping the potential difference constant, the resistance of an electric circuit is doubled. State the change in the reading of an ammeter connected in the circuit.

Q23. The resistance of a resistor is kept constant and the potential difference across its two ends is decreased to half of its former value. State the change that will occur in the current flowing through it.

Q24. The potential difference across the terminals of a cell is 1.5 volt. It is connected with a resistance of 30 ohms. Calculate the current flowing through the circuit.

Q25. What is the shape of *V-I* graph for a metallic wire? Why?

Q26. When do you say that the resistance of a wire is 1 Ω?

Q27. The length of a wire is doubled and its cross-sectional area is also doubled. What is the change in its resistivity?

Q28. What is electrical resistivity?

Q29. On what factors does the resistivity of a conductor depend?

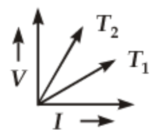
Q30. What happens to resistance when length of conductor is doubled without affecting the thickness of conductor?

Q31. On what factors does the resistance of a conductor depend?

Q32. Mention any two factors on which the resistance of a cylindrical conductor depends.

Q33. The combination shown has resistance of 5 Ω, what is the value of *R*?

Q34. The voltage-current (*V-I*) graph of a metallic circuit at two different temperatures T_1 and T_2 is shown in figure, which of the two temperatures is higher and why?



Q35. What is the SI unit of resistivity?

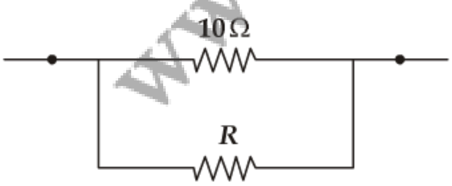
Q36. A given length of a wire is doubled on itself. By what factor does the resistance of the wire change?

Q37. What happens to the resistance of a conductor when the length of the conductor is reduced to half?

Q38. What happens to the resistance of a conductor when its temperature is increased?

Q39. How does the resistance of a wire depend on its radius?

Q40. The combination shown has resistance of 5 Ω, what is the value of *R*?



Q41. You have two metallic wires of resistances 6 Ω and 3 Ω. How will you connect these wires to get the effective resistance of 2 Ω?

Q42. Give an example of resistances joined in series from your daily life.

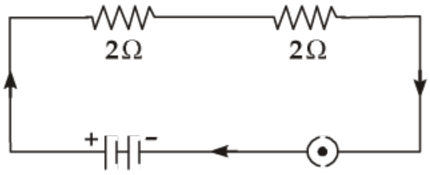
Q43. In which arrangement, series or parallel, are various electrical devices connected in the domestic lighting circuit?

Q44. What is the lowest resistance that can be obtained by combining four coils of resistors of 4 Ω, 8 Ω, 12 Ω and 24 Ω?

Q45. In a circuit if resistors of 5 Ω and 10 Ω are connected in series, compare the current passing through the two resistors.

Q46. Two resistors of 30 Ω and 60 Ω are connected in parallel in an electric circuit. How does the current passing through the two resistors compare?

Q47. What is the effective resistance in the given circuit?



Q48. Write the relation between electric power (*P*) in watt of a device with potential difference (*V* volt) across it and current (*I* ampere) flowing through it.

Q49. Nichrome is used to make the element of an electric heater. Why?

Q50. Name any two appliances/devices based on heating effect of current.

Q51. State Joule's law of heating.

Q52. What is heating effect of electric current?

Q53. How much heat energy is generated when a current *I* is passed through a resistor *R* for time *t*?

Q54. Should the heating element of an electric iron be made of iron, silver or nichrome wire?

Q55. Would you connect a fuse in series or in parallel to an electric circuit?

Q56. In the circuit shown power dissipated in 12 Ω resistance is 6 watt. What is the power dissipated in the 8 Ω resistance?

Q57. How many joules are equal to 1 kW h?

Q58. Out of 60 W and 40 W lamps, which one has a higher electrical resistance when in use?

Q59. Out of the two, a toaster of 1 kW and an electric heater of 2 kW, which has a greater resistance?

Q60. Name two special characteristics of a heating element wire.

Q61. For an electric iron of 1 kW rating at 220 V, fuse of how much capacity is to be used?

Q62. *n* electrons, each carrying a charge – *e*, are flowing across a unit cross-section of a metallic wire in unit time from east to west. Write an expression for electric current and also give its direction of flow. Give reason for your answer.

Q63. A TV set shoots out a beam of electrons. The beam current is 10 μA. How many electrons strike the TV screen in each second? How much charge strikes the screen in a minute?

Q64. Explain how a cell maintains an electric current in a circuit.

Q65. The charge possessed by an electron is 1.6×10^{-19} coulomb. Find the number of electrons that will flow per second to constitute a current of 1 ampere.

Q66. Mention the condition under which charges can move in a conductor. Name the device which is used to maintain this condition in an electric circuit.

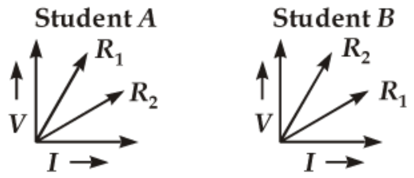
Q67. A current of 2 A passes through a circuit for 1 minute. If potential difference between the terminals of the circuit is 3 V, what is the work done in transferring the charge.

Q68. How much work is done in moving a charge of 2 C across two points having a potential difference of 12 V?

Q69. How would the reading of V change if it is connected between B and C?

Q70. What is an electric circuit? Distinguish between an open and a closed circuit.

Q71. Two students A and B performed experiments on two given resistors R_1 and R_2 and plotted the V-I graphs shown in figure. If $R_1 > R_2$, which of the two students correctly performed the experiment? Justify your answer.



Q72. What do you mean by resistance of a conductor? Define its unit.

Q73. How do Ohm's law be verified experimentally? Does it hold good under all conditions? Comment.

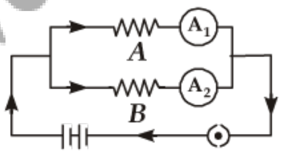
Q74. In an experiment to study the relationship between the potential difference across a resistor and the current through it, a student recorded the following observations:

Potential difference (V)	2	3	4.5	5	6
Current (A)	0.08	0.12	0.15	0.20	0.24

Find in which one of the above sets of reading the trend is different from others and must be rejected. Calculate the mean value of resistance of the resistor based on the remaining sets of readings.

Q75. How much current will an electric bulb draw from 220 V source if the resistance of the bulb is 1200 Ω? If in place of bulb, a heater of resistance 100 Ω is connected to the source calculate the current drawn by it.

Q76. In the circuit diagram shown (see figure), the two resistance wires A and B are of same length and same material, but A is thicker than B. Which ammeter A_1 or A_2 will indicate higher reading for current? Give reason.



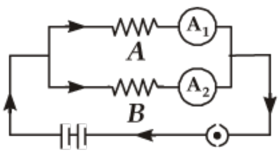
Q77. A wire of length L and resistance R is stretched so that the length is doubled and area of cross-section halved. How will (a) resistance change, and (b) resistivity change?

Q78. In an electric circuit with a resistance wire and a cell, the current flowing is I. What would happen to this current if the wire is replaced by another thicker wire of same material and same length. Give reason.

Q79. State the factors on which the resistance of a cylindrical conductor depend. Hence, define resistivity.

Q80. Calculate the resistance of an electric bulb which allows a 10 A current when connected to a 220 V power source.

Q81. In the circuit diagram of (see figure), the two resistance wires A and B are of same area of cross-section and same material, but A is longer than B. Which ammeter A_1 or A_2 will indicate higher reading for current? Give reason.



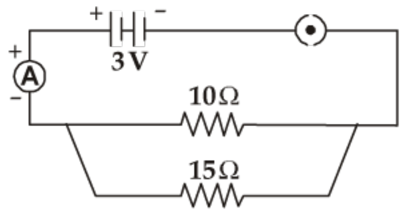
Q82. Two wires of equal length, one of copper and the other of manganin (an alloy) have the same thickness. Which one can be used for (a) electric transmission lines, (b)electrical heating devices? Why?

Q83. Table gives the resistivity of three samples in (Ω-m)

Sample	*A*	*B*	*C*
Resistivity	1.6×10^{-8}	7.5×10^{17}	44×10^{-6}

Which of them is a good conductor and which is an insulator? Why?

Q84. Study the following circuit and answer the questions that follow:



(a) State the type of combination of the two resistors in the circuit.

(b) How much current is flowing through (i) 10 Ω and (ii) 15 Ω resistors?

(c) What is the ammeter reading?

Q85. Derive the relation $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$, when resistors are joined in parallel.

Q86. Derive the relation $R = R_1 + R_2 + R_3$, when resistors are joined in series.

Q87. An aluminium wire has radius 0.25 mm and length of 75 m. If the resistance of the wire is 10 Ω, calculate the resistivity of aluminium.

Q88. Two metallic wires *A* and *B* of the same material are connected in parallel. Wire *A* has length *l* and radius *r*. Wire *B* has a length 2*l* and radius 2*r*. Calculate the ratio of the equivalent resistance in parallel combination and the resistance of wire *A*.

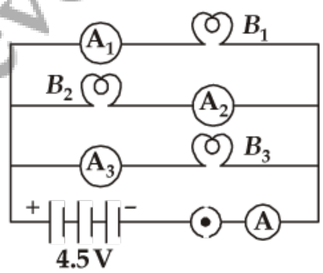
Q89. A piece of wire of resistance 20 Ω is drawn out so that its length is increased to twice its original length. Calculate the resistance of the wire in the new situation.

Q90. The following table gives the resistivity of three samples:

Sample	*A*	*B*	*C*
Resistivity	1.6×10^{-8} Ω-m	5.3×10^{-8} Ω-m	100×10^{-8} Ω-m

Which of them is suitable for heating elements of electrical appliances and why?

Q91. B_1, B_2 and B_3 are three identical bulbs connected as shown in the figure. When all the three bulbs glow, a current of 3 A is recorded by the ammeter *A*.



(a) What happens to the glow of the other two bulbs when the bulb B_1 gets fused?

(b) What happens to the glow of the other two bulbs when the bulb B_2 gets fused?

Q92. (a) What material is used in making the filament of an electric bulb?

(b) Name the characteristics which make it suitable for this.

Q93. Two room heaters are marked 220 V, 500 W and 220 V, 800 W respectively. If the heaters are conected in parallel to 220 V mains supply, calculate

(a) the current drawn by each heater.

(b) the resistance of each heater.

(c) total electric energy consumed in commercial units if they operate simultaneously for 2 hours.

Q94. An electric lamp is marked 100 W, 220 V. It is used for 5 hours daily. Calculate (a) its resistance while glowing, (b) energy consumed in kW h per day.

Q95. (a) Define the term 'volt'.

(b) State the relation between work, charge and potential difference for an electric circuit.

Calculate the potential difference between the two terminals of a battery if 100 joules of work is required to transfer 20 coulombs of charge from one terminal of the battery to the other.

Q96. State Ohm's law. How can it be verified experimentally? Does it hold good in all conditions? Comment.

Q97. Describe an activity to find relationship between the potential difference (V) across two ends of a conductor and the current (I) flowing through it by including in your answer (a) the diagram of the electric circuit, (b) a V-I graph.

Q98. (a) Draw a schematic diagram of a circuit consisting of a battery of five 2 V Cells, a 5 Ω resistor, a 10 Ω resistor and a 15 Ω resistor and a plug key all connected in series.

