CHAPTER 13
CURRENT ELECTRICITY

MULTIPLE CHOICE

1. **The SI unit of current is**
   A ohm B. volt
   C watt D. ampere
2. **Metals are good conductors of electricity because they have**
   A large number of bounded electrons
   B small number of bounded electrons
   C. large number of free electrons
   D small number of free electrons
3. **The direction of .conventional current flowing in the circuit is:**
   A From positive to negative in external circuit
   B From negative to positive terminal
   C Both directions
   D. Along the flow of electrons
4. **The uniform velocity gained by the electrons in a conductor placed is electric field is called:**
   A. Phase velocity. B. Drift velocity
   C. Constant velocity D. Variable velocity
5. **If 2 ampere current flows through 2m long conductor. The charge flowing through it in one hour will be:**
   A. 3600 C B. 7200 C C. 1C D. 100 C
6. **The electromotive force of a battery is the voltage between its terminals when**
   A. the circuit is open
   B the circuit is closed
   C its internal resistance is the minimum
   D its internal resistance is the maximum
7. **The reciprocal of resistance is called**
   A. resistivity B. conductivity
   C Ω^{-1} D none of these
8. **The unit of resistivity is**
   A Ω m B. Ω /m C. m/ Ω D N/m
9. **Fractional change in resistance per kelvin rise in temperature is called**
   A Conductance
   B Resistance
   C Resistivity
   D. Temperature coefficient of resistance

10. **The relation V = IR represents:**
A Ampere's law
B Coulomb's law
C Ohm's law
D Len's law

11. **The resistance of a conductor does not depend on its:**
A Length
B Area
C Resistivity
D Mass

12. **Resistance of a solid one metre in length and one square metre in cross-sectional area is called:**
A Conductivity
B Resistivity
C Reactance
D Conductance

13. **The fractional change in resistance per kelvin is known as:**
A Temp co-efficient of resistance
B Temp co-efficient of conductance
C Temp co-efficient of resistivity
D None of these

14. **The SI unit of temperature co-efficient of resistivity of a material is:**
A Ohm-m
B K
C K^{-1}
D Ohm-K

15. **The heat produced by current I in resistance R in time t is**
A I^2Rt
B I^2R^2t
C IRt
D IR^2t

16. **Power dissipation is expressed by**
A $P = \frac{1}{R}$
B. $P = VR$
C $RV = P$
D $P = I^2R$

17. **Whenever current is drawn from a cell its terminal potential difference and emf becomes**
A Different
B same
C zero
D. negative

18. **A charged particle is projected at an angle into a uniform magnetic field. Which of the following parameters of the charged particle will be affected by the magnetic field?**
A energy
B momentum
C speed
D. velocity

19. **A rheostat can operate as**
A transformer
B. amplifier
C Oscillator
D. Potential divider

20. **The algebraic sum of potential changes for a closed circuit is**
A. Positive
B. Negative
C Zero
D. greater than unity

21. **The value of temperature co-efficient of resistance of most thermistors is**
A. Positive
B. Negative
C Zero
D. infinity

22. **Three resistors of resistances 2, 3 and 6 ohms are connected in parallel, their equivalent resistance is:**
A 11 ohm
B. 1.0 ohm
C 2 ohm
D 6 ohm

23. **The amount of work done per coulomb of charge passing though conductor is:**

A. I^2R B. VI C. VQ D. V

24. The electrical energy converted into heat is given by expression:

A. IRt B. I^2Rt C. VI^2t D. I^2R

25. Which one of the following bulbs has least resistance?

A. 100 watt B. 200 watt
C. 500 watt D. 1000 watt

26. Electromotive force is closely related to:

A. Electric force B. Magnetic force
C. Potential difference D. Electric intensity

27. If the conductivity of a material is small then it is

A. A conductor B. A Poor conductor
C. A good conductor D. An insulator

28. Thermistor is

A. a resistor B. Thermally sensitive resistor
C. An adiabatic resistor D. An isothermal resistor

29. The power output of a lamp is 6 W. How much energy does the lamp give out in 2 minutes?

A. 3 J B. 12 J C. 120 J D. 720 J

30. Semi conductor diode is an example of:

A. Ohmic device B. Non-ohmic device
C. Insulator D. Super-conductivity

31. A rheostat can be used as a:

A. Variable resistor B. Potential divider
C. Constant resistor D. Both A and B

32. A complex network consisting of number of resistors and more than one battery can be solved by:

A. Ohm's Law B. Ampere's Law
C. Kirchhoff's rules D. Gauss's law

33. Three arms of a balanced wheat stone bridge are of 95 ohms resistance each. What is the resistance of the fourth arm:

A. 190 ohm B. 95 ohms
C. 285 ohms D. 150 ohms

34. The proportionality constant between current and potential difference is

A. P B. R C. I / R D. V

Answers:

1. C	**2. D**	**3. A**	**4. B**	**5. B**	**6. A**	**7. D**
8. A	**9. D**	**10. C**	**11. C**	**12. B**	**13. A**	**14. C**
15. A	**16. D**	**17. A**	**18. D**	**19. D**	**20. C**	**21. B**
22. B	**23. D**	**24. B**	**25. D**	**26. C**	**27. B**	**28. B**
29. D	**30. B**	**31. D**	**32. C**	**33. B**	**34. B**	

www.ilmkidunya.com

SHORT & LONG QUESTIONS

Q1: Define electric current. Write its formula and its unit?

Ans: Electric current:

Rate of flow of electric charge is called electric current.

Explanation:

An electric current is caused by the motion of electric charge. If a net charge ΔQ passes through any cross section of a conductor in time Δt, we say that an electric current I has been established through the conductor where

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

Unit of current:

The SI unit of current is ampere

Ampere:

It is a current due to flow of charge at the rate of one coulomb per second.

Note:

i. In case of metallic conductors, the charge carriers are electrons.

ii.. The charge carriers in electrolyte are positive and negative ions e.g., in a $CuSO_4$ solution the charge carriers are Cu^{++} and SO^{--}_4 ions.

iii. In gases, the charge carriers are electrons and ions.

Q2: What do you mean by the term conventional current? OR Discuss the current direction?

Ans: "The conventional current in a circuit is defined as that equivalent current which passes from a point at higher potential to a point at a lower potential as if it represented a movement of positive charges."

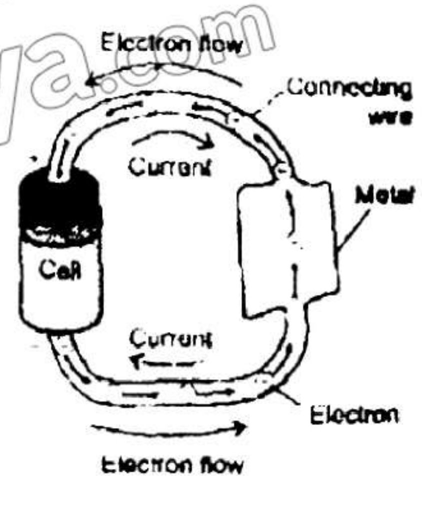
Explanation:

i. Early scientists regarded an electric current as a flow of positive charge from positive to negative terminal of the battery through an external circuit.

ii. Later on, it was found that a current in metallic conductors is actually due to the flow of negative charge carriers called electrons moving in the opposite direction i.e., from negative to positive terminal of the battery, but it is a convention to take the direction of current as the direction in which positive charges flow. This current is referred as conventional current.

iii. Reason for naming for conventional current:

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 the opposite direction. As the current is measured by its external effects so a current due to motion of negative charges, after reversing its direction of flow can be substituted by an equivalent current due to flow of positive charges.



iv. While analyzing the electric circuit, we use the direction of the current according to the above mentioned convention.

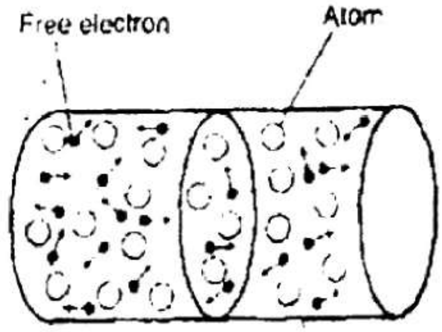
v. If we wish to refer to the motion of electrons, we use the term electronic current.

Q3: Explain how current passes through a metallic conductor?

Ans: Current through a metallic conductor:

i. Free electrons:

In a metal, the valence electrons are not attached to individual atoms but are free to move about within the body. These electrons are known as free electrons. The free electrons are in random motion just like the molecules of a gas in a container and they act as charge carriers in metals.



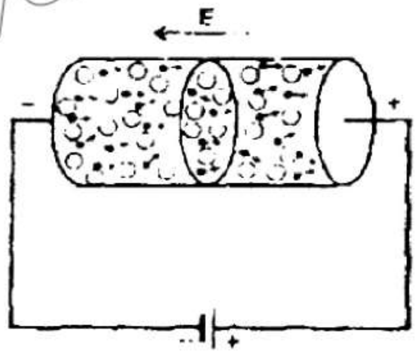
ii. The speed of randomly moving electrons depends upon temperature.

Current through the wire is zero:

If we consider any section of metallic wire, the rate at which the free electrons pass through it from right to left is the same as the rate at which they pass from left to right. As a result the current through the wire is zero.

iii. Application of battery to the wires:

If the ends of the wire are connected to a battery, an electric field E will be set up at every point within the wire. The free electrons will now experience a force in the direction opposite to **E**. As a result of this force the free electrons acquire a motion in the direction of -E. It may be noted that the force experienced by the free electrons does not produce a net acceleration because the electrons keep on colliding with the atoms of the conductor. The overall effect of these collisions is to transfer the energy of accelerating electrons to the lattice with the result that the electrons acquire an average velocity, called the drift velocity in the direction of **-E**.



iv. Drift velocity:

The drift velocity is of the order of $10^{-3}ms^{-1}$, whereas the velocity of free electrons at room temperature due to their thermal motion is several hundred kilometers per second.

v. Establishment of electric field:

Thus, when an electric field is established in a conductor, the free electrons modify their random motion in such a way that they drift slowly in a direction opposite to the field. In other words the electrons, in addition to their violent thermal motion, acquire a constant drift velocity due to which a net directed motion of charges takes place along the wire and a current begins to flow through it.

vi. A steady current is established in a wire when a constant potential difference is maintained across it which generates the requisite electric field E along the wire.

Q4: Discuss source of current. Give some examples also?

Ans: Source of current:

i. In order to have a constant current the potential difference across the conductors or the ends of the wire should be maintained constant. This is achieved by connecting the ends of the wire to the terminals of a device called a source of current

ii. Every source of current converts some non electrical energy such as chemical, mechanical, heat or solar energy into electrical energy

iii. **Types of sources of current:**
There are many types of sources of current. A few examples are mentioned below

(i) **Cells** (primary as well as secondary) which convert chemical energy into electrical energy

(ii) **Electric generators** which convert mechanical energy into electrical energy.

(iii) **Thermo-couples** which convert heat energy into electrical energy.

(iv) **Solar cells** which convert sunlight directly into electrical energy.

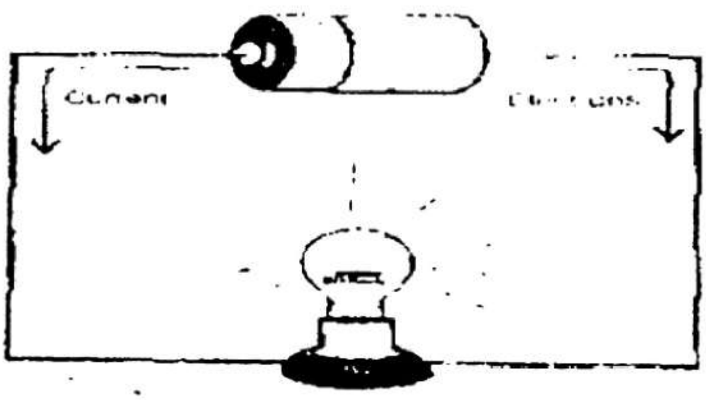
Q5: How conventional current flows through a wire?

