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Electricity

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Electricity

It is controllable and convenient form of energy for a variety of uses in home, schools, hospitals, industries, and so on.

Electric Charge

It is the property associated with the matter due to which it shows some definite effect like electric field, magnetic field, and electromagnetic field.

Properties

- Electric charge is a scalar Quantity.
- Electric charge is quantised.
- Electric charge is invariant.
- Net charge can neither be created nor be destroyed it can remain constant.

Electric Field

The space around a given charge in which another charge can experience the force of attraction or repulsion.

Electric Current

When an electric charge is free to move in an electric field, it starts moving in the direction of force due to field.
The dynamic state of electric charge is called electric current.

$I = q/t$ Ampere = coulomb/ second

→The S.I unit of current = Ampere
→The S.I unit of electric charge = coulomb

1 Ampere: It is constituted by the flow of one coulomb of charge per second.

*1 milliamperes $=10^{-3}$A
*1 micro-ampere$=10^{-6}$A
*Charge on $e^-=-1.6\times10^{-19}$C
*1 coulomb contained = 6.25×10^{18}electron
*Drift speed = 1mm/S

Drift Speed

A steady current flow through a conductor, the electron in it move with a certain average, it is drift speed.

Electric current

A continuous and closed path of an electric current.

Electric current was considered to be flow of positive charge and the direction of flow of positive charge was taken to be the direction of electric current.

Ammeter measure electric current and it is connected in series.
Voltmeter measure potential difference and it is connected in parallel.

Electric potential

Electric potential at a point is defined as the work done required in moving a unit charge from infinity to that point. →किसी भी charge को किसी भी point पे ले जाने मे जो energy लगती है वही उसका potential है।

Electric potential difference

It is defined as the work done required to move a unit positive charge from one point to another.

$V=W/q$ volt=joule/coulomb

➔The S.I unit of electric potential difference is volt (v).

1 volt: It is a potential difference between two points in a current carrying conductor when 1 joule of work is done to move a charge of 1 coulomb from one point to the other.

Ohms Law

If the physical condition of the conductor remain unchanged, the ratio of potential difference to the flowing current remain constant. i.e. V/I= constant

➔The V-I graph is a straight line.

V/I is a constant ratio.

$V \propto I$

$V = RI$

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

Resistance

It is the property of a conductor to resist the flow of charges.

➔The S.I unit of resistance is ohm(Ω).

1 Ohm: If the potential difference across the two end of a conductor in 1V and the current through it is 1A, then the resistance 'R' of the conductor is 1Ω.

- Current through a resistor is inversely proportional to its resistance.
- A component used to regulate current without changing the voltage source is called **variable resistance.**
- **Rheostat** is used to change the resistance.
- A conductor having some appreciable resistance is called a **resistor**.

The resistance of a conductor depends on

- On its length
- On its area of cross-section
- On the nature of its material

$R \propto l$

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

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

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

Note Resistivity doesn't depend on any of these (MCQ में फसना मत)

{ρ = rho}

ρ(rho) is a constant of proportionality and is called the electrical resistivity of the material of the conductor.

➔The S.I unit of resistivity is Ω/m.

- The metals and alloy have very low resistivity in the range of 10^{-8}m to 10^{-6}m.
- Insulator have resistivity 10^{12} to 10^{17}m.
- Resistance and resistivity of a material vary with temperature.

Alloy do not oxidise (burn) readily at high-temperature that's why they are commonly used in electrical heating device.

Nichrome –> Nickel, chromium, manganese and iron metal.

P.Y.Qs

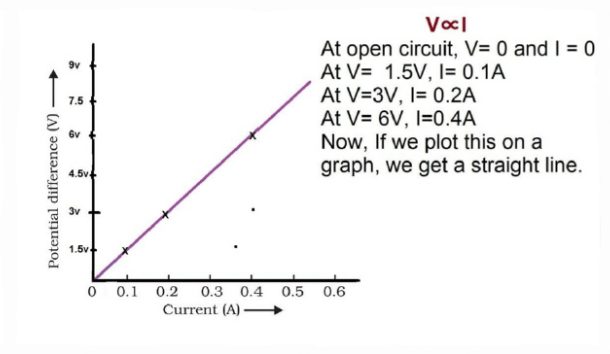
Question: Elements of electric toasters and electric iron are made of an alloy rather than a pure metal. Give two reason to justify the statement.

Answer: (a)Alloys do not oxidise readily at high-temperature, so they are more resistance to corrosion.
(b) Alloys have lower electrical conductivity than pure metals.

activity 12.1

Calculate the ratio of V to I for each pair of potential difference V and current I.
Plot a graph between V and I, and observe the nature of the graph.

