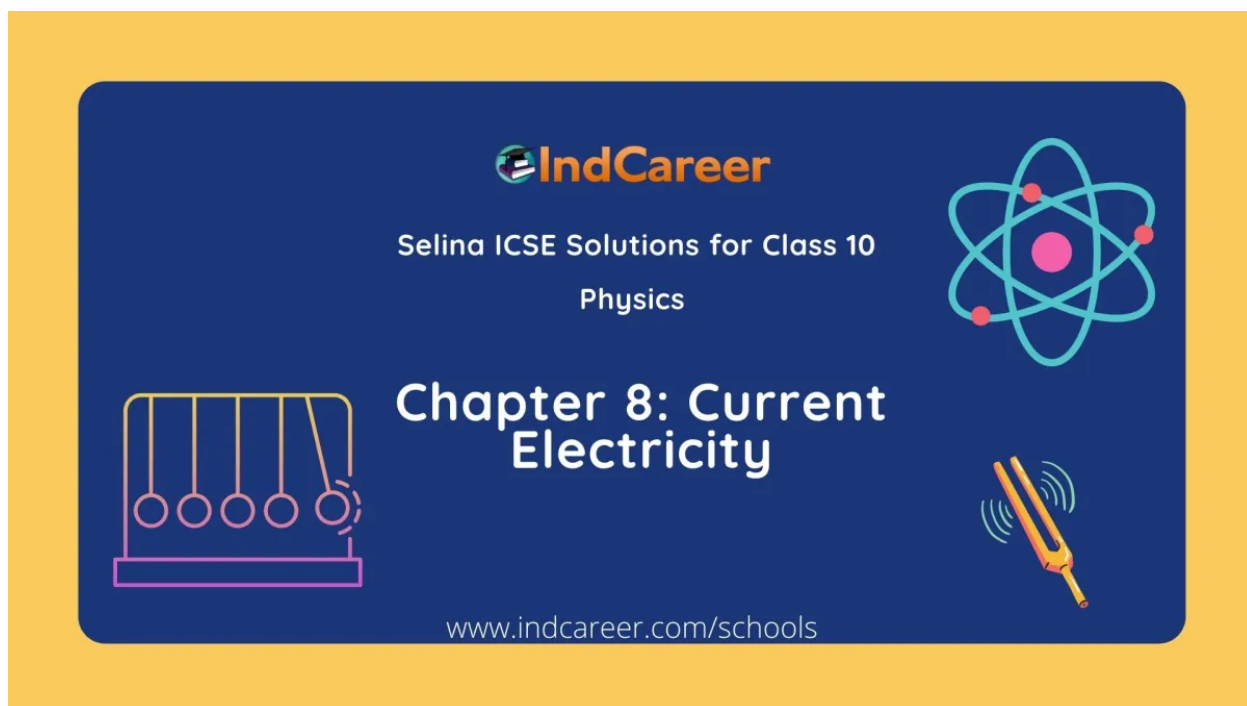


Selina Class 10 ICSE Solutions Physics :

Chapter 8- Current Electricity



For any clarifications or questions you can write to **info@indcareer.com**

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Chapter 8- Current Electricity

Class 10: Physics Chapter 8 solutions. Complete Class 10 Physics Chapter 8 Notes.

Selina Class 10 ICSE Solutions Physics : Chapter 8- Current Electricity

Selina 10th Physics Chapter 8, Class 10 Physics Chapter 8 solutions

Exercise 8(A)

Solution 1.

Current is defined as the rate of flow of charge.

$$I = Q/t$$

Its S.I. unit is Ampere.

Solution 2.

Electric potential at a point is defined as the amount of work done in bringing a unit positive charge from infinity to that point. Its unit is the volt.

Solution 3.

The potential difference between two points is equal to the work done in moving a unit positive charge from one point to the other.

It's S.I. unit is Volt.

Solution 4.

One volt is the potential difference between two points in an electric circuit when 1 joule of work is done to move charge of 1 coulomb from one point to other.

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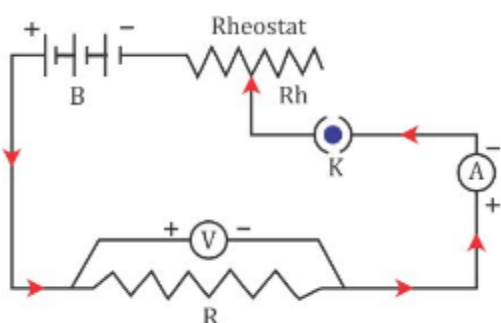
Solution 7.

In a metal, the charges responsible for the flow of current are the free electrons. The direction of flow of current is conventionally taken opposite to the direction of motion of electrons.

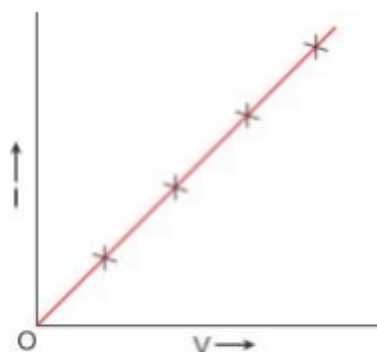
Solution 8.

It states that electric current flowing through a metallic wire is directly proportional to the potential difference V across its ends provided its temperature remains the same. This is called Ohm's law.

$$V = IR$$

**Solution 11.**

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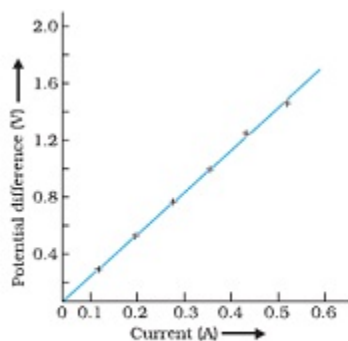


The slope of I-V graph ($= \frac{\Delta I}{\Delta V}$) is equal to the reciprocal of the resistance of the conductor, i.e.

$$\text{Slope} = \frac{\Delta I}{\Delta V} = \frac{1}{\text{Resistance of conductor}} = \text{Conductance}$$

Solution 12.

Ohmic Resistor: An ohmic resistor is a resistor that obeys Ohm's law. For example: all metallic conductors (such as silver, aluminium, copper, iron etc.)

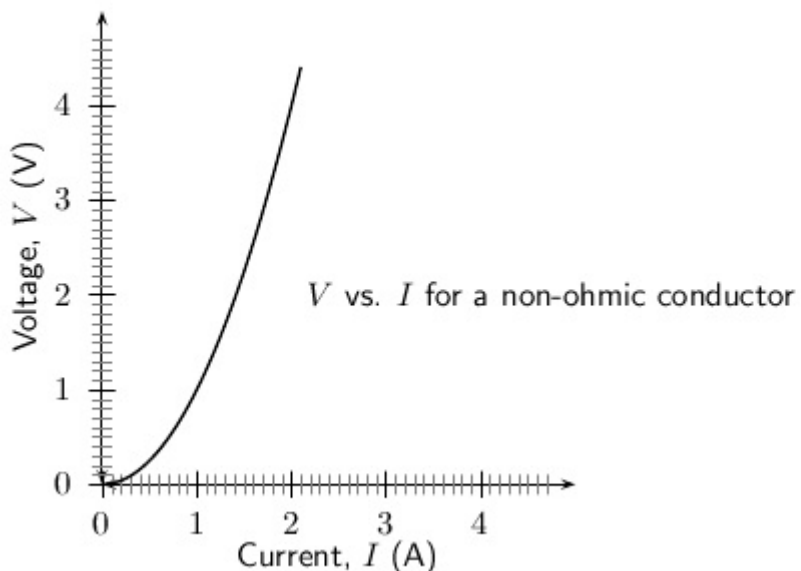


From above graph resistance is determined in the form of slope.

