Chapter 3
Electricity

In Text Questions-Pg-200

Q.1 What does an electric circuit mean?
Ans.; The electric circuit is the continuous path which allows electric current or electrons to flow through it. An electric circuit consists of connecting wires, other elements (like electric bulb, resistances, key etc.) and a battery.

Q.2 Define the unit of current.
Ans.: The SI unit of electric current is Ampere, commonly denoted by letter A. 1 Ampere is defined as - When an amount of charge equivalent to 1 coulomb flows through a cross-section of a conductor in 1 second.

Q.3 Calculate the number of electrons constituting one coulomb of charge.
Ans.: We know that, the charge of an electron, e = 1.6 X 10^{-19} Coulomb
Therefore, 1.6 X 10^{-19} C of charge is equivalent to = 1 electron

By unitary method,
$= \frac{1}{1.6\times10^{-19}} \times 1$
$= \frac{10^{19}}{1.6}$ (Taking the power in Numerator)
$= \frac{10\times10^{18}}{1.6}$

$= 6.25 \times 10^{18}$
Thus, 6.25×10^{18} electrons constitute 1 coulomb of charge.

In Text Questions-Pg-202

Q.1 Name a device that helps to maintain a potential difference across a conductor.
Ans.: An electric cell or a battery helps to maintain a potential difference across a conductor.

Q.2 What is meant by saying that the potential difference between two points is 1 V?
Ans.: The potential difference between two points is said to be 1 volt (1V) if the amount of work done in moving a charge of 1 Coulomb (1C) between the two points is equivalent to 1 Joule (1J)

Q.3 How much energy is given to each coulomb of charge passing through a 6 V battery?
Ans.: The charge passing through the battery is 1 coulomb. The potential difference is 6V. We have to find out the energy which is equal to the work done in moving the charge through 6V. Now,

Potential Difference (V) = $\frac{work\ done\ (W)}{charge\ (C)}$

$\implies$ W = V $\times Q$

= 6V $\times$ 1C = 6 joules
Since the work done on each coulomb of charge is 6 joules. Therefore, the energy given to each coulomb of charge is also 6 joules.

In Text Questions-Pg-209

Q.1 On what factors does the resistance of a conductor depend?
Ans.; The electrical resistance of a conductor depends on the factors listed below:

1) Nature of the material of the conductor – eg. A wire made of copper would be a better conductor than a wire made of iron

2) Length of the conductor – eg. A shorter wire would be a better conductor than a longer wire

3) Area of cross-section of the conductor – eg. A thick copper wire is a better conductor than a thin copper wire

4) Temperature of the conductor – resistance goes up with increase in temperature

Q.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?
Ans.: The current will flow more easily through a thick wire than a thin wire of the same material when connected to the same source. This is mainly because the resistance of a wire is inversely proportional to the square of its diameter. And, a thick wire has greater diameter than a thin wire. Therefore, thick wire will offer less resistance to the current flow and thin wire will offer more resistance to the current flow. Thus, current flows easily through thick wire.

Q.3 Let the resistance of an electrical component remain 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.: We know, From Ohm's Law:

$V \propto R \ or \ V = IR$

Since the resistance is constant and the potential difference is decreased to half of the former value. Thus, the current through the component will also decrease to half of its former value.

Q.4 Why are coils of electric toasters and electric irons made of an alloy rather than a pure metal ?

Ans.: The coils (or heating elements) of toasters and electric irons are made of an alloy rather than a pure metal due to the following two reasons:

1) The resistivity of an alloy is much higher than that of a pure metal, and

2) An alloy does not undergo oxidation easily even at high temperature

Q.5 Use the data in Table on page 23 of this book to answer the following:

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

(b) Which material is the best conductor?

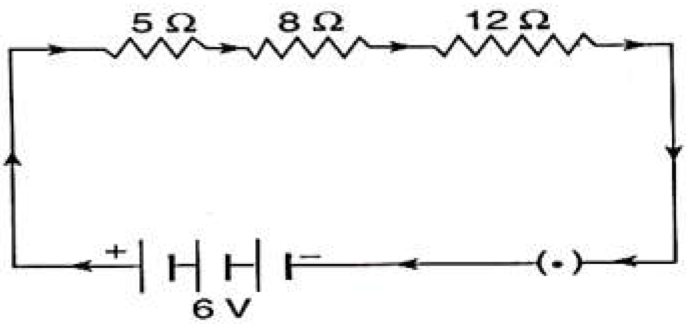
Ans.: (a) The electrical resistivity of iron is $10.0\times 10^{-8}\Omega m$. And, the electrical resistivity of mercury is $94.0\times 10^{-8}\Omega m.$. Since the resistivity of mercury is greater than that of iron, it will offer more hindrance to current flow as compared to iron. Therefore, iron is a better conductor than mercury.