Ans: Conventional current flows from higher to lower potential through a wire

Q6: Describe the function of battery between ends of a conductor?

Ans: Function of battery:

A source of current such as battery maintains a nearly constant potential difference between ends of a conductor



Q7: Explain the following effects of current?

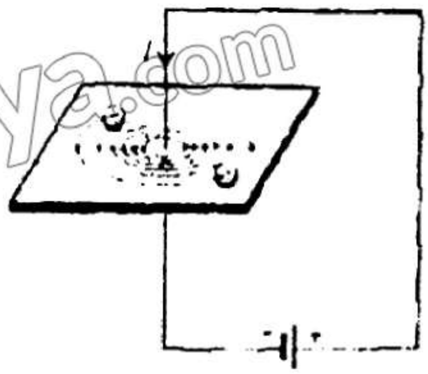
(i) Heating effect

(ii) Magnet ic effect

(iii) Chemical effect?

Ans: Effects of current:

I. Heating Effect:



a. Current flows through a metallic wire due to motion of free electrons. During the course of their motion, they collide frequently with the atoms of the metal. At each collision, they lose some of their kinetic energy and give it to atoms with which they collide. Thus as the current flows through the wire, it increases the kinetic energy of the vibrations of the metal atoms, i.e., it generates heat in the wire

www.ilmkidunya.com

b. It is found that the heat H produced by a current I in the wire of resistance R during a time interval t is given by

$$H = I^2Rt$$

Uses of heating effect:

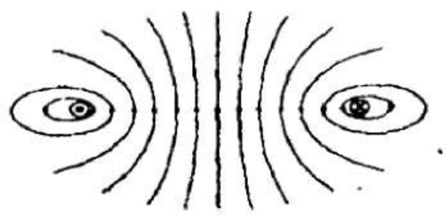
The heating effect of current is utilized in electric heaters, kettles, toasters and electric irons etc.

ii. Magnetic Effect:

a. The passage of current is always accompanied by a magnetic field in the surrounding space.

b. The strength of the field depends upon the value of current and the distance from the current element.

c. The pattern of the field produced by a current carrying straight wire, a coil and a solenoid is shown in Fig.



Uses of magnetic effect:

Magnetic effect is utilized in the detection and measurement of current. All the machines involving electric motors also use the magnetic effect of current.

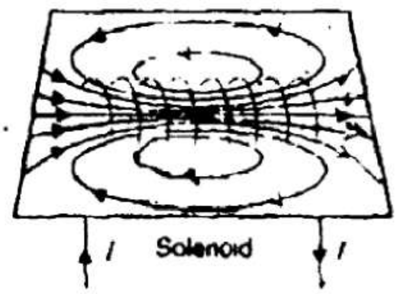
iii. Chemical Effect:

a. Electrolysis:

Certain liquids such as dilute sulphuric acid or copper sulphate solution conduct electricity due to some chemical reactions that take place within them. The study of this process is known as electrolysis.

Electrolyte:

The liquid which conducts current is known as electrolyte.



Electrode:

The material in the form of wire or rod or plate which leads the current into or out of the electrolyte is known as electrode.

Anode:

The electrode connected with the positive terminal of the current source is called anode.

Cathode:

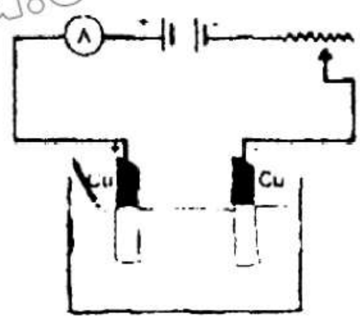
The electrode connected with negative terminal is known as cathode.

Voltameter:

The vessel containing the two electrodes and the liquid is known as voltameter.

Example:

As an example we will consider the electrolysis of copper sulphate solution. The voltameter contains dilute solution of copper sulphate. The anode and cathode are both copper plates. When copper sulphate is dissolved in water, it dissociates into Cu^{++} and SO_4^{-} ions. On passing current through the voltameter, Cu^{++} moves towards the cathode and the following reaction takes place.



Reaction at cathode:

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

Reaction at anode:

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

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

Uses of chemical effect:

Chemical effect of current illustrates the basic principle of electroplating.

Electroplating:

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

Q8: State Ohm's law. Derive a mathematical relation for potential difference?

Ans: Ohm's law:

"The current flowing through a conductor is directly proportional to the potential difference across its ends provided the physical state such as temperature etc. of the conductor remains constant".

Mathematical form of ohm's law:

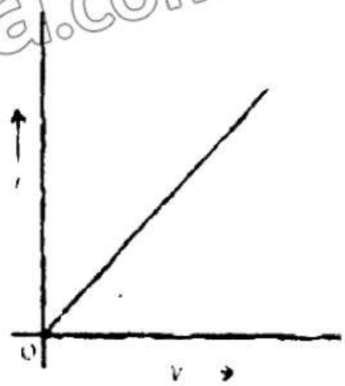
Symbolically Ohm's law can be written as

$$V \propto I$$

It implies that

$$V = RI$$

where R, the constant of proportionality is called the resistance of the conductor. The value of the resistance depends upon the nature, dimensions and the physical state of the conductor.



Note:

A sample of a conductor is said to obey Ohm's law if its resistance R remains constant that is, the graph of its V versus I is exactly a straight line

Q9: Define resistance and its unit?

Ans: Resistance:

The resistance is a measure of the opposition to ... tion of electrons due to their continuous bumping with the atoms of the lattice

Unit of resistance:

The unit of resistance is ohm.

Ohm:

A conductor has a resistance of 1 ohm if a current of 1 ampere flows through it when a potential difference of 1 volt is applied across its ends. The symbol of ohm is Ω. If I is measured in amperes, V in volts, then R is measured in ohms i.e

$$R\text{ (ohms)} = \frac{V\text{ (volts)}}{I\text{ (amperes)}}$$

Q10: Describe the difference between ohmic and non-ohmic device? Explain with the help of graph?

Ans: Ohmic Device:

A conductor which strictly obeys Ohm's law is called Ohmic

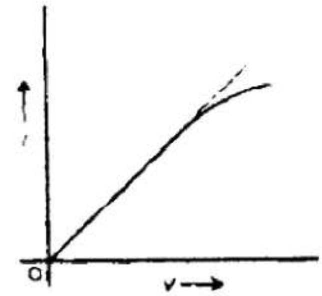
Non-Ohmic Device:

There are devices, which do not obey Ohm's law i.e., they are non Ohmic. The examples of non Ohmic devices are filament bulbs and semiconductor diodes.

Graphical explanation of ohmic and non-ohmic devices:

Let us apply a certain potential difference across the terminals of a filament lamp and measure the resulting current passing through it. If we repeat the measurement for different values of potential difference and draw a graph of voltage V versus current I, it will be seen that the graph is not a straight line.

It means that a filament is a non Ohmic device.

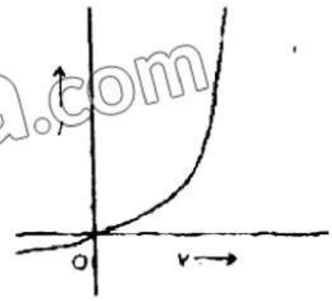


Reason of deviation:

i. This deviation of I - V graph from straight line is due to the increase in the resistance of the filament with temperature. As the current passing through the filament is increased from zero, the graph is a straight line in the initial stage because the change in the resistance of the filament with temperature due to small current is not appreciable.

ii. As the current is further increased, the resistance of the ilament continues to increase due to rise in its temperature and graph is not a straight line.

iii. Another example of non Ohmic device is a semiconductor diode. The current - voltage plot of such a diode is shown in Fig. The graph is not a straight line.

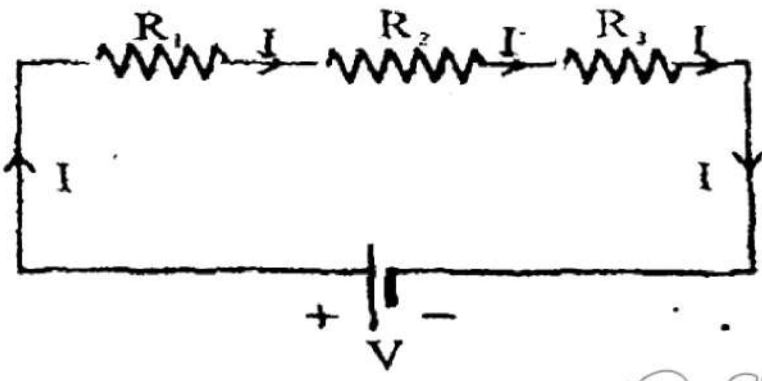


iv. Semi conductor is also a non ohmic device.

Q11: How are resistances connected in series? Describe the characteristics features of this combination?

Ans: Series combination of Resistances

1. There is one path in which the electrons can flow in the circuit.



2. The current flow is the same throughout a series circuit.

$$I = I_1 = I_2 = I_3$$

3. Sum of the potential difference across individual components in a series circuit is equal to the potential difference across the whole circuit.

$$V = V_1 + V_2 + V_3$$

4. The total resistance R_e of the resistors connected in series circuit is equal to the sum of the separate resistors.

$$R_e = R_1 + R_2 + R_3$$

5. For n resistances

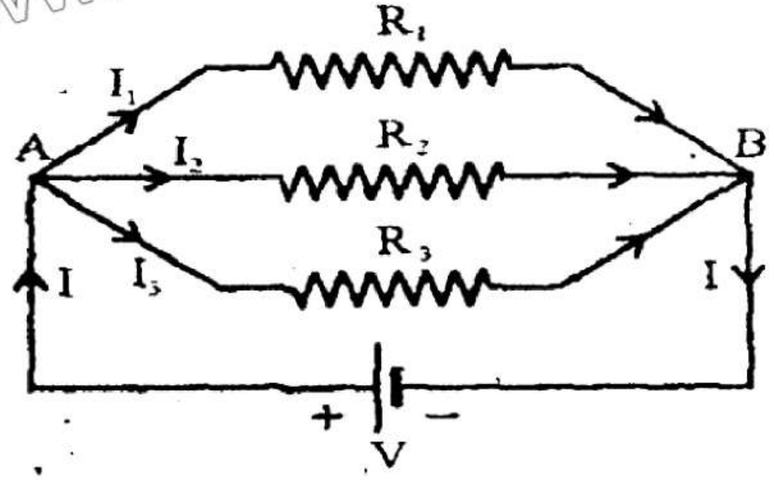
$$R_e = R_1 + R_2 + R_3 \ldots\ldots R_n$$

www.ilmkidunya.com

Q12: How are resistances connected in Parallel? Describe the characteristics features of this combination?

Ans: Parallel combination of Resistances:

1. There are more than one paths for the follow of electrons in the circuit.



2. The current flow in the main circuit is the sum of the currents in the separate branches.

$$I = I_1 + I_2 + I_3$$

3. Each component connected in parallel has the same potential difference across it.

$$V = V_1 = V_2 = V_3$$

4. The reciprocal of equivalent resistance $\frac{1}{R_e}$ of the equivalent resistance of the combination is the sum of the reciprocals of the individual resistances.

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

5. For n resistances

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

Q13: What are the advantages of cell connected in parallel?

Ans: The advantages of connecting cells in parallel:

i. The cells will last longer before they need to be replaced;

ii. A higher current can be supplied

Q14: Show that the equivalent resistance of three resistors in series is given by $R = R_1 + R_2 + R_3$?

