ELECTRICITY PROBLEMS

Points to Be Remember

- **Current: The rate of flow of charge (Q) through a conductor is called current .**

  Current (I) is given by,

  Current $= \frac{\text{Charge}}{\text{Time}}$ **or** $I = \frac{Q}{t}$

  The SI unit of current is ampere (A) : 1A = 1 C/s

  The current flowing through a circuit is measured by a device called ammeter. Ammeter is connected in series with the conductor. The direction of the current is taken as the direction of the flow of positive charge.

- **Ohm's law : At any constant temperature, the current (I) flowing through a conductor is directly proportional to the potential (V) applied across it.**

  Mathematically,

  $I = V/R$ **or** $V = IR$

- **Resistance : Resistance is the property of a conductor by virtue of which it opposes the flow of electricity through it. Resistance is measured in ohms. Resistance is a scalar quantity.**

- **Resistivity : The resistance offered by a cube of a substance having side of 1 meter, when current flows perpendicular to the opposite faces, is called its resistivity (ρ). The SI unit of resistivity is ohm.m.**

- **Equivalent resistance : A single resistance which can replace a combination of resistances so that current through the circuit remains the same is called *equivalent resistance*.**

- **Law of combination of resistances in series: When a number of resistance are connected in series, their equivalent resistance is equal to the sum of the individual resistances.**

  If R_1, R_2, R_3, etc. are combined in series, then the equivalent resistance (R) is given by,

  $R = R_1 + R_2 + R_3 + ...$

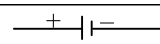
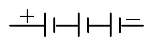
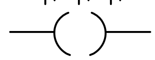
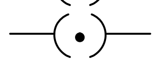
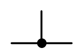
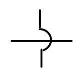
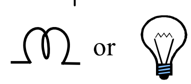
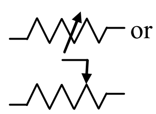
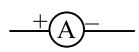
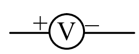
  The equivalent resistance of a number of resistances connected in series is higher than each individual resistance.

- **Law of combination of resistances in parallel : When a number of resistances are connected in parallel, the reciprocal of the equivalent resistance is equal to the sum of the reciprocals of the individual resistances.**

If R_1, R_2, R_3, etc. are combined in parallel, then the equivalent resistance (R) is given by.

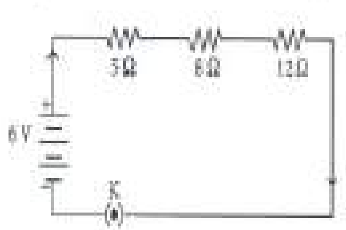
$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

The equivalent resistance of a number of resistances connected in parallel is less than each of all the individual resistances.

S.N	Components	Symbols
1.	Electric cell	
2.	Battery	
3.	Plug key (switch open)	
4.	Plug key (switch closed)	
5.	A wire joint	
6.	Wires crossing without joining	
7.	Electric bulb	
8.	A resistor of resistance R	
9.	Variable resistance or rheostat	
10.	Ammeter	
11.	Voltmeter	
12.	Fuse	

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

Answer :



An electric lamp of 100 Ω, a toaster of 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 the three appliances, and what is the current through it?

Answer : Let resistance of lamp, R_1 = 100 Ω

Resistance of toaster, R_2 = 50 Ω

Resistance of filter, R_3 = 500 Ω

Net resistance,

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

[∵ R_2, R_2 and R_3 are connected in parallel]

$$\frac{1}{R} = \frac{1}{100} + \frac{1}{50} + \frac{1}{500} = \frac{16}{500} \text{ or } R = \frac{500}{16} = 31.25\Omega$$

So, resistance of iron to take same current as much Current drawn by all the appliances should be 31.25 Ω . Current through circuit,

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

Thus, current through iron is 7.04 A.

What is (a) the highest, (b) the lowest total resistence. Which can be secured by combinations of four coils of resistance 4Ω, 8Ω, 12Ω, 24Ω ?

Answer : (a) Resistance is maximum when resistors are connected in series.

