Electricity

**1. (A)** Show how you would connect three resistors each of resistance 6 N, so that the combination has a resistance of 9 2. Also justify your answer. (2024)

OR

(B) In the given circuit calculate the power consumed in watts in the resistor of 2Ω :
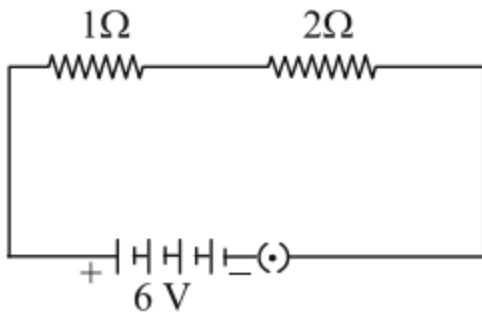
Answer. (A) When two 6 Ω resistances are connected in parallel and the third resistance of 6Ω is connected in series combinations to this, then equivalent resistance will be 9 Ω /
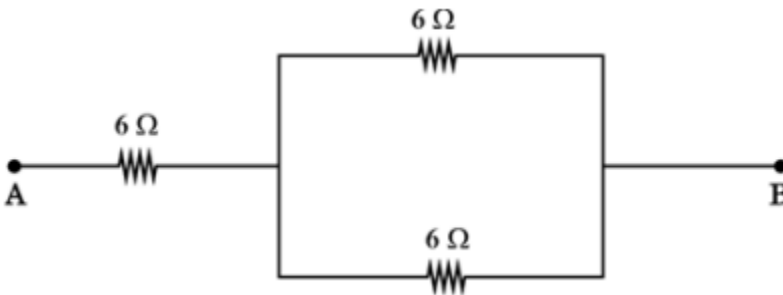
[Award marks for writing the statement or drawing the diagram]

$$\frac{1}{R_P} = \frac{1}{6\,\Omega} + \frac{1}{6\,\Omega}$$

$$\therefore\ R_P = 3\,\Omega$$
$$R_S = 6 + 3 = 9\Omega$$

OR

(B) Equivalent resistance $= R_1 + R_2 = 1\,\Omega + 2\,\Omega = 3\ \Diamond$

$$I = \frac{\overset{7}{V}}{R}$$
$$= \frac{6\,V}{1\,\Omega + 2\,\Omega} = \frac{6\,V}{3\,\Omega} = 2\,A$$

Electric power, $P = I^2 R$

$$= (2A)^2 \times 2\,\Omega = 4 \times 2\ W = 8\ W$$

11.1 Electric Current and Circuit

MCQ

The expressions that relate (i) Q, I and t and (ii) Q, V and W respectively are (Here the symbols have their usual meanings)

(a) (i) $I = \dfrac{Q}{t}$ (ii) $W = \dfrac{V}{Q}$

(b) (i) $Q = I \times t$ (ii) $W = V \times Q$

(c) (i) $Q = \dfrac{I}{t}$ (ii) $V = \dfrac{W}{Q}$

(d) (i) $I = \dfrac{Q}{t}$ (ii) $Q = \dfrac{V}{W}$ (2023

LA (5 marks)

2. Define electric current. (1/5, Board Term I, 2017)
3. Define one ampere. (1/5, Board Term 1, 2015)

11.3 Circuit Diagram

LA (5 marks)

4. Draw the symbols of commonly used components in electric circuit diagrams for
(i) An electric cell
(ii) Open plug key
(iii) Wires crossing without connection
(iv) Variable resistor
(v) Battery
(vi) Electric bulb
(vii) Resistance (4/5, Board Term I, 2017)

11.4 Ohm's Law

MCQ

5. A student plots V-I graphs for three samples of nichrome wire with resistances R_1, R_2 and R_3. Choose from the following the statements that holds true for this graph.
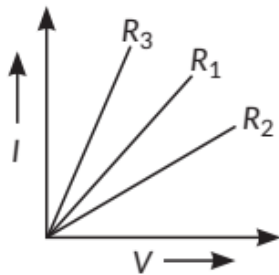
(a) $R_1 = R_2 = R_3$
(c) $R_3 > R_2 > R_1$
(b) $R_1 > R_2 > R_3$
(d) $R_2 > R_1 > R_3$ (2020, AI 2019)

### VSA (1 mark)

6. State Ohm's law. (AI 2019)

SA II (3 marks)

7. (a) State Ohm's Law. Represent it mathematically.
(b) Define 1 ohm.
(c) What is the resistance of a conductor through which a current of 0.5 A flows when a potential difference of 2 V is applied across its ends? (Term II, 2021-22)

8. A V-I graph for a nichrome wire is given below. What do you infer from this graph? Draw a labelled circuit diagram to obtain such a graph.
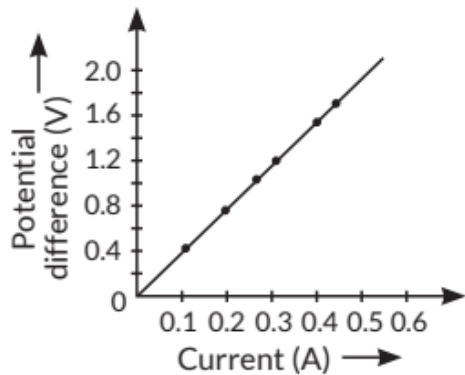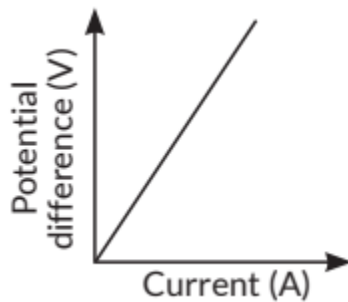

(2020)

9. Study the V-I graph for a resistor as shown in the figure and prepare a table showing the values of (in amperes) corresponding to four different values V (in volts). Find the value of current for $V = 10$ volts. How can we determine the resistance of the resistor from this graph? (Board Term I, 2016)
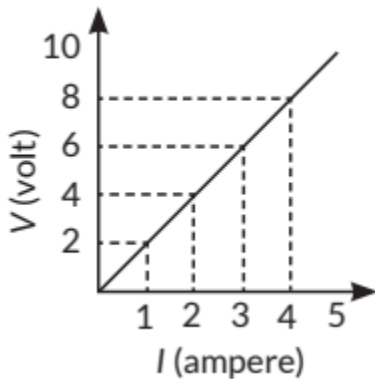
10. V-I graph for a conductor is as shown in the figure

(i) What do you infer from this graph?
(ii) State the law expressed here. (Board Term 1, 2014)

LA (5 marks)

11. State Ohm's law. Draw a labelled circuit diagram to verify this law in the laboratory. If you draw a graph between the potential difference and current flowing through a metallic conductor, what kind of curve will you get? Explain how would you use this graph to determine the resistance of the conductor. (Board Term I, 2016)

12. State and explain Ohm's law. Define resistance and give its SI unit. What is meant by 1 ohm resistance? Draw V-I graph for an ohmic conductor and list its two important features. (Board Term 1, 2014)

11.5 Factors on which the Resistance of a Conductor Depends

MCQ

For question No. 13 and 14, two statements are given- one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.
(a) Both (A) and (R) are true and (R) is the correct explanation of the assertion (A).
(b) Both (A) and (R) are true, but (R) is not the correct explanation of the assertion (A).
(c) (A) is true, but (R) is false.
(d) (A) is false, but (R) is true.

13. Assertion (A): The metals and alloys are good conductors of electricity.
Reason (R): Bronze is an alloy of copper and tin and it is not a good conductor of electricity. (2020) R

14. Assertion (A): Alloys are commonly used in electrical heating devices like electric iron and heater.
Reason (R): Resistivity of an alloy is generally higher than that of its constituent metals but the alloys have low melting points then their constituent metals. (2020)

15. A cylindrical conductor of length 'l' and uniform area of cross section 'A' has resistance 'R' The area of cross section of another conductor of same material and same resistance but of length '21' is

(a) $\frac{A}{2}$ (b) $\frac{3A}{2}$

(c) 2A   (d) 3A   (2020)

VSA (1 mark)

16. How is the resistivity of alloys compared with those of pure metals from which they may have been formed? (Board Term 1, 2017)

SAI (2 marks)

17. (i) List three factors on which the resistance of a conductor depends.
(ii) Write the SI unit of resistivity. (Board Term 1, 2015)

SA II (3 marks)

18. (i) In the following figure, three cylindrical conductors A, B and C are shown along with their lengths and areas of cross-section. If these three conductors are made of the same material and RA, RB and RC be their respective resistances, then find (I) R_A/ R_B, and (II) R_A/ R_C.

(ii) If the conductor A is made of copper and the conductor C is made of constantan (alloy of copper and nickel), then which one of the two will have more electrical resistance and why? (Term II, 2021-22 C)

19. (a) List the factors on which the resistance of a uniform cylindrical conductor of a given material depends.
(b) The resistance of a wire of 0.01 cm radius is 10Ω If the resistivity of the wire is $50 \times 10^{-8} \Omega$ m, find the length of this wire. (Term II, 2021-22)

20. (a) List the factors on which the resistance of a conductor in the shape of a wire depends.
(b) Why are metals good conductors of electricity whereas glass is a bad conductor of electricity? Give reason.
(c) Why are alloys commonly used in electrical heating devices? Give reason. (2018)

21. Calculate the resistivity of the material of a wire of length 1 m, radius 0.01 cm and resistance 20 ohms. (Board Term 1, 2017)

22. A copper wire has diameter 0.5 mm and resistivity $1.6 \times 10^{-8} \Omega$ m. Calculate the length of this wire to make it resistance 100 Ω. How much does

the resistance change if the diameter is doubled without changing its length?
(Board Term I, 2015)

23. The resistance of a wire of 0.01 cm radius is 10 Q. If the resistivity of the material of the wire is 50×10^{-8} ohm meter, find the length of the wire.
(Board Term I, 2014)

LA (5 marks)

24. If the radius of a current carrying conductor is halved, how does current through it change? (2/5 Board Term I, 2014)

25. Define resistance of a conductor. State the factors on which resistance of a conductor depends. Name the device which is often used to change the resistance without changing the voltage source in an electric circuit. Calculate the resistance of 50 cm length of wire of cross sectional area 0.01 square mm and of resistivity 5×10^{-8} m.
(Board Term I, 2014) (Cr)

11.6 Resistance of a System of Resistors

MCQ

26. Two LED bulbs of 12 W and 6 W are connected in series. If the current through 12 W bulb is 0.06 A the current through 6 W bulb will be
(a) 0.04 A
(b) 0.06 A
(c) 0.08 A
(d) 0.12 A (2023)

27. If a person has five resistors each of value $\frac{1}{5}\ \Omega$, then the maximum resistance he can obtain by connecting them is
(a) 1 Ω
(c) 10 Ω
(b) 5 Ω
(d) 25 Ω (2020)

28. The maximum resistance which can be made using four resistors each of 2 Ω is
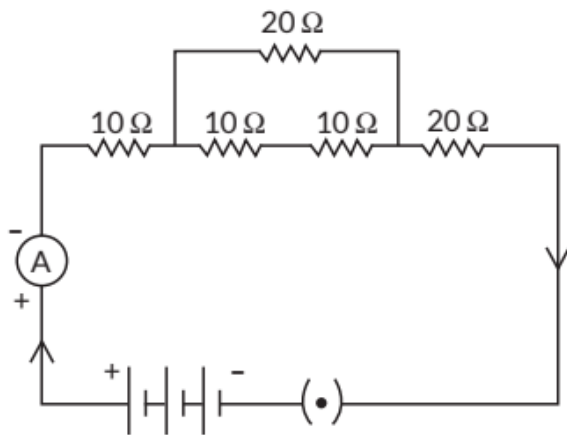(a) 2 Ω

