Chapter 12: ELECTRICITY

P12

1. What is electric current?

Electric current is defined as rate of flow of charges.

2. What is a conductor?

The substances through which electricity can flow are called conductors. Ex: Metals like Silver, copper, aluminium, alloys such as nichrome and carbon in the form of graphite, etc.

3. What is an electric circuit?

A closed and continuous path along which an electric current flows is called an electric circuit.

4. What is an open circuit?

An electric circuit through which no current flows is called an open circuit.

5. What is a closed circuit?

An electric circuit through which current flows continuously is called a closed circuit.

6. What are insulators?

The substances through which electricity cannot flow are called insulators. Ex: Glass, ebonite, rubber, most plastics, paper, dry wood, cotton, mica, Bakelite, porcelain, dry air.

7. How is electric current expressed?

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

8. What is the conventional flow of electricity?

Conductor A having an excess of electron is said to be at –ve or lower potential, while conductor B having a deficit of electron is said to be at +ve or higher potential. The electric current flows from a region of higher potential to a region of lower potential. That is in a direction opposite to the direction of flow of electrons. This is known as conventional flow of electric current.

9. Write the formula for the current through a cross-section.

$I = \frac{Q}{t}$ Where the Q is the net charge, t is time and I is the current.

10. Write the SI unit of charge.

coulomb (C)

11. Define coulomb.

One coulomb is equivalent to the charge contained in nearly $6x10^{18}$ electrons.

12. What is the charge of an electron?

Electron has a negative charge of 1.6×10^{-19} C.

13. Calculate the number of electrons constituting one coulomb of charge.

One electron possesses a charge of 1.6×10^{-19}C,

i.e., 1.6×10^{-19}C of charge is contained in 1 electron.

$\therefore$ 1 C of charge is contained in $= \frac{1}{1.6x10^{-19}} = \frac{10^{19}}{1.6} = \frac{10}{1.6} x10^{18} = 6.25 \times 10^{18}$

Therefore, 6.25×10^{18} electrons constitute one coulomb of charge.

14. State the unit of electric current.

Electric current is expressed by ampere (A).

15. Define ampere or Define the unit of electric current.

The electric current flowing through a conductor is said to be one ampere when one coulomb of charge flows through any cross-section of a conductor in one second.

$$1\,\text{ampere} = \frac{1\,\text{coulomb}}{1\,\text{second}}$$

16. Name the other units of electric current.

Milliampere ($1mA = 10^{-3}$ ampere)

Microampere ($1\mu A = 10^{-6}$ ampere)

17. A current of 0.5A is drawn by a filament of an electric bulb for 10 minutes. Find the amount of electric charge that flows through the circuit.

I=0.5A

t=10 minutes= 10x60 = 600 seconds

Q=Ixt

Q=0.5A x 600s

Q=300C

18. What is an ammeter?

The instrument used to measure current in a circuit is called ammeter.

19. How is an ammeter connected in a circuit?

An ammeter is always connected in series in a circuit through which the current is to be measured.

20. Why should an ammeter have a very low resistance?

Since the entire current passes through the ammeter, it should not change the value of current flowing in the circuit.

21. Name an instrument that measures electric current in a circuit.

Ammeter

22. Define electric potential

The electric potential at a point in an electric field is defined as the work done in moving a unit positive charge from infinity to that point.

23. State the SI unit of electric potential.

The SI unit of electric potential is volt.

24. Define potential difference.

The potential difference between two points in an electric circuit is defined as the amount of work done in moving a unit positive charge from one point to the other point.

$$\text{Potential difference} = \frac{\text{Work done}}{\text{Charge moved}} \quad V = \frac{W}{Q}$$

25. What do you mean by saying that the potential difference between two points is 1 V?

OR

Define 1 volt.

If 1 Joule of work is required to move a charge of amount 1 coulomb from one point to another, then the potential difference between the two points is 1 V.

$$1 \text{ volt} = \frac{1 \text{ joule}}{1 \text{ coloumb}}$$

26. Name the device that helps to maintain a potential difference across a conductor.

Any source of electricity like battery, cell, power supply, etc. helps to maintain a potential difference across a conductor.

27. What is a voltmeter?

A Voltmeter is a device used to measure the potential difference.

28. How is a voltmeter connected in a circuit?

A voltmeter is always connected in parallel across the points where the potential difference is to be measured.

29. Why should a voltmeter have a high resistance?

A voltmeter should have a high resistance so that it draws a negligible current from the circuit.

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

Q=2C

V=12v

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

W= V x Q

W=12 x 2

W = 24 joules

31. How much energy is given to each coulomb of charge passing through a 6v battery?

Charge Q = 1C

V=6v

$$\text{Potential difference} = \frac{\text{Work done}}{\text{Charge moved}}$$

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

W= V x Q

W=6 x 1

W = 6 joules

32. How much work is done in moving a charge of 2 coulombs from a point at 118 volts to a point at 128 volts?

Potential difference V= 128 – 118 =10 volts

Work done = ?

Charge moved = 2 coulombs

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

$$10 = \frac{W}{2}$$

W = 10x2

W = 20 joules

33. Calculate the work done in moving a charge of 4 coulombs from a point at 220 volts to another point at 230 volts?

Potential difference V= 230 – 220 = 10 volts

Work done = ?

Charge moved = 4 coulombs

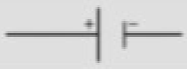
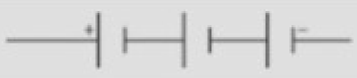
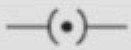
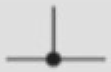
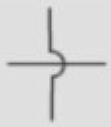
$$V = \frac{W}{Q}$$

$$10 = \frac{W}{4}$$

W = 10x4

W = 40 joules

34. Write the symbols of the following components.

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 joining	
7	Electric bulb	
8	A resistor of resistance *R*	
9	Variable resistance or rheostat	
10	Ammeter	
11	Voltmeter	

35. State Ohm's law.

At constant temperature, the current flowing through a conductor is directly proportional to the potential difference across its ends.

36. Write the mathematical form of Ohm's law.

V = R x I

Where V = potential difference

I = current

R=resistance (constant)

37. Define resistance.

Resistance is defined as the ratio of the potential difference across the conductor to the current flowing though the conductor.

OR

Resistance is the property of a conductor to resist the flow of charges through it.

$$R = \frac{\text{Potential difference}}{\text{Current}}$$

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

38. What is the cause of resistance?

When free electrons drift inside a conductor, they frequently collide with its positive ions or atoms. The motion of the electrons is opposed during the collisions.

39. State the SI unit of resistance.

The SI unit of resistance is ohm denoted by the symbol Ω

40. Define one ohm.

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 of the conductor is 1 ohm.

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

41. What is the relation between the resistance and current?

The current through a resistor is inversely proportional to its resistance.

42. Name the physical quantity whose unit is volt/ampere.

Resistance

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

When resistance is doubled, current becomes I/2. The reading of the ammeter is halved.

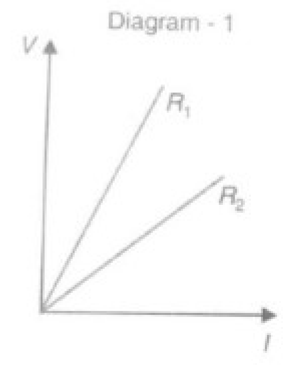
44. Two students perform experiments on two given resistors R1 and R2 and plot the V-I graphs as shown by diagrams. If R1 > R2, which of the two diagrams correctly represent the situation on the plotted curves? Justify your answer.

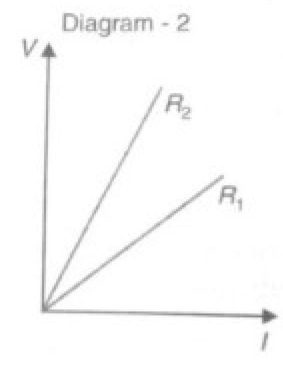
Resistance of a resistor = slope of V-I graph.

Given: R1 > R2

Slope of R1 > slope of R2.

Hence diagram-1 correctly represents the given situation.





45. How much current will an electric bulb draw from a 220 V source, if the resistance of the bulb filament is 1200 Ω? (b) How much current will an electric heater coil draw from a 220 V source, if the resistance of the heater coil is 100 Ω?

(a) V = 220 V; R = 1200 Ω.

Current I = 220 V/1200 Ω = 0.18 A.

(b) V = 220 V, R = 100 Ω.

Current I = 220 V/100 Ω = 2.2 A.

46. The potential difference between the terminals of an electric heater is 60 V when it draws a current of 4 A from the source. What current will the heater draw if the potential difference is increased to 120 V?

Potential difference V = 60 V, current I = 4 A.

According to Ohm's law,

$$R = \frac{V}{I} = \frac{60\ \text{V}}{4\ \text{A}} = 15\ \Omega.$$

When the potential difference is increased to 120 V the current is given by

$$\text{current} = \frac{V}{R} = \frac{120\ \text{V}}{15\ \Omega} = 8\ \text{A}.$$

The current through the heater becomes 8 A.

47. What is a rheostat?

A device used to change the magnitude of the current by changing the length of the resistance wire inserted into the circuit called variable resistance or rheostat.

48. What does the following symbol mean in the circuit diagram? Write its function.

The symbol represents variable resistance. It varies the resistance in the circuit there by changing the magnitude of the current.

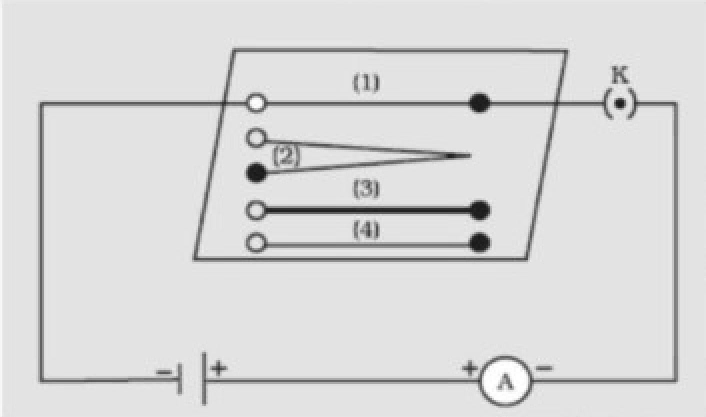
49. What is the difference between resistance and resistor?