(b) Silver metal has the lowest resistivity nearly about $1.60 \times 10^{-8}\Omega m$. Therefore, silver metal is the best conductor of electricity.

In Text Questions-Pg-213

Q.1 Draw a schematic diagram of a circuit consisting of a battery of three cells of 2 V each, a 5Ω resistor, an 8 Ω resistor, and a 12resistor, and a plug key, all connected in series.

Ans.: In this problem, we have 3 cells of voltage2 V each. Thus, the total voltage of the three cells connected together to form a battery will be 3 X 2V = 6V. The circuit also consists 3 resistors of 5 Ω , 8 Ω , 12 Ω respectively and a plug key, all connected in series as shown in the figure given below:



Q.2 Redraw the circuit of Question 1 putting an ammeter to measure the current through the resistors and a voltmeter to measure the potential difference across the 12Ω resistor. What would be the reading in the ammeter and the voltmeter?

Ans.: We redraw the circuit by including an ammeter circuit and a voltmeter across the 12 Ω resistor, as shown in figure. Please note that the ammeter is always connected n series with the circuit but the voltmeter has been put in parallel with the 12 Ω resistor

We will now calculate the current reading in the ammeter and potential difference reading in the voltmeter:

(i) Calculation of current flowing in the circuit. The three resistors of 5 Ω , 8 Ω and 12 Ω are connected in series. So, net resistance in series is the sum of all the resistances.

Ans: Total resistance, $5\,\Omega + 8\Omega + 12\Omega = 25\Omega$

Potential difference, V = 6 V

And, Current, I = ?

We know,

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

$\Longrightarrow$ V = IR = 0.24A $\times$ 12Ω

And, Potential difference, V =?

We know that,

Thus, the potential difference across the 12 Ω resistor is 2.88V. So, the voltmeter will show a reading of 2.88 V.

In Text Questions-Pg-216

Q.1 Judge the equivalent resistance when the following are connected in parallel:

(a) 1 Ω and 10^6 Ω

(b) 1 Ω, 10^3 Ω and 10^6 Ω

Ans.: (a) The equivalent resistance of two resistances 1 Ω and 10^6 Ω connected in parallel will be less than 1 Ω.This is because when a number of resistances are connected in parallel, then their equivalent resistance is less than the smallest individual resistance. Here, since the smallest resistance is 1 Ω. Therefore, the net resistance will be less than 1 Ω

(b) The equivalent resistance of three resistances1,10^3 Ω and 10^6 Ω connected in parallel will be less than 1 Ω because the smallest resistance is 1.

Q.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?

Ans..: The combined resistance R of three resistors (or electrical devices) R_1 R_2 and R_3, connected in parallel is given by the formula:

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

Here, Resistance of electric lamp, R_1 = 100 Ω

Resistance of toaster, R_2 = 50 Ω

Resistance of water filter, R_3 = 500 Ω

Putting these values of R_1 R_2 and R_3 in the above formula, we get:

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

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

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

R = 31.25 Ω

Thus, the resistance of electric iron will also be 31.25 Ω

Now, Potential difference, V= 220 V

Current, I =?

By Ohm's law : R = $\frac{V}{I}$

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

Thus, the current passing through the electric iron is 7.04 amperes.

Q.3 What are the advantages of connecting electrical devices in parallel with the battery instead of connecting them in series?

Ans.: The advantages of connecting electrical devices in parallel rather than series are as follows:

a) The voltage is same across all the elements in case of parallel circuits. Even if any one of the electrical devices stop working, it will not affect other electrical appliances and they will work normally. On the other hand, in series circuit, the current through all devices is same. If one electrical appliance stops, Then the whole circuit is broken and no current flows. As a result, all other appliances also stop working.

b) In case of parallel circuits, each electrical appliance works independently, i.e. it has its own switch. Each device can be turned on or turned off independently, without affecting other appliances. In series circuit, all the electrical appliances have only one switch due to which they cannot be turned on or turned off independently.

c) In parallel circuits, each electrical appliance gets the same voltage as that of the battery due to which all the appliances work properly. In series circuit, the appliances do not get the same voltage but get the same current. Each appliance has a different voltage.

