

ELECTRICITY

1. Name a device that helps to maintain a potential difference across a conductor.

Answer. Cell or battery

2. Define 1 volt. Express it in terms of SI unit of work and charge calculate the amount of energy consumed in carrying a charge of 1 coulomb through a battery of 3 V.

Answer. When 1 joule of work is done in carrying 1 coulomb of charge, from infinity to a point in the electric field, then potential at that point is called 1 volt. Potential difference between two points is

$$V = \frac{W}{Q}$$

or

$$W = Q \times V \\ = 1 \times 3 = 3 \text{ J}$$

3. Write S.I. unit of resistivity.

Answer. Ohm-metre (Ωm).

4. How is an ammeter connected in a circuit to measure current flowing through it?

Answer. In series

5. What happens to resistance of a conductor when its area of cross-section is increased?

Answer.

Resistance decreases as $R \propto \frac{1}{A}$.

6. Name the physical quantity which is (i) same (ii) different in all the bulbs when three bulbs of:

(a) same wattage are connected in series.

(b) same wattage are connected in parallel.

(c) different wattage are connected in series.

(d) different wattage are connected in parallel.

Answer. (a) For identical bulbs in series- same current, same potential difference.

(b) For identical bulbs in parallel- same potential difference, different current.

(c) For unidentical bulbs in series- same current, different potential difference.

(d) For unidentical bulbs in parallel- different current, same potential difference.

7. A given length of a wire is doubled on itself and this process is repeated once again. By what factor does the resistance of the wire change?

Answer. Am. Length becomes one-fourth of the original length and area of cross-section becomes four times that of original.

i.e. $l_2 = \frac{1}{4}l_1$ and $A_2 = 4A_1$

$$\therefore \frac{R_2}{R_1} = \frac{l_2}{l_1} \times \frac{A_1}{A_2} = \frac{1}{4} \times \frac{1}{4} = \frac{1}{16}$$

$$\Rightarrow R_2 = \frac{1}{16}R_1$$

So, new resistance is (1/16)th of original resistance.

8. What is an electric circuit? Distinguish between an open and a closed circuit.

Answer. An arrangement for maintaining the continuous flow of electric current by the electrical energy source through the various electrical components connected with each other by conducting wires is termed as electric circuit.

An open circuit does not carry any current, while a closed circuit carries current.

9. (a) Define the term 'volt'.

(b) State the relation between work, charge and potential difference for an electric circuit.

Calculate the potential difference between the two terminals of a battery if 100 J of work is required to transfer 20 C of charge from one terminal of the battery to the other.

Answer.

(a) When 1 joule of work is done in carrying 1 coulomb of charge, from infinity to a point in the electric field, then potential at that point is called 1 volt.

(b) Potential difference, $V = \text{Work done on unit charge} = W/q$

Work is 100 J, $q=20\text{C}$

Potential difference, $V=W/q=100/20=5\text{V}$

10. A 9Ω resistance is cut into three equal parts and connected in parallel. Find the equivalent resistance of the combination.

Answer.

$$\text{Resistance of each part} = \frac{R}{3} = \frac{9}{3} = 3 \Omega$$

$$\therefore R_1 = R_2 = R_3 = 3 \Omega$$

In parallel combination,

$$\begin{aligned} \frac{1}{R_p} &= \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \\ &= \frac{1}{3} + \frac{1}{3} + \frac{1}{3} = \frac{3}{3} = 1 \end{aligned}$$

$$\therefore R_p = 1 \Omega$$

11. (a) Define the term 'coulomb'.

(b) State the relationship between the electric current, the charge moving through a conductor and the time of flow.

Calculate the charge passing through an electric bulb in 20 minutes if the value of current is 200 mA.

Answer.

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

$$t = 20 \times 60 = 1200 \text{ seconds,}$$

$$I = 200 \text{ mA} = 200 \times 10^{-3} \text{ A}$$

$$\text{Charge passing} = q = It = 200 \times 10^{-3} \times 1200 = 240 \text{ C}$$

(a) When 1 A current flows across the wire in 1 second, the charge transfer across its ends is said to be 1 coulomb.

(b) The relationship between the electric current I, the charge q and time t is

12. (a) How is the direction of electric current related to the direction of flow of electrons in a wire?