Ans: To find the equivalent resistance, we start from the fact that the potential difference V across the set is sum of the potential differences across the individual resistors:

$$V = V_1 + V_2 + V_3$$

Because the current in each resistor is I, the potential differences across them are

$$V_1 = IR_1 \quad V_2 = IR_2 \quad V_3 = IR_3$$

The potential difference across the equivalent resistance R is

www.ilmkidunya.com

$$V = IR$$

Substituting the values of 'V's in

$$V = V_1 + V_2 + V_3$$

$$IR = IR_1 + IR_2 + IR_3$$

Now we divide both sides of this equation by I and find that

$$R = R_1 + R_2 + R_3$$

Q15: Show that the equivalent resistance of three resistors in parallel is given by $V/R = V/R_1 + V/R_2 + V/R_3$?

Ans: To find the equivalent resistance, we start from the fact that the total current I is equal to the sum of the currents through the separate resistors:

$$I = I_1 + I_2 + I_3 \quad \text{.........(1)}$$

Because the potential difference V is the same across all the resistors, their respective currents are

$$I_1 = \frac{V}{R_1} \qquad I_2 = \frac{V}{R_2} \qquad I_2 = \frac{V}{R_3}$$

The smaller the resistance, the greater the current through a resistor in a parallel set. The total current is given in terms of the equivalent resistance R by

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

Substituting for the I in $I = I_1 + I_2 + I_3$ gives

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

Now we divide both sides of this equation by V:

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

Q16: Prove that $R = \rho\frac{L}{A}$. OR Describe the unit of resistivity?

Ans: Relation between resistance and resistivity:

It has been experimentally seen that the resistance R of a wire is directly proportional to its length L and inversely proportional to its cross sectional area A. Expressing mathematically we have

$$R \propto L \quad \text{............ (1)}$$

$$R \propto \frac{1}{A} \quad \text{............ (2)}$$

By combining 1 and 2 we get,

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

$$R = \rho\frac{L}{A} \quad \text{............ (3)}$$

Where ρ is a constant of proportionality known as resistivity of specific resistance of the material of the wire.

Difference between resistance and resistivity:

It may be noted that resistance is the characteristic of a particular wire whereas the resistivity is the property of the material of which the wire is made.

From Eq 3 we have

$$\rho = \frac{RA}{L} \quad \text{....... (4)}$$

www.ilmkidunya.com

Resistivity (ρ):

The resistance of a metre cube of a material is called resistivity denoted by ρ.

Unit of resistivity:

The SI unit of resistivity is ohm-metre (Ω m)

Conductance:

Conductance is another quantity used to describe the electrical properties of materials. In fact conductance is the reciprocal of resistance i.e.

$$\text{Conductance} = \frac{1}{\text{resistance (R)}}$$

Unit of conductance:

The SI unit of conductance is mho or siemen.

Conductivity:

Likewise conductivity, a is the reciprocal of resistivity i.e.,

$$\sigma = \frac{1}{\rho}$$

Unit of conductivity:

The SI unit of conductivity is $ohm^{-1}\ m^{-1}$ or $mh\ m^{-1}$

Q17: Why silver and copper are two best conductors? OR What is the reason that most electric wires are made of copper?

Ans: Silver and copper are two best conductors. That is the reason that most electric wires are made of copper. As

$$\text{resistivity } (\rho) \text{ of silver} = 1.52 \times 10^{-8}\ \Omega\ m$$
$$\text{resistivity } (\rho) \text{ of cooper} = 1.54 \times 10^{-8}\ \Omega\ m$$

The resistivity of these two metals is less than other metals that is why silver and cooper are the best conductors ($\sigma = \frac{1}{\rho}$)

Q18: Explain the relation of resistivity with the temperature?

Ans: Resistivity and temperature:

i. The resistivity of a substance depends upon the temperature also.

ii. 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.

iii. As the temperature of the conductor rises, the amplitude of vibration of the atoms in the lattice increases and hence, the probability of their collision with free electrons also increases. One may say that the atoms then offer a bigger target, that is, the collision cross-section of the atoms increases with temperature. This makes the collisions between free electrons and the atoms in the lattice more frequent and hence, the resistance of the conductor increases

Q19: Describe the change in resistance of a metallic conductor with temperature graphically? OR What is meant by temperature coefficient of resistance and negative temperature coefficient?

Ans: Experimentally the change in resistance of a metallic conductor with temperature is found to be nearly linear over a considerable range of temperature above and below 0°C.

Temperature coefficient of resistance:

The fractional change in resistance per kelvin is known as the temperature coefficient of resistance i.e.,

$$\alpha = \frac{R_t - R_0}{R_0 t} \quad \text{.........} \quad \textbf{(1)}$$

where R_0 and R_t are resistances at temperature 0°C and t°C. As resistivity ρ depends upon the temperature, Eq. 1 gives

$$R_t = \rho_t \frac{L}{A} \qquad \text{and} \qquad R_0 = \rho_0 \frac{L}{A}$$

Substituting the values of R_t and R_0 in Eq. 1, we get as $\alpha = \frac{\rho_t - \rho_0}{\rho_0 t}$.......... **(2)**

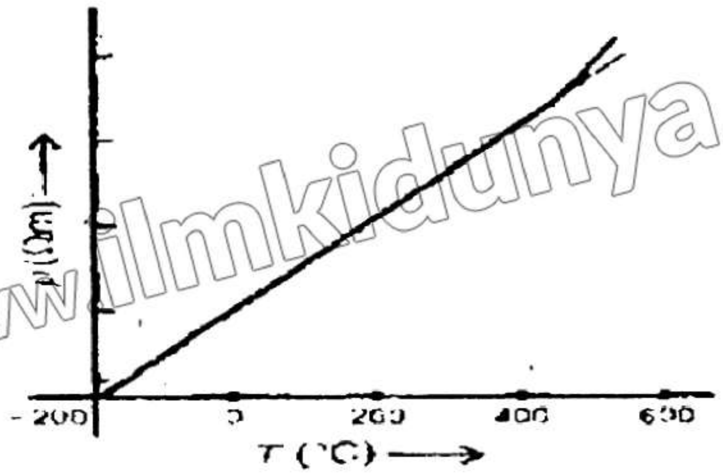
where ρ_0 is the resistivity of a conductor at 0°C and ρ_t, is the resistivity at t°C.

Negative temperature coefficients:

There are some substances like germanium, silicon etc., whose resistance decreases with increase in temperature, i.e., these substances have negative temperature coefficients.

Q20: Draw the variation of resistivity of copper with temperature by using graph?

Ans: Variation of resistivity of copper with temperature:



Q21: Draw a table to show the values of ρ (resistivity or specific resistance) and α (temperature coefficient of resistance)?

Ans:

Substance	ρ (Ωm)	α (K^{-1})
Silver	1.52×10^{-8}	0.00380
Cooper	1.54×10^{-8}	0.00390
Gold	2.27×10^{-8}	0.00340
Aluminium	2.63×10^{-8}	0.00390
Tungsten	5.00×10^{-8}	0.00460
Iron	11.00×10^{-8}	0.00520
Platinum	11.00×10^{-8}	0.00520
Constanton	49.00×10^{-8}	0.00001
Mercury	94.00×10^{-8}	0.00091
Nichrome	100.00×10^{-8}	0.00020
Carbon	3.5×10^{-8}	-0.0005
Germanium	0.5	-0.05
Silicon	20-2300	-0.07

www.ilmkidunya.com

www.ilmkidunya.com

Q22: How inspectors can easily check the reliability of a concrete bridge?

Ans: Reliability of a concrete bridge:

Inspectors can easily check the reliability of a concrete bridge made with carbon fibers. The fibers conduct electricity. If sensor shows that electrical resistance is increasing over time the fibers are separating because of cracks.

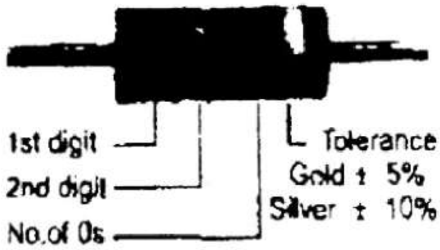
Q23: Explain how code for carbon resistances colour are used?

Ans: Colour code for carbon resistances:

i. Carbon resistors are most common in electronic equipment.

ii. They consist of a high-grade ceramic rod or cone (called the substrate) on which is deposited a thin resistive film of carbon.

iii. The numerical value of their resistance is indicated by a colour code which consists of bands of different colours printed on the body of the resistor.



Resistor Colour Code

iv. The colour used in this code and the digits represented by them are given in table.

The Colour Code	
Colour	**Value**
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Gray	8
White	9

Note:

It is easy to remember colour and their respective numbers as

B.B. ROY Goes Britain Via Germany West

B	**B**	**R**	**O**	**Y**	**Goes**	**Britain**	**Via**	**Germany**	**West**
↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**

Interpretation of colour bands:

Usually the code consists of four bands. Starting from left to right, the colour bands are interpreted as follows:

1. The first band indicates the first digit in the numerical value of the resistance.

2. The second band gives the second digit.

3. The third band is decimal multiplier i.e., it gives the number of zeros after the first two digits.

4. The fourth band gives resistance **tolerance**. Its colour is either silver or gold. Silver band indicates a tolerance of ± 10%, a gold band shows a tolerance of ±5 %. If there no fourth band, tolerance is understood to be +20%. By tolerance, we mean the possible variation from the marked value.

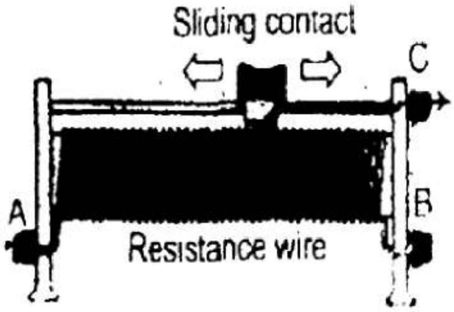
For example:

A 1000 Ω resistor with a tolerance of ± 10% will have an actual resistance anywhere between 900 Ω and 1100 Ω.

Q24: Describe the construction, working and uses of rheostat?

Ans: Rheostat:

It is a wire wound variable resistance.



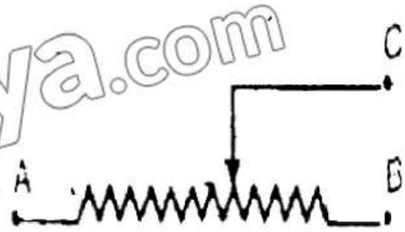
Construction of rheostat:

It consists of a bare manganin wire wound over an insulating cylinder. The ends of the wire are connected to two fixed terminals A and B.

A third terminal C is attached to a sliding contact which can also be moved over the wire.

Use of rheostat:

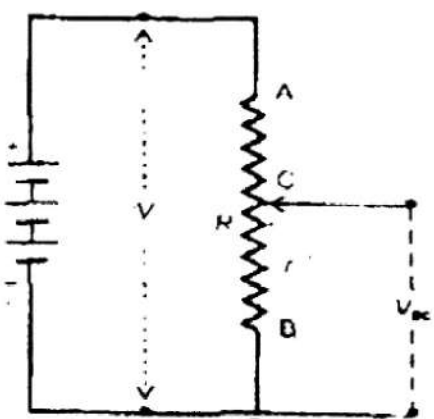
A rheostat can be used as a variable resistor as well as a potential divider.



Working of rheostat as a variable resistor:

To use it as a variable resistor one of the fixed terminal say A and the sliding terminal C are inserted in the circuit.

In this way the resistance of the wire between A and the sliding contact C is used. If the sliding contact is shifted away from the terminal A, the length and hence the resistance included in the circuit increases and if the sliding contact is moved towards A, the resistance decreases.



Working of rheostat as a potential divider:

A rheostat can also be used as a potential divider. This is illustrated in Fig.