(b) 4 Ω
(c) 8 Ω
(d) 16 Ω (2020)

29. The maximum resistance which can be made using

four resistors each of resistance $\frac{1}{2}$ Ω is

(a) 2 Ω
(b) 1 Ω
(c) 2.5 Ω
(d) 8 Ω (2020)

SAI (2 marks)

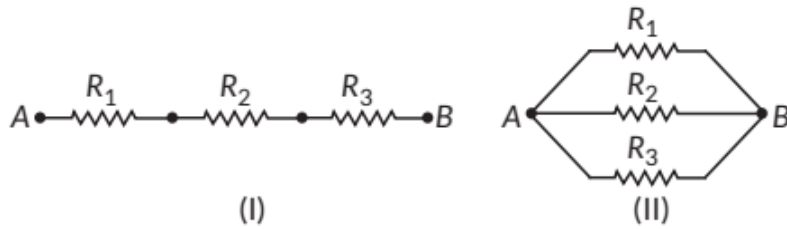30. Calculate the equivalent resistance of the following electric circuit:
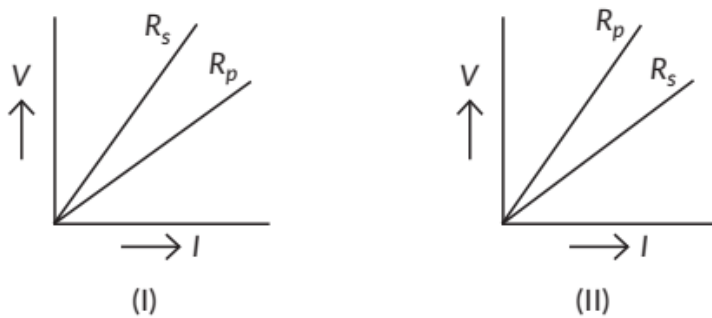

(Term II, 2021-22)

31. Three resistors of 10 Ω , 15 Ω and 5 Ω are connected in parallel. Find their equivalent resistance. (Board Term 1, 2014)

SA II (3 marks)

32. (i) Write the formula for determining the equivalent resistance between A and B of the two combinations (1) and (II) of three resistors R_1, R_2 and R_3 arranged as follows:

(I)   (II)

(ii) If the equivalent resistance of the arrangements (I) and (II) are R_s and R_P respectively, then which one of the following V-I graphs is correctly labelled? Justify your answer.

(I)   (II)

(Term II, 2021-22 C) Ⓤ

33. In the circuit given below, the resistors R_1, R_2 and R_3 have the values 10 9, 20 Ω and 30 Ω respectively, which have been connected to a battery of 12 V. Calculate

(a) the current through each resistor,
(b) the total circuit resistance, and
(c) the total current in the circuit.
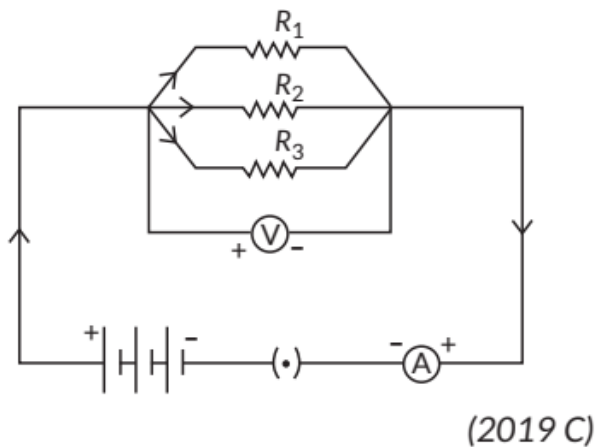
(2019 C)

(2019 C)

34. Show how would you join three resistors, each of resistance 9Ω so that the equivalent resistance of the combination is (i) 13.5 Ω, (ii) 6Ω ? (2018)

35. Three resistors of 3Ω each are connected to a battery of 3 V as shown. Calculate the current drawn from the battery.
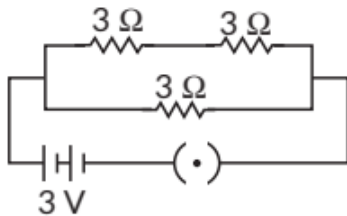

(Board Term I, 2017)

LA (4/5 marks)

36. (i) How is electric current related to the potential difference across the terminals of a conductor? Draw the labelled circuit diagram to verify this relationship.
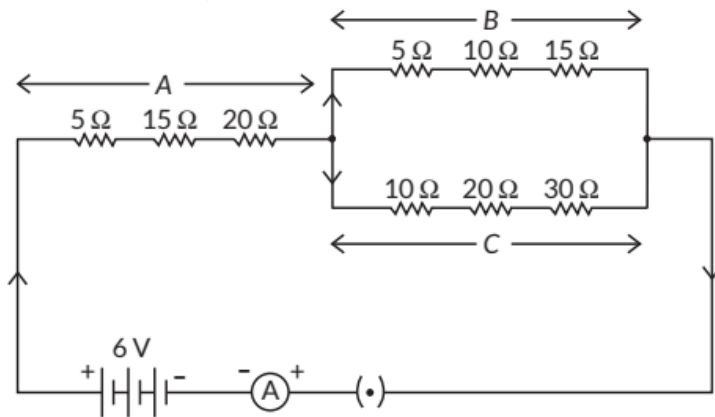(ii) Why should an ammeter have low resistance?
(iii) Two V-I graphs A and B for series and parallel combinations of two resistors are as shown. Giving reason state which graph shows (a) series, (b) parallel combination of the resistors.
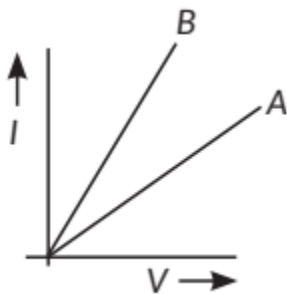
(2023,

37. Study the following electric circuit in which the resistors are arranged in three arms A, B and C :

(a) Find the equivalent resistance of arm A.
(b) Calculate the equivalent resistance of the parallel combination of the arms B and C.
(c) (i) Determine the current that flows through the ammeter.

OR

(ii) Determine the current that flows in the ammeter when the arm B is withdrawn from the circuit. (Term II, 2021-22)

38. (a) List two disadvantages of using a series circuit in homes.
(b) Calculate the effective resistance between A and B in the circuit given below:
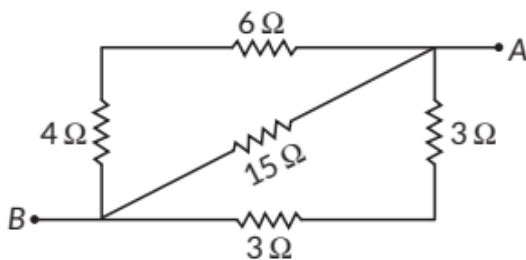
(2020 C)

39. (a) A 6Ω resistance wire is doubled on itself. Calculate the new resistance of the wire.
(b) Three 2Ω resistors A, B and C are connected in such a way that the total resistance of the combination is 3 Ω. Show the arrangement of the three resistors and justify your answer. (2020)

40. Draw a schematic diagram of a circuit consisting of a battery of 3 cells of 2 V each, a combination of three resistors of 10 9, 20Ω and 30Ω connected in parallel, a plug key and an ammeter, all connected in series. Use this circuit to find the value of the following:
(a) Current through each resistor
(b) Total current in the circuit
(c) Total effective resistance of the circuit. (2020)

41. (a) With the help of a suitable circuit diagram prove that the reciprocal of the equivalent resistance of a group of resistances joined in parallel is equal to the sum of the reciprocals of the individual resistances.

(b) In an electric circuit two resistors of 12Ω each are joined in parallel to a 6 V battery. Find the current drawn from the battery. (Delhi 2019)

42. For the series combination of three resistors establish the relation $R = R_1 + R_2 + R3$ where the symbols have their usual meanings. Calculate the equivalent resistance of the combination of three resistors of 6 9, 9Ω and 18 Ω joined in parallel. (Board Term 1, 2016)

43. State ohm's law. Represent it graphically. In the given circuit diagram calculate
(i) the total effective resistance of the circuit.
(ii) the current through each resistor.
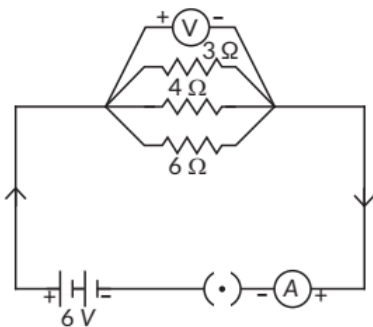
(Board Term I. 2015)

44. (a) Prove that the equivalent resistance of three resistors R_1, R_2 and R_3 in series is $R_1 + R_2 + R_3$.
(b) You have four resistors of 8 Ω each. Show how would you connect these resistors to have effective resistance of 8 Ω? (4/5, Board Term I, 2015)

45. Draw a labelled circuit diagram showing three resistors R_1, R_2 and R_3 connected in series with a battery (E), a rheostat (Rh), a plug key (K) and an ammeter (A) using standard circuit symbols. Use this circuit to show that the same current flows through every part of the circuit. List two precautions you would observe while performing the experiment. (Board Term 1, 2014)

46. Two wires A and B are of equal length and have equal resistances. If the resistivity of A is more than that of B, which wire is thicker and why? For the electric circuit given below calculate:
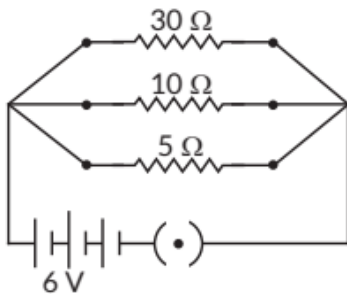
(i) current in each resistor,
(ii) total current drawn from the battery, and
(iii) equivalent resistance of the circuit. (Board Term 1, 2014)

11.7 Heating Effect of Electric Current

MCQ

47. The resistance of a resistor is reduced to half of its initial value. If other parameters of the electrical circuit remain unaltered, the amount of heat produced in the resistor will become
(a) four times
(b) two times
(c) half
(d) one fourth (2023)

48. The resistance of a resistor is reduced to half of its initial value. In doing so, if other parameters of the circuit remain unchanged, the heating effects in the resistor will become
(a) two times
(b) half
(c) one-fourth
(d) four times (2020)

SA II (3 marks)

49. (i) State Joule's law of heating. Express it mathematically when an appliance of resistance R is connected to a source of voltage V and the current flows through the appliance for a time t.
(ii) A 5 Ω resistor is connected across a battery of 6 volts. Calculate the energy that dissipates as heat in 10 s. (Term II, 2021-22)

50. (a) Calculate the resistance of a metal wire of length 2 m and area of cross-section 1.55 x 10^{-6} m^2. (Resistivity of the metal is 2.8×10^{-8} Ω)
(b) Why are alloys pr eferred over pure metals to make the heating elements of electrical heating devices? (Term II, 2021-22) Ev

51. (a) Write the mathematical expression for Joule's law of heating.
(b) Compute the heat generated while transferring 96000 coulomb of charge in two hours through a potential difference of 40 V. (2020)

52. Write Joule's law of heating. (1/3, 2018)

53. Explain the use of an electric fuse. What type of material is used for fuse wire and why? (Board Term 1, 2016)

54. (a) Why is tungsten used for making bulb filaments of incandescent lamps?
(b) Name any two electric devices based on heating effect of electric current. (2/5, Board Term I, 2015)

