CLASS X
PHYSICS
CHAPTER 8 - ELECTRICITY

SOLUTIONS

1. 3×10^{17} electrons cross in 30 seconds through an area. What is the electric current?

Ans:

Charge carried by 1 electron,

$$e \ = -1.6 \times 10^{-19} C$$

$$\therefore Total\ charge\ in\ 3 \times 10^{17} electron, Q = \pm ne$$

$$= 3 \times 10^{17} \times 1.6 \times 10^{-19} C$$

$$= 4.8 \times 10^{-2} C$$

We have ,

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

$$= \frac{4.8 \times 10^{-2} c}{30s} \ = \frac{4.8 \times 10^{-2}}{3 \times 10} cs^{-1}$$

$$= 1.6 \times 10^{-3}\ A$$

2. The potential at a point is 20V. Calculate the amount of work done to bring charge of 0.5C from infinity to this point.

Ans: Potential difference $= \frac{work\ done\ (W)}{charge\ (Q)}$

Amount of work done $= V \times Q$

$= 20 \times 0.5$ J

$= 10\ J$

3. A potential difference of 20V appears across the ends of resistor when $2.5A$ of current is passed through it. What is the resistance of the resistor?

Ans.

Given,

V = 20V

I = 2.5 A

R = ?

We have,

V=IR

$$\Rightarrow R = \frac{V}{I} = \frac{20}{2.5} = \frac{200}{25} = 8\Omega.$$

4. How much charge flows through a wire carrying $2.5A$ current in 20 minutes?

Ans:

Here I = 2.5A

t = 20 min . = 20×60 seconds

Q =?

We have, $Q = I\ t$

$= 2.5 \times 20 \times 60\ C$

= 3000

= 3×10^3C

5. A Nichrome wire has diameter 1.0 mm and resistivity of $1.0 \times 10^{-4}\Omega$. Calculate the required length of this wire to make a resistance of 14 Ω.

Ans :

Here, area of cross section, $A = \pi r^2 = \frac{22}{7} \times \left(\frac{d}{2}\right)^2$

Resistivity, $\rho = 1.0 \times 10^{-4}\ \Omega\, m$

$R = 14\Omega$

$d = 1.0mm$

$= 1 \times 10^{-3}m$

We have, $l = \frac{R \times A}{\rho}$

$$= \frac{14 \times \frac{22}{7} \times (1 \times 10^{-3})^2}{1.0 \times 10^{-4} \times 4}$$

$$= \frac{14 \times 22 \times 10^{-2}}{7 \times 4}$$

$$= 11 \times 10^{-2} \quad m$$

$$= 11\ cm$$

6. A copper wire of certain length has a resistance of $10\ \Omega$. What will be its resistance after stretching to double its length?

Ans:

When wire is stretched to double its length, the area of cross section would be reduced to half.

New length = $2l$

New cross section = $\frac{A}{2}$

Hence, new resistance of the resulting wire R' is given by.

$$R' = \frac{\rho \times 2l}{\frac{A}{2}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots (i)$$

And, $$R = \frac{\rho \times l}{A} \ldots\ldots\ldots\ldots\ldots\ldots (ii)$$

From (i) and (ii) we get,

$$\frac{R'}{R} = \frac{\rho \times 2l}{\frac{A}{2}} \times \frac{A}{\rho \times l} = 4$$

$$\Rightarrow R' = 4R$$

$$= 4 \times 10$$

$$= 40\,\Omega$$

7. Two resistors of resistances10 Ω and 20Ω are connected in parallel. A battery supplies a current of 6A to the combination shown in the circuit. Calculate the current in each resistor.