R_{max} = 4 + 8 + 12 + 24 = 48 Ω

(i) Resistance is minimum when resistors are connected in parallel.

$$R_{\min} = 1/\left[\frac{1}{4} + \frac{1}{8} + \frac{1}{12} + \frac{1}{24}\right] = \frac{24}{12}\Omega = 2\Omega$$

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

Answer : Given, Charge, q = 96000 C, Time, t = 1 h= 3600 s

Potential difference, V = 50 V

We know that,

Heat generated, H = VIt=$\frac{Vqt}{t}$ $\left[\because I = \frac{q}{t}\right]$

=Vq = 50 × 96000 = 4800000 J = 4800 kJ

4800 kJ is generated while transferring 96000 C of charge.

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

Answer : Given, Resistance, R = 20 Ω,

Current, I = 5 A, Time, t = 30 s

We know that,

Heat developed, $H = I^2Rt$

$=(5)^2 \times 20 \times 30 = 5 \times 5 \times 20 \times 30 = 15000\ J = 15\ kJ$

15 kJ heat is developed in 30 s.

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

Answer : Given, I = 5 A, V = 220 V, t = 2h

∴ Power of motor,

$P = VI = 220 \times 5 = 1100\ W = 1.1\ kW$

∴ Energy consumed $= Pt = 1.1 \times 2 = 2.2\ kWh$

Thus, the power of the motor is 1.1 kW and energy consumed is 2.2 kWh.

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

Answer : Given, V = 220 V, I = 5A

∴ Resistance of the wire, $R' = \frac{V}{I} = \frac{220}{5} = 44\Omega$

The net resistance 44 Ω is less than the individual resistance 176 Ω, so individual resistances are to be connected in parallel order.

In parallel connection, equivalent resistance

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

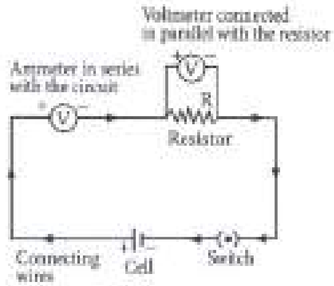
$$\therefore 44\Omega = \frac{176\Omega}{n} \quad or \quad n = \frac{176}{44} = 4 \quad resistors$$

(a) State Ohm's Law.

(b) Draw a schematic diagram of the circuit for studying Ohm's Law.

Answer : (a) Ohm's Law states that at constant temperature, current flowing through a conductor is directly proportional to the potential difference across its ends.

(b)

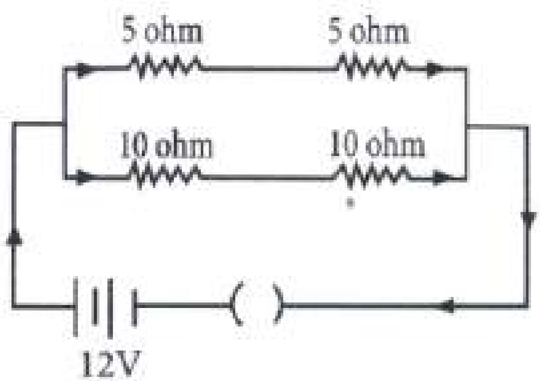


If a 12 V battery is connected to the arrangement of resistances given below, calculate

(i) the total effective resistance of the arrangement and

(ii) the total current flowing in the circuit

Answer :



(i) The 5 Ω resistors are connected in series. Therefore, their effective resistance = (5 + 5) = 10 Ω

The 10 Ω resistors are connected in series. Therefore, their effective resistance = (10 + 10) = 20 Ω

Now these 10 Ω equivalent and 20 Ω equivalent are connected in parallel. Therefore, the equivalent resistance (R_{eq}) will be:

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$$
$$\frac{1}{R_{eq}} = \frac{1}{10} + \frac{1}{20}$$
$$\frac{1}{R_{eq}} = \frac{2+1}{20}$$
$$\frac{1}{R_{eq}} = \frac{20}{3} = 6.76\Omega$$

(ii) Total Current = Total voltage / Total equivalent resistor

=12 / 6.67

= 1.8 A.

How much current will an electric bulb draw from 220 V source if the resistance of the bulb is 1200 Ω? If in place of bulb, a heater of resistance 100 Ω is connected to the sources, calculate the current drawn by it.