On increasing the potential difference across a resistance we see an increase in the current, it proves that V∝I
i.e. Ohm's law.



V∝I
At open circuit, V= 0 and I = 0
At V= 1.5V, I= 0.1A
At V=3V, I= 0.2A
At V= 6V, I=0.4A
Now, If we plot this on a graph, we get a straight line.

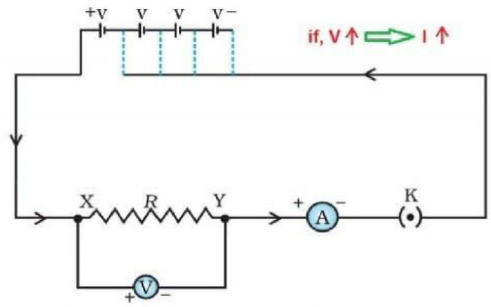


Figure 12.2 Electric circuit for studying Ohm's law

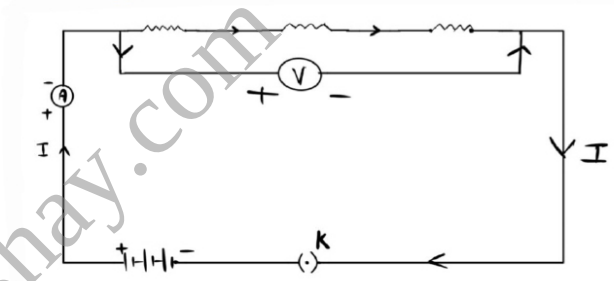
Resistor in series

value of current in the ammeter is the same.
voltage is not same v=v₁+v₂+v₃.....

Now $V = V_1 + V_2 + V_3$
$V = IR$; $V = IR_1$; $V = IR_2$; $V = IR_3$
from (1) $IR = IR_1 + IR_2 + IR_3$
$IR = I(R_1 + R_2 + R_3)$
$R = R_1 + R_2 + R_3$

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

⇒ Current Same रहेगी



Requivalent: If the combination of a resistance are replaced by a single resistance such that same current flows from the same voltage.

In series - device are connected end to end

Resistor in Parallel

Value of volt in the voltage is same
Current is not the same $I = I_1 + I_2 + I_3$...

Now $I = I_1 + I_2 + I_3$

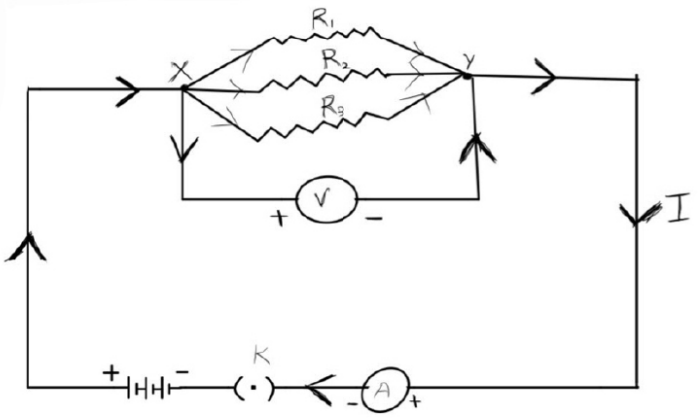
$I = \frac{V}{R}$; $I_1 = \frac{V}{R_1}$; $I_2 = \frac{V}{R_2}$; $I_3 = \frac{V}{R_3}$

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

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

$$R_{eq} = \frac{R_1 R_2 R_3}{R_2 R_3 + R_1 R_3 + R_1 R_3}$$

⇒ Voltage Same रहेगी



Disadvantage of series connection

- In series connection when one component fail the circuit is broken and a none of the component works.
- It is impracticable to connect an electric devices in series, because they need currents wildly different value to operate properly.

Advantage of parallel connection

- A parallel circuit divides the current through the electrical gadgets.
- The total resistance in a parallel circuit is decreased.

P.Y.Qs

Question: Calculate the resistance of a metal wire of length 2m and area of cross-section $1.55\times10^{-6}m^2$, if the resistivity of the metal be $2.8\times10^{-8}\Omega m$?

$$R=\frac{\rho l}{A}=\frac{2.8\times10^{-8}\times2}{1.55\times10^{-6}}$$

$$=\frac{2.8\times2\times10^{-8-(-6)}}{1.55}$$

$$=\frac{2.8\times2}{1.55}\times10^{-2}=0.036\Omega.$$ Ans

P.Y.Qs

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

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

$$I_2=\frac{V}{R_2}=\frac{220V}{100\Omega}=2.2\ Amp.$$ Ans

Activity 12.2

Are the ammeter readings different for different components connected in the gap XY? What do the above observations indicate?

