CURRENT ELECTRICITY

Q # 1. What do you know about electric current?

Ans. Electric Current

The amount of electric charge that flows through a cross section of a conductor per unit time is known as electric current.

If ΔQ is the amount of charge flow through a cross-section in time Δt , then the electric current I is described mathematically as:

$$I = \frac{\Delta Q}{\Delta t}$$

It is a base quantity and its unit is ampere.

Ampere

If one coulomb charge flows through a cross-section of a conductor in one second then the current will be one ampere.

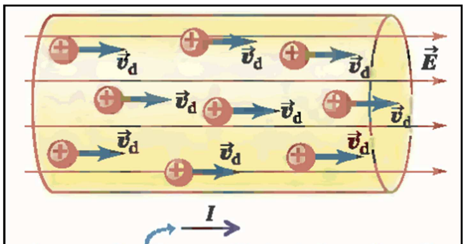
$$1\text{ Ampere} = \frac{1\text{ Coulomb}}{1\text{ second}}$$

Q # 2. Write down a note on the direction of flow of current through any conductor.

Ans. Current direction

Earlier, it was thought that the current flow through a conductor due to positive charges from higher potential to lower potential in any external circuit. But later on, it was found that the flow of current in metallic conductor is due to the flow of electrons from the point of lower potential to the point of higher potential.

But still we also take the direction of flow of current along the flow of positive charges. The reason is that it has been found experimentally that positive charge moving in one direction is equivalent in all external effects to a negative charge moving in opposite direction.



A conventional current is treated as a flow of positive charges, regardless of whether the free charges in the conductor are positive, negative, or both.

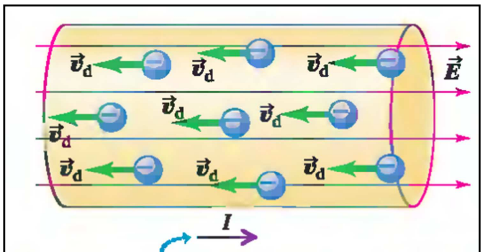
Conventional current

The current flow due to positive charges from a point at higher potential to a point at lower potential is called conventional current.

Q # 3. Describe the effect of electric field on the motion of free electrons.

Ans. All atoms contain free electrons. In the absence of any external electric field, the free electrons are in random motion just like the molecules of gas in a container and the net current through wire is zero.

If the ends of the wire are connected to a battery, an electric field (**E**) will setup at every point with in the wire. Due to electric effect of the battery the electrons will experience a force in the direction opposite to **E**.

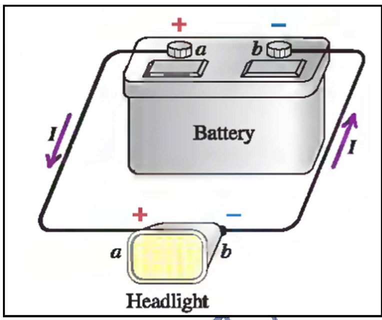


In a metallic conductor, the moving charges are electrons — but the *current* still points in the direction positive charges would flow.

Drift velocity

When electric field is established across the ends of a conductor, the free electrons modify their random motion and drift slowly with a constant velocity in the direction opposite to E. This constant velocity is known as drift velocity.

Q # 4. Write down a note on the sources of current?



Ans. Sources of current

A source which maintains constant potential difference between the ends of the conductor is called sources of current. Source of current converts some non electrical energy (chemical, mechanical, heat or solar energy) to electrical energy.

Examples

i) Cells which convert chemical energy into electrical energy.
ii) Electric generators convert mechanical energy into electrical energy.
iii) Thermo couples convert heat energy into electrical energy.
iv) Solar cells convert light energy into electrical energy.

Q # 5. Describe the effects of current?

Ans. Effects of Current.

The presence of current produces various effects through which it can be detected. Its some effects are given below

i) Heating effect.
ii) Magnetic effect.
iii) Chemical effect.

i) Heating Effect

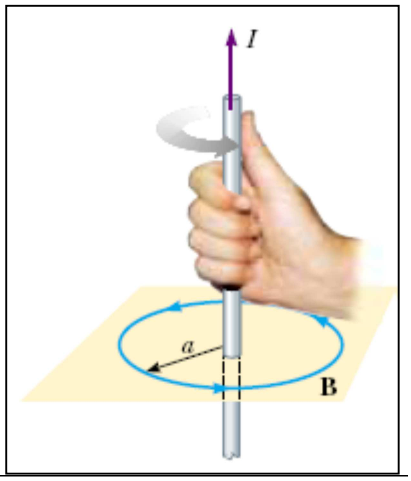
Current flow through a metallic conductor due to the motion of free electrons. During their motion they frequently collide with one another. On each collision they transfer some of their kinetic energy to the atom with which they collide. And these collisions produce heating effect in the wire.

It is found that the heat H produced by the current I in the wire of resistance R during time interval y is given by the expression:

$H = I^2RT$

The heating effect of the current is utilized in electric heaters, kettle, toaster and electric iron etc.