Resistance	Resistor
The property by virtue of which a material opposes the flow of current through it is called resistance.	Any material which has some resistance is called a resistor.

50. What is the resistance of a closed plug key?

Almost zero.

51. What is the observation in the following activity?



We notice the following observations.

i. When the length of the wire is doubled, the ammeter reading decreases to one-half its initial value.

ii. When we use a thicker wire of the same material and of the same length, the current in the circuit increases.

iii. When we use copper wire of similar dimensions in place of the nichrome wire, the current in the circuit increases.

This activity helps us to conclude that the resistance of a conductor depends on a) its length, b) its area of cross-section, c) the nature of its material.

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

The resistance of a conductor depends:

a) On its length
b) On its area of cross-section
c) On the nature of its material
d) Temperature of the conductor

53. Explain the factors on which the resistance of a conductor depends.

Factors affecting the resistance: At constant temperature, the resistance of a conductor depends on the following factors:

a) Length: Resistance of a conductor is directly proportional to its length. $R \alpha L$

b) Area of cross-section: Resistance of a conductor is inversely proportional to its area of cross-section. $R \alpha \frac{1}{A}$

c) Nature of the material: Resistance also depends on the nature of the material of which the conductor is made. The resistance of a copper wire is much less than that of a nichrome wire of same length and area of cross-section.

$$R \alpha \frac{L}{A} \Rightarrow R = \rho \frac{L}{A}$$

d) Temperature: Resistance increases with increase in temperature because the random motion of electrons and the amplitude of vibration of fixed positive ions increase. As a result number of collision increases.

54. Name the property by virtue of which two conductors having identical structures offer different resistances to the flow of current when connected to the same source of electric current.

Resistivity of the material of the conductor.

55. Define resistivity.

Resistivity is defined as the resistance offered by a cube of material of side 1m when current flows perpendicular to its opposite faces.

$$\rho = \frac{R \times A}{L}$$

56. State the SI unit of resistivity.

SI unit of resistivity is ohm-meter (Ω m)

57. Distinguish between electrical resistance and resistivity of a conductor.

Resistance	Resistivity
Electrical resistance of a conductor changes with change in length or area of cross-section of the conductor.	Electrical resistivity of a conductor remains constant at a particular temperature.

58. A copper wire of resistivity $1.6\text{x}10^{-8}$ ohm-metre has a cross-sectional area of $20\text{x}10^{-4}\text{cm}^2$. Calculate the length of this wire required to make a 10 ohm coil.

$R=10\Omega, \rho = 1.6\text{x}10^{-8}$ ohm-metre.

$A=20\text{x}10^{-4}\text{cm}^2 = 20\text{x}10^{-8}\ \text{m}^2$

$$\rho = \frac{R \times A}{L}$$

$$L = \frac{RA}{\rho} = \frac{10 \times 20 \times 10^{-8}}{1.6\text{x}10^{-8}} = \frac{2000}{6} = 12.5\text{m}$$

59. A copper wire has diameter 0.5 mm and resistivity of $1.6 \times 10^{-8}\ \Omega$ m. What will be the length of this wire to make its resistance 10 Ω? How much does the resistance change if the diameter is doubled?

$\rho = 1.6\text{x}10^{-8}\Omega\text{m}$

$R = 10\Omega$

$$l = \frac{RA}{\rho} = \frac{10\text{x}3.14\text{x}\left(\frac{0.0005}{2}\right)^2}{1.6\text{x}10^{-8}} = \frac{10\text{x}3.14\text{x}25}{4\text{x}1.6} = 122.72\text{m}$$

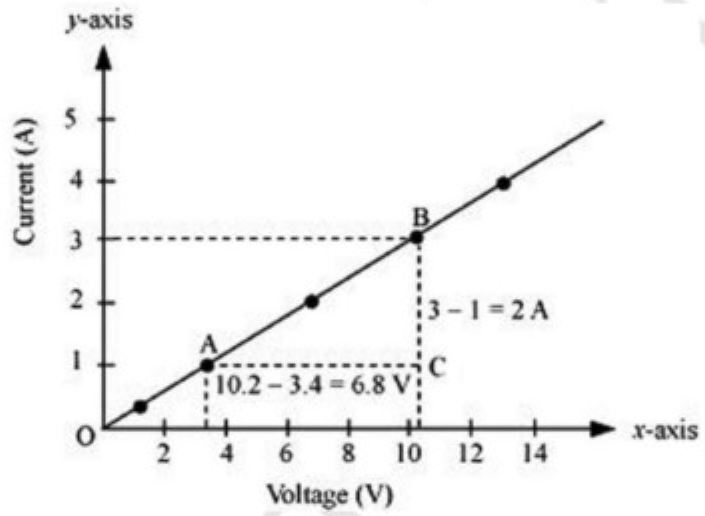
If the diameter of the wire is doubled, new diameter= 2 x 0.5 = 1 mm = 0.001m

$$R' = \rho\frac{l}{A} = \frac{1.6x10^{-8}x122.72}{\pi\left(\frac{1}{2}x10^{-3}\right)} = \frac{1.6x10^{-8}x122.72x4}{3.14x10^{-6}} = 250.2x10^{-2} = 2.5\Omega$$

60. The values of current I flowing in a given resistor for the corresponding values of potential difference V across the resistor are given below. Plot a graph between V and I and calculate the resistance of that resistor.

I (amperes)	0.5	1.0	2.0	3.0	4.0
V (volts)	1.6	3.4	6.7	10.2	13.2

The voltage is plotted on x-axis and current is plotted on y-axis.



The slope of the line gives the value of resistance (R) as,

$$\text{slope} = \frac{I}{R} = \frac{BC}{AC} = \frac{2}{6.8}$$

$$R = \frac{6.8}{2} = 3.4\Omega$$

The resistance of the resistor is 3.4Ω

61. Resistance of a metal wire of length 1 m is 26 Ω at 20°C. If the diameter of the wire is 0.3 mm, what will be the resistivity of the metal at that temperature?

Resistance R of the wire = 26 Ω, the diameter d = 0.3 mm = 3×10^{-4} m and the length l of the wire = 1 m.

The resistivity of the given metallic wire is

$$\rho = \frac{R\ x\ \pi d^2}{4L} = \frac{26\ x\ 3.14\ x\left(3x10^{-4}\right)^2}{4x1} = 1.84x10^{-6}\,\Omega m$$

$\rho = 1.84 \times 10^{-6}\ \Omega$ m

The resistivity of the metal at 20°C is $1.84 \times 10^{-6}\ \Omega$ m.

It is resistivity of manganese.

62. A wire of given material having length l and area of cross-section A has a resistance of 4 Ω. What would be the resistance of another wire of the same material having length l/2 and area of cross-section 2A?

For first wire

$$R_1 = \rho \frac{l}{A} = 4\Omega$$

Now for second wire

$$R_2 = \rho \frac{l/2}{2A} = \frac{1}{4} \rho \frac{l}{A}$$

$$R_2 = \frac{1}{4} R_1$$

$R_2 = 1\Omega$

The resistance of the new wire is 1Ω.

63. How can we classify solids on the basis of their resistivity values?

On the basis of the resistivity values, solids can be classified into three categories:

Conductors: Metals and their alloys have low resistivity in the range of $10^{-8}\Omega$m to $10^{-6}\Omega$m. These are good conductors of electricity. They offer low resistance to the flow of current. Copper & aluminium have lowest resistivities.

Insulators: These are substances which have large resistivities, more than $10^{4}\Omega$m. Insulators like glass and rubber have high resistivities in the range of $10^{12}\Omega$m to $10^{17}\Omega$m.

Semiconductors: These are the substances whose resistivities lie between those of conductors and insulators i.e. between 10^{-6} to $10^{-4}\Omega$m.

Ex: Germanium and silicon.

64. A wire of resistivity ρ is stretched to three times its length. What will be its new resistivity?

Resistivity remains unchanged as it does not depend on length. It depends on the nature of the material of the wire.

65. Two wires of equal lengths, one of copper and the other of nichrome have the same resistance. Which wire will be thicker?

Let copper and nichrome wire have equal length and equal resistances given by l and R respectively.

Since, resistance is $R = \rho l/A$, where A is the cross section of the wire

Thus, $A = \rho l/R$

Let A_1 and A_2 are the area of cross section of copper and nichrome respectively, hence, $A1/A2 = \rho 1/\rho 2$ ………(1)

Since resistivity of nichrome ρ2 is greater than that of resistivity of copper ρ1

Hence, from eq. 1, we find that nichrome wire has a greater cross section of area and hence is thicker from the copper wire.

66. Why do we use copper and aluminium wires for transmission of electric current?

This is because; copper and aluminium have low resistivity or high conductivity.

67. What happens to the resistance of a conductor when its area of cross section is increased?

As $R \alpha \frac{1}{A}$,the resistance decreases when area of cross section is increased.

68. A given length of wire is doubled on itself and this process is repeated once again. By what factor does the resistance of the wire change?

We know, $R = \rho \frac{L}{A}$

After the wire is doubled, $R = \rho \frac{\frac{L}{4}}{4 \times A} = \rho \frac{L}{16A} = \frac{R}{16}$

69. Which metal has the lowest resistivity?

Silver (resistivity = 1.60×10^{-8} ohm-metre)

70. Is the resistivity of an alloy lower or higher than that of its constituent metals?

The resistivity of an alloy is generally higher than that of pure metals which from the alloy.