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

$$I = V/R$$

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

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

$$V_{BC} = \frac{V}{R} \times r = \frac{r}{R} V \quad \ldots\ldots (1)$$

where r is the resistance of the portion BC of the wire. The circuit shown in Fig. is known as potential divider.

Eq.1 shows that this circuit can provide at its output terminals a potential difference varying from zero to the full potential difference of the battery depending on the position of the sliding contact.

Movement of sliding contact:

www.ilmkidunya.com

As the sliding contact C is moved towards the end B, the length and hence the resistance r of the portion BC of the wire decreases which according to Eq 1, decreases V_{BC}. On the other hand if the sliding contact C is moved towards the end A, the output voltage V_{BC} increases.

Q25: Describe the construction, working and uses of thermistor?

Ans: Thermistors:

A thermistor is a heat sensitive resistor. Most thermistors have negative temperature coefficient of resistance i.e., the resistance of such thermistors decreases when their temperature is increased. Thermistors with positive temperature coefficient are also available.

Construction of thermistor:

Thermistors are made by heating under high pressure semiconductor ceramic made from mixtures of metallic oxides of manganese, nickel, cobalt, copper, iron etc. These are pressed into desired shapes, and then baked at high temperature.

Different types of thermistors are shown in Fig. They may be in the form of beads, rods or washers.

Working of thermistor:

Thermistors with high negative temperature coefficient are very accurate for measuring low temperatures especially near 10 K. The higher resistance at low temperature enables more accurate measurement possible.

Use of thermistor:

Thermistors have wide applications as temperature sensors i.e., they convert changes of temperature into electrical voltage which is duly processed.

Q26: How a zero-ohm resistor is indicated?

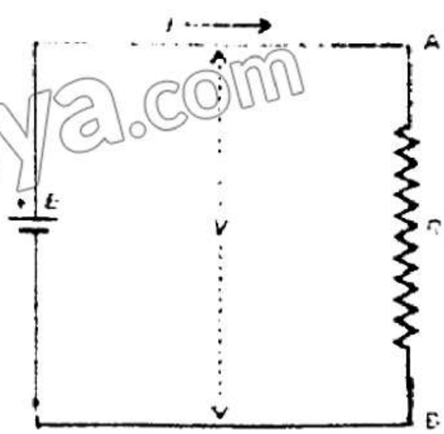
Ans: A zero-ohm resistor is indicated by a single black colour band around the body of the resistor

Q27: Derive a relation for electrical power and power dissipation in resistors?

Ans: Electrical power and power dissipation in resistors

The power of a battery appear as the power dissipated in the resistor R. Using the meaning of potential difference, the work done in moving a charge ΔQ up through the potential difference V is given by

Work done $= \Delta W = V \times \Delta Q$ .... **(1)**



This is the energy supplied by the battery.

Electrical power:

The rate at which the battery is supplying electrical energy is the power output or electrical power of the battery. Using the definition of power we have

$$\text{Electrical Power} = \frac{\text{Energy supplied}}{\text{time taken}} = V\frac{\Delta Q}{\Delta t}$$

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

$$\text{Electrical power} = V \times I \qquad \textbf{(2)}$$

Eq. 2 is a general relation for power delivered from a source of current I operating on a voltage V.

Power dissipation in resistors:

In the circuit shown in Fig. the power supplied by the battery is expended or dissipated in the resistor R. The principle of conservation of energy tells us that the power dissipated in the resistor is also given by Eq. 2

$$\text{Power dissipated } (P) = V \times I \qquad (3)$$

Alternative equation for calculating power can be found by substituting V = IR, in turn I = V/R Eq. 3 becomes

$$P = V \times I = IR \times I = I^2R$$

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

Note:

Thus we have three equations for calculating the power dissipated in a resistor

$$P = V \times I, \qquad P = I^2R, \qquad \text{and} \qquad P = \frac{V^2}{R}$$

If V is expressed in volts and I in amperes, the power is expressed in watts.

Q28: State and prove Joule's law?

Ans: Electric energy and Joule's law:

The amount of heat energy generated in a resistance due to flow of electric current is equal to the product of the square of current I, the resistance R and the time duration t. This is known as Joule's law.

Explanation:

Consider two points having a potential difference of V volts, if one Coulomb of charge passes between these points; the amount of energy supplied by the charge would be V Joule. Then we will get QV joule energy

$$\text{Energy} = W = QV \qquad (\text{Work} = FS = QV)$$

$$W = QV = I \times t \times V \qquad (Q = It)$$

By Ohm's Law

$$V = I \times R$$

$$W = (It)(IR)$$

$$W = I^2Rt$$

This is the mathematical form of Joule's law.

Q29: Derive a relation for electromotive force (emf) and potential difference?

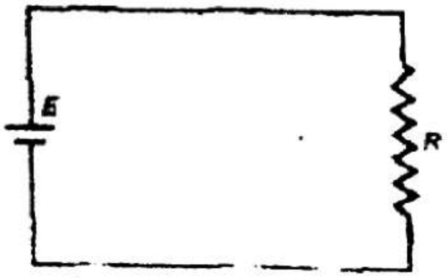
OR

Show that terminal voltage is less than the emf of the source?

Ans: Electromotive force (emf) and potential difference:

i. A source of electrical energy, say a cell or a battery, when connected across a resistance maintains a steady current through it.

ii. The cell continuously supplies energy which is dissipated in the resistance of the circuit.



Suppose when a steady current has been established in the circuit, a charge ΔQ passes through any cross section of the circuit in time Δt. During the course of motion, this

www.ilmkidunya.com

charge enters the cell at its low potential end and leaves at its high potential end. The source must supply energy ΔW to the positive charge to force it to go to the point of high potential.

Electromotive force (emf):

The emf E of the source is defined as the energy supplied to unit charge by the cell

i.e. $$E = \frac{\Delta W}{\Delta Q} \quad \ldots\ldots\ldots \quad (1)$$

Unit of Electromotive force (emf):

It may be noted that electromotive force is not a force and we do not measure it in Newton's. The unit of emf is joule/coulomb which is volt (V)

Internal resistance (r) of the cell:

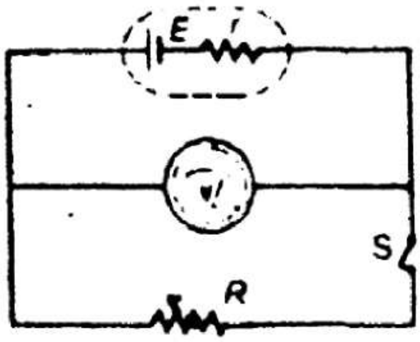
Like other components in a circuit a cell also offers some resistance. This resistance is due to the electrolyte present between the two electrodes of the cell and is called the internal resistance r of the cell.

Relation between electromotive force (emf) and potential difference:

Let us consider the performance of a cell of emf E and internal resistance r as shown in Fig.

A voltmeter of infinite resistance measures the potential difference across the external resistance R or the potential difference V across the terminals of the cell. The current I flowing through the circuit is given by

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



$$E = IR + Ir \quad \ldots\ldots\ldots \quad (2)$$

$$E = V_t + Ir$$

$$V_t = E - Ir \quad \ldots\ldots\ldots \quad (3)$$

Here IR = V is the terminal potential difference of the cell in the presence of current I. When the switch S is open, no current passes through the resistance. In this case the voltmeter reads the emf E as terminal voltage. Thus terminal voltage in the presence of the current (switch on) would be less than the emf E by Ir. (As Shown in Eq. 3)

Q30: Why law of conservation of energy is not satisfied in case of emf and terminal potential difference?

Ans: Law of conservation of energy and emf:

Let us interpret the Eq. ($E = V_t + Ir$) on energy considerations. The left side of this equation is the emf E of the cell which is equal to energy gained by unit charge as it passes through the cell from its negative to positive terminal. The right side of the equation gives an account of the utilization of this energy as the current passes the circuit. It states that, as a unit charge passes through the circuit, a part of this 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 potential drop IR. Thus the emf gives the energy supplied to unit charge by the cell and the potential drop across the various elements account for the dissipation of this energy into other forms as the unit charge passes through these elements.

charge enters the cell at its low potential end and leaves at its high potential end. The source must supply energy ΔW to the positive charge to force it to go to the point of high potential.

Electromotive force (emf):

The emf E of the source is defined as the energy supplied to unit charge by the cell.

i.e. $$E = \frac{\Delta W}{\Delta Q} \qquad (1)$$

Unit of Electromotive force (emf):

It may be noted that electromotive force is not a force and we do not measure it in Newton's. The unit of emf is joule/coulomb which is volt (V).

Internal resistance (r) of the cell:

Like other components in a circuit a cell also offers some resistance. This resistance is due to the electrolyte present between the two electrodes of the cell and is called the internal resistance r of the cell.

Relation between electromotive force (emf) and potential difference:

Let us consider the performance of a cell of emf E and internal resistance r as shown in Fig.

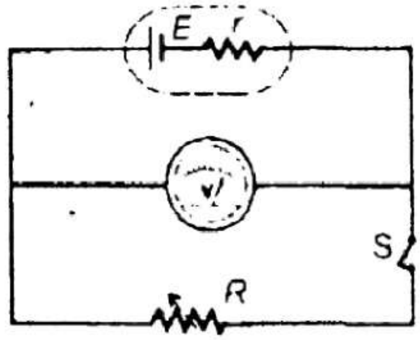
A voltmeter of infinite resistance measures the potential difference across the external resistance R or the potential difference V across the terminals of the cell. The current I flowing through the circuit is given by

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

$$E = IR + Ir \qquad (2)$$

$$E = V_t + Ir$$

$$V_t = E - Ir \qquad \ldots\ldots\ldots (3)$$



Here IR = V is the terminal potential difference of the cell in the presence of current I. When the switch S is open, no current passes through the resistance. In this case the voltmeter reads the emf E as terminal voltage. Thus terminal voltage in the presence of the current (switch on) would be less than the emf E by Ir. (As Shown in Eq. 3).

Q30: Why law of conservation of energy is not satisfied in case of emf and terminal potential difference?

Ans: Law of conservation of energy and emf:

Let us interpret the Eq. ($E = V_t + Ir$) on energy considerations. The left side of this equation is the emf E of the cell which is equal to energy gained by unit charge as it passes through the cell from its negative to positive terminal. The right side of the equation gives an account of the utilization of this energy as the current passes the circuit. It states that, as a unit charge passes through the circuit, a part of this 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 potential drop IR. Thus the emf gives the energy supplied to unit charge by the cell and the potential drop across the various elements account for the dissipation of this energy into other forms as the unit charge passes through these elements

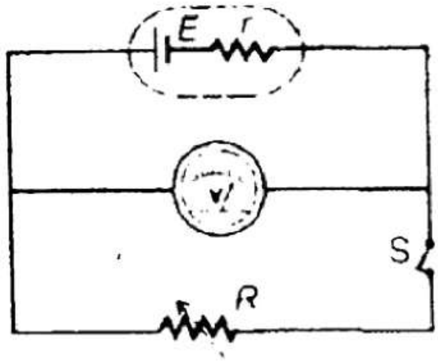
Q31: Describe the difference between emf and potential difference?

Ans: Difference between emf and potential difference:

i. The emf is the "cause" and potential difference is its "effect". **ii.** The emf is always present even when no current is drawn through the battery or the cell, but the potential difference across the conductor is zero when no current flows through it.

Q32: Describe maximum power output?

Ans: Maximum power output:



i. In the circuit of Fig. as the current I flow through the resistance R, the charges flow from a point of higher potential to a point of lower potential and as such, they loose potential energy.

ii. If V is the potential difference across R, the loss of potential energy per second is VI. This loss of energy per second appears in other forms of energy and is known as power delivered to R by current I.