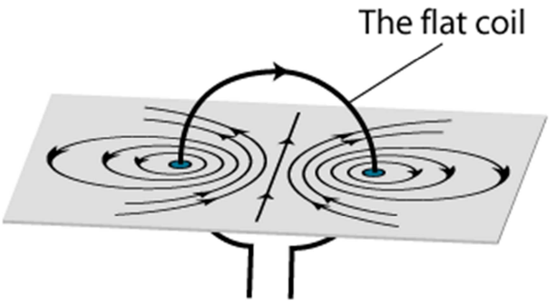
ii) Magnetic Effect



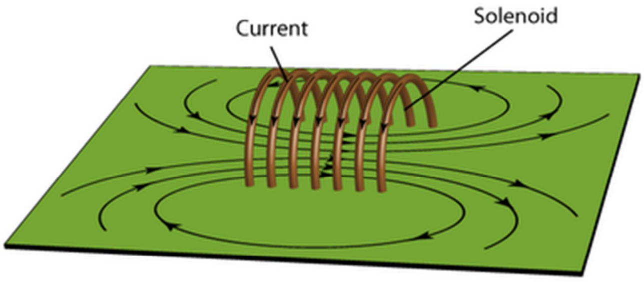
The flow of current always carries magnetic field surrounding it in space. The strength of magnetic field depends upon the value of current and the distance from the element. The pattern of the field produced by a current carrying straight wore, a coil and a solenoid is shown in the figure.

Magnetic effect is used to detect the presence of current.

Moreover, all the machines involving electric motors also use the magnetic effect of current.



Magnetic field pattern generated by a flat coil



Magnetic field generated by a solenoid. The field pattern is resemble a long bar magnet.

iii) Chemical Effect

Certain liquids (such as copper sulphate solution) conduct electricity due to some chemical reaction takes place within them. The study of this process is known as electrolysis. The chemical reaction produced during electrolysis of a liquid are due to chemical effects of current. It depends upon the nature of the liquid and quantity of electricity passed through the liquid.

Example

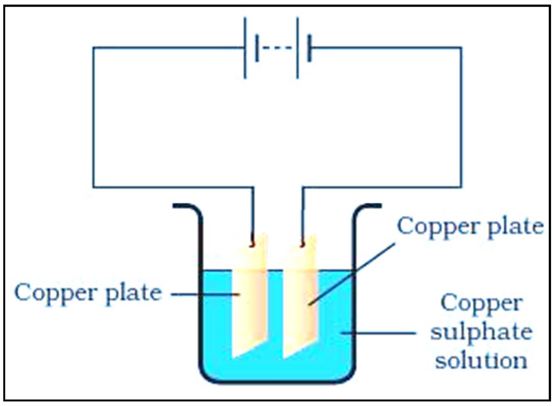
When $CuSO_4$ dissolved in water it dissociates into Cu^{++} and SO_4^{--}. On passing the current the following reaction takes place due to chemical effect of electric current.

At cathode

$$Cu^{++} + 2e^{-1} \rightarrow \quad Cu$$

The copper atoms thus formed are deposited at the cathode plate. While copper is being deposited at the cathode, the SO_4^{--} ions move towards the anode. Copper atoms from anode go into the solution as copper atoms combine with sulphate ions to form copper sulphate:

$$Cu^{++} + SO_4^{--} \rightarrow CuSO_4$$



As the electrolysis proceeds, copper is continuously deposited on the cathode, while an equal amount of copper dissolved into the solution and the density of copper sulphate solution remains unaltered.

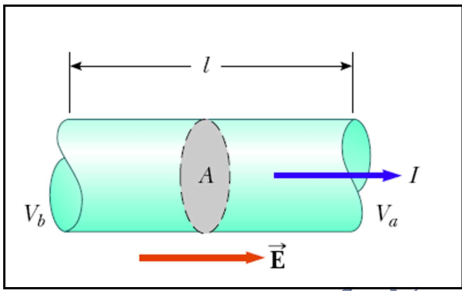
Electroplating

A process of coating a thin layer of some expensive metal (gold, silver etc) on an article of some cheap metal is called electroplating.

Q # 6. Define Ohm's law.

Ans. Ohm's law

It states that "the current flowing through a conductor is directly proportional to the applied potential difference if all physical states remain same."



Mathematically it is expressed as

$$V \propto I$$

$$V = R\ I$$

Where R(resistance) is the constant of proportionality.

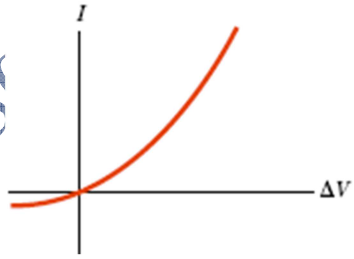
Resistance

The opposition against the flow of current is known as resistance. The SI unit of resistance is Ohm. Mathematically, it is described as:

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

Q # 7. What do you know about the Non-Ohmic devices?