Solution 13.

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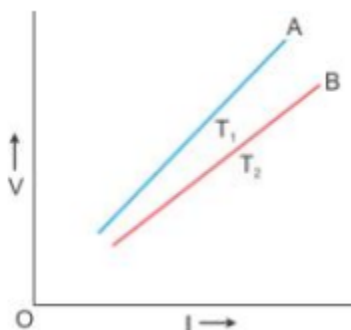
The conductors which do not obey Ohm's Law are called non-ohmic resistors. Example: diode valve.



Solution 14.

1. Ohmic resistor obeys ohm's law i.e., V/I is constant for all values of V or I ; whereas Non-ohmic resistor does not obey ohm's law i.e., V/I is not same for all values of V or I .
2. In Ohmic resistor, V - I graph is linear in nature whereas in non-ohmic resistor, V - I graph is non-linear in nature.

Solution 16.



In the above graph, $T_1 > T_2$. The straight line A is steeper than the line B, which leads us to conclude that the resistance of conductor is more at high temperature T_1 than at low

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temperature T_2 . Thus, we can say that resistance of a conductor increases with the increase in temperature.

Solution 17.

Resistance of a wire is inversely proportional to the area of cross-section of the wire.

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

$$R \propto \frac{1}{\pi r^2}$$

This means if a wire of same length, but of double radius is taken, its resistance is found to be one-fourth.

Solution 18.

Resistance of a wire is directly proportional to the length of the wire.

$$R \propto l$$

The resistance of a conductor depends on the number of collisions which the electrons suffer with the fixed positive ions while moving from one end to the other end of the conductor. Obviously the number of collisions will be more in a longer conductor as compared to a shorter conductor. Therefore, a longer conductor offers more resistance.

Solution 19.

With the increase in temperature of conductor, both the random motion of electrons and the amplitude of vibration of fixed positive ions increase. As a result, the number of collisions increases. Hence, the resistance of a conductor increases with the increase in its temperature.

The resistance of filament of a bulb is more when it is glowing (i.e., when it is at a high temperature) as compared to when it is not glowing (i.e., when it is cold).

Solution 20.

Iron wire will have more resistance than copper wire of the same length and same radius because resistivity of iron is more than that of copper.

Solution 21.

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1. Resistance of a wire is directly proportional to the length of the wire means with the increase in length resistance also increases.
 $R \propto l$
2. Resistance of a wire is inversely proportional to the area of cross-section of the wire. If area of cross-section of the wire is more, then resistance will be less and vice versa.
 $R \propto 1/A$
3. Resistance increases with the increase in temperature since with increase in temperature the number of collisions increases.
4. Resistance depends on the nature of conductor because different substances have different concentration of free electrons. Substances such as silver, copper etc. offer less resistance and are called good conductors; but substances such as rubber, glass etc. offer very high resistance and are called insulators.

Solution 22.

The resistivity of a material is the resistance of a wire of that material of unit length and unit area of cross-section.

Its S.I. unit is ohm metre.

Solution 23.

Expression :

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

ρ - resistivity

R - resistance

l - length of conductor

A - area of cross-section

Solution 24.

Metal < Semiconductor < Insulator

Solution 26.

Manganin

Solution 28.

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'Copper or Aluminium' is used as a material for making connection wires because the resistivity of these materials is very small, and thus, wires made of these materials possess negligible resistance.

The connection wires are made thick so that their resistance can be considered as negligible.

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

Therefore, greater the area of cross-section, lesser shall be the resistance.

Solution 30.

Manganin is used for making the standard resistor because its resistivity is quite large and the effect of change in temperature on their resistance is negligible.

Solution 31.

Generally fuse wire is made of an alloy of lead and tin because its resistivity is high and melting point is low.

Solution 32.

A wire made of tungsten is used for filament of electric bulb because it has a high melting point and high resistivity.

A nichrome wire is used as a heating element for a room heater because the resistivity of nichrome is high and increase in its value with increase in temperature is high.

Solution 33.

A superconductor is a substance of zero resistance at a very low temperature. Example: Mercury at 4.2 K.

Solution 34.

Superconductor

Solution 1 (MCQ).

Nichrome is an ohmic resistance.

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Hint: Substances that obey Ohm's law are called Ohmic resistors.

Solution 2 (MCQ).

For carbon, resistance decreases with increase in temperature.

Hint: For semiconductors such as carbon and silicon, the resistance and resistivity decreases with the increase in temperature.

Numericals

Solution 1.

Number of electrons flowing through the conductor,

$$n = 6.25 \times 10^{16} \text{ electrons.}$$

Time taken, $t = 2 \text{ s}$

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

Let I be the current flowing through the conductor.

$$\text{Then, } I = \frac{ne}{t}$$

$$\therefore I = \frac{(6.25 \times 10^{16})(1.6 \times 10^{-19})}{2} = 5 \times 10^{-3} \text{ A}$$

or, $I = 5 \text{ mA}$

Thus, 5 mA current flows from B to A.

Solution 9.

Let ' l ' be the length and ' a ' be the area of cross-section of the resistor with resistance, $R = 1\Omega$

When the wire is stretched to double its length, the new length $l' = 2l$ and the new area of cross-section,

$$a' = a/2$$

$$\therefore \text{Resistance } (R') = \rho \frac{l'}{a'} = \rho \frac{2l}{a/2}$$

$$\therefore R' = 4\rho \frac{l}{a} = 4R$$

$$\therefore R' = 4 \times 1 = 4\Omega$$

Solution 11.

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Resistance (R) = 9 ohm

Length l = 30 cm

New Length (l) = 30 cm = $3/1 = 10$ cm

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

New Resistance :

With change in length, there will be change in area of cross-section also in the same order.

$$R' = \rho \frac{l/3}{3A}$$

$$R' = \frac{1}{9} \rho \frac{l}{A}$$

$$R' = \frac{1}{9} R$$

$$R' = 1 \text{ ohm}$$

Solution 12.

Resistance (R) = 1 ohm

Resistivity (ρ) = 1.7×10^{-8} ohm metre

Radius (r) = 1 mm = 10^{-3} m

Length (l) = ?

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

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

$$= \frac{R\pi r^2}{\rho}$$

$$= \frac{1 \times \pi \times 10^{-6}}{1.7 \times 10^{-8}}$$

$$= 184.7 \text{ m}$$

Exercise 8(B)

Solution 1.

e.m.f.: When no current is drawn from a cell, the potential difference between the terminals of the cell is called its electro-motive force (or e.m.f.).

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Terminal voltage: When current is drawn from a cell, the potential difference between the electrodes of the cell is called its terminal voltage.

Internal Resistance: The resistance offered by the electrolyte inside the cell to the flow of electric current through it is called the internal resistance of the cell.