Answer : Given: V = 220 V, R_1 1200 Ω, I_1 = ?, R_2 = 100Ω , I_2 =?

Using Ohm's law, $V = I_1R_1$

$I_1 = \frac{V}{R_1} = \frac{220}{1200}$ =0.18 A

$I_2 = \frac{V}{R_2} = \frac{220}{100}$ = 2.2 A

An electric bulb is rated at 60 W, 240 V. Calculate its resistance. If the voltage drops to 192 V, calculate the power consumed and the current drawn by the bulb. (Assume that the resistance of the bulb remain unchanged.)

Answer : Given: P_1 = 60 W, V_1 = 240 V, R = ?, P_2 = ?, V_2 = 192 V, I_1 = ?

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

We get $R = \frac{V_1^2}{P_1} = \frac{(240)^2}{60} = 960\Omega$

Again $P_2 = \frac{V_2^2}{R} = \frac{192 \times 192}{960} = 38.4W$

Current drawn by bulb at 192 V is

$I = \frac{V}{R} = \frac{192}{960} = 0.2A$

(i) What is the meaning of electric power of an electrical device? Write its SI unit.

(ii) An electric kettle of 2 kW is used for 2 h . Calculate the energy consumed in

(a) kilowatt hour and

(b) joules

Answer : (i) Electric power of an electrical device is defined as its rate of consumption of electrical energy.

i.e., P=E/t

The SI unit of electrical power is watt (W)

(ii) Given, electric power $P = 2\text{ kW}$ Time, $t = 2\text{ h}$

We know that,

(a) Electric energy, $W = Pt = 2 \times 2 = 4\text{kWh}$

(b) But $1\text{kWh} = 3.6 \times 10^6\text{ J}$

$\therefore \quad W = 4 \times 3.6 \times 10^6\text{ J}$

$= 14.4 \times 10^6\text{ J} = 1.44 \times 10^{-}\text{J}$

An electric lamp is marked 100 W, 220 V. It i used for 5 hours daily. Calculate.

(i) its reistance while glowing

(ii) energy consumed in kWh per day

Answer : (i) Resistance of a glowing lamp is related to its power and voltage as

Power= $\frac{(voltage)^2}{Resistance}$

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

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

Therefore, the resistance of the bulb when glowing is 484Ω

(ii) Power=100 W=0.1 kW

Energy= Power x time

=0.1 kW x 5h

=0.5 kWh

0.5 kWh is the amount of energy is consumed by the bulb per day.

(i) Draw a diagram to show how two resistor R_1 and R_2 are connected in series.

(ii) In a circuit, if the two resistors of 5 ohm and 10 ohm are connected in series, how does the current passing through the two resistors compare?

Answer : (i)

(ii) Current through both the resistors will be the same.

A bulb is rated at 5.0 volt, 100 mA. Calculate its

(i) power and

(ii) resistance

Answer : Voltage (V) = 5.0 V

Current (I) = 100 mA = 0.1 A

(i) Power = VI = 5×0.1= 0.5W

(ii) Resistance = $\frac{V}{I} = \frac{5}{0.1} = 50\Omega$

A wire of resistance 10 ohm is bent in the form of a closed circle. What is the effective resistance between the two points at the ends of any diameter of the circle?

As the wire is bent in the form of a closed circle, it will be have like two resistors of 5Ω each, connected in parallel. Therefore, the equivalent resistance can be calculated as:

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\frac{1}{R_{eq}} = \frac{1}{5} + \frac{1}{5} = \frac{1}{R_{eq}} = \frac{2}{5}$$

$$\frac{1}{R_{eq}} = \frac{5}{2} = 2.5\Omega$$

The effective resistance between the two points at the ends of an diameter of the circle is 2.5 Ω.