(d) Parallel circuits divide the current among electrical devices hence each device get necessary current to operate properly.

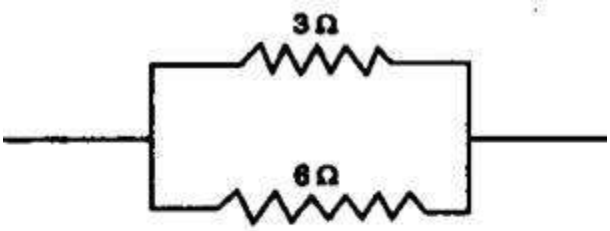
Q.4 How can three resistors of resistances 2 Ω, 3 Ω, and 6 Ω be connected to give a total resistance of

(a) 4 Ω, and (b) 1 Ω?

Ans.:

(a) In order to obtain a total resistance of 4 Ω from three resistors of 2Ω, 3 Ω and 6 Ω .

Firstly, connect the two resistors of 3 Ω and 6 Ω in parallel to get a total resistance of 2 which is less than the lowest individual resistance.



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

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

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

$$\Rightarrow R = \frac{6}{3} = 2\ \Omega$$

Then the net R from parallel connection is connected in series with the remaining 2 Q resistor to get a total resistance of 4 Q. This is because in series combination:

R = $R_1 + R_2$

R = 2 + 2

R = 4 Ω

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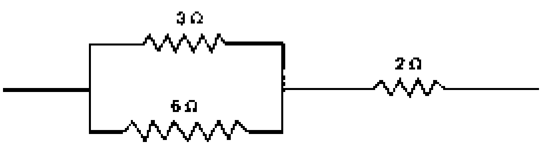
R = $R_1 + R_2$

R = 2 + 2

R = 4 Ω

The arrangement of three resistors of 2,3 Ω and 6 Ω which gives a total resistance of 4 can now be represented as follows :



Thus, we can obtain a total resistance of 4 Ω by connecting parallel combination of 3 Ω and 6 Ω resistors in series with 2 Ω resistor

(b) In order to obtain a total resistance of 1 Ω from three resistors of 2 Ω, 3 Ω and 6Q, all the three resistors should be connected in parallel. This is because in parallel combination:

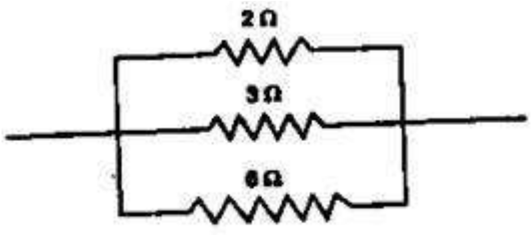
$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

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

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

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

R = 1 Ω



Q.5 What is (a) the highest, and (b) the lowest, total resistance that can be secured by the combination of four coils of resistances 4, 8 Ω, 12 Ω and 24 Ω ?

Answer:

(a) The highest resistance can be secured (or obtained) by connecting all the four coils in series. In this case:

R = $R_1 + R_2 + R_3 + R_4$

R = 4 + 8 + 12 + 24

R = 48 Ω

Thus, the highest resistance which can be secured is 48 ohms.

(b) The lowest resistance can be secured by connecting all the four coils in parallel. In this case:

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

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

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

$\frac{1}{R} = \frac{12}{24}$

$\frac{1}{R} = 2\Omega$

Thus, the lowest resistance which can be secured is 2Ω.

In Text Questions-Pg-218

Q.1 Why does the cord of an electric heater not glow while the heating element does?

Ans.: The heating element of an electric heater is made of an alloy example nichrome, which has high resistance whereas the cord is made of copper metal which has very low resistance as compared to the heating element. Now, the heating element of an electric heater made of nichrome glows because it becomes red-hot due to the large amount of heat produced on passing current. On the other hand, the connecting cord of the electric heater made of copper does not glow because negligible heat is produced in it by passing the same current (due to its extremely low resistance).

Q.2 Compute the heat generated while transferring 96000 coulombs of charge in one hour through a potential difference of 50 V.