Ans:

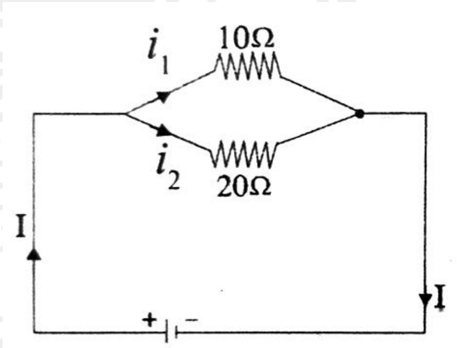


FIGURE : (1)

Connection of two resistors of resistances10 Ω and 20 Ω in parallel

Here, $\frac{1}{R_p} = \frac{1}{10} + \frac{1}{20}$

$$= \frac{2+1}{20}$$

$$= \frac{3}{20}$$

$$\Rightarrow R_p = \frac{20}{3}\,\Omega$$

Hence, the potential difference across the two resistors is given by

$$V = IR_p = 6 \times \frac{20}{3} = 40V$$

$$\therefore \quad i_1 = \frac{V}{R_1} = \frac{40}{10} = 4A$$

$$i_1 = \frac{V}{R_2} = \frac{40}{20} = 2A$$

8. You are given three resistors of resistances $1, 2, 3\ ohms$. Show by diagrams, how with the help of these resistors you can get resistance of

(i) 6Ω

(ii) $1.5\ \Omega$

(iii) 2.2Ω

(iv) $\frac{6}{11}\ \Omega$

(v) $\frac{11}{3}\Omega$

Ans :

(i) Since the equivalent resistance is greater than 3Ω.

$\therefore R\_s = 1 + 2 + 3 = 6\ \Omega$

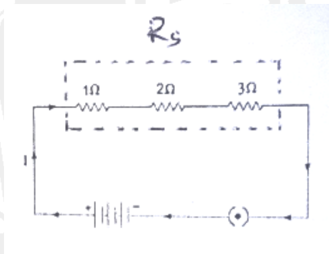


Figure (i)

ii) Resistors of $1\ \Omega$ and $2\ \Omega$ are connected in series.

$R_s = 1 + 2\ = 3\ \Omega$

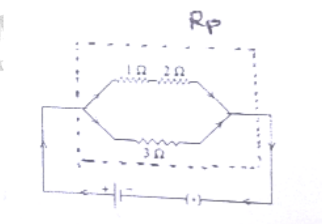


Figure . (ii)

Then, resistors of resistances $Rs = 3\Omega$ and 3Ω are connected in parallel.

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

$$\therefore \quad R\_P \quad = \quad 3/2 \quad = \quad 1.5\,\Omega$$

(iii) Resistors of resistances 2 Ω and 3 Ω are connected in parallel.

$$\frac{1}{R_P} \quad = \quad \frac{1}{2} + \frac{1}{3}$$

$$\Rightarrow \frac{1}{R_P} \quad = \quad \frac{3+2}{6} \quad = \quad \frac{5}{6}$$

$$\therefore R_P \quad = \frac{6}{5}\Omega$$

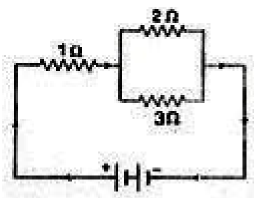


Figure : (iii)

Then, resistors of resistances$R_P = \frac{6}{5}\ \Omega$ and 1 Ω are connected in series.

$$R_s \quad = \quad \frac{6}{5} + 1 \quad = \frac{6+5}{5} \quad = \frac{11}{5} \quad = 2.2\ \Omega$$

(iv) Resistors of resistances 1 Ω, 2 Ω and 3 Ω are connected in parallel.

$$\frac{1}{R_P} \quad = \frac{1}{1} + \frac{1}{2} + \frac{1}{3}$$

$$\Rightarrow \frac{1}{R_P} \quad = \frac{6+3+2}{6}$$

$$\therefore \quad R_P \quad = \frac{6}{11}\Omega$$

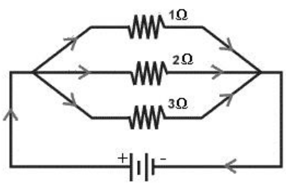


Figure : (iv)