(b) Calculate the electric current passing through the above circuit when the key is closed.

Q99. Two resistors, with resistances 5 Ω and 10 Ω respectively are to be connected to a battery of emf 6 V so as to obtain: (i) minimum current flowing (ii) maximum current flowing

(a) How will you connect the resistances in each case?

(b) Calculate the strength of the total current in the circuit in the two cases.

Q100. Describe a simple experiment to demonstrate variation of resistance on (a) length, (b) cross-section area, and (c) material of the conductor. What are the conclusions drawn?

Q101. Two wires A and B have equal lengths and equal resistance, which one is thicker? The resistivity of A is more than the resistivity of B.

Q102. Describe an activity to show the variation of resistance on material of the conductor.

Q103. Describe an activity to show the variation of resistance with area of cross-section of a conductor.

Q104. (a) List the factors on which the resistance of a cylindrical conductor depends and hence derive an expression for its resistance.

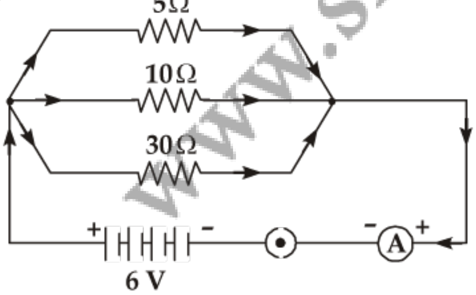
(b) How will the resistivity of a conductor change when its length is tripled by stretching it?

Q105. In the given figure, calculate (a) the total resistance of the circuit, (b) current flowing through the circuit, and (c) potential difference across the lamp and the resistor.

Q106. State the formula correlating the electric current flowing in a conductor and the voltage applied across it. Also show this relationship by drawing a diagram.

What would be the resistance of a conductor if the current flowing through it is 0.35 A when the potential difference across it is 1.4 V?

Q107. For the circuit diagram given below in figure calculate:

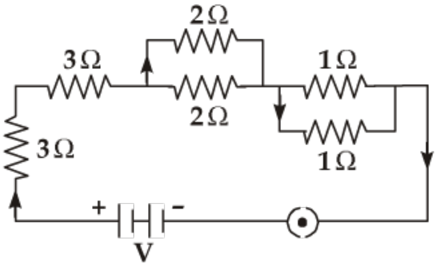


(a) the value of current through each resistor.

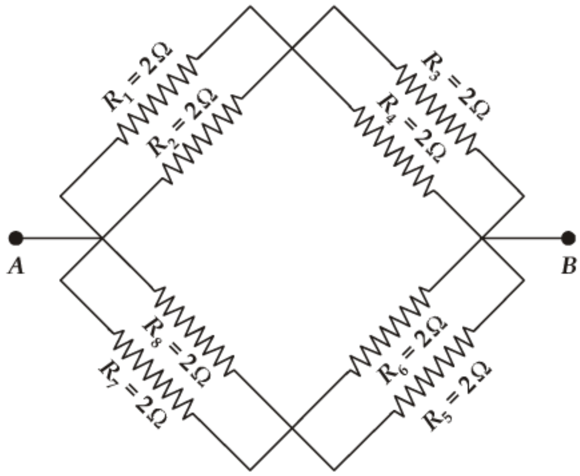
(b) The total current in the circuit.

(c) the total effective resistance of the circuit.

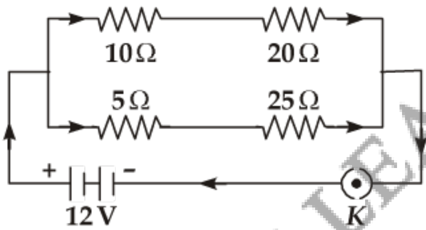
Q108 Find the equivalent resistance of the following circuit (see figure)



Q109 Find the equivalent resistance across the two ends *A* and *B* of the circuit (see figure)



Q110 If a 12 V battery is connected to the arrangement of resistances given below, calculate: (a) the total effective resistance of the arrangement, and (b) the total current flowing in the circuit.

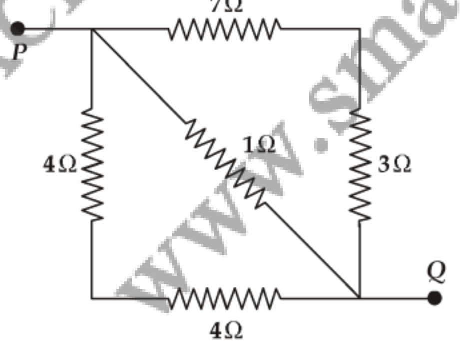


Q111 Two identical resistors are first connected in series and then in parallel. Find the ratio of equivalent resistances in two cases.

Q112 (a) Why an ammeter is likely to burn out if you connect it in parallel?

(b) Why is series arrangement not found satisfactory for domestic lights?

Q113 Calculate the effective resistance between *P* and *Q* in circuit as shown in figure.



Q114 A torch bulb is rated 5 V and 500 mA. Calculate (a) its power, (b) its resistance, and (c) the energy consumed if this bulb is lighted for 4 hours.

Q115 An electric kettle of 2 kW works for 2 h daily. Calculate the (a) energy consumed in SI and commercial unit, (b) cost of running it in the month of June at the rate of Rs. 3.00 per unit.

Q116 The potential difference between the terminals of an electric heater is 110 V, when it draws a current of 5 A from the source. What current will the heater draw and what will be its wattage if the potential difference is increased to 220 V. Consider that the resistance of the heater element does not change with temperature.

Q117 An electric iron consumes energy at a rate of 840 W when heating is at the maximum rate and 360 W when the heating is at the minimum. The voltage is 220 V. What are the current and the resistance in each case?

Q118 Two lamps, one rated 60 W at 220 V and the other 40 W at 220 V, are connected in parallel to the electric supply at 220 V.

(a) Draw a circuit diagram to show the connections.

(b) Calculate the current drawn from the electric supply.

(c) Calculate the total energy consumed by the two lamps together when they operate for one hour.

Q119 In a household 5 tube lights of 40 W each are used for 5 hours and an electric press of 500 W for 4 hours every day. Calculate the total electrical energy consumed by the tube lights and press in a month of 30 days.

Q120 Two wires *A* and *B* have equal lengths and equal resistance, which one is thicker? The resistivity of *A* is more than the resistivity of *B*.

Or

A device of resistance *R* is connected across a source of *V* voltage and draws a current *I*. Derive an expression for power in terms of voltage and resistance

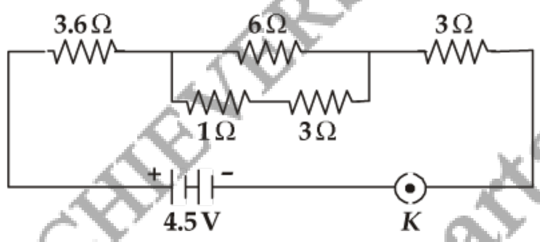
Q121 Two lamps rated 100 W, 220 V and 25 W, 220 V are connected in parallel to 220 V supply. Calculate the total current through the circuit.

Q122 (a) Express Joule's law of heating mathematically.

(b) What is the resistance of 12 m wire having radius 2×10^{-4} m and resistivity 3.14×10^{-8} Ω-m.

Q123 Briefly describe the working of an electric bulb. Explain the choice of filament. Why is an inactive gas filled in the bulb?

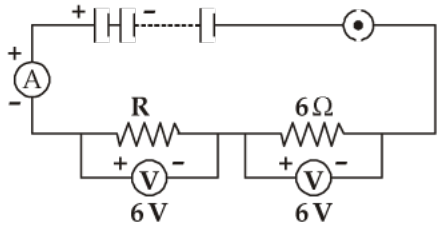
Q124 Find the current flowing through the following electric circuit:



Q125 Two identical resistors each of resistance 10 Ω are connected (a) in series and then (b) in parallel, in line to a battery of 6 volts. Calculate the ratio of power consumed in the combination of resistors in the two cases.

Q126 Find (a) the highest, (b) the lowest value of resistance that can be obtained by the combination of four resistors of 4 Ω, 8 Ω, 12 Ω and 24 Ω.

Q127 A circuit is shown in the diagram (see figure) given below. Find (a) the value of *R*, (b) the reading of the ammeter, (c) the potential difference across the terminals of battery.



Q128(a) What is an electric circuit?

(b) Calculate the number of electrons that flow per second to constitute a current of one ampere. Charge on an electron is 1.6×10^{-19} C.

(c) Draw an electric circuit for studying Ohm's law. Label the circuit component used to measure electric current and potential difference.

Q129 Draw the symbols of commonly used components in electrical circuit diagrams.

Q130(a) State Ohm's law. Express it mathematically.

(b) Write symbols used in electric circuits to represent:

(i) Variable resistance (ii) Voltmeter.

(c) An electric bulb is rated 220 V and 100 W. When it is operated on 110 V, what will be the power consumed?

Q131 Two conductors *A* and *B* of resistances 5 Ω and 10 Ω respectively are first joined in parallel and then in series. In each case the voltage applied is 20 V.

(a) Draw the circuit diagram to show the combination of these conductors in each case.

(b) In which combination will the voltage across the conductors *A* and *B* be the same?

(c) In which arrangement will the current through *A* and *B* is the same?

(d) Calculate the equivalent resistance for each arrangement.

Q132 Find out the following in the electric circuit given in figure.

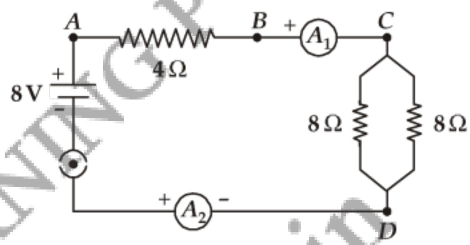
(a) Effective resistance of two 8 Ω resistors in the combination.

(b) Current flowing through 4 Ω resistor.

(c) Potential difference across 4 Ω resistance.

(d) Power dissipated in 4 Ω resistor.

(e) Difference in ammeter readings, if any



Q133 Describe an activity to find the combined resistance when three resistors R_1, R_2 and R_3 are connected in parallel and obtain the relation for it using Ohm's law. State two advantages of connecting household appliances in parallel arrangement.

Q134 What is heating effect of electric current? Find an expression for amount of heat produced. Name some appliancs based on heating effect of current.

Q135(a) Derive expression for equivalent resistance of a parallel combination of resistances.

(b) Calculate the ratio of equivalent resistance for a series combination of '*n*' number of identical resistors to the paralel combination of the same type of '*n*' number of resistors.

Q136(a) Resistors R_1, R_2 and R_3 are connected in series to a battery. Draw the circuit diagram showing the arrangement. Derive an expression for the equivalent resistance of the combination.

(b) Resistors are given as R_1 = 10 Ω, R_2 = 20 Ω and R_3 = 30 Ω. Calculate the effective resistance when they are connected in series. Also calculate the current flowing when the combination is connected to a 6 V battery.

Q137(a) Define electric resistance of a conductor.

(b) List two factors on which resistance of a conductor depends.

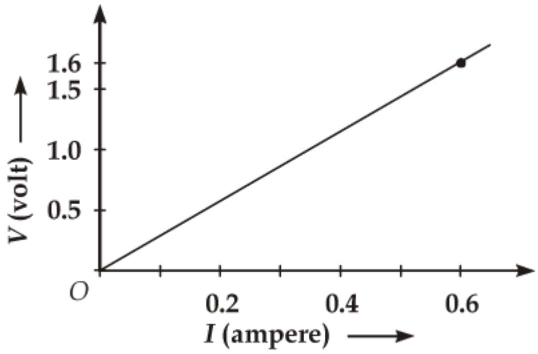
(c) Resistance of a metal wire of length 1 m is 104 Ω at 20 °C. If the diameter of the wire is 0.15 mm, find the resistivity of the metal at that temperature.