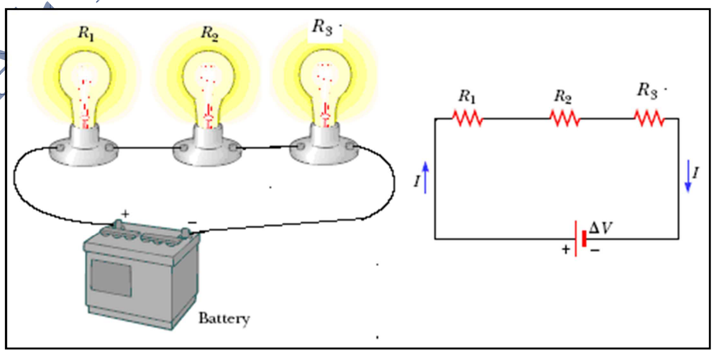
Ans. Those devices which don't the Ohm's law are called non Ohmic devices. The current-voltage graph of non-ohmic devices is not a straight line. The example of non ohmic devices are filament bulb and semi-conductor diodes.



Q # 8. Write down a short note on series and parallel combination of resistances?

Series combination of resistances

If the resistances are connected end to end this kind of combination of resistances is known as series combination of resistances.



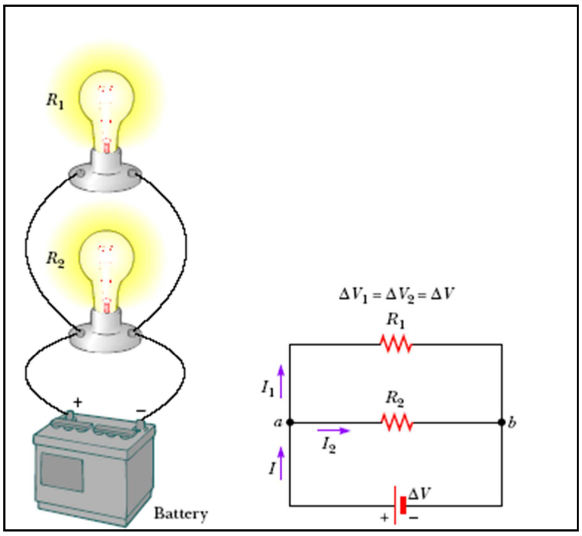
In this type of combination the voltage divides itself but current through each resistance remain same.

And the equivalent resistance is given by

$$R_e = R_1 + R_2 + R_3$$

Parallel Combination of Resistances

If resistances are connected in such a way that their ends are joined at two points this kind of combination is known as parallel combination of resistances.



In this type of combination the voltage across each resistance remain same but current divides it self.

And the equivalent resistance R_e can be find out by using expression:

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

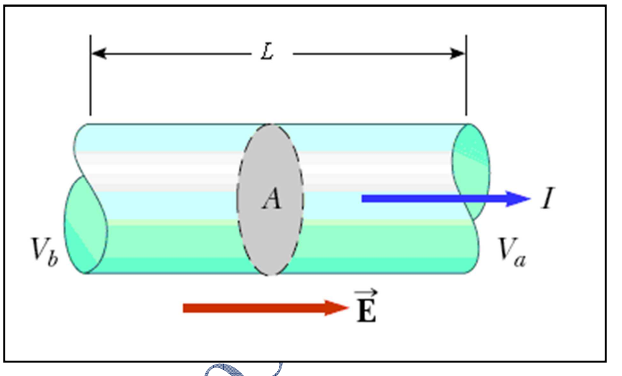
Q # 9. Define resistivity and derive its expression? Also describe the effect of temperature on the resistivity of conductor.

Ans. Resistivity

The resistance of a meter cube of material is called its resistivity.

Expression

The resistance of the wire is directly proportional to the length of the wire (L) and inversely proportional to the cross sectional area (A).



Mathematically, it is described as:

$R \propto L$ ---------- (1)

$R \propto \frac{1}{A}$ ---------- (2)

Combining (1) & (2), we get:

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

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

And the value of ρ is

Where ρ is constant of proportionality known as Resistivity.

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

Its unit is Ohm meter.

Effect of temperature on resistivity of conductor

The resistance offered by a conductor to the flow of electric current is due to collisions which the free electrons encounter with atoms of the lattice. As the temperature of the conductor rises, the amplitude of vibration of atoms increases and hence the probability of their collision with free electrons also increases which result increase of resistance of conductor.

Q # 10. Write a note on

i) **Temperature Coefficient of Resistance**

ii) **Temperature Coefficient of Resistivity**

Ans. Temperature Coefficient of Resistance

The fractional change in resistance per Kelvin is known as the temperature coefficient of resistance. It is denoted by symbol α and is described mathematically as:

$$\alpha = \frac{R_t - R_0}{R_0 t}$$

where R_0 is the resistance of the conductor at 0^0C and R_t is the resistance at t^0C.

Temperature Coefficient of Resistivity.

The fractional change in resistivity per Kelvin is known as the temperature coefficient of resistivity.

Temperature coefficient of resistivity $\alpha = \frac{\rho_t - \rho_0}{\rho_0 t}$

ρ_o = resistance of conductor at 0^oc

ρ_t = resistance of conductor at t^oc

Q # 11. Write a note on carbon resistor?