Ans.: First of all we will calculate the current (I) by using the given values of charge (Q) and time (t). We know that:

Current , I =

$\frac{Q}{t} = \frac{96000C}{1h} = \frac{96000}{60 \times 60S}$ = (As 1 hour = 3600 seconds)

∴ I = 26.67A

We will now calculate the resistance by using Ohm's law:

Resistance, R = $\frac{V}{I}$ = $\frac{50V}{26.67\text{A}}$ = 1.87 Ω.

And, Time, t= 1h = 60x60s = 3600 s

Heat generated, H = $I^2 \times R \times t$

= $(26.67)^2$ × 1.87 Ω × 3600 J

= 4788397J

= 4.79 × 10^6J

or

4.8 × 10^6J

Thus, the heat generated is 4.8 x 10^6J.

Q.3 An electric iron of resistance 20 Ω takes a current of 5 A. Calculate the heat developed in 30 s.

Ans.: Here, Current, I = 5 A

Resistance, R = 20 Ω

Time, t = 30 s

Now, we know, Heat produced is given as,

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

= $(5)^2$ × 20 Ω × 30s

= 15000J

Thus, the heat developed is 15000 joules.

Q.1 What determines the rate at which energy is delivered by a current?

Ans. : Electric power of the appliance the rate at which energy is delivered by a current.

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

Ans.: Here,

Voltage, V = 220 V

Current, I = 5 A

Power, P = V x I = 220V X 5 A = 1100 Watts

Thus, the power of the motor is 1100 watts.

Now,

Power, P = 1100 W (Calculated above)

Time, t = 2 hour = 2 x 60 min x 60 sec

$= 2 \times 60 \times 60s$

= 7200 s

So, Energy, E = P x t

E = 1100W X 7200 sec

$= 7.92 \times 10^6$J

Thus, the energy consumed is 7.92×10^6Joules.

Exercise-Pg-221

Q.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.: The resistance of wire is R. This wire is cut into five equal pieces as a result resistance of each piece of wire will be R⁄5.Now, when these five pieces are connected in parallel, the equivalent resistance for the combination is R’. We can write,

(Assume that each piece of wire is named R_1, R_2, R_3, R_4, R_5)

$$\frac{1}{R'} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4} + \frac{1}{R_5}$$

$$\frac{1}{R'} = \frac{5}{R} + \frac{5}{R} + \frac{5}{R} + \frac{5}{R} + \frac{5}{R}$$

$$\frac{1}{R'} = \frac{5+5+5+5+5}{R}$$

$$\frac{1}{R'} = \frac{25}{R}$$

On cross multiplication , we get, $\frac{R}{R'} = \frac{25}{1} = 25$

Thus, the correct answer is: Option (d)

Q.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.: the electrical power is not represented as IR^2.

Q.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.: The bulb parameters are as given below:

Power, P = 100W

Potential difference, V = 220V

Then Resistance, R = ?

Now,

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

$$\Longrightarrow R = \frac{V^2}{P} = \frac{(220V)^2}{100\,W}$$

= 484Ω

This resistance of the bulb will remain constant i.e. 484 Ω

Now, when we operate this bulb on 110 V, then, Power, P =?

Potential difference, V = 110V

And, resistance, R = 484 Ω

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

P = $\frac{(110)^2}{484} = \frac{110\times110}{484}$ = 25W

Thus, the correct answer is: (d) 25 W.

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

A. 1 : 2

B. 2 : 1

C. 1 : 4

D. 4 : 1

Ans.: Suppose the resistance of each one of the two wires is R.

Case (i) When both wires are connected in series. Then, net resistance will be R+

R = 2R.

According to Ohms Law:

Current(I) = $\frac{V}{2R}$

Then, heat produced will be $H1 = \frac{V^2}{4R^2} \times 2R \times t$ (As H = $I^2 \times R \times t$)

Case (ii) When both wires are connected in parallel. Then, net resistance will be $\frac{R}{2}$.

According to Ohms Law:Current(I)= $\frac{V\times 2}{R}$

Then, heat produced will be H2 = $\frac{V^2\times 4\times R\times t}{R^2\times 2}$

Now, The ratio after simplifying will be as follow:-

$\frac{H1}{H2} = \frac{V^2\times t\times R}{2R\times V^2\times 2\times t}$

$\therefore \frac{H1}{H2} = \frac{1}{4}$

Thus, option (c) is correct.