Q138(a) Name an instrument that measures electric current in a circuit. Define the unit of electric current.

(b) What do the following symbols mean in circuit diagrams?

(i)  (ii) 

(c) An electric circuit consisting of a 0.5 m long nichrome wire *XY*, an ammeter, a voltmeter, four cells of 1.5 V each and a plug key was set up.



(i) Draw a diagram of this electric circuit to study the relation between the potential difference maintained between the points '*X*' and '*Y*' and the electric current flowing through *XY*.

(ii) Following graph was plotted between *V* and *I* values:

What would be the values of $\frac{V}{I}$ ratios when the potential difference is 0.8 V, 1.2 V and 1.6 V respectively? What conclusion do you draw from these values?

Q139 Two resistors with resistance of 10 Ω and 15 Ω are connected to a battery of 12 V so as to obtain and measure (*i*) minimum electric current, (ii) maximum electric current.

(a) State the mode of connecting the resistors in each case with the help of a circuit diagram.

(b) Calculate the strength of total electric current in the circuit in each case.

Q140 Experimentally prove that in parallel combination of three resistances: (a) Potential difference across each resistor is same, and (b) Total circuit is equal to the sum of currents flowing through individual resistors.

Q141 Experimentally prove that in series combination of three resistances: (a) current flowing through each resistance is same, and (b) total potential difference is equal to the sum of potential differences across individidual resistors.

Date: 25/9/2021

S1. A coulomb (1 C).

S2. Time rate of flow of charge through any cross-section of a conductor is called ***electric current***.

S3. An ampere (A), which is defined as the rate of flow of 1 coulomb of charge per second.

S4. In an electric circuit, the direction of conventional current is taken as opposite to the direction of flow of electrons.

S5. Potential difference between two points A and B, in an electric field, is defined as the amount of work done in order to move unit positive charge from point B to point A. Thus,

$$V_A - V_B = \frac{W_B^A}{q}.$$

S6. A volt (1 V).

S7. Amount of work done to bring 1 C charge from point B to point A in the electric field is 1 joule.

S8.

(a) An electric cell

(b) Battery of cells

S9. (a) a cell, (b) an ammeter.

S10. A measuring instrument used to measure electric current.

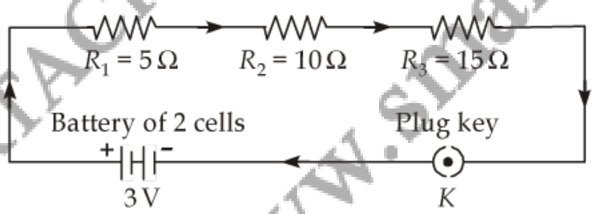
S11. An ammeter.

S12. In series of the electric circuit.

S13. A measuring instrument used to measure potential difference between two points in an electric circuit.

S14. (a) Ammeter, (b) Voltmeter.

S15. Schematic diagram is shown here



S16. An ohm (1 Ω), where 1 ohm = $\frac{1 \text{ volt}}{1 \text{ ampere}}$.

S17. Electrical resistance.

S18. The electric resistance of a conductor is its property to oppose flow of electric charge through it and is measured by the potential difference being applied across the conductor so as to maintain the flow of one ampere current through it.

S19. Silver, because its electrical resistivity is least out of the given materials.

S20. Silver.

S21. $V = IR = (0.2\text{ A}) \times (20\,\Omega) = 4\text{ V}$.

S22. The reading of ammeter (*i.e.*, current flowing in the circuit) is reduced to one-half of its previous value.

S23. The current flowing through the conductor is reduced to one-half of its previous value in accordance with the relation $I = \frac{V}{R}$.

S24. Current $I = \frac{\text{Potential difference } V}{\text{Resistance } R} = \frac{1.5\text{ V}}{30\,\Omega} = 0.05\text{ A}$.

S25. A straight inclined line passing through the origin because for a metallic wire $V \propto I$.

S26. Resistance of a wire is said to be 1 Ω, if for flow of 2 A current through the wire one has to maintain a potential difference of 2 volt across its ends.

S27. There is no change because resistivity of a material depends only on its nature and is independent of its dimensions.

S28. The electrical resistivity of a material is the resistance offered by unit cube of that material.

S29. On the material of conductor only (provided the temperature does not change).

S30. Resistance is doubled because it is directly proportional to length.

S31. Resistance of a conductor: (a) is directly proportional to its length, (b) inversely proportional to its cross-section area and depends on the material of the conductor. Resistance also depends on the temperature.

S32. Resistance of a conductor: (a) is directly proportional to its length, (b) inversely proportional to its cross-section area and depends on the material of the conductor. Resistance also depends on the temperature.

S33. As $2 + R = 5\,\Omega \quad \Rightarrow \quad R = 5 - 2 = 3\,\Omega$.

S34. Temperature T_2 is higher because resistance of metallic circuit $\left(R = \frac{V}{I}\right)$ is higher at temperature T_2 and resistance increases with increase in temperature.

S35. A ohm-metre (Ω-m).

S36. When given length of wire is doubled on itself, its new length $L' = \frac{L}{2}$ and new cross-section area $A' = 2A$. Hence, its new resistance

$$R' = \frac{\rho L'}{A'} = \frac{\rho\left(\frac{L}{2}\right)}{(2A)} = \frac{1}{4}\frac{\rho L}{A} = \frac{R}{4}$$

Thus, resistance is reduced to one-fourth of its original value.

S37. The resistance of conductor is reduced to one-half of its previous value because $R \propto$ length L.

S38. On increasing the temperature, the resistance of given conductor also increases.

S39. The resistance of a wire is inversely proportional to the square of its radius.

$$\left[\textbf{Hint: } R \propto \frac{1}{A} \text{ and } A = \pi r^2, \text{ hence } R \propto \frac{1}{\pi r^2} \text{ or } R \propto \frac{1}{r^2}\right]$$

S40. In parallel $\frac{1}{10} + \frac{1}{R} = \frac{1}{5}$.

Hence $\frac{1}{R} = \frac{1}{5} - \frac{1}{10} = \frac{1}{10} \Rightarrow 10\,\Omega$.

S41. In parallel, because than $\frac{1}{R} = \frac{1}{6} + \frac{1}{3} = \frac{1+2}{6} = \frac{3}{6} = \frac{1}{2}$ and hence $R = 2\,\Omega$.

S42. Electric frill used for festival lighting.

S43. In parallel.

S44. To obtain lowest resistance given four coils must be connected in parallel. Then the equivalent resistance will be

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4} = \frac{1}{4} + \frac{1}{8} + \frac{1}{12} + \frac{1}{24} = \frac{6+3+2+1}{24} = \frac{12}{24} = \frac{1}{2} \Rightarrow 2\,\Omega.$$

S45. In series arrangement of resistances, same current flows through all the resistors.

S46. In parallel arrangement current flowing through different resistors are in the inverse ratio of their resistances. Hence, current passing through $30\,\Omega$ resistor is double of the current passing through $60\,\Omega$ resistor.

S47. As two resistances are connected in series, hence the effective resistance $R = 2 + 2 = 4\,\Omega$.

S48. Power (P) = Potential difference (V) $\times$ Current (I).

S49. Nichrome is an alloy of high resistivity and high melting point and does not oxidise easily.

S50. Electric iron, Electric toaster, Electric oven etc.

S51. As per Joule's law the heat produced in a resistor is (a) directly proportional to square of current flowing through it, (b) directly proportional to resistance, and (c) directly proportional to time. Mathematically

$$\text{Heat } H = I^2Rt.$$

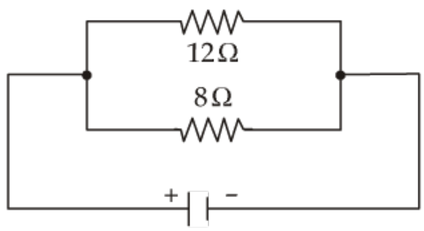
S52. When electric current is passed through a resistor, electrical energy is dissipated and appears as heat energy. This is known as the heating effect of electric current.

S53. Heat energy generated I^2Rt.

S54. Nichrome wire, because its resistivity and melting point are high and it does not oxidise easily.

S55. In series of the electric circuit.

S56. In parallel arrangement voltage V remains same.



Hence, $\frac{P_1}{P_2} = \frac{R_2}{R_1}$

$\therefore$ Power in 8 resistance $P_2 = \frac{P_1 R_1}{R_2} = \frac{6 \times 12}{8} = 9\,\text{W}$.

S57. 3.6×10^6 J.

S58. 40 W lamps has a higher electrical resistance because $R = \dfrac{V^2}{P}$.

S59. Toaster has a greater resistance because its power is less and $R = \dfrac{V^2}{P}$.

S60. A heating element wire should have high resistivity and high melting point.

S61. Current flowing through iron $\quad I = \dfrac{1\text{ kW}}{220\,V} = \dfrac{1000\text{ W}}{220\text{ V}} = 4.54$ A.

Hence, a fuse of 5 A capacity may be used with electric iron.

S62. Electric current in a circuit is defined as the time rate of flow of electric charge through any cross-section and its direction is opposite to that of flow of electrons. Hence in present case

$$\text{Electric current } I = \frac{q}{t} = \frac{ne}{1} = ne.$$

As electrons are flowing from East to West, the direction of electric current is from West to East.

S63. We know that current $\quad I = \dfrac{q}{t} = \dfrac{ne}{t}$

As current $I = 10\ \mu\text{A} = 10 \times 10^{-6}\text{ A} = 10^{-5}$ A and charge on an electron $e = 1.6 \times 10^{-19}$ C, hence number of electrons striking the TV screen in time $t = 1$ s is given by

$$n = \frac{It}{e} = \frac{10^{-5} \times 1}{1.6 \times 10^{-19}} = 6.25 \times 10^{13}$$

And charge striking the screen in time $t = 1$ minute = 60 s is

$$q = It = 10^{-5} \times 60 = 6 \times 10^{-4}\text{ C}.$$

S64. A cell is a current source which supplies electrical energy to maintain the flow of charges (*e.g.*, electrons) in the circuit at the expense of its internal chemical energy.

S65. Here current $I = 1$ A, time $t = 1$ s and charge on each electron $e = 1.6 \times 10^{-19}$ C.

As $\quad I = \dfrac{q}{t} = \dfrac{ne}{t}$

Hence, number of electrons flowing $n = \dfrac{It}{e} = \dfrac{1 \times 1}{1.6 \times 10^{-19}} = 6.25 \times 10^{18}$.

S66. Electric charges can move in a conductor when a potential difference is maintained across its ends. An electric cell is used to maintain potential difference across the conductor and thus can be used for flow of charges (*i.e.*, flow of current).

S67. Here, $I = 2$ A, time $t = 1$ minute = 60 s and $V = 3$ V

$\therefore$ Total charge flowing $q = It = 2 \times 60 = 120$ C

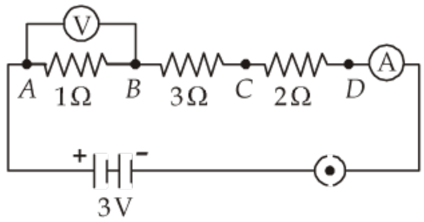
$\therefore$ Work done $W = qV = 120 \times 3 = 360$ J.