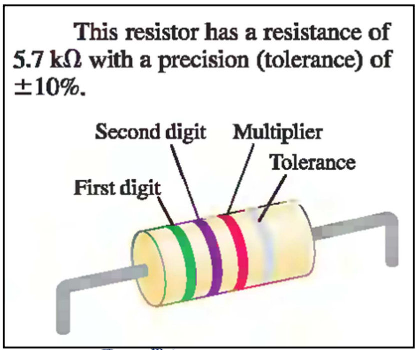
Ans.

Carbon resistors

Carbons resistors consist of high grade ceramic rod, on which a thin resistive film of carbon is deposited. The numerical value of their resistance is indicated by the color code which consist of bands of different colors printed on the body of the conductor.

Usually, the code consist of four bands, which are interpreted as:

- The first band indicates the first digit in the numerical value of the resistance.
- The second band gives the second digit of numerical value.
- The third band is decimal multiplier i.e., it gives the number of zeros after the first two digits.
- The fourth band gives resistance tolerance.



Q # 12. What do you know about rheostat. Also describe its construction.

Ans. It is wire wounded variable resistor. It is consist of an insulating cylinder on which a manganin wire is wounded over an insulating cylinder. The ends of the wire are connected to two fixed terminals (A and B). A third terminal is attached to a sliding contact which can which can be moved over the wire.

Q # 13. Describe the working of a Rheostat as

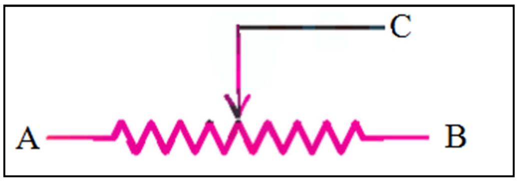
i) Variable Resistor

ii) Potential Divider

Ans.

Rheostat as variable resistor

Rheostat can be used as a variable resistor. For this purpose, one of its fixed terminal A and the sliding terminal C is inserted in the circuit. If sliding contact C move towards terminal A then the resistance involved in the circuit decreases, if it moves towards B then the resistance involved in the circuit increases.



Rheostat as potential divider

To use rheostat as potential divider, potential difference V is applied across the fixed ends A and B of rheostat with the help of a battery. If R is the resistance of the wire AB, the current I passing through is given by:

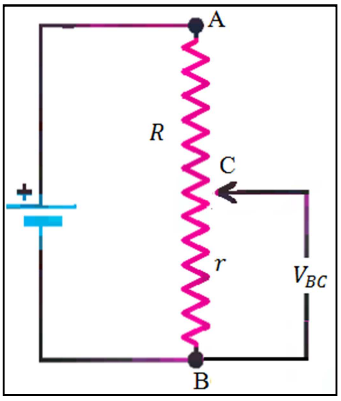
$$I = \frac{V}{R}$$

The potential difference between the portion BC of the wire AB is given by:

$$V_{BC} = current \times resistance$$

$$V_{BC} = \frac{V}{R} \times r = \frac{r}{R} V$$

Where r is the resistance of the portion BC of wire. The equation shows that this circuit can provide potential difference at output terminal varying from zero to the



full potential difference of the battery depending on the position of sliding contact. As the sliding contact moves towards the end B, the resistance r of portion of the wire decreases which result in decrease of output voltage V_{BC}. On the other hand if the sliding contact C is moved towards the end A, the output voltage V_{BC} increases.

Q # 14. Write a note on thermistors.

Ans. Thermistors

Thermistors are heat sensitive resistors. These are made up by heating under high pressure ceramic, from mixture of metallic oxides of nickel, cobalt, copper, iron etc. These are pressed into desired shapes and then baked at high temperature.

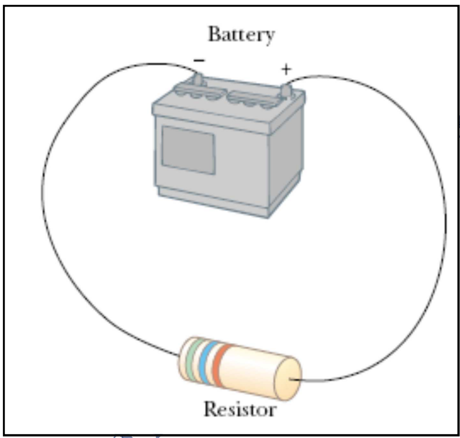
Termisters with positive temperature coefficient of resistance as well as negative temperature of resistance are available. The thermistors having high negative coefficient of temperature are used for accurate measuring of temperature up to 10K.

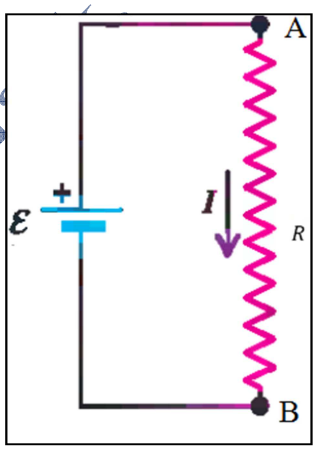
Q # 15. Define electrical power and derive its expression?