(b) Calculate the current in a circuit if 500 C of charge passes through it in 10 minutes.

Answer.

(a) Conventional direction of electric current is opposite to the direction of flow of electrons in a wire.

(b) $q = 500 \text{ C}$, $t = 10 \times 60 = 600 \text{ s}$

$$I = 500/600 = 5/6 \text{ A}$$

13. An electric iron has a rating of 750 W, 220 V. Calculate the (i) current flowing through it, and (ii) its resistance when in use.

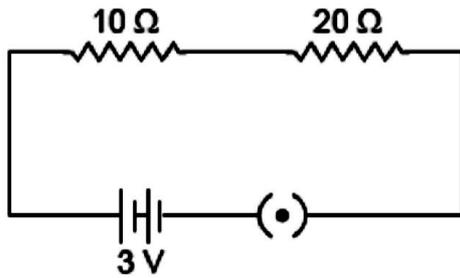
Answer. Given: $P = 750 \text{ W}$, $V = 220 \text{ V}$

(i) $P = VI$

$$750 = 220 \times I \Rightarrow I = \frac{750}{220} = 3.40 \text{ A}$$

$$(ii) \quad P = \frac{V^2}{R} \Rightarrow R = \frac{V^2}{P} = \frac{220^2}{750} \Rightarrow R = 64.53 \Omega$$

14. Study the following electric circuit and find (i) the current flowing in the circuit and (ii) the potential difference across 10Ω resistor.



Answer.

10 Ω and 20 Ω are connected in series, their equivalent resistance is

$$R_s = R_1 + R_2 \\ = 10 + 20 = 30 \Omega$$

(i) Current flowing in the circuit

$$I = \frac{V}{R_s} = \frac{3}{30} \\ = \frac{1}{10} = 0.1 \text{ A}$$

(ii) Potential difference across 10 Ω resistor

$$V = IR \\ = \frac{1}{10} \times 10 = 1 \text{ volt.}$$

15. What is meant by electric current? Name and define its SI unit. In a conductor electrons are flowing from B to A. What is the direction of conventional current? Give justification for your answer. A steady current of 1 ampere flows through a conductor. Calculate the number of electrons that flows through any section of the conductor in 1 second. (Charge on electron 1.6×10^{-19} coulomb).

Answer.

- Electric Current: The amount of charge 'Q' flowing through a particular area of cross section in unit time 't' is called electric current, i.e.
- Electric current, $I = Q/t$
- SI unit of electric current is ampere.
- One ampere of current is that current which flow when one coulomb of electric charge flowing through a particular area of cross-section of the conductor in one second, i.e. $1\text{A} = 1 \text{Cs}^{-1}$.
- The direction of conventional current is A to B, i.e. opposite to the direction of flow of electrons. In a metal, flow of electrons carrying negative charge constitutes the current. Direction of flow of electrons gives the direction of electronic current by convention, the direction of flow of positive charge is taken as the direction of conventional current.
Charge = $q = ne$

$$\text{For } q = 1 \text{ coulomb, } n = \frac{1 \text{ C}}{1.6 \times 10^{-19} \text{ C}} = \frac{10^{19}}{1.6} = 6.25 \times 10^{18} \text{ electrons}$$

16. What is meant by electrical resistivity of a material? Derive its S.I. unit.

Answer. Mathematically, resistivity of the conducting material is given by

$$\rho = R \times A/J$$

$$\text{If } l = 1 \text{ m, } A = 1 \text{ m}^2, \text{ then } \rho = R$$

Hence, the resistivity of the material is defined as the resistance offered by a metallic wire having a unit length and a unit area of cross-section. Since unit length and unit area of cross-section forms a cube, the specific resistance or resistivity can also be defined as the resistance offered by a cube of a material of side 1 m when current flows perpendicularly through the opposite faces. In

SI system, its units is

$$\begin{aligned} \text{Unit of } \rho &= \frac{\text{Unit of } R \times \text{Unit of area of cross - section}}{\text{Unit of length of conductor}} \\ &= \frac{\Omega \times \text{m}^2}{\text{m}} = \Omega\text{m} \end{aligned}$$

17. (a) Write two points of difference between electric energy and electric power. (6) Out of 60 W and 40 W lamps, which one has higher electrical resistance when in use.

