CERT FOLDER

ext Questions

1 What does an electric circuit mean? **Pg 200**

Sol. A closed and continuous path of electric current is known as electric circuit.

2 Define the unit of electric current. **Pg 200**

Sol. The SI unit of electric current is ampere (A).

The current flowing through a conductor is said to be 1A, if a charge of 1coulomb (C) flows through it in 1second (s)

or $1\text{A} = \dfrac{1\text{C}}{1\text{s}}$

3 Calculate the number of electrons constituting one coulomb of charge. **Pg 200**

Sol. We know that, charge on one electron $= 1.6 \times 10^{-19}$C

$\Rightarrow 1.6 \times 10^{-19}$ coulomb charge in 1 electron.

$\therefore$ 1 coulomb charge $= \dfrac{1}{1.6 \times 10^{-19}} \simeq 6 \times 10^{18}$ electrons

4 Name a device that helps to maintain a potential difference across a conductor. **Pg 202**

Sol. Electric cell or battery is a device that helps to maintain a potential difference across a conductor.

5 What is meant by saying that the potential difference between two points is 1 V? **Pg 202**

Sol. The potential difference between two points is said to be 1 V if 1 J of work is done in moving 1 coulomb of electric charge from one point to other point.

6 How much energy is given to each coulomb of charge passing through a 6 V battery? **Pg 202**

Sol. Given, charge, $q = 1$ C, potential, $V = 6$ V, $W = ?$

As we know, $W = q\,V = 1 \times 6 = 6$ J

6 J is given to each coulomb of charge passing through a 6V battery.

7 On what factors does the resistance of a conductor depend? **Pg 209**

Sol. The resistance of a conductor depends on following factors :

(i) Length of the conductor.
(ii) Area of cross-section of the conductor.
(iii) Nature of material of the conductor.

8 Will current flow more easily through a thick wire or a thin wire of the same material, when connected to the same source? Why? **Pg 209**

Sol. Resistance is inversely proportional to the area of cross-section of the wire. Since, thick wire has a large area of cross-section, its resistance will be less. Thus, current will flow more easily through the thick wire.

9 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? **Pg 209**

Sol. Let resistance be R. Potential difference V across the two ends becomes $V/2$. Since, $I = V/R$

As $V \rightarrow V/2$, $\quad I = \dfrac{V}{2R} = \dfrac{1}{2}I$

In other words, current through the component becomes half of its original value.

10 Why are coils of electric toasters and electric irons made of alloy rather than a pure metal? **Pg 209**

Sol. Alloys have a higher resistivity than their constituent metals. They do not oxidise or burn at higher temperatures as they have high melting point. Thus, they are used to make coils of electrical toasters and electric irons rather than pure metals.

11 Use the given table to answer the questions.

Electrical Resistivity of Some Substances at 20° C

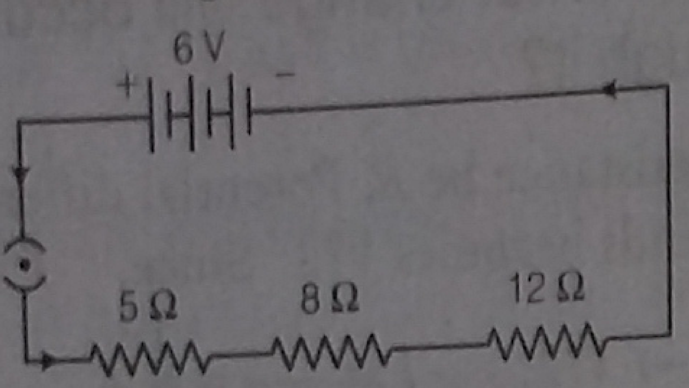
	Material	Resistivity (Ω-m)
Conductors	Silver	1.60×10^{-8}
	Copper	1.62×10^{-8}
	Aluminium	2.63×10^{-8}
	Tungsten	5.20×10^{-8}
	Nickel	6.84×10^{-8}
	Iron	10.0×10^{-8}
	Chromium	12.9×10^{-8}
	Mercury	94.0×10^{-8}
	Manganese	1.84×10^{-6}
Alloys	Constantan (Cu + Ni)	49×10^{-6}
	Manganin (Cu + Mn + Ni)	44×10^{-6}
	Nichrome (Ni + Cr + Mn + Fe)	100×10^{-6}
Insulators	Glass	10^{10}-10^{14}
	Hard rubber	10^{13}-10^{16}
	Ebonite	10^{15}-10^{17}
	Diamond	10^{12}-10^{13}
	Dry paper	10^{12}

(i) Which among iron and mercury is a better conductor?
(ii) Which material is the best conductor? **Pg 209**

The substance which has less resistivity is a better conductor.
(i) Iron is a better conductor than mercury.
(ii) Silver is the best conductor as it has the least resistivity.

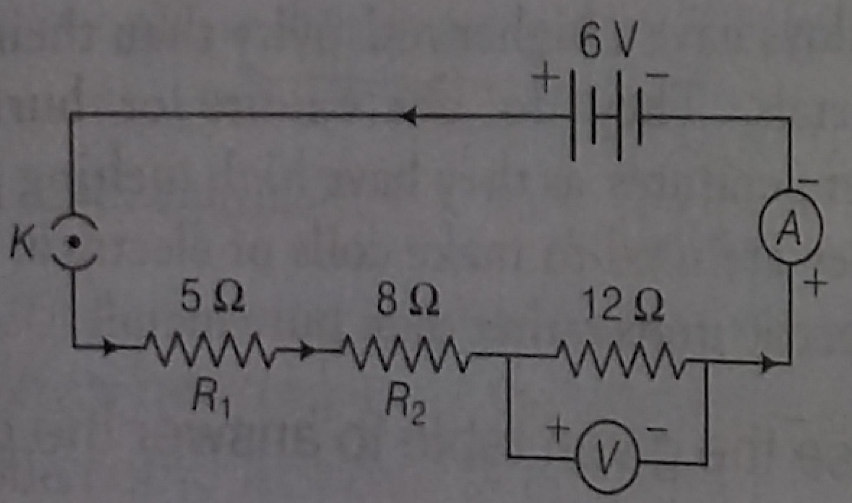
12 Draw a schematic diagram of a circuit consisting of a battery of three cells of 2 V each, a 5 Ω resistor, a 8 Ω resistor and a 12 Ω resistor and a plug key, all connected in series. **Pg 213**

Sol. The schematic diagram is shown as below:



13 Redraw the above circuit, putting in an ammeter to measure the current through the resistors and a voltmeter to measure the potential difference across 12 Ω resistor. What would be the readings in ammeter and voltmeter? **Pg 213**

Sol.