LA (5 marks)

55. (i) Draw a labelled circuit diagram of the circuit used to show the variation of potential difference across the ends of a resistor with current flowing through it. If you use this circuit, what relation would you find between the voltmeter reading, V and the ammeter reading, /?
(ii) A wire of given material having length 'I' and area of cross-section 'A' has a resistance of 4 Ω. Find the resistance of another wire of the same material having length 1/2 and area of cross- section 2A. (2021 C)

56. A fuse wire melts at 5 A. If it is desired that the fuse wire of same material melt at 10 A, then whether the new fuse wire should be of smaller or larger radius than the earlier one? Give reasons for your answer. (3/5, Board Term 1, 2014)

11.8 Electric Power

MCQ

57. An electric kettle consumes 1 kW of electric power when operated at 220 V. The minimum rating of the fuse wire to be used for it is
(a) 1A
(b) 2 A
(c) 4A
(d) 5 A (2023)

58. Two bulbs of 100 W and 40 W are connected in series. The current through the 100 W bulb is 1 A. The current through the 40 W bulb will be
(a) 0.4 A
(b) 0.6 A
(c) 0.8 A
(d) 1A (2020)

VSA (1 mark)

59. Write the relation between resistance (R) of filament of a bulb, its power (P) and a constant voltage V applied across it. (Board Term 1, 2017)

60. Power of a lamp is 60 W. Find the energy in joules consumed by it in 1s. (Board Term 1, 2016)

SAI (2 marks)

61. An electric heater rated 1100 W operates at 220 V. Calculate (i) its resistance, and (ii) the current drawn by it. (Term II, 2021-22)

SA II (3 marks)

62. (a) What is the meaning of electric power of an electrical device? Write its SI unit.
(b) An electric kettle of 2 kW is used for 2 h. Calculate the energy consumed in
(i) kilowatt hour and
(ii) joules (Term II, 2021-22)

63. (i) Define electric power and write its Sl unit.
(ii) Two bulbs rated 100 W; 220 V and 60 W; 220 V are connected in parallel

to an electric mains of 220 V. Find the current drawn by the bulbs from the mains. (Term II, 2021-22)

64. Define the term electric power. An electric device of resistance R when connected across an electric source of voltage V draws a current I. Derive an expression for the power in terms of resistance R and voltage V. What is the power of a device of resistance 400 Ω operating at 200 V? (Term II, 2021-22 C)

65. Two lamps, one rated 100 W at 220 V and the other 60 W at 220 V, are connected in parallel to electric mains supply of 220 V. Draw a circuit diagram to show this arrangement and calculate the current drawn by the two lamps from the mains. (2021 C)

66. Two lamps, one rated 100 W; 220 V, and the other 60 W; 220 V, are connected in parallel to electric mains supply. Find the current drawn by two bulbs from the line, if the supply voltage is 220 V. (2/3, 2018, Board Term I, 2014)

67. How much current will an electric iron draw from a 220 V source if the resistance of its element when hot is 55 ohms? Calculate the wattage of the electric iron when it operates on 220 volts. (Board Term 1, 2016)

68. An electric iron has a rating of 750 W; 200 V. Calculate:
(i) the current required.
(ii) the resistance of its heating element.
(iii) energy consumed by the iron in 2 hours. (Board Term I, 2015)

69. An electric bulb is connected to a 220 V generator. The current is 2.5 A. Calculate the power of the bulb. (1/3, Board Term I, 2015)

LA (5 marks)

70. (a) Define electric power and state its SI unit. The commercial unit of electrical energy is known as 'unit'. Write the relation between this 'unit' and joule.
(b) In a house, 2 bulbs of 50 W each are used for 6 hours daily and an electric geyser of 1 kW is used for 1 hour daily. Calculate the total energy consumed in a month of 30 days and its cost at the rate of Rs. 8.00 per kWh.

71. (a) Define power and state its SI unit. (2023)
(b) A torch bulb is rated 5V and 500 mA. Calculate its

(i) power

(ii) resistance

(iii) energy consumed when it is lighted for

$2\frac{1}{2}$ hours. (2020)

72. Two identical resistors, each of resistance 15Ω, are connected in (i) series, and (ii) parallel, in turn to a battery of 6 V. Calculate the ratio of the power consumed in the combination of resistors in each case. (2020)

73. (a) An electric bulb is rated at 200 V; 100 W. What is its resistance?
(b) Calculate the energy consumed by 3 such bulbs if they glow continuously for 10 hours for complete month of November.
(c) Calculate the total cost if the rate is ₹ 6.50 per unit (2020)

74. (a) What is meant by the statement, "The resistance of a conductor is one ohm"?
(b) Define electric power. Write an expression relating electric power, potential difference and resistance.
(c) How many 132 Ω resistors in parallel are required to carry 5 A on a 220 V line? (2020)

75. An electric lamp of resistance 20 Ω and a conductor of resistance 4 Ω are connected to a 6 V battery as shown in the circuit. Calculate.
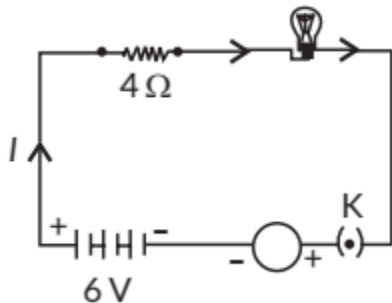
(a) the total resistance of the circuit
(b) the current through the circuit,
(c) the potential difference across the (i) electric lamp and (ii) conductor, and
(d) power of the lamp. (Delhi 2019)

76. Compare the power used in 2 Ω resistor in each of the following circuits.

(AI 2019)
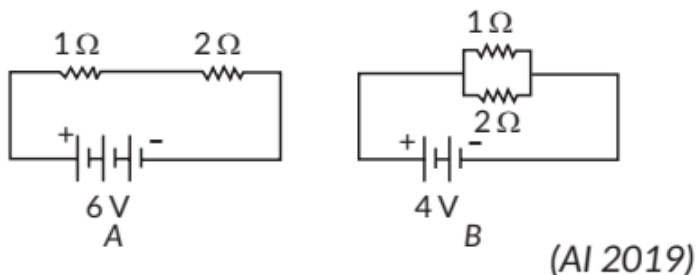
77. A bulb is rated 40 W; 220 V. Find the current drawn by it, when it is connected to a 220 V supply. Also find its resistance. If the given bulb is replaced by a bulb of rating 25 W; 220 V, will there be any change in the value of current and resistance? Justify your answer and determine the change. (AI 2019)

CBSE Sample Questions

11.2 Electric Potential and Potential Difference

VSA (1 mark)

1. Some work is done to move a charge Q from infinity to a point A in space. The potential of the point A is given as V. What is the work done to move this charge from infinity in terms of Q and V? (2020-21)
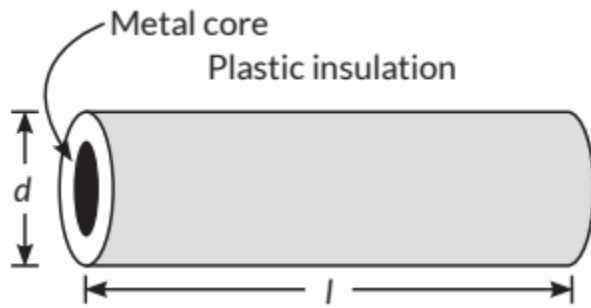
11.5 Factors on which the Resistance of a Conductor Depends

MCQ

2. A complete circuit is left on for several minutes, causing the connecting copper wire to become hot. As the temperature of the wire increases, the electrical resistance of the wire
(a) decreases
(b) remains the same
(c) increases
(d) increases for some time and then decreases. (2022-23)

3.

Plastic insulation surrounds a wire having diameter d and length I as shown above. A decrease in the resistance of the wire would be produced by an increase in the

(a) length of the wire
(b) diameter d of the wire
(c) temperature of the wire
(d) thickness of the plastic insulation (2022-23)

11.6 Resistance of a System of Resistors

VSA (1 mark)

Two unequal resistances are connected in parallel. If you are not provided with any other parameters (e.g., numerical values of I and R), what can be said about the voltage drop across the two resistors? (2020-21)
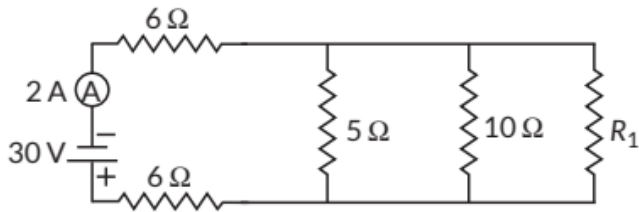
SAI (2 marks)

5. A student has two resistors 2 Ω and 3 Ω. She has to put one of them in place of R_2 as shown in the circuit. The current that she needs in the entire circuit is exactly 9A. Show by calculation which of the two resistors she should choose.
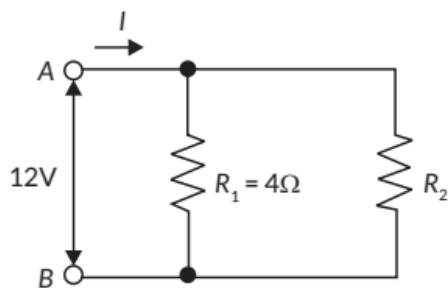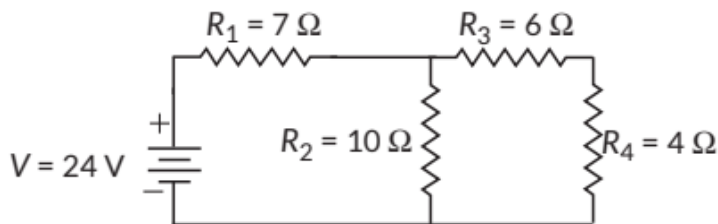

(2020-21)

SA II (3 marks)

6.

In the above circuit, if the current reading in the ammeter A is 2 A, what would be the value of R_1? (Term II, 2021-22)

7.

Calculate the total resistance of the circuit and find the total current in the circuit. (Term II, 2021-22)

11.8 Electric Power

SA II (3 marks)

8. (a) It would cost a man ₹ 3.50 to buy 1.0 kW h of electrical energy from the main electricity board. His generator has a maximum power of 2.0 kW. The generator produces energy at this maximum power for 3 hours. Calculate how much it would cost to buy the same amount of energy from the main electricity board.
(b) A student boils water in an electric kettle for 20 minutes. Using the same mains supply he wants to reduce the boiling time of water. To do so should he increase or decrease the length of the heating element? Justify your answer. (Term II, 2021-22)

LA (5 marks)

9. In the given circuit, A, B, C and D are four lamps connected with a battery of 60 V.
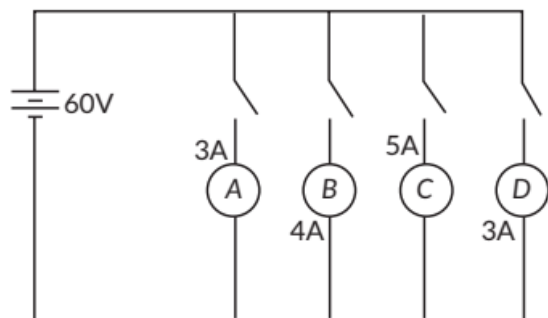
Analyse the circuit to answer the following questions.
(i) What kind of combination are the lamps arranged in (series or parallel)?
(ii) Explain with reference to your above answer, what are the advantages (any two) of this combination of lamps.
(iii) Explain with proper calculations which lamp glows the brightest.
(iv) Find out the total resistance of the circuit. (2020-21)

SOLUTIONS

Previous Years' CBSE Board Questions

1.