Ans. Electrical power

"The rate at which battery is supplying electrical energy is called its electrical power."

Consider a circuit consisting of a battery E connected in series with resistance R as shown in the figure:





A steady current I flows through the circuit and steady potential difference V exist between the terminals A and B of the resistor R. Using the meaning of potential difference, the work done ΔW in moving ΔQ up through the potential difference V is:

$$\Delta W = V \times \Delta Q$$

This is the energy supplied by the battery. The rate at which the battery is supplying electrical energy is called the electrical power of the battery.

$$Electrical\ Power = \frac{Energy\ Supplied}{Time\ Taken} = V\,\frac{\Delta Q}{\Delta t}$$

Since $I = \frac{\Delta Q}{\Delta t}$

$$Electrical\ Power = VI$$

By the principal of conservation of energy, the electrical power of the battery is dissipated in the resistor R. Therefore,

$$Power\ Dissipated\ (P) = VI$$

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

$$Power\ Dissipated\ (P) = VI = IR * I = I^2R$$

$$Power\ Dissipated\ (P) = VI = V * \frac{V}{R} = \frac{V^2}{R}$$

Q # 16. differentiate between emf of a battery and potential difference?

Ans.

Electromotive Force	Potential Difference
i. Energy supplied by a battery to the charge carriers to move in circuit is called electromotive force (emf).	i. Work done per unit charge in moving it from one point to another is called potential difference.
ii. emf is the cause	ii. Potential difference is the effect of emf
iii. the emf is always present even when no current is drawn through battery.	iii. The potential difference across the conductor is zero when no current flows through it.

Q # 17. Describe the relationship between the emf of a battery and terminal potential difference. Explain this relationship on the basis of energy consideration.

Ans. Consider a battery of emf E having internal resistance r. The current I flowing through the circuit is given by:

$$I = \frac{E}{R + r}$$

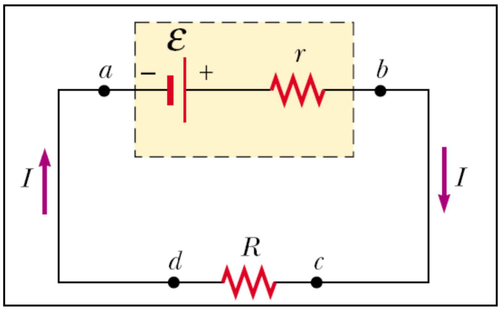
Or

$$E = IR + Ir \quad \text{-----------------} \quad (1)$$

Here $IR = V$ is the terminal potential difference of the battery in the presence of current I and Ir is the voltage drop on internal resistance of the battery.

Explanation

The left side of equation (1) is the emf of the battery, which is equal to the energy gained by unit charge (electron) to move from its negative to positive terminal. The right side of the equation gives an account of the utilization of this energy. It states that, as a unit charge passes through a circuit, a part of its energy equal to Ir is dissipated into the cell and the rest of the energy is dissipated into the external resistance R. it is given by the potential drop IR.



Q # 18. Derive the expression for maximum power output?

Ans. Maximum power output.

As the current I is flows through the of resistance R, the charges flow from a point of higher potential to a point of lower potential and as such, they loose potential energy. Then power delivered by the battery of resistance R will be:

$$Power\ delivered\ to\ R = P_{out} = VI$$

$$P_{out} = I^2R$$

$$\because V = IR$$

As the current flowing through the circuit is $I = \frac{E}{R+r}$, therefore

$$P_{out} = \left(\frac{E}{R+r}\right)^2 R$$

$$= \frac{E^2R}{(R+r)^2} = \frac{E^2R}{R^2+r^2+2Rr}$$

$$P_{out} = \frac{E^2R}{R^2+r^2-2Rr+2Rr+2Rr}$$

$$P_{out} = \frac{E^2R}{(R-r)^2+4Rr} \quad \text{---------------} \quad (1)$$

When $R = r$, the denominator of the expression of P_{out} is least and so P_{out} is then maximum.

Thus the maximum power is delivered to the resistance (load), when internal resistance of the source equals the load resistance. For $R = r$, the equation (1) becomes:

$$P_{out} = \frac{E^2R}{(R-R)^2+4R*R} = \frac{E^2R}{4R^2} = \frac{E^2}{4R}$$

Q # 19. Explain the Kirchhoff's Rules.

Ans. Kirchhoff's 1st Rule

It states that

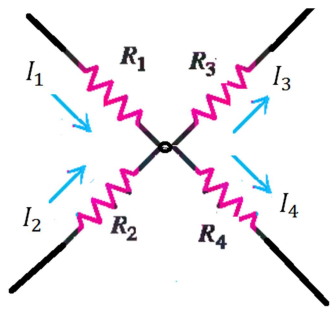
"The sum of all the current flowing towards point is equal to sum of all the currents flowing away from the point"

Or

The sum of all the currents meeting at a point in the circuit is zero.