Equivalent resistance of the circuit,

$$R = R_1 + R_2 + R_3 = 5 + 8 + 12 = 25\,\Omega$$

[∵ R_1, R_2 and R_3 are connected in series]

In series combination, current flowing through all the resistances is same and equal to the total current flowing through the circuit.

∴ Current in the resistors, $I = \frac{V}{R} = \frac{6}{25} = 0.24$ A

∴ Ammeter reading = 0.24 A

Potential across 12 Ω resistance,

$$V = IR = 0.24 \times 12 = 2.88\text{ V}$$

∴ Voltmeter reading is 2.88 V.

14 Judge the equivalent resistance when the following are connected in parallel
(i) 1 Ω and 10^6 Ω
(ii) 1 Ω, 10^3 Ω and 10^6 Ω. **Pg 216**

Sol. (i) 1 Ω (ii) 1 Ω

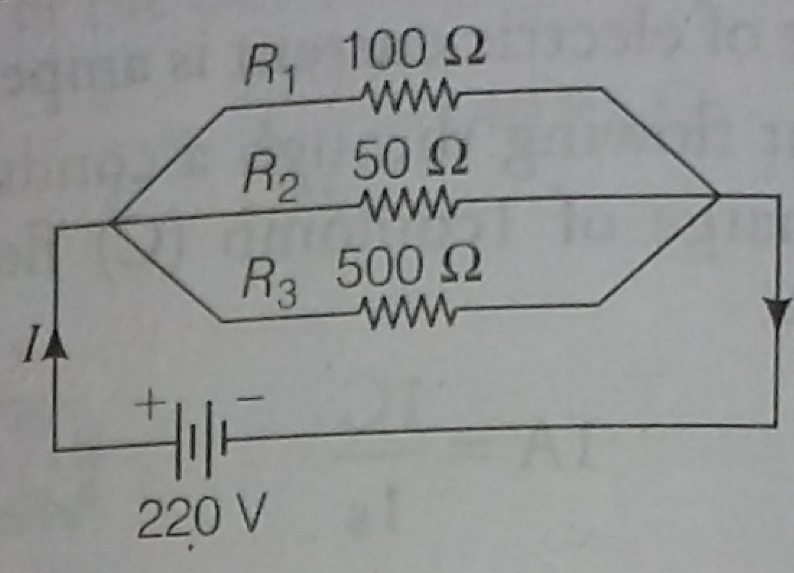
When resistors are connected in parallel, then the equivalent resistance is less than the least resistance connected in the combination. In both the above cases, the equivalent resistance is less than 1 Ω but is approximately 1 Ω.

15 An electric lamp of 100 Ω, a toaster of 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 the three appliances and what is the current through it? **Pg 216**

Sol. Let resistance of lamp be $R_1 = 100\,\Omega$

Resistance of toaster be $R_2 = 50\,\Omega$

Resistance of filter be $R_3 = 500\,\Omega$



Net resistance,

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

[∵ R_1, R_2 and R_3 are connected in parallel]

$$\frac{1}{R} = \frac{1}{100} + \frac{1}{50} + \frac{1}{500} = \frac{16}{500} \text{ or } R = \frac{500}{16} = 31.25\,\Omega$$

So, resistance of iron to take same current as much current drawn by all the appliances should be 31.25 Ω.

Current through circuit,

$$I = \frac{V}{R} = \frac{220}{31.25} = 7.04\text{ A}$$

Thus, current through iron is 7.04 A.

16 What are the advantages of connecting electrical appliances in parallel with the battery instead of connecting them in series? **Pg 216**

Sol. Following are the advantages of connecting electrical devices in parallel with the battery:

(i) Parallel circuits divides the current among the electrical devices, so that they can have necessary amount of current to operate properly.

(ii) If one of the devices in a parallel combination fuses or fails, then the other devices keep working without being affected.

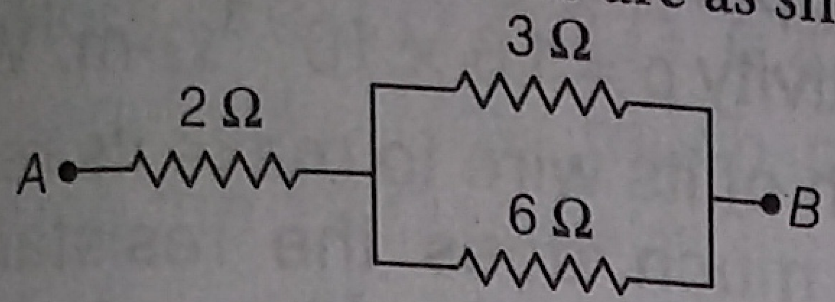
17 How can three resistors of resistances 2 Ω, 3 Ω and 6 Ω be connected to give a total resistance of
(i) 4 Ω (ii) 1 Ω? **Pg 216**

Sol. (i) If 3 Ω and 6 Ω are connected in parallel, thus equivalent resistance of parallel combination

