NCERT Solutions for Class 10 Science Chapter 11 – Electricity

Intext Questions with Solutions of Class 10 Science Chapter 11 – Electricity

1.

What does an electric circuit mean?

Ans: A continuous, closed route of an electric current is called an electric circuit.
There are several electric components in the circuit such as: Conductors, Cell, Switch, Load.

2.

Define the unit of current.

Ans: The unit of electric current is the ampere. If one coulomb of charge traverses a portion of a conductor in one second, the current is defined as one ampere.

$$I = \frac{Q}{t} \text{ or } 1A = ICs^{-1}$$

3.

Calculate the number of electrons constituting one coulomb of charge.

Ans:

Charge on one electron, $e = 1.6 \times 10^{-19}$ C
Total charge, $Q = 1$ C
Number of electrons, $n = \frac{Q}{e}$

$$= \frac{1C}{1.6 \times 10^{-19}} = 6.25 \times 10^{18}$$

4.

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

Ans: A battery.

5.

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

Ans: If one joule of work is required to move one coulomb of electric charge from one location to another, the potential difference between two points is said to be one volt.

6.

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

Ans: Energy given by battery = charge x potential difference
or W = QV = 1C X 6V = 6J.

7.

On what factors does the resistance of a conductor depend?

Ans: The following variables affect the conductor's resistance:

A. The conductor's temperature
B. Conductor cross-sectional area
C. The conductor's length
D. The conductor's material composition

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?

Ans: The relationship between resistance and cross-sectional area can be expressed as:

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

Resistance is inversely related to the cross-sectional area of the wire. As resistance diminishes, current amplifies.
A thicker wire allows less current to flow, while a thinner wire permits more current to pass.

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?

Ans: Through the use of Ohm's Law, one is able to ascertain the change in the current that is passing through the electrical component.

Ohm's Law states that the current is determined by the following:
I = V/R

From this point forward, the gap in potential is cut in half while maintaining the same level of resistance.
Assume that the new voltage V`=V/2.

The new resistance will be denoted by R' = R, and the new quantity of current will be denoted by I'.
The following is an example of how Ohm's law can be used to determine the change in the current:

$$I` = \frac{V`}{R`} = \frac{\frac{V}{2}}{R} = \frac{1}{2}\frac{V}{R} = \frac{1}{2}$$

Because of this, the amount of current that is going through the electrical component is cut in half.

10.

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

Ans: The heating elements of electric toasters, irons, and similar devices are constructed from an alloy instead of a pure metal due to

i. the significantly higher resistivity of alloys compared to pure metals, and
ii. the resistance of alloys to oxidation (or combustion) at elevated temperatures, even when incandescent.

11.

Use the data in Table 11.2 to answer the following –
(a) Which among iron and mercury is a better conductor?
(b) Which material is the best conductor?

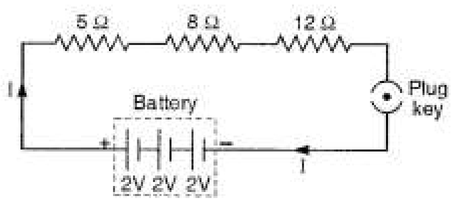
Ans:

a. Because mercury has a higher resistance than iron, iron is a better conductor than mercury.
b. Silver is the best conductor of all the materials indicated in the table because it has the lowest resistance
   (1.60×10^{-8}).

12.

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.

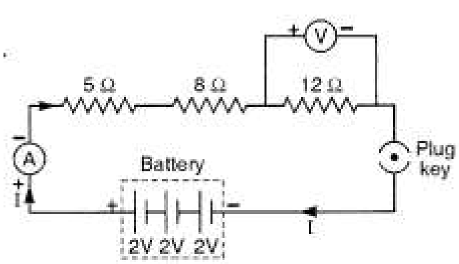
Ans: Three 2 V cells make into a battery with a potential of 6 V. Three resistors with resistances of 12 Ω, 8 Ω, and 5 Ω connected in series with a 6 V battery are depicted in the circuit diagram below.



13.

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?