(c) What is the commercial unit of electric energy? Convert it into joules.

Answer. (a) Difference between electric energy and electric power:

Electrical energy	Electric power
(i) The work done or energy supplied by the source in maintaining the flow of electric current is called electrical energy. It appears in the form of heat given by $H = VI t = \frac{V^2 t}{R} = I^2 R T$	(i) The time rate at which electric energy is consumed or dissipated by an electrical device is called electric power and is given by $P = VI = \frac{V^2}{R} = I^2 R$
(ii) It is equal to the product of power and time i.e. $E = P \times t$	(ii) It is equal to the rate of doing work by an energy source i.e. $P = \frac{W}{t}$
(iii) Its SI unit is joule (J) $1 \text{ J} = 1 \text{ W} \times 1 \text{ s}$	(iii) Its SI unit is watt (W) $1 \text{ W} = 1 \text{ J s}^{-1}$

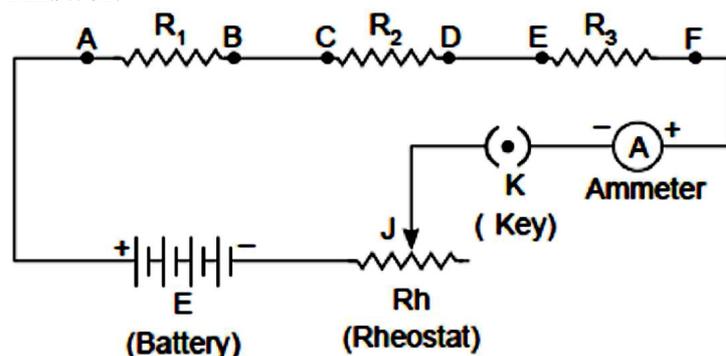
i.e. less the power of electrical device, higher is its electrical resistance.

(c) Kilowatt hour – Commercial unit of electrical energy

$$\begin{aligned} 1 \text{ kWh} &= 1000 \text{ Wh} = 1000 \text{ J/S} \times 3600 \text{ sec} \\ &= 3600000 \text{ J} = 3.6 \times 10^6 \text{ J} \end{aligned}$$

18. Draw a labelled circuit diagram showing three resistors R_1 , R_2 and R_3 connected in series with a battery (E), a rheostat (Rh), a plug key (K) and an ammeter (A) using standard circuit symbol. Use this circuit to show that the same current flows through every part of the circuit. List two precautions you would observe while performing the experiment.

Answer.



Aim: Same current flows through every part of the above circuit.

Procedure:

Connect ammeters, 'A₁' between B and C, and 'A₂' between D and E.

Adjust the sliding contact of the rheostat initially for a small current.

Note all the ammeter readings. These reading give us current flowing through the resistors R_1 , R_2 and R_3

The current in the circuit is now increased by changing the position of sliding contact J' of the rheostat.

Note all the ammeter readings each time.

Conclusion: Same reading of all the ammeter in each observation concluded that same current flows through every part of the circuit.

Precautions:

All the connection should be tight and properly connected as per circuit diagram.

The positive terminal of the ammeter and voltmeter must be connected to the positive terminal of the battery or battery eliminator.

19. **State Ohm's law. Write the necessary conditions for its validity. How is this law verified experimentally? What will be the nature of graph between potential difference and current for a conductor? Name the physical quantity that can be obtained from this graph.**

Answer. Ohm's law : When the physical conditions such as temperature etc. remain same, the current flowing through the conductor is directly proportional to the potential difference applied across the ends of the conductor, i.e.,