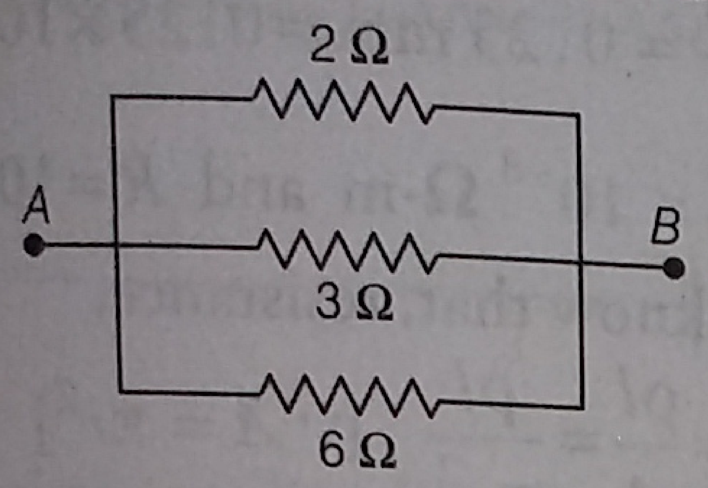
$$= \frac{1}{1/3 + 1/6} = 2\,\Omega$$

If this combination is connected in series with 2 Ω resistance, then total equivalent resistance $= 2\,\Omega + 2\,\Omega = 4\,\Omega$.

The resistor connections are as shown below:



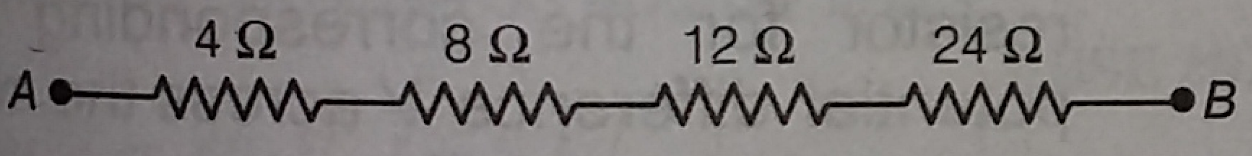
(*ii*) Since, equivalent resistance is less than the least value of resistance (i.e. 2 Ω), it means that all three resistors are connected in parallel.



$$\text{Equivalent resistance} = \frac{1}{\frac{1}{2}+\frac{1}{3}+\frac{1}{6}} = 1\ \Omega$$

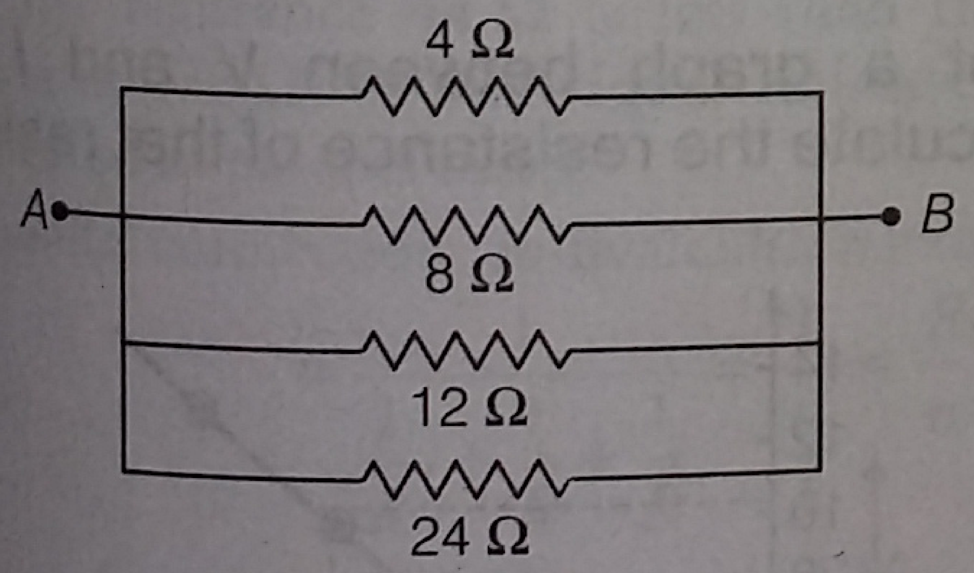
18 What is (*i*) the highest and (*ii*) the lowest total resistance which can be secured by combinations of four coils of resistances 4 Ω, 8 Ω, 12 Ω and 24 Ω? **Pg 216**

Sol. (*i*) Resistance is maximum when resistors are connected in series.



$$R_{max} = 4+8+12+24 = 48\ \Omega$$

(*ii*) Resistance is minimum when resistors are connected in parallel.



$$R_{min} = 1/\left[\frac{1}{4}+\frac{1}{8}+\frac{1}{12}+\frac{1}{24}\right] = \frac{24}{12}\ \Omega = 2\ \Omega$$

19 Why does the cord of an electric heater not glow while heating element does? **Pg 218**

Sol. The cord of an electric heater has lesser resistance than its heating element. So, more heat is produced in the heating element than the cord and it glows.

20 Compute the heat generated while transferring 96000 C of charge in one hour through a potential difference of 50 V? **Pg 218**

Sol. Given, Charge, $q = 96000$ C, Time, $t = 1\text{ h} = 3600$ s

Potential difference, $V = 50$ V

We know that,

Heat generated, $H = VIt = \frac{Vqt}{t}$ $\left[\because I = \frac{q}{t}\right]$

$= Vq = 50 \times 96000 = 4800000\text{ J} = 4800\text{ kJ}$

4800 kJ is generated while transferring 96000 C of charge.

21 An electric iron of resistance 20 Ω takes a current 5 A. Calculate the heat developed in 30 s. **Pg 218**

Sol. Given, Resistance, $R = 20\ \Omega$,

Current, $I = 5$ A, Time, $t = 30$ s

We know that,

Heat developed, $H = I^2Rt$

$= (5)^2 \times 20 \times 30 = 5 \times 5 \times 20 \times 30 = 15000\text{ J} = 15\text{ kJ}$

15 kJ heat is developed in 30 s.