71. How does the resistivity of an alloy like constantan change with temperature?

The resistivity of an alloy like constantan does not change with its temperature.

72. Which metal is used almost exclusively for filaments of electric bulb?

Tungsten

73. Name a metal which offers higher resistance to the passage of electricity than copper.

Aluminium

74. The following table gives the value of electrical resistivity of some materials. Which one is the best conductor of electricity out of them?

Material	Copper	Silver	Constantan
Electrical resistivity (inΩm)	1.62×10^{-8}	1.6×10^{-8}	49×10^{-4}

Since, silver has the least resistivity, it is the best conductor of electricity.

75. Will the current flow more easily through a thick wire or a thin wire of the same material, when connected to the same source? Why?

The current flows more easily through a thick wire than a thin wire of the same material. Larger the area of cross-section of a conductor, more is the ease with which, the electrons can move through the conductor. Hence smaller is the resistance of the conductor.

76. Let the resistance of an electrical component remains constant while the potential difference across the two ends of the component decreases to half of its former value. What change will occur in the current through it?

When potential difference is halved, the current through the component also decreases to half of its initial value. This is in accordance with Ohm's law.

77. Why are coils of electric toasters and electric irons made of an alloy rather than a pure metal?

The coils of electric toaster and electric iron are made of alloys instead of pure metal due to:

a) Alloys have higher resistivity than that of their constituent metals.

b) Alloys do not oxidize (or burn) readily at high temperatures.

78. Which among iron and mercury is a better conductor?

Resistivity of iron = $10 \times 10^{-8} \Omega m$

Resistivity of mercury is $94 \times 10^{-8} \Omega m$

So iron is a better conductor because it has lower resistivity than mercury.

79. Aluminium wire has a radius of 0.25mm and length 75m. If the resistance of the wire is 10Ω. Calculate the resistivity of aluminium.

R=0.25mm=0.25x10-3m, L=75m, R=10Ω

Resistivity $\rho = \frac{RA}{L} = \frac{R \times \pi r^2}{L} = \frac{10 \times 3.14\left(0.25 \times 10^{-3}\right)^2}{75} = 2.62 \times 10^{-8} \Omega m$

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

The volume of wire remains same in both cases.

Volume = Area of cross-section x length

$V = A'L' = AL$

$\frac{A'}{A} = \frac{L}{L'} = \frac{L}{2L} = \frac{1}{2}$

$\frac{R'}{R} = \frac{\rho \frac{L'}{A'}}{\rho \frac{L}{A}} = \frac{L'}{L} \times \frac{A}{A'} = \frac{2}{1} \times \frac{2}{1} = 4$

$R' = 4R = 4 \times 20 = 80 \Omega$

81. A wire of resistance 10Ω is drawn out so that its length is thrice its original length. Calculate its new resistance (resistivity and density of the wire remains unchanged)

The volume of wire remains same in both cases.

$$V = A'L' = AL$$

$$\frac{A'}{A} = \frac{L}{L'} = \frac{L}{3L} = \frac{1}{3}$$

$$\frac{R'}{R} = \frac{\rho\frac{L'}{A'}}{\rho\frac{L}{A}} = \frac{L'}{L} x \frac{A}{A'} = \frac{3}{1} x \frac{3}{1} = 9$$

$$R' = 9R = 9 \text{ x } 10 = 90\,\Omega$$

82. A wire has a resistance of 16Ω. It is melted and drawn into a wire of half its length. Calculate the resistance of the new wire. What is the percentage change in its resistance?

The volume of wire remains same in both cases.

$$V = A'L' = AL$$

$$\frac{A'}{A} = \frac{L}{L'} = \frac{L}{\frac{L}{2}} = \frac{2}{1}$$

$$\frac{R'}{R} = \frac{\rho\frac{L'}{A'}}{\rho\frac{L}{A}} = \frac{L'}{L} x \frac{A}{A'} = \frac{1}{2} x \frac{1}{2} = \frac{1}{4}$$

$$R' = \frac{1}{4}R = \frac{1}{4} \text{ x } 16 = 4\,\Omega$$

$$\text{Change in resistance} = \frac{R - R'}{R} x 100 = \frac{16 - 4}{16} x 100 = 75\%$$

83. What will be the resistance of a metal wire of length 2m and area of cross-section $1.55x10^{-6}m^2$, if the resistivity of the metal be $2.8x10^{-8}\Omega m$

Resistivity (ρ) = $2.8x10^{-8}m$

Area of cross-section (A) = $1.55x10^{-6}m^2$

Length of wire (l) = 2m

Resistance (R)=?

$$R = \rho\frac{L}{A}$$

$$R = 2.8x10^{-8} x \frac{2}{1.55x10^{-6}}$$

$$R = 3.613x10^{-2}\,\Omega$$

$$R = 0.03613\,\Omega$$

84. The resistance of a metal wire of length 1m is 25Ω at 20°C. If the diameter of the wire is 0.3mm,

a) What must be the resistivity of metal at that temperature?

b) What will be resistance of the wire of length 3m and diameter 0.5mm if the wire is of the same material?

a)

Resistivity (ρ) =?

Resistance (R) = 25Ω

Diameter (d) = $0.3\text{x}10^{-3}\text{m} = 3\text{x}10^{-4}\text{m}$

Length of wire (l) = 1m

Resistance (R)=?

$$R = \rho\frac{L}{A} = \frac{\rho L}{\pi\left(\frac{d}{2}\right)^2} = \frac{4\rho l}{\pi d^2}$$

$$\rho = \frac{\pi d^2 R}{4L}$$

$$= \frac{3.14\text{x}(3\text{x}10^{-4})^2\text{x}25}{4\text{x}1}$$

$$R = 1.77\text{x}10^{-6}\,\Omega\text{m}$$

b) $L' = 3\text{m}$

$d' = 0.5\text{x}10^{-3}\text{m} = 5\text{x}10^{-4}\text{m}$

$$R' = \frac{4\rho L'}{\pi(d')^2}$$

$$\frac{R'}{R} = \left(\frac{L'}{L}\right)\text{x}\left(\frac{d}{d'}\right)^2$$

$$R' = \left(\frac{L'}{L}\right)\text{x}\left(\frac{d}{d'}\right)^2\text{x R}$$

$$R' = \left(\frac{3}{1}\right)\text{x}\left(\frac{3\text{x}10^{-4}}{5\text{x}10^{-4}}\right)\text{x } 25 = 27\Omega$$

85. What is the need for using combination of resistances in an electrical circuit?

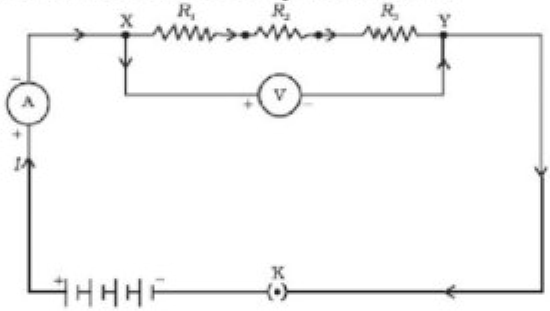
In order to obtain a desired value of current in an electrical circuit, a number of resistances have to be used. Resistances can be combined together in the following three ways:

i) Series combination ii) parallel combination iii) mixed combination

86. Write a note on resistances in series.

- The current has a single path for its flow. Hence the same current passes through each resistor and so the potential difference across any resistor is directly proportional to its resistance.
- The potential difference across the entire circuit is equal to the sum of the potential differences across the individual resistors.

$$V = V_1 + V_2 + V_3$$

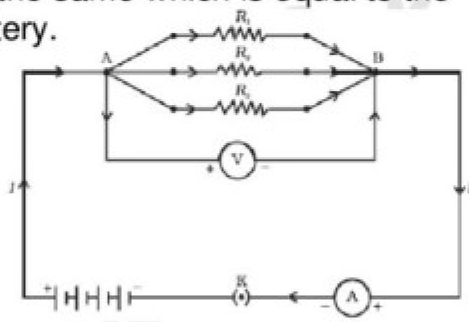


- When several resistors are joined in series, the resistance of the combination Rs equals the sum of their individual resistances, R1, R2, R3, and is thus greater than any individual resistance.

$R_S = R_1 + R_2 + R_3$

87. Write a note on resistances in parallel.

- The potential difference across each resistance is the same which is equal to the potential difference across the terminals of the battery.



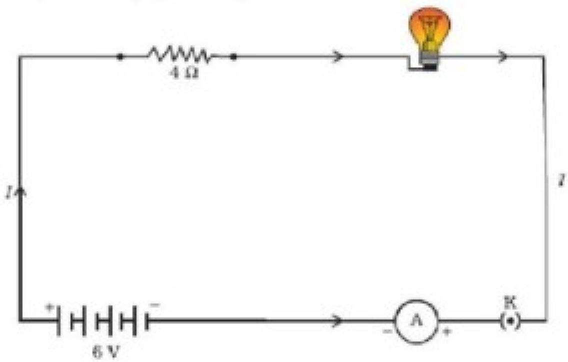
- The current in a resistor is inversely proportional to its resistance. The sum of the currents I_1, I_2, I_3 ... etc in the separate branches of the parallel circuit is equal to the current I drawn from the source

  $I = I_1 + I_2 + I_3$

- 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.

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

88. An electric lamp, whose resistance is 20 Ω, and a conductor of 4 Ω resistance are connected to a 6 V battery. Calculate (a) the total resistance of the circuit, (b) the current through the circuit, and (c) the potential difference across the electric lamp and conductor.



a)

The resistance of electric lamp, R1 = 20 Ω,

The resistance of the conductor connected in series, R2 = 4 Ω.

Then the total resistance in the circuit

R = R1 + R2

Rs = 20 Ω + 4 Ω = 24 Ω.

b)

The total potential difference across the two terminals of the battery

V = 6 V.

