EDUCATION SOURCE
A Source of Your Way to Success

ELECTRICITY

CHAPTER:12

EDUCATION SOURCE

CLASS:10TH

science

CHAPTER: 12
ELECTRICITY

Page: 200

Q1:- What does an electric circuit mean?

Ans: Electric circuit means it consists of electric devices such as switch, bulb, source of energy etc. and all connected by connecting wires.

Q2:- Define the unit of current.

Ans: The unit of current is ampere and one ampere of current is defined as the 1 Coulomb of charge that is flowing through a wire in 1s.

Q3:- Calculate the number of electrons constituting one coulomb of charge?

Ans: 1 $electrons$ = 1.6 x 10^{-19} coulomb

And 1 coulomb = $\frac{1}{1.6 \text{ x } 10^{-19}}$ $electrons$

$= \frac{10^{19}}{1.6} = \frac{10 \text{ x } 10^{18}}{1.6}$

1 coulomb = 6.25 x 10^{18} $electrons$

Page: 202

Q1:- Name a device that helps to maintain a potential difference across a conductor.

Ans: Battery.

Q2:- What is meant by saying that the potential difference between two points is 1 V?

Ans: 1 V potential difference between two points means that 1 joule of work done is required to move 1 coulomb charge from one point to another.

Q3:- How much energy is given to each coulomb of charge passing through a 6 V battery?

Ans: We know,

W = V x Q
W = 6 x 1
W = 6 joules.

Page: 209

Q1:- On what factors does the resistance of a conductor depend?

Ans: Resistance of a conductor depends on:

(i) Nature of material (resistivity – ρ)

(ii) Length of wire (l).
Therefore, R α l

(iii) The cross-sectional area of the wire (A).
$R \ \alpha \ {}^{1}/_{A}$ (A=πr^2)

Q2:- 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 easily through the thick wire because the resistance of thick wire is less than of thin wire.

$$R \quad \alpha \, 1/A$$

Q3:- 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: We know that

V α I

If potential difference becomes half, it means the current will also become half.

Q4:- Why are coils of electric toasters and electric irons made of an alloy rather than a pure metal?

Ans: The alloys have high resistance than metals that's why the coils of toaster and electric iron are made up of an alloy.

Q5:- 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?

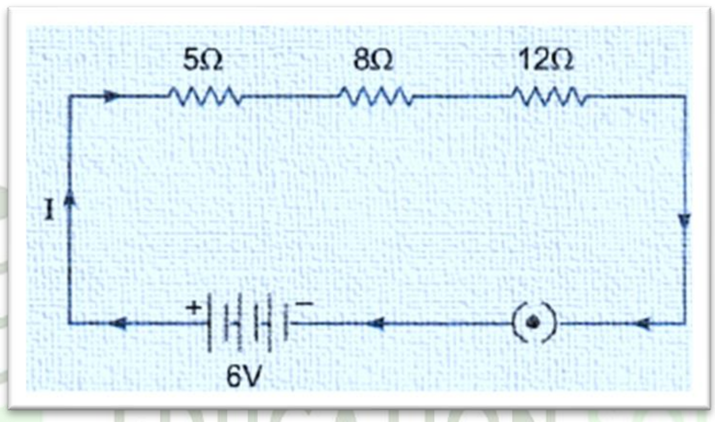
Ans:

a) IRON.
b) SILVER

Page: 213

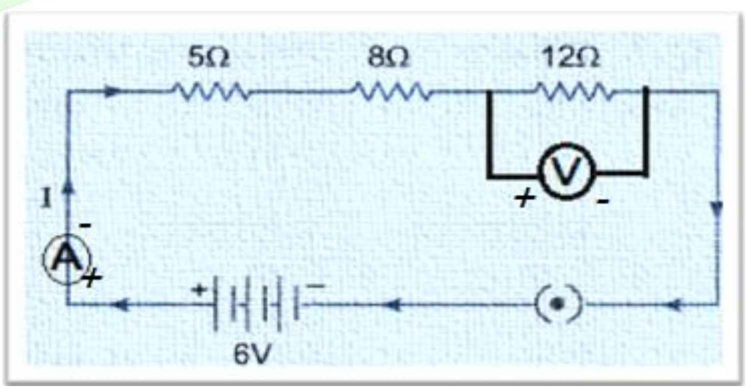
Q1:- **Draw a schematic diagram of a circuit consisting of a battery of three cells of 2 V each, a 5 Ω resistor, an 8 Ω resistor, and a 12 Ω resistor, and a plug key, all connected in series.**

Ans:



Q2:- **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:



Total resistance (R) = 5 + 8 +12 = 25 Ω

We know, $I = V/R$

$$I = \frac{6}{25}$$

$$I = 0.24\,A$$

Potential difference across 12Ω resistor = IR

= 0.24 x 12

= 2.88 V

Ammeter reads 0.24 A and voltmeter reads 2.88 V

Page: 216

Q1:- 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:

a) Resistance of parallel connection:

$$\frac{1}{R} = \frac{1}{1} + \frac{1}{10^6} = \frac{(10^6 + 1)}{10^6}$$ = 0.9 Ω.

b) Resistance of parallel connection:

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

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

$$\frac{1}{R} = \frac{1001001}{1000000}$$

R = 0.9 **Ω**

Q2:- 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 electric iron will have equivalent resistance to the same as 100 Ω, 50 Ω and 500 Ω resistors are in parallel

Let it be R Ω.

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

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

$$\frac{1}{R} = \frac{16}{500}$$

$$R = \frac{500}{16}$$

R = 31.25 Ω

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

$$I = \frac{220 \times 16}{500}$$

I = 7.04 A

Q3:- What are the advantages of connecting electrical devices in parallel with the battery instead of connecting them in series?

Ans: Advantages of connecting electrical devices in parallel:

(i) In parallel, the total resistance of the appliances (circuit) is reduced and so value of current gets increased.

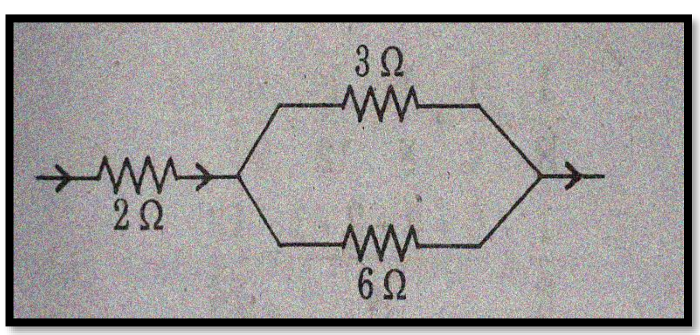
(ii) We can switch off and on electrical appliances independently.

(iii) If a fault develops in the circuit, it will not affect all appliances.

Q4:- 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?

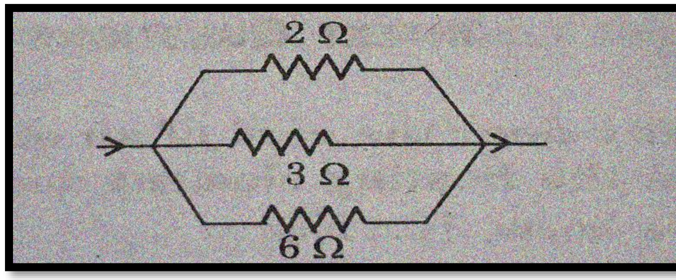
Ans:

a) For 4 Ω.
The 3 Ω and 4 Ω resistors are connected in parallel and this combination is connected in series to 2 Ω resistor.



b) For 1 Ω resistance:

All these three resistances are connected in parallel to get equivalent of 1 Ω.



Q5:- 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) For highest resistance, resistors are connected in series:

$R = R_1 + R_2 + R_3 + R_4$

$= 4 + 8 + 12 + 24$

$R = 48\ \Omega.$

b) The lowest resistance will be obtained when these are connected in parallel:

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

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

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

$R = 2\ \Omega.$

Page: 218

Q1:- Why does the cord of an electric heater not glow while the heating element does?

Ans: The heating element of the heater is made up of alloy which has very high resistance so when current flows through the heating element, it becomes too hot and glows red. But the resistance of cord which is usually of copper or aluminium is very low so it does not glow.

Q2:- **Compute the heat generated while transferring 96000 coulombs of charge in one hour through a potential difference of 50 V.**

Ans: Given, Q = 96000 C,

t = 1h = 60 x 60 = 3600s,

V = 50 V

Now, heat produced,

$H = QV = 96000 \times 50 = 4.8 \times 10^6$ J.

Q3:- **An electric iron of resistance 20 Ω takes a current of 5 A. Calculate the heat developed in 30 s.**

Ans: Given, R = 20 Ω,

I = 5 A,

t = 30s

Now, heat developed,

$H = I^2 Rt = (5)^2 \times 20 \times 30 = 15000$ J.

$H = 1.5 \times 10^4$ J

Page: 220

Q1:- **What determines the rate at which energy is delivered by a current?**

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

Q2:- **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:

Given, I = 5A

V = 220 V

t = 2h = 2 x 60 x 60

= 7200 s

Power, P = VI

= 220 x 5

= 1100 W

Energy consumed,

W = VIt = 220 x 5 x 7200

$= 7.92 \times 10^6$ J.

