Physics Homework

Here are some worksheets related to chapter - Electricity in Physics.

Read the worksheets and write the answers of practice questions in a separate thin notebook.

This notebook will be collected and assessed in July.

All the Best!

Class: X Name of the student:____________________Name of the Class Teacher: _________

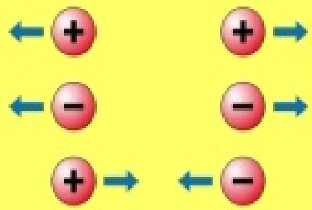
ELECTRICITY

CHARGE : is a fundamental property of an atom. The atoms are constituted of electrons, protons and neutrons. We can say that electric charge is the property of matter that causes it to experience force.

Charge may be positive or negative.

Like charges repel each other.

Unlike charges attract each other.



coulomb(C): is the S.I. unit of charge

Charge on 1 electron = Negative charge of 1.6×10^{-19} C

If the charge on an electron is 'e' and 'n' is the no. of electrons passing through any point in time 't', then the charge (Q) can be written as

Charge = number of electrons x charge of an electron

$$\boxed{Q = ne}$$

Here Number of Electrons in 1C charge =

$n = Q / e \quad Q = 1\ C \qquad e = 1.6 \times 10^{-19}$

$n = Q / e \quad = 6.25 \times 10^{18}$

Hence , 1 coulomb = charge on 6.25×10^{18} electrons

Let us Practice:

1.Write the S.I. unit of Charge and Current.

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

ELECTRIC CURRENT: Electric current is expressed by the amount of charge flowing through a particular area in unit time. In other words, it is the rate of flow of electric charges in a conductor.

If a net charge Q, flows across any cross-section of a conductor in time t, then the current I, through the cross-section is

$$\boxed{I = Q / t}$$

The S.I. unit of Electric current is **ampere** (A) named after the French scientist Andre - Marie Ampere.

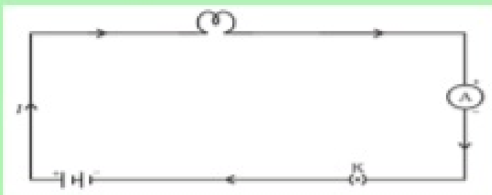
One ampere is constituted by the flow of one coulomb of charge per second, that is

$$\boxed{1\ A = 1\ C/1\ s}$$

1 milliampere $\longrightarrow$ 1 mA = 10^{-3}A

1 microampere $\longrightarrow$ 1 µA = 10^{-6} A

Ammeter is the instrument which measures electric current in the circuit. It is always connected in **series** in a circuit through which the current is measured.



Direction of Flow of Electric Current in a circuit: Electric current flows in the circuit from the positive terminal of the cell to the negative terminal of the cell through the bulb and ammeter.

ELECTRIC POTENTIAL (V):The work done(W),in a current carrying conductor, to move a unit positive charge(Q) from infinity to any point A is called electric potential(V)

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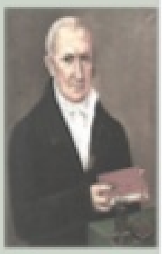
Electricity

Potential Difference

The electric potential difference between two points in an electric circuit carrying some current is defined as-

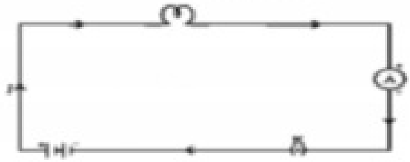
- **the work done to move a unit charge from one point to the other.**
- Potential difference = Work done(W) / Charge (Q)
- **V = W/Q**
- The SI unit of electric potential difference is volt (V).
- **One volt** is the potential difference between two points in a current carrying conductor when **1 joule of work** is done to move a charge of **1 coulomb** from one point to the other.
- **1 volt = 1 joule/ 1 coulomb**
- **$1V = 1JC^{-1}$.**
- The potential difference is measured by means of an instrument called the **voltmeter.**
- The voltmeter is always connected in parallel across the points between which the pot. diff. is to be measured.



Alessandro Volta, an Italian physicist [The SI unit of P.D(volt) is named after him]

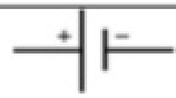
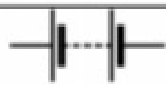
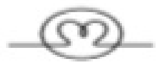
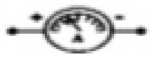
Electric Circuit

A continuous and closed path of an electric current is called an electric circuit .If the circuit is open or broken anywhere, the current stops flowing .
An **electric circuit,** comprises a cell (or a battery), a plug key, electrical component(s), and connecting