∴ Power delivered to R = P_{out} = VI........ **(1)**

$$P_{out} = I^2 R \;......\; \textbf{(2)}$$

$$(\because V = IR)$$

As

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

From Eq. 2

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

$$P_{out} = \frac{E^2 R}{(R+r)^2} = \frac{E^2 R}{(R-r)^2 + 4Rr} \;........\; \textbf{(3)}$$

Note:

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

ii. Thus we see that maximum power is delivered to a resistance (load), when the internal resistance of the source equals the load resistance.

iii. The value of maximum output power as given by Eq. 3 is $\frac{E^2}{4R}$.

Q33: How voltmeter connected across the terminal of a cell measures emf and terminal potential difference?

Ans: A voltmeter connected across the terminal of a cell measures

(a) the emf of the cell on open circuit

(b) The terminal potential difference on a closed circuit.

Q34: Why we use Kirchhoff's rules?

Ans: Kirchhoff's rules:

Ohm's law and rules of series and parallel combination of resistance are quite useful to analyze simple electrical circuits consisting of more than one resistance. However such a method fails in the case of complex networks consisting of a number of resistors, and a number of voltage sources. Problems of such networks can be solved by a system of analysis, which is based upon two rules, known as Kirchhoff's rules.

www.ilmkidunya.com

Q35: State and explain Kirchhoff's first rule?

Ans: Kirchhoff's first rule (Kirchhoff's point rule):

It states that the sum of all the currents meeting at a point in the circuit is zero i.e.,

$$\sum I = 0 \quad \ldots \quad (1)$$

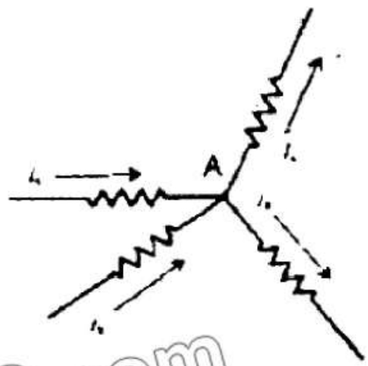
Convention:

It is a convention that a current flowing towards a point is taken as positive and that flowing away from a point is taken as negative.

Explanation:

Consider a situation where four wires meet at a point A.

The currents flowing into the point A are I_1 and I_2 and currents flowing away from the point are I_3 and I_4. According to the convention currents I_1, and I_2 are positive and currents I_3 and I_4, are negative. Applying Eq. 1 we have



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

or $$I_1 + I_2 = I_3 + I_4 \quad \ldots\ldots \quad (2)$$

Using Eq. 2 Kirchhoff's first rule can be stated in other words as

Second statement of Kirchhoff's first rule:

'The sum of all the currents flowing towards a point is equal to the sum of all the currents flowing away from the point."

Kirchhoff's first rule and law of conservation of charge:

Kirchhoff's first rule which is also known as Kirchhoff's point rule is a manifestation of law of conservation of charge. If there is no sink or source of charge at a point, the total charge flowing towards the point must be equal to the total charge flowing away from it.

Q36: State and explain Kirchhoff's second rule?

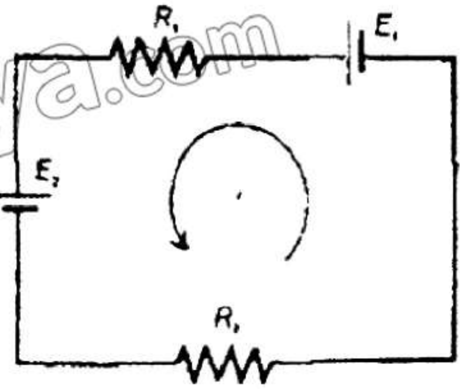
Ans: Kirchhoff's second rule:

It states that the algebraic sum of voltage changes in a closed circuit or a loop must be equal to zero.

Explanation:

i. Consider a closed circuit shown in Fig. The direction of the current I flowing through the circuit depends on the cell having the greater emf.

ii. Suppose E_1, is greater than E_2, so the current flows in counter clockwise direction. We know that a steady current is equivalent to a continuous flow of positive charges through the circuit.



iii. When a positive charge ΔQ due to the current I in the closed circuit, passes through the cell E_2, from low (-ve) to high potential (+ve), it gains energy because work is done on it. The energy gain is $E_1\,\Delta Q$.

iv. 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.

v. 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. The minus sign shows that the charge is passing from high to low potential.

vi. Similarly the loss of energy while passing through the resistor R_2 is $- IR_2 \Delta Q$.

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

viii. According to the law of conservation of energy the total change in energy of our system is zero. Therefore, we can write which is Kirchhoff's second rule and it states that

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

$$E_1 - IR_1 - E_2 - IR_2 = 0 \quad \ldots\ldots\ldots \quad (1)$$

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

Rules for finding the potential changes:

Before applying this rule for the analysis of complex network it is worthwhile to thoroughly understand the rules for finding the potential changes

(i) If a source of emf is traversed from negative to positive terminal, the potential change is positive; it is negative in the opposite direction.

(ii) If a resistor is traversed in the direction of current, the change in potential is negative, it is positive in the opposite direction.

Q37: Discuss procedure of solution of circuit problems?

Ans: Procedure of solution of circuit problems:

(i) Draw the circuit diagram.

(ii) The choice of loops should be such that each resistance is included at least once in the selected loops.

(iii) Assume a loop current in each loop, all the loop currents should be in the same sense. It may be either clockwise or anticlockwise.

(iv) Write the loop equations for all the selected loops. For writing each loop equation the voltage change across any component is positive if traversed from low to high potential and it is negative if traversed 'rom high to low potential.

(v) Solve these equations for the unknown quantities.

Q38: Explain how Wheatstone bridge can be used to find the unknown resistance?

Ans: Wheatstone bridge:

Wheatstone Bridge is an electric circuit that is used to measure the value of an unknown resistance accurately.

Construction of Wheatstone bridge:

The Wheatstone bridge circuit shown in Fig. consists of four resistances R_1, R_2, R_3 and R_4 connected in such a way so as to form a mesh ABCDA. A battery is connected between points A and C. A sensitive galvanometer of resistance R_g is connected between points B and D.

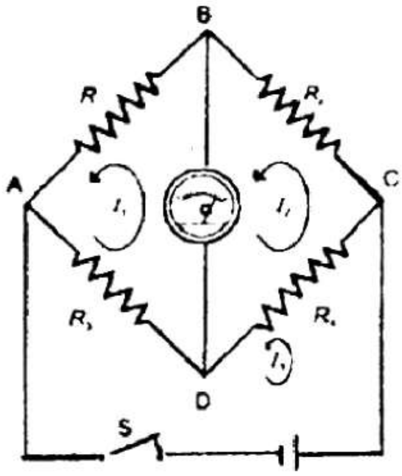
Working of Wheatstone bridge:

If the switch S is closed, a current will flow through the galvanometer. We are to determine the condition under which no current flows through the galvanometer even after the switch is closed. For this purpose we analyses this circuit using Kirchhoff's second rule. We consider the loops ABDA, BCDB and

ADCA and assume anticlockwise loop currents I_1, I_2 and I_3, through the loops respectively.

Application of Kirchhoff's second rule:

The Kirchhoff's second 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 second rule to loop BCDB we have

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

The current flowing through the galvanometer will be zero if,

$$I_1 - I_2 = 0 \quad \text{or } I_1 = I_2.$$

With this condition Eq. 1 and Eq. 2 reduce to

$$-I_1R_1 = (I_1 - I_3)\,R_3 \qquad (3)$$

$$-I_1R_2 = (I_2 - I_3)\,R_4 \qquad (4)$$

Dividing Eq. 3 by Eq. 4 we get,

$$\frac{R_1}{R_2} = \frac{R_3}{R_4} \text{..........} \qquad (5)$$

Note:

i. Whenever the condition of Eq. 5 is satisfied, no current flows through the galvanometer and it shows no deflection, or conversely when the galvanometer in the **Wheatstone bridge** circuit shows no deflection, Eq. 5 is satisfied.

ii. If we connect three resistances R_1, R_2 and R_3 of known adjustable values and a fourth resistance R_4 of unknown value and the resistances R_1, R_2 and R_3 are so adjusted that the galvanometer shows no deflection then, from the known resistances R_1, R_2 and R_3 the unknown resistance R_4 can be determined by using Eq. 5.

Q39: Why the resistance of the voltmeter should be high?

Ans: Potential difference is usually measured by an instrument called a voltmeter. The voltmeter is connected across the two points in a circuit between which 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 to be 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.

Ideal voltmeter:

An ideal voltmeter would have an infinite resistance.

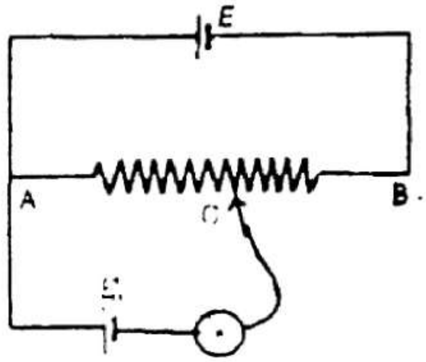
Q40: Why prefer potentiometer as compared to digital voltmeter and cathode ray oscilloscope?

Ans: There are some potential measuring instruments such as digital voltmeter and cathode ray oscilloscope which practically do not draw any current from the circuit because of their large resistance and are thus very accurate potential measuring instruments. But these instruments are very expensive and are difficult to use. A very simple instrument which can measure and compare potential differences accurately is a potentiometer.

Q41: Explain how potentiometer can be used to measure and compare potential differences?

Ans: Potentiometer:

Potentiometer is a simple instrument which is used to measure and compare potential differences accurately.

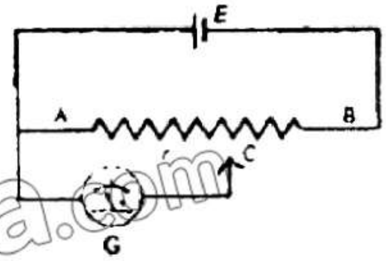


Construction of potentiometer:

A potentiometer consists of a resistor R in the form of a wire on which a terminal C can slide (Fig a.)

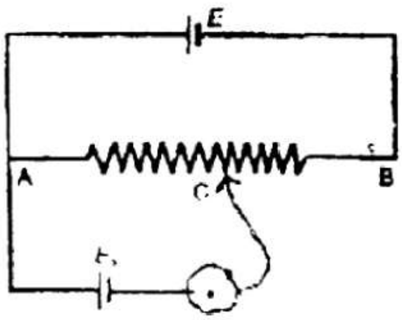
Working of potentiometer:

i. The resistance between A and C can be varied from 0 to R as the sliding contact C is moved from A to B.



ii. If a battery of emf E is connected across R (Fig b.), the current flowing through it is I = E/R. If we represent the resistance between A and C by r, the potential drop between these points will be rI = r E/R.

iii. As C is moved from A to B, r varies from 0 to R and the potential drop between A and C changes from 0 to E. Such an arrangement also known as **potential divider** can be used to measure the unknown emf of a source by using the circuit shown Fig c.



iv. Here R is in the form of a straight wire of uniform area of cross section.

v. A source of potential, say an emf whose emf E_x is to be measured is connected between A and the sliding contact C through a galvanometer G.

vi. It should be noted that the positive terminal of E_x, and that of the potential divider are connected to the same point A.

vii. If, in the loop AGCA, the point C and the negative terminal of E_x, are at the same potential then the two terminals of the galvanometer will be at the same potential and no current will flow through the galvanometer. Therefore, to measure the potential E_x the position of C is so adjusted that the galvanometer shows no deflection. Under this condition, the emf E_x of the cell is equal to the potential difference between A and C whose value Er/R is known.

viii. Calculation of unknown emf:

In case of a wire of uniform cross section, the resistance is proportional to the length of the wire. Therefore, the unknown emf is also given by

$$E_x = E\frac{r}{R} = E\frac{\ell}{L} \quad .... \quad (1)$$

Where L is the total length of the wire AB and ℓ is its length from A to C, after C has been adjusted for no deflection.