It is described mathematically as:

$$\sum I = \mathbf{0}$$



Explanation

Consider a section where four wires meet at a point A. I_1 and I_2 are flowing towards the point where I_3 and I_4 flowing away from the point A. Mathematically represented as

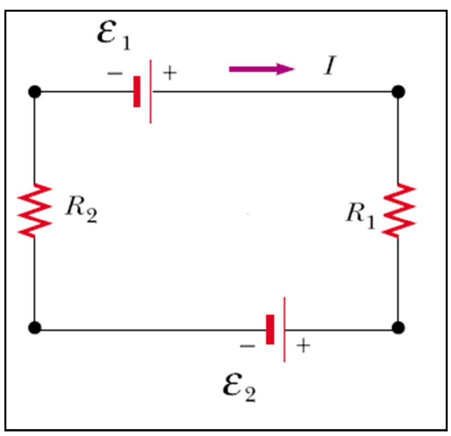
$$I_1 + I_2 + (-I_3) + (-I_4) = 0,$$

$$\Rightarrow I_1 + I_2 = I_3 + I_4$$

Kirchhoff's 2nd Rule

It states that

"The algebraic sum of all the potential changes in closed circuit is zero".



Explanation

Consider a closed circuit shown in the figure below:

Suppose E_1 is greater than E_2 .

- When a positive charge ΔQ passes through the cell E_1 from low $(-ve)$ to high potential $(+ve)$, it gained energy because the work is done on it. The energy gained by charge is $E_1\Delta Q$.

- When the current passes through the cell E_2, it loses energy equal to $-E_2\Delta Q$ because here the charge passes from high to low potential.
- In going through the resistor R_1, the charge ΔQ loses energy equal to $-IR_1\Delta Q$ where IR_1 is potential difference across R_1.
- Similarly the loss of energy while passing through the resistor R_2 is $-IR_2\Delta Q$.

Finally, the charge reaches the negative terminal of the cell E_1 from where we started.

According to the law of conservation of energy, the total change in energy is zero. Therefore, we can write:

$$E_1\Delta Q - IR_1\Delta Q - E_2\Delta Q - IR_2\Delta Q = 0$$

Or

$$E_1 - IR_1 - E_2 - IR_2 = 0$$

This is mathematical form of Kirchhoff's rule.

Q # 20. Write a note on Wheatstone Bridge.

Ans. Wheatstone Bridge

Wheatstone Bridge is the combination of four resistances, arranged in the form of mesh, used to find out unknown resistance.

Explanation

Consider four resistances R_1, R_2, R_3, R_4 connected in such a way so as to form a mesh ABCDA. A battery of emf is connected between points A and C. A sensitive galvanometer of resistance R_g is connected between points B and D.

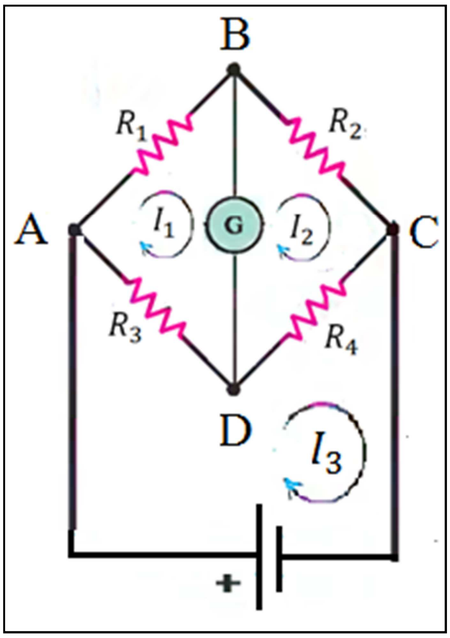
Let the current I_1, I_2, I_3 flows through the loops ABDA, BCDB, ADCA respectively.

The Kirchhoff's 2nd Rule as applied to loop ABDA gives:

$$-I_1R_1 - (I_1 - I_2)R_g - (I_1 - I_3)R_3 = 0 \quad \text{----------} \quad (1)$$

Similarly by applying the Kirchhoff's 2nd Rule to the loop BCDB, we have:

$$-I_2R_2 - (I_2 - I_3)R_4 - (I_2 - I_1)R_g = 0 \quad \text{----------} \quad (2)$$



The current through the galvanometer will be zero if $I_1 - I_2 = 0$ or $I_1 = I_2$. With this condition, the equation (1) and (2) reduces to:

$$-I_1R_1 = (I_1 - I_3)R_3 \quad \text{----------} \quad (3)$$

$$-I_1R_2 = (I_1 - I_3)R_4 \quad \text{----------} \quad (4)$$

Dividing equation (3) and (4), we get:

$$\frac{-I_1R_1}{-I_1R_2} = \frac{(I_1 - I_3)R_3}{(I_1 - I_3)R_4}$$

$$\Rightarrow \frac{R_1}{R_2} = \frac{R_3}{R_4} \quad \text{----------} \quad (5)$$