Solution 2.

e.m.f. of cell

1. It is measured by the amount of work done in moving a unit positive charge in the complete circuit inside and outside the cell.
2. It is the characteristic of the cell i.e., it does not depend on the amount of current drawn from the cell
3. It is equal to the terminal voltage when cell is not in use, while greater than the terminal voltage when cell is in use.

Terminal voltage of cell

1. It is measured by the amount of work done in moving a unit positive charge in the circuit outside the cell.
2. It depends on the amount of current drawn from the cell. More the current is drawn from the cell, less is the terminal voltage.
3. It is equal to the emf of cell when cell is not in use, while less than the emf when cell is in use.

Solution 3.

Internal resistance of a cell depends upon the following factors:

1. The surface area of the electrodes: Larger the surface area of the electrodes, less is the internal resistance.
2. The distance between the electrodes: More the distance between the electrodes, greater is the internal resistance.

Solution 4.

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(a) Total resistance = $R + r$

(b) Current drawn from the circuit :

As we know that,

$$\mathcal{E} = V + v$$

$$= IR + Ir$$

$$= I(R + r)$$

$$I = \mathcal{E} / (R + r)$$

(c) p.d. across the cell : $\frac{\mathcal{E}}{(R + r)} \times R$

(d) voltage drop inside the cell: $\frac{\mathcal{E}}{R + r} \times r$

Solution 5.

(a) Terminal voltage is less than the emf : Terminal Voltage < e.m.f.

(b) e.m.f. is equal to the terminal voltage when no current is drawn.

Solution 6.

When the electric cell is in a closed circuit the current flows through the circuit. There is a fall of potential across the internal resistance of the cell. So, the p.d. across the terminals in a closed circuit is less than the p.d. across the terminals in an open circuit by an amount equal to the potential drop across the internal resistance of the cell.

Solution 7.

(a) Total Resistance in series:

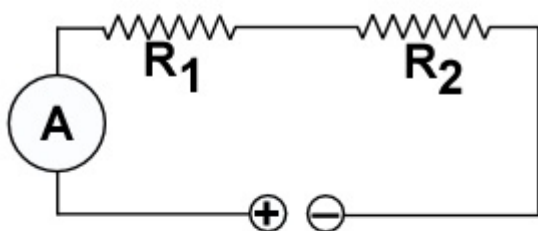
$$R = R_1 + R_2 + R_3$$

(b) Total Resistance in parallel:

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

Solution 8.

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If current I is drawn from the battery, the current through each resistor will also be I .

On applying Ohm's law to the two resistors separately, we further have

$$V_1 = I R_1$$

$$V_2 = I R_2$$

$$V = V_1 + V_2$$

$$IR = I R_1 + I R_2$$

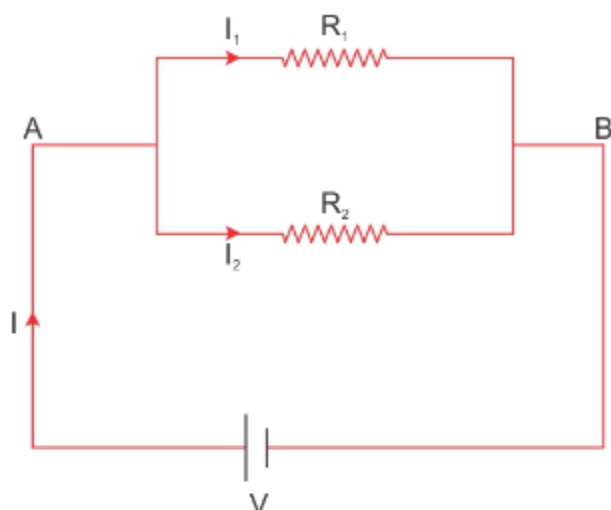
$$R = R_1 + R_2$$

Total Resistance in series R :

$$R = R_1 + R_2 + R_3$$

Solution 9.

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On applying Ohm's law to the two resistors separately, we further have

$$I_1 = V / R_1$$

$$I_2 = V / R_2$$

$$I = I_1 + I_2$$

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

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

Solution 10.

- (a) series
- (b) parallel
- (c) parallel
- (d) series

Solution 11.

For the same change in I , change in V is less for the straight line A than for the straight line B (i.e., the straight line A is less steeper than B), so the straight line A represents small resistance, while the straight line B represents more resistance. In parallel combination, the resistance decreases while in series combination, the resistance increases. So A represents the parallel combination.

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Solution 1 (MCQ).

In series combination of resistances, current is same in each resistance.

Hint: In a series combination, the current has a single path for its flow. Hence, the same current passes through each resistor.

Solution 2 (MCQ).

In parallel combination of resistances, P.D. is same across each resistance.

Hint: In parallel combination, the ends of each resistor are connected to the ends of the same source of potential. Thus, the potential difference across each resistance is same and is equal to the potential difference across the terminals of the source (or battery).

Solution 3 (MCQ).

(a) and (d)

Solution:

In fig (a), the resistors are connected in parallel between X and Y.

Let R' be their equivalent resistance.

$$\text{Then, } \frac{1}{R'} = \frac{1}{2} + \frac{1}{2} = \frac{2}{2} \Omega$$

$$\text{or, } R' = 1\Omega \dots\dots\dots(i)$$

In fig (d), a series combination of two 1Ω resistors is in parallel with another series combination of two 1Ω resistors.

Series resistance of two 1Ω resistors,

$$R = (1+1)\Omega = 2\Omega$$

Thus, we can say that across X and Y, two 2Ω resistors are connected in parallel.

Let R' be the net resistance across X and Y.

$$\text{Then, } \frac{1}{R'} = \frac{1}{2} + \frac{1}{2} = \frac{2}{2} \Omega$$

$$\text{or, } R' = 1\Omega \dots\dots\dots(ii)$$

From (i) and (ii), it is clear that (a) and (d) have the same equivalent resistance between X and Y

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Numericals

Solution 1.

(i) Ammeter reading = 0 because of no current

$$\text{Voltage } V = \varepsilon - Ir$$

$$V = 2 - 0 \times 1 = 2 \text{ volt}$$

(ii) Ammeter reading :

$$I = \varepsilon / (R + r)$$

$$I = 2 / (4 + 1) = 2 / 5 = 0.4 \text{ amp}$$

Voltage reading :

$$\text{Voltage } V = \varepsilon - Ir$$

$$V = 2 - 0.4 \times 1 = 2 - 0.4 = 1.6 \text{ V}$$

Solution 2.

$$\varepsilon = 3 \text{ volt}$$

$$I = 1.5 \text{ A}$$

$$V = 2.7 \text{ V}$$

$$V = \varepsilon - Ir$$

$$r = (\varepsilon - V) / I$$

$$= (3 - 2.7) / 1.5 = 0.2 \text{ ohm}$$

Solution 3.

$$(a) \varepsilon = 1.8 \text{ V}$$

$$\text{Total Resistance} = 2 + 4.5 + 0.7 = 7.2 \text{ W}$$

$$I = ?$$

$$I = \varepsilon / R (\text{total resistance})$$

$$I = 1.8 / 7.2 = 0.25 \text{ A}$$

(b) Current (calculated in (a) part) $I = 0.25 \text{ A}$

$$\text{Now, total resistance excluding internal resistance} = 4.5 + 0.7 = 5.2 \text{ ohm}$$

$$V = IR = 0.25 \times 5.2 = 1.3 \text{ V}$$

Solution 4.