Exercise:

Q1:- 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

Q2:- 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

Q3:- 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

Q4:- 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

Q5:- How is a voltmeter connected in the circuit to measure the potential difference between two points?

Ans: A voltmeter is always connected in parallel across the points between which the potential difference is to be measured.

Q6:- 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:

a) Given, d = 0.5 mm

r = d /2 = 0.5 / 2 = 0.25 mm

= 2.5×10^{-4} m,

Resistivity (ρ) = 1.6×10^{-8} Ωm,

R = 10 Ω
L =?

We know that R = $\frac{\rho L}{A}$,
Therefore, we have

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

$$L = \frac{R\Pi r^2}{\rho}$$

$$L = \frac{10\left(\frac{22}{7}\right)(2\cdot5\times10^{-4})^2}{1\cdot6\times10^{-8}}$$

= 122.76 m
The length of this wire is 122.76 m

b) Given, d = 1mm

Or r = 0.5 mm = 5 x 10^{-4} m

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

Or R = $\frac{(1.6 \text{ x } 10^{-8} \text{ x } 122.76)}{3.14 \text{ x } (5X10^{-4})^2}$ = 2.5 Ω

Q7:- The values of current I flowing in a given resistor for the corresponding values of potential difference V across the resistor are given below –
Plot a graph between V and I and calculate the resistance of that resistor.

Ans:

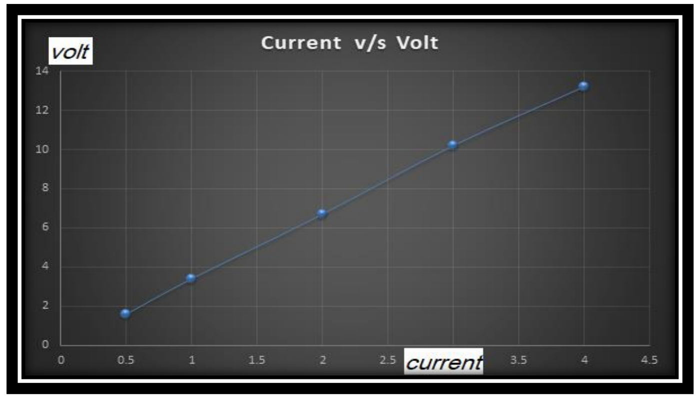
I (amperes)	*0.5*	*1.0*	*2.0*	*3.0*	*4.0*
V (Volts)	***1.6***	***3.4***	***6.7***	***10.2***	***13.2***

For V = 4 V

I = 1.25 A

Therefore,

R = $\frac{V}{I}$ = $\frac{4}{1.25}$ = 3.2 Ω.



Q8:- 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: Given

V = 12V

I = 25 mA = 25 x 10^{-3} A

$$R = \frac{V}{I} = \frac{12}{2.5 \times 10^{-3}}$$

$$R = \frac{12}{2.5} \times 10^{3}$$

$$R = 4.8\,X10^{3}$$

$$R = 4.8\,k\,\Omega$$

Q9:- 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: In series combination, same strength of current passes through each and every resistor.

R_{eq} = $R_1 + R_2 + R_3 + R_4 + R_5$

= 0.2 + 0.3 + 0.4 + 0.5 + 12 = 13.4 Ω.

Therefore, I = $\frac{V}{R_{eq}}$ = $\frac{9}{13.4}$ = 0.67 A

I = 0.67 A.

Q10:- How many 176 Ω resistors (in parallel) are required to carry 5 A on a 220 V line?

Ans: Let the number of resistors = n

Therefore, $\frac{1}{R} = \frac{1}{176} + \frac{1}{176} + \cdots + n\ times$

$$\frac{1}{R} = \frac{n}{176}$$

$$R = \frac{176}{n}$$

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

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

$$\frac{176}{n} = \frac{V}{I}$$

$$n = \frac{176\ I}{V}$$

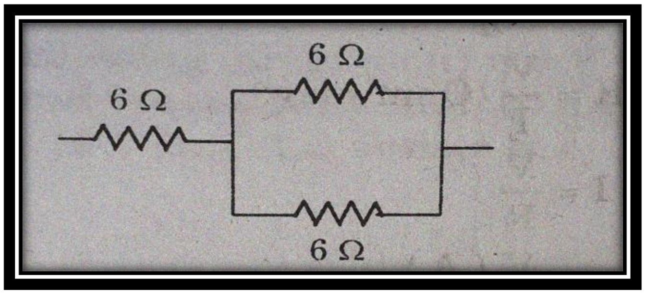
$$h = \frac{176 \times 5}{220}$$

Number of resistors = 4.