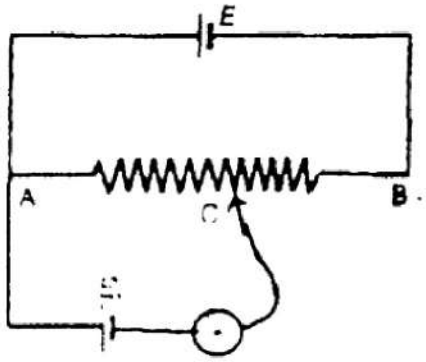
ix. Null condition:

www.ilmkidunya.com

Q41: Explain how potentiometer can be used to measure and compare potential differences?

Ans: Potentiometer:

Potentiometer is a simple instrument which is used to measure and compare potential differences accurately



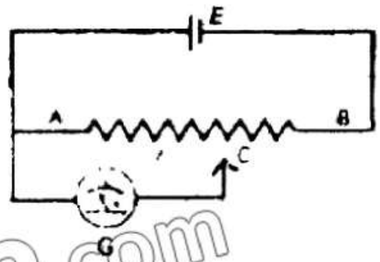
Construction of potentiometer:

A potentiometer consists of a resistor R in the form of a wire on which a terminal C can slide (Fig a.)

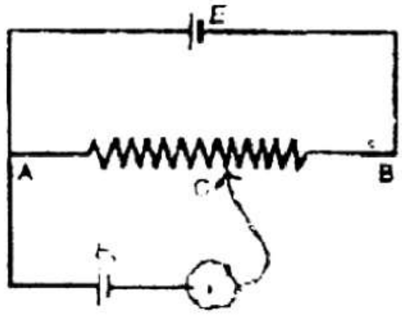
Working of potentiometer:

i. The resistance between A and C can be varied from 0 to R as the sliding contact C is moved from A to B.

ii. If a battery of emf E is connected across R (Fig b.), the current flowing through it is I = E/R. If we represent the resistance between A and C by r, the potential drop between these points will be rI = r·E/R



iii. As C is moved from A to B, r varies from 0 to R and the potential drop between A and C changes from 0 to E. Such an arrangement also known as **potential divider** can be used to measure the unknown emf of a source by using the circuit shown Fig c



iv. Here R is in the form of a straight wire of uniform area of cross section.

v. A source of potential, say an emf whose emf E_x is to be measured is connected between A and the sliding contact C through a galvanometer G.

vi. It should be noted that the positive terminal of E_x, and that of the potential divider are connected to the same point A.

vii. If, in the loop AGCA, the point C and the negative terminal of E_x, are at the same potential then the two terminals of the galvanometer will be at the same potential and no current will flow through the galvanometer. Therefore, to measure the potential E_x the position of C is so adjusted that the galvanometer shows no deflection. Under this condition, the emf E_x of the cell is equal to the potential difference between A and C whose value Er/R is known.

viii. **Calculation of unknown emf:**

In case of a wire of uniform cross section, the resistance is proportional to the length of the wire. Therefore, the unknown emf is also given by

$$E_x = E\frac{r}{R} = E\frac{\ell}{L} \quad .... \quad (1)$$

Where L is the total length of the wire AB and ℓ is its length from A to C, after C has been adjusted for no deflection.

ix. **Null condition:**

www.ilmkidunya.com

As the maximum potential that can be obtained between A and C is E, so the unknown emf E_x, should not exceed this value, otherwise the null condition will not be obtained.

x. It can be seen that the unknown emf E_x determined when no current is drawn from it and therefore, potentiometer is one of the most accurate methods for measuring potential.

xi. Comparison of the emfs:

The method for measuring the emf of a cell as described above can be used to compare the emfs E_1, and E_2 of two cells. The balancing lengths, ℓ_1 and ℓ_2 are found separately for the two cells. Then,

$$E_1 = E\frac{\ell_1}{L} \quad \text{and} \quad E_2 = E\frac{\ell_2}{L}$$

Dividing these two equations, we get

$$\frac{E_1}{E_2} = \frac{\ell_1}{\ell_2} \quad \ldots\ldots\ldots\ldots\ldots \quad (2)$$

So equation 2 shows that the ratio of the emfs is equal to ratio of the balancing lengths.

SUMMARY

1. The electric current is said to be caused by the motion of electric charge.
2. The heat energy H produced by a current I in the wire of resistance R during a time interval t is given by $H = I^2Rt$
3. The passage of current is always accompanied by a magnetic field in the surrounding space.
4. Certain liquids conduct electricity due to some chemical reaction that takes place within them. The study of this process is known as electrolysis.
5. The potential difference V across the ends of a conductor is directly proportional to the current I flowing through it provided the physical state such as temperature etc. of the conductor remains constant.
6. The fractional change in resistance per kelvin is known as temperature coefficient of resistance.
7. A thermistor is a heat sensitive resistor. Most thermistors have negative temperature coefficient of resistance.
8. Electrical power $P = VI = I^2R = \frac{V^2}{R}$
9. The emf E of the source is the energy supplied to unit charge by the cell
10. The sum of all the currents meeting at a point in a circuit is zero is the Kirchhoff's first rule.
11. The algebraic sum of potential changes in a closed circuit is zero is known as Kirchhoff's second rule.

SOLUTION OF EXERCISE

13.1. A potential difference is applied across the ends of a copper wire. What is the effect on the drift velocity of the free by:

(a) Increasing potential difference

(b) Decreasing length and temperature of the wire

Ans: Drift velocity:

The average directed velocity along the conductor in the presence of applied electric field is called drift velocity and is given by

$$v_d = \frac{eE\tau}{m}$$

Where τ is relaxation time, E is electric field strength and m is mass of the electron

(a) The drift velocity of free electrons increases with increases of potential difference because by increasing potential difference electric field increases.

$$v_d \propto V \quad \text{or} \quad v_d \propto E$$

(b) Decreasing resistance and temperature of the wire it increases electric current (rate of flow of charges) which demands increase in drift velocity because

$$v_d \propto \frac{1}{R} \quad \text{and} \quad v_d \propto \frac{1}{L}$$

13.2. Do bends in a wire affect its resistance?

Ans: Bends in a wire have no effect on its electric resistance because the electrons whose motion constitutes an electric current are extremely small with very little mass and therefore can change direction readily.

As the dimensions (length, diameter, volume etc.) of a wire are not affected by the bends, then its resistance will not be affected by the bends.

13.3. What are the resistances given in the figures A and B? What is the tolerance of each? Explain what is meant by tolerance?

Ans:

Fig A:

First digit for brown colour = 1

Second digit for green colour = 5

Number of zeros for red colour = 00

(Because red colour has value 2 therefore it has two zeros)

R = resistance = 1500 Ω

4^{th} digit for gold represents tolerance = ± 5%

R = 1500 ± 5% Ω ⇒ R = 1500 ± 75 Ω

www.ilmkidunya.com

$\Rightarrow \quad R = 1425 \text{ to } 1575\ \Omega$

Fig B:

First digit for yellow colour = 4
Second digit for white colour = 9
Number of zeros for orange colour = 000
(Because orange colour has value 3 therefore it has three zeros)
R = resistance = 49000 Ω
4^{th} digit for silver represents tolerance = ± 10%
$R = 49000 \pm 10\%\ \Omega$ $\Rightarrow R = 49000 \pm 4900\ \Omega$
$\Rightarrow \quad R = 44100 \text{ to } 53900\ \Omega$.

Tolerance:

Tolerance is the variation of the actual resistance from the marked value on the resistor.

13.4. Why does the resistance of a conductor increase with rise in temperature?

Ans: Effect of Temperature upon Resistance:

When the temperature of the conductor rises, average speed of the random motion of the free elec trons increases which enhances the rate of collision of electrons and the atoms. This causes an increase in the resistance of the conductor. The increase in resistance is directly proportional to the increase of temperature. i.e. $T \propto R$.

13.5. What are the difficulties in testing whether filament of a lighted bulb obeys Ohm's law?

Ans: When the current in an electric bulb rises to a maximum then its temperature and resistance increases. To apply Ohm's law we must have resistance and temperature constant. In bulb it doesn't happen, and its V-I graph is not a straight line Showing that bulb is non Ohmic.

13.6. Is filament resistance lower or higher in a 500 W, 220 V light bulbs than in a 100 W, 220 V bulbs?

Ans: Since $R = \frac{V^2}{P}$

Now $R_1 = \frac{(220)^2}{500} = 96.8\ \Omega$

Also $R_2 = \frac{(220)^2}{100} = 484\Omega$

Clearly, R_1 is less than R_2.

Hence, 500 W, 220 V bulb has lower filament resistance than 100 W, 220 V bulb.

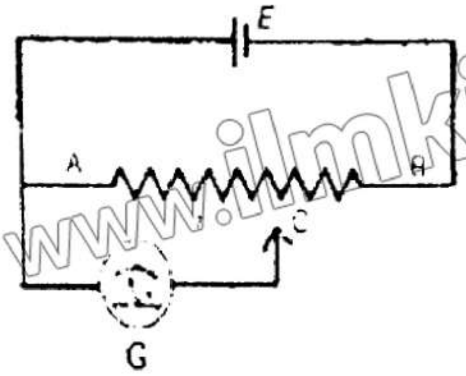
13.7. Describe a circuit which will give a varying potential?

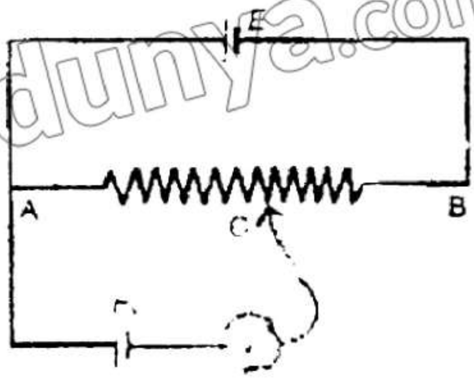
Ans: A potential divider circuit can give a continuously varying potential.

For example:

Rheostat, potentiometer etc

iii. As C is moved from A to B, r varies from 0 to R and the potential drop between A and C changes from 0 to E. Such an arrangement also known as **potential divider** can be used to measure the unknown emf of a source by using the circuit shown Fig c.





13.8. Explain why the terminal potential difference of a battery decreases when the current drawn from it is increased?

Ans: Since $V = E - Ir$

This relation shows that the terminal potential difference of a battery decreases when the current drawn from it is increased.

The reason is that a battery of emf. e, suffers an internal potential drop (Ir) due to its internal resistance (r).

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

Ans: Wheatstone bridge:

Wheatstone bridge is an electric circuit that is used to measure the value of an unknown resistance accurately.

Determination of an unknown resistance:

If we connect three resistances R_1, R_2 and R_3 of known adjustable values and a fourth resistance R_4 of unknown value and the resistances R_1, R_2 and R_3 are so adjusted that the galvanometer shows no deflection then, from the known resistances R_1, R_2 and R_3 the unknown resistance R_4 can be determined by using Eq

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

SOLUTION OF EXAMPLES

Example 13.1: 1.0×10^7 electron pass through a conductor in 1.0 μs. Find the current in ampere flowing through the conductor. Electronic charge is 1.6×10^{-19}C.

Number of electrons	=	n	=	1.0×10^7
Time taken = Δt = 1.0 μs	=			1.0×10^{-6} s
Charge on electron	=	e	=	1.6×10^{-19} C
Current	=	I	=	?

Using the formula.

$$I = \frac{\Delta Q}{\Delta t} \qquad \text{(Since Q= ne)}$$

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

$$I = \frac{1.0 \times 10^7 \times 1.6 \times 10^{-19}}{1.0 \times 10^{-6}} = 1.6 \times 10^{-6} \text{A}$$

Example 13.2: 0.75 A current flows through an iron wire when a battery of 1.5V is connected across its ends. The length of the wire is 5.0 m and its cross-sectional area is $2.5 \times 10^{-7} m^2$. Compute the resistivity of iron.