(b): As, $I = \dfrac{Q}{t}$, $V = \dfrac{W}{Q}$ or $Q = It$, $W = VQ$

2. Electric current is the amount of charge flowing through a particular area in unit time.

3. One ampere is constituted by the flow of one coulomb of charge per second.
$1A = 1Cs^{-1}$

4.

S. No.	Component	Symbol
(i)	An electric cell	—╎⊢
(ii)	Open plug key	—( )—
(iii)	Wires crossing without connection	
(iv)	Variable resistor	or
(v)	Battery	+╎⊦╎⊢
(vi)	Electric bulb	
(vii)	Resistance	—⋀⋀⋀—

5. (d): The inverse of the slope of I-V graph gives the resistance of the material. Here the slope of R_3 is highest. Thus, R_2 R_1 R_3.

6. It states that the potential difference V, across the ends of a given metallic wire in an electric circuit is directly proportional to the current flowing through it, provided its temperature remains the same. Mathematically, V∞ I V = RI where R is resistance of the conductor.

7. (a) Ohm's law states that the electric current flowing through a conductor is directly proportional to the potential difference applied across its ends, provided physical conditions like temperature etc., are kept unchanged.

Mathematically, $V \propto I$

or $\dfrac{V}{I} = $ constant or $\dfrac{V}{I} = R \Rightarrow V = IR$

where, R is called the resistance of the conductor. Sl unit of resistance is ohm and is denoted by 2. It is a constant of proportionality and its value depends upon the size, nature of material and temperature.
(b) If the potential difference across the two ends of a conductor is 1 V and the current through it is 1 A, then the resistance R, of the conductor is said to be 1 Ω.

(c) Given, potential difference $V = 2$ V
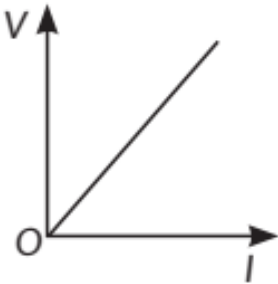Current, $= 0.5$ A
Using Ohm's law, $V = IR$

$$\Rightarrow \quad R = \frac{V}{I} \quad \Rightarrow \quad R = \frac{2\,V}{0.5\,A} = 4\,\Omega$$

The shape of the grapn obtained by plotting potential difference applied across conductor against the current flowing through it will be a straight line. According to ohm's law,
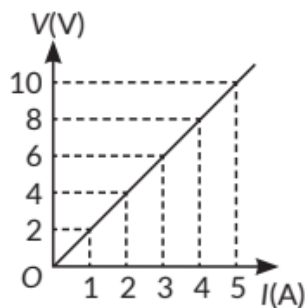

So, the slope of V-I graph at any point represents the resistance of the given conductor. As graph is a straight line, so it is clear from the graph that V I.
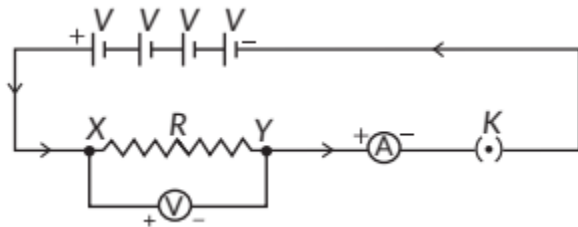
9. Since, the graph is a straight line so we can either extrapolate the data or simply mark the value from graph as shown in figure.

Current, I(A)	Voltage, V(V)
0	0
1	2
2	4
3	6
4	8

Hence, the value of current for V = 10 volts is 5 amperes (or 5 A). From Ohm's law, V = IR,

We can write, $R = \dfrac{V}{I}$

At any point on the graph, resistance is the ratio of values of V and I. Since, the given graph is straight line (ohmic conductor) so, the slope of graph will also give the resistance of the resistor

$R = \dfrac{10\,V}{5\,A} = 2\,\Omega$

10. (i) The shape of the graph obtained by plotting potential difference applied across conductor against the current flowing through it will be a straight line. According to ohm's law,

$V = IR$ or $R = \dfrac{V}{I}$

So, the slope of V-I graph at any point represents the resistance of the given conductor. As graph is a straight line, so it is clear from the graph that V ∞ I.
(ii) The law expressed here is ohms law. It states that the potential difference V, across the ends of a given metallic wire in an electric circuit is directly proportional to the current flowing through it, provided its temperature remains the same. Mathematically,
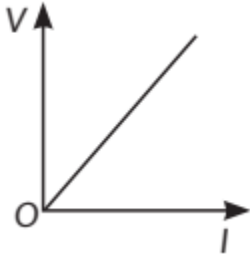
$V \propto I$
$V = RI$

where R is resistance of the conductor.

11. It states that the potential difference V, across the ends of a given metallic wire in an electric circuit is directly proportional to the current flowing through it, provided its temperature remains the same. Mathematically,
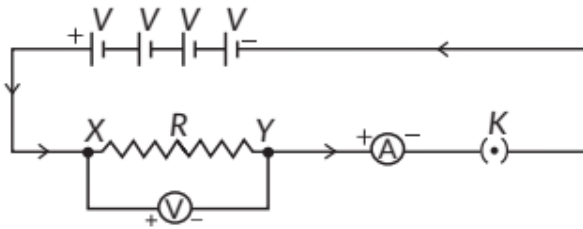
$V \propto I$
$V = RI$

where R is resistance of the conductor. The shape of the graph obtained by plotting potential difference applied across conductor against the current flowing through it will be a straight line. According to ohm's law,

$$V = IR \text{ or } R = \frac{V}{I}$$

So, the slope of V-I graph at any point represents the resistance of the given conductor. As graph is a straight line, so it is clear from the graph that

$V \propto I$.

12. Ohm's law: It states that the potential difference V, across the ends of a given metallic wire in an electric circuit is directly proportional to the current flowing through it, provided its temperature remains the same. Mathematically,
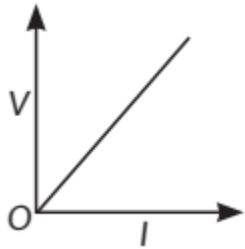
$V \propto I$

$V = RI$

where R is resistance of the conductor. Resistance: It is the property of a conductor to resist the flow of charges through it. Its SI unit is ohm (Ω). If the potential difference across the two ends of a conductor is 1 V and the current through it is 1 A, then the resistance R, of the conductor is 1 ohm (1Ω).

$$1\,ohm = \frac{1\,volt}{1\,ampere}$$

V-I graph for an ohmic conductor can be drawn as given in figure. Important feature of V-I graph are:
(i) It is a straight line passing through origin.
(ii) Slope of V-I graph gives the value of resistance of

conductor slope = $R = \dfrac{V}{I}$

13. (c) Metals and Alloys are good conductors of electricity. Bronze is an alloy of copper and tin which are metals and thus is a good conductor of electricity.

14. (c) Alloy These are mixture of metal with other elements in nature.

15. (c) The resistance of a conductor of length I, and area of cross section, A is

where p is the resistivity of the material. Now for the conductor of length 21, cross-section A' and resistivity p. area of

$$R' = \rho\frac{l'}{A'} = \rho\frac{2l}{A'}$$

But given, $R = R' \Rightarrow \rho\dfrac{l}{A} = \rho\dfrac{2l}{A'}$ or $A' = 2A$

16. The resistivity of an alloy is generally higher than that of its constituent metals.

17. (i) Resistance of a conductor depends upon the following factors:
(1) Length of the conductor: Greater the length (1) of the conductor more will be the resistance (R).
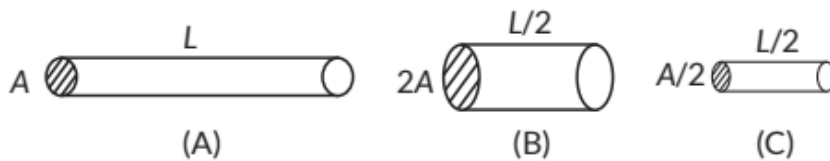$R \propto l$

(2) Area of cross-section of the conductor: Greater the cross-sectional area of the conductor, less will be the resistance.

$$R \propto \frac{1}{A}$$

(3) Nature of conductor.
(ii) SI unit of resistivity is 2 m.

18. (i) We have three cylindrical conductors A, B and C –

| A (A) | 2A (B) | A/2 (C) |

These three conductors are made of the same materials and their respective resistance are OR$_A$, R$_B$ and R$_C$.

$$\because \quad R = \frac{\rho L}{A}. \text{ So, } R_A = \frac{\rho \times L}{A} = \frac{\rho L}{A}$$

$$R_B = \frac{\rho \times L/2}{2A} \Rightarrow \frac{\rho L}{4A}, \quad R_C = \frac{\rho \times L}{\frac{A}{2} \times 2} \Rightarrow \frac{\rho L}{A}$$

Then, (I) $\quad \frac{R_A}{R_B} = \frac{\rho L}{A} \bigg/ \frac{\rho L}{4A} \Rightarrow 4 \; ; \; \frac{R_A}{R_B} = 4.$

(II) $\quad \frac{R_A}{R_C} = \frac{\rho L}{A} \bigg/ \frac{\rho L}{A} \Rightarrow 1.$

(ii) Resistivity of alloys is generally higher than its constituent metals. Therefore, constantan has more resistance.

19. (a) The resistance of a uniform cylindrical conductor depends on
(i) Length of the conductor (1)
(ii) Area of cross-section of the conductor (A)

(b) The formula of resistance, $R = \frac{\rho l}{A}$,

where p = Resistivity of the material

Given, $R = 10 \, \Omega$

$\rho = 50 \times 10^{-8} \, \Omega \, m.$

Radius of the wire = 0.01 cm

Area of cross-section of the wire = πr^2

$$= 3.14 \left(\frac{0.01}{100}\right)^2 = 3.14 \left(\frac{0.01 \times 0.01}{10000}\right) = 3.14 \times 10^{-8} \, m^2$$

Since, $R = \dfrac{\rho l}{A} \Rightarrow l = \dfrac{R \times A}{\rho} = \dfrac{10 \times 3.14 \times 10^{-8}}{50 \times 10^{-8}}$

$$\Rightarrow l = \frac{3.14}{5} = 0.628 \, m$$

The length of this wire is 0.628 m.

20. (a) Resistance of a conductor depends upon the following factors:

(1) Length of the conductor: Greater the length (1) of the conductor more will be the resistance (R). Rol

$$R \propto \frac{1}{A}$$

(2) Area of cross-section of the conductor: Greater the cross-sectional area of the conductor, less will be the resistance.

(3) Nature of conductor.

(b) Metal have very low resistivity and hence they are good conductors of electricity. Whereas glass has very high resistivity so glass is a bad conductor of electricity.

(c) Alloys are commonly used in electrical heating devices due to the following reasons

(i) Alloys have higher resistivity than metals

(ii) Alloys do not get oxidised or burn readily.

21. We are given, the length of wire, | = 1 m, radius of wire, r = 0.01cm = 1×10⁻⁴m and resistance, R = 20 As we know,

$R = \rho \dfrac{l}{A}$, where ρ is resistivity of the material of the wire.