22 What determines the rate at which energy is delivered by a current? **Pg 220**

Sol. Electric power determines the rate at which energy is delivered by a current.

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

Sol. Given, $I = 5$ A, $V = 220$ V, $t = 2$ h

∴ Power of motor,

$P = VI = 220 \times 5 = 1100\text{ W} = 1.1\text{ kW}$

∴ Energy consumed $= Pt = 1.1 \times 2 = 2.2$ kWh

Thus, the power of the motor is 1.1 kW and energy consumed is 2.2 kWh.

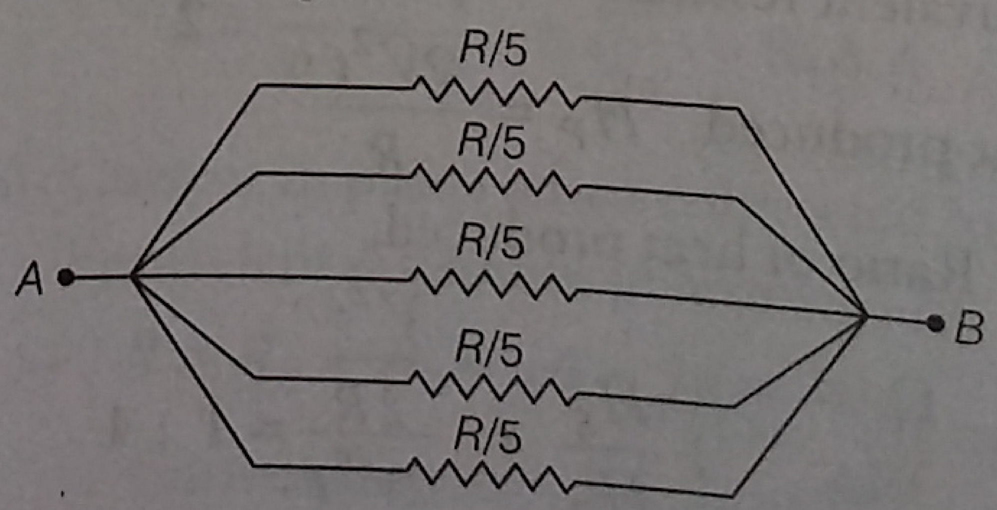
EXERCISES

(On Pages 221 and 222)

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

(a) $\frac{1}{25}$ (b) $\frac{1}{5}$ (c) 5 (d) 25

Sol. (*d*) Resistance of complete wire is R. If it is cut into 5 equal parts, then resistance of each part will be $\frac{R}{5}$. Five parts of resistance $\frac{R}{5}$ each are connected in parallel as shown in the figure



Equivalent resistance,

$$R' = \frac{1}{\left(\frac{1}{R/5}\right)+\left(\frac{1}{R/5}\right)+\left(\frac{1}{R/5}\right)+\left(\frac{1}{R/5}\right)+\left(\frac{1}{R/5}\right)} = \frac{1}{\frac{25}{R}} = \frac{R}{25}$$

$$\therefore \quad \text{Ratio, } \frac{R}{R'} = \frac{R}{\frac{R}{25}} = 25$$

2 Which of the following terms does not represent electric power in a circuit?

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

(*b*) $\therefore$ Electric power $= VI = I\,R \times I = I^2\,R$ $[\because V = IR]$

or $VI = V\dfrac{V}{R} = \dfrac{V^2}{R}$ $\left[\because I = \dfrac{V}{R}\right]$

So, IR^2 does not represent electric power.

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

Sol. (*d*) Given, $V = 220$ V, $P = 100$ W

$\therefore$ Resistance of bulb, $R = V^2/P$

$= \dfrac{220 \times 220}{100} = 484\ \Omega$

Now, when $V = 110$ V,

then power consumed,

$P = \dfrac{V^2}{R} = \dfrac{110 \times 110}{484} = 25$ W

4 Two conducting wires of 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

Sol. (*c*) Let R be the resistance of each wire. The resistance of both the wires will be same because they are of same material and have same length and same cross- sectional area. Equivalent resistance in series

$= R + R = 2R$

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

If wires are connected in series, then $H_S = \dfrac{V^2t}{2R}$

Equivalent resistance in parallel $= \dfrac{R}{2}$

Heat produced, $H_P = \dfrac{2V^2t}{R}$

$\because$ Ratio of heat produced,

$$\frac{H_S}{H_P} = \frac{\frac{V^2t}{2R}}{\frac{2V^2t}{R}} = 1 : 4$$

Thus, the ratio of H_S and H_P is 1:4.

5 How is voltmeter connected in circuit to measure the potential difference between the two points?

Sol. A voltmeter is always connected in parallel in the circuit to measure the potential difference between two points.

6 A copper wire has diameter 0.5 mm and resistivity $\rho = 1.6 \times 10^{-8}\ \Omega$-m. What will be the length of its wire to make its resistance 10 Ω? How much does the resistance change, if diameter is doubled? **CBSE 2014**

Sol. Given, radius of wire = diameter / 2

$= \dfrac{0.5}{2} = 0.25$ mm $= 0.25 \times 10^{-3}$ m,

$\rho = 1.6 \times 10^{-8}\ \Omega$-m and $R = 10\ \Omega$

(*i*) We know that, resistance,

$R = \dfrac{\rho l}{A} = \dfrac{\rho l}{\pi r^2}$ $[\because A = \pi r^2]$

or $l = \dfrac{R\pi r^2}{\rho} = \dfrac{10 \times 3.14 \times 0.25 \times 0.25 \times 10^{-6}}{1.6 \times 10^{-8}}$