Observe the ammeter readings in each case. Analyse the observations.

Electric current flows through a component depending upon the resistance of the component. We use different components in the gap XY such as nichrome wire, torch bulb, and 10W bulb. conductivity is different for different materials.

since V is constant in the case so according to Ohm's Law

V=IR

so current I become inversely proportional to resistance R

conclusion: Different materials show different conductance or resistance.

P.Y.Qs

Question: What is mean by resistance of a conductor? Name and define its SI unit. list the factors on which the resistance of a conductor depends. How is the resistance of a wire affected

(i) if its length is doubled

(ii) its radius is doubled

Answer: It is a position offered to the flow of current by a conductor.

Ohm, it is the resistance of a conductor to which 1 A current flows under a potential difference of one volt.

The factors are - length, area of cross-section, material temperature.

(i) length is doubled, resistance is double

(ii) radius is doubled, area of cross-section become four times, so resistance become one-fourth.

Heating effect of electric current

If the electric circuit is purely resistive, that is, a configuration of resistors only connected to a battery; the source energy continually gets dissipated entirely in the form of heat. This is known heating effect of electric current.

$P=Vq/t=VI$ $H=Vit$ $H=i^2Rt$ $H=V^2t/R$

The energy required to maintain continuous flow of free e^-(that is electric current) through a conductor is called **electrical energy**.

Joule law of heating

Heat produce in a resistor is
(i) directly proportional to the square of current for a given resistance.
(ii) directly proportional to the resistance for a given current.
(iii) directly proportional to the time for which the current flow through. $H=I^2RT$

Tungsten has high melting point 3380°C, is used for making bulb filament.

Electric power

Rate of consumption of electrical energy is known as **electrical power**.

$$P=VI=I^2R=V^2/R$$

➔The S.I unit of electrical power is watt(w).

1 Watt: It is the power consumed by a device that carries 1A of current when operated at a potential difference of 1 watt.

1KW = 1000W

1Wh: One watt hour is the energy consumed when 1 watt of power is used for 1hr.

commercial unit of energy = electrical energy is kwh,

1KWH= 1000W × 3600 Sec.

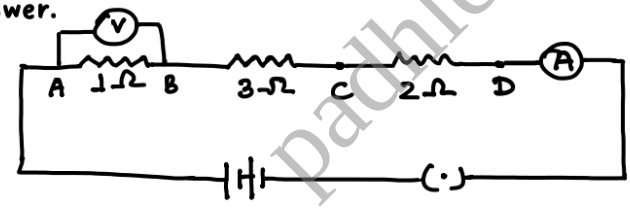
$=3.6\times10^6$ Watt second

$=3.6\times10^6$ joule (j).

⇒ 1 calorie = 4.2 j (approx)

P.Y.Qs

Question: How would the reading of voltmeter(V) change if it is connected between B and C? justify your answer.



$R=R_1+R_2+R_3=1+2+3=6\ \Omega$

$V=IR$

$I=\frac{V}{R}=\frac{3}{6}=\frac{1}{2}A$

Voltage across 1Ω, $V=IR=\frac{1}{2}\times1=0.5V$

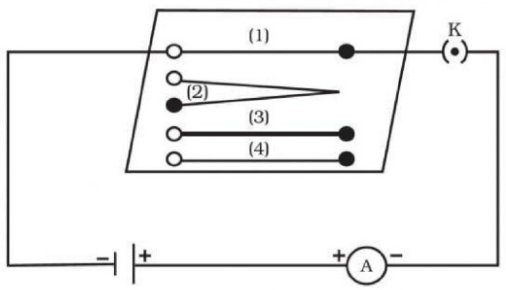
Voltage across 3Ω, $V=IR=\frac{1}{2}\times3=1.5V$

activity 12.3

Does the current depend on the length of the conductor?
Does the current depend on the area of cross-section of the wire used?

Ammeter (current) reading varies inversely with the change in length of the wire. **For example**, if we double the length of the wire, the current reduces to half.

Ammeter reading changes with the change in the thickness of the wire. **For example**, if we increase the cross-sectional area of a wire by double, its resistance will be halved

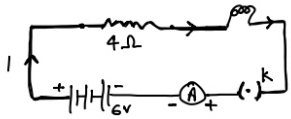


(Ammeter reading changes with length and thickness of the resistance wire)

Case 1: Wire of length l, Case 2: Wire of length 2l,
Case 3: Wire of double thicness,
Case 4: Wire of thickness halved.