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(a) $\mathcal{E} = 15 \text{ V}$

$R = 6 + 3 = 9 \text{ ohm}$

$r = 3 \text{ ohm}$

$I = ?$

$I = \mathcal{E} / (R + r)$

$I = 15 / (9 + 3) = 15/12 = 1.25 \text{ A}$

(b) Current (calculated in (a) part) $I = 1.25 \text{ A}$

External Resistance $R = 6 + 3 = 9 \text{ ohm}$

$V = IR = 1.25 \times 9 = 11.25 \text{ V}$

Solution 5.

In first case

$I = 1 \text{ A}, R = 1.9 \text{ ohm}$

$\mathcal{E} = I(R + r) = 1(1.9 + r)$

$\mathcal{E} = 1.9 + r \text{-----(1)}$

In second case

$I = 0.5 \text{ A}, R = 3.9 \text{ ohm}$

$\mathcal{E} = I(R + r) = 0.5(3.9 + r)$

$\mathcal{E} = 1.95 + 0.5r \text{-----(2)}$

From eq. (1) and (2),

$1.9 + r = 1.95 + 0.5r$

$r = 0.05/0.5 = 0.1 \text{ ohm}$

Substituting value of r

$\mathcal{E} = 1.9 + r = 1.9 + 0.1 = 2 \text{ V}$

Solution 6.

Let R' be their equivalent resistance of the 4Ω and 6Ω resistors, connected in parallel.

Then, $\frac{1}{R'} = \frac{1}{4} + \frac{1}{6} = \frac{3+2}{12} = \frac{5}{12} \Omega$

or, $R' = \frac{12}{5} = 2.4 \Omega$

Solution 7.

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$$R_1 = 2 \text{ ohm}$$

$$R_2 = 2 \text{ ohm}$$

$$R_3 = 2 \text{ ohm}$$

$$R_4 = 2 \text{ ohm}$$

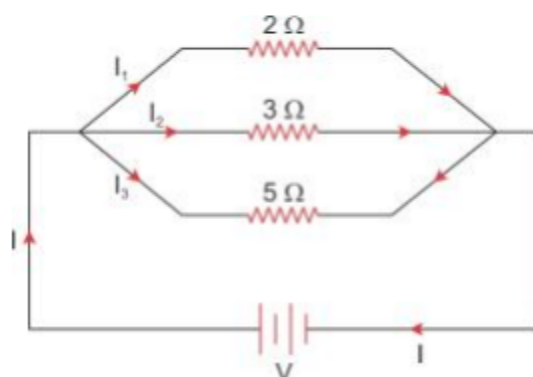
$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4}$$

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

$$R = 0.5 \text{ ohm}$$

Solution 8.

The three resistors should be connected in parallel to get a total resistance less than 1Ω .



Let R' be the total resistance.

$$\text{Then, } \frac{1}{R'} = \frac{1}{2} + \frac{1}{3} + \frac{1}{5} = \frac{15+10+6}{30} = \frac{31}{30} \Omega$$

$$\text{or, } R' = \frac{30}{31} = 0.97 \Omega$$

Solution 9.

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A parallel combination of two resistors, in series with one resistor.

$$R_1 = 2 \text{ ohm}$$

$$R_2 = 2 \text{ ohm}$$

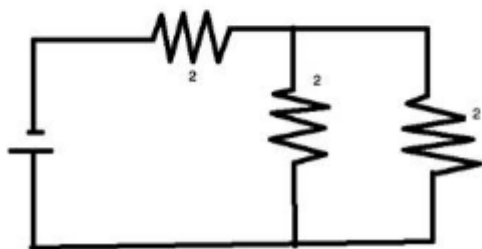
$$R_3 = 2 \text{ ohm}$$

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

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

$$R' = 1 \text{ ohm}$$

$$R = R' + R_3 = 1 + 2 = 3 \text{ ohm}$$



Solution 10.

$$r_1 = r_2 = r_3 = r_4 = 2.0 \text{ ohm}$$

$$r' = r_1 + r_2 = 2 + 2 = 4 \text{ ohm}$$

$$\frac{1}{r''} = \frac{1}{r_3} + \frac{1}{r_4} = \frac{1}{2} + \frac{1}{2} = 1$$

$$r'' = 1 \text{ ohm}$$

$$r = r' + r'' = 4 + 1 = 5 \text{ ohm}$$

Solution 11.

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Resistance of each set :

$$r_1 = 2 + 2 + 2 = 6 \text{ ohm}$$

$$r_2 = 2 + 2 + 2 = 6 \text{ ohm}$$

$$r_3 = 2 + 2 + 2 = 6 \text{ ohm}$$

$$r_4 = 2 + 2 + 2 = 6 \text{ ohm}$$

Now these resistances are arranged in parallel :

$$\frac{1}{r} = \frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3} + \frac{1}{r_4}$$

$$\frac{1}{r} = \frac{1}{6} + \frac{1}{6} + \frac{1}{6} + \frac{1}{6}$$

$$r = \frac{6}{4} = 1.5 \text{ ohm}$$

Solution 12.

$$r_1 = 4 \text{ ohm}$$

$$r_2 = 8 \text{ ohm}$$

$$r_3 = x \text{ ohm}$$

$$r_4 = 5 \text{ ohm}$$

$$r = 4 \text{ ohm}$$

$$r' = r_1 + r_2 = 4 + 8 = 12 \text{ ohm}$$

$$r'' = r_3 + r_4 = (x + 5) \text{ ohm}$$

$$\frac{1}{r} = \frac{1}{r'} + \frac{1}{r''}$$

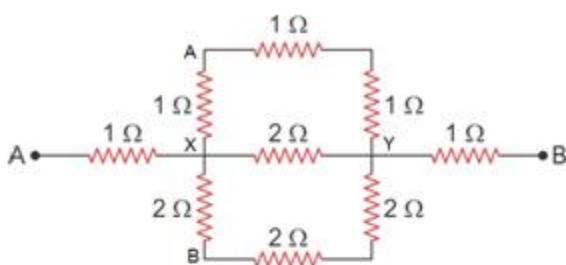
$$\frac{1}{4} = \frac{1}{12} + \frac{1}{5+x}$$

$$\frac{1}{6} = \frac{1}{5+x}$$

$$x = 1 \text{ ohm}$$

Solution 13.

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In the figure above,

Resistance between XAY = $(1+1+1) = 3\Omega$

Resistance between XY = 2Ω

Resistance between XBY = 6Ω

Let R' be the net resistance between points X and Y.

$$\text{Then, } \frac{1}{R'} = \frac{1}{2} + \frac{1}{3} + \frac{1}{6} = \frac{3+2+1}{6} = \frac{6}{6}\Omega$$

or, $R' = 1\Omega$

thus, we can say that between points A and B,
three 1Ω resistors are connected in series.

Let R_{AB} be the net resistance between points A and B.

Then, $R_{AB} = (1 + 1 + 1)\Omega = 3\Omega$

Solution 14.