$= 122.66$ m

(*ii*) Resistance, $R \propto \dfrac{1}{d^2}$

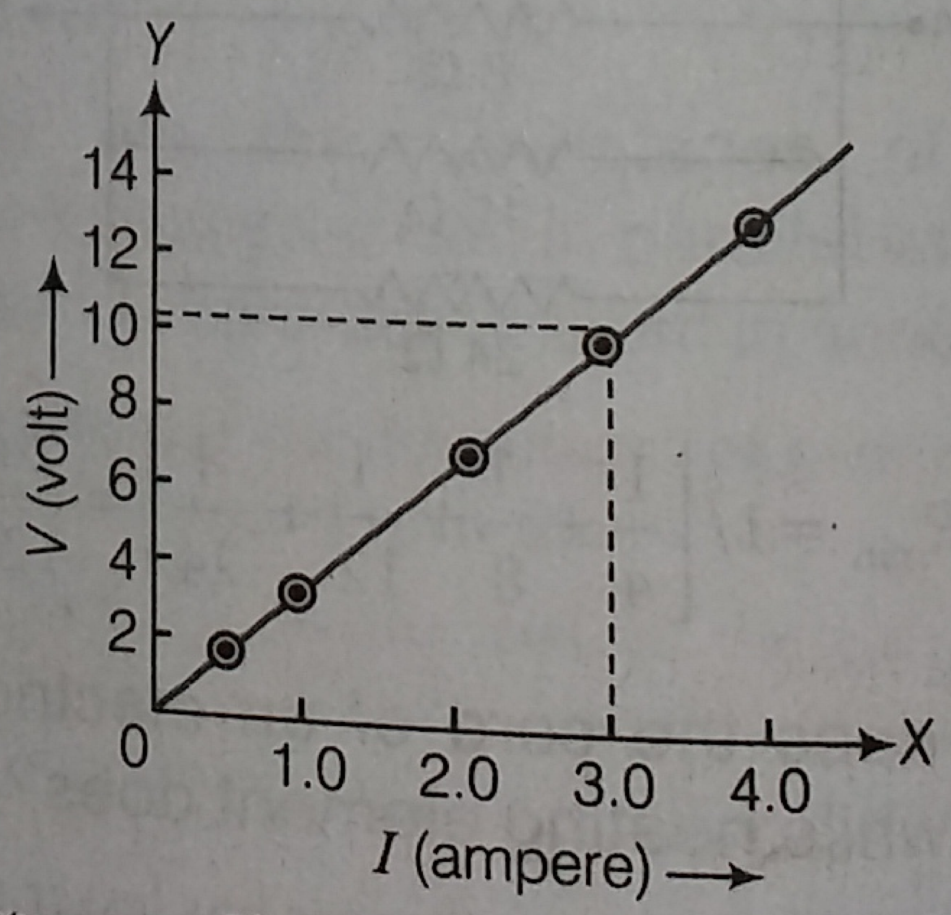
If diameter is doubled, then resistance becomes one-fourth of its original value.

7 The values of current I flowing in a given resistor for the corresponding values of potential difference V across the resistor are as given below:

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

Plot a graph between V and I and also calculate the resistance of that resistor.

Sol.



Resistance = Slope of graph

$= \dfrac{Y\text{- intercept}}{X\text{- intercept}} = \dfrac{(10.2 - 0)\ \text{V}}{(3.0 - 0)\ \text{A}} = 3.4\ \Omega$

Thus, the resistance of the resistor is 3.4 Ω.

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

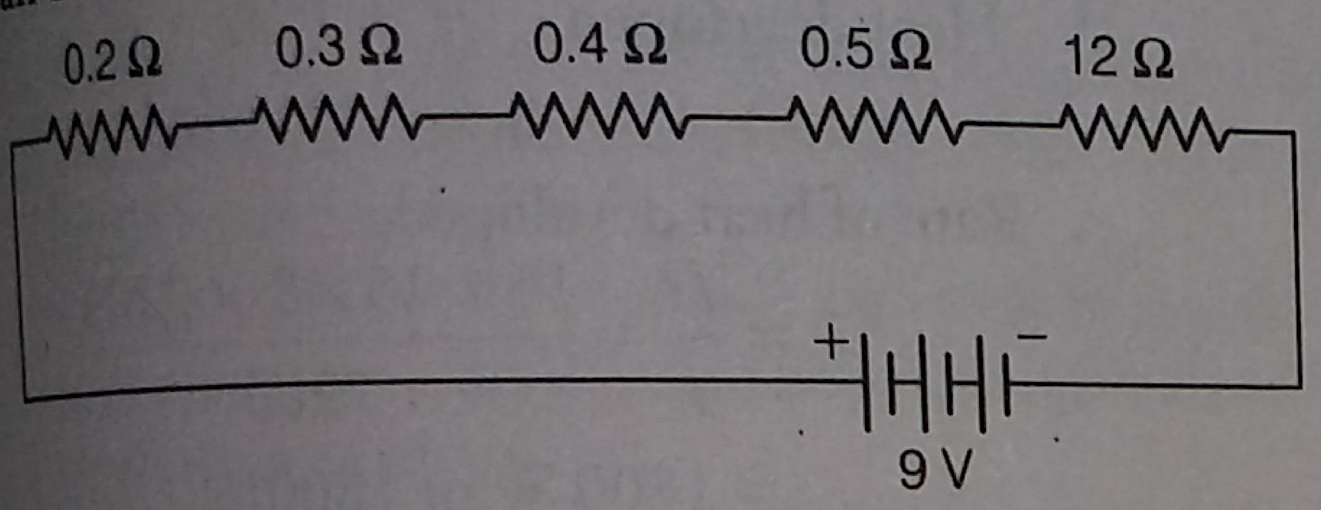
Sol. Given, $V = 12$ V, $I = 2.5$ mA $= 2.5 \times 10^{-3}$ A, $R = ?$

$\therefore$ Resistance, $R = \dfrac{V}{I}$ [by Ohm's law]

$\Rightarrow R = \dfrac{12}{2.5 \times 10^{-3}} = 4.8 \times 10^3\ \Omega$

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?