Find the current drawn from the battery by the network of four resistors shown in the figure

Answer : Equivalent resistance of the given network is

$$\frac{1}{R} = \frac{V}{R_4} + \frac{1}{R_1+R_2+R_3} = \frac{1}{10} + \frac{1}{10+10+10}$$

$$\frac{1}{10} + \frac{1}{30} = \frac{3+1}{30} = \frac{4}{30}$$

$$\therefore R = \frac{V}{R} = \frac{3}{7.5} = 7.5\Omega$$

Current drawn from the battery

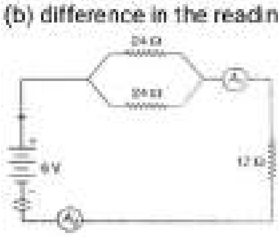
$$I = \frac{V}{R} = \frac{3}{7.5} = \frac{30}{75} = \frac{2}{5}$$

I = 0.4 A

(i) How will you infer with the help of an experiment that the same current flows through every part of the circuit containing three resistors R_1,R_2 and R_3 in series connected to a battery of V volts?

(ii) Study the following circuit and find out the (a) current in 12Ω resistor.

(b) difference in the reading of A_1 and A_2 if any



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Answer : (i) The experimental set up comprise three resistors R_1,R_2 and R_3 of three different values such as 1 Ω, 2 Ω and 3 Ω which are connected in series.

Connect them with a battery of 6 V , an ammeter and plug key, as shown in figure

The key K is closed and the ammeter reading is recorded. Now, the position of ammeter is changed to anywhere in between the resistors again, the ammeter reading is recorded each time. It's observed that there was identical reading each time, which shows that same current flows through every part of the circuit containing three resistances in series connected to a battery.

(ii) (a) Equivalent resistance of given circuit is R, then

$R = (24\|24) + 12 = \frac{24\times24}{24+24} + 12$ =12+12=24 Ω

Therefore Current through $12 Ω resistor,

$I = \frac{V}{R} = \frac{6}{24} = 0.25\text{ A}$

(b) Difference in reading of A_1 and A_2 = $(0.25 - 0.25)\text{A} = 0\text{ A}$

Draw a schematic diagram of a circuit consisting of a battery of four dry cells of 1.5 V each, a 2Ω resistor, a 6Ω resistor, 16Ω resistor and a plug key all connected in series. Put an ammeter to measure the current in the circuit and a voltmeter across the 16Ω resistor to measure potential difference across its two ends. Use Ohm's law to determine.

(a) ammeter reading, and

(b) voltmeter reading when key is closed

Answer : Circuit diagram consisting of battery, resistors and key is

Total voltage of battery, $V = 1.5 \times 4 = 6.0\text{ V}$

Equivalent resistance, $R = 2\Omega + 6\Omega + 16\Omega = 24\Omega$

(a) Current in the circuit (ammeter reading)

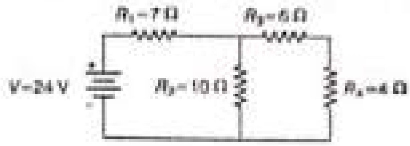
⇒ using ohm's law, V=I R

$I = \frac{V}{R} = \frac{6}{24} = 0.25\text{ A}$

(b) Voltage across the 16Ω resistor (voltmeter reading when key is closed) in series, current is same in all resistors.

Potential across 16Ω resistor will be, $V = IR = 0.25 \times 16 = 4\text{ V}$

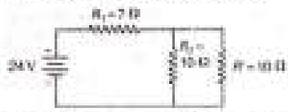
Calculate the total resistance and the total current in the circuit.



Answer : Here, resistances R_3 and R_4 are in series, so their equivalent resistance is

$R = R_3 + R_4 = 6 + 4 = 10\Omega$

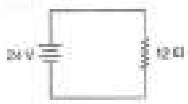
The circuit is reduced to



Now, resistances R2 and R' are in parallel, so their equivalent resistance,

$R' = \frac{R_2 R'}{R_2 + R'} = \frac{10 \times 10}{10 + 10} = \frac{100}{20} = 5\Omega$

The circuit now becomes



The resistances R_1 and R' are in series, so their equivalent or total resistance of circuit, $R_{eq} = R_1 + R' = 7 + 5 = 12\Omega$

The final circuit is as shown

By Ohm's law, $I = \frac{V}{R_{eq}} = \frac{24}{12} = 2\ \text{A}$

Several electric bulbs designed to be used on a 220 V electric supply line are rated at 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?