P.Y.Qs

Question: An electric lamp of resistance 20Ω and a conductor of resistance 4Ω are connected to a 6 V battery as shown in the circuit. Calculate:
(a)the total resistance of the circuit,
(b)the current through the circuit,
(c)the potential difference across the (i) electric lamp and (ii)conductor,and
(d)power of the lamp



(a) Here Conductor and lamp are in series
$R_{eq} = R_1 + R_2$
$R_{eq} = 4 + 20 = 24\Omega$

(b) $I = \frac{V}{R_{eq}}$; $I = \frac{6}{24} = 0.25A$

(c) (i) Potential difference across the electric lamp
$V_L = IR_L$
$V_L = 0.25 \times 20$
$V_L = 5$

(ii) Potential difference across the Conductor
$V_c = IR_c$
$V_c = 0.25 \times 4$
$V_c = 1V$

(d) Power of the lamp
$P = \frac{V_L^2}{R_L} = \frac{(5)^2}{20} = \frac{25}{20}$
$P = 1.25\ W$

Series mtlb Current same rahega to vo current kitna rahega
→ Ye hum nikalenge Req se
⇒ $[I = \frac{V}{R_{eq}}]$ se hum nikal lenge I_{eq} (equivalent current)
ab series me itna current har jagah rahega
→ fir hum alag-alag voltage nikal lenge ($V_1 = IR_1$; $V_2 = IR_2$ ... $V_n =$)
→ $P = \frac{V^2}{R}$

Activity 12.4

Do you find any change in the value of current through the ammeter.
Reading of ammeter remains constant irrespective of the position.

Examplar

1-Electrical resistivity of a given metallic wire depends upon
(a) its length
(b) its shape
(b) its thickness
(d) nature of the material
Ans-d

2-What is the maximum & minimum resistance which can be made using five resistors each of 1/5 respectively?
(a) 1/5 & 1/10Ω
(b) 5 & 1/5 Ω
(c) 10 &25 Ω
(a) 1 & 1/25 Ω
Ans-d

⇒ resistor ko agar hum lagayenge
- Series → maximum resistance ~~मिलेगा~~
- Parallel → minimum resistance ~~मिलेगा~~

3-If the current I through a resistor is increased by 100% (assume that temperature remains unchanged), the increase in power dissipated will be
(a) 100%
(b) 300%
(c) 200%
(a) 400%
Ans-b

4-In an electrical circuit three incandescent bulbs A, B, and C of rating 40W, 60W, and 100W, respectively are connected in parallel to an electric source. Which of the following is likely to happen regarding their brightness?
(al Brightness of all the bulbs will be the same.
(b) Brightness of bulb A will be the maximum.
(C) Brightness of bulb B will be more than that of A.
(d) Brightness of bulb C will be less than that of B.
Ans-C

5-Should the resistance of an ammeter be low or high? Give reason.
Answer: It should be as close to zero as possible. Ideally it should be zero ohm. If it is non-zero and substantial it will affect the true current.

6-State Ohms law? Does it hold good under all conditions? Comment.
Answer: Ohm's law states that at constant temperature, the current flowing through a conductor is directly proportional to the potential difference across its ends.
Ohm's law does not hold under all conditions. Ohm's Law does not hold for non-ohmic material such as electrolyte.

7-Why is parallel arrangement used in domestic wiring?
Answer: To provide the same potential difference across each electrical appliance. Because if an appliance gets damaged or is turned off the current always has other independent dedicated parallel paths to other appliances and hence every appliance is still works fine.

8-Three incandescent bulbs of 100 W each are connected in series in an electric circuit. In another circuit another set of three bulbs of the same wattage are connected in parallel to the same source.
(a) Will the bulb in the two circuits glow with the same brightness? Justify your answer.
(b) Now let one bulb in both the circuits get fused, Will the rest of the bulbs continue to glow in each circuit? Give reason,
Answer:

Let us assume that resistance of each bulb is R
Case(1)
Current in each bulb = $\frac{V}{3R}$

case (2)
Net current = $\frac{3V}{R}$
Current will get equally divided in three bulbs = $\frac{I}{3} = \frac{V}{R}$

Bulbs in case (2) will glow with great brightness current ∝ Brightness

B) Now I one bulb gets fused, in case (1) rest of bulbs will not glow because in series voltage eruption in one appliance will affect other appliances.
But in case (b) all other bulbs will glow as voltage eruption in one bulb does not affect the voltage of other bulbs.