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

Ans.: The volt meter is always connected in parallel connection across the two points where the potential difference is to be measured in the circuit.

Q.6 A copper wire has diameter 0.5 mm and resistivity of 1.6 x $10^{-8}\Omega$ 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?

Ans.: The radius of wire,

r = $\frac{d}{2} = \frac{0.5mm}{2} = 0.25\times 10^{-3}$m

Area of the cross-section can be calculated by,

A = $\pi r^2 = \frac{22}{7}\times (0.25\times 10^{-3})^2 = 0.196\times 10^{-6} m^2$

The Resistivity of the resistor, p = 1.6×10^{-6} Ωm

Resistance, R= 10Ω

Formula used:

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

Where,ρ is the resistivity of the copper wireL is the length of the copper wireA is the area of the cross-section of the wireSolving the above equation for the length

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

Putting the values in the above equation, we get

L = $\frac{10\Omega \times (0.196 \times 10^{-6} m^2)}{1.6 \times 10^{-8}\ \Omega m}$ = 122.5 m

Thus, the length of copper wire required to make 10Ω resistance will be 122.5 meters.

(b) If the diameter is twice, D'=2D

Where,D' is the new diameterD is the initial diameterThen, according to the question, the new diameter is twice the initial diameter. D' = 2(0.5mm) = 1mmNow, the new radius R' =D (Initial diameter of the cross-section)= D'/2 = 0.5 mmAs we know, R = $\rho \frac{L}{A}$

Putting the values in the above formula, we get R = 1.6 × $10^8 \frac{112.5m}{\pi \times (0.5 \times 10^{-3})^2}$

Thus, Resistance, R=2.5 Ω Thus, if we twice the diameter of the copper wire the resistance become the quarter part of the initial resistance.

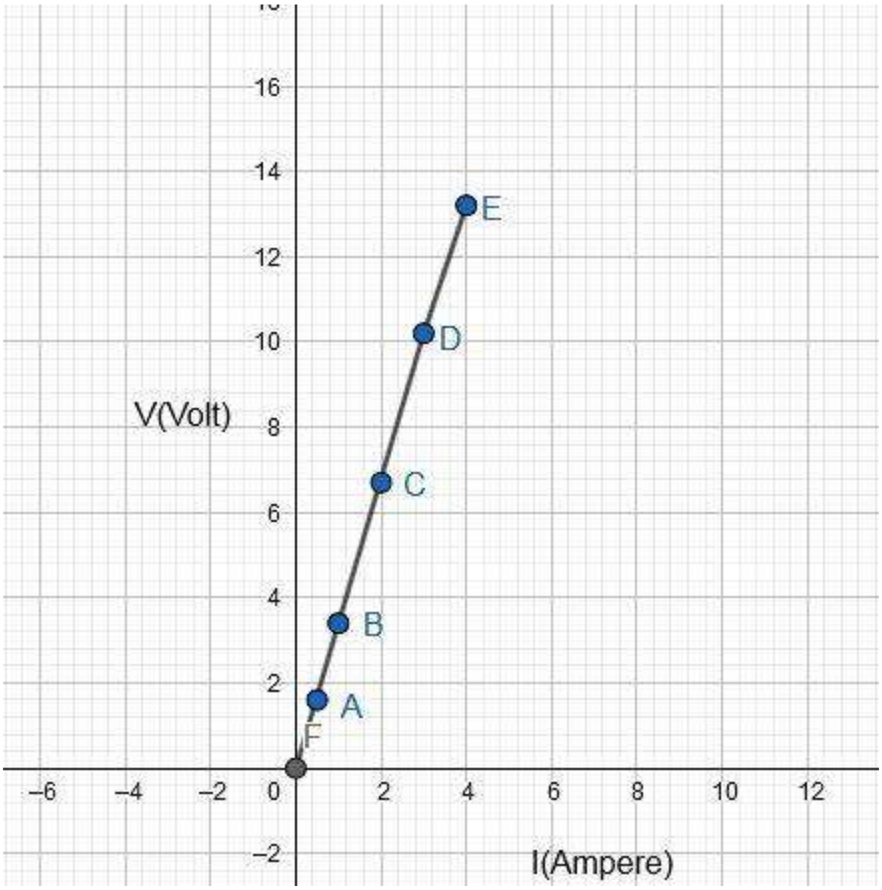
Q.7 The values of current I flowing in a given resistor for the corresponding values of potential difference V across the resistor are given below:

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 plotted by using the given data is shown below:

Ans.: The graph between V and I plotted by using the given data is shown below:



We know that Resistance = Slope of the Graph= $\frac{y-intercept}{x-intercept} = \frac{(10.2-0)V}{(3.0-0)A}$

= 3.4 Ω

Thus, the resistance of the resistor is 3.4 ohms.