By Ohm's law, the current through the circuit is given by

I = V/Rs

= 6 V/24 Ω

= 0.25 A.

c)

Applying Ohm's law to the electric lamp and conductor separately,

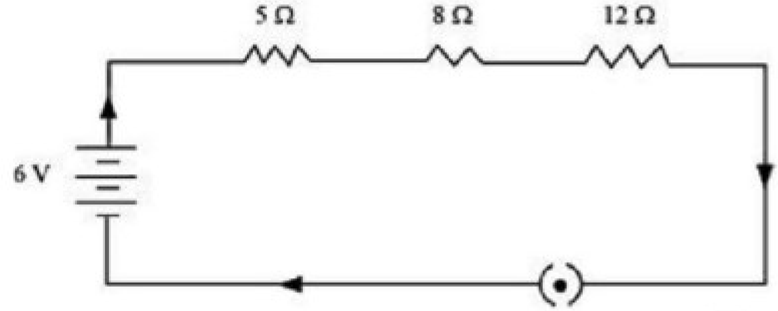
Potential difference across the electric lamp,

V1 = 20 Ω × 0.25 A= 5 V;

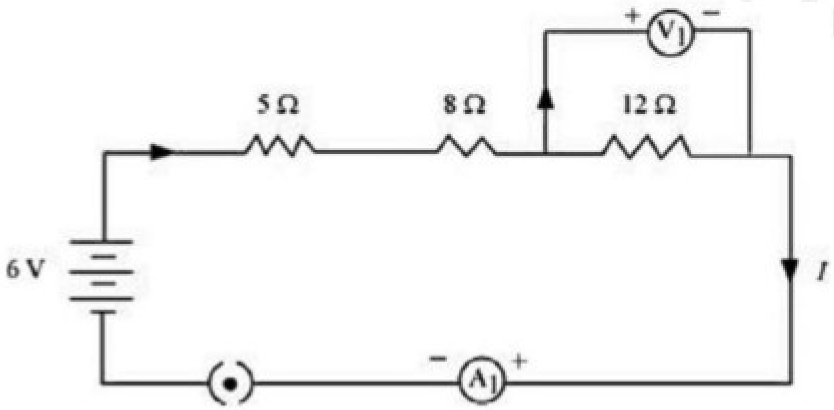
Potential difference across the conductor,

V2 = 4 Ω × 0.25 A= 1 V.

89. Draw a schematic diagram of a circuit consisting of a battery of three cells of 2 V each, a 5 Ω resistor, an 8 Ω resistor, and a 12 Ω resistor, and a plug key, all connected in series.



90. Redraw the circuit of Question 88, putting in an ammeter to measure the current through the resistors and a voltmeter to measure the potential difference across the 12 Ω resistor. What would be the readings in the ammeter and the voltmeter?



91. A battery of 9 V is connected in series with resistors of 0.2 Ω, 0.3 Ω, 0.4 Ω, 0.5 Ω and 12 Ω, respectively. How much current would flow through the 12 Ω resistor?

There is no current division occurring in a series circuit. Current flow through the component is the same, given by Ohm's law:

$v = IR$ or $I = \frac{V}{R}$ where, R is the equivalent resistance of resistances 0.2Ω, 0.3Ω, 0.4 Ω, 0.5 Ω and 12 Ω. These are connected in series. Hence, the sum of the resistances will give the value of R.

$R = 0.2 + 0.3 + 0.4 + 0.5 + 12 = 13.4\ \Omega$

Potential difference, $V = 9$ V

$$I = \frac{9}{13.4} = 0.671\text{A}$$

The current that would flow through the 12 Ω resistor is 0.671 A.

92. How many 176 Ω resistors (in parallel) are required to carry 5 A on a 220 V line?

For x number of resistors of resistance 176 Ω, the equivalent resistance of the resistors connected in parallel is given by Ohm's law as:

$V = IR$ or $R = \frac{V}{I}$ where, Supply voltage, $V = 220$ V, Current, $I = 5$ A

Equivalent resistance of the combination = R, given as

$$\frac{1}{R} = x \times \frac{1}{176} \Rightarrow R = \frac{176}{x}$$

$$\frac{V}{I} = \frac{176}{x}$$

$$x = \frac{176 \times I}{V} = \frac{176 \times 5}{220} = 4$$

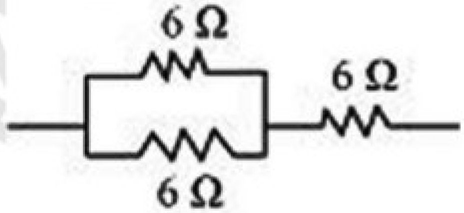
Therefore, four resistors of 176Ω are required to draw the given amount of current.

93. Show how you would connect three resistors, each of resistance 6 Ω, so that the combination has a resistance of (i) 9 Ω, (ii) 4 Ω.

If we connect the resistors in series, then the equivalent resistance will be the sum of the resistors, i.e., 6 Ω + 6 Ω + 6 Ω = 18 Ω, which is not desired. If we connect the resistors in parallel, then the equivalent resistance will be 6/3=2, which is also not desired. Hence, we should either connect the two resistors in series or parallel.

(i) Two resistors in parallel

Two 6 Ω resistors are connected in parallel. Their equivalent resistance will be

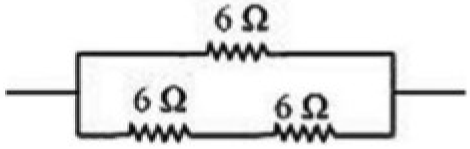


$$R = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2}} = \frac{1}{\frac{1}{6} + \frac{1}{6}} = \frac{1}{\frac{2}{6}} = \frac{6}{2} = 3\Omega$$

The third 6 Ω resistor is in series with 3 Ω. Hence, the equivalent resistance of the circuit is 6 Ω + 3 Ω = 9 Ω.

(ii) Two resistors in series

Two 6 Ω resistors are in series. Their equivalent resistance will be the sum 6 + 6 =12 Ω



The third 6 Ω resistor is in parallel with 12 Ω. Hence, equivalent resistance will be

$$R = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2}} = \frac{1}{\frac{1}{12} + \frac{1}{6}} = \frac{1}{\frac{3}{12}} = \frac{12}{3} = 4\Omega$$

Therefore, the total resistance is 4 Ω

94. Several electric bulbs designed to be used on a 220 V electric supply line, are rated 10 W. How many lamps can be connected in parallel with each other across the two wires of 220 V line if the maximum allowable current is 5 A?

Resistance R1 of the bulb is given by the expression,

$P_1 = \frac{V^2}{R_1} \Rightarrow R_1 = \frac{V^2}{P_1}$ where, Supply voltage, V = 220 V; Maximum allowable current, I = 5 A

Rating of an electric bulb, P_1=10W

$$R_1 = \frac{(220)^2}{5} = 4840\Omega$$

According to Ohm's law, V = I R where, R is the total resistance of the circuit for x number of electric bulbs

$$R = \frac{V}{I} = \frac{220}{5} = 44\Omega$$

Resistance of each electric bulb, R1 = 4840 Ω

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots \text{ upto x times}$$

$$\frac{1}{R} = \frac{1}{R_1} \times x$$

$$x = \frac{R_1}{R} = \frac{4840}{44} = 110$$

Therefore, 110 electric bulbs are connected in parallel.

95. A hot plate of an electric oven connected to a 220 V line has two resistance coils A and B, each of 24 Ω resistance, which may be used separately, in series, or in parallel. What are the currents in the three cases?

Supply voltage, V = 220 V

Resistance of one coil, R = 24Ω

(i) Coils are used separately

According to Ohm's law, $V_1 = I_1R_1$ where, I1 is the current flowing through the coil

$$I_1 = \frac{V}{R_1} = \frac{220}{24} = 9.166A$$

Therefore, 9.16 A current will flow through the coil when used separately.

(ii) Coils are connected in series

Total resistance, R_2 = 24 Ω + 24 Ω = 48 Ω

According to Ohm's law, $V_2 = I_2R_2$ where, I2 is the current flowing through the coil

$$I_2 = \frac{V}{R_2} = \frac{220}{48} = 4.58A$$

Therefore, 4.58A current will flow through the circuit when the coils are connected in series.

(iii) Coils are connected in parallel

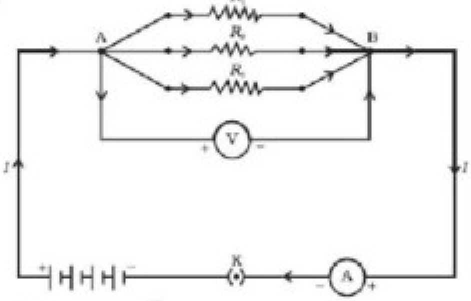
Total resistance, $R_3 = \dfrac{1}{\frac{1}{24} + \frac{1}{24}} = \dfrac{1}{\frac{2}{24}} = \dfrac{24}{2} = 12\Omega$

According to Ohm's law, $V_3 = I_3R_3$ where, I3 is the current flowing through the coil

$$I_3 = \frac{V}{R_3} = \frac{220}{12} = 18.33A$$

Therefore, 18.33 A current will flow through the circuit when coils are connected in parallel.

96. In the circuit diagram given, suppose the resistors R1, R2 and R3 have the values 5 Ω, 10 Ω, 30 Ω, respectively, which have been connected to a battery of 12 V. Calculate (a) the current through each resistor, (b) the total current in the circuit, and (c) the total circuit resistance.



R1 = 5 Ω, R2 = 10 Ω, and R3 = 30 Ω.