$$I \propto V \text{ or } V \propto I$$

$$\Rightarrow \frac{V}{I} = \text{constant}$$

$$\Rightarrow V = IR$$

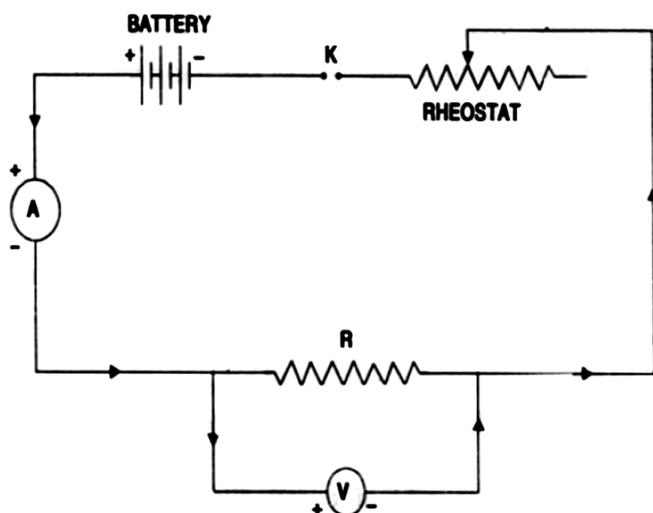
where R is constant of proportionality and is called resistance of the wire.

Necessary condition for validity of Ohm's law is that physical condition such as temperature of the conductor remains same.

Procedure:

Experiment to verify ohm's law

Procedure : 1. Connect the various components as.

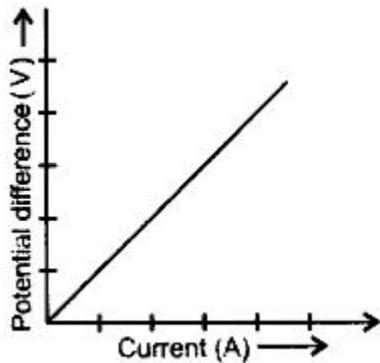


2. Close the key, so that current begins to flow in the circuit.
3. Note down the potential difference (V) across the conductor PQ of resistance R shown by the voltmeter and the corresponding current (I) shown by the ammeter.
4. Now move the knob of rheostat so that the current in the circuit increases.
5. Again note down the potential difference (V) across the conductor R in the voltmeter and current in the circuit shown by ammeter.
6. Repeat the experiment five times by increasing the current in the circuit by moving the knob of the rheostat in steps.

S. No.	Potential Difference (V)	Current (I)	V/ I
1			
2			
3			
4			

The value of $V/I = R$ (constant)

Plot a graph between V and I by taking V along X- axis along. We get a straight line passing through origin.



Conclusion : From the graph between V and I, we conclude that $I \propto V$, which is Ohm's law. Hence Ohm's law is verified experimentally.

Ohm's law does not hold under all conditions. Ohm's law does not hold for non-ohmic material such as electrolyte.

20. (a) Define electric power. Express it in terms of potential difference V and resistance R.
 (b) An electrical fuse is rated at 2 A. What is meant by this statement?
 (c) An electric iron of 1 kW is operated at 220 V. Find which of the following fuses that respectively rated at 1 A, 3 A and 5 A can be used in it.

Answer.

(a) Electric power: It is the rate of doing work by an energy source or the rate at which the electrical energy is dissipated or consumed per unit time in the electric circuit is called electric power.

$$\begin{aligned} \text{So, Power } P &= \frac{\text{Work done } (w)}{\text{Time } (t)} \\ &= \frac{\text{Electrical energy dissipated}}{\text{Time } (t)} \\ &= VI = \frac{V^2}{R} \end{aligned}$$

(b) It means, the maximum current will flow through it is only 2 A. Fuse wire will melt if the current exceeds 2 A value through it.

(c) Given: $P = 1 \text{ kW} = 1000 \text{ W}$, $V = 220 \text{ V}$

$$\text{Current drawn, } I = \frac{P}{V} = \frac{1000}{220} = \frac{50}{11} = 4.54 \text{ A}$$

To run electric iron of 1 kW, rated fuse of 5 A should be used.

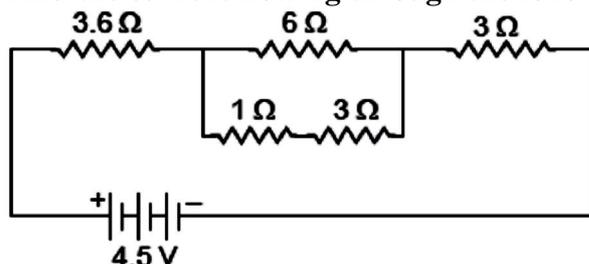
21. Write relation between heat energy produced in a conductor when a potential difference V is applied across its terminals and a current I flows through for 't'

Answer. Heat produced, $H = VIt$

22. State difference between the wire used in the element of an electric heater and in a fuse wire.

Answer. The wire used in the element of electric heater has a high resistivity and have a high melting point, i.e. even at a high temperature element do not burn while fuse wire have a low melting point and high resistivity.