Ans: An ammeter must be connected in series with resistors, whereas a voltmeter should be connected in parallel to the resistor to measure the potential difference, as illustrated in the image below.



Ohm's Law enables us to ascertain the readings of the ammeter and voltmeter.
The cumulative resistance of the circuit is 5 Ω + 8 Ω + 12 Ω = 25 Ω.

The circuit's potential difference is 6 V; hence, the current traversing the circuit or the resistors can be computed as follows:

I = V/R = 6/25 = 0.24 A
Designate the potential difference across the 12 Ω resistor as V1.
The acquired current V1 can be computed as follows:
V1 = 0.24 A × 12 Ω = 2.88 V

Consequently, the ammeter will register 0.24 A, and the voltmeter will indicate 2.88 V.

14.

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.

Ans:

(i) Equivalent resistance < 1 Ω.
(ii) Equivalent resistance < 1 Ω.

The equivalent resistance is zero when the resistances are connected in parallel.

15.

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?

Ans:

Resistance of electric lamp, $R_1 = 100\ \Omega$
Resistance of toaster, $R_2 = 50\ \Omega$
Resistance of water filter, $R_3 = 500\ \Omega$
Equivalent resistance R_p of the three appliances connected in parallel, is

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} = \frac{1}{100} + \frac{1}{50} + \frac{1}{500} = \frac{16}{500}$$

$$\text{Or } R_p = \frac{500}{16}\Omega = 31.25\Omega$$

Resistance of electric iron = Equivalent resistance of the three appliances connected in parallel = $31.25\ \Omega$
Applied voltage, $V = 220$ V

$$\text{Current, } I = \frac{V}{R} = \frac{220V}{31.25\Omega}$$

16.

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

Ans: The benefits of connecting electrical equipment in parallel with the battery are:

i. In parallel circuits, if one electrical appliance stops working due to a malfunction, the other appliances continue to function normally.
ii. In parallel circuits, each electrical appliance has its own switch, allowing it to be turned on and off separately without impacting other appliances.
iii. In parallel circuits, all electrical appliances receive the same voltage (220 V) as the power supply line.
iv. Parallel connection of electrical appliances reduces the overall resistance of the household circuit, resulting in a high current from the power source.

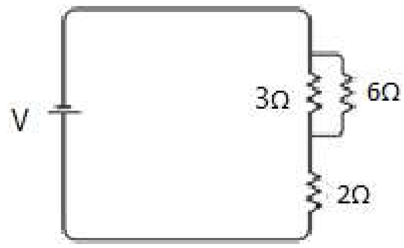
17.

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?

Ans:

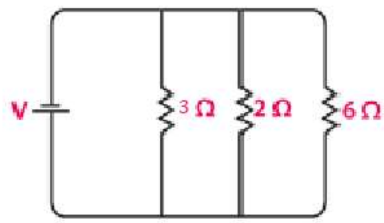
i. A total resistance of 4Ω can be achieved by connecting a 2Ω resistor in series with the parallel arrangement of 3Ω and 6Ω resistors.

$$\text{So, } R = R_1 + \frac{R_2 R_3}{R_2 + R_3} = 2 + \frac{3 \times 6}{3+6} = 4\Omega$$



i. A total resistance of 1Ω can be achieved by connecting 2 Ω, 3 Ω, and 6 Ω resistors in parallel.

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



18.

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?

Ans:

a. The resistance of the four resistors connected in series will be the largest since it is the sum of their individual resistances. The resistors linked in series will have a total equivalent resistance of 4 Ω + 8 Ω + 12 Ω + 24 Ω = 48 Ω.
b. The resistors' equivalent resistances will be the lowest if they are linked in parallel. When connected in parallel, their corresponding resistance is

$$R = \frac{1}{\frac{1}{4}+\frac{1}{8}+\frac{1}{12}+\frac{1}{24}} = \frac{24}{12} = 2\Omega$$

19.

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

Ans: The heat generated by a system is directly proportional to its resistance.

The thermal element generates an increased amount of heat, which results in its glowing appearance due to its increased resistance.