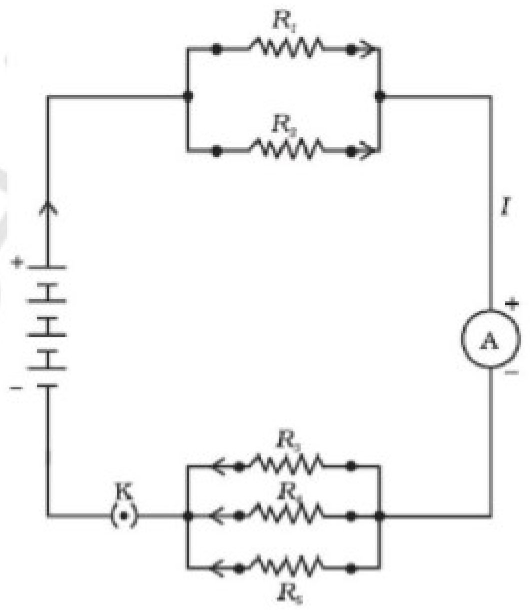
Potential difference across the battery V = 12 V.

This is also the potential difference across each of the individual resistor; therefore, to calculate the current in the resistors, we use Ohm's law.

The current I1, through R1 = V/ R1

I1 = 12 V/5 Ω = 2.4 A.

97. If in figure, R1 = 10 Ω, R2 = 40 Ω, R3 = 30 Ω, R4 = 20 Ω, R5 = 60 Ω, and a 12 V battery is connected to the arrangement. Calculate (a) the total resistance in the circuit, and (b) the total current flowing in the circuit.



Suppose we replace the parallel resistors R1 and R2 by an equivalent resistor of resistance, R′. Similarly we replace the parallel resistors R3, R4 and R5 by an equivalent single resistor of resistance R″.

1/ R′ = 1/10 + 1/40 = 5/40

R′ = 8 Ω.

Similarly, 1/ R″ = 1/30 + 1/20 + 1/60 = 6/60;

R″ = 10 Ω.

The total resistance, R = R′ + R″ = 18 Ω.

To calculate the current, use Ohm's law

I = V/R = 12 V/18 Ω = 0.67 A.

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

Ratio of currents in the two resistors is 1:1 because current is same in a series circuit.

99. Two resistors R1 and R2 may form (a) a series combination or (b) a parallel combination and the combination may be connected to a battery of 6 volts. (i) In which case will the potential difference across R1 and R2 be same?

ii) In which combination will the current through R1 and R2 be the same?

i) The potential difference around R1 and R2 will be in parallel combination.

ii) The current through R1 and R2 will be same in series.

100. Two conducting wires of same material, equal length and equal diameters are first connected in series and then in parallel.

OR

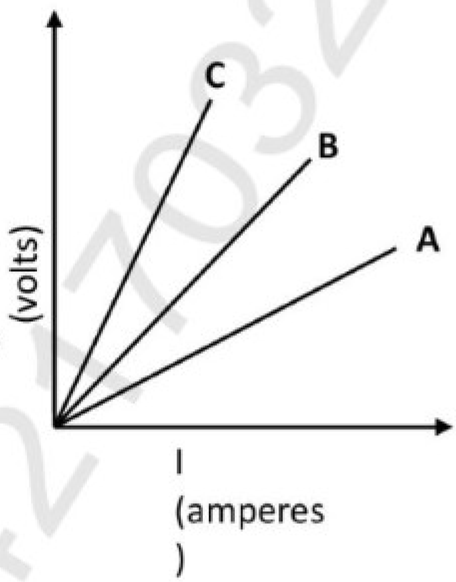
Two identical resistors are first connected in series and then in parallel. Find the ratio of equivalent resistance in two cases.

$R_s = R + R = 2R$

$$R_p = \frac{R \times R}{R + R} = \frac{R^2}{2R} = \frac{R}{2}$$

$$\frac{R_s}{R_p} = \frac{2R}{\frac{R}{2}} = 4:1$$

101. Three V-I graphs are drawn individually for two resistors and their series combinations. Out of A, B, C which one represents the graph for series combination of the other two.
Give reason for your answer.



Resistance of a resistor = slope of V-I graph.

Slope of C = Slope of A + slope of B

$R_C = R_A + R_B$

Hence C represents series combination of A & B

102. Two metallic wires A and B are connected in parallel. Wire A has length l and radius r, wire B has length 2l and radius 2r. Compare the ratio of the total resistances.

$$R_A = \rho\frac{l}{A} = \rho\frac{l}{\pi r^2}$$

$$R_B = \rho\frac{2l}{A} = \rho\frac{2l}{\pi(2r)^2} = \rho\frac{2l}{4\pi r^2} = \rho\frac{l}{2\pi r^2}$$

The resistance Rp of the parallel combination is given by

$$\frac{1}{R_p} = \frac{1}{R_A} + \frac{1}{R_B} = \frac{\pi r^2}{\rho l} + \frac{2\pi r^2}{\rho l} = \frac{3\pi r^2}{\rho l}$$

$$R_p = \frac{\rho l}{3\pi r^2}$$

$$\frac{R_p}{R_A} = \frac{\rho l}{3\pi r^2} \times \frac{\pi r^2}{\rho l} = \frac{1}{3}$$

$R_p : R_A = 1:3$

103. Judge the equivalent resistance when the following are connected in parallel – (a) 1 Ω and 106Ω, (b) 1 Ω and 103Ω and 106Ω.

(a) When 1 Ω and 106 Ω are connected in parallel:

Let R be the equivalent resistance.

$$\therefore \frac{1}{R} = \frac{1}{1} + \frac{1}{10^6}$$

$$R = \frac{10^6}{10^6 + 1} \approx \frac{10^6}{10^6} = 1\Omega$$

Therefore, equivalent resistance = 1 Ω

(b) When 1 Ω, 103Ω and 106Ω are connected in parallel:

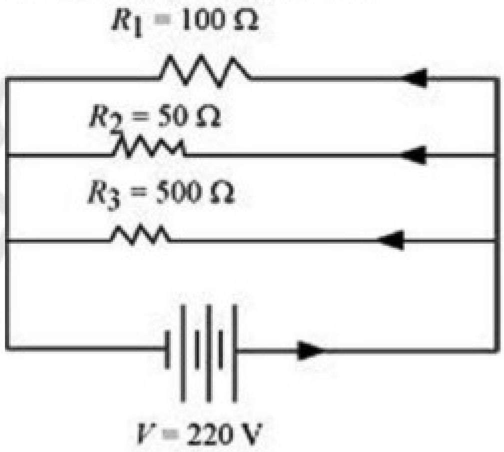
Let R be the equivalent resistance.

$$\frac{1}{R}=\frac{1}{1}+\frac{1}{10^3}+\frac{1}{10^6}=\frac{10^6+10^3+1}{10^6}$$

$$R=\frac{1000000}{1001001}=0.999\Omega$$

Therefore, equivalent resistance = 0.999 Ω

104. An electric lamp of 100 Ω, a toaster of resistance 50 Ω, and a water filter of resistance 500 Ω are connected in parallel to a 220 V source. What is the resistance of an electric iron connected to the same source that takes as much current as all three appliances, and what is the current through it?



Resistance of electric lamp, R1 = 100 Ω

Resistance of toaster, R2 = 50 Ω

Resistance of water filter, R3 = 500 Ω

Voltage of the source, V = 220 V

These are connected in parallel, as shown in the following figure.

Let R be the equivalent resistance of the circuit.

$$\frac{1}{R}=\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}=\frac{1}{100}+\frac{1}{50}+\frac{1}{500}$$

$$\Rightarrow\frac{1}{R}=\frac{5+10+1}{500}=\frac{16}{500}$$

$$\Rightarrow R=\frac{500}{16}\Omega$$

According to Ohm's law, $V=IR$

$I=\frac{V}{R}$ Where, Current flowing through the circuit $=I$

$$I=\frac{V}{R}=\frac{220}{500/16}=\frac{220\times16}{500}=7.04A$$

7.04 A of current is drawn by all the three given appliances.

Therefore, current drawn by an electric iron connected to the same source of potential 220 V = 7.04 A

Let R' be the resistance of the electric iron. According to Ohm's law,

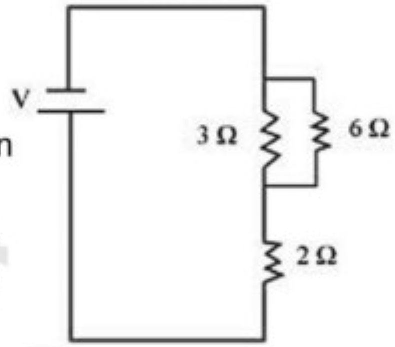
$$V=IR'\Rightarrow R'=\frac{V}{I}=\frac{220}{7.04}=31.25\Omega$$

Therefore, the resistance of the electric iron is 31.25 Ω and the current flowing through it is 7.04 A.

105. What are the advantages of connecting electrical devices in parallel with the battery instead of connecting them in series?

There is no division of voltage among the appliances when connected in parallel. The potential difference across each appliance is equal to the supplied voltage. The total effective resistance of the circuit can be reduced by connecting electrical appliances in parallel.

106. How can three resistors of resistances 2 Ω, 3 Ω and 6 Ω be connected to give a total resistance of (a) 4 Ω, (b) 1 Ω?



There are three resistors of resistances 2 Ω, 3 Ω and 6 Ω respectively.

(a) The following circuit diagram shows the connection of the three resistors.

Here, 6 Ω and 3 Ω resistors are connected in parallel.

Therefore, their equivalent resistance will be given by

$$R = \frac{1}{\frac{1}{R_1}+\frac{1}{R_2}} = \frac{1}{\frac{1}{6}+\frac{1}{3}} = \frac{6\times 3}{6+3} = 2\Omega$$

This equivalent resistor of resistance 2 Ω is connected to a 2 Ω resistor in series.

Therefore, equivalent resistance of the circuit = 2 Ω + 2 Ω = 4 Ω

Hence, the total resistance of the circuit is 4 Ω

All the resistors are connected in series. Therefore, their equivalent resistance will be given as

$$R = \frac{1}{\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}} = \frac{1}{\frac{1}{2}+\frac{1}{3}+\frac{1}{6}} = \frac{1}{\frac{3+2+1}{6}} = \frac{6}{6} = 1\Omega$$

Therefore, the total resistance of the circuit is 1 Ω

107. What is (a) the highest, (b) the lowest total resistance that can be secured by combinations of four coils of resistance 4 Ω, 8 Ω, 12 Ω, 24 Ω?