23. Find the current flowing through the following electric circuit.



Answer.

Series combination of $1\ \Omega$ and $3\ \Omega$ resistance is in parallel combination with $6\ \Omega$. Their equivalent resistance is

$$\frac{1}{R_p} = \frac{1}{6} + \frac{1}{3+1} = \frac{1}{6} + \frac{1}{4} = \frac{2+3}{12}$$

$$\therefore R_p = \frac{12}{5} = 2.4\ \Omega$$

Now, $3.6\ \Omega$, $2.4\ \Omega$ and $3\ \Omega$ are in series, their equivalent resistance be

$$\begin{aligned} R_s &= R_1 + R_2 + R_3 \\ &= 3.6 + 2.4 + 3 = 9\ \Omega \end{aligned}$$

Hence, the current flowing through the circuit is

$$I = \frac{V}{R} = \frac{4.5}{9} = \frac{45}{90} = \frac{1}{2} = 0.5\ \text{A.}$$

24. An electric bulb of resistance $200\ \Omega$ draws a current of 1 Ampere. Calculate the power of the bulb the potential difference at its ends and the energy in kWh consumed burning it for 5h.

Answer. Power of the bulb,

Power of the bulb,

$$P = I^2 R = (1)^2 \times 200$$

$$\Rightarrow P = 200\ \text{W}$$

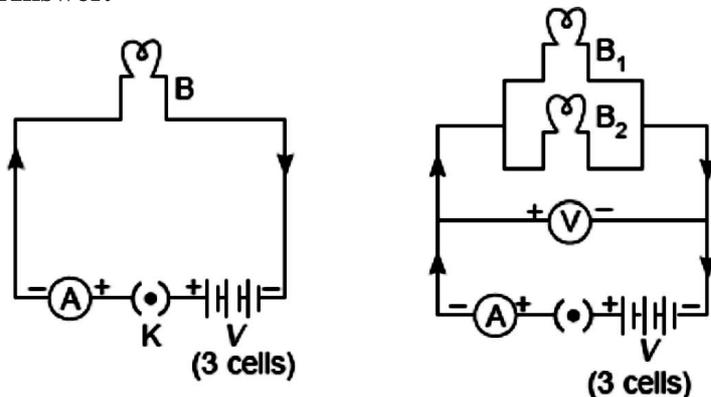
Energy consumed by bulb in 5h in burning = Power \times Time

$$= 200 \times 5$$

$$= 1000\ \text{Wh} = 1\ \text{kWh}$$

25. Draw a schematic diagrams of an electric circuit comprising of 3 cells and an electric bulb, ammeter, plug-key in the ON mode and another with same components but with two bulbs in parallel and a voltmeter across the combination.

Answer.



26. Explain the role of fuse in series with any electrical appliance in an electric circuit. Why should a fuse with defined rating for an electric circuit not be replaced by one with a larger rating?

Answer. Fuse wire is a safety device connected in series with the live wire of circuit. It has high resistivity and low melting point. It melts when a sudden surge of large current passes through it and disconnects the entire circuit from the electrical supply. But, in case if we use a larger rating instead of a defined rating, then it will not protect the circuit as high current will easily pass through it and it will not melt.

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

Answer.

Given: $P_1 = 60 \text{ W}$, $V_1 = 240 \text{ V}$, $R = ?$, $P_2 = ?$, $V_2 = 192 \text{ V}$, $I_1 = ?$

Using, $P_1 = \frac{V_1^2}{R}$

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

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

Current drawn by bulb at 192 V is

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

Current drawn by bulb at 192 V is

28. The charge possessed by an electron is 1.6×10^{-19} coulombs. Find the number of electrons that will flow per second to constitute a current of 1 ampere.

Answer.

Given: $q = 1.6 \times 10^{-19} \text{ C}$, $I = 1 \text{ A}$, $n = ?$, $t = 1 \text{ s}$

We know, $q = It$ and $q = ne$

$$\therefore ne = It$$

$$\Rightarrow n = \frac{It}{e} = \frac{1 \times 1}{1.6 \times 10^{-19}}$$

$$= 6.25 \times 10^{18} \text{ electrons}$$

29. Two devices of rating 44 W, 220 V and 11 W, 220 V are connected in series. The combination is connected across a 440 V mains. The fuse of which of the two devices is likely to burn when the switch is ON? Justify your answer.