Answer : Given, Potential difference, V = 220 V

Power, P = 10 W; Current, I = 5 A

∴ Resistance of bulb,

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

Since, bulbs are connected in parallel,

Equivalent resistance (R)

$= \frac{Individual \quad resistance(R')}{Number \quad of \quad bulbs \quad (n)}$

$\Rightarrow R = \frac{4840}{n}\Omega, V = IR$

$\Rightarrow 220 = \frac{5 \times 4840}{n}$

$\Rightarrow n = \frac{5 \times 4840}{220} = 110 \quad bulbs$

Two lamps, one rated at 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?

Answer : Given, potential, V = 220 V
Power, P_1 = 100 W
Power, P_2 = 60 W
$\therefore Current, I_1 = \frac{P_1}{V}$
$= \frac{100}{220} = \mathbf{0.45} A$
Current, $I_2 = \frac{P_2}{V} = \frac{60}{220} = \mathbf{0.27} A$
∴ Total current drawn,
$I = I_1 + I_2$
= 0.45 + 0.27
= 0.72 A

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

Answer : Given, P_1 = 250 W, P_2 = 1200 W,
t_1 = 1h = 3600 s, t_2 = 10 min = 600 s
∴ Energy
$Q_1 = P_1 t_1$ = 250 × 3600 = 900000 J = 900 kJ
and $Q_2 = P_2 t_2$ = 1200 × 600 = 720000 J = 720 kJ
Thus, TV set uses more energy.

A current of 0.5 A is drawn by a filament of an electric bulb for 10 minutes. Find the amount of electric charge that flows through the circuit.

Answer : We are given, I = 0.5 A; t = 10 min = 600 s.
From Eq we have
Q = It
= 0.5 A × 600 s
= 300 C

Ex.3 A current of 5.0 A flows through a circuit for 15 min. Calculate the amount of electric charge that flows through the circuit during this time.

Sol. Given : Current, I = 5.0 A
Time, t = 15 min. = 15 × 60 s = 900 s
Then, Charge that flows through the circuit,
Q = Current × Time
= 5.0A × 900 s
= 4500 A.s = 4500 C

Ex.4 A piece of wire is redrawn by pulling it until its length is doubled. Compare the new resistance with the original value.

Sol. Volume of the material of wire remains same. So, when length is doubled, its area of cross-section will get halved. So, if *l* and a are the original length and area of cross-section of wire,

Original value of the resistance, $R = \rho \times \frac{\lambda}{a}$

and,

New value of the resistance,

$$R' = \rho \times \frac{2\lambda}{a/2} = \rho\frac{\lambda}{a} \times 4 = 4R$$

Ex.5 Calculate the resistance of 100 m long copper wire. The diameter of the wire is 1 mm.

Sol. Using the relationship,

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

We have, $r = \frac{1}{2}$ mm = 0.5×10^{-3} m

$$R = \frac{1.6 \times 10^{-6} \text{ohm.cm} \times 100\text{m}}{3.141 \times (0.5 \times 10^{-3}\text{m})^2}$$

$$R = 2.04 \text{ ohm}$$

Ex.6 If four resistances each of values 1 ohm are connected in series. Calculate equivalent resistance.

Sol. In series,

$R_1 = R_2 = R_3 = R_4 = 1$ohm

putting values, we get,

$R_s = 1 + 1 + 1 + 1 = 4$

Ex.7 Suppose a 6-volt battery is connected across a lamp whose resistance is 20 ohm the current in the circuit is 0.25 A, calculate the value of the resistance from the resistor which must be used.

Sol. Lamp resistance, R = 20 ohm

Extra resistance from resistor, R = ? (to be calculated)

For R and R' in series,

Total circuit resistance, $R_S = R + R'$

From relation, (Ohm's law) $R_S = \frac{V}{I}$

Putting values, we get, $R_S = \frac{6}{0.25}$

= 24 ohm

But $R_S = R + R'$

Hence $R' = R_S - R$

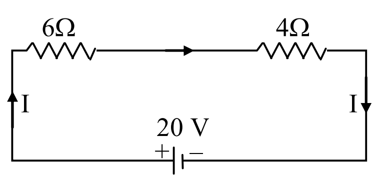
= 24 – 20 = 4 ohm

Extra resistance from resistor,

R' = 4 ohm.