Current = I = 0.75A

Potential difference = V = 1.5V

Length of the wire = L = 5.0 m

Area of cross-section of wire = A = $2.5 \times 10^{-7} m^2$

Resistivity of iron = ρ =?

By Ohm's law

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

$$R = \frac{1.5}{0.75} = 2.0\ VA^{-1} = 2.0\ \Omega \qquad (\because VA^{-1} = \Omega)$$

Since

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

$$\rho = \frac{2.0 \times 2.5 \times 10^{-7}}{5.0} = 1.0 \times 10^{-7}\ \Omega m$$

Example 13.3: **A platinum wire has resistance of 10 Ω at 0°C and 20 Ω at 273°C. Find the value of temperature coefficient of resistance of platinum?**

Resistance of wire at 0°C = R_0 = 10 Ω

Resistance of wire at 273°C = R = 20 Ω

Initial temperature = t_1 = 0 + 273 = 273 K

Final temperature = t_2 = 273 + 273 = 546 K

Temperature difference = t = $t_2 - t_1$ = 546 K - 273 K = 273 K

Temperature coefficient of resistance = α = ?

Temperature coefficient of resistance = $\alpha = \frac{R_t - R_0}{R_0 t}$

$$\alpha = \frac{20 - 10}{10 \times 273} = \frac{1}{273} = 3.66 \times 10^{-3}\ K^{-1}$$

Example 13.4: **The potential difference between the terminals of a battery in open circuit is 2.2 V. When it is connected across a resistance of 5.0 Ω, the potential falls to 1.8 V. Calculate the current and the internal resistance of the battery.**

Potential difference = E = 2.2V

Resistance = R = 5.0 Ω

Fall in potential = V = 1.8 V

(i) Current = I =?

(ii) Internal Resistances = r = ?

(i) By Ohm's law

$$V = IR$$

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

$$I = \frac{1.8}{5.0} = 0.36\ A$$

(ii) **Internal resistance 'r' can be calculated by using the relation**

$E = V + Ir \Rightarrow E - V = Ir \Rightarrow r = \frac{E - V}{I}$

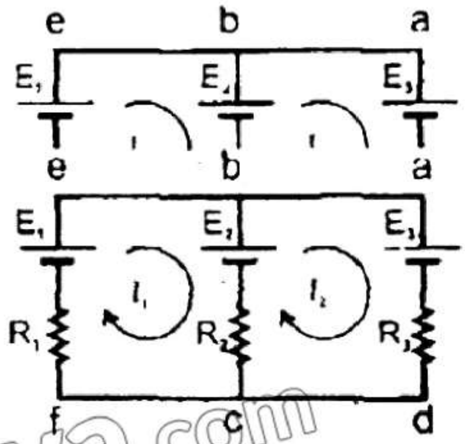
$$r = \frac{2.2 - 1.8}{0.36} = \frac{0.4}{0.36} = 1.11\ \Omega$$

www.ilmkidunya.com

Example13.5: Calculate the currents in the three resistance of the circuit as shown in the figure given below:

$R_1 = 10\ \Omega$
$R_2 = 30\ \Omega$
$R_3 = 15\ \Omega$
$E_1 = 40\ \Omega$
$E_2 = 60\ \Omega$
$E_3 = 50\ \Omega$

Solution:



(i) Current through R_1 = ?
(ii) Current through R_2 = ?
(iii) Current through R_3 = ?

Direction of current in the loops, abcda and befcb is clockwise. Starting from point 'a' and applying Kirchhoff's 2[nd] rule, we have

For Loop abcda:

$$-E_1 - I_1R_1 - (I_1 - I_2) R_2 + E_2 = 0 .... (1)$$

For Loop ebace:

$$-E_2 - (I_2 - I_1) R_2 - I_2E_2 = 0 \quad .... (2)$$

Using values in (1), we have

$$-40 - I_1 \times 10 - (I_1 - I_2) \times 30 + 60 = 0$$
$$20 - 10 [(I_1 + 3 (I_1 - I_2)] = 0$$
$$20V - 10 (I_1 + 3I_1 - 3I_2) = 0$$
$$4I_1 - 3I_2 = 2V\Omega^{-1} = 2A$$

Substituting the values in (2), we have

$$-60 - (I_2 - I_1) \times 30 - I_2 \times 15 + 50 = 0$$
$$10 - 15 \times [I_2 + 2(I_2 - I_1)] = 0$$
$$-15 (I_2 + 2I_2 - 2I_1) = 10$$

Multiplying both sides by 3, we have

$$6I_1 - 9I_2 = \frac{30}{15} = 2A \quad ...... (ii)$$

In order to solve this equation for 'I_1' and 'I_2' multiply Eq. (i) by 3 Eq (ii) by 2, we have

$$12I_1 - 9I_2 = 6A$$
$$12I_1 - 18I_2 = 4A$$
$$- \quad + \quad -$$
$$9 I_2 = 2A$$
$$I_2 = \frac{2}{9} A$$

Substituting this value of I_2 in Eq. (i) we have

$$4I_1 = -3 \times \frac{2}{9} A = 2A \Rightarrow 4I_1 - \frac{2}{3} A = 2A$$
$$4I_1 = 2A + \frac{2}{3} A = \frac{8A}{3} \Rightarrow I_1 = \frac{2A}{3}$$

The given figure shows that 'I_1' and 'I_2' are the actual current through the resistances 'R_1' is the difference of 'V and 'I_2' and its direction is along the larger current.

Current passing through $R_1 = I_1 = \frac{2}{3} A = 0.66A$

The direction of 'I_1' is from a to d

Current passing through R_2 = I_2 = $\frac{2}{9}$ A = 0.22 A

The direction of this current is from f to c

SOLUTION OF PROBLEMS

13.1 How many electrons pass through an electric bulb in one minute if the 300 mA current is passing through it?

Solution:

Time	=	t	=	1 min.	=	60 s
Current	=	I	=	300 mA	=	0.3 A

Number of electrons = n =?

Since $I = \frac{Q}{t}$ ⇒ $Q = I \times t$ .... (1)

But,

Total charge = Q = ne .... (2)

Comparing Equations (1) and (2) we get,

$$n \times e = I \times t$$

$$n = \frac{I \times t}{e}$$

$$n = \frac{0.3 \times 60}{1.6 \times 10^{-19}} = 1.125 \times 10^{20} \text{ electrons}$$

13.2 A charge of 90 C passes through a wire in 1 hour and 15 minutes. What is the current in the wire?

Solution:

Charge = q = 90 C

Time = t = 1 hour & 15 minutes = 75 minutes = 75 × 60 s = 4500 s

Current = I = ?

Since $I = \frac{Q}{t}$ (1)

Using values in equation (1) we get

$$I = \frac{90}{4500} = 0.02 \text{ A} = 20 \text{ mA}$$

13.3 Find the equivalent resistance of the circuit total current drawn from the source and the current through each resistor.

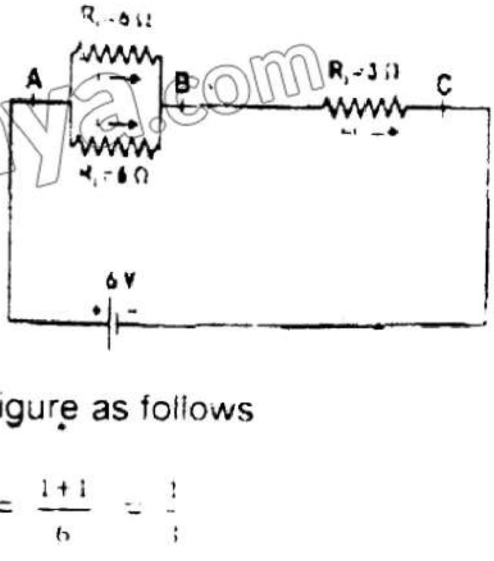
Solution:

R_1 = 6 Ω

R_2 = 6 Ω

R_3 = 3 Ω

V = 6V



Equivalent Resistance = R_{eq} =? Total current = I =?

Current through R_1 = I_1 = ?

Current through R_2 = I_2 = ?

Current through R_3 = I_3 = ?

In order to solve this numerical first of all we label the figure as follows

For the parallel combination of R_1 and R_2

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

www.ilmkidunya.com

The direction of ' I ' is from a to d

Current passing through R_2 = I_2 = $\frac{2}{9}$ A = 0.22 A

The direction of this current is from f to c

SOLUTION OF PROBLEMS

13.1 How many electrons pass through an electric bulb in one minute if the 300 mA current is passing through it?

Solution:

Time = t = 1 min. = 60 s

Current = I = 300 mA = 0.3 A

Number of electrons = n =?

Since $I = \frac{Q}{t}$ ⇒ $Q = I \times t$ .... (1)

But,

Total charge = Q = ne .... (2)

Comparing Equations (1) and (2) we get,

$$n \times e = I \times t$$

$$n = \frac{I \times t}{e}$$

$$n = \frac{0.3 \times 60}{1.6 \times 10^{-19}} = 1.125 \times 10^{20} \text{ electrons}$$

13.2 A charge of 90 C passes through a wire in 1 hour and 15 minutes. What is the current in the wire?

Solution:

Charge = q = 90 C

Time = t = 1 hour & 15 minutes = 75 minutes = 75 × 60 s = 4500 s

Current = I = ?

Since $I = \frac{Q}{t}$ (1)

Using values in equation (1) we get,

$$I = \frac{90}{4500} = 0.02 \text{ A} = 20 \text{ mA}$$

13.3 Find the equivalent resistance of the circuit total current drawn from the source and the current through each resistor.

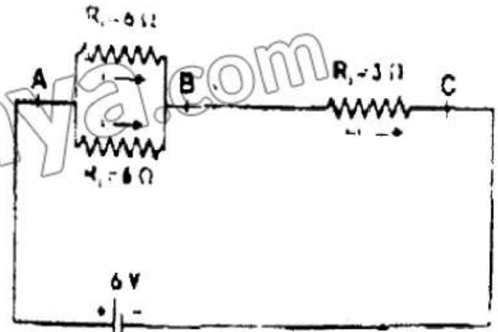
Solution:

R_1 = 6 Ω

R_2 = 6 Ω

R_3 = 3 Ω

V = 6V



Equivalent Resistance = R_{eq} =? Total current = I =?

Current through R_1 = I_1 = ?

Current through R_2 = I_2 = ?

Current through R_3 = I_3 = ?

In order to solve this numerical first of all we label the figure as follows

For the parallel combination of R_1 and R_2

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

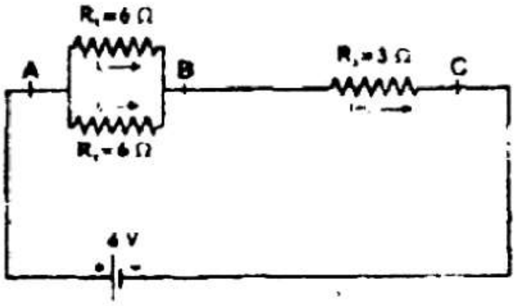
$R = 3\,\Omega$

This resistance R will be in series with R_3

$R_{eq} = R + R_3 = 3 + 3 = 6\,\Omega$

According to Ohm's law,

$$I = \frac{V}{R_{eq}}$$



Using values we get,

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

Again using Ohm's law,

$$V_{BC} = IR_3$$

$$V_{BC} = 1 \times 3 = 3\text{ volts}$$

It is clear that,

$V_{AB} + V_{BC} = 6V \quad \Rightarrow \quad V_{AB} = 6V - V_{BC} = 6V - 3V = 3V$

Now,

$$I = \frac{V_{AB}}{R_1} = \frac{3}{6} = 0.5\text{ A}$$

And, $I_2 = \frac{V_{AB}}{R_2} = \frac{3}{6} = 0.5\text{ A}$

From figure it is clear that,

$$I_1 = I = 1\text{ A}$$

13.4 A rectangular bar of iron is 2.0 cm by 2.0 cm in cross section and 40 cm long. Calculate its resistance if the resistivity of iron is 11 × 10 Ωm.