Wire cut into three pieces means new resistance = $27/3 = 9$

Now three resistance connected in parallel :

$$\frac{1}{r} = \frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3} = \frac{1}{9} + \frac{1}{9} + \frac{1}{9}$$

$$r = 9/3 = 3\text{ ohm}$$

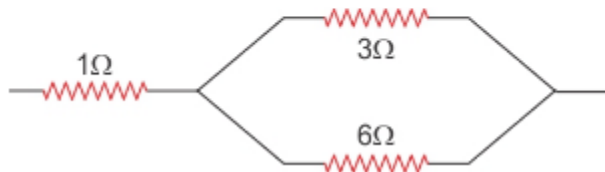
Solution 15.

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

$$r = 2 \text{ ohm}$$

$$R = 2 + 1 = 3 \text{ ohm}$$



Solution 16.

$$R_1 = 1 + 2 = 3 \text{ ohm}$$

$$R_2 = 1.5 \text{ ohm}$$

R_1 and R_2 are connected in parallel

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{3} + \frac{1}{1.5} = 1$$

$$R = 1 \text{ ohm}$$

Solution 17.

$$R_1 = 3 + 2 = 5 \text{ ohm}$$

$$R_2 = 30 \text{ W}$$

$$R_3 = 6 + 4 = 10 \text{ ohm}$$

R_1 , R_2 and R_3 are connected in parallel

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} = \frac{1}{5} + \frac{1}{30} + \frac{1}{10} = \frac{10}{30}$$

$$R = 3 \text{ ohm}$$

Solution 18.

<https://www.indcareer.com/schools/selina-class-10-icse-solutions-physics-chapter-8-current-electricity/>

(a) $R_1 = 2 + 2 + 2 = 6 \text{ ohm}$

$R_2 = 2 \text{ ohm}$

R_1 and R_2 are connected in parallel

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{6} + \frac{1}{2} = \frac{4}{6}$$

$$R = 6 / 4 = 1.5 \text{ ohm}$$

(b) $R_1 = 2 + 2 = 4 \text{ ohm}$

$R_2 = 2 + 2 = 4 \text{ W}$

R_1 and R_2 are connected in parallel

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{4} + \frac{1}{4} = \frac{1}{2}$$

$$R = 2 \text{ ohm}$$

Solution 19.

(a) $R_1 = 3 + 3 = 6 \text{ W}$

$R_2 = 3 \text{ W}$

R_1 and R_2 are connected in parallel

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{6} + \frac{1}{3} = \frac{1}{2}$$

$$R = 2 \text{ ohm}$$

(b) As calculated above $R = 2 \text{ ohm}$

$R_3 = 3 \text{ ohm}$

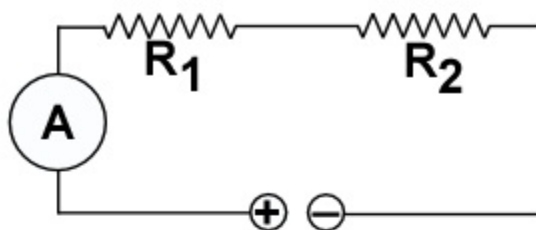
$R_4 = 3 \text{ ohm}$

$$R' = R + R_3 + R_4 = 2 + 3 + 3 = 8 \text{ ohm}$$

Solution 20.

<https://www.indcareer.com/schools/selina-class-10-icse-solutions-physics-chapter-8-current-electricity/>

(a)



$$R_1 = 2 \text{ ohm}$$

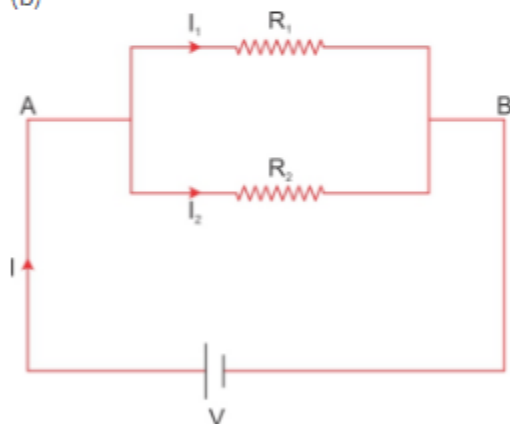
$$R_2 = 3 \text{ ohm}$$

$$R = R_1 + R_2 = 2 + 3 = 5 \text{ ohm}$$

$$V = 6 \text{ V}$$

$$I = \frac{V}{R} = \frac{6}{5} = 1.2 \text{ ohm}$$

(b)



R_1 and R_2 are connected in parallel

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{2} + \frac{1}{3} = \frac{5}{6}$$

$$R = 1.2 \text{ ohm}$$

$$V = 6 \text{ V}$$

$$I = \frac{V}{R} = \frac{6}{1.2} = 5 \text{ A}$$

Solution 21.

<https://www.indcareer.com/schools/selina-class-10-icse-solutions-physics-chapter-8-current-electricity/>

(a)

$$R_1 = 6 \text{ ohm}$$

$$R_2 = 4 \text{ ohm}$$

$$R = R_1 + R_2 = 6 + 4 = 10 \text{ ohm}$$

$$V = 20 \text{ V}$$

$$I = V/R = 20/10 = 2 \text{ A}$$

(b) $R = 6 \text{ W}$

$$I = 2 \text{ A}$$

$$V = ?$$

$$V = IR = 6 \times 2 = 12 \text{ V}$$

Solution 23.

For resistor A:

$$R = 1 \text{ ohm}$$

$$V = 2 \text{ V}$$

$$I = V/R = 2/1 = 2 \text{ A}$$

For resistor B:

$$R = 2 \text{ ohm}$$

$$V = 2 \text{ V}$$

$$I = V/R = 2/2 = 1 \text{ A}$$

Solution 24.

<https://www.indcareer.com/schools/selina-class-10-icse-solutions-physics-chapter-8-current-electricity/>

(a)

$$V = 4 \text{ V}$$

$$I = 0.4 \text{ A}$$

Total Resistance $R' = ?$

$$R' = V/I = 0.4/4 = 10 \text{ ohm}$$

(b)

$$R_1 = 20 \text{ ohm}$$

$$R' = 10 \text{ ohm}$$

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

$$\frac{1}{10} = \frac{1}{R} + \frac{1}{20}$$

$$\frac{1}{R} = \frac{1}{10} - \frac{1}{20} = \frac{1}{20}$$

$$R = 20 \Omega$$

(c)

$$R = 20 \text{ ohm}$$

$$V = 4 \text{ V}$$

$$I = V/R = 4/20 = 0.2 \text{ A}$$

Solution 25.

(a)

Resistance of 1m of wire = 3 ohm

Resistance of 1.5 m of wire = $3 \times 1.5 = 4.5 \text{ W}$

$$\frac{1}{R} = \frac{1}{4.5} + \frac{1}{4.5} + \frac{1}{4.5} = \frac{3}{4.5}$$

$$R = 1.5 \text{ ohm}$$

(b)

$$I = 2 \text{ A}$$

$$V = IR = 2 \times 4.5 = 9 \text{ V}$$

(c)

$R = 3 \text{ ohm}$ for 1 m

For 5 m : $R = 3 \times 5 = 15 \text{ ohm}$

But Area A is double i.e. 2A and Resistance is inversely proportional to area so Resistance will be half.

$$R = 15/2 = 7.5 \text{ ohm}$$

Solution 26.