Additionally, the resistance of the wire is reduced, which results in a reduction in the amount of heat generated. Therefore, the heating element emits light, while the filament remains unlit.

20.

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

Ans:

Here, Q = 96,000 C, t =1 hour = 1 x 60 x 60 sec = 3,600 s, V = 50 V
Heat generated, H = VQ = 50Vx 96,000 C = 48,00,000 J = 4.8×10^6 J

21.

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

Ans: Joule's law of heating, which is provided by the equation, can be used to determine how much heat is produced.
H = Vit
When we change the values in the equation above, we obtain
H =100 × 5 × 30 = 1.5×10^4 J
The electric iron produced 1.5×10^4 J of heat in 30 seconds.

22.

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

Ans: The power of an appliance is the rate at which energy is delivered by a current or consumed by the device.

23.

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

Ans:

Here, $I = 5$ A, $V = 220$ V, $t = 2h = 7{,}200$ s
Power, $P = VI = 220 \times 5 = 1100$ W
Energy consumed $= P \times t = 100 \text{ W} \times 7200 \text{ s} =$
$7{,}20{,}000 \text{ J} = 7.2 \times 10^5$ J

Exercise Questions with Solutions of Class 10 Science Chapter 11 – Electricity

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

Ans: (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

Ans: (b) IR^2

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

Ans: (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

Ans: (c) 1 : 4

5.

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

Ans: To measure the potential difference between two places, the voltmeter needs to be linked in parallel.
This is due to the voltmeter's ability to measure the voltage across the parallel circuit.
However, voltmeters cannot be utilized for a series circuit. In a series circuit, an ammeter is utilized instead.

6.

A copper wire has diameter 0.5 mm and resistivity of 1.6 × 10–8 Ω 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?

Ans: The resistance of a copper wire, characterized by its length in meters and cross-sectional area in square meters, is expressed by the formula.

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

The area of cross section of wire can be calculated as: $A = \pi \frac{(\text{diameter})^2}{2}$

Substituting the value in formula, we get

$$l = \frac{RA}{\rho}$$

$$= \frac{10 \times 3.14 \times \left(\frac{0.0005^2}{2}\right)}{(1.6 \times 10^{-8})} = \frac{10 \times 3.14 \times 25}{4 \times 1.6}$$

$$= 122.72\text{m}$$

If the diameter of the wire is doubled then the new diameter will be 1 or 0.001m

$\therefore$ The ressistance can be calculated as: $R = \rho \frac{l}{A}$

$$= 1.6 \times 10^{-8} \times \frac{122.72\text{m}}{\pi(\frac{0.001}{2})^2} = 250.2 \times 10^{-2} = 2.5\Omega$$

The wire measures 122.72 m in length, and its resistance is 2.5 ohms.

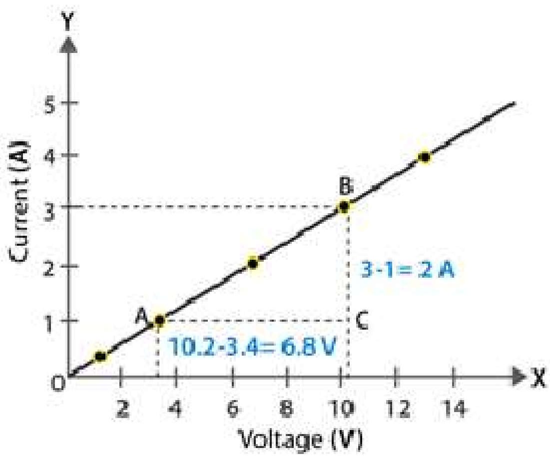
7.

The values of current I flowing in a given resistor for the corresponding values of potential difference V across the resistor are 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 calculate the resistance of that resistor

Ans: The IV characteristic is the graph that shows the relationship between current and voltage. On one side, we see the voltage, and on the other, we see the current. The table provides the various current levels for various voltage values. Below are the I V graph plot for the properties of the provided resistor.



A measure of resistance can be found by observing the line's slope.
Here is how to determine the slope:

Slope = 1/R = BC/AC = 2/6.8
To calculate R,
R = 6.8/2 = 3.4 Ω
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 the resistance of the resistor.