S68. It is given that potential difference $V = 12$ V and amount of charge flown $q = 2$ C.

$\therefore$ Total work done for moving the charge $W = qV$

$$= 2\text{ C} \times 12\text{ V} = 24\text{ J}.$$

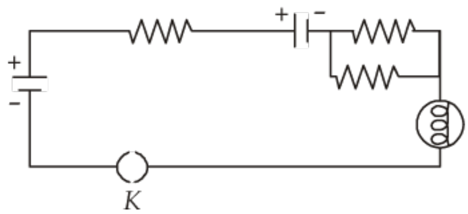
S69. Curret flowing through entire series circuit is same and for a series circuit, potential differences across various resistors are in the ratio of resistances.



$$\therefore \qquad \frac{V_{AB}}{V_{BC}} = \frac{1\,\Omega}{3\,\Omega}$$

$$\Rightarrow \qquad V_{BC} = 3\,V_{AB}.$$

S70. Electric circuit is a combination of conductors and current sources. These elements viz., conductors and current sources are joined together by means of connecting wires of very low resistance in such a way that there is no short circuit.



When no current is flowing in the circuit, it is an open circuit as in adjoining figure when plug in key K is not put in its place.

When the current is flowing in the circuit, it is a closed circuit. In the given figure if plug in key K is put in place, the current will begin to flow.

S71. Slope of V-I curve gives the value of resistance R of a resistor. As $R_1 > R_2$ hence slope of V-I graph for R_1 should be more than that of R_2. Hence student A has correctly performed the experiment.

S72. The resistance of a conductor is a property of the conductor, which affects the flow of current through it on maintaining a potential difference across its ends.

Unit of resistance is 1 ohm. Resistance of a conductor is said to be 1 ohm, if a potential difference of 1 V is to be applied across its ends for maintaining flow of 1 A current.

S73. I-V graph for a given conductor is drawn. As the graph comes out to be a straight line passing through the origin, Ohm's law is experimentally verified.

Ohm's law is true for metallic conductor/resistor so long as temperature remains unchanged.

S74. From the given set of readings, we find the value of resistance as:

$$R_1 = \frac{V_1}{I_1} = \frac{2}{0.08} = 25\,\Omega, \quad R_2 = \frac{V_2}{I_2} = \frac{3}{0.12} = 25\,\Omega, \quad R_3 = \frac{V_3}{I_3} = \frac{4.5}{0.15} = 30\,\Omega$$

$$R_4 = \frac{V_4}{I_4} = \frac{5}{0.20} = 25\,\Omega \quad \text{and} \quad R_5 = \frac{V_5}{I_5} = \frac{6}{0.24} = 25\,\Omega$$

Thus, it is clear that the 3rd reading is wrong and must be rejected. On the basis of remaining set of observations we find that the mean value of resistance of the resistor is 25 Ω.

S75. As here $V = 220$ V and $R = 1200\,\Omega$

$\therefore$ Current drawn by electric bulb $I = \dfrac{V}{R} = \dfrac{220}{1200} = \dfrac{11}{60}$ A

If instead of bulb we connect a heater then $R = 100\,\Omega$ and hence current drawn by it

$$I' = \frac{V}{R'} = \frac{220}{100} = 2.2\text{ A}.$$

S76. Since wire A is thicker, its cross-section area is more but resistance is less than that of B because resistance of a wire is inversely proportional to its cross-section area. As a result more current will pass through wire A and so reading of ammeter A_1 is more.

S77. (a) The new resistance of wire $R' = \dfrac{\rho L'}{A'} = \dfrac{\rho(2L)}{\left(\dfrac{A}{2}\right)} = \dfrac{4\rho L}{A} = 4R.$

Thus, resistance increases to four times its original value.

(b) The resistivity of the material of wire remains unchanged because it is a characteristic of the material of wire and is independent of its dimensions.

S78. If given resistance wire is replaced by another thicker wire of same material and same length then cross-section area of wire is increased and consequently its resistance decreases $\left[\text{As } R = \dfrac{\rho L}{A}\right]$. So the current flowing in the circuit increases.

S79. The resistance of a cylindrical conductor *i.e.*, a wire (R) is (*i*) directly proportional to its length L, (*ii*) inversely proportional to its cross-section area A and (*iii*) depends on the nature of material of wire. mathematically,

$$R \propto \frac{L}{A} \qquad \text{or} \qquad R = \frac{\rho \cdot L}{A}.$$

Here, ρ is known as the resistivity of given material. It is defined as the resistance offered by a unit cube of given material when current flows perpendicular to the opposite faces.

S80. Given that voltage of power source $V = 220\text{ V}$

Current flowing $I = 10\text{ A}$

∴ Resistance of electric bulb $R = \dfrac{V}{I} = \dfrac{220\text{ V}}{10\text{ A}} = 22\,\Omega.$

S81. Since wire A is longer than B resistance of wire A is more because resistance of a wire is directly proportional to its length. Consequently current flowing through wire A is less. Hence, ammeter A1 wil give less reading and A_2 give more reading.

S82. (a) Copper is used for electric transmission lines because its resistivity and consequently resistance is small and power loss in transmission lines is small.

(b) Manganin alloy is used for electrical heating devices because its resistivity is high and it does not oxidize easily on heating.

S83. Sample A is a good conductor because its resistivity is extremely small at $1.6 \times 10^{-8}\,\Omega$-m. Sample B is an insulator because its resistivity is extremely high at $7.5 \times 10^{17}\,\Omega$-m.

S84. (a) The two resistors are joined in parallel in the circuit.

(b) (i) Current flowing through $10\,\Omega$ resistor

$$I_1 = \frac{V}{R_1} = \frac{3\text{ V}}{10\,\Omega} = 0.3\text{ A}.$$

(ii) Current flowing through $15\,\Omega$ resistor

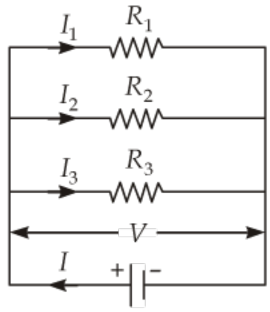
$$I_2 = \frac{V}{R_2} = \frac{3\text{ V}}{15\,\Omega} = 0.2\text{ A}.$$

(c) Ammeter reading I = Total current in the circuit

$$= I_1 + I_2 = 0.3 + 0.2 = 0.5\text{ A}.$$

S85. **In parallel combination** of three resistances R_1, R_2 and R_3, the current in each of the resistances is different. If I is the current drawn from the cell then it is divided into branches I_1, I_2 and I_3, Thus,

$$I = I_1 + I_2 + I_3$$



The potential difference across each of these resistances is the same.

Thus, from Ohm's law $I_1 = \dfrac{V}{R_1}$, $I_2 = \dfrac{V}{R_2}$, $I_3 = \dfrac{V}{R_3}$

If R is the equivalent resistance then,

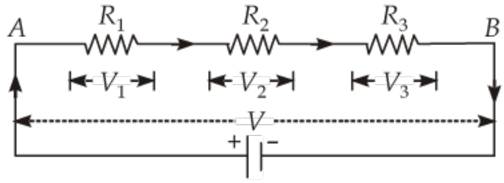
$$I = \frac{V}{R}$$

$$\frac{V}{R} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

and

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}.$$

S86. **In series combination**, the same current flows in all the resistances but the potential difference across each of the resistance is different.



According to Ohm's law, we have

$$V_1 = IR_1, \quad V_2 = IR_2, \quad V_3 = IR_3$$

If the total potential difference between A and B is V, then

$$V = V_1 + V_2 + V_3$$
$$= IR_1 + IR_2 + IR_3$$
$$= I(R_1 + R_2 + R_3)$$

Let the equivalent resistance be R, then

$$V = IR$$

and hence $\quad IR = I(R_1 + R_2 + R_3)$

$\Rightarrow \quad R = R_1 + R_2 + R_3.$

S87. As per question length of wire $L = 75$ m, radius $r = 0.25$ mm $= 0.25 \times 10^{-3}$ m and resistance $R = 10\,\Omega$.

As $\quad R = \dfrac{\rho L}{A} = \dfrac{\rho L}{\pi r^2},$

Hence, $\quad$ Resistivity $\rho = \dfrac{R\pi r^2}{L}$

$\Rightarrow \quad \rho = \dfrac{10 \times 22 \times (0.25 \times 10^{-3})^2}{7 \times 75} = 2.62 \times 10^{-8}\,\Omega\text{-m}.$

S88. Let resistivity of material of wires A and B be ρ.

$\therefore$ Resistance of wire A of length l and radius r will be

$$R_A = \frac{\rho l}{A} = \frac{\rho l}{\pi r^2} \quad \text{... (i)}$$

and resistance of wire B of length $2l$ and radius $2r$ will be

$$R_B = \frac{\rho \cdot (2l)}{\pi (2r)^2} = \frac{1}{2}\frac{\rho l}{\pi r^2} = \frac{R_A}{2} \quad \text{... (ii)}$$

$\therefore$ If equivalent resistance of parallel combination of R_A and R_B be R_p, then

$$\frac{1}{R_p} = \frac{1}{R_A} + \frac{1}{R_B} = \frac{1}{R_A} + \frac{2}{R_A} = \frac{3}{R_A}$$

$\Rightarrow \quad R_p = \dfrac{R_A}{3} \quad \Rightarrow \quad \dfrac{R_p}{R_A} = \dfrac{1}{3}.$

S89. The new resistance of wire $\quad R' = \dfrac{\rho L'}{A'} = \dfrac{\rho(2L)}{\left(\dfrac{A}{2}\right)} = \dfrac{4\rho L}{A} = 4R.$

Thus, resistance increases to four times its original value.

The new resistance $R' = 4R = 4 \times 20\,\Omega = 80\,\Omega.$

S90. The element C is best suited for preparing heating element of electrical appliances because its resistivity is more than that of other two materials. Hence, while preparing an element of given resistance we shall have to use a wire of lesser length and may be thicker.

S91. (a) Since bulbs B_1, B_2 and B_3 are connected in parallel, each bulb is independent of other. Hence if bulb B_1 gets fused then glow of other two bulbs B_2 and B_3 will remain unchanged.

(b) If bulb B_2 gets fuse, reading of ammeter B_2 immediately becomes zero but readings of ammeters A_1 and A_3 remain unchanged. However, reading of ammeter A, which is equal to sum of the readings of A_1, A_2 and A_3, will now fall from its previous value.

S92. (a) Tungsten is used in making the filament of an electric bulb.

(b) Tungsten is best suited for making filament of an electric bulb because it is a strong high metal with extremely high value of melting point (3380 °C)

S93. In parallel each heater operates at same voltage $V = 220\,V$. It is given that $P_1 = 500\,W$ and $P_2 = 800\,W$.

(a) $I_1 = \frac{P_1}{V} = \frac{500\ W}{220\ V} = \frac{25}{11}\ A$, and $I_2 = \frac{P_2}{V} = \frac{800\ W}{220\ V} = \frac{40}{11}\ A$.

(b) $R_1 = \frac{V}{I_1} = \frac{220}{(25/11)} = 96.8\ \Omega$, and $R_2 = \frac{V}{I_2} = \frac{220}{(40/11)} = 60.5\ \Omega$.