Q.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.

Answer: In this problem,

The current, I = 2.5mA = 2.5×10^{-3} A

Potential difference, V = 12 V

And, Resistance, R=?

And, From Ohm's law:

V = IR

$\Rightarrow$ R = $\frac{V}{I}$ = $\frac{12V}{2.5\times10^{-3}A}$ = 4800 Ω

The value of the resistor is 4800 Ω.

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

Ans.: All the resistors are connected in series.

Thus, equivalent resistance, R = 0.2 Ω + 0.3Ω + 0.4Ω + 0.5 Ω + 12 = 13.4 Ω

Potential difference, V = 9V

And, Current, I=?

$\Rightarrow$ I = $\frac{V}{R}$ = $\frac{9V}{13.4\Omega}$ = 0.67A Ω

Since in series connection, the current throughout the circuit is same. Therefore, 0.67 A will flow through the 12Ω resistor.

Q.10 How many 176 resistors in parallel are required to carry 5 A on a 220 V line?

Ans.: Here, Potential difference = is 220 V

And the current, I = 5 A.

V = IR

$\Rightarrow$ R = $\frac{V}{I}$ = $\frac{220V}{5A}$ = 44 Ω

Thus, the resistance of the circuit is 44 ohms.

Now, we need to find the number of 176Ω resistors should be connected in parallel to obtain a resultant resistance of 44 Ω. Suppose the number of 176 Ω resistors required is 'n'.

Then,

$$\frac{1}{R_{net}} = \frac{1}{R} \times n$$

$$\frac{1}{44\Omega} = \frac{1}{176\Omega} \times n$$

On cross –multiplying we get,

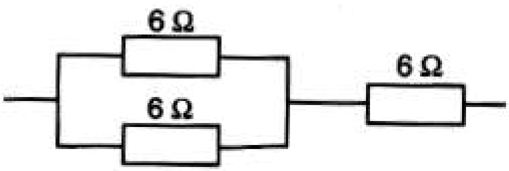
n = $\frac{176\Omega}{44\Omega}$ = 4

Thus, 4 resistors of 176 Ω each should be connected in parallel.

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

Ans.

(i) In order to get a resistance of 9 Ω from three resistors of 6 Ω each, we connect two 6 Ω resistors in parallel and then this parallel combination is connected in series with the third 6 Ω resistor .



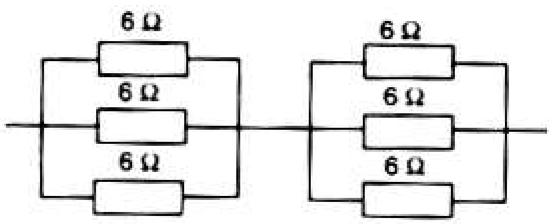
For parallel connection: $\frac{1}{R} = \frac{1}{6} + \frac{1}{6} = \frac{1+1}{6} = \frac{2}{6} = \frac{1}{3}$

OR R = 3Ω

And for series connection: R= 3 Ω + 6 Ω = 9 Ω

(ii) In order to get a resistance of 4 Ω , their are multiple cases

(a) 1st CaseFrom three resistors of 6 Ω each, we connect all the three 6 Ω resistors in parallel:

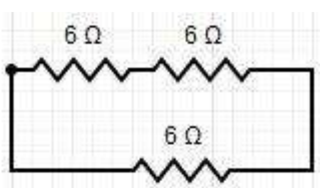


Then, Net Resistance R = 2 Ω + 2 Ω = 4Ω.