Solution:

Area $= A = 2cm \times 2cm = 4cm^2 = 4 \times 10^{-4}\text{ m}^2$

Length $= L = 0.40$ m

Resistivity $= \rho = 11 \times 10^{-8}\,\Omega$ m

Resistance $= R = ?$

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

$$R = \frac{11 \times 10^{-8} \times 0.40}{4 \times 10^{-4}} = 11 \times 10^{-5} = 1.1 \times 10^{-4}\,\Omega$$

13.5 The resistance of an iron wire at 0 °C is 1 × 10^4 Ω. What is the resistance at 500° C if the temperature coefficient of resistance of iron is 5.2 × 10^{-3} K^{-1}?

Solution:

Lower Temperature $= T_0 = 0\,°C = 0 + 273 = 273$ K

Higher Temperature $= T = 500\,°C = 500 + 273 = 773$ K

Temperature Difference $= \Delta T = T - T_0 = 773 - 273 = 500$ K

Resistance at $T_0 = R_0 = 1 \times 10^4\,\Omega$

Temperature co-efficient $= \alpha = 5.2 \times 10^{-3}\text{ K}^{-1}$

Resistance at T $= R_t = ?$

Since $R_t = R_0 (1 + \alpha\,\Delta T)$

$R_t = 1 \times 10^4 \times 1 + 5.2 \times 10^{-3} \times 500$

$R_t = (1 + 2600 \times 10^{-3}) \times 10^4$

$= (1 + 2.6) \times 10^4$

$R_t = 3.6 \times 10^4\,\Omega$

www.ilmkidunya.com

13.6 Calculate terminal potential difference of each of cells in circuit of Fig.

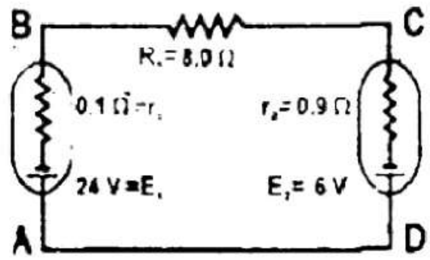
Solution:

In the given circuit the battery with emf 24 V is the charger and the battery with emf 6 V is being charged. We have to determine

$V_{AB} = ?$ and $V_{CD} = ?$

Total resistance of the circuit $= R = r_1 + R_1 + r$

$\Rightarrow \quad R = 0.1 + 8 + 0.90 = 9\,\Omega$



From the figure it is clear that both batteries will oppose each other therefore,

$V = 24 - 6 = 18$ volt.

According to ohm's law,

$$I = \frac{V}{R} = \frac{18}{19} = 2A$$

For 24 V battery which is being discharged we can write,

$E_1 = Ir + V_{AB}$

$24 = 2 \times 0.1 + V_{AB}$

$V_{AB} = 24 - 0.2 \text{ volts} = 23.8 \text{ volts}$

For the 6 V battery which is being charged

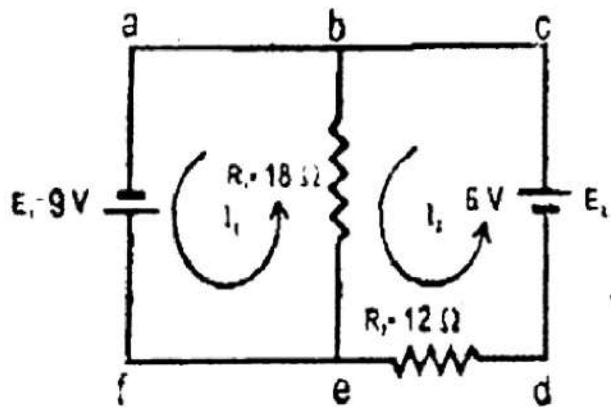
$V_{CD} = E_2 + Ir$

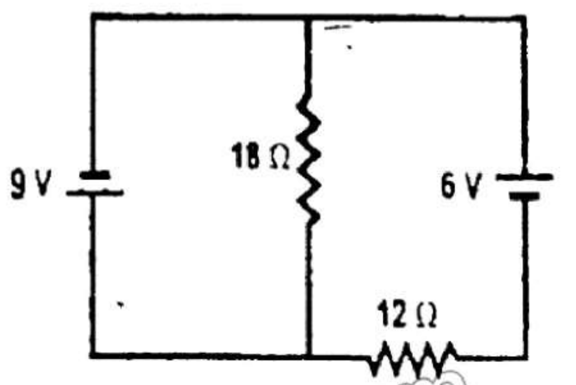
$V_{CD} = (6 + 2 \times 0.9) = (2.4 + 1.8) = 7.8$ volts

13.7 Find the current which flows in all the resistance of the circuit of Fig.

Solution:

First of all label both the loops and name the currents as I_1 and I_2 in the anticlockwise direction.





Applying the Kirchhoff's 2nd rule to loop afeba we get,

$E_1 - (I_1 - I_2) R_1 = 0$

$9 - (I_1 - I_2)18 = 0 \quad \Rightarrow 8(I_1 - I_2) = 9 \quad \Rightarrow \quad (I_1 - I_2) = 9/18$

$I_1 - I_2 = 0.5A$.......... (1)

$I_1 = 0.5A + I_2$..........(2)

Equation for loop edcbe,

$- I_2R_2 + E_2 - (I_2 - I_1) R_1 = 0$

$0 = -I_2R_2 + 6 - (I_2 - I_1)18$

$6 = + I_2R_2 + (I_2 - I_1)18 \quad \Rightarrow \quad 6 = +I_2R_2 + 18I_2 - 18I_1$

www.ilmkidunya.com

$6 \quad = \quad +12I_2 + 18I_2 - 18I_1 \qquad \Rightarrow \quad 6 = 30I_2 - 18I_1$

Dividing both sides by 6 we get

$1 \quad = \quad 5I_2 - 3I_1$ .... (3)

Using the value of I_1 from equation (2) in equation (3), we get,

$1 \quad = \quad 5I_2 - 3\,(0.5 + I_2) \qquad \Rightarrow \quad 1 = 5I_2 - 1.5 - 3I_2$

$1 + 1.5 = \quad 5I_2 - 3I_2 \qquad \Rightarrow \quad 1 + 1.5 = 5I_2 - 3\,I_2 \qquad \Rightarrow \quad 2.5 = 2\,I_2$

$I_2 \quad = \quad 1.25A$

Putting this value of I_2 in eq. (2) we get

$I_1 \quad = \quad 0.5 + 1.25 \qquad \Rightarrow \quad I_1 = 1.75A$

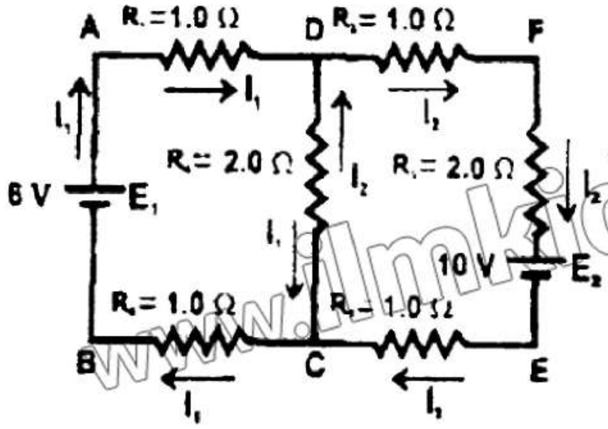
Current through R_2 = I_2 = 1.25 A

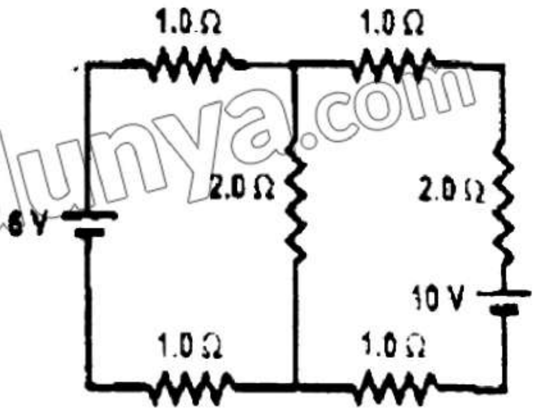
Current through R_1 = $I_1 - I_2$ = 1.75 – 1.25 = 0.50 A

13.8 Find the current and power dissipated in each resistance of the circuit, shown in Fig.

Solution:

We complete the loop as follows,





According to Kirchhoff's rule the loop for ABCDA,

$E_1 - I_1R_6 - (I_1 - I_2)\,R_4 - I_1R_1 = 0$

$6 - I_1 - 2\,(I_1 - I_2) - I_1 \quad = \quad 0 \qquad \Rightarrow \quad 6 - I_1 - 2I_1 + 2I_2 - I_1 = 0$

$6 - 4I_1 + 2I_2 = 0 \qquad \Rightarrow \quad -4I_1 + 2I_2 = -6$

Dividing both sides by 2 we get

$-2I_1 + I_2 = \quad -3$ .... (1)

$I_2 \quad = \quad 2I_1 - 3$ .... (2)

For loop EFDCE,

$-E_2 - I_2R_3 - I_2R_2 - (I_2 - I_1)\,R_4 - I_2R_5 = 0$

$-10 - 2I_2 - I_2 - 2\,(I_2 - I_1) - I_2 \quad = \quad 0$

$-10 - 2I_2 - I_2 - 2I_2 + 2I_1 - I_2 \quad = \quad 0 \qquad \Rightarrow \quad -10 - 6I_2 + 2I_1 = 0$

Dividing both sides by 2, we get,

$-5 - 3I_2 + I_1 \quad = \quad 0$

$I_1 \quad = \quad 3I_2 + 5$ .... (3)

Using this value of I_1 in equation (2) we get,

$I_2 \quad = \quad 2\,(3I_2 + 5) - 3 \quad = \quad 6I_2 + 10 - 3$

$5I_2 \quad = \quad 7 \qquad \Rightarrow \quad I_2 = 1.4A$

Putting this value of I_2 in Eq. (3), we get,

$I_1 \quad = \quad 3\,(1.4) - 5 \quad = \quad 4.2 - 5 = -0.8\ A$

Taking only magnitude we can write,

Current through R_1 = I_1 = 0.8 A

www.ilmkidunya.com

Current through R_2 $= I_2 =$ 1.4 A
Current through R_3 $= I_2 =$ 1.4 A
Current through R_4 $= I_1 - I_2 = -0.8 - 1.4 = -2.2$ A
$=$ 2.2 A (Magnitude only)
Current through R_5 $= I_2 =$ 1.4 A
Current through R_6 $= I_1 =$ 0.8 A
Now,

Power dissipation through $R_1 = I_1^2\ R_1 = (0.8)^2\ (1) = 0.64$ watt
Power dissipation through $R_2 = I_2^2\ R_2 = (1.4)^2\ (1) = 1.96$ watt
Power dissipation through $R_3 = I_3^2\ R_3 = (1.4)^2\ (2) = 3.92$ watt
Power dissipation through $R_4 = I_4^2\ R_4 = (2.2)^2\ (2) = 9.68$ watt
Power dissipation through $R_5 = I_5^2\ R_5 = (1.4)^2\ (1) = 1.96$ watt
Power dissipation through $R_6 = I_6^2\ R_6 = (0.8)^2\ (1) = 0.64$ watt

www.ilmkidunya.com
www.ilmkidunya.com
www.ilmkidunya.com