$\therefore \quad 20\,\Omega = \rho\dfrac{l}{\pi r^2} = \rho\dfrac{1\,m}{3.14 \times (10^{-4})^2 m^2}$

$\therefore \quad \rho = 6.28 \times 10^{-7}\Omega\,m$

22. Given; resistivity of copper $= 1.6 \times 10^{-8}$ Ω m, diameter of wire, d = 0.5 mm and resistance of wire, R = 100 Ω

Radius of wire, $r = \dfrac{d}{2} = \dfrac{0.5}{2}$mm

$= 0.25$ mm $= 2.5 \times 10^{-4}$ m

Area of cross-section of wire, $A = \pi r^2$

$\therefore \quad A = 3.14 \times (2.5 \times 10^{-4})^2$

$\simeq 1.9625 \times 10^{-7}\,m^2 \simeq 1.9 \times 10^{-7}\,m^2$

As, $R = \rho\dfrac{l}{A}$

$\therefore \quad 100\,\Omega = \dfrac{1.6 \times 10^{-8}\Omega m \times l}{1.9 \times 10^{-7} m^2}$

$l \approx 1200$ m

If diameter is doubled (d' = 2d), then the area of cross- section of wire will become

$A' = \pi r^2 = \pi\left(\dfrac{d'}{2}\right)^2 = \pi\left(\dfrac{2d}{2}\right)^2 = 4A$

Now $R \propto \dfrac{1}{A}$, so the resistance will decrease by four times or new resistance will be

$R' = \dfrac{R}{4} = \dfrac{100}{4} = 25\,\Omega$

23. Here, r = 0.01 cm = 10⁻⁴ Ω, p = 50×10⁻⁸ Ω and R = 10 Ω

As, $R = \rho \dfrac{l}{A}$ or $l = \dfrac{RA}{\rho} = \dfrac{R}{\rho}(\pi r^2)$ $\hspace{2cm}$ $(\because A = \pi r^2)$

So, $l = \dfrac{10}{50 \times 10^{-8}} 3.14 \times (10^{-4})^2 = 0.628 \text{ m} = 62.8 \text{ cm}$

24. If the radius of conductor is halved, the area of cross-section reduced to $\left(\dfrac{1}{4}\right)^{th}$ of its previous value.

Since, $R \propto \dfrac{1}{A}$, resistance will become four times

From Ohm's law, $V = IR$

For given V, $I \propto \dfrac{1}{R}$

So, current will reduce to one-fourth of its previous value.

25. Resistance is the property of a conductor to resist the flow of charges through it. Factors affecting resistance of a conductor: Resistance of a conductor depends upon the following factors:
(1) Length of the conductor: Greater the length (l) of the conductor more will be the resistance (R). $R \propto l$
(2) Area of cross-section of the conductor: Greater the cross-sectional area of the conductor, less will be the resistance.

$R \propto \dfrac{1}{A}$

(3) Nature of conductor. Rheostat is the device which is oftenly used to change the resistance without changing the voltage source in an electric circuit.

We are given, length of wire, $l = 50$ cm $= 50 \times 10^{-2}$m cross-sectional area, A $=$ 0.01 mm^2 $=$ 0.01 x 10-6m^2 and resistivity, $p = 5 \times 10^{-8}$ Ω m.

As, resistance, $R = \rho \dfrac{l}{A}$

$\therefore \quad R = \left(\dfrac{5 \times 10^{-8} \times 50 \times 10^{-2}}{0.01 \times 10^{-6}}\right) \Omega = 2.5 \ \Omega$

26. (b): As they are connected in series, so current is same in both the bulbs.

27. (a): The maximum resistance can be obtained from a group of resistors by connecting them in series. Thus,

$$R_s = \frac{1}{5} + \frac{1}{5} + \frac{1}{5} + \frac{1}{5} + \frac{1}{5} = 1\,\Omega$$

28. (c) A group of resistors can produce maximum resistance when they all are connected in series.

$R_1 = 2\,\Omega + 2 + 2\,\Omega + 2\,\Omega = 8\,\Omega$

29. (a) The maximum resistance can be produced from a group of resistors by connecting them in series.

30.

[Topper's Answer, 2022]

31. Here, $R_1 = 10\,\Omega$, $R_2 = 15\,\Omega$, R3 $= 5\,\Omega$. In parallel combination, equivalent resistance, (Req) is given by

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}. \text{ So, } \frac{1}{R_{eq}} = \frac{1}{10} + \frac{1}{15} + \frac{1}{5}$$

$$\frac{1}{R_{eq}} = \frac{3+2+6}{30} = \frac{11}{30} \quad \therefore \quad R_{eq} = \frac{30}{11}\Omega = 2.73\,\Omega$$

32.

(i) $A \bullet\!\!-\!\!\text{ww}\!\!-\!\!-\!\!\text{ww}\!\!-\!\!-\!\!\text{ww}\!\!-\!\!\bullet B$

with R_1, R_2, R_3 above.
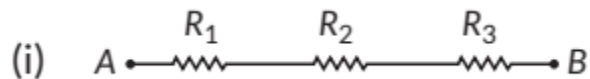
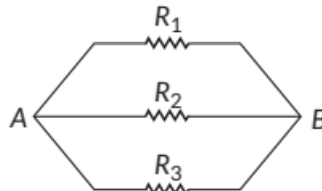We know that resistance R_1, R_2 and R_3 are in series.

SO, $R_{AB} = R1 + R_2 + R_3$

We know that, resistance R_1, R_2 and R_3 are in parallel.

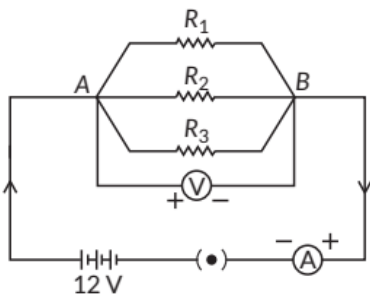So, $\dfrac{1}{R} = \dfrac{1}{R_1} + \dfrac{1}{R_2} + \dfrac{1}{R_3}$

$\dfrac{1}{R} = \dfrac{R_2 R_3 + R_3 R_1 + R_1 R_2}{R_1 R_2 R_3}$

or $\left[R = \dfrac{R_1 R_2 R_3}{R_1 R_2 + R_2 R_3 + R_3 R_1} \right]$

(ii) The slope of V-I graph gives the resistance. The greater the slope greater will be the resistance. We know, Rs > Rp Graph (l) is correct.

33.

Here, $R_1 = 10\ \Omega$, $R2 = 20\ \Omega$

$R3 = 30\ \Omega$ and $V = 12\ V$

(a) Current through R_1, $I_1 = \dfrac{V}{R_1} = \dfrac{12}{10} = 1.2\ A$

Current through R_2, $I_2 = \dfrac{V}{R_2} = \dfrac{12}{20} = 0.6\ A$

Current through R_3, $I_3 = \dfrac{V}{R_3} = \dfrac{12}{30} = 0.4\ A$
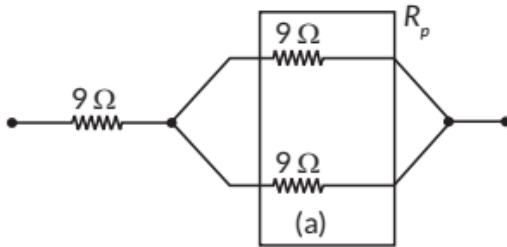
(b) Total circuit resistance

$$\frac{1}{R_{AB}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \qquad (\because \text{they are in parallel})$$

$$= \frac{1}{10} + \frac{1}{20} + \frac{1}{30} = \frac{11}{60}$$

$$R_{AB} = \frac{60}{11}\,\Omega = 5.45\,\Omega$$

(c) Total current, $I_{AB} = \dfrac{V}{R_{AB}} = \dfrac{12}{5.45} = 2.21\,\text{A}.$

34. (i) The resistance of the series combination is higher than each of the resistances. A parallel combination of two 9 resistors is equivalent to 4.5 Q. We can obtain 13.5 9 by coupling 4.5 92 and 9 Q in series. So, to obtain 13.5 Q, the combination is as shown in figure (a).
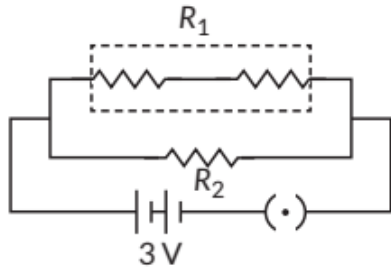

(a)

(ii) To obtain a equivalent resistance of 6 Ω we have to connect two 9 Ω resistors in series and then connect the third 9 Ω resistor in parallel

(b)
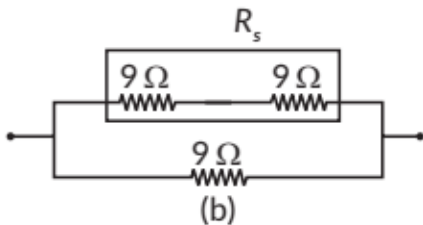
35. As given in circuit diagram, two 3 Ω resistors are connected in series to form R1, so R1=3 Ω +3 Ω =6 Ω And, R_1 and R_2 are in parallel combination, Hence, equivalent resistance of circuit (Req) is given by

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\therefore \quad \frac{1}{R_{eq}} = \frac{1}{6} + \frac{1}{3} = \frac{1+2}{6} = \frac{3}{6} = \frac{1}{2}$$

or Req=292
Using Ohm's law, $V = IR$

We get, $3V = I \times 2\,\Omega$ or $I = \dfrac{3}{2}A = 1.5\,A$
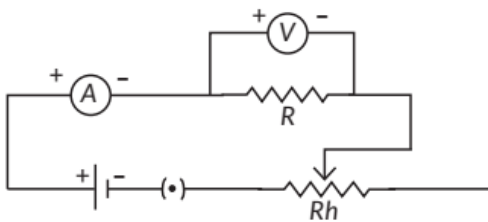
Current drawn from the battery is 1.5 A.

36. (i) It states that the potential difference V, across the ends of a given metallic wire in an electric circuit is directly proportional to the current flowing through it, provided its temperature remains the same.
Mathematically,

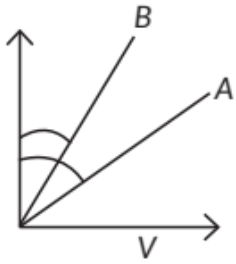$V \propto I$

$V = RI$

where R is resistance of the conductor.

(ii) To measure the entire current passing through the circuit, the ammeter should have low resistance.
(iii) $R_S = R_1 + R_2 =$ Maximum resistance
$R_p = \dfrac{R_1 R_2}{R_1 + R_2} =$ Minimum resistance
So, RA > RB

Thus, A shows series combination and B shows parallel combination.

37.

(a) Equivalent resistance of Arm A =
$$R_A = R_1 + R_2 + R_3 \quad \text{(as in series)}$$
$$R_A = 5\Omega + 15\Omega + 20\Omega$$
$$R_A = 40\Omega$$
So equivalent resistance is (Arm A) $\boxed{40\,\Omega}$

(b) $R_B = 5\Omega + 10\Omega + 15\Omega = 30\Omega$
(as in series)
$$R_C = 10\Omega + 20\Omega + 30\Omega = 60\Omega$$
(as in series)
R_B and R_C are in parallel
$$\frac{1}{R_K} = \frac{1}{30} + \frac{1}{60} = \frac{1}{R} = \frac{2+1}{60}$$
$$R_K = \frac{60}{3} = \boxed{20\,\Omega}$$

(c) So total current = $R_K + R_A = R$
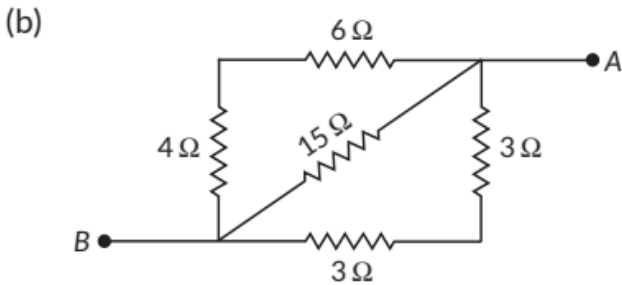(as in series) $20\Omega + 40\Omega = 60\Omega$
Potential Difference = 6V

By Ohm law $V = IR$ $\qquad 6 = I \times 60$
$I = \frac{6}{60}$, $I = \frac{1}{10}\,A$ or 0.1 Ampere
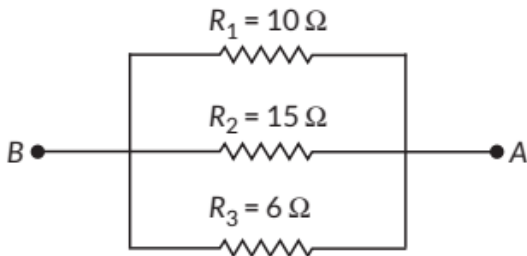
[Topper's Answer, 2022]

38. (a) Two disadvantages of using a series circuit in homes:
(i) If all devices are connected in series, the greater's the resistance.
(ii) If a device have faulted then all devices of home stop working.