(v) $\frac{11}{3}\ \Omega$

The equivalent resistance is greater than 3 Ω

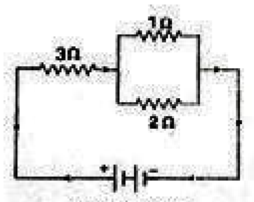


Figure : (v)

$$\frac{1}{R_1} = \frac{1}{1} + \frac{1}{2}$$

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

$$= \frac{3}{2}$$

$\therefore R_1 \quad = \frac{2}{3}$

Hence, the equivalent resistance $= \frac{2}{3} + 3 \quad = \frac{2+9}{3} \quad = \frac{11}{3}\ \Omega.$

9. A resistor of 10 Ω is combined in parallel with another resistor of X Ω. The resultant resistance of the combination is found to be 3.75 Ω. What is the value of X?

Ans:

Here,

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

$$\Rightarrow \frac{1}{3.75} = \frac{1}{10} + \frac{1}{X}$$

$$= \frac{X+10}{10X}$$

$$\Rightarrow 10X = 3.75\,X + 3.75 \times 10$$

$$\Rightarrow 10X = 3.75\,X + 37.5$$

$$\Rightarrow 10X - 3.75X = 37.5$$

$$\Rightarrow 6.25\,X = 37.5$$

$$\therefore \quad X = \frac{37.5}{6.25}\Omega = 6\ \Omega$$

10. How many resistors of 200 Ω each are required in parallel combination so as to carry 5A on a 200V line supply?

Ans:

Given, $R = 200\,\Omega$, $V = 200V$, $I = 5A$.

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

$$= \frac{200}{5}$$

$$= 40\,\Omega$$

If no. of resistors be "n" we get,

$$\frac{1}{R_p} = n\frac{1}{200}$$

$$\Rightarrow \frac{1}{40} = \frac{n}{200}$$

$$\Rightarrow n40 = 200$$

$$\therefore n = \frac{200}{40} = 5$$

Hence, the required number of resistors $= 5$.

11. Suppose there are a number of bulbs rated at 220V – 100W each. How many bulbs can be connected in parallel across a 220V supply line, if the maximum permissible current is $5A$ only?

Ans:

Given, $R = \frac{V^2}{P} = \frac{220\times220}{100} = 484\,\Omega$

And $R_p = \frac{V}{I} = \frac{220}{5} = 44\Omega$

If 'n' be the no. of bulbs connected in parallel

We get, $\frac{1}{R_p} = n \times \frac{1}{R}$

$= n \times \frac{1}{484}$

$\Rightarrow \frac{1}{44} = n \times \frac{1}{484}$

$\therefore n = \frac{484}{44} = 11$

12. Calculate the energy transferred in kWh by a $5A$ current flowing through a resistance of $2\ \Omega$ for 40 minutes.

Ans:

Here, $I = 5A$

$R = 2\ \Omega$

$t = 40min = \frac{40}{60}\ hours$

The energy transferred,

$$W = I^2Rt$$

$$= \frac{5 \times 5 \times 2 \times 40}{60} Wh$$

$$= \frac{200}{6} Wh$$

$$= \frac{200}{6 \times 1000} kWh$$

$$= 0.033\ kWh.$$

13. An electric bulb is rated at $220V - 200W$. What is the resistance of the filament?

Ans:

Given, $V = 220V$

$P = 200W$

The resistance of the filament,

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

$$= \frac{220 \times 220}{200}$$

$$= 242\,\Omega$$

14. Two resistors of $10\,\Omega$ and $20\,\Omega$ are connected in series across a $12\,V$ battery. Calculate the power consumed by each of them respectively.

Ans :

Given,

$$Rs = 10 + 20 = 30\,\Omega$$

Hence $I = \frac{V}{R_S} = \frac{12}{30} = \frac{2}{5}A$

∴ Power consumed by $10\,\Omega = I^2R$

$$= \frac{4}{25} \times 10\,W$$

$$= 1.6W.$$

And the power consumed by $20\,\Omega = I^2R$

$$= \frac{4}{25} \times 20\,W$$

$$= 3.2\,W$$

15. If the potential difference between the ends of a fixed resistor is doubled by how much does the electric power increase?