Answer.

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

$$R_1 = \frac{V^2}{P_1} = \frac{220 \times 220}{44} = 1100 \Omega$$

$$R_2 = \frac{V^2}{P_2} = \frac{220 \times 220}{11} = 4400 \Omega$$

Equivalent resistance in series

$$R_s = R_1 + R_2 = 1100 + 4400 = 5500 \Omega$$

Current, $I = \frac{V}{R_s} = \frac{440}{5500} = 0.08 \text{ A}$

According to Joule's law of heating

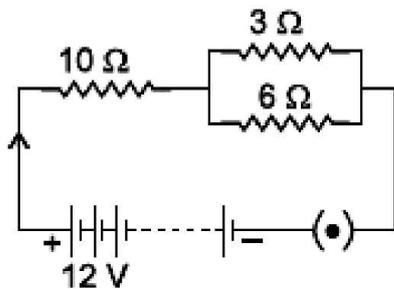
$$H_1 = I^2 R_1 t \\ = (0.08)^2 \times 1100 \times 1 = 7.04 \text{ J}$$

$$H_2 = I^2 R_2 t \\ = (0.08)^2 \times 4400 \times 1 = 28.16 \text{ J}$$

$$\Rightarrow H_2 > H_1$$

30. Consider the circuit shown in the diagram. Find the current in 3Ω resistor.

Answer. 3 Ω and 6 Ω are in parallel.



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

$$\therefore R_p = 2 \Omega$$

R_p and 10Ω are connected in series. So,

$$R_s = R_p + R_3 = 2 + 10 = 12 \Omega$$

Total current in the circuit,

$$I = \frac{V}{R_s} = \frac{12}{12} = 1 \text{ A}$$

Potential difference across, $R_p = IR_p = 1 \times 2 = 2 \text{ V}$

So, Potential difference across, $3 \Omega = 2 \text{ V}$

Current through 3Ω , $I_1 = \frac{V}{R_1} = \frac{2}{3} = 0.67 \text{ A}$

31. Series arrangements are not used for domestic circuits. List any three reasons.

Answer. Series arrangements are not used for domestic circuit because

The electrical appliances need current of widely different values to operate properly.

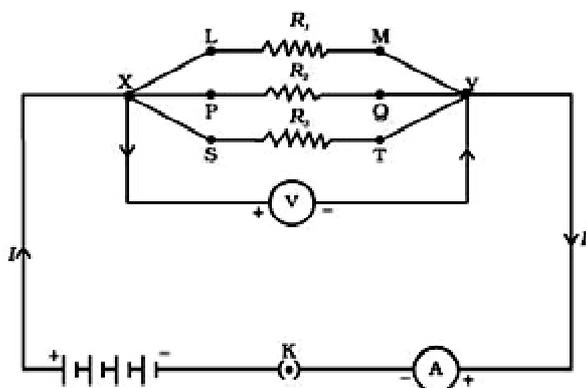
In series arrangement, when one component fails, the circuit is broken and none of the components works.

All electrical appliances work at a constant voltage. But in series circuit, the current is constant throughout the electric circuit and potential is different across the different components. So, series arrangement is not suitable for domestic circuits.

32. Explain with the help of a labelled circuit diagram, how will you find the resistance of a combination of three resistors, of resistance R_1 , R_2 and R_3 joined in parallel. Also mention how will you connect the ammeter and the voltmeter in the circuit while measuring the current in the circuit and the potential difference across one of the three resistors of the combination.

Answer. Parallel Combination:

Connect the three given resistor R_1 , R_2 and R_3 in parallel between the point XY with a battery, a plug key and ammeter in series as shown in figure.



Connect voltmeter in parallel with these resistors between the terminals X and Y.

Close the key and note the ammeter and voltmeter reading. Ammeter shows the total current drawn by the parallel combination of these resistors while voltmeter shows the voltage applied across the combination.