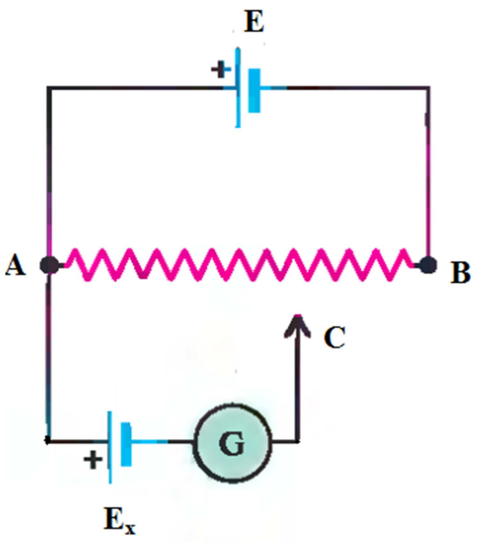
If we connect three resistance R_1, R_2, R_3 of known adjustable values and unknown resistance R_4 in such a way that no current pass through galvanometer, then the unknown resistance can be find out easily by equation (5).

Q # 21. What do you know about potentiometer? Also describe the advantage of potentiometer over voltmeter.

Ans.

Potentiometer

It is a device that is used to measure potential difference between two points without drawing any current from original circuit.



Advantage of Potentiometer over Voltmeter

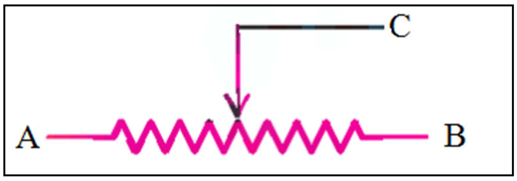
Potential difference is usually measured by an instrument called voltmeter. The voltmeter is connected across the two points in a circuit between which the potential difference is to be measured. It is necessary that the resistance of the voltmeter be large compared to the circuit resistance across which the voltmeter is connected. Otherwise an appreciable current will flow through the voltmeter which will alter the circuit current and the potential difference measured. Thus the voltmeter can read the correct potential difference only when it does not draw any current from the circuit across which it is connected.

On the other hand, potentiometer is a very simple instrument which can measure and compare potential difference accurately without drawing any circuit current.

Q # 22. Explain the construction and working of Potentiometer?

Construction

It is consist of a wire which has resistance R between its two fixed terminals A and B while a sliding terminal C can slide over the wire. The resistance r between A & C can be varies from 0 to R by moving sliding contact C from A to B.



If a battery of emf E is connected across R .Then current flowing through it is

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

If we represent the resistance between A and C by r. Then potential drop across r will be:

$$V = r\frac{E}{R}$$

Thus the potential drop can be varied from 0 to V across A & C terminals by sliding the terminal C from A to B.

A source of potential difference whose emf is E_x is to be measured is connected A and sliding contact C through a galvanometer G. The potential divider is connected at point A. After adjusting the circuit the sliding contact is so adjusted that galvanometer show no deflection. At this condition the emf E_x is equal to potential difference across A and C, whose value is known, i.e.,

$$E_x = r\,\frac{E}{R} \quad ---------- \quad (1)$$

In case of a wire if uniform cross sectional area, the resistance is proportional to length.

So $r \propto l$ & $R \propto L$

Therefore, unknown emf E_x is given by :

$$E_x = r\,\frac{E}{R}$$

Comparison of different emfs

We can compare different emfs E_1 & E_2 of two cells easily by finding the balancing condition. If l_1 is the balancing length corresponding the E_1, then:

$$E_1 = E\,\frac{l_1}{L} \quad ---------- \quad (2)$$

Similarly, if l_2 is the balancing length corresponding the E_2, then:

$$E_2 = E\,\frac{l_2}{L} \quad ---------- \quad (3)$$

Dividing equation (2) and (3), we get:

$$\frac{E_1}{E_2} = \frac{l_1}{l_2}$$

This expression tells that the ratio of two emfs is equal to ratio of their balancing lengths.

EXERCISE SHORT QUESTIONS

Q # 1. A potential difference is applied across the ends of a copper wire. What is the effect on the drift velocity of free electrons by

i. **Increasing the potential difference**

ii. **Decreasing the length and the temperature of the wire.**

Ans. The drift velocity V_d of electrons in a conductor is described by the formula:

$$V_d = \frac{\Delta V}{ne\rho L}$$

Where ΔV is the potential difference between the ends of conductor, L is the length of conductor and ρ is the resistivity of wire. From equation, it is clear that

i. Drift velocity of electron increases with increase in potential difference

ii. Drift velocity of electron also increases by decreasing the length and temperature of wire.

Q # 2. Do bends in a wire affect its electrical resistance? Explain.

Ans. The resistance of the conductor is described by the formula:

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

Where L is the length and A is the cross-section area of conductor, ρ the electrical resistivity of the material which depends upon the nature of conductor.

Hence the resistance of conductor depends upon the geometry and nature of conductor. Hence the bends in conducting wires don't affect its electrical resistance.

Q # 3. What are the resistances of the resistors given in the figure A and B. What is the tolerance of each? Explain what is meant by the tolerance.