Ex.8 A resistance of 6 ohms is connected in series with another resistance of 4 ohms. A potential difference of 20 volts is applied across the combination. Calculate the current through the circuit and potential difference across the 6 ohm resistance.

Sol. For better understanding we must drawn a proper circuit diagram. It is shown in fig.



We use proper symbols for electrical components.Resistances are shown connected in series, with 20 V battery across its positive and negative terminals. Direction of current flow is also shows from positive terminal of the battery towards its negative terminal.

Potential difference, V = 20 V

Potential difference across 6 Ω,

V_1 = ? (to be calculated)

Total circuit resistance = 10 Ω

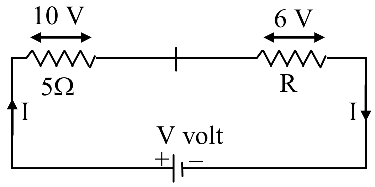
From Ohm's law, $R_S = \frac{V}{R_S}$

Circuit current, I = 2 ampere or (2A)

Putting values, we get, $V_1 = 2 \times 6 = 12$ volts

Potential difference across 6 Ω resistance = 12 V

Ex.9 Two resistances are connected in series as shown in the diagram.



(i) What is the current through the 5 ohm resistance ?

(ii) What is the current through R ?

(iii) What is the value of R ?

(iv) What is the value of V ?

Sol. First resistance, $R_1 = 5\,\Omega$

(i) Current through 5 ohm resistance, $I = ?$

(ii) Current through R, $I = ?$

(iii) Value of second resistance, $R = ?$

(iv) Potential difference applied by the battery,

$V = ?$

(i) From Ohm's law, $R = \frac{V}{I}$

We have, $I = \frac{V}{R} = \frac{V_1}{R_1}$

$I = \frac{10}{5} = 2$ ampere

Current through 5 Ω resistance = 2 ampere (2A).

(ii) Since R is in series with 5 Ω, same current will flow through it,
Current through R = 2 A.

(iii) From Ohm's law, $R = \frac{V}{I}$

$R_2 = \frac{V_2}{I}$

$R_2 = \frac{6}{2} = 3$ ohms

Resistance R has value = 3 ohms.

(iv) From relation, $V = V_1 + V_2$

$V = 10 + 6 = 16$ volts

$V = 16$ volts

Ex.10 Resistors R_1, R_2 and R_3 having values 5Ω , 10Ω, and 30Ω respectively are connected in parallel across a battery of 12 volt. Calculate (a) the current through each resistor (b) the total current in the circuit and (c) the total circuit resistance.

Sol. Here,

$R_1 = 5\Omega, R_2 = 10\Omega, R_3 = 30\ \Omega, V = 12$ V

(a) $I_1 = ?$ $I_2 = ?$ $I_3 = ?$

(b) $I = I_1 + I_2 + I_3 = ?$

(c) $R_p = ?$

(a) From relation, (Ohm's law), $R = \frac{V}{I}$

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

Putting values, we get, $I_1 = \frac{V}{R_1} = \frac{12}{5} = 2.4$ A

$$I_2 = \frac{V}{R_2} = \frac{12}{10} = 1.2 \text{ A}$$

$$I_3 = \frac{V}{R_3} = \frac{12}{30} = 0.4 \text{ A}$$

(b) Total current, $I = I_1 + I_2 + I_3$

$$I = 2.4 + 1.2 + 0.4 = 4 \text{ A}$$

(c) From relation $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

$$\frac{1}{R_p} = \frac{1}{5} + \frac{1}{10} + \frac{1}{30} = \frac{6+3+1}{30} = \frac{10}{30}$$

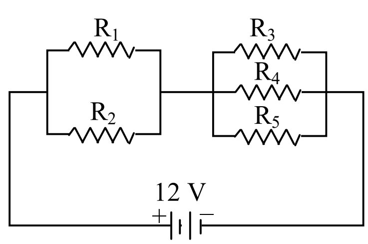
$R_p = 3$ ohm.

Ex.11 Resistors R_1 = 10 ohms, R_2 = 40 ohms, R_3 = 30 ohms, R_4 = 20 ohms, R_5 = 60 ohms and a 12 volt battery is connected as shown.

Calculate :

(a) the total resistance and (b) the total current flowing in the circuit.