Ans :

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

If potential difference doubled, the power becomes

$$P' = \frac{(2V)^2}{R} = \frac{4V^2}{R} = 4P.$$

Hence, the electric power will increase four times that of the original power.

16. Which one will consume more energy?

(i) A 300w TV set in 1 hr.

(ii) 1000 w electric heater in 10 minutes?

Ans:

Energy consumed by $TV = 300 \times 1wh = 300\,wh.$

Energy consumed by electric heater $= 1000 \times \frac{10}{60} wh$

$$= 166.6\,wh$$

Hence, the TV set will consume more energy.

17. State whether an electric heater will consume more or less electrical energy per second when the length of its heating element is reduced. Give an explanation for your answer.

Ans:

When the length of heating element of the electric heater is reduced, resistance of the heating element decreases, thereby increasing the current passing through the heater. Then, electrical energy consumed also increases.

18. Is it possible to have a particle with charge.$2.0 \times 10^{-19} C$

Ans :

No, between the charge carried by the electron ($e = 1.6 \times 10^{-19} C$) is the smallest.

Now, $Q = ne$

$$\therefore n = \frac{Q}{e} = \frac{2.0 \times 10^{-19} C}{(1.6 \times 10^{-19}) C}$$

$= \frac{5}{4} = 1.25$ which is a fraction.

As n cannot be a fraction, a particle of charge $2.0 \times 10^{-19} C$ is not possible.

19. A bulb is rated as $250V$ and $0.4A$. Find its (i) resistance (ii) power.

Ans

(i) Here, $V = 250V$

$I = 0.4A$

$R = ?$

We have, $R = \frac{V}{I}$

$= \frac{250}{0.4}$

$= \frac{2500}{4}$

$= 625\,\Omega$

(ii.) Again,

$P = VI$

$= 250 \times 0.4\,w$

$= 100\,W$

20. **An electric kettle rated at $220V$ and $2.2kW$ works for $3\ hrs$. Find the energy consumed and current drawn.**

Ans :

Given, $V = 220V$

$P = 2.2\ kW$

$t = 3\ hours.$

Energy consumed, $E = W = P \times t$

$= 2.2 \times 3\ kWh.$

$= 6.6\ kWh.$

And the current,

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

$= \frac{2.2 \times 1000}{220} [\ 2.2\ kW = 2.2 \times 1000W\ ]$

$= \frac{2200}{220}$

$= 10A$

21. **A piece of nichrome wire of resistance R is cut into four equal parts. These parts are then combined in parallel. If R' is the equivalent resistance of the parallel combination then the ratio $\frac{R}{R'}$ will be.**

A. 16

B. 4

C. ¼

D. $\frac{1}{16}$

Ans :

(A) If the wire of resistance R in cut into 4 equal pairs, then resistor of each part is

$$\frac{1}{Rp} = 4 \times \frac{1}{Rp} = \frac{16}{R}$$

$$\therefore \frac{R}{Rp} = 16$$

22. **The term that does not represent the electrical power of a circuit is**

A. I^2R

B. IR^2

C. $\frac{V^2}{R}$

D. VI

Ans: (B)

$$P = V \times I$$

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

$$P = I^2R$$

23. **An electric bulb is rated $220V - 100W$. The same is operated at $110V$ due to load shedding. The actual power consumed will be**

A. $100W$

B. $75W$

C. $50W$

D. $25W$

Ans : (D)

$$V1 = 220V\ ;\ P1 = 100W$$

$$\therefore R = \frac{\mathrm{V1}}{\mathrm{P1}} = \frac{220\times220}{100} = 484\ \Omega$$

$V1 \quad = 110V\,;\ R = \quad 484\ \Omega$

$\therefore\ P_2 = \frac{v^2}{R} = \frac{(110\times110)}{484} = \frac{100}{4} = 25W$

