Page 216

Question 1:

Judge the equivalent resistance when the following are connected in parallel – **(a)** 1 Ω and 10^6 Ω, **(b)** 1 Ω and 10^3 Ω, and 10^6 Ω.

Answer 1:

(a). The net resistance in parallel is given by

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

Here, $R_1 = 1\ \Omega$ and $R_2 = 10^6\ \Omega$

So,

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

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

(b). The net resistance in parallel is given by

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

Here, $R_1 = 1\ \Omega$, $R_2 = 10^3\ \Omega$ and $R_3 = 10^6\ \Omega$

So,

$$\frac{1}{R} = \frac{1}{1} + \frac{1}{10^3} + \frac{1}{10^6} = \frac{10^6 + 10^3 + 1}{10^6} = \frac{1001001}{1000000}$$

$$\Rightarrow R = \frac{1000000}{1001001} = 0.999\Omega \approx 1\Omega$$

Question 2:

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?

Answer 2:

Given that the electric lamp of 100 Ω, a toaster of resistance 50 Ω and water filter of resistance 500 Ω are connected in parallel.
The net resistance in parallel is given by

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

Here, $R_1 = 100\ \Omega$, $R_2 = 50\ \Omega$ and $R_3 = 500\ \Omega$

So,

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

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

$$\Rightarrow R = \frac{500}{16} = 31.25\ \Omega$$

Now, using Ohm's law V = IR, we have

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

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

Question 3:

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

Answer 3:

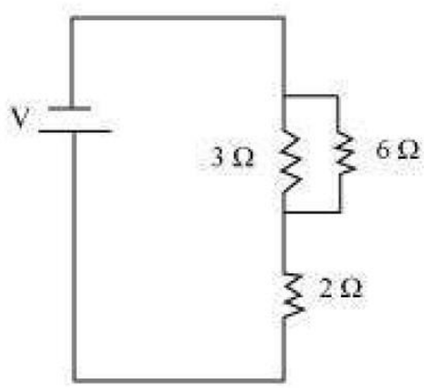
In parallel there is no division of voltage among the appliances. The potential difference across each appliance is equal to the supplied voltage and the total effective resistance of the circuit can be reduced by connecting electrical appliances in parallel.

Question 4:

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?

Answer 4:

(a). To get total resistance 4 Ω, connect 3 Ω and 6 Ω resistors in parallel and 2 Ω resistance in series with the resultant.



Since, 3 Ω and 6 Ω resistors in parallel, so the net resistance

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

$$\frac{1}{R_{12}} = \frac{1}{3} + \frac{1}{6} = \frac{2+1}{6} = \frac{3}{6} = \frac{1}{2}$$

$$\Rightarrow R_{12} = \frac{2}{1} = 2\ \Omega$$

Now, the resultant R_{12} and 2 Ω resistors are in series. So the net resistance

$$R = R_{12} + 2\ \Omega = 2 + 2 = 4\ \Omega$$

(b). To get total resistance 1 Ω, connect 2 Ω, 3 Ω and 6 Ω resistors in parallel.

The net resistance in parallel is given by

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

Here, $R_1 = 2\ \Omega$, $R_2 = 3\ \Omega$ and $R_3 = 6\ \Omega$

So,

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

$$= \frac{3 + 2 + 1}{6} = \frac{6}{6}$$

$$\Rightarrow R = \frac{6}{6} = 1\ \Omega$$

Question 5:

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?

Answer 5:

Connecting resistors in series always gives maximum resistance and parallel gives minimum resistance.

(a). The highest total resistance is given by

$$R = R_1 + R_2 + R_3 + R_4 = 4\ \Omega + 8\ \Omega + 12\ \Omega + 24\ \Omega = 48\ \Omega$$

(b). The lowest total resistance is given by

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4}$$

$$\frac{1}{R} = \frac{1}{4} + \frac{1}{8} + \frac{1}{12} + \frac{1}{24}$$

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

$$\Rightarrow R = \frac{24}{12} = 2\ \Omega$$