The circuit diagram for the given system of resistors can be drawn as below



∴ Total resistance, $R = R_1 + R_2 + R_3 + R_4 + R_5$
$= 0.2\ \Omega + 0.3\ \Omega + 0.4\ \Omega + 0.5\ \Omega + 12\ \Omega = 13.4\ \Omega$

Current through all resistors in series is the same.

∴ Current through 12 Ω resistor $= \dfrac{V}{R}$

$$= \frac{9\ V}{13.4\ \Omega} = 0.67\ A$$

10 How many 176 Ω resistors (in parallel) are required to carry 5A on a 220V line? **CBSE 2014**

Sol. Given, $V = 220$ V, $I = 5$ A

∴ Resistance of the wire, $R = \dfrac{V}{I} = \dfrac{220}{5} = 44\,\Omega$

The net resistance 44 Ω is less than the individual resistance 176 Ω, so individual resistances are to be connected in parallel order.

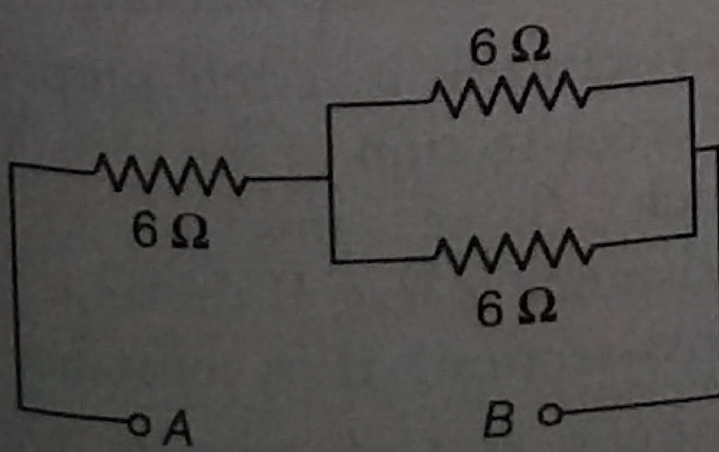
In parallel connection, equivalent resistance

$$= \frac{1}{\frac{1}{R} + \frac{1}{R} + \frac{1}{R}} = \frac{1}{\frac{n}{R}} = \frac{R}{n}$$

$$\therefore \quad 44\ \Omega = \frac{176\ \Omega}{n} \quad \text{or} \quad n = \frac{176}{44} = 4 \text{ resistors}$$

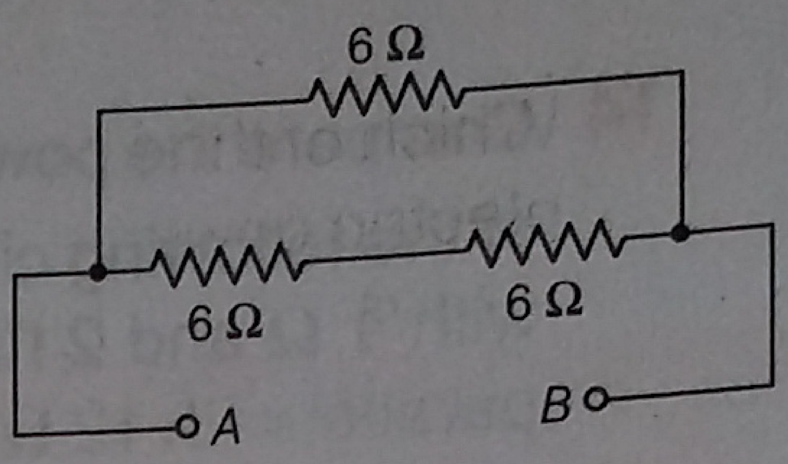
11 Show how would you connect three resistors, each of resistance 6 Ω, so that the combination has a resistance of (*i*) 9 Ω and (*ii*) 4 Ω?

Sol. (*i*) If two 6 Ω resistors are connected in parallel, then the equivalent resistance is $\left(\dfrac{6}{2}\right) = 3\ \Omega$.



This combination is connected in series with a 6 Ω resistor to get overall equivalent resistance of $(6+3) = 9\ \Omega$.

(*ii*) Equivalent resistance of two 6 Ω resistances connected in series,



$R' = 6 + 6 = 12\ \Omega$

. Now, 12 Ω and 6 Ω resistors are connected in parallel.

Equivalent resistance, $R_{eq} = \dfrac{12 \times 6}{12 + 6} = \dfrac{72}{18} = 4\ \Omega$

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

Sol. Given, Potential difference, $V = 220$ V

Power, $P = 10$ W; Current, $I = 5$ A

∴ Resistance of bulb,

$$R' = \frac{V^2}{P} = \frac{220 \times 220}{10} = 4840\ \Omega$$

Since, bulbs are connected in parallel,

Equivalent resistance (R)

$$= \frac{\text{Individual resistance } (R')}{\text{Number of bulbs } (n)}$$

$$\Rightarrow R = \frac{4840}{n}\ \Omega, V = IR$$

$$\Rightarrow 220 = \frac{5 \times 4840}{n}$$

$$\Rightarrow \quad n = \frac{5 \times 4840}{220} = 110 \text{ bulbs}$$

13 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 three cases?

Sol. Given, $V = 220$ V, $R_A = R_B = 24\ \Omega$

(*i*) Current in plates when used separately,

$$I = \frac{V}{R_A} = \frac{V}{R_B} = \frac{220}{24} = 9.16\ A$$

(*ii*) Current in plates when connected in series.

Equivalent resistance in series,

$$R = R_A + R_B = 24 + 24 = 48\ \Omega$$

∴ Current flowing, $I = \dfrac{V}{R} = \dfrac{220}{48} = 4.58$ A

(*iii*) Current in plates when connected in parallel.

