Question 1:
What does an electric circuit mean?

Answer 1:
An electric circuit is the pathway in which current can flow. It consists of electric devices, switching devices, source of electricity, etc. that are connected by conducting wires.

Question 2:
Define the unit of current.

Answer 2:
The unit of electric current is ampere (A). *When 1 C of charge flows through a conductor in 1 s, it called 1 ampere (A) current.*

$$I = \frac{Q}{t}$$

Question 3:
Calculate the number of electrons constituting one coulomb of charge.

Answer 3:
We know that one electron possesses a charge of 1.6×10^{-19} C.

$$Number\ of\ electron = \frac{Total\ charge}{Charge\ on\ 1\ electron}$$
$$= \frac{1}{1.6 \times 10^{-19}} = 6.25 \times 10^{18}$$

So, the number of electrons constituting one coulomb of charge is 6×10^{18}.

Question 1:
Name a device that helps to maintain a potential difference across a conductor.

Answer 1:
A cell, battery, power supply, etc. helps to maintain a potential difference across a conductor.

Question 2:
What is meant by saying that the potential difference between two points is 1 V?

Answer 2:
When 1 J of work is required to move a charge of 1 C from one point to another, then it is said that the potential difference between the two points is 1 V.

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

$$1\ V = \frac{1\ J}{1\ C}$$

Question 3:
How much energy is given to each coulomb of charge passing through a 6 V battery?

Answer 3:

$$Potential\ Difference = \frac{Work\ done}{Charge}$$

or $Work\ done\ (or\ Energy) = Potential\ Difference \times Charge$

So, Work done = 6 Volt × 1 Coulomb = 6 Joules

Question 1:
On what factors does the resistance of a conductor depend?

Answer 1:
The resistance of a conductor depends upon the following factors:

- Length of the conductor
- Cross-sectional area of the conductor
- Material of the conductor
- Temperature of the conductor.

Question 2:
Will current flow more easily through a thick wire or a thin wire of the same material, when connected to the same source? Why?

Answer 2:
Resistance (R) is inversely proportional to the area of cross-section (A) of the wire. So, thicker the wire, lower is the resistance of the wire and vice-versa. Therefore, current can flow more easily through a thick wire than a thin wire.

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

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

Question 3:
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?

Answer 3:
According to the Ohm's law $V = IR$
If the resistance remains constant, V is directly proportional to I.

$$V \propto I$$

Now, if potential difference is reduced to half of its value, the current also become half of its original value.

Question 4:

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

Answer 4:

The resistivity of an alloy is higher than the pure metal and it does not corrode easily. Moreover, even at high temperatures, the alloys do not melt readily. Hence, the coils of heating appliances such as electric toasters and electric irons are made of an alloy rather than a pure metal.

Question 5:

Use the data in Table 12.2 to answer the following –

(a) Which among iron and mercury is a better conductor?

(b) Which material is the best conductor?

Table 12.2 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 (alloy of Cu and Ni)	49×10^{-6}
	Manganin (alloy of Cu, Mn and Ni)	44×10^{-6}
	Nichrome (alloy of Ni, Cr, Mn and Fe)	100×10^{-6}
Insulators	Glass	$10^{10} - 10^{14}$
	Hard rubber	$10^{13} - 10^{16}$
	Ebonite	$10^{15} - 10^{17}$
	Diamond	$10^{12} - 10^{13}$
	Paper (dry)	10^{12}

Answer 5:

(a). Resistivity of iron ($10.0 \times 10^{-8}\ \Omega\, m$) is lesser than that of the mercury ($94.0 \times 10^{-8}\ \Omega\, m$). So, iron is good conductor as compared to mercury.

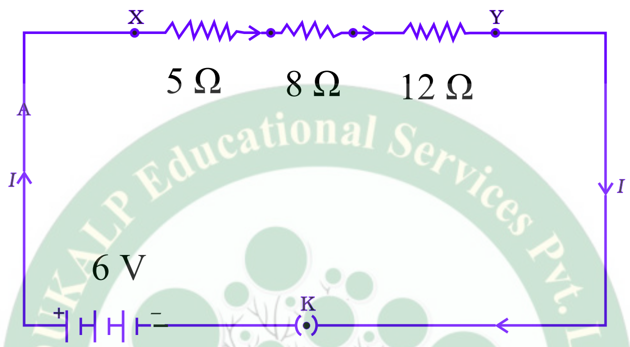
(b). Silver has lowest resistivity, so it is the best conductor.