(c) Total power $P = P_1 + P_2 = 500 + 800 = 1300\,W$, time = 2 h

$\therefore$ Total energy consumed $E = Pt = 1300 \times 2\,h = 2600\ W\,h$

$$= \frac{2600}{1000}\ kW\,h = 2.6\ kW\,h = 2.6 \text{ units.}$$

S94. Here, $P = 100\,W$, $V = 220\,V$ and $t = 5\,h$

(a) Resistance of electric lamp $R = \frac{V^2}{P} = \frac{200 \times 200}{100} = 400\,\Omega$

(b) Energy consumed per day $E = Pt = 100\,W \times 5\,h = 500\,Wh$

$$= \frac{500}{1000}\ kW\,h = 0.5\ kW\,h.$$

S95. (a) The term 'volt' is the SI unit of potential difference. Potential difference is said to be 1 volt if one joule work is to be done to carry 1 coulomb positive charge from one point to another.

(b) The relation between work (W), charge (Q) and potential difference (V) for an electric circuit is

$$V = \frac{W}{Q}$$

Given that $W = 100\,J$ and $Q = 20\,C$

$\therefore$ Potential difference $V = \frac{W}{Q} = \frac{100\ J}{20\ C} = 5$ volt $= 5\,V$.

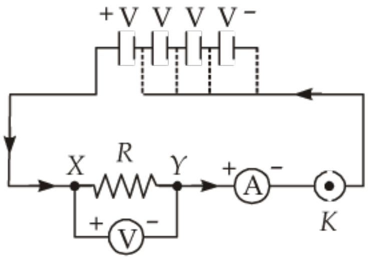
S96. According to Ohm's law, temperature remaining constant, the current passing through a conductor is directly proportional to the potential difference across its ends, *i.e.*,

$$V \propto I \quad \text{or} \quad V = IR$$

Here, R is known as the resistance of given conductor.

The circuit diagram of the experimental set up has been shown in figure. Here, XY is a resistance wire, A an ammeter and V a voltmeter. A battery of four cells is being used as a current source and K is a plug key.

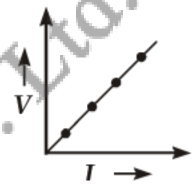
Initially use one cell only. Put plug in key K and note current and voltage by noting ammeter and voltmeter readings respectively. Let these be I_1 and V_1.



Then connect two cells in the circuit and note current I_2 and potential difference V_2 across the resistance. Similarly take readings with three cells and four cells in the circuit. From our observations, we find that

$$\frac{V_1}{I_1} = \frac{V_2}{I_2} = \frac{V_3}{I_3} = \frac{V_4}{I_4} = \text{a constant} \qquad (R\text{, the resistance of given wire}).$$

If we plot V-I graph, the graph comes out to be a straight line as shown in figure. It experimentally verifies Ohm's law. Ohm's law does not hold good under all conditions. It is true for metals and alloys only provided that temperature does not change during the course of experiment.



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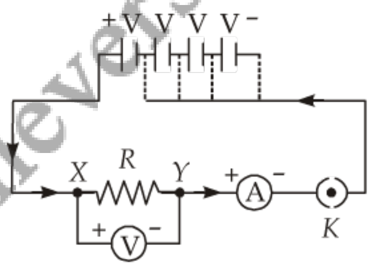

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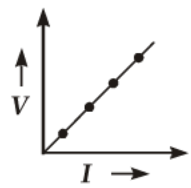
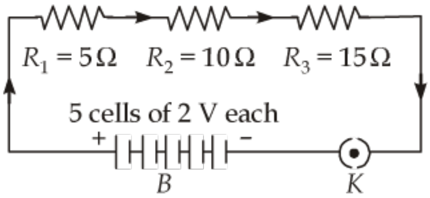


S98. (a) The schematic diagram is given in figure.



(b) Here, Total voltage $V = 5 \times 2 = 10\,\text{V}$

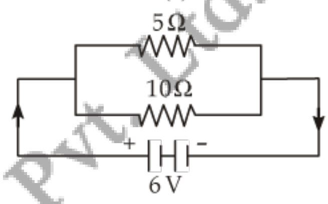
and Total resistance $R = R_1 + R_2 + R_3 = 5 + 10 + 15 = 30\,\Omega$

$\therefore$ Current passing through the circuit when the key is closed

$$I = \frac{V}{R} = \frac{10\ \text{V}}{30\ \Omega} = \frac{1}{3}\ \text{A} = 0.33\ \text{A}.$$

S99. Here, $R_1 = 5\,\Omega$, $R_2 = 10\,\Omega$ and $V = 6\,\text{V}$.

(a)



(b)

(a) (i) For minimum current flowing in the circuit resistances R_1 and R_2 should be connected in series as shown in figure (a).

(ii) For maximum current flowing in the circuit resistances R_1 and R_2 should be connected in parallel as shown in figure (b).

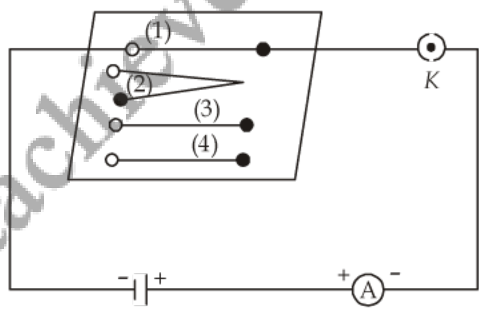
(b) (i) In series combination $R_s = R_1 + R_2 = 5\,\Omega + 10\,\Omega = 15\,\Omega$

$\therefore$ Minimum current $I_{\text{min}} = \dfrac{V}{R_s} = \dfrac{6\ \text{V}}{15\ \Omega} = 0.4\ \text{A}$

(ii) In parallel combination $\dfrac{1}{R_p} = \dfrac{1}{5} + \dfrac{1}{10} \Rightarrow R_p = \dfrac{10}{3}\,\Omega$

$\therefore$ Maximum current $I_{\text{max}} = \dfrac{V}{R_p} = \dfrac{6\ \text{V}}{\frac{10}{3}\,\Omega} = 1.8\ \text{A}.$

S100. To demonstrate dependence of resistance on length, cross-section area and material of the conductor we complete an electric circuit as shown in figure.



(a) **Effect of length:** Take the resistance wire number 1 of length l and connect it in the circuit. Put plug in key K and note ammeter reading. Let it be I_1. Now instead of wire number 1, connect wire number 2 of double length but of same material and same thickness. As before note ammeter reading I_2.

Experimentally, it is observed $I_2 = \dfrac{I_1}{2}$. It shows that resistance of 2nd wire is double of 1st wire. Thus, we conclude that

$$\frac{R_2}{R_1} = \frac{l_2}{l_1} = \frac{2l}{l} = 2 \quad \text{or} \quad R \propto l.$$

(b) **Effect of cross-section area:** Replace the wire by resistance wire number 3 of length l but thickness more than wire number 1. Again put plug in key and note ammeter reading I_3. It is more than I_1. It means for a thicker wire (*i.e.*, a wire of greater cross-section area) the resistance is less. Exact calculations show that resistance is inversely proportional to cross-section area of the conductor.

Thus, $R \propto \dfrac{1}{A}.$

(c) **Effect of material:** Now, take a wire number 4 of some other material but of length l and same thickness as wire number 1. Connect the wire in the circuit and again note ammeter reading I_4. We know that I_4 is different from I_1. It shows that resistance depends on material of the conductor.

S101. Since,

$$\text{Resistance } R = \rho \frac{\text{Length}}{\text{Area of cross-section}} = \frac{\rho L}{A}$$

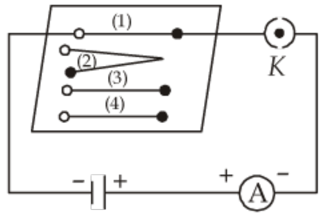
We have

$$R = \rho_A \frac{L}{\text{Area of } A} = \rho_B \frac{L}{\text{Area of } B}$$

$$\Rightarrow \qquad \frac{\rho_A}{\rho_B} = \frac{\text{Area of } A}{\text{Area of } B}$$

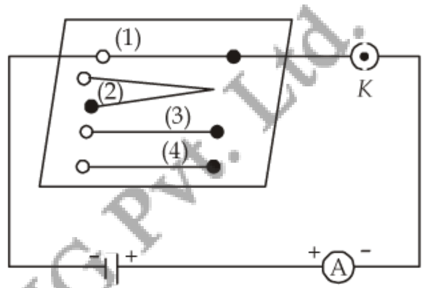
Since, $\rho_A > \rho_B$, area of A is more than area of B. Thus, A is a thicker wire.

S102. To demonstrate dependence of resistance on material of the conductor we complete an electric circuit as shown in figure.



Effect of material: Now, take a wire number 4 of some other material but of length l and same thickness as wire number 1. Connect the wire in the circuit and again note ammeter reading I_4. We that I_4 is different from I_1. It shows that reasistance depends on material of the conductor.

S103. **Effect of cross-section area:** Replace the wire by resistance wire number 3 of length l but thickness more than wire number 1. Again put plug in key and note ammeter reading I_3. It is more than I_1. It means for a thicker wire (*i.e.*, a wire of greater cross-section area) the resistance is less. Exact calculations show that resistance is inversely proportional to cross-section area of the conductor.



Thus, $$R \propto \frac{1}{A}.$$

S104. (a) The resistance of a cylindrical conductor *i.e.*, a wire (R) is (i) directly proportional to its length L, (ii) inversely proportional to its cross-section area A and (iii) depends on the nature of material of wire. mathematically,

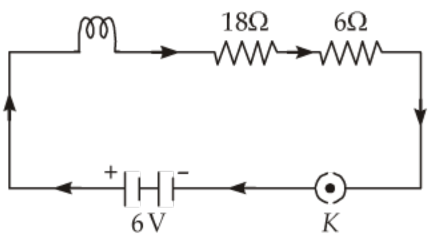
$$R \propto \frac{L}{A} \qquad \text{or} \qquad R = \frac{\rho \cdot L}{A}.$$

Here, ρ is known as the resistivity of given material. It is defined as the resistance offered by a unit cube of given material when current flows perpendicular to the opposite faces.

(b) The resistivity of the conductor remains unchanged.

S105. (a) Since lamp of resistance $R_1 = 18\,\Omega$ and resistor $R_2 = 6\,\Omega$ are connected in series, hence total resistance of the circuit

$$R = R_1 + R_2 = 18 + 6 = 24\,\Omega.$$



(b) As voltage $V = 6\,\text{V}$

∴ Current flowing through the circuit

$$I = \frac{V}{R} = \frac{6\text{ V}}{24\,\Omega} = 0.25\text{ A}.$$

(c) Potential difference across the lamp

$$V_1 = IR_1 = 0.25 \times 18 = 45\text{ V},$$

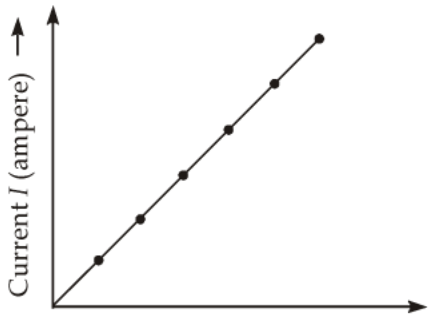
and potential difference across the resistor

$$V_2 = IR_2 = 0.25 \times 6 = 15\text{ V}$$

S106. The formula correlating the electric current I flowing in a conductor and the voltage applied V across it is

$$I \propto V$$

or
$$\frac{V}{I} = \text{a constant}$$
$$= R$$
$$= \text{resistance of given conductor.}$$



The relationship is shown in figure.