(b)

Now, equivalent resistance between A and B

We know that 6 Ω and 4 Ω are in series, then
$R_1 = 6\,\Omega + 4\,\Omega = 10$ and 3Ω and 3Ω are in series, $R_3 = 3\Omega + 3\Omega = 6Q$ Now equivalent resistance between A and B,

$$\frac{1}{R_{AB}} = \frac{1}{10} + \frac{1}{15} + \frac{1}{6}, \quad \frac{1}{R_{AB}} = \frac{3+2+5}{30} \Rightarrow R_{AB} = 3\,\Omega.$$

39. (a) Given resistance of wire, R = 69 Let / be the length of the wire and A be its area of cross-

section. Then $R = \dfrac{\rho l}{A} = 6\,\Omega$
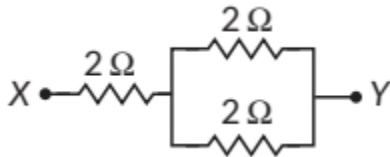
Now when the length is doubled, l' = 21

and $A' = \dfrac{A}{2}$ [∵ Al = A′l′]

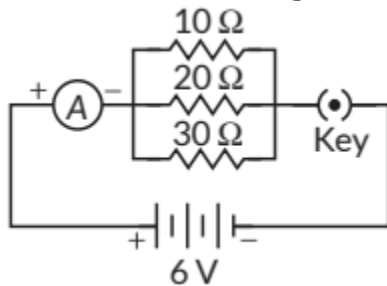∴ $R' = \dfrac{\rho(2l)}{A/2} = \dfrac{4\rho l}{A} = 4 \times 6\,\Omega = 24\,\Omega$

In order to get a total resistance of 32, the three resistors has to be connected as shown.

Such that, $\dfrac{1}{R_P} = \dfrac{1}{2} + \dfrac{1}{2} = 1 \Rightarrow R_P = 1\,\Omega$

and $R_S = 2\,\Omega + 1\,\Omega = 3\,\Omega$

40. The circuit diagram is as shown below.

(a) Given, voltage of the battery $= 2V + 2V + 2V = 6\ V$ Current through 10 Ω resistance,

$$I_{10} = \dfrac{V}{R} = \dfrac{6}{10} = 0.6\ A$$

Current through 20 resistance,

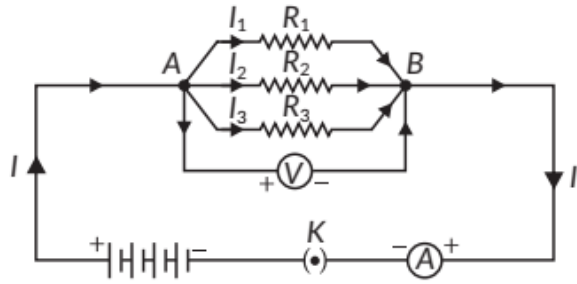$$I_{20} = \dfrac{V}{R} = \dfrac{6}{20} = 0.3\ A$$

Current through 30 resistance,

$$I_{30} = \dfrac{V}{R} = \dfrac{6}{30} = 0.2\ A$$

(b) Total current in the circuit, $I = I_{10} + I_{120} + I_{130}$
$= 0.6 + 0.3 + 0.2 = 1.1\ A$

(c) Total resistance of the circuit,

$$\dfrac{1}{R_P} = \dfrac{1}{10} + \dfrac{1}{20} + \dfrac{1}{30} = \dfrac{11}{60} \quad \therefore \quad R_P = \dfrac{60}{11}\,\Omega$$

41. (a) Resistors in parallel: When resistors are connected in parallel.

(i) The potential difference across their ends is the same.
(ii) The sum of current through them is the current drawn from the source of energy or cell.

$$I = I_1 + I_2 + I_3 \text{ or } \frac{V}{R_P} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

(iii) The equivalent resistance is given by,

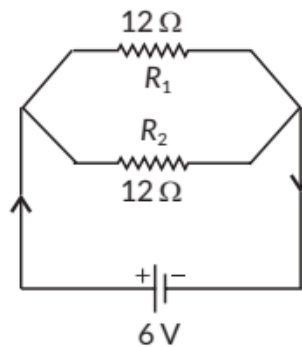$$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

Hence, equivalent resistance in parallel combination is equal to the sum of reciprocals of the individual resistances.

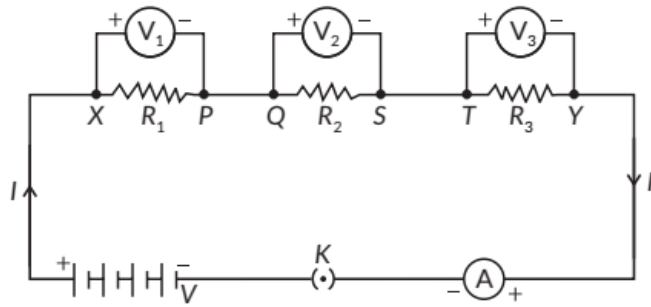(b) $\dfrac{1}{R} = \dfrac{1}{R_1} + \dfrac{1}{R_2}$

$\dfrac{1}{R} = \dfrac{1}{12} + \dfrac{1}{12} = \dfrac{2}{12}$

$\Rightarrow R = 6\,\Omega$

∴ Current, $I = \dfrac{V}{R} = \dfrac{6}{6} = 1\,A$

42.

Given figure shows the series combination of three resistors R_1, R_2 and R_3 connected across a voltage source of potential difference V. Let current I is flowing through the circuit. V_1, V_2 and V_3 are the potential differences across resistors R_1, R_2 and R_3 respectively. Since, the total potential difference across a combination of resistors in series is equal to the sum of potential difference across the individual resistors.

$V = V_1 + V_2 + V_3$

In series current through each resistor is same. ...(i)

Applying the Ohm's law,

$V_1 = IR_1$, $V_2 = IR_2$ and $V_3 = IR_3$ ...(ii)

If Rs, is the equivalent resistance of the circuit, then

$V = IR_S$ ...(iii)

From eqns. (i), (ii) and (iii), we can write
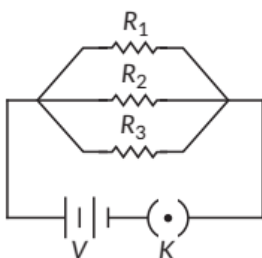
$IR_1 = IR_1 + IR2 + IR3$

or $R_S = R_1 + R_2 + R_3$

We can conclude that when several resistors are joined in series, the resistance of the combination R_s, equals the sum of their individual resistances, R_1, R_2 and R_3.

Given: $R_1 = 6\,\Omega$, $R\,\Omega = 9\,\Omega$, $R_3 = 18\,\Omega$

are connected in parallel.

Equivalent resistance, R_{eq}, is given by

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$\therefore \quad \frac{1}{R_{eq}} = \frac{1}{6} + \frac{1}{9} + \frac{1}{18} = \frac{3+2+1}{18} = \frac{6}{18} = \frac{1}{3}$$
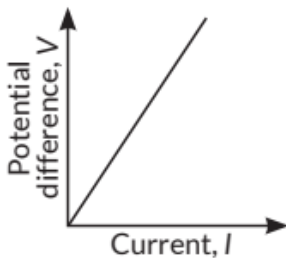
or $\quad R_{eq} = 3\,\Omega$

43. **Ohm's law:** It states that the potential difference V, across the ends of a given metallic wire in an electric circuit is directly proportional to the current flowing through it, provided its temperature remains the same.
Mathematically,

$V \propto I$

$V = RI$

where R is resistance of the conductor. Graphical representation of Ohm's law

For the given circuit
R1=3 Ω, R2 = 4 Ω, R3 = 6 Ω and V = 6 V.
(i) Total effective resistance of the circuit, Reg is given by

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} = \frac{1}{3} + \frac{1}{4} + \frac{1}{6} = \frac{9}{12}$$

or, $\quad R_{eq} = \frac{12}{9}\,\Omega = \frac{4}{3}\,\Omega = 1.33\,\Omega$

(ii) Since, potential difference across each resistor connected in parallel is same.
So, $V_1 = V_2 = V_3 = 6V$
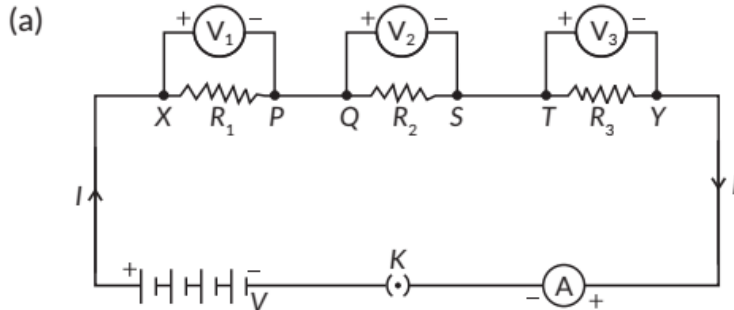Applying Ohm's law,

$V_1 = I_1R_1$ or $I_1 = \dfrac{V_1}{R_1}$ or $I_1 = \dfrac{6}{3}A = 2\,A$

Similarly, $I_2 = \dfrac{6\,A}{4} = 1.5\,A$ and $I_3 = \dfrac{6}{6}A = 1\,A$

(Note that net current in the circuit is $I = I_1 + I_2 + I_3$)

44.

(a)

Given figure shows, the series combination of three resistors R_1, R_2 and R_3 connected across a voltage source of potential difference V.

Let current I is flowing through the circuit. V_1, V_2 and V_3 are the potential differences across resistors R_1, R_2 and R_3 respectively. Since, the total potential difference across a combination of resistors in series is equal to the sum of potential difference across the individual resistors.

$V = V_1 + V_2 + V_3$ ...(i)

In series current through each resistor is same. Applying the Ohm's law,

$V_1 = IR_1$, $V_2 = IR_2$ and $V_3 = IR_3$ ...(ii)

If R, is the equivalent resistance of the circuit, then

$V = IR_S$ ...(iii)

From eqns. (i), (ii) and (iii), we can write

$IR_1 = IR_1 + IR_2 + IR_3$

or $R_S = R_1 + R_2 + R_3$

We can conclude that when several resistors are joined in series, the resistance of the combination R, equals the sum of their individual resistances, R_1, R_2 and R_3.