24. Two identical heating coils are first connected in series and then in parallel across the same potential difference. The ratio of heat generated in series to that of parallel would be

A. 1:1

B. 1:2

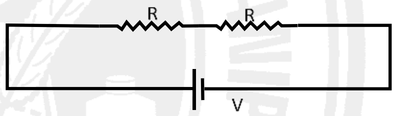
C. 1:4

D. 4:1

Ans : (C)

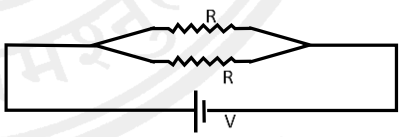
$$Rs = 2R$$

$$\therefore\quad Hs = \frac{V^2}{Rs}t$$



$$\frac{1}{Rp} = \frac{2}{R} \qquad \therefore Rp = \frac{R}{2}$$

$$\therefore Hp = \frac{V^2}{Rp}t$$



$$Now\ Hs\!:\!Hp = \frac{Hs}{Hp} = \frac{\frac{V^2}{Rs}t}{\frac{V^2}{Rp}t}$$

$$= \frac{Rp}{Rs} = \frac{\frac{R}{2}}{2R} = \frac{1}{4} = 1:4$$

25. A positive charge free to move is released from rest. It will move towards the region of

A. Lower potential

B. Higher potential

C. Equal potential

D. Any of the above

Ans : (A)

26. Joule/coulomb is the same as

A. Watt.

B. Volt.

C. Ohm

D. Ampere.

Ans : (B)

We have el. potential difference ,

$$V = \frac{W.D.}{charge}$$

If $W.D = 1\ J$, Charge ,$q = 1C$, then$1\ v = \frac{1\ J}{1\ C}$

27. An ammeter is always connected in ……….and a voltmeter in ……..The proper words for the empty places are respectively.

A. Series: series

B. Parallel : parallel

C. Series: parallel

D. Parallel : series.

Ans : (C)

28. Three equal resistances, when combined in series have equivalent resistance of 90 Ω. Their equivalent resistance when combined in parallel will be

A. 60 Ω

B. 30 Ω

C. 20 Ω

D. 10 Ω

Ans: (D)

$R_s = 3R$ $\therefore R = \frac{90}{3} = 30\Omega$

$\frac{1}{\text{Rp}} = 3 \times \frac{1}{30} = \frac{1}{10}$

$\therefore R_p = 10\ \Omega$

29. Why is the series arrangement of components not used for domestic circuits? Explain.

Ans :

(i) Total resistance becomes large and the current gets reduced.

(ii) When one of the components gets fused the circuit is broken and none of the components may operate.

(iii) In series arrangement same current will flow through all the appliances and not used for domestic circuits.

30. Why are copper and aluminum wires usually used for transmission of electricity? Explain.

Ans :

The reasons are given below:

Copper and aluminum are good conductors because of having low resistivities. When electricity is transmitted through copper and aluminum wires the power losses in the form of heat are very small. So usually used for transmission of electricity.

TRY TO ANSWER

1. What do you mean by electric circuit?

Ans : A continuous and closed path of an electric current is called an electric circuit.

2. Define one ampere of current.

Ans : One ampere of electric current is constituted by the flow of one coulomb of charge per second that is

$$1A = \frac{1C}{1s}$$

3. Calculate the number of electrons in 4.8C of electric charge.

Ans : Total charge, $Q = 4.8\,C$

Electronic charge, $e = -1.6 \times 10^{-19}\ C$

Now, $Q = \pm\, ne$

$$\therefore \text{n} = \frac{Q}{e} = \frac{4.8}{1.60 \times 10^{-19}}$$

$$= 3 \times 10^{19} electron$$

4. What is the device that can maintain a potential difference across a conductor?

Ans: A battery or a cell is the device to maintain potential difference between the two ends of a conductor.

5. What is meant by saying that the potential difference between two points is 1 volt?

Ans: One volt is the potential difference between two points in a current carrying conductor when one joule of work is to be done in order to move a charge of one coulomb from one point to the other.