(b)2nd CaseWe connect two resistors of 6 Ω in series and another resistor of 6 Ω in parallel to them R= 6 Ω + 6Ω= 12ΩThen Net Resistance

$\frac{1}{R} = \frac{1}{12} + \frac{1}{6} = \frac{1}{4}$

Then R = 4 Ω



Q.12 Several electric bulbs designed to be used on a 220 V electric supply line are rated 10 W each. How many bulbs 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.: First we will calculate the resistance R of one bulb.
We know,

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

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

Therefore, resistance of one bulb is 4840 Ω

We will now calculate the total resistance of the circuit by using Ohm's Law:

Thus, from Ohm's Law:

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

Thus, the total resistance of the circuit is 44 Ω.

Now, we need to find out the number of 4840 Ω bulbs should be connected in parallel to obtain a total resistance of 44 Ω. Suppose the number of 4840 Ω bulbs required is x. Then:

$$\frac{1}{44} = \frac{1}{4840} \times x$$

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

Thus, 110 bulbs can be connected in parallel in this circuit.

Q.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.: Case (i): When each coil is used separately

Here, Potential difference, V = 220 V

Resistance of a coil, R = 24

Using Ohm's Law, the current passing through one coil is given as,

$I = \frac{V}{R} = \frac{220}{24}$

$\Rightarrow$ I = 9.17A

Case (ii) Calculation of current when the two coils are connected in series

When the two coils of 24 each are connected in series, then their combined resistance will be R = 24 Ω + 24 Ω =48 Ω

Potential difference, V = 220 V
And, Resistance, R = 48 Q
Again, Current passing through both coils connected in series, is given as:
$I = \frac{V}{R} = \frac{220V}{48\Omega}$ = 4.58A

Case (iii) Calculation of current when the two coils are connected in parallel

When the two coils of 24 Ω each are connected in parallel, then their combined resistance will be given as:

$\frac{1}{R} = \frac{1}{24} + \frac{1}{24}$

$= \frac{1+1}{24} = \frac{2}{24}$

R = 12 Ω

Here, Potential difference, V = 220 V
Resistance of two coils in parallel connection, R = 12 (Two coils in parallel)

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

Q.14 Compare the power used in the 2 resistor in each of the following circuits:

(i) a 6 V battery in series with 1 and 2 a resistors.

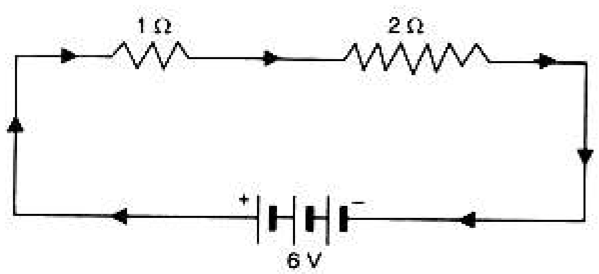
(ii) a 4 V battery in parallel with 12 and 2 resistors.

Ans.: (i) In the First Case:

Potential difference, V = 6 V

And, Net Resistance, R = 1Ω + 2Ω = 3Ω (Resistors are connected in series)

Now, by Ohm's law: V = IR ⇒ $I = \frac{V}{R} = \frac{6V}{3\Omega}$ = 2A

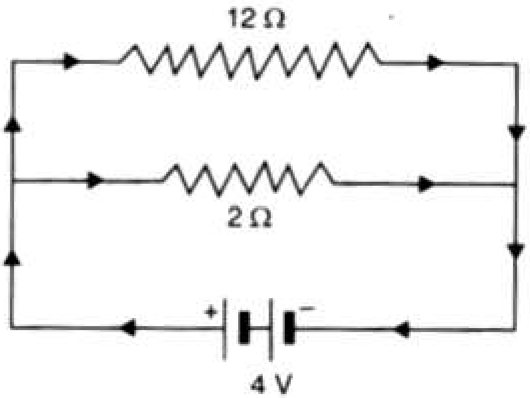


Thus, the current flowing in the circuit containing 1Ω and 2 Ω resistors in series is 2 A. In a series circuit, the same current flows throughout the circuit. So, the current flowing through the 2 Ω resistor is also 2A. Now, we know that the current (in 2 Ω resistor) is 2 A and its resistance is 2Ω . Now, Power used in 2 Ω resistor is given as:

P = $I^2R = (2A)^2 \times 2\Omega$ = 8W.