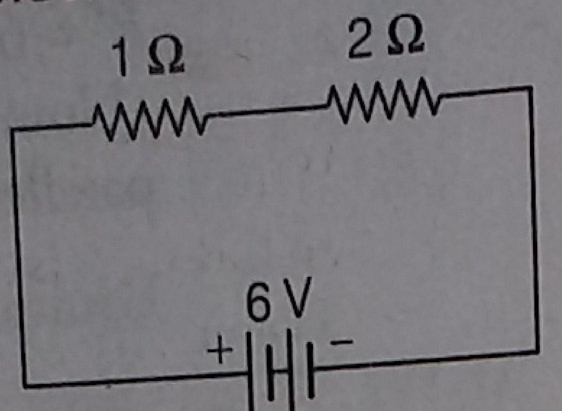
Equivalent resistance in parallel,

$$R = \frac{R_A R_B}{R_A + R_B} = \frac{24 \times 24}{48} = 12\ \Omega$$

∴ Current flowing, $I = \dfrac{V}{R} = \dfrac{220}{12} = 18.32$ A

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

(*i*) The circuit shown below has resistance connected in series combination:



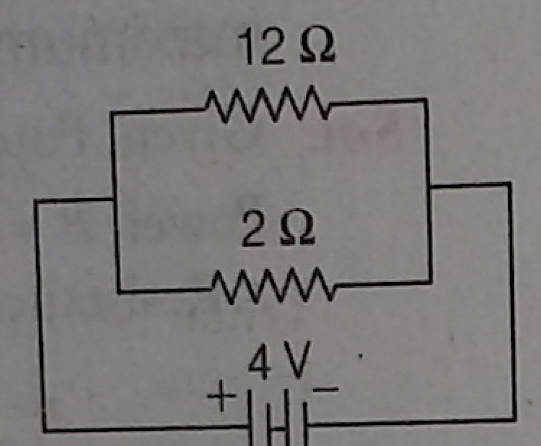
Current in the circuit,

$$I = \frac{V}{R_1 + R_2} = \frac{6}{3} = 2\text{ A}$$

∴ Power used $= I^2R = 2^2 \times 2$

$= 2 \times 2 \times 2 = 8\text{W}$

(*ii*) The circuit is shown as below:



In parallel combination, potential across each resistor is same and equal to the potential applied to the circuit.

Potential across 2 Ω resistor,

$V = 4\text{ V}$

Power used, $\frac{V^2}{R} = \frac{4 \times 4}{2} = 8\text{ W}$

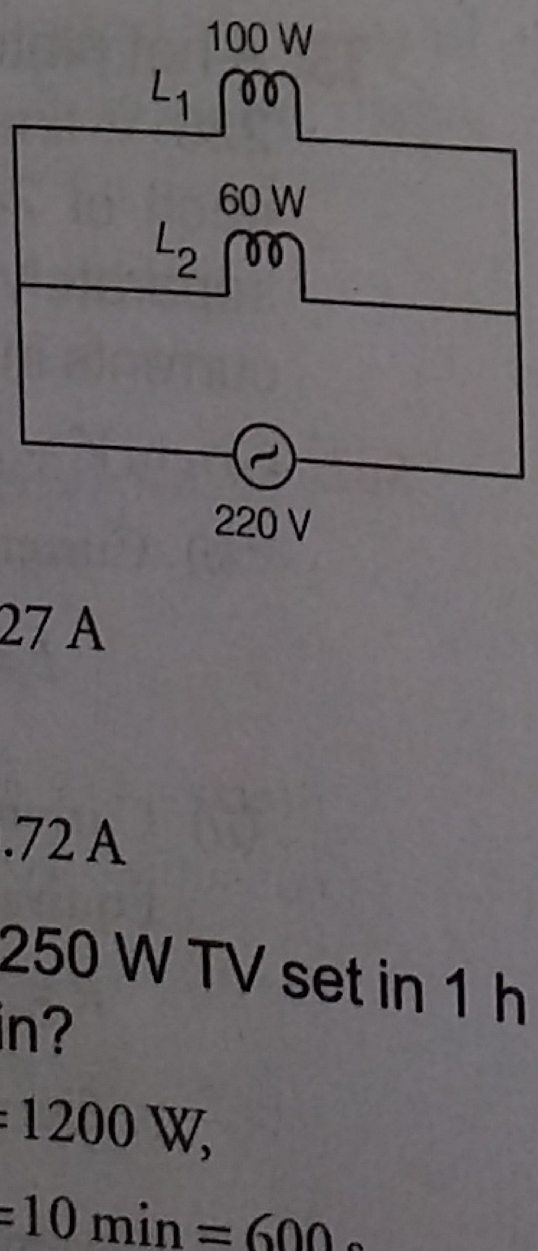
Power used in both the cases is same.

15 Two lamps, one rated at 100 W-220 V and other 60 W-220 V are connected in parallel to electric mains supply. What current is drawn from the line, if supply voltage is 220 V?

Sol. Given, potential, $V = 220$ V

Power, $P_1 = 100$ W

Power, $P_2 = 60$ W



∴ Current, $I_1 = \frac{P_1}{V}$

$= \frac{100}{220} = 0.45\text{ A}$

Current, $I_2 = \frac{P_2}{V} = \frac{60}{220} = 0.27\text{ A}$

∴ Total current drawn,

$I = I_1 + I_2 = 0.45 + 0.27 = 0.72\text{ A}$

16 Which uses more energy, a 250 W TV set in 1 h or a 1200 W toaster in 10 min?

Sol. Given, $P_1 = 250$ W, $P_2 = 1200$ W,

$t_1 = 1\text{ h} = 3600\text{ s}$, $t_2 = 10\text{ min} = 600\text{ s}$

∴ Energy,

$Q_1 = P_1t_1 = 250 \times 3600 = 900000\text{ J} = 900\text{ kJ}$

and $Q_2 = P_2t_2 = 1200 \times 600 = 720000\text{ J} = 720\text{ kJ}$

Thus, TV set uses more energy.