In the given problem $I = 0.35\text{ A}$ and $V = 1.4\text{ V}$

$\therefore$ Resistance $R = \frac{V}{I} = \frac{1.4}{0.35} = 4.0\,\Omega.$

S107. (a) Since the three resistances, shown in the circuit have been joined in parallel, hence voltage across each of them is same having a value $V = 6\text{ V}$.

$\therefore$ Current I_1 through resistance $R_1 = 5\,\Omega$,

$$I_1 = \frac{V}{R_1} = \frac{6}{5} = 1.2\text{ A}$$

Current I_2 through resistance $R_2 = 10\,\Omega$,

$$I_2 = \frac{V}{R_2} = \frac{6}{10} = 0.6\text{ A}$$

and current I_3 through resistance $R_3 = 30\,\Omega$,

$$I_3 = \frac{V}{R_3} = \frac{6}{30} = 0.2\text{ A}$$

(b) Total current in the circuit $I = I_1 + I_2 + I_3 = 1.2 + 0.6 + 0.2 = 2.0\text{ A}.$

(c) Total effective resistance of the circuit

$$R_{eq} = \frac{V}{I} = \frac{6}{2.0} = 3.0\,\Omega.$$

S108. Equivalent resistance of $2\,\Omega$ and $2\,\Omega$ resistors joined in parallel is

$$\frac{1}{R_1} = \frac{1}{2} + \frac{1}{2} = \frac{2}{2} = 1 \quad \Rightarrow \quad R_1 = 1\,\Omega$$

Again equivalent resistance of $1\,\Omega$ and $1\,\Omega$ resistors joined in parallel is

$$\frac{1}{R_2} = \frac{1}{1} + \frac{1}{1} = \frac{2}{1} \quad \Rightarrow \quad R_2 = 0.5\,\Omega$$

Now equivalent resistance of the circuit.

$$R = 3\Omega + 3\Omega + 0.5\Omega + 1\Omega = 7.5\Omega.$$

S109. Equivalent resistance of R_1 and R_2 joined in parallel is R_{12}, where

$$\frac{1}{R_{12}} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{2} + \frac{1}{2} = \frac{1}{1}$$

$\Rightarrow$ $R_{12} = 1\,\Omega$

Similarly, $R_{34} = R_{56} = R_{78} = 1\,\Omega$

Now, R_{12} and R_{34} are in series making a resistance

$$R_q = R_{12} + R_{34} = 1 + 1 = 2\,\Omega$$

Similarly, R_{56} and R_{78} are in series and make a resistance $R_{10} = 2\,\Omega$.

Finally, R_9 and R_{10} are connected in parallel between the points A and B and hence equivalent resistance R is give as

$$\frac{1}{R} = \frac{1}{R_9} + \frac{1}{R_{10}} = \frac{1}{2} + \frac{1}{2} = \frac{1}{1} \quad \Rightarrow \quad R = 1\,\Omega.$$

S110. (a) Effective resistance R_1 of series combination of $10\,\Omega$ and $20\,\Omega$ resistances

$$R_1 = 10 + 20 = 30\,\Omega$$

Similarly effective resistance R_2 of series combination of $5\,\Omega$ and $25\,\Omega$ resistances

$$R_2 = 5 + 25 = 30\,\Omega$$

As R_1 and R_2 are joined in parallel, hence total effective resistance of the arrangement

$$R = \frac{R_1 R_2}{R_1 + R_2} = \frac{30 \times 30}{30 + 30} = 15\,\Omega$$

(b) $\therefore$ Total current flowing in the circuit $I = \frac{V}{R} = \frac{12\text{ V}}{15\,\Omega} = 0.8$ A.

S111. Let two resistors of value R each are first joined in series, when equivalent resistance

$$R_s = R + R = 2R$$

On joining these very resistors in parallel let equivalent resistance be R_p, where

$$\frac{1}{R_p} = \frac{1}{R} + \frac{1}{R} = \frac{2}{R} \Rightarrow R_p = \frac{R}{2}$$

$$\therefore \quad \frac{R_s}{R_p} = \frac{2R}{\left(\frac{R}{2}\right)} = \frac{4}{1}.$$

S112. (a) An ammeter has a very low resistance used to measure electric current flowing in a circuit. If an ammeter is connected in parallel with an electrical circuits, the net resistance of circuit becomes even less than the resistance of an ammeter and a strong current begins to flow. As a result the ammeter is likely to burn out.

(b) In house hold electric circuits, series circuit is not followed, it is because if one component of series circuit fails, the entire circuit is broken and none of the components works. Moreover, same current flows through all the components irrespective of their operating needs.

S113. In the arrangement of resistors shown in figure, resistances of $7\,\Omega$ and $3\,\Omega$ are connected in series and constitute a resistance R_1 of value $R_1 = 7 + 3 = 10\,\Omega$.

Similarly resistances of $4\,\Omega$ and $4\,\Omega$ are in series and constitute a single resistance R_2 of value $R_2 = 4 + 4 = 8\,\Omega$.

Now $R_1 = 10\,\Omega$, $R_2 = 8\,\Omega$ and resistance $R_3 = 1\,\Omega$ are connected in parallel between the points P and Q. Hence, effective resistance R is given by

$$\frac{1}{R} = \frac{1}{10} + \frac{1}{8} + \frac{1}{1} = \frac{4 + 5 + 40}{40} = \frac{49}{40} \quad \Rightarrow \quad R = \frac{40}{49} = 0.81\,\Omega.$$

S114. (a) ∴ Power of torch bulb $P = VI = 5 \times 0.5 = 2.5\,\text{W}$.

(b) ∴ Resistance of torch bulb $R = \dfrac{V}{I} = \dfrac{5}{0.5} = 10\,\Omega$.

(c) Energy consumed by the bulb in 4 hours

$$E = Pt = 2.4 \times 4 = 10\,\text{W h}.$$

S115. Here power $P = 2\,\text{kW}$, time of use $t = 2\,\text{h}$ daily.

∴ Total time of use in the month of June $t = 2 \times 30 = 60\,\text{h}$

∴ (i) Energy consumed $E = P \times t = 2\,\text{kW} \times 60\,\text{h} = 120\,\text{kW h} = 120$ units

⇒ $E = 120 \times 3.6 \times 10^6\,\text{J} = 4.32 \times 10^8\,\text{J}$

(ii) Cost @ Rs. 3.00 per unit = 3×120 = Rs. 360.

S116. As here $V = 110\,\text{V}$ and $I = 5\,\text{A}$, hence resistance of the electric heater

$$R = \frac{V}{I} = \frac{110}{5} = 22\,\text{W}.$$

When potential difference is increased to $V' = 220\,\text{V}$, then

(a) the current $I' = \dfrac{V'}{R} = \dfrac{220}{22} = 10\,\text{A}$,

(b) the power $P = V'I' = 220 \times 10 = 2200\,\text{W} = 2.2\,\text{kW}$.

S117. (a) **When heating is at maximum rate**, the power rating $P = 840\,\text{W}$ and supply voltage $V = 220\,\text{V}$

∴ Current flowing $I = \dfrac{P}{V} = \dfrac{840\,\text{W}}{220\,\text{V}} = 3.82\,\text{A}$

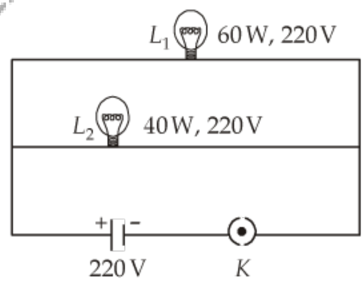
and Resistance of electric iron $R = \dfrac{V}{I} = \dfrac{220\,\text{V}}{3.82\,\text{A}} = 57.6\,\Omega$.

(b) **When heating is at minimum rate**, the power rating $P = 360\,\text{W}$ and supply voltage $V = 220\,\text{V}$

∴ Current flowing $I = \dfrac{P}{V} = \dfrac{360\,\text{W}}{220\,\text{V}} = 1.64\,\text{A}$

and Resistance of electric iron $R = \dfrac{V}{I} = \dfrac{220\,\text{V}}{1.64\,\text{A}} = 134.2\,\Omega$.

S118. (a) The circuit daigram showing the connections is given here in figure.



(b) Current drawn by 60 W bulb $I_1 = \dfrac{P_1}{V} = \dfrac{60}{220} = \dfrac{3}{11}\,\text{A}$

and current drawn by 40 W bulb $I_2 = \dfrac{P_2}{V} = \dfrac{40}{220} = \dfrac{2}{11}\,\text{A}$

∴ Total current drawn by the combination from power supply

$$I = I_1 + I_2 = \left(\frac{3}{11} + \frac{2}{11}\right)\text{A} = \frac{5}{11}\,\text{A}$$

(c) Total power of two lamps $P = P_1 + P_2 = (60 + 40)\,\text{W} = 100\,\text{W}$.

∴ Energy consumed by two lamps in 1 hour

$$E = P \cdot t = 100\,\text{W} \times 1\,\text{h} = 100\,\text{W h}.$$

S119. Energy consumed by 5 tube lights of 40 W each used for 5 hours in a day $5 \times 40 \times 5 = 1000\,\text{W h} = 1.0\,\text{kW h}$.

Energy consumed by electric press of 500 W for 4 hours in a day $= 500 \times 4 = 2000\,\text{W h} = 2.0\,\text{kW h}$.

∴ Total energy consumed per day $= 1.0 + 2.0 = 3.0\,\text{kW h}$.

∴ Total electrical energy consumed in a month of 30 days $3.0 \times 30 = 90.0\,\text{kW h}$.

S120. Amount of work done in carrying a charge Q through a potential difference V is

$$W = QV$$

But $\quad Q = It \quad \therefore \quad W = VIt$

and power defined as the rate of doing work is

$$P = \frac{W}{t} = \frac{VIt}{t} = VI.$$

If R be the value of resistance of the conductor, then $V = RI$ and hence

$$P = VI = (RI)\,I = I^2R.$$

Again $\quad P = VI = V \cdot \left(\frac{V}{R}\right) = \frac{V^2}{R}$

Thus, in general we can say that electric power is given by

$$P = VI = I^2R = \frac{V^2}{R}.$$

S121. In parallel grouping voltage remains same across each lamp. Hece currents I_1 and I_2 flowing through 2 lamps are:

$$I_1 = \frac{P_1}{V} = \frac{100}{220} = \frac{5}{11}\text{ A}$$

and $\quad I_2 = \frac{P_2}{V} = \frac{25}{220} = \frac{5}{44}\text{ A}$

$\therefore$ Total current $\quad I = I_1 + I_2 = \frac{5}{11} + \frac{5}{44} = \frac{20+5}{44} = \frac{25}{44}\text{ A}.$

S122. (a) If on applying, a potential difference V across the ends of a conductor of resistance R, the current I flows for a time t, then as per Joule's law of heating the electric energy consumed is given by

$$W = QV = VIt = I^2Rt = *.$$

Generally, it is convenient to use the formula $W = I^2Rt$ for series connected circuits because the current I is same in all resistors. For parallel arrangement we prefer to use the relation $W = \frac{V^2t}{R}$, because here V is same across all branches of the circuit.