<https://www.indcareer.com/schools/selina-class-10-icse-solutions-physics-chapter-8-current-electricity/>

In parallel $R = \frac{1}{2} + \frac{1}{2} = 1 \text{ ohm}$

$I = 1.2 \text{ A}$

$\varepsilon = I(R+r) = 1.2(1+r) = 1.2 + 1.2 r$

In series $R = 2+2=4 \text{ ohm}$

$I=0.4 \text{ A}$

$\varepsilon = I(R+r) = 0.4(4+r) = 1.6 + 0.4 r$

It means :

$1.2 + 1.2 r = 1.6 + 0.4 r$

$0.8 r = 0.4$

$r = 0.4 / 0.8 = \frac{1}{2} = 0.5 \text{ ohm}$

(i) Internal resistance $r = 0.5 \text{ ohm}$

(ii) $\varepsilon = I(R+r) = 1.2(1+0.5) = 1.8 \text{ V}$

Solution 27.

(a) In parallel $1/R = 1/3 + 1/6 = 1/2$

So $R = 2 \text{ ohm}$

$r = 3 \text{ W}$

$\varepsilon = 15 \text{ V}$

$\varepsilon = I(R+r)$

$15 = I(2+3)$

$I = 15/5 = 3 \text{ A}$

(b) $V = ?$

$R = 2 \text{ ohm}$

$V = IR = 3 \times 2 = 6 \text{ V}$

(c) $V = 6 \text{ V}$

$R = 3 \text{ ohm}$

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

(d) $R = 6 \text{ ohm}$

$V = 6 \text{ V}$

$I = V/R = 6/6 = 1 \text{ A}$

Solution 28.

<https://www.indcareer.com/schools/selina-class-10-icse-solutions-physics-chapter-8-current-electricity/>

(a) $R = 4 \, \Omega$

$I = 0.25 \, \text{A}$

$V = IR = 0.25 \times 4 = 1 \, \text{V}$

(b) Internal Resistance $r = 3 \, \text{ohm}$

$I = 0.25 \, \text{A}$

$V = IR = 0.25 \times 3 = 0.75 \, \text{V}$

(c) Effective resistance of parallel combination of two $2 \, \text{ohm}$ resistances $= 1 \, \text{ohm}$

$V = I/R = 0.25/1 = 0.25 \, \text{V}$

(d) $I = 0.25 \, \text{A}$

$\varepsilon = 2 \, \text{V}, r = 3 \, \text{ohm}$

$\varepsilon = I(R' + r)$

$2 = 0.25(R' + 3)$

$R' = 5 \, \text{W}$

$$\frac{2R}{2 + R} + 4 = 5$$

$R = 2 \, \text{ohm}$

Solution 29.

(a) $R_1 = 6 \, \text{W}$

$R' = R_2 + R_3 = 2 + 4 = 6 \, \text{W}$

R_1 and R' in parallel :

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R'} = \frac{1}{6} + \frac{1}{6} = \frac{2}{6}$$

$R = 3 \, \text{ohm}$

(b) $R = 3 \, \text{ohm}$

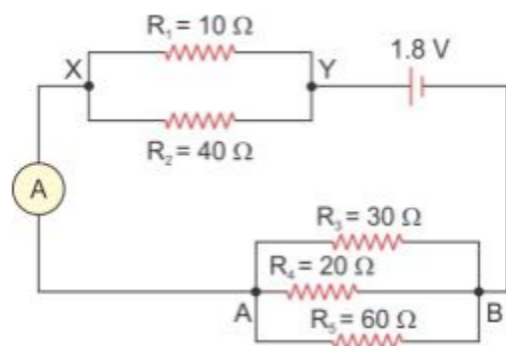
$V = 6 \, \text{V}$

$I = ?$

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

Solution 30.

<https://www.indcareer.com/schools/selina-class-10-icse-solutions-physics-chapter-8-current-electricity/>



(a) In the figure above,

Let resistance between X and Y be R_{XY}

$$\text{Then, } \frac{1}{R_{XY}} = \frac{1}{10} + \frac{1}{40} = \frac{4+1}{40} = \frac{5}{40} \Omega$$

$$\text{or, } R_{XY} = 8 \Omega$$

Let R_{AB} be the net resistance between points A and B.

$$\text{Then, } \frac{1}{R_{AB}} = \frac{1}{30} + \frac{1}{20} + \frac{1}{60} = \frac{2+3+1}{60} = \frac{6}{60} \Omega$$

$$\text{or, } R_{AB} = 10 \Omega$$

$$\therefore \text{Total resistance of the circuit} = 8 \Omega + 10 \Omega = 18 \Omega$$

$$(b) \text{ Current, } I = \frac{\text{Voltage}}{\text{Total resistance}} = \frac{1.8}{18} \text{ A}$$

$$\text{or, } I = 0.1 \text{ A}$$

Thus, 0.1A shall be the reading of the ammeter.

Exercise 8(C)

Solution 1.

Electrical energy, $W = I^2 R t$ joule

Solution 2.

$$(a) \text{ Electrical Power, } P = \frac{V^2}{R}$$

$$(b) \text{ Electrical Power, } P = I^2 R$$

Solution 3.

<https://www.indcareer.com/schools/selina-class-10-icse-solutions-physics-chapter-8-current-electricity/>

(a) Q represents Charge and V represents Voltage.

(b)

Electrical Power, $P = I^2R$

where I: Current

and R: Resistance

Solution 4.

The S.I. unit of electrical energy is joule.

$$1\text{Wh} = 3600 \text{ J}$$

Solution 5.

The power of an appliance is 100 W. It means that 100 J of electrical energy is consumed by the appliance in 1 second.

Solution 6.

The S.I. unit of electrical power is Watt.

Solution 7.

(i) The household unit of electricity is kilowatt-hour (kWh).

One kilowatt-hour (kWh) is the electrical energy consumed by an electrical appliance of power 1 kW when it is used for one hour.

(ii) The voltage of the electricity that is generally supplied to a house is 220 Volt.

Solution 8.

(i) Electrical power is measured in kW and

(ii) Electrical energy is measured in kWh.

Solution 9.

One kilowatt-hour (kWh) is the electrical energy consumed by an electrical appliance of power 1 kW when it is used for one hour.

Its value in SI unit is $1\text{kWh} = 3.6 \times 10^6 \text{ J}$

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Solution 10.

Kilowatt is the unit of electrical power whereas kilowatt-hour is the unit of electrical energy.

Solution 11.

(a)

$$1 \text{ kWh} = \frac{1 \text{ volt} \times 1 \text{ ampere} \times 1 \text{ hour}}{1000}$$

(b) $3.6 \times 10^6 \text{ J}$

Solution 12.

An electrical appliance such as electric bulb, geyser etc. is rated with power (P) and voltage (V) which is known as its power rating. For example: If an electric bulb is rated as 50W-220V, it means that when the bulb is lighted on a 220 V supply, it consumes 50 W electrical power.

(a) To calculate the resistance of the appliance, the expression is:

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

(b) The safe limit of current I is: $I = \frac{P}{V}$

Solution 13.

It means that if the bulb is lighted on a 250 V supply, it consumes 100 W electrical power (which means 100J of electrical energy is converted in the filament of bulb into the light and heat energy in 1 second).