(b) If you have four 8 Ω resistors and the effective resistance is also 8 Ω then the two 8 Ω resistors are connected in series. Now you have pair of two 16 Ω resistors (8 Ω + 8 Ω). If you connect these resistors in parallel, you will have net resistance 8 Ω.
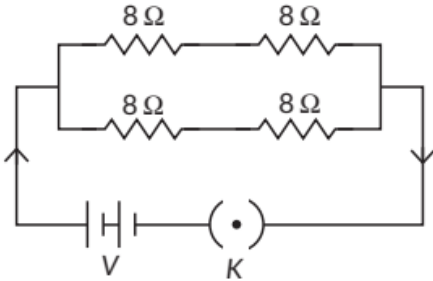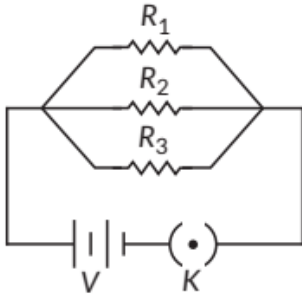
45.
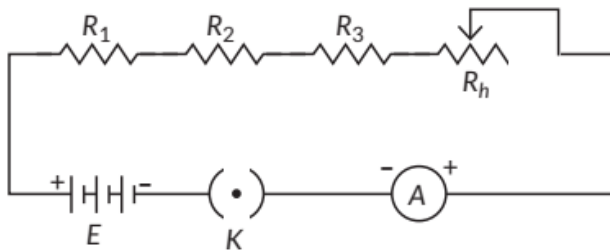
Change the positions of ammeter and note the reading of ammeter each time. You will find that all the reading obtained are same. So, the value of the current in the ammeter is the same, independent of its position in the electric circuit. It means that in this circuit (series combination) the current is the same in every part of the circuit. Precautions:

(i) All the connections are neat and tight.

(ii) Ammeter is connected with the proper polarity, i.e., positive terminal of the ammeter should go to positive terminal and negative terminal of ammeter to the negative terminal of the battery or cell used.

46. Let I_A, a_A and R_A be the length, area of cross-section and resistance of wire A and I_B, a_B and R_B are that of

wire B.

Here, I_A I_B and $R_A = R_B$

If P_A and P_B are the resistivities of wire A and B respectively then

$R_A = \rho_A \dfrac{l_A}{a_A}$ and $R_B = \rho_B \dfrac{l_B}{a_B}$, As $R_A = R_B$

$\therefore \quad \rho_A \dfrac{l_A}{a_A} = \rho_B \dfrac{l_B}{a_B}$ or $\dfrac{\rho_A}{\rho_B} = \dfrac{a_A}{a_B}$ $\qquad (\because\ l_A = l_B)$

Since P_A P_B therefore α_A > B Hence, wire A is thicker than wire B. For parallel combination,

(ii) Total current drawn from battery,
$1 = 1_1 + 1_2 + 1_3 = 0.2 + 0.6 + 1.2 = 2\ A$
(iii) Equivalent resistance of the circuit, Reg can be obtained by Ohm's law

$V = I\,R_{eq}$

So, $6\ V = 2\ A \times R_{eq}$ or, $R_{eq} = \dfrac{6}{2} = 3\,\Omega$

Aliter, $\dfrac{1}{R_{eq}} = \dfrac{1}{R_1} + \dfrac{1}{R_2} + \dfrac{1}{R_3}$

$= \dfrac{1}{30} + \dfrac{1}{10} + \dfrac{1}{5} = \dfrac{1+3+6}{30} = \dfrac{10}{30} = \dfrac{1}{3}$ or $R_{eq} = 3\,\Omega$

47. (b): As voltage is same, resistance is halved,

$H = \dfrac{V^2}{R} t$

So, $H' = \dfrac{V^2}{R/2} t = 2H$ (heat becomes two times).

48.

(a) : We know, $H = I^2 R t = \dfrac{V^2}{R} \cdot t$

Now when, $R' = \dfrac{R}{2},\ V' = V$ and $t' = t$

$H' = \dfrac{V'^2 t'}{R'} = \dfrac{V^2 t}{R/2} = \dfrac{2V^2 t}{R} = 2H$

49. (i) According to the Joule's law of heating, when a
current (/) is passed through a conductor of resistance (R)

for a certain time (t), the conductor gets heated up and the amount of energy released is given by

$$H = I^2 Rt \quad \text{or} \quad H = \frac{V^2}{R} t$$

(ii) $H = \frac{V^2}{R} t$

Here, $V = 6$ volt, $R = 5\ \Omega$, $t = 10$ sec

Hence, $H = \frac{6 \times 6}{5} \times 10 = 72$ J.

50. (a) Here, length of the wire, $I = 2$ m Area of cross-section, $A = 1.55 \times 10^{-6}$ m^2 Resistivity of metal, $p = 2.8 \times 10^{-8}$ m

Formula of resistance, $R = \frac{\rho l}{A}$

$\therefore \quad R = \frac{2.8 \times 10^{-8} \times 2}{1.55 \times 10^{-6}} = 3.61 \times 10^{-2}\ \Omega$

(b) Alloys are preferred over pure metals to make the heating elements of electrical heating devices because they have high melting point and higher resistance than pure metals.

51. (a) The Joule's law of heating implies that heat produced in a resistor is
(i) directly proportional to the square of current for a given resistance,
(ii) directly proportional to resistance for a given current, and
(iii) directly proportional to the time for which the current flows through the resistor. i.e., $H = I^2 Rt$
(b) Given, charge q = 96000 C, time t = 2h = 7200s and potential difference V = 40 V

We know, $H = I^2 Rt = \frac{Q^2}{t^2} \times \frac{V}{Q} \times t \times t = VQ$

$\quad = 40 \times 96000 = 3.84 \times 10^6$ J = 3.84 MJ

52. According to the Joule's law of heating, when a current (I) is passed through a conductor of resistance (R) for a certain time (t), the conductor gets heated up and the amount of energy released is given by

$$H = I^2 Rt \quad \text{or} \quad H = \frac{V^2}{R} t$$

53. Electric fuse protects circuits and appliances by stopping the flow of any unduly high electric current. It consists of a piece of wire made of a metal or an alloy of appropriate melting point, for example aluminium, copper, iron, lead etc. If a current larger than the specified value flows through the circuit, the temperature of the fuse wire increases. This melts the fuse wire and breaks the circuit.
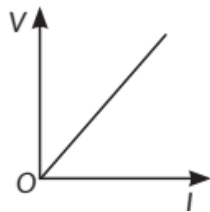
54. (a) (i) Tungsten is a strong metal and has high melting point (3380°C).
(ii) It emits light at high temperatures (about 2500°C).
(b) Electric laundry, iron and electric heater are based on heating effect of electric current.

55. (i) The potential difference V, across the ends of a given metallic wire in an electric circuit is directly proportional to the current flowing through it, provided its temperature remains the same. Mathematically,

$$V \propto I$$
$$V = RI$$

where R is resistance of the conductor. The shape of the graph obtained by plotting potential difference applied across conductor against the current flowing through it will be a straight line. According to ohm's law,

$$V = IR \text{ or } R = \frac{V}{I}$$

So, the slope of V-I graph at any point represents the resistance of the given conductor. As graph is a straight line, so it is clear from the graph that $V \propto I$.

(ii) A wire having length 'I' and area of cross section 'A' has a resistance $R = 4\Omega$
Then other wire of same material having length 1/2 and area of cross section
2A has a resistance R' = ?

$$\because \quad R = \frac{\rho l}{A} \; ; R = 4\Omega$$

$$R' = \frac{\rho l/2}{2A} \Rightarrow \frac{\rho l/2}{2A} \Rightarrow \frac{\rho l}{4A}$$

$$\therefore \quad R' = \frac{R}{4}$$

56. Let the resistance of the wire be R, heat produced in the
fuse at 5 A in 1s is
$H = (5)^2 R$ ($H = I^2 Rt$)
So, fuse melts at $(5)^2 R$ joules of heat.
Let, the resistance of new wire is R'
So, heat produced in 1 second $= (10)^2 R'$
To prevent it from melting

$$(5)^2 R = (10)^2 R' \quad \text{or} \quad R' = \frac{R}{4}, \text{As } R \propto \frac{1}{A}$$

.. cross-sectional area of new fuse wire is four times the first fuse.
Now, $A = \pi r^2$, so new radius is twice the previous one. So, at 10A, the new fuse
wire of same material and length has larger radius than the earlier one.

57. (d): Given: P = 1 kW, V = 220 V
P = VI

$$I = \frac{P}{V} = \frac{1000}{220} = \frac{100}{22} = 4.54 \text{ A}$$

So, minimum rating of fuse wire is 5 A.

58. (d): Given power of first bulb, $P_1 = 100$ W and second bulb $P_2 = 40$ W
Current through 100 W bulb, $I_1 = 1$ A
Current through 40 W bulb, $I_2 = ?$
Since both the bulbs are connected in series, the electric current passing
through both the bulbs are same i.e., $I_2 = 1A$.

59.
$$P = \frac{V^2}{R}$$

60. Here, power of lamp, P = 60 W time, t = 1s
So, energy consumed = Power x time = (60x 1)J = 60 J

61. Power of electric heater, P = 1100 W Operating voltage, V = 220 V

(i) Its resistance, $R = \frac{V^2}{P}$

$R = \frac{220 \times 220}{1100}\Omega$; R = 44 Ω

(ii) Resistance, R = 44 Ω
operating voltage, V = 220 V

So, current $I = \frac{V}{R} = \frac{220}{44} = 5\ A$

62. (a) The electric power of an electrical device is the rate at which electric energy is dissipated or consumed in an electric circuit.

$$\text{Power} = \frac{\text{Work}}{\text{Time}} = \frac{\text{Energy}}{\text{Time}}$$

The SI unit of electric power is watt (W)
1 W = 1 volt x 1 ampere = 1 VA
(b) (i) Electrical energy is the product of power and time.
E=Pxt
= 2 kW x 2 h = 4 kWh
(ii) Electric energy consumed in joules
1 kWh = 3.6 x 10⁶ J
= 4 kWh = 3.6 × 10⁶ x 4 = 14.4 x 10⁶ J.

63. (i) The rate at which electric energy is dissipated or consumed in an electric circuit is called electric power. SI unit of electric power is watt (W).
(ii) Given, $P_1 = 100$ W, $V_1 = 220$ V
$P_2 = 60$ W, $V_2 = 220$ V
P=VI

64. Electric Power: The rate at which electrical energy is consumed or dissipated is called electrical power.

$$\text{Power} = \frac{\text{Work done}}{\text{Time}} = \frac{W}{t}$$

$$P = VI, \qquad\qquad [\because \quad V = IR]$$
$$P = (IR).I = I^2R$$

$$P = \frac{V^2}{R} = \frac{qV}{t}$$

Power is expressed in Joule/second or watt (W). We have a device that has the resistance of 4009Ω and operating at 200 V –

$$\because \quad P = \frac{V^2}{R} ; \quad P = \frac{200 \times 200}{400} = 100\,W$$

65. Two lamps rated 100 W, 220 V and 60 W, 220 V and connect in parallel to electric mains supply of 220 V.

Let first lamp has resistance $R_1 = \dfrac{V_1^2}{P_1}$

Here, P_1 = 100 W and V_1 = 220 V

So, $R_1 = \dfrac{220 \times 220\,\Omega}{100} = 484\,\Omega$

For second lamp has resistance $R_2 = \dfrac{V_2^2}{P_1}$

Here, P_2 = 60 W, and V_2 = 220 V

So, $R_2 = \dfrac{V_2^2}{P_1} = \dfrac{220 \times 220}{60} = 806.67\,\Omega$ or $R_2 = 807\Omega$