The dissipated electrical energy reappears as heat. Thus, heat produced

$$H = VIt = I^2Rt = \frac{V^2t}{R}\text{ J}.$$

(b) As per question length of wire $L = 12$ m, radius $r = 2 \times 10^{-4}$ m and resistivity $\rho = 3.14 \times 10^{-8}\ \Omega$-m.

$\therefore$ Resistance of given wire $R = \frac{\rho L}{A} = \frac{\rho L}{\pi r^2} = \frac{3.14 \times 10^{-8} \times 12}{3.14 \times (2 \times 10^{-4})^2} = 3\,\Omega.$

S123. An electric bulb utilises heating effect of electric current to produce light. Its main component is the heating filament which must retain as much of the heat generated as is possible, so that when joined to potential source it gets very hot and emits light. Therefore, the filament is thermally isolated by using insulating supports. The filament must not melt at such high temperatures. Therefore, bulb filament is made using a strong metal having high melting point. From this consideration tungsten filament having a melting point of 3380 °C is best suited.

S124. In circuit combined resistance R_1 of the series grouping of $1\,\Omega$ and $3\,\Omega$ resistors

$$R_1 = 1 + 3 = 4\,\Omega.$$

Combined resistance of parallel grouping of $6\,\Omega$ and $R_1 = 4\,\Omega$ resistors is R_2, where

$$\frac{1}{R_2} = \frac{1}{6} + \frac{1}{4} = \frac{2+3}{12} = \frac{5}{12}$$

$\Rightarrow$ $$R_2 = 2.4\,\Omega.$$

$\therefore$ Total resistance of circuit $$R = 3.6 + R_2 + 3 = 3.6 + 2.4 + 3 = 9\,\Omega.$$

$\therefore$ Current flowing $$I = \frac{V}{R} = \frac{4.5\text{ V}}{9\,\Omega} = 0.5\text{ A}.$$

S125. Here, $R_1 = R_2 = 10\,\Omega$ and $V = 6$ volt

(a) In series net resistance $$R_s = R_1 + R_2 = 10 + 10 = 20\,\Omega$$

and power $$P_s = \frac{V^2}{R_s} = \frac{(6)^2}{20} = 1.8\text{ W}$$

(b) In parallel net resistance $$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{10} + \frac{1}{10} = \frac{1}{5}$$

$\Rightarrow$ $$R_p = 5\,\Omega$$

and power $$P_p = \frac{V^2}{R_p} = \frac{(6)^2}{5} = 7.2\text{ W}$$

$\Rightarrow$ $$\frac{P_s}{P_p} = \frac{1.8}{7.2} = \frac{1}{4}.$$

S126. (a) When all four resistances are connected in series, the circuit resistance is highest having a value

$$R_1 = 4 + 8 + 12 + 24 = 48\,\Omega$$

(b) When these four resistances are connected in parallel, the circuit resistance is lowest having a value R_2, where

$$\frac{1}{R_2} = \frac{1}{4} + \frac{1}{8} + \frac{1}{12} + \frac{1}{24} = \frac{6+3+2+1}{24} = \frac{12}{24} = \frac{1}{2}$$

$\Rightarrow$ $$R_2 = 2\,\Omega.$$

S127. (a) Since R and 6Ω resistors are in series, hence same current flows through them and so,

$$\frac{R}{6\,\Omega} = \frac{6\text{ V}}{12\text{ V}} \Rightarrow 3\,\Omega.$$

(b) Ammeter reading $$I = \frac{6\text{ V}}{R} = \frac{6\text{ V}}{3\,\Omega} = 2\text{ A}.$$

(c) Potential difference across the terminals of battery = 6 V + 12 V = 18 V.

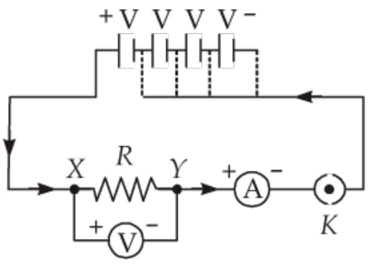
S128. (a) A continuous and closed path of an electric current is called an electric circuit.

(b) Here current $I = 1$ A, time $t = 1$ s and charge on each electron $e = 1.6 \times 10^{-19}$ C.

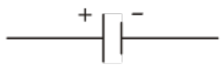
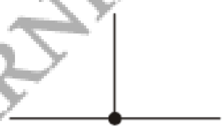
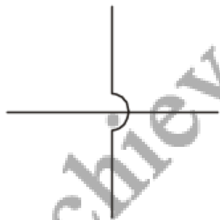
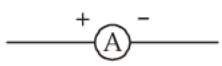
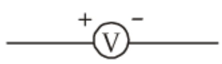
As $$I = \frac{q}{t} = \frac{ne}{t}$$

Hence, number of electrons flowing $n = \dfrac{It}{e} = \dfrac{1 \times 1}{1.6 \times 10^{-19}} = 6.25 \times 10^{18}$.

(c)



S129. Symbols of some commonly used components in circuit diagrams.

Sl. No.	*Components*	*Symbols*
1.	An electric cell	
2.	A battery or a combination of cells	
3.	Plug key or switch (open)	
4.	Plug key or switch (closed)	
5.	A wire joint	
6.	Wires crossing without connection	
7.	Electric bulb	 or 
8.	A resistor or resistance R	
9.	Variable resistor or rheostat	 or 
10.	Ammeter	
11.	Voltmeter	

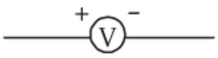
S130.(a) **Ohm's law:** According to Ohm's law, physical conditions like temperature remaining constant, the current passing through a conductor is directly proportional to the potential difference across the conductor *i.e.*,

$$V \propto I \quad \text{or} \quad V = IR.$$

Here, R is known as the resistance of given conductor. It is a property of the conductor which affects the flow of current. For a given conductor value of resistance R is a constant at a given temperature.

(b) Symbols for given electrical components are given below:

(i) Variable resistance  or 

(ii) Voltmeter 

(c) As rating of bulb is 220 V, 100 W, hence $P = VI = \dfrac{V^2}{R}$.

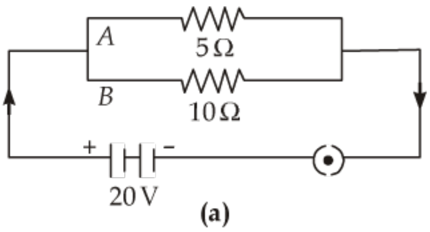
$\therefore$ Resistance of bulb filament $R = \dfrac{V^2}{P} = \dfrac{220 \times 220}{100} = 484\,\Omega$.

When the bulb is operated at a voltage $V' = 110\,\text{V}$, the power consumed is

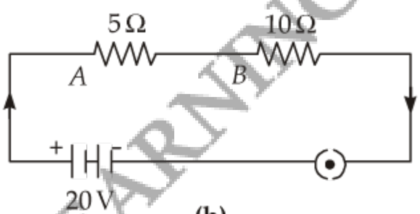
$$P' = \frac{V'^2}{R} = \frac{110 \times 110}{484} = 25\,\text{W}.$$

New power = 25 W.

S131.(a) Parallel combination is shown in figure (a) and series combination in figure (b).



(a)



(b)

(b) In parallel combination the voltage across conductors A and B will be same.

(c) In series arrangement the current through conductors A and B is same.

(d) In parallel arrangement equivalent resistance R_p is given by:

$$\frac{1}{R_p} = \frac{1}{5} + \frac{1}{10} = \frac{2+1}{10} = \frac{3}{10} \quad \Rightarrow \quad R_p = \frac{10}{3} = 3.33\,\Omega$$

In series arrangement equivalent resistance R_s is given by $R_s = 5 + 10 = 15\,\Omega$.

S132.(a) Two resistors, each of 8 Ω, are connected in parallel, hence their effective resistance R1, is given by

$$\frac{1}{R_1} = \frac{1}{8} + \frac{1}{8} = \frac{1}{4} \quad \Rightarrow \quad R_1 = 4\,\Omega.$$

(b) As $R_1 = 4\,\Omega$ is in series with resistance $R_2 = 4\,\Omega$ in the circuit, hence total net resistance of the circuit $R = R_1 + R_2 = 4 + 4 = 8\,\Omega$.

$\therefore$ Current flowing through 4 Ω resistor = Current flowing in the circuit $I = \dfrac{8\,\text{V}}{8\,\Omega} = 1\,\text{A}$.

(c) Potential difference across 4 Ω resistor $V_2 = R_2 I = 4 \times 1 = 4\,\text{V}$.

(d) Power dissipated in 4 Ω resistor $P_2 = V_2 I = 4 \times 1 = 4\,\text{W}$.

(e) Both ammeters A_1 and A_2 will give exactly same reading and there is no difference at all in their readings.

S133. Arrange three resistors R_1, R_2 and R_3 in parallel as shown in figure. Measure potential difference V by using a voltmeter between the points X and Y and measure total current I flowing in the circuit by the help of ammeter A. Then connect ammeter A in branches LM, PQ and ST respectively and measure currents I_1, I_2 and I_3 flowing through resistors R_1, R_2 and R_3 separately. On performing the activity we find that:

$$I = I_1 + I_2 + I_3$$

As per Ohm's law $$I_1 = \frac{V}{R_1}, \quad I_2 = \frac{V}{R_2}, \quad I_3 = \frac{V}{R_3} \quad \text{and} \quad I = \frac{V}{R'}$$

where R is the equivalent resistance of the parallel arrangement.

$\Rightarrow$ $$\frac{V}{R} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3} \quad = \quad \frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

For advantages of parallel grouping of household appliances with the battery are as follows:

(a) Voltages across each electrical device is same and the device can take current as per its resistance.

(b) Separate on/off switches can be applied across each device.

(c) Total resistance in parallel circuit decreases, hence, a greater current may be drawn from the cell.

(d) If one electrical device is damaged, then other devices continue to work properly.

S134. When a current flows through a conducting wire (resistance wire), heat is developed and temperature of wire rises. It is known as the heating effect of electric current.

If V be the potential differece maintained across the ends of a wire then, by definition, the amount of work done for flow of 1 C charge through the wire is V.

$\therefore$ Work done for flow of Q charge

$$W = VQ = VIt \qquad [\because \ Q = It]$$

where I is the current flowing in time t.

As $V = IR$, hence

$$W = VIt = (IR)\, It = I^2 Rt$$

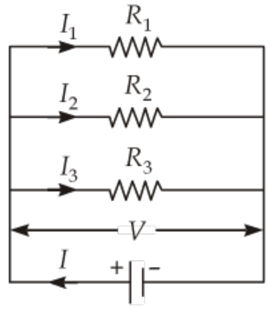
This work done (*i.e.*, electrical energy dissipated) is converted into heat. Hence, the amount of heat produced,

$$Q = I^2Rt \text{ joule}$$

Thus, amount of heat produced depends on the product of the square of the current I flowing through the resistance R and the time t during which the current flows.

Incandescent lamps, electric iron, electric stove, toaster, geyser, electric room heater etc., are the appliances based on heating effect of electric current.

S135. (a) **In parallel combination** of three resistances R_1, R_2 and R_3, the current in each of the resistances is different. If I is the current drawn from the cell then it is divided into branches I_1, I_2 and I_3, Thus,



$$I = I_1 + I_2 + I_3$$

The potential difference across each of these resistances is the same.