Q11:- 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.

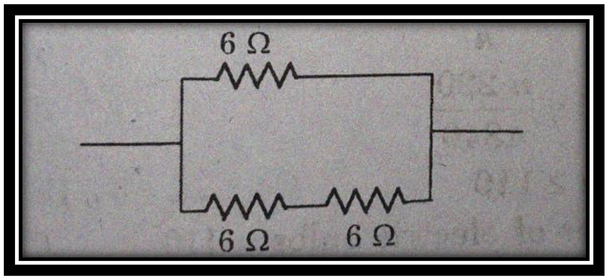
Ans:

(i) For 9 Ω



The two resistors are connected in parallel and one is connected in series to these two resistors to get 9 Ω.

(ii) For 4 Ω



The resistors are connected in series and this combination is connected to third resistor in parallel to get 4 Ω.

Q12:- 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:

Given, V = 220 V, P = 10 W, n =? , I = 5 A

Total resistance of each bulb

$$R = \frac{V^2}{p} = \frac{(220)^2}{10} = 4840\ \Omega$$

Acc. To Ohms law

V= IR

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

$$R = \frac{220}{5} = 44\ \Omega$$

Let n be the number of bulbs in the circuit in parallel, then

$$n = \frac{4840}{44}$$

Or $n = 110$

Q13:- 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 the plates are connected in series

R = 24 + 24 = 48 Ω.

$I = \frac{V}{R} = \frac{220}{48}$ A = 4.6 A

Case (ii): When the plates are connected on parallel.

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

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

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

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

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

$$R = 12$$

$I = \frac{V}{R} = \frac{220}{12} = 18.3$ A

Case (iii): When only one resistance is connected.

$$I = \frac{V}{R} = \frac{220}{24} = 9.2\text{ A}$$

Q14:- 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) Since 2 Ω and 1 Ω resistors are in series

Therefore, equivalent resistance is

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

Hence, current through the combinations

$$I = \frac{V}{R} = \frac{6}{3} = 2\text{A}$$

Hence, power consumed by 2 Ω resistor

$$P_s = I^2 R = (2)^2 \times 2 = 8\text{ W}$$

(ii) Since 12 Ω and 2 Ω are in parallel

therefore, potential difference across 2 Ω resistor is 4 V

Hence, power consumed by 2 Ω resistor is

$$P_p = \frac{V^2}{R} = \frac{(4)^2}{2} = 8\text{ W}.$$

Thus, in both cases the power consumed by the 2 Ω resistor is 8 W therefore, ratio of power consumed in the two cases is 1:1.

Q15:- 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:

Given $P_1 = 100$ W,

$P_2 = 60$ W

$V = 220$ V

In parallel combination of lamps, the total power consumed is given by

$$P = P_1 + P_2$$

$$P = 100 + 60 = 160 \text{ W}$$

Since,

$$P = VI,$$

Therefore,

$$I = \frac{P}{V} = \frac{160}{220} = 0.727 \text{ A}$$

Q16:- Which uses more energy, a 250 W TV set in 1 hr, or a 1200 W toaster in 10 minutes?

Ans:

Energy used by 250 W TV set in 1 h

$$W = 250 \, X \, 1 \, h = 250 \, Wh$$

Energy used by 1200 W toaster in 10 min = $\frac{1\,h}{6}$

$$W = 1200 \times \frac{1\,h}{6} = 200 \text{ Wh}$$

Thus, a 250 W TV set uses more power in 1 h than a 1200 W toaster in 10 minutes.

Q17:- An electric heater of resistance 8 Ω draws 15 A from the service mains 2 hours. Calculate the rate at which heat is developed in the heater.

Ans:

Given,

$I = 15$ A,

$R = 8\ \Omega$,

$t = 2$ h

Now, $H = I^2 R = (15)^2 \times 8 = 1800$ J/s

Q18:- 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:

a) Tungsten is an alloy as such it has a high resistivity and high melting point therefore, it is used exclusively in filaments of electric lamps.

b) Alloys have high resistivity and high melting point as compared to pure metals of which they are made, therefore, they are used as heating elements.

c) In case of series arrangement, if one electrical appliance fails in the circuit the entire circuit will be switched off. Thus, series arrangement is not used in household electrical circuits.

d) We know that

$$R = \rho l / A$$

Resistance is inversely proportional to the area of cross section. It means if resistance increases or decreases the area of cross-section will decrease or increase respectively.

e) Copper and aluminium are the good conductors of electricity. That's why they are generally used for electricity transmission.