Using Ohm's law, find the equivalent resistance of the combination, i.e. equivalent resistance,

$$R = \frac{\text{Voltmeter reading}}{\text{Ammeter reading}}$$

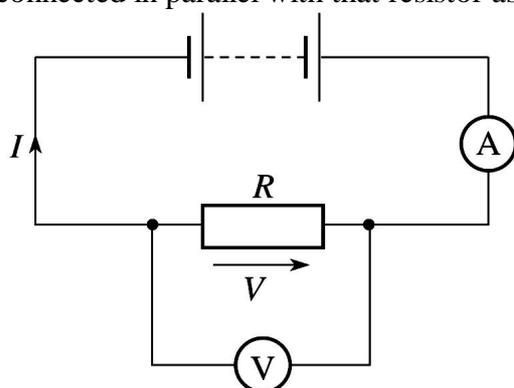
Thus, in parallel circuit,

$$I = I_1 + I_2 + I_3$$

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

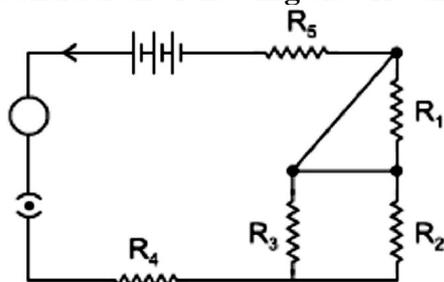
$$\Rightarrow \frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

To find the current flow through any one of the resistor, ammeter will be connected in series with that resistor and to measure the potential difference across that resistor, voltmeter must be connected in parallel with that resistor as shown.



33. Deduce the expression for the equivalent resistance of the parallel combination of three resistors R_1 , R_2 and R_3

Consider the following electric circuit:



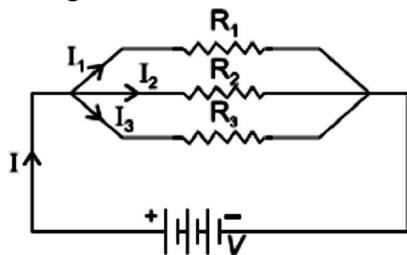
(a) Which two resistors are connected in series?

(b) Which two resistors are connected in parallel?

(c) If every resistor of the circuit is of 2Ω , what current will flow in the circuit?

Answer. Consider the following parallel circuit shown below: Let I_1 , I_2 and I_3 be the current flow through the resistor R_1 , R_2 and R_3 connected in parallel.

Using Ohm's law, current through each resistor is



[Parallel circuit]

$$I_1 = \frac{V}{R_1}, I_2 = \frac{V}{R_2} \text{ and } I_3 = \frac{V}{R_3}$$

Let their equivalent resistance be R_p then

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

Total current through the circuit is

$$I = I_1 + I_2 + I_3$$

or $\frac{V}{R_p} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$

or $\frac{V}{R_p} = V \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \right)$

or $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

(a) R_5 and R_4 with Parallel combination of R_2 and R_3 are in series

(b) R_2 and R_3 are in parallel.

(c) R_2 and R_3 in parallel gives $R_p = 1 \Omega$

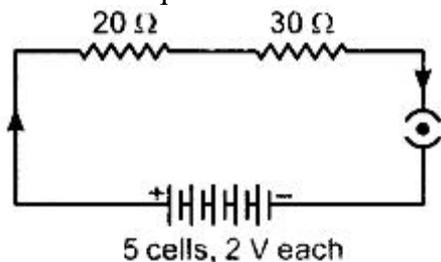
R_p , R_5 and R_4 are in series. So, $R_{eq} = 5 \Omega$

R_1 is not to be taken as it is shorted.

Current flowing, $I = \frac{V}{R} = \frac{5}{5} = 1A$

34. Draw a schematic diagram of an electric circuit consisting of a battery of five 2 V cells, a 20 Ω resistor, a 30 Ω resistor, a plug key, all connected in series. Calculate the value of current flowing through the 20 Ω resistor and the power consumed by the 30 Ω resistor.