(ii) In the Second Case:

Here, 4 V battery is attached across the parallel combination of 12 Ω and 2 Ω resistors, so the potential difference across the 2 resistor will also be 4 V. Because in parallel connection
Voltage is same.
Now, Potential difference, V= 4 V
And Resistance, R = 2 Ω



So, Power used in 2 Ω resistor, P = $\frac{V^2}{R} = \frac{(4V)^2}{2\ \Omega}$ = 8W
Thus, the power used in the 2 Ω resistor in the second case is also 8W.

From both the cases we can say that the 2 Ω resistor uses equal power in both the circuits.

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

Answer: Given the power of the two lamps, we will calculate the resistances R_1 and R_2 of two lamps separately.

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

$\Rightarrow$ R = $\frac{V^2}{p}$

For first lamp, R = $\frac{220V \times 220V}{100W}$ = 484 Ω

For second lamp, R = $\frac{220V \times 220V}{60W}$ = 806.67 Ω

Now, The two lamps of resistances 484 Ω and 806.7 Ω are connected in parallel.

So, the combined resistance of two lamps can be calculated as follows:

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

$$\frac{1}{R} = \frac{1}{484} + \frac{1}{806.7}$$

$$\frac{1}{R} = \frac{390442.8}{1290.7}$$

Total resistance, R= 302.5 Ω

Current drawn from the line can now be calculated by using Ohm's law as follows:

V = IR

$\Longrightarrow$ I = $\frac{V}{R}$ = $\frac{220V}{302.5\Omega}$ = 0.72A

Thus, the current drawn from the line is 0.72 A.

Q.16 Which uses more energy, a 250 W TV set in 1hr or a 1200 W toaster in 10 minutes ?

Ans.: (i) For TV set:

Power, P= 250W= $\frac{250W}{1} \times \frac{1KW}{1000W}$ = 0.25kW

Time, t = 1 h

So, Electric energy, E= P x t = 0.25Kw x 1 h = 0.25 kWh

(ii) For toaster:

Power, P= 250W = $\frac{1200W}{1} \times \frac{1kW}{1000W}$ = 1.2kW

Time, t = 10 min = $\frac{10}{60}$ h

So, Electric energy, E= P x t= 1.2 kW x $\frac{10}{60}$ h = 0.20 kWh

From the above calculations, it is clear that the TV set uses more energy (0.25 kWh) whereas toaster uses less energy (0.20 kWh).

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

Ans.: Given

Resistance, R =8Ω Current, I=15 A Time period, T = 2 hours Power, P is the rate at which the heat is developed by the heaterFormula used: Power, P= I^2 R

Where I is the currentR is the resistancePutting the values in the above equation, we getH = 15 X 15 X 8 = 1800 WThus, the rate at which heat is developed in the heater is 1800 joules per second.

Q.18 Explain the following:

(a) Why is the tungsten used almost exclusively for the 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.:

(a) Tungsten is used almost exclusively for making the filaments of electric lamps and electric bulbs because it has very high melting point nearly 3380°C due to which the tungsten filament can be kept white-hot without melting away.

(b) The coils (or heating elements) of toasters and electric irons are made of an alloy rather than a pure metal because the resistivity of an alloy is much higher than that a pure metal, and an alloy does not undergo oxidation easily even at high temperature, when it is red hot but metals can get easily oxidized at higher temperatures.

(c) The series arrangement is not used for domestic circuits because of the following disadvantages:

(i) In series arrangement, the current throughout the circuit is same. If one electrical appliance stops working due to some defect, then all other appliances also stops working (because the whole circuit is broken).

(ii) In series arrangement, all the electrical appliances can have only one switch due to which they cannot be turned 'on' or 'off' independently.

(iii) In series arrangement, all the appliances do not get the same voltage (220 V) as that of the power supply line (because the line voltage is shared by all the appliances). Due to this, the appliances do not work properly.

(iv) In series arrangement of electrical appliances, the overall resistance of the circuit increases too much because in series the net resistance is the addition of all the resistances. Due to this the current from power supply is low. Because of this, all the appliances of different power ratings cannot draw sufficient current for their proper working.

(d) The resistance of a wire is inversely proportional to its area of cross-section i.e. Thus, when the area of cross-section of wire increases (or thickness of wire increases), then its resistance decreases. Similarly, when the area of cross-section of wire decreases (or thickness of wire decreases), then its resistance increases.

(e) Copper and aluminium wires are usually employed for transmission of electricity because copper and aluminium are good conductors of electric current due to their low electrical resistivity. $R \propto \frac{1}{A}$.