Thus, $$1volt = \frac{1\ joule}{1\ \ coulomb}$$

6. How much energy is given to 2coulomb of charge passing through a cell 1.5 volt?

Ans : Energy given by a cell = charge × potential difference=2 x 1.5 = 3J.

7. Name the factors on which the resistance of a conductor depends.

Ans : (i) Length of the conductor.($R \propto \ell$)

(ii) Area of cross section of the conductor.($R \propto \frac{1}{A}$)

(iii) Temperature of the conductor.

(iv) Materials of the conductor.

8. Through which of the wires a thick one and a thin one of the same material, will current flow easily when connected to the same battery or cell? Why?

Ans : A thick wire has low resistance than that of the thin wire and the current will flow more easily through a thick wire.

9. Suppose the potential difference across an electrical component of fix resistance decreases to half of its former value. What change will occur in the current passing through it?

Ans : We have , $V = IR$

Now, the potential difference is decreased to half, $V' = \frac{V}{2}$ and current is changed to I'

$$\therefore V' = I'R$$

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

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

$$= \frac{I}{2}$$

Hence, the current is also reduced to half of its former value.

10. Why does the connecting wires i.e. the cord of an electric iron or an electric heater not glows while the heating element glows?

Ans : This is because of the fact that the heating element has very high resistance while connecting wires have very low resistance.

EXTRA QUESTIONS AND ANSWERS

1. The three resistors R_1, R_2 and R_3 are connected in series. Find the equivalent resistance.

Ans: Let R_1, R_2 and R_3 be the resistances which are connected in series with voltage V, current I and potential difference across the resistances be V_1, V_2 and V_3 respectively.

Thus, $V = V1 + V2 + V3$ –-------------- (i)

Applying ohm's law to the entire circuit, we get,

$IRS = IR1 + IR2 + IR3$

[R_S = Equivalent resistance]

$\Rightarrow IRs = I(R1 + R2 + R3)$

$\therefore RS = R1 + R2 + R3.$

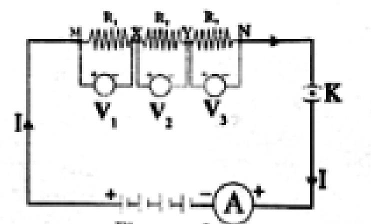


Figure I
Connection of three resistors R_1,R_2 &R_3 in Series

2. The three resistors R_1, R_2 and R_3 are connected in parallel. Find the equivalent resistance.

Ans: Let R_1, R_2 and R_3 be the resistances which are connected in parallel with a voltage V. Let I_1, I_2 and I_3 be the current passing through the resistances respectively.

The total current, $I = I_1 + I_2 + I_3$

Applying ohm's law,

$$\frac{V}{R_P} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

[R_P=equivalent resistance]

$$\therefore \frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

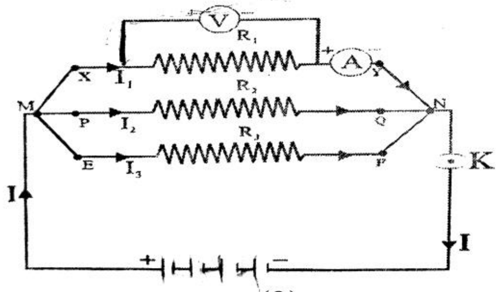


Figure (2)
Connection of three resistors R_1, R_2 & R_3 in parallel.

Thus, the reciprocal of the equivalent resistance of the combination is equal to the sum of the reciprocals of the individual resistances.

3. In household electric circuit, parallel combination is preferred. Give two points.

Ans : (i) All the appliances get the same voltage.

(ii) When one of the components get fused or fails the other components are not affected.

4. Electric fuse is made up of a low melting point wire. Explain why?

Ans : Whenever a high current flows in the circuit due to overloading or short circuiting the fuse gets heated then melts and disconnects the circuit from the main supply line, thereby preventing the various electrical application used at homes from getting damaged.