There are four coils of resistances 4 Ω, 8 Ω, 12 Ω and 24 Ω respectively

(a) If these coils are connected in series, then the equivalent resistance will be the highest, given by the sum 4 + 8 + 12 + 24 = 48 Ω

(b) If these coils are connected in parallel, then the equivalent resistance will be the lowest, given by

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

Therefore, 2 Ω is the lowest total resistance.

108. When a 12V battery is connected across an unknown resistor, there is a current of 2.5mA in the circuit. Find the value of the resistance of the resistor.

V=12V, I=2.5mA = 2.5x10-3A

$$R = \frac{V}{I} = \frac{12}{2.5x10^{-3}} = 4800\Omega$$

109. Why do we use parallel circuit arrangement for domestic wiring?

A parallel circuit divides the current through the electrical appliances. The total resistance in a parallel circuit is decreased. This is helpful particularly when each gadget has different resistance and requires different current to operate properly. When one component of the circuit fails rest of them work properly.

110. What are the disadvantages of connecting electrical devices in series?

In a series circuit the same amount of current passes throughout the electric circuit. This is impractical to connect an electric bulb and an electric heater in series; because they need currents of widely different values to operate properly. Another major disadvantage of a series circuit is that when one component fails the circuit is broken and none of the components works.

111. What is heating effect of current?

The effect of electric current due to which heat is produced in a wire when current is passed through it is called heating effect of current or Joule heating.

112. State Joule's law of heating.

The amount of heat produced in a conductor is:

(i) Directly proportional to the squire of the current through the conductor i.e. $H \alpha I^2$
(ii) Directly proportional to the resistance of the conductor i.e. $H \alpha R$
(iii) Directly proportional to the time for which the current is passed i.e. $H \alpha t$

113. Derive an expression for the work done in a conductor of resistance R on passing current I through it for time t

$W = Q \times V$

But $Q = I \times t$ and $V = I \times R$

$W = I \times t \times I \times R$

$W = I^2 \times R \times t$

114. Why does the cord of an electric heater not glow while the heating element does?

The heating element of an electric heater is a resistor. The amount of heat produced by it is proportional to its resistance. The resistance of the element of an electric heater is very high. As current flows through the heating element, it becomes too hot and glows red. On the other hand, the resistance of the cord is low. It does not become red when current flows through it.

115. Compute the heat generated while transferring 96000 coulomb of charge in one hour through a potential difference of 50 V.

Voltage $V = 50$ V

Time, $t = 1$ h $= 1 \times 60 \times 60$ s

The amount of heat (H) produced is given by the Joule's law of heating as $H = V I t$

$$\text{Amount of current } I = \frac{\text{Amount of charge}}{\text{Time of flow of charge}}$$

$$= \frac{96000}{1x60x60} = \frac{96000}{3600} = \frac{960}{36} = \frac{80}{3} A$$

$$H = 50x\frac{80}{3}x60x60 = 4.8x10^6 J$$

The heat generated is $4.8x10^6$ J

116. An electric iron of resistance 20 Ω takes a current of 5 A. Calculate the heat developed in 30 s.

Current, I = 5 A

Time, t = 30 s

The amount of heat (H) produced is given by the Joule's law of heating as

H=V I t

Voltage, V = Current × Resistance = 5 × 20 = 100 V

$H = 100 \times 5 \times 30 = 1.5 \times 10^4$ J

The amount of heat developed in the electric iron is 1.5×10^4 J

117. Define electric power.

Electric power of an appliance is the rate at which it consumes electric energy.

OR

It is the rate at which work is done in maintaining an electric current in an electric circuit.

118. Write the expression for power.

$$\text{Electric power } P = \frac{W}{t} = \frac{VIt}{t} = VI$$

$$P = VI = IRxI = I^2R$$

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

119. State the SI unit of power.

SI unit of power is watt.

120. Define 1 watt

One watt is the power consumed by a device that carries 1A of current when operated at a potential difference of 1V.

121. Define watt-hour.

Watt-hour is defined as the electric energy consumed by an appliance of 1 watt in one hour.

122. Name the commercial unit of electrical energy.

The commercial unit of electrical energy is kilowatt hour (kWh).

123. Define kilowatt-hour.

A kilowatt-hour is the energy supplied in 1 hour to an appliance whose power is 1kW or 1000W.

1kWh = 1 kilowatt x 1 hour = 1000 watt x 3600 seconds

$= 3.6 \times 10^6$ watt second.

$1 kWh = 3.6 \times 10^6 J$

124. What determines the rate at which energy is delivered by a current?

The rate of consumption of electric energy in an electric appliance is called electric power. Hence, the rate at which energy is delivered by a current is the power of the appliance.

125. An electric motor takes 5 A from a 220 V line. Determine the power of the motor and the energy consumed in 2 h.

Voltage, V = 220 V

Current, I = 5 A

Time, $t = 2 h = 2 \times 60 \times 60 = 7200 s$

P = VI

$P = 220 \times 5 = 1100 W$

Energy consumed by the motor = Pt

$P = 1100 \times 7200 = 7.92 \times 10^6 J$

Power of the motor = 1100 W

Energy consumed by the motor $= 7.92 \times 10^6 J$

126. An electric bulb is rated 220 V and 100 W. When it is operated on 110 V, the power consumed will be – (a) 100 W (b) 75 W (c) 50 W (d) 25 W

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

$$R = \frac{V^2}{P} = \frac{(220)^2}{100} = \frac{48400}{100} = 484\Omega$$

The resistance of the bulb remains constant if the supply voltage is reduced to 110V. If the bulb is operated on 110V, then the energy consumed by its is

$$P^1 = \frac{(V^1)^2}{R} = \frac{(110)^2}{484} = \frac{12100}{484} = \frac{1100}{44} = \frac{100}{4} = 25W$$

127. Compare the power used in the 2 Ω resistor in each of the following circuits: (i) a 6 V battery in series with 1 Ω and 2 Ω resistors, and (ii) a 4 V battery in parallel with 12 Ω and 2 Ω resistors.

(i) Potential difference, V = 6 V

1 Ω and 2 Ω resistors are connected in series.

Equivalent resistance of the circuit, R = 1 + 2 = 3 Ω

According to Ohm's law, V = IR

This current will flow through each component of the circuit because there is no division of current in series circuits.

Current flowing through the 2 Ωresistor is 2A.

$P = (I)^2 R = (2)^2 2 = 8W$

(ii) Potential difference, V = 4 V

12 Ω and 2 Ω resistors are connected in parallel. The voltage across each component of a parallel circuit remains the same.

Voltage across 2Ωresistor will be 4 V.

Power consumed by 2 Ω resistor is given by

Power used by 2 Ω resistor is 8 W.

128. 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. What current is drawn from the line if the supply voltage is 220 V?

Both the bulbs are connected in parallel. Therefore, potential difference across each of them will be 220 V, because no division of voltage occurs in a parallel circuit.

Current drawn by the bulb of rating 100 W is given by,

power = Voltage x current

$$\text{Current} = \frac{\text{power}}{\text{voltage}} = \frac{110}{220}\text{A}$$

Similarly, current drawn by the bulb of rating 100 W is given by,

$$\text{Current} = \frac{\text{power}}{\text{voltage}} = \frac{60}{220}\text{A}$$

$$\text{Hence, current drawn from the line} = \frac{110}{220} + \frac{60}{220} = \frac{170}{220} = 0.727\text{A}$$

129. Which uses more energy, a 250 W TV set in 1 hour or a 1200 W toaster in 10 minutes?

H = P x t

Energy consumed by a TV set of power 250 W in 1 h = 250 × 3600 = 9×10^5 J

Energy consumed by a toaster of power 1200 W in 10 minutes = 1200 × 600 = 7.2×10^5 J

Energy consumed by a 250 W TV set in 1 h is more than the energy consumed by a toaster of power 1200 W in 10 minutes.

130. An electric heater of resistance 8 Ω draws 15 A from the service mains 2 hours. Calculate the rate at which heat is developed in the heater.

R = 8 Ω

I = 15 A

$P= I^2R$

$P = 15^2 \times 8 = 225 \times 8 = 1800$ J/s

Heat is produced by the heater at the rate of 1800 J/s.

131. Explain why tungsten is used almost exclusively for filament of electric lamps.

The melting point and resistivity of tungsten are very high. It does not burn readily at a high temperature. The electric lamps glow at very high temperatures. Hence, tungsten is mainly used as heating element of electric bulbs.

132. Why are the conductors of electric heating devices, such as bread-toasters and electric irons, made of an alloy rather than a pure metal?

The conductors of electric heating devices such as bread toasters and electric irons are made of alloy because resistivity of an alloy is more than that of metals. It produces large amount of heat.

133. Why is the series arrangement not used for domestic circuits?

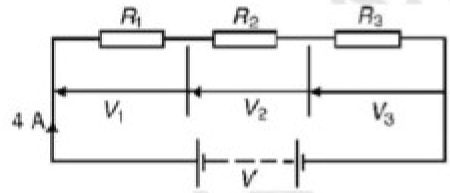
There is voltage division in series circuits. Each component of a series circuit receives a small voltage for a large supply voltage. As a result, the amount of current decreases and the device becomes hot. Hence, series arrangement is not used in domestic circuits.