Sol. The situation is shown in (figure).



For R_1 and R_2 in parallel

$$\frac{1}{R_{P_1}} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{10} + \frac{1}{40} = \frac{4+1}{40} = \frac{5}{40} = \frac{1}{8}$$

or $R_{P_1} = 8$ ohm

For R_3, R_4 and R_5 is parallel

$$\frac{1}{R_{P_2}} = \frac{1}{R_3} + \frac{1}{R_4} + \frac{1}{R_5} = \frac{1}{30} + \frac{1}{20} + \frac{1}{60}$$

$$= \frac{2+3+1}{60} = \frac{6}{60} = \frac{1}{10}$$

or R_{P_2} = 10 ohm.

(a) For R_{P_1} and R_{P_2} in series.

Total resistance, $R = R_{P_1} + R_{P_2}$

Putting values, we get, R = 8 + 10 = 18

Total resistance, R = 18 ohms. Ans.

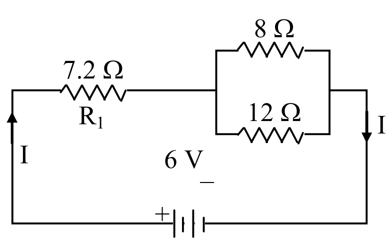
(b) From relation, (Ohm's law) $R = \frac{V}{I}$

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

Putting values, we get, $I = \frac{12}{18} = \frac{2}{3} = 0.67$

Total current, I = 0.67 A. Ans

Ex.12 In the circuit diagram given below. find



(i) total resistance of the circuit

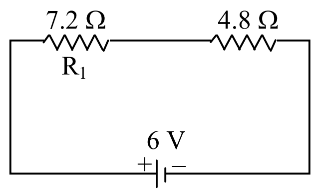
(ii) total current flowing in the circuit

(iii) potential difference across R_1

Sol. (i) For total resistance

8 Ω and 12 Ω are connected in parallel.

Their equivalent resistance comes in series with 7.2 Ω resistance as shown in fig.



With 7.2 Ω and 4.8 Ω in series

$$R_S = 7.2 + 4.8 = 12\ \Omega$$

Total circuit resistance = 12 ohms.

(ii) For total current

Total circuit resistance, R = 12 ohm

Potential difference applied, V = 6 V

$$I = ?$$

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

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

$$I = \frac{6}{12} = 0.5$$

Total circuit current = 0.5 A Ans.

(iii) For potential difference across R_1

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

$$V = IR$$

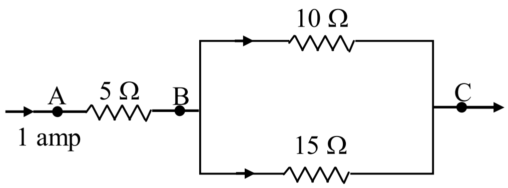
$$V_1 = IR_1$$

$$V_1 = 0.5 \times 7.2$$

$$= 3.6\ V$$

Potential difference across, $V_1 = 3.6$ V. Ans

Ex.13 Three resistances are connected as shown in diagram through the resistance 5 ohms, a current of 1 ampere is flowing :



(i) What is the current through the other two resistors?

(ii) What is the potential difference (p.d.) across AB and across AC?

(iii) What is the total resistance.

Sol. **(i) For current in parallel resistors**

For same potential difference across two parallel resistors,

$V = I_1R_1 = I_2R_2$ i.e. $= \frac{I_1}{I_2} = \frac{R_2}{R_1}$

Current divides itself in inverse ration of the resistances.

Also total current, $I = I_1 + I_2$

$$\frac{I_1}{I_2} = \frac{R_2}{R_1} = \frac{15}{10} = \frac{3}{2}$$

Also, $I_1 + I_2 = 1$ **amp.**

$I_1 = 0.6A, I_2 = 0.4 A.$ **Ans.**

Current is 0.6 A through 10 Ω

(ii) For p.d. across AB

From Ohm's law, $R = \frac{V}{I}, V = IR$

$V = 1 \times 5 = 5V$

P.D. across AB $= 5$ V. **Ans**

For parallel combination of 10 Ω and 15 Ω P.D. across BC, $V = I_1R_1 = 0.6 \times 10 = 6$ V

P.D. across AC = P.D. across AB + P.D. across BC.