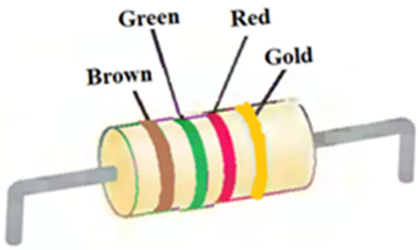


Fig. A

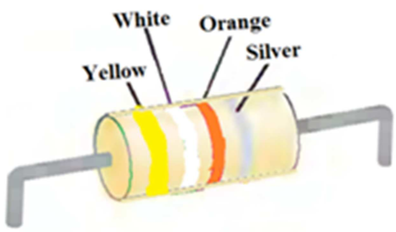


Fig. B

For figure A. The color codes for figure A are as follows:	For figure B. The color codes for figure B are as follows:
Brown 1 (First Digit)	Yellow 4 (First Digit)
Green 5 (Second Digit)	White 9 (Second Digit)
Red 2 (Number of Zero)	Orange 3 (Number of Zero)
Therefore	Therefore
Resistance = 1500 Ω	Resistance = 49000 Ω
And	And
Tolerance = T = 5%	Tolerance = T = 10%

Tolerance

Tolerance means the possible variation in the value of resistance from the marked value. For example, a 1000 Ω resistance with a tolerance of 10% can have an actual resistance between 900 Ω and 1100 Ω.

Q # 4. Why does the resistance of conductor rise with temperature?

Ans. The resistance offered by a conductor to the flow of electric current is due to collisions which the free electrons encounter with atoms of the lattice. As the temperature of the conductor rises, the amplitude of vibration of atoms increases and hence the probability of their collision with free electrons also increases which result increase of resistance of conductor.

Q # 5. What are the difficulties in testing whether the filament of a lighted bulb obeys ohm's law?

Ans. Ohm's law states that the current flowing through the conductor is directly proportional to the potential difference applied across its ends provided that the temperature of the conductor remains constant. In case of a lighted bulb, the temperature of the filament increases with the passage of current through it. Hence the Ohm's law can't be applied to filament bulb.

Thus the main difficulty in testing whether the filament of a lighted bulb obeys ohm's law is the change in temperature with the flow of current in it.

Q # 6. Is the filament resistance lower or higher in a 500 W, 220 V bulb than in a 100 W, 220 V bulb?

Ans. We know that

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

The resistance of filament of 500 W, 220 V bulb is:

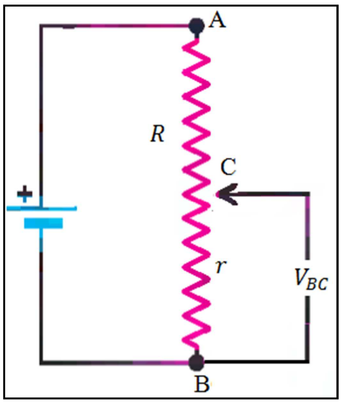
$$R = \frac{V^2}{P} = \frac{(220)^2}{500} = 98.6\ \Omega$$

The resistance of filament of 100 W, 220 V bulb is:

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

It is clear that the filament resistance is lowered in a 500 W, 220 V bulb than 100 W, 220 V bulb.

Q # 7. Describe a circuit which will give a continuously varying potential.



Ans. To use rheostat as potential divider, potential difference V is applied across the fixed ends A and B of rheostat with the help of a battery. If R is the resistance of the wire AB, the current I passing through is given by:

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

The potential difference between the portion BC of the wire AB is given by:

$$V_{BC} = current\ \times resistance$$

$$V_{BC} = \frac{V}{R} \times r = \frac{r}{R} V$$

Where r is the resistance of the portion BC of wire. The equation shows that this circuit can provide potential difference at output terminal varying from zero to the full potential difference of the battery depending on the position of sliding contact. As the sliding contact moves towards the end B, the resistance r of portion of the wire decreases which result in decrease of output voltage V_{BC}. On the other hand if the sliding contact C is moved towards the end A, the output voltage V_{BC} increases.

Q # 8. Explain why the terminal potential difference of a battery decreases when current drawn from it is increases.

Ans. The terminal potential difference V_t of the battery of emf ε is described by the formula:

$$V_t = \varepsilon - Ir$$

Where r is the internal resistance of the battery and I is the current flowing through outer circuit.

It is clear from equation that when I is large, the factor Ir becomes large and V_t becomes small. Hence terminal potential difference of a battery decreases when current drawn from it is increased.

Q # 9. What is Wheatstone bridge? How can it be used to determine an unknown resistance?

Ans. It is an electrical circuit which can be used to find the unknown resistance of a wire. The circuit of Wheatstone bridge is shown in the figure.

It consist of four resistance connected in the form of a mesh, galvanometer, battery and a switch. When the bridge is balanced, it satisfies the following relation:

$$\frac{R_1}{R_2} = \frac{R_3}{R_4} \Rightarrow R_4 = \frac{R_2 \times R_3}{R_1}$$

If the values of R_1, R_2, R_3 are known, then R_4 can be calculated, provided the bridge is balanced.

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