17 An electric heater of resistance 8 Ω draws 15 A from the mains for 2 h. Calculate the rate at which heat is developed in the heater.

Sol. Given, Resistance, $R = 8\ \Omega$, Current, $I = 15$ A

Time, $t = 2\text{ h} = 7200\text{ s}$

∴ Heat developed, $H = I^2Rt$

$= 15 \times 15 \times 8 \times 7200\text{ J}$

∴ Rate of heat developed,

$$P = \frac{H}{t} = \frac{15 \times 15 \times 8 \times 7200}{7200}$$

$= 1800\text{ W or } 1800\text{J/s}$

Thus, the rate at which heat is developed in the heater is 1800 joule per second.

18 Explain the following questions

(*i*) Why is tungsten used almost exclusively for filament of electric lamps? **CBSE 2015, 14**

(*ii*) Why are the conductors of electric heating devices such as bread toasters and electric irons made of alloys rather than pure metals?

(*iii*) Why is the series arrangement not for used domestic circuits?

(*iv*) How does the resistance of a wire vary with its area of cross-section?

(*v*) Why are copper and aluminium wires usually employed for electricity transmission?

Sol. (*i*) Tungsten has a high melting point (3380 °C). It does not melt at high temperature. It retains as much of heat generated, so that it becomes very hot and emits light. That is the reason why tungsten is used as filament of electric lamps.

(*ii*) Conductors of electric heating devices are made of alloys because alloys do not oxidise (burn) readily at high temperature unlike metals. Also, alloys have a greater resistivity (generally) as compared to their constituent pure metals.

(*iii*) There are 2 reasons for not using series connections for domestic circuits.

I. Devices of different current ratings cannot be connected as the current is constant in series circuit.

II. If one device fails, the circuit is broken and all devices stop working.

(*iv*) Resistance is inversely proportional to the area of cross-section of the wire. Thus, if the wire is thick (large area of cross-section), then resistance is less. If the wire is thin (less area of cross-section), then resistance is large.

(*v*) Copper and aluminium wires are used for transmission of electricity because they have low resistivity. So, they conduct the electric current without heavy heat losses. Also, they are quite cost effective, as compared to silver.

SUMMARY

- **Electricity** is one of the most convenient and widely used form of energy in today's world.
- An **electric charge** is a physical entity which is defined by excess or deficiency of electrons on a body. The SI unit of electric charge is coulomb (C).
- The total charge acquired by a body is an integral multiple of magnitude of charge on a single electron. This principle is called **quantisation of charge**.
- **Electric current** is defined as the rate of flow of electric charge through any cross-section of a conductor in unit time.

  Electric current $(I) = \dfrac{\text{Charge } (q)}{\text{Time } (t)}$

  The SI unit of electric current is **ampere** (A).
- **Electric potential** is defined as the amount of work done when a unit positive charge is moved from infinity to a point in an electric field.

  Electric potential $(V) = \dfrac{\text{Work done } (W)}{\text{Charge moved } (q)}$

  The SI unit of electric potential is **volt** (V).
- **Electric potential difference** is defined as the work done per unit charge in moving a unit positive charge from one point to other point.
- A closed and continuous path through which electric current flows is known as **electric circuit**.
- George Simon Ohm established a relationship between the electric current I, flowing in a metallic wire and potential difference V, across its terminals.
- According to Ohm's law, the electric current flowing through a conductor is directly proportional to the potential difference applied across its ends, provided the temperature remains unchanged.

  $$V \propto I$$

  or

  $$V = IR$$

  Where, R is the constant of proportionality called resistance of the conductor at a given temperature.
- **Resistance** is the property of a conductor due to which it opposes the flow of electric current through it.

  Mathematically, Resistance $(R) = \dfrac{\text{Potential difference } (V)}{\text{Electric current } (I)}$

  The SI unit of resistance is **ohm** (Ω).
- At a given temperature resistance of a conductor depends on its (i) length l, (ii) cross-section area A, and (iii) nature of the material of the conductor.

  It is found that $R \propto l$ and $R \propto \dfrac{1}{A}$

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

  Where, ρ is the constant of proportionality called resistivity or specific resistance of the conductor.
- **Resistivity** of a conductor is defined as the resistance of a conductor of unit length and unit area of cross-section. The SI unit of resistivity is ohm-metre (Ω - m).
- In an electric circuit resistors may be connected (i) series (ii) parallel arrangement.
- When two or more resistors are connected end to end, they are said to be connected in series. If R_1, R_2 and R_3 be three resistors joined in series then the equivalent resistor R_S is given by

  $$R_S = R_1 + R_2 + R_3$$
- When two or more resistors are connected simultaneously between two points, then they form a parallel arrangement. If R_1, R_2 and R_3 be the individual resistors joined in parallel then the equivalent resistor R_P is given by

  $$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$
- Practical electrical circuits may involve the combination of basic series and parallel circuits.
- When an electric current is passed through a high resistance wire like nichrome wire, then the wire becomes very hot and produces heat. This is called the **heating effect of current**.
- When a current is passed through a resistance wire, heat is produced. Amount of heat produced depends on (i) current flowing I, (ii) resistance R of that wire, and (iii) time t for which current is being flown.
- If on applying, a potential difference V across the ends of a conductor of resistance R, the current I flows for a time t, then as per Joule's law of heating the electric energy consumed is given by

  $$W = qV = VIt = I^2Rt = \frac{V^2t}{R}$$

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

  $$H = VIt = I^2Rt = \frac{V^2t}{R}$$
- **Electric Power** is defined as the amount of electric energy consumed in a circuit per unit time.

  Electric Power $(P) = \dfrac{W}{t}$

  The SI unit of electric power is watt (W).

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