Question 1:

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.

Answer 1:

The required schematic diagram is given below:



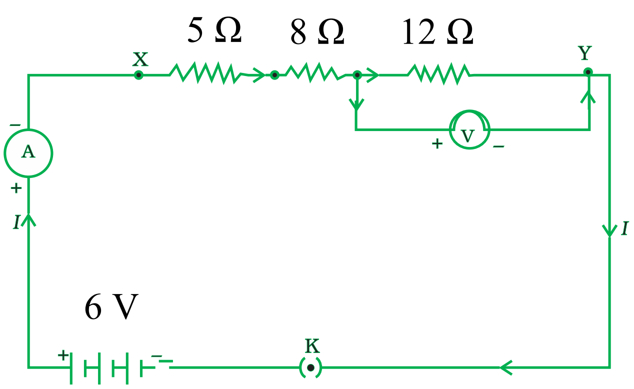
Question 2:

Redraw the circuit of Question 1, 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?

Answer 2:

Resisters are connected in series.

So, the net resistance in the circuit = 5 Ω + 8 Ω + 12 Ω = 25 Ω



Net potential = 6 V
Using Ohm's law V = IR, we have

$6 = I \times 25 \Rightarrow I = \frac{6}{25} = 0.24\ Ampere$

Now for the 12 Ω resistor, current = 0.24 A
So, using Ohm's law V = 0.24 × 12 V = 2.88 V

Hence, the reading in the ammeter is 0.24 and voltmeter is 2.88.

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:

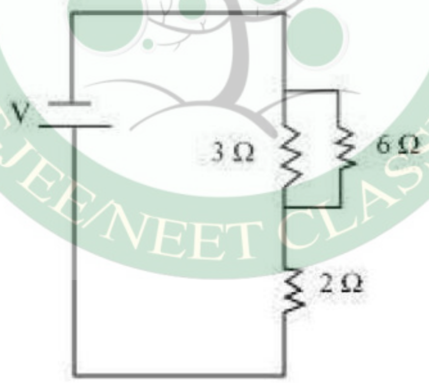
In parallel there is no division of voltage among the appliances. The potential difference across each appliance is equal to the supplied voltage and the total effective resistance of the circuit can be reduced by connecting electrical appliances in parallel.

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

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

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

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

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

Question 1:

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

Answer 1:

The heating element of an electric heater is a resistor. According to Joule's law of heating, the amount of heat produced by it is proportional to its resistance.

$$H = I^2Rt$$

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.

Question 2:

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

Answer 2:

According to Joule's law of heating, the amount of heat produced is given by

$$H = VIt$$

Where,
V = 50 V

$$I = \frac{Charge}{time} = \frac{9600\ coulomb}{1\ hr} = \frac{9600}{60 \times 60} = \frac{80}{3}\ A$$

and t = 1 hour = 60 × 60 seconds

So,

$$H = 50 \times \frac{80}{3} \times 60 \times 60$$

$$= 4800000\ J = 4.8 \times 10^6\ J$$

Question 3:

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

Answer 3:

According to Joule's law of heating, the amount of heat produced is given by

$$H = VIt$$

Where,

V = IR = 5A × 20 Ω = 100 V

I = 5 A

and t = 30 seconds

So,

$$H = 100 \times 5 \times 30\ J$$

$$= 15000\ J = 1.5 \times 10^4\ J$$

Question 1:
What determines the rate at which energy is delivered by a current?

Answer 1:
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.

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

Answer 2:
Power of the electric motor is given by

$$P = VI$$

Where, $V = 220$ V and $I = 5$ A

So, Power $P = 220 \times 5 = 1100$ W

Now, the energy consumed = Power × time

Where, $P = 1100$ W

$t = 2$ hours $= 2 \times 60 \times 60$ seconds $= 7200$ seconds

So, the energy consumed $E = 1100 \times 7200$ J $= 7920000$ J