Answer. $R_{eq} = 20 + 30 = 50 \Omega$



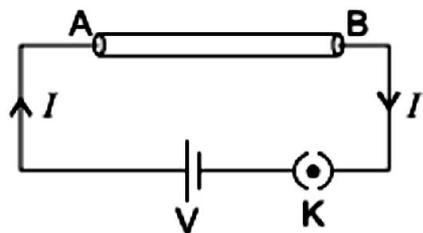
Here, $V = 5 \times 2 V = 10V$, Total Resistance, $R = 20\Omega + 30\Omega = 50\Omega$

Current through both 20 Ω and 30 $\Omega = I = V/R = 10/50 A = 0.2 A$

Power consumed by 30 $\Omega = I^2R = (0.2)^2 \times 30 = 1.2W$

35. Derive the expression for the heat produced due to a current I flowing for a time interval 't' through a resistor 'R' having a potential difference 'V' across its ends. With which name is the relation known? How much heat will an instrument of 12 W produce in one minute if it is connected to a battery of 12 V?

Answer. Heat produced in a conductor: Consider a wire AB having a resistance 'R' connected across the terminals of a cell. Let V be the potential difference applied by cell across the ends of a wire.



Let W be the work done in carrying the charge q across the conductor, then

$$V = \frac{W}{q} \text{ or } W = V \times q \quad (i)$$

but

$$q = I \times t$$

So,

$$W = V \times It \quad (ii)$$

This work done will appear in the form of heat produced in the wire, i.e.

$$H = VIt \quad (iii)$$

Using Ohm's law, $V = IR$

$$\text{So, } H = (IR) It = I^2Rt$$

This is the expression for the heat produced in the wire. This is called Joule's law of heating.

Heat produced in one minute

$$H = P \times t = 12 \text{ W} \times 60 \text{ s} = 720 \text{ J}$$

36. A piece of wire of resistance 20Ω is drawn out so that its length is increased to twice its original length. Calculate the resistance of the wire in the new Situation.

Answer.

$$\text{Using, } R = \frac{\rho l}{A},$$

$$\text{We have, } \frac{R_1}{R_2} = \frac{l_1}{A_1} \cdot \frac{A_2}{l_2}$$

$$\text{Given: } l_2 = 2l_1$$

Volume of material will be conserved.

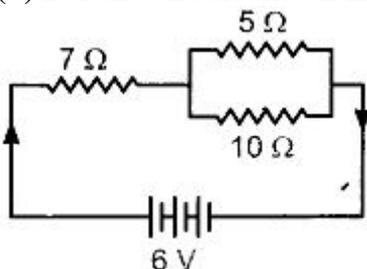
$$\text{So, } A_1 l_1 = A_2 l_2$$

$$\therefore \frac{A_1}{A_2} = \frac{l_2}{l_1} = 2$$

$$\frac{R_1}{R_2} = \frac{l_1}{l_2} \cdot \frac{l_1}{l_2} = \frac{l_1^2}{l_2^2} = \frac{1}{4}$$

$$\therefore R_2 = 4R_1 = 80 \Omega$$

37. (a) Two resistors R_1 and R_2 may form (i) a series combination or (ii) a parallel combination, and the combination may be connected to a battery of 6 volts. In which combination, will the potential difference across R_1 and across R_2 be the same and in which combination, will the current through R_1 and through R_2 be the same?
 (b) For the circuit shown in this diagram, calculate



- (i) the resultant resistance.
 (ii) the total current.
 (iii) the voltage across 7Ω resistor.

Answer. (a) Potential difference across R_1 and R_2 is same in parallel combination of R_1 and R_2

and the current through R_1 and R_2 will be same when they are connected in series.

(b) (i) 5Ω and 10Ω are in parallel.

$$\text{So, } \frac{1}{R_1} = \frac{1}{5} + \frac{1}{10} = \frac{10+5}{50} = \frac{15}{50}$$

$$\Rightarrow R_1 = \frac{50}{15} \Omega = 3.33 \Omega$$

Since, 7Ω is in series with R_1

$$\begin{aligned} R_{eq} &= R_1 + 7 \\ &= 3.33 + 7 = 10.33 \Omega \end{aligned}$$

$$(ii) \text{ Total current drawn} = \frac{V}{R_{eq}}$$

$$I = \frac{6}{10.33} = 0.58 \text{ A}$$

$$(iii) \text{ Voltage across } 7 \Omega \text{ resistor} = I \times 7 = 0.58 \times 7 = 4.06 \text{ V}$$

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