$= 5 + 6 = 11$ V

(iii) For total circuit resistance

For 10 Ω and 15 Ω in parallel

$$R_p = \frac{10 \times 15}{10 + 15} = \frac{150}{25} = 6\ \Omega$$

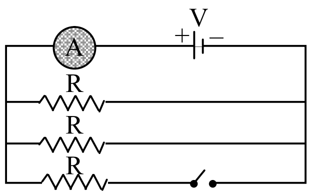
Total resistance = 5 + 6 = 11 Ω

Total circuit resistance = 11 Ω. Ans

$$\left[\text{Also } R = \frac{V}{I} = \frac{11}{1} = 11\Omega\right]$$

Ex.14 **In the diagram shown below (Fig.), the cells and the ammeter both have negligible resistance. The resistors are identical. With the switch K open, the ammeter reads 0.6 A. What will be the ammeter reading when the switch is closed ?**

Sol.



Let the cell have potential difference V and each resistor have resistance R

With key open

Potential difference, = V

Circuit resistance of two parallel resistors,

$$R_{P_1} = \frac{R}{n_1} = \frac{R}{2}\Omega$$

Circuit current, $I_1 = 0.6$ **A**

With key closed

Potential difference = V

Circuit resistance of three parallel resistors,

$$R_{P_2} = \frac{R}{n_2} = \frac{R}{3}\Omega$$

Circuit current, $I_2 = ?$

For same potential difference V

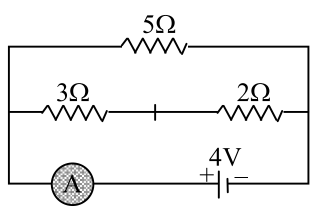
$$V = I_1 R_{P_1} = I_2 R_{P_2}$$

$$I_2 = \frac{I_1 R_{P_1}}{R_{P_2}}$$

$$I_2 = 0.6 \times \frac{R}{2} \times \frac{3}{R} = 0.9$$

Circuit current with closed key = 0.9 A.

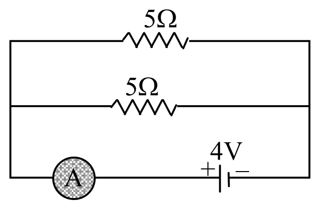
Ex.15 **In the circuit diagram.**



Find (i) total resistance

(ii) current shown by the ammeter A.

Sol. 3 Ω and 2 Ω in series become 5 Ω. Equivalent circuit is shown in fig.



(i) For total resistance

$R_1 = R_2 = 5\ \Omega$ are in parallel.

$$R_p = \frac{5 \times 5}{5+5} = \frac{25}{10} = 2.5\ \Omega$$

Circuit resistance = 2.5 ohm

(ii) For circuit current

Potential difference, $V = 4\ V$

Circuit resistance $R_p = 2.5\ \Omega$

Circuit current, I = ? (to be calculated)

From Ohm's law, $R = \frac{V}{I}$

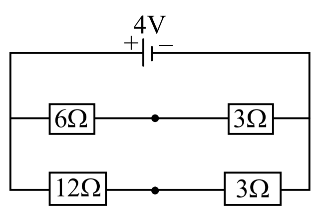
$$I = \frac{V}{R_P}$$

$$I = \frac{4}{2.5} = 1.6\ A$$

Circuit current = 1.6 A

Ammeter reads circuit current 1.6 A

Ex.16 For the circuit shown in the following diagram what is the value of



(i) current through 6 Ω resistor

(ii) potential difference (p.d.) across 12 Ω.

Sol. **(i) For current through 6 Ω**

Current from 4 V battery flows through first parallel branch having 6 Ω and 3 Ω in series.

Current in this branch

$$I = \frac{4}{6+3} = \frac{4}{9} = 0.44 \text{ A}$$

(ii) For p.d. across 12 Ω

Current through second parallel branch

$$I = \frac{4}{12+3} = \frac{4}{15} \text{ A}$$

P.D. across 12 Ω, $V = \frac{4}{15} \times 12 = 3.2 \text{ V}.$