As, both lamps are connected in parallel, So, total resistance of circuit, RT =

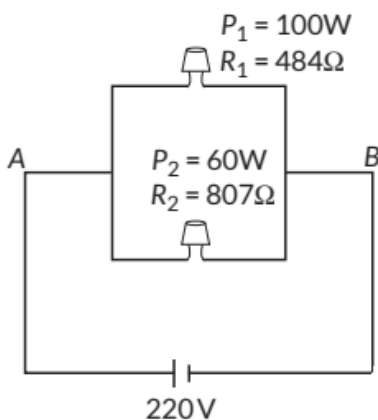$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\frac{1}{R_T} = \frac{1}{484} + \frac{1}{807}$$

$R_T = 302.55\Omega$

or $R_T = 303\Omega$

Voltage, $V = 220$ V

So, current, $I_T = \dfrac{V}{R_T} = \dfrac{220}{303} = 0.726\,A \approx 0.73\,A$

66. Since both the bulbs are connected in parallel and to a 220 V supply, the voltage across each bulb is 220 V. Then Current drawn by 100 W bulb,

$$I_1 = \frac{\text{Power rating}}{\text{Voltage applied}} = \frac{100W}{220V} = 0.454A$$

Current drawn by 60 W bulb, $I_2 = \dfrac{60W}{220V} = 0.273A$

Total current drawn from the supply line,
1 = 11+12=0.454 A+ 0.273 A = 0.727 A = 0.73 A

67. Here, $V = 220$ V, $R = 55\Omega$

By Ohm's law $V = IR$

.. $220 = 1 \times 55$ or $1 = 4$ A

Wattage of electric iron = Power = $\dfrac{V^2}{R} = \dfrac{(220)^2}{55} = 880\,W$

68. Here, P = 750 W, V = 200 V
(i) As P = VI
I = P/V = (750/200) A = 3.75A
(ii) By Ohm's law V = IR or R = V/I

$$\therefore \quad R = \dfrac{200}{3.75}\Omega = 53.3\,\Omega$$

(iii) Energy consumed by the iron in 2 hours
=Pxt = 750 W x 2h = 1.5 kWh
or E = $(750 \times 2 \times 3600)$ J = 5.4 x 10^6 J

69. Here, V = 220 V, I = 2.5 A Power of the bulb P = VI = 220×2.5 W = 550 W

70. (a) The electric power of an electrical device is the rate at which electric energy is dissipated or consumed in an electric circuit.
The SI unit of electric power is watt (W).
1 W = 1 volt x 1 ampere = 1 VA
1 unit = 1 kWh = 3.6 x 10^6 J
(b) 2 bulbs: P = 50 W, t = 6 hr daily
1 geyser : P = 1 kW, t = 1 hr
E=Pxt used by every 2 bulbs + energy used by geyser
= 30 days, Rs. = 8/kWh
Now, total energy consumed in one day
= $2 \times 50 \times 6 + 1$ x 1000 = 1600 Wh
Total energy consumed in 30 days
= 30 x 1600 Wh = 48 kWh
Bill = 8×48 = Rs. 384.

71. (a) Power is defined as the rate at which electric energy is dissipated or consumed in an electric circuit.
P=VI=I^2R = V^2/R
The SI unit of electric power is watt (W). It is the power consumed by a device that carries 1 A of current when operated at a potential difference of 1 V.
1 W = 1 volt x 1 ampere = 1 VA

(b) Given, V = 5 V and I = 500 mA = 0.5 A
(i) Power, P = V x 15 x 0.5 = 2.5 W

(ii) As, $P = \dfrac{V^2}{R} \Rightarrow R = \dfrac{V^2}{P} = \dfrac{25}{2.5} = 10 \ \Omega$

(iii) Given, time t = 2.5 hrs = 9000 s
The energy consumed, E = Pxt
= 2.5 × 9000 = 2.25 x 104 J = 6.25 Watt hour

72. Given, $R_1 = R_2 = 15\Omega$, V= 6 V
(i) When connected in series,
$R_s = R_s + R_1 = 15\Omega + 15\Omega = 30\Omega$

Power, $P_S = \dfrac{V^2}{R_S} = \dfrac{36}{30}$ W
...

(ii) When connected in parallel,
$\dfrac{1}{R_P} = \dfrac{1}{R_1} + \dfrac{1}{R_2} \Rightarrow R_P = \dfrac{15}{2} \ \Omega$

∴ Power, $P_P = \dfrac{V^2}{R_P} = \dfrac{36}{15} \times 2$ W

∴ The ratio, $\dfrac{P_S}{P_P} = \dfrac{36}{30} \times \dfrac{15}{36 \times 2} = \dfrac{1}{4}$

73.

(a) As power $P = VI = \dfrac{V^2}{R}$

∴ $R = \dfrac{V^2}{P} \Rightarrow R = \dfrac{R = (200)^2}{100} = 400 \ \Omega$

(b) Power of 1 bulb is 100 W Power of 3 bulbs, P = 3 x 100 W = 300 W These
bulb glows for 10 hours in a day, so energy consumed in a day,
E=Pxt = 300 x 10 = 3000 Wh = 3 kWh
total energy consumed by 3 bulbs in month of
November (30 days) will be
ET = 30 x 3 kWh

ET = 90 kWh or 90 units (1 unit = 1 kWh)
(c) cost of 1 unit (1 kWh) = 6.50 = 6.50 × 90 = * 585

74. (a) One Ohm is equal to the resistance of a conductor through which a current of one ompere flows when a potential difference of one volt is maintained across conductor.
(b) The rote at which energy is used by an electrical appliances is called electric power. Expression relating electric power (P), potential difference (V) and resistance (R) is given by

$$P = \frac{V^2}{R}$$

$$R_{eq} = \frac{132}{n}$$

Now, $V = IR_{eq}$

$$220 = 5 \times \frac{132}{n} \; ; \; n = \frac{5 \times 132}{220} = n = 3$$

75. Resistance of the lamp = 20
External resistance = 4 Q
(a) As both the lamp and external resistance are connected in series, therefore the total resistance,

$$R = 20 + 4 = 24 \, \Omega$$

(b)   Current, $I = \dfrac{V}{R} = \dfrac{6}{24} = 0.25 \, A$

(c) (i) Potential difference across the electric lamp

$$= \frac{\text{Total voltage}}{\text{Total resistance}} \times \text{Resistance of lamp} \; = \frac{6}{24} \times 20 = 5 \, V$$

(ii) Potential difference across conductor

$$= \frac{\text{Total voltage}}{\text{Total resistance}} \times \text{Resistance of conductor}$$

$$= \frac{6}{24} \times 4 = 1 V$$

(d) Power of the lamp = (current)2 x resistance of lamp = (0.25)2 x 20 = 1.25 W

76. In circuit A,
Total resistance, R = 1 + 2 = 39

Voltage across 2 Ω = $\dfrac{V_{Total}}{R_{Total}} \times 2\,\Omega = \dfrac{6}{3} \times 2 = 4\,V$

∴   Power used in 2 Ω resistor, $P = \dfrac{V^2}{R} = \dfrac{(4)^2}{2} = 8\,W$

In circuit B, Voltage across both the resistance is same i.e. 4 V and both are connected in parallel combination.

∴   Power used in 2 Ω resistor = $\dfrac{V^2}{R} = \dfrac{(4)^2}{2} = 8\,W$

Power used in 2Ω resistor in each case is same i.e. 8 W.

77. In first case, P = 40 W, V = 220 V

Current drawn, $I = \dfrac{P}{V} = \dfrac{40}{220} = 0.18\,A$

Also, resistance of bulb,

$R = \dfrac{V^2}{P} = \dfrac{(220)^2}{40} = 1210\,\Omega$

In second case, P = 25 W, V = 220 V

Current drawn, $I = \dfrac{P}{V} = \dfrac{25}{220} = 0.11\,A$

Also, resistance of the bulb,

$R = \dfrac{V^2}{P} = \dfrac{(220)^2}{25} = 1936\,\Omega$

Hence, by replacing 40 W bulb to 25 W bulb, having same source of voltage the amount of current flows decreases while resistance increases.

CBSE Sample Questions

1. Work done to bring charge Q from infinity to point at potential V is W = QV.
(1)

2. (c): As electrical resistance of a wire is directly proportional to its temperature, therefore on increasing the temperature of the wire would increase its electrical resistance. (1)

3. (b): The resistance of the wire of length I having diameter d and resistivity p can be given by the formula,

$$R = \frac{\rho l}{\pi \left(\frac{d}{2}\right)^2} \Rightarrow R \propto \frac{1}{d^2}$$

Therefore, on decreasing the resistance, there would be an increase in the diameter of the wire. (1)

4. For the parallel combination, voltage-drop is same across both the resistors.

5. The overall current needed = 9 A.
The applied voltage is 12 V.
By Ohm's law V = IR,
The resistance for the entire circuit, (1)

$$R = \frac{12}{9} = \frac{4}{3}\Omega.$$

Here, R_1 and R_2 are in parallel.

Hence, $R = \frac{(R_1 R_2)}{R_1 + R_2} = \frac{4R_2}{(4 + R_2)} = \frac{4}{3}$

$\therefore \quad R_2 = 2\,\Omega$

6. As shown in diagram, 5 ohm, 10 ohm and R_1 are in parallel

$$\frac{1}{R_p} = \frac{1}{5} + \frac{1}{10} + \frac{1}{R_1} ; \quad \frac{1}{R_p} = \frac{3}{10} + \frac{1}{R_1}$$

$$R_p = \frac{10 R_1}{3 R_1 + 10}$$

Now, 6 ohm, 6 ohm and R, are in series

Thus, $R_{eq} = \frac{10 R_1}{3 R_1 + 10} + 12$

From Ohm's law, V = I Reg From the circuit

$$R_{eq} = \frac{30}{2} = 15\,\Omega$$

From equation (i) and (ii)

$$12 + \frac{10R_1}{3R_1 + 10} = 15 \; ; \; 10\,R_1 = (9\,R_1 + 30)$$

$R_1 = 30\,\Omega$

7. Since R_3 and R_4 are connected in series,
$R_{34}\ R_3 + R_4$
$= 6 + 4 = 10\,\Omega$
Now, R_{34} and R_2 are connected in parallel,

$$\text{so, } R_{234} = \frac{R_{34}\,R_2}{R_{34} + R_2} = \frac{10 \times 10}{10 + 10} = 5\,\Omega$$

Also, R_1 and R_{234} are connected in series,
$R_{eq} = R_1 + R_{234} = 7 + 5 = 12\,\Omega$

$$\text{From Ohm's law, Current, } I = \frac{V}{R_{eq}} = \frac{24}{12} = 2\,A$$

So, total resistance of the circuit (R_{eq}) = 12
total current in the circuit (I) = 2 A (1)

8. (a) Energy = Power x Time
So, Energy (E) = 3 x 2 = 6 kWh (1/2)
Cost of buying electricity from the main electricity board
= 6 x 3.50
21.0 (1/2)
(b) To reduce the boiling time using the same mains supply, the rate of heat production should be large.

$$\text{We know that } P = \frac{V^2}{R}. \text{ Since } V \text{ is constant, } R \text{ should be}$$

decreased. Since R is directly proportional to I so length should be decreased.
(2)

9. (i) The lamps are in parallel.
(ii) Advantages: (1)
If one lamp goes faulty, it will not affect the working of the other lamps. They will also be using the full potential of the battery as they are connected in parallel. (1)
(iii) The lamp with the highest power will glow the brightest.
$P=VI$
In this case, all the bulbs have the same voltage, but lamp
C has the highest current.
Hence, lamp C will glow the brightest with power
$P = 5 \times 60$ Watt $= 300$ W.
(iv) The total current in the circuit
$I = 3 + 4 + 5 + 3A = 15$ A
Voltage, $V = 60$ V (2)
As $V = IR$
Hence, $R = V/I = 60/15$ A $= 4A$ (1)