Ans:

Here, V = 12 V and I = 2.5 mA = 2.5×10^{-3} A

∴ Resistance, R $= \frac{V}{I} = \frac{12V}{2.5\times10^{3}A} = 4{,}800\ \Omega$

$= 4.8 \times 10^{-3}\ \Omega$

9.

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?

Ans: There is no present division in a series connection. Every resistor has the same amount of current flowing through it.
We apply Ohm's law to determine how much current is passing through the resistors.
However, let's first determine the equivalent resistance in this way.
R = 0.2 Ω + 0.3 Ω + 0.4 Ω + 0.5 Ω + 12 Ω = 13.4 Ω

Now, using Ohm's law,

$$I = \frac{V}{R} = \frac{9V}{13.4\Omega} = 0.671A$$

The current flowing across the 12 Ω is 0.671 A.

10.

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

Ans:

Suppose n resistors of 176 Ω are connected in parallel.
Then, $\frac{1}{R} = \frac{1}{176} + \frac{1}{176} + \cdots$ n times

Or, $\frac{1}{R} = \frac{n}{176}, R = \frac{176}{n}\Omega$

By Ohm's law $R = \frac{V}{I}, \frac{176}{n} = \frac{220}{5}$ or $n = \frac{176\times5}{220} = 4$

11.

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.

Ans: Here, $R_1 = R_2 = R_3 = 6\ \Omega$.

i. When R1 is connected in series with the parallel arrangement of R2 and R3, as illustrated in Fig. (a).The corresponding resistance is

$$R = R_1 + \frac{R_2 R_3}{R_2 + R_3} = 6 + \frac{6 \times 6}{6 + 6} = 6 + 3 = 9$$

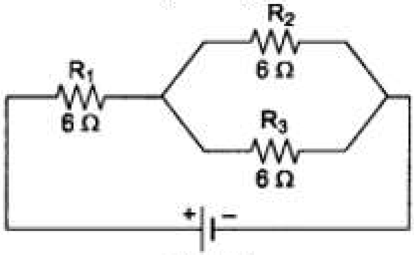


Fig. (a)

ii. When a series combination of R1 and R2 is connected in parallel with R3, as illustrated in Fig. (b), the corresponding resistance is

$$R = \frac{12 \times 6}{12 + 6} = \frac{72}{18} = 4\Omega$$

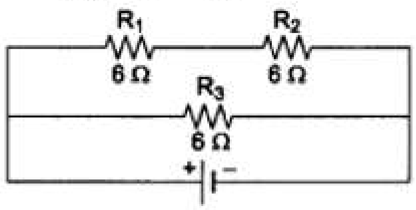


Fig. (b)

12.

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?

Ans:

Here, current, I = 5 A, voltage, V = 220 V

∴ Maximum power, P = I x V = 5 x 220 = 1100W

Required no. of lamps $= \frac{\text{Max. Power}}{\text{Power Of 1 Lamp}} = \frac{1100}{10} = 110$

∴ 110 lamps can be connected in parallel.

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 the three cases?

Ans:

(i) When the two coils A and B are used separately. R = 24 Ω, V = 220 V

Current, $I = \frac{V}{R} = \frac{220V}{24\Omega} = 9.167A$

(ii) When the two coils are connected in series,
$R = 24\Omega + 24\Omega = 48\Omega$, $V = 220V$

$$\text{Current, } I = \frac{V}{R} = \frac{220V}{48\Omega} = 4.58A$$

(iii) When the two coils are connected in parallel.

$$R = \frac{24 \times 24}{24 + 24} = 12\Omega, \qquad V = 220V$$

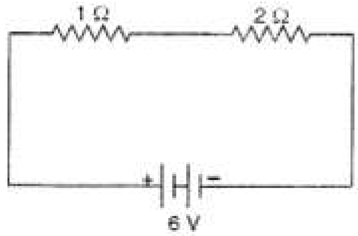
$$\text{Current, } I = \frac{V}{R} = \frac{220V}{12\Omega} = 18.33A$$

14.