Thus, from Ohm's law $\quad I_1 = \frac{V}{R_1}, \quad I_2 = \frac{V}{R_2}, \quad I_3 = \frac{V}{R_3}$

If R is the equivalent resistance then,

$$I = \frac{V}{R}$$

$$\frac{V}{R} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

and $\quad \frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}.$

(b) Let value of each resistor be $R\Omega$. Then for series combination of n such resistors, the equivalent resistance R_s is

$$R_s = R + R + \ldots n \text{ times} = nR \qquad \ldots\text{(i)}$$

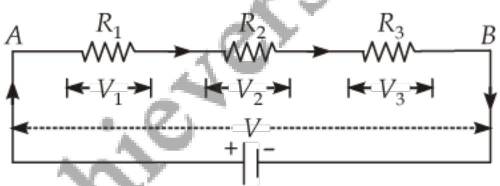
If equivalent resistance for parallel combination of these resistors be R_p, then

$$\frac{1}{R_p} = \frac{1}{R} + \frac{1}{R} + \ldots n \text{ times} = \frac{n}{R}$$

$\Rightarrow \quad R_p = \frac{R}{n} \qquad \ldots\text{(ii)}$

$\therefore \quad \frac{P_s}{P_p} = \frac{nR}{(R/n)} = n^2.$

S136. (a) **In series combination**, the same current flows in all the resistances but the potential difference across each of the resistance is different.



According to Ohm's law, we have

$$V_1 = IR_1, \quad V_2 = IR_2, \quad V_3 = IR_3$$

If the total potential difference between A and B is V, then

$$V = V_1 + V_2 + V_3$$
$$= IR_1 + IR_2 + IR_3$$
$$= I(R_1 + R_2 + R_3)$$

Let the equivalent resistance be R, then

$$V = IR$$

and hence $\quad IR = I(R_1 + R_2 + R_3)$

$\Rightarrow \quad R = R_1 + R_2 + R_3.$

(b) Here, $\quad R_1 = 10\,\Omega, \quad R_2 = 20\,\Omega \quad$ and $\quad R_3 = 30\,\Omega$

$\therefore$ Effective resistance in series $R = R_1 + R_2 + R_3 = 10 + 20 + 30 = 60\,\Omega$

As voltage of battery $\quad V = 6\text{ V}$

$\therefore$ Current flowing in series combination of resistors

$$I = \frac{V}{R} = \frac{6\text{ V}}{60\,\Omega} = 0.1\text{ A}.$$

S137. (a) Electrical resistance of a coductor may be considered as a measure of the opposition offered by it for flow of electric charge through it.

Mathematically, resistance

$$R = \frac{V}{I} = \frac{\text{(Potential difference)}}{\text{(Current)}}.$$

(b) At a given temperature resistance of a conductor depends on its (i) length L, (ii) cross-section area A, and (iii) nature of the material of conductor. It is found that $R \propto L$ and $R \propto \frac{1}{A}$.

Mathematically, $$R = \frac{\rho L}{A}.$$

Where ρ is a constant known as resistivity of the material of conductor. Its value depends only on the nature of material of the conductor and the temperature and is independent of the dimensions (*i.e.*, length and cross-section area) of the conductor.

(c) Here length of wire $L = 1$ m, resistance $R = 104\,\Omega$ and diameter of wire $D = 0.15\text{ mm} = 0.15 \times 10^{-3}$ m

As per relation $$R = \frac{\rho L}{A} = \frac{4\rho L}{\pi D^2},$$ we have

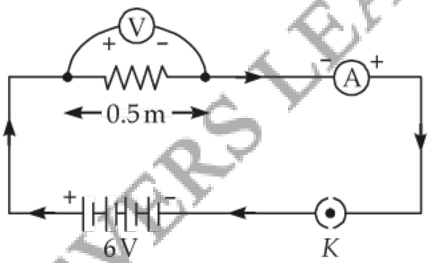
$$\text{Resistivity } \rho = \frac{\pi D^2 R}{4L} = \frac{22 \times (0.15 \times 10^{-3})^2 \times 104}{7 \times 4 \times 1} = 1.84 \times 10^{-6}\,\Omega\text{-m}.$$

S138. (a) An ammeter measures electric current in a circuit. Unit of electric current is 1 ampere. The current is said to be 1 ampere if 1 coulomb of charge flows through a cross-section of conductor per second.

(b) (i) Symbol  means a variable resistor or rheostat.

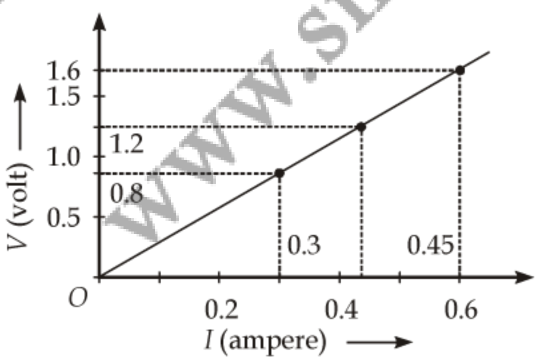
(ii) Symbol  means a plug key or switch which is closed one.

(c) (i) The diagram of the electric circuit is shown below:



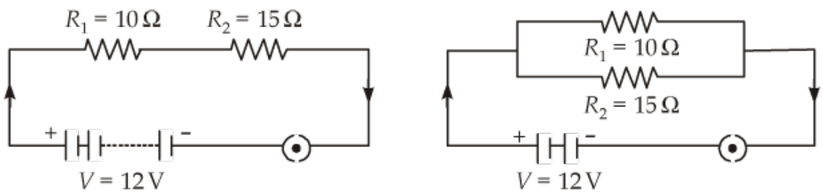
(ii) From graph we find that current values corresponding to potential difference of 0.8 V, 1.2 V and 1.6 V respectively are 0.3 A, 0.45 A and 0.6 A.

$\therefore$ $\frac{V}{I}$ ratios are $\frac{0.8\text{ V}}{0.3\text{ A}} = 2.67\,\Omega$, $\frac{1.2\text{ V}}{0.45\text{ A}} = 2.67\,\Omega$ and $\frac{1.6\text{ V}}{0.6\text{ A}} = 2.67\,\Omega$.



From these values we conclude that ratio $\frac{V}{I}$ is a constant *i.e.*, $V \propto I$. It means that Ohm's law is being strictly followed.

S139. (a) To obtain minimum electric current the resistors should be connected in series as shown in diagram (a). To obtain maximum electric current the resistors should be connected in parallel as shown in diagram (b).



(a) (b)

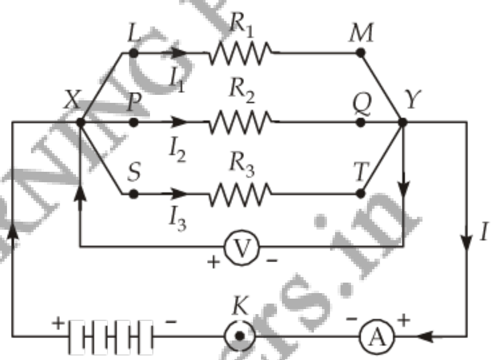
(b) In series arrangement $R_s = R_1 + R_2 = 10 + 15 = 25\,\Omega$

$\therefore$ Circuit current $I_{min} = \dfrac{V}{R_s} = \dfrac{12}{25} = 0.48$ A

In parallel arrangement $\dfrac{1}{R_p} = \dfrac{1}{R_1} + \dfrac{1}{R_2} = \dfrac{1}{10} + \dfrac{1}{15} + \dfrac{3+2}{30} = \dfrac{5}{30} = \dfrac{1}{6} \Rightarrow R_p = 6\,\Omega$

$\therefore$ Circuit current $I_{max} = \dfrac{V}{R_p} = \dfrac{12\ V}{6\,\Omega} = 2$ A.

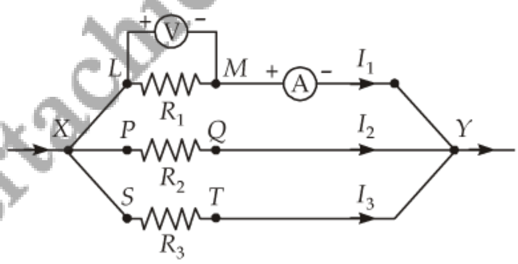
S140. Parallel combination of resistors: We take three resistors R_1, R_2 and R_3 and join them in parallel between the points X and Y. Complete the electric circuit by joining a battery of 6-12 V capacity, and ammeter A, voltmeter V and a plug key K as shown in figure.



(a) Plug the key and note the ammeter reading I and voltmeter reading V. So, potential difference across the paralel combination of resistances is V volt.

(b) Take out the plug from the key. Remove the ammeter and voltmeter from the circuit. Insert the ammeter A in series with the resistor R_1 and voltmeter in parallel with the resistor R_1 (*i.e.*, across the points L and M as shown in figure). Plug the key and note readings of voltmeter and ammeter. Voltmeter reading is even now V but ammeter reading is I_1, where $I_1 < I$.

(c) Similarly measure the currents through R_2 and R_3. Let these be I_2 and I_3 respectively. Also measure potential differences across points PQ and ST. Potential differences are found to be V each time.

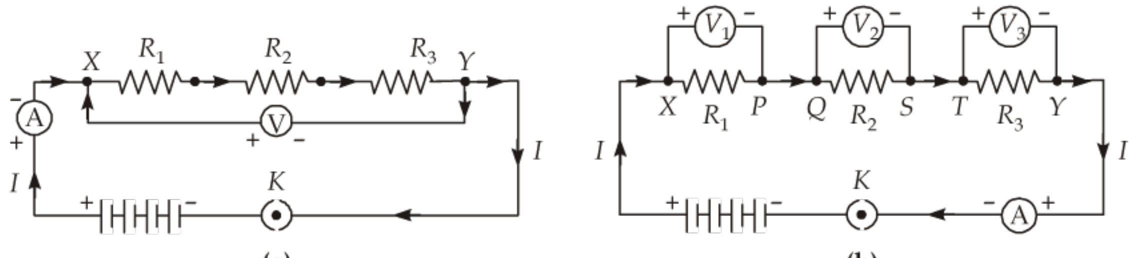


(d) As voltmeter reading across R_1, R_2 and R_3 is same as across the parallel combination, we conclude that in parallel combination of resistors, the total potential difference is equal to the potential difference across any one resistor.

(e) Experimentally, we find that $I = I_1 + I_2 + I_3$. It proves that in parallel arrangement of resistors the total current is equal to the sum of the currents flowing through individual resistors.

S141. Series combination of resistors: We take three resistors R_1, R_2 and R_3 and join them in series between the points X and Y in an electric circuit as shown in following figure (a). The circuit contains a battery of 6-12 V capacity, an ammeter and a plug key.

(a) Plug the key and note the ammeter reading. Then change the position of ammeter to anywhere in between the resistors and again note the ammeter reading. We find that ammeter reading remains unchanged. It shows that in series arrangement same current flows through each resistor.



(a) (b)

(b) Insert a voltmeter across the ends X and Y of the series combination of three resistors. Plug the key so as to complete the circuit and note the voltmeter reading. It gives the potential difference V across the series combination of resistors.

The out plug from key K and disconnect the voltmeter. Now insert the voltmeter across the ends X and P of first resistor R_1 as shown in figure (b). Plug the key and note the voltmeter reading. Let the potential difference across R_1, as given by voltmeter reading, be V_1. Similarly, measure the potential difference across the other two resistors R_2 and R_3 separately. Let these potential differences be V_2 and V_3, respectively. Experimentally we find that

$$V = V_1 + V_2 + V_3$$

It shows that in series arrangement of resistors total potential difference is equal to the sum of potential differences across individual resistors.