Solution 14.

Appliance	Power (in watt)	Voltage (in volts)	Time (hours)	Electrical energy (E = P × t)
Fluorescent tube	40	220	12	0.48 kWh
Television set	120	220	4	0.48 kWh
Refrigerator	150	220	24	3.6 kWh

Solution 15.

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Resistance of 220 V, 50 W lamp is

$$R_1 = \frac{V^2}{P_1} = \frac{220^2}{50} = 968 \, \Omega$$

Resistance of 220 V, 100 W lamp is

$$R_2 = \frac{V^2}{P_2} = \frac{220^2}{100} = 484 \, \Omega$$

Since the two lamps are connected in series
so same current I passes through each lamp.

Power consumed in 220 V, 50 W lamp is $P_1 = I^2 R_1$

Power consumed in 220 V, 100 W lamp is $P_2 = I^2 R_2$

Since $R_1 > R_2$, $P_1 > P_2$.

i.e. 50 W lamp consumes more power.

Solution 16.

When current is passed in a wire, the heat produced in it depends on the three factors:

1. on the amount of current passing through the wire,
 2. on the resistance of wire and
 3. on the time for which current is passed in the wire.
- Dependence of heat produced on the current in wire: The amount of heat H produced in the wire is directly proportional to the square of current I passing through the wire, i.e., $H \propto I^2$
 - Dependence of heat produced on the resistance of wire: The amount of heat H produced in the wire is directly proportional to the resistance R of the wire, i.e., $H \propto R$
 - Dependence of heat produced on the time: The amount of heat H produced in the wire is directly proportional to the time t for which current is passed in the wire, i.e., $H \propto t$

Solution 1 (MCQ).

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$$I^2Rt$$

Note:

$$\text{Electrical energy (W)} = I^2Rt = VIt = \frac{V^2t}{R}$$

Solution 2 (MCQ).

$$144 \, \Omega$$

Solution:

Given, Power (P) = 100 W

Potential difference, V = 120 volt

$$\therefore \text{Resistance, } R = \frac{(V)^2}{P} = \frac{(120)^2}{100} = 144\Omega$$

Numericals

Solution 1.

<https://www.indcareer.com/schools/selina-class-10-icse-solutions-physics-chapter-8-current-electricity/>

Given, Current (I) = 2 A

Resistance, R = 75 Ω

Time, t = 2 min = 120s

(a) Heat produced, $H = I^2 R t$

$$\text{or, } H = (2)^2 (75) (120) \text{ J} = 36000 \text{ J}$$

(b) Charge passed, $Q = I t$

$$\text{or, } Q = (2) (120) \text{ C} = 240 \text{ C}$$

Solution 2.

Given,

Power, P = 60 W

Voltage, V = 250 V

As Power, P = VI

$$I = \frac{60}{250} = 0.24 \text{ A}$$

$$\text{Resistance of bulb } R = \frac{V^2}{P} = \frac{250^2}{60} = 1041.6 \Omega$$

Now if voltage falls to 200 V, power consumed will be

$$P = \frac{V^2}{R} = \frac{200^2}{1041.6} = 38.4 \text{ W}$$

Solution 3.

Given,

Power, P = 100 W

Voltage, V = 250 V

As Power, P = VI

$$I = \frac{100}{250} = 0.4 \text{ A}$$

Solution 4.

<https://www.indcareer.com/schools/selina-class-10-icse-solutions-physics-chapter-8-current-electricity/>

(a) Given,

$$\text{Power, } P = 100 \text{ W}$$

$$\text{Voltage, } V = 220 \text{ V}$$

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

$$R = \frac{(220)^2}{100} = 484 \Omega$$

(b) The safe limit of current that can pass through it

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

$$I = \frac{100}{220} = 0.45 \text{ A}$$

Solution 5.

Energy consumed per day, $E = P \times t$

$$= 40 \times 12.5$$

$$= 500 \text{ Wh}$$

Energy consumed for 30 days

$$E = 500 \times 30 = 15000 \text{ Wh} = 15 \text{ kWh}$$

Solution 6.

Energy, $E = \text{Power} \times \text{time}$

$$= 750 \times 16$$

$$= 12000 \text{ Wh}$$

or $E = 12 \text{ kWh}$

Solution 7.

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Given,

$$\text{Resistance, } R = 200 \Omega$$

$$\text{Voltage, } V = 200 \text{ V}$$

$$\text{time, } t = 5 \text{ min} = 5 \times 60 \text{ sec} = 300 \text{ sec}$$

$$\text{As, Energy, } E = \frac{V^2 t}{R}$$

(i) In joules

$$E = \frac{(200)^2 \times 300}{200}$$

$$\therefore E = 60000 \text{ J}$$

(ii) In kWh

$$\text{As } 1 \text{ kWh} = 3.6 \times 10^6 \text{ J}$$

$$1 \text{ J} = \frac{1}{3.6 \times 10^6} \text{ kWh}$$

$$60000 \text{ J} = \frac{60000}{3.6 \times 10^6} = 0.0167 \text{ kWh}$$

Solution 8.

(a) Given,

$$\text{Power, } P = 24 \text{ W}$$

$$\text{Voltage, } V = 12 \text{ V}$$

$$\text{Current, } I = ?$$

$$\text{As Power, } P = VI$$

$$(i) \quad I = \frac{24}{12} = 2 \text{ A}$$

$$(ii) \text{Energy, } E = P \times t$$

$$E = 24 \times 20 \times 60 \text{ sec}$$

$$E = 28,800 \text{ J}$$

Solution 9.

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Given,

$$\text{Current, } I = 0.2 \text{ A}$$

$$\text{Potential difference, } V = 15 \text{ V}$$

$$\text{Time, } t = 60 \text{ sec}$$

$$\text{As } V = IR$$

$$(a) \quad R = \frac{15}{0.2} = 75 \Omega$$

$$(b) \quad \text{Heat energy, } H = I^2 R t$$
$$H = (0.2)^2 \times 75 \times 60$$

$$\text{or} \quad H = 180 \text{ J}$$

Solution 10.

Given,

$$\text{Voltage, } V = 240 \text{ V}$$

$$\text{Power, } P = 60 \text{ W}$$

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

$$\therefore R = \frac{(240)^2}{60} = 960 \Omega$$

$$I = \frac{P}{V} = 0.25 \text{ A}$$

When one lamp is connected across the mains, it draws 0.25 A current, while if two lamps are connected in series across the mains, current through each bulb becomes

$$\frac{240 \text{ V}}{(960 + 960) \Omega} = 0.125 \text{ A}$$

(i.e., current is halved), hence heating ($= I^2 R t$) in each bulb becomes one-fourth, so each bulb appears less bright.

Solution 11.

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Given,

$$\text{Voltage, } V_1 = 220 \text{ V}$$

$$V_2 = 110 \text{ V}$$

$$\text{Power, } P_1 = P_2 = P = 60 \text{ W}$$

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

$$R_1 = \frac{V_1^2}{P} = \frac{(220 \times 220)}{60}$$

$$R_2 = \frac{V_2^2}{P} = \frac{(110 \times 110)}{60}$$

On dividing R_1 and R_2

$$\frac{R_1}{R_2} = \frac{\frac{(220 \times 220)}{60}}{\frac{(110 \times 110)}{60}} = \frac{4}{1}$$

$$\therefore R_1 : R_2 = 4 : 1$$

Solution 12.