134. How does the resistance of a wire vary with its area of cross-section?

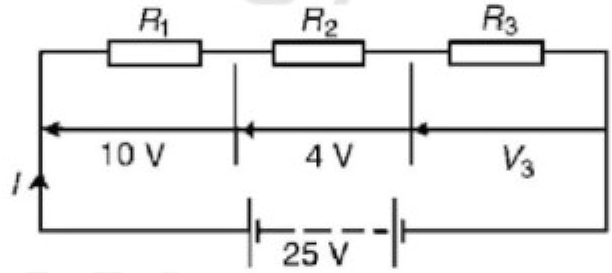
Resistance (R) of a wire is inversely proportional to its area of cross-section (A)

PRACTICE EXERCISE

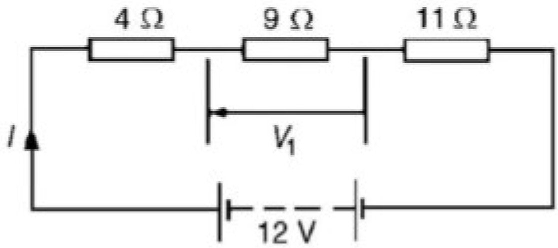
1. For the circuit shown in below Figure, determine (a) the battery voltage V, (b) the total resistance of the circuit, and (c) the values of resistance of resistors R1, R2 and R3, given that the p.d.'s across R1, R2 and R3 are 5 V, 2 V and 6 V respectively.



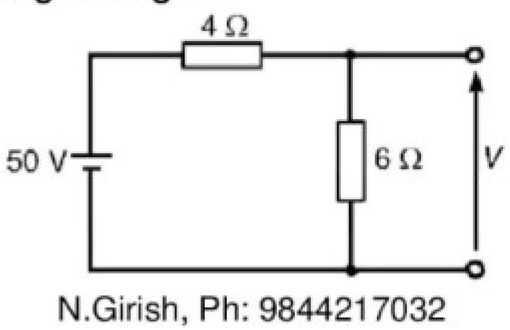
2. For the circuit shown in below Figure, determine the p.d. across resistor R3. If the total resistance of the circuit is 100Ω, determine the current flowing through resistor R1. Find also the value of resistor R2



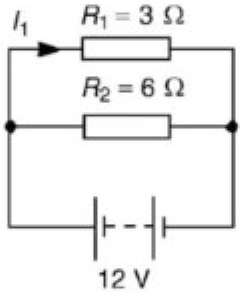
3. A 12 V battery is connected in a circuit having three series-connected resistors having resistances of 4 Ω, 9 Ω and 11 Ω. Determine the current flowing through, and the p.d. across the 9Ω resistor.



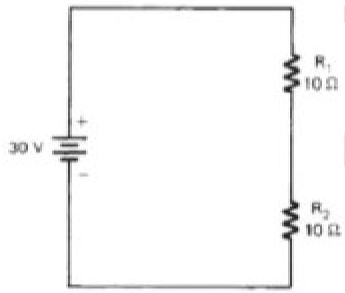
4. Find the voltage V in the given figure.



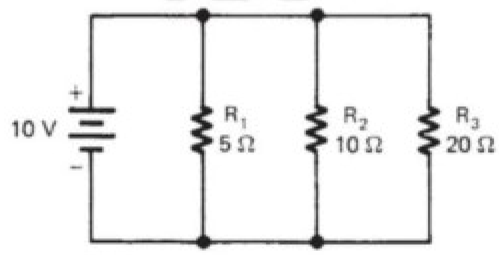
5. **Two resistors, of resistance 3Ω and 6Ω, are connected in parallel across a battery having a voltage of 12 V. Determine (a) the total circuit resistance and (b) the current flowing in the 3Ω resistor.**



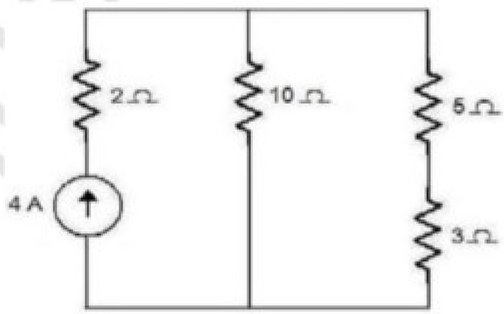
6. **Find the voltage across each resistance in the given circuit.**



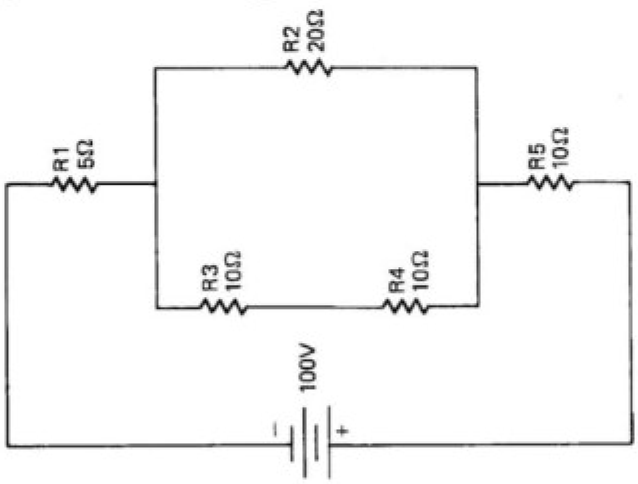
7. **Find the current across the each resistance and total current flowing in the given circuit.**



8. **Find the current through 10 ohm resistor for the following circuit.**

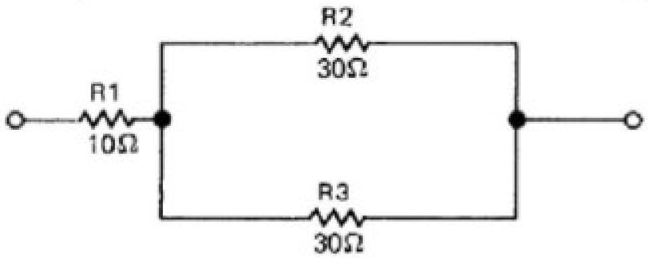


9. **In the given circuit, (i) find the equivalent resistance and total current flowing in the circuit. (ii) Find the voltage and current across each resistance in the circuit.**

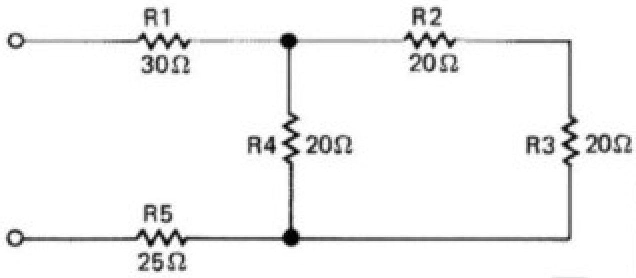


10. Find the equivalent resistance of the following circuits:

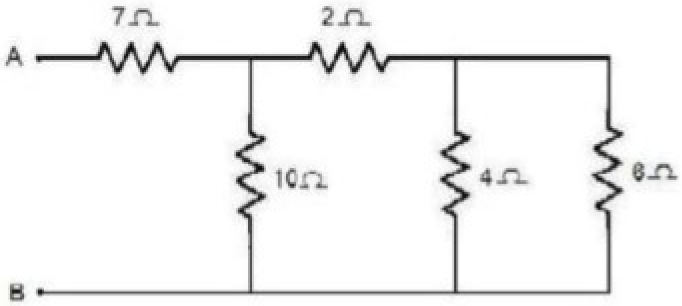
(i)



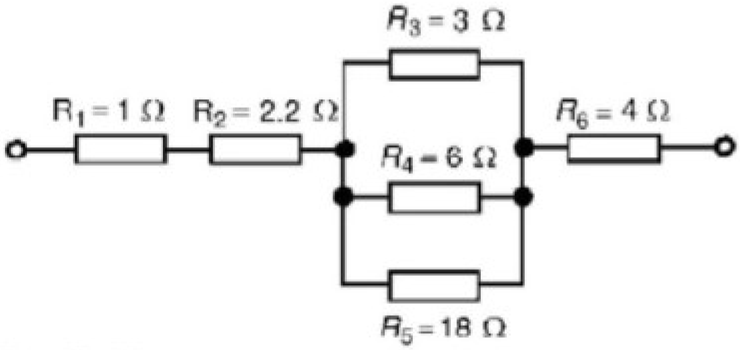
(ii)



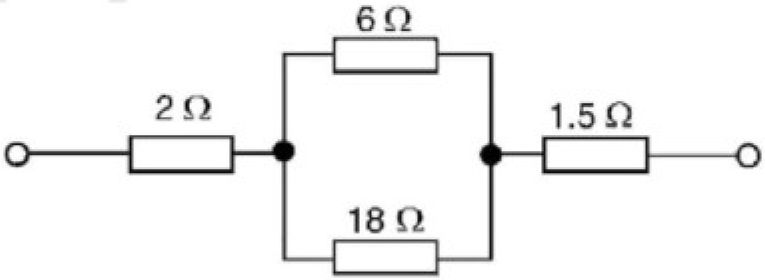
(iii)



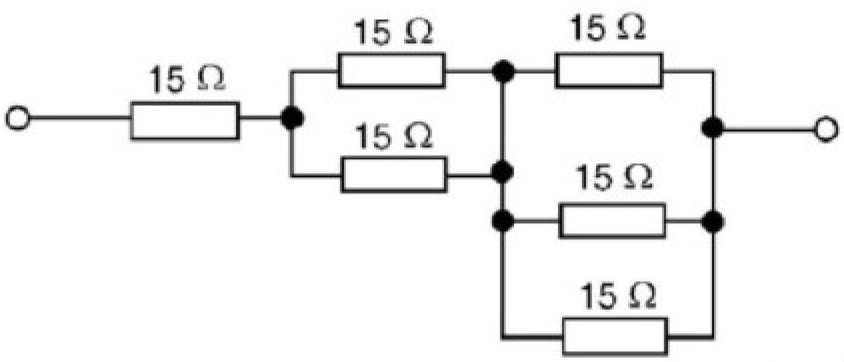
(iv)



(v)



(v)



Multiple Choice Questions:

1. **A piece of wire of resistance R is cut into five equal parts. These parts are then connected in parallel. If the equivalent resistance of this combination is R′, then the ratio R/R′ is:**

   (a) 1/25 (b) 1/5 (c) 5 **(d) 25**

2. **Which of the following terms does not represent electrical power in a circuit?**

   (a) I^2R **(b) IR^2** (c) VI (d) V^2/R

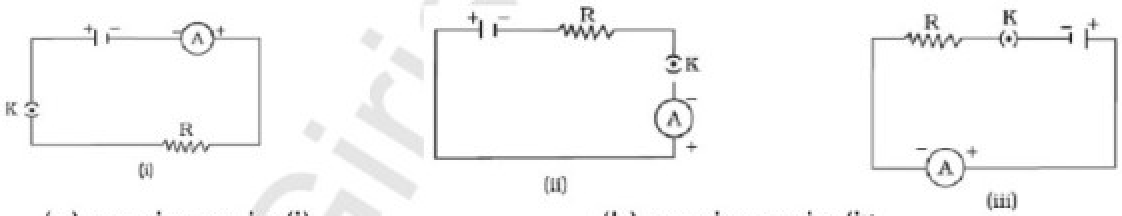
3. **An electric bulb is rated 220 V and 100 W. When it is operated on 110 V, the power consumed will be:**

   (a) 100 W (b) 75 W (c) 50 W **(d) 25 W**

4. **Two conducting wires of the same material and of equal lengths and equal diameters are first connected in series and then parallel in a circuit across the same potential difference. The ratio of heat produced in series and parallel combinations would be:**

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

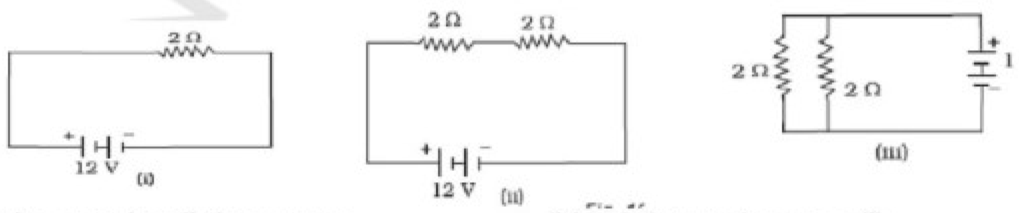
5. **A cell, a resistor, a key and ammeter are arranged as shown in the circuit diagrams. The current recorded in the ammeter will be:**



   (a) maximum in (i) (b) maximum in (ii)

   (c) maximum in (iii) **(d) the same in all the cases**

6. **In the following circuits, heat produced in the resistor or combination of resistors connected to a 12 V battery will be:**



   (a) same in all the cases (b) minimum in case (i)

   (c) maximum in case (ii) (d) maximum in case (iii)

7. **Electrical resistivity of a given metallic wire depends upon:**

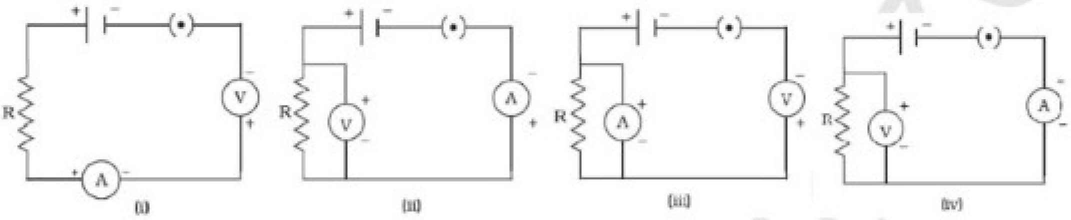
(a) its length (b) its thickness

(c) its shape **(d) nature of the material**

8. A current of 1 A is drawn by a filament of an electric bulb. Number of electrons passing through a cross section of the filament in 16 seconds would be roughly:

(a) 10^{20} (b) 10^{16} (c) 10^{18} (d) 10^{23}

9. Identify the circuit in which the electrical components have been properly connected:



(a) (i) **(b) (ii)** (c) (iii) (d) (iv)

10. What is the maximum resistance which can be made using five resistors each of 1/5 Ω?

(a) 1/5 Ω (b) 10 Ω (c) 5 Ω **(d) 1 Ω**

11. What is the minimum resistance which can be made using five resistors each of 1/5 Ω?

(a) 1/5 Ω **(b) 1/25 Ω** (c) 1/10 Ω (d) 25 Ω

12. The proper representation of series combination of cells,obtaining maximum potential is:

(a) (i) (b) (ii) (c) (iii) (d) (iv)

13. Which of the following represents voltage?

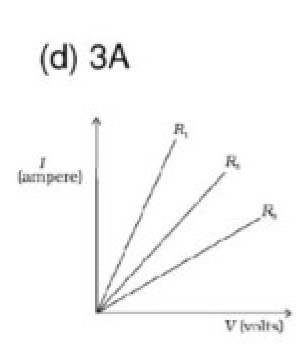
(a) $\frac{\text{Work done}}{\text{Current x time}}$ (b) Work done x charge

(c) $\frac{\text{Work done x time}}{\text{Current}}$ (d) Work done x charge x time

14. A cylindrical conductor of length l and uniform area of cross section A has resistance R. Another conductor of length 2l and resistance R of the same material has area of cross section

(a) A/2 (b) 3A/2 **(c) 2A** (d) 3A

15. A student carries out an experiment and plots the V-I graph of three samples of nichrome wire with resistances R1, R2 and R3 respectively. Which of the following is true?



(a) R1 = R2 = R3 (b) R1 > R2 > R3

(c) R3 > R2 > R1 (d) R2 > R3 > R1

16. If the current I through a resistor is increased by 100% (assume that temperature remains unchanged), the increase in power dissipated will be:

(a) 100% (b) 200% **(c) 300%** (d) 400%

17. The resistivity does not change if:

(a) the material is changed

(b) the temperature is changed

(c) the shape of the resistor is changed

(d) both material and temperature are changed

18. In an electrical circuit three incandescent bulbs A, B and C of rating 40W, 60W and 100W respectively are connected in parallel to an electric source. Which of the following is likely to happen regarding their brightness?

(a) Brightness of all the bulbs will be the same

(b) Brightness of bulb A will be the maximum

(c) Brightness of bulb B will be more than that of A

(d) Brightness of bulb C will be less than that of B

19. In an electrical circuit two resistors of 2 Ω and 4 Ω respectively are connected in series to a 6 V battery. The heat dissipated by the 4 Ω resistor in 5 s will be

(a) 5 J (b) 10 J **(c) 20 J** (d) 30 J

20. An electric kettle consumes 1 kW of electric power when operated at 220 V. A fuse wire of what rating must be used for it?

(a) 1 A (b) 2 A (c) 4 A **(d) 5 A**

21. Two resistors of resistance 2 Ω and 4 Ω when connected to a battery will have:

(a) same current flowing through them when connected in parallel

(b) same current flowing through them when connected in series

(c) same potential difference across them when connected in series

(d) different potential difference across them when connected in parallel

22. Unit of electric power may also be expressed as:

(a) volt ampere **(b) kilowatt hour** (c) watt second (d) joule second

Fill in the blanks:

1. A continuous and closed path of an electric current is called an electric circuit.
2. The SI unit of electric charge is coulomb (C).
3. The electric current is expressed by a unit called ampere (A).
4. 1 Milliampere = 10^{-3}A.
5. 1 microampere = 10^{-6}A.
6. An ammeter is always connected in series in a circuit through which the current is to be measured.
7. Electric current flows in the circuit from the positive terminal of the cell to the negative terminal of the cell.
8. Potential difference (V) between two points = Work done (W)/Charge (Q).

9. The SI unit of electric potential difference is volt (V).
10. The voltmeter is always connected in parallel across the points between which the potential difference is to be measured.
11. The property of a conductor to resist the flow of charges through it is called resistance.
12. The SI unit of resistance is ohm.
13. If the potential difference across the two ends of a conductor is 1V and the current through it is 1A, then the resistance R, of the conductor is 1Ω.
14. The current through a resistor is inversely proportional to its resistance.
15. A component used to regulate current without changing the voltage source is called variable resistance/Rheostat.
16. A device called rheostat is often used to change the resistance in the circuit.
17. A conductor having some appreciable resistance is called a resistor.
18. The SI unit of resistivity is Ωm.
19. Resistance and resistivity of a material vary with temperature.
20. The resistivity of an alloy is higher than that of its constituent metals.
21. Tungsten is used exclusively for filaments of electric bulbs.
22. Copper and aluminium are generally used for electrical transmission lines.
23. In a series combination of resistors the current is the same in every part of the circuit or the same current through each resistor.
24. The total potential difference across a combination of resistors in series is equal to the sum of potential difference across the individual resistors.
25. In a series circuit the current is constant throughout the electric circuit.
26. In a series circuit when one component fails the circuit is broken and none of the components works.
27. A parallel circuit divides the current through the electrical gadgets.
28. The effect utilised in devices such as electric heater, electric iron is heating effect of electric current.
29. The generation of heat in a conductor is an inevitable consequence of electric current.
30. The filament of a bulb should have a high melting point.
31. The material used in the filament of an electric bulb is tungsten.
32. Electric bulbs are usually filled with chemically inactive nitrogen/argon gas to prolong the life of filament.
33. A fuse protects circuits and appliances by stopping the flow of any unduly high electric current.
34. The fuse is placed in series with the device.
35. For an electric iron which consumes 1 kW electric power when operated at 220 V, a 5A fuse must be used.
36. The rate at which electric energy is consumed in an electric circuit is called as electric power.
37. The SI unit of electric power is watt (W).

38. The power consumed by a device that carries 1 A of current when operated at a potential difference of 1 V is 1 watt.

39. The commercial unit of electric energy is kilowatt hour (kW h).

40. 1 kW h = 3,600,000 J = 3.6×10^6 J.