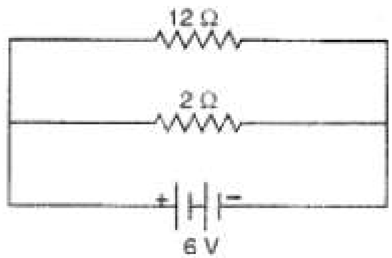
Compare the power used in the 2 Ω resistor in each of the following circuits:
(i) a 6 V battery in series with 1 Ω and 2 Ω resistors, and
(ii) a 4 V battery in parallel with 12 Ω and 2 Ω resistors.

Ans:

(i) The circuit diagram is shown in figure.
Total resistance, $R = 1\Omega + 2\Omega = 3\Omega$
Potential difference, $V = 6$ V



Power used in 2Ω resistor $= I^2R = (2)^2 \times 2 = 8$ W
(ii) The circuit diagram for this case is shown :
Power used in 2 resistor $= \frac{V^2}{R} = \frac{4^2}{2} = 8$ W.



[∵ Current is different for different resistors in parallel combination.]

15.

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?

Ans:

Since both the bulbs are connected in parallel, the voltage across each of them will be the same.

Current drawn by the bulb of rating 100 W can be calculated as follows:

$P = V \times I$

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

Substituting the values in the equation, we get

$I = \frac{100W}{220V} = \frac{100}{220}A$

Similarly, the current drawn by the bulb of rating 60 W can be calculated as follows:

$I = \frac{60W}{220V} = \frac{60}{220}A$

Therefore, the current drawn from the line is

$\frac{100}{220} + \frac{60}{220} = 0.727A$

16.

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

Ans:

The energy utilized by electrical devices is represented by the equation

$H = Pt$, where P represents the appliance's power and t denotes the duration.

The energy consumed by a television with a power rating of 250 W can be computed using this formula:

$H = 250 \text{ W} \times 3600 \text{ s} = 9 \times 10^5 \text{ J}$

Likewise, the energy utilized by a toaster with a power rating of 1200 W is

$H = 1200 \text{ W} \times 600 \text{ s} = 7.2 \times 10^5 \text{ J}$

The estimates indicate that the energy consumption of the television exceeds that of the toaster.

17.

An electric heater of resistance 44 Ω draws 5 A from the service mains for 2 hours. Calculate the rate at which heat is developed in the heater.

Ans:

Here, R = 8 Ω, 1 = 15 A, t = 2 h
The rate at which heat is developed in the heater is equal to the power.
Therefore, $P = I^2 R = (15)^2 \times 8 = 1800\ Js^{-1}$

18.

Explain the following.
(a) Why is the tungsten used almost exclusively for filament of electric lamps?
(b) Why are the conductors of electric heating devices, such as bread-toasters and electric irons, made of an alloy rather than a pure metal?
(c) Why is the series arrangement not used for domestic circuits?
(d) How does the resistance of a wire vary with its area of cross-section?
(e) Why are copper and aluminium wires usually employed for electricity transmission?

Ans:

i. Tungsten is predominantly utilized for the filaments of electric lamps due to its exceptionally high melting point of 3300°C. When electricity is passed through a tungsten filament, its temperature increases to 2700°C, producing heat and light energy without melting.
ii. The conductors of electric heating devices, such as bread toasters and electric irons, are composed of an alloy rather than a pure metal. This is due to the higher resistivity of alloys compared to pure metals, as well as their resistance to oxidation and burning at elevated temperatures.
iii. The series arrangement is not utilized in domestic circuits because, in a series circuit, the failure of one electrical appliance due to a defect results in the cessation of operation of all other appliances, as the entire circuit becomes interrupted.
iv. The resistance of a wire is inversely proportional to its cross-sectional area, expressed as $R \propto (1/\pi r^2)$. An increase in the cross-sectional area of a conductor of fixed length results in a

decrease in resistance, as this allows for a greater number of free electrons to facilitate movement within the conductor.

v. Copper and aluminium wires are commonly utilized for electricity transmission due to their low resistances. Thus, they do not experience excessive heating when conducting electric current.