Given,

$$\text{Power, } P = 250 \text{ W}$$

$$\text{Voltage, } V = 230 \text{ V}$$

$$(i) \text{ Energy, } E = P \times t$$

$$\text{Time, } t = 1 \times 60 \times 60 = 3600 \text{ sec}$$

$$\text{As, Energy, } E = 250 \times 3600 = 9 \times 10^5 \text{ J}$$

$$(ii) \quad 1000 \text{ Wh} = 250 \times t$$

$$\text{time, } t = \frac{1000}{250} = 4 \text{ hours}$$

If it consumes 1kWh of energy then it requires 4 hours.

Solution 13.

<https://www.indcareer.com/schools/selina-class-10-icse-solutions-physics-chapter-8-current-electricity/>

Given,

$$\text{Power, } P = 250 \text{ W}$$

$$\text{Voltage, } V = 100 \text{ V}$$

- (i) Current through each heater, $I = ?$

$$\text{As } P = VI$$

$$\Rightarrow I = \frac{P}{V} \\ = \frac{250}{100} = 2.5 \text{ A}$$

$$\therefore \text{Current taken for the three heaters} = 3 \times 2.5 = 7.5 \text{ A}$$

- (ii) Resistance for each heater, $R = \frac{V}{I}$

$$= \frac{100}{2.5} = 40 \Omega$$

- (iii) Time for which energy is supplied, $t = 5 \text{ h}$

$$\text{As, Energy, } E = P \times t$$

$$E = 250 \times 5 = 1250 \text{ Wh}$$

$$\text{or } E = 1.25 \text{ kWh}$$

$$\text{Energy for three heaters} = 3 \times 1.25 = 3.75 \text{ kWh}$$

Solution 14.

Given,

$$\text{Voltage, } V = 4 \text{ V}$$

$$\text{Resistance of the battery, } R_B = 2.5 \Omega$$

$$\text{Current, } I = 0.5 \text{ A}$$

- (i) Energy supplied by the battery, $E = \frac{V^2 t}{R}$

$$t = 10 \times 60 = 600 \text{ sec}$$

$$R = \frac{V}{I} = \frac{4}{0.5} = 8 \Omega$$

$$E = \frac{(4)^2 \times 600}{8} = 1200 \text{ J}$$

- (ii) Total resistance, $R = 8 \Omega$

$$\text{Resistance of the battery, } R_B = 2.5 \Omega$$

$$\text{Resistance of the bulb, } R_b = 8 - 2.5 \Omega = 5.5 \Omega$$

- (iii) Energy dissipated in the bulb in 10 min, $E = I^2 R t$

$$E = (0.5)^2 \times 5.5 \times 600 = 825 \text{ J}$$

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Solution 15.

Given,

$$\text{Resistance, } R_A = 4\Omega$$

$$\text{Resistance, } R_B = 6\Omega$$

$$\text{Voltage, } V = 6\text{ V}$$

(i) As resistances are connected in parallel

$$\text{Equivalent Resistance} = \frac{1}{R} = \frac{1}{R_A} + \frac{1}{R_B}$$

$$\frac{1}{R} = \frac{1}{4} + \frac{1}{6} = \frac{10}{24}$$

$$R = 2.4\Omega$$

$$\begin{aligned} \text{As power, } P &= \frac{V^2}{R} \\ &= \frac{(6)^2}{2.4} = 15\text{ W} \end{aligned}$$

(ii) Power dissipation across each resistor, $P = VI$

$$\text{Current across resistor } R_A, I_A = \frac{V}{R_A}$$

$$I_A = \frac{6}{4} = 1.5\text{ A}$$

Power dissipation across resistor R_A ,

$$P = VI_A = 6 \times 1.5 = 9\text{ W}$$

(ii) Current across resistor R_B , $I_B = \frac{V}{R_B}$

$$I_B = \frac{6}{6} = 1\text{ A}$$

Power dissipation across resistor R_B ,

$$P = VI_B = 6 \times 1 = 6\text{ W}$$

Solution 16.

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Given,

$$\text{E.m.f. of battery, } V = 15 \text{ V}$$

$$\text{Internal resistance of battery, } R_B = 2\Omega$$

$$\text{Resistances given in circuit, } R_1 = 4\Omega$$

$$R_2 = 6\Omega$$

(i) When resistors are connected in series,

$$\text{Equivalent resistance, } R = R_B + R_1 + R_2 = 12\Omega$$

$$\text{Current in the circuit, } I = \frac{15}{12} = 1.25 \text{ A}$$

$$\text{Now voltage across resistor } R_2, \quad V_2 = IR = 1.25 \times 6$$

$$V_2 = 7.50 \text{ V}$$

$$\text{Time, } t = 1 \text{ min} = 60 \text{ sec}$$

$$\begin{aligned} \text{Energy across } R_2, \quad E &= \frac{V^2 t}{R} = \frac{(7.5)^2 \times 60}{6} \\ E &= 562.5 \text{ J} \end{aligned}$$

Solution 17.

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

$$\text{Heat gained} = \left(\frac{V^2}{R} \right) \times t$$

$$\left(\frac{V_1^2}{R} \right) \times t_1 = \left(\frac{V_2^2}{R} \right) \times t_2$$

$$t_2 = \left(\frac{V_1}{V_2} \right)^2 \times t_1$$

$$= \left(\frac{220}{200} \right)^2 \times 300 = 363 \text{ s} = 6.05 \text{ min}$$

Solution 18.

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Given,

Voltage, $V = 220 \text{ V}$

Current, $I = 8 \text{ A}$

Time, $t = 2 \text{ h}$

Energy, $E = VIt$

$$E = 220 \times 8 \times 2 = 3520 \text{ Wh}$$

$$\Rightarrow E = 3.52 \text{ kWh}$$

Cost of energy = Rs. 4.50/kWh

$$\therefore \text{Cost of 3.52 kWh of energy} = \text{Rs. } 4.50 \times 3.52 \text{ kWh} \\ = 15.84$$

Solution 19.

Given,

Power of kettle, $P = 2.5 \text{ kW}$

Voltage, $V = 250 \text{ V}$

Time, $t = 2 \text{ h}$

As, Energy, $E = P \times t$

$$= 2.5 \times 2 = 5 \text{ kWh}$$

Cost per unit of energy = Rs. 5.40

$$\text{Cost for 5 kWh of energy} = 5.40 \times 5 = \text{Rs. } 27$$

Solution 20.

Given,

power of geyser, $P = 1500 \text{ W}$

Voltage, $V = 250 \text{ V}$

$$(i) \quad \text{Current, } I = \frac{P}{V}$$

$$I = \frac{1500}{250} = 6 \text{ A}$$

$$(ii) \quad \text{Time, } t = 50 \text{ h}$$

Energy, $E = P \times t$

$$= 1500 \times 50 = 75000 \text{ Wh} = 75 \text{ kWh}$$

$$(iii) \quad \text{Cost per unit of energy} = \text{Rs. } 4.20$$

$$\text{Cost for 75 kWh of energy} = 4.20 \times 75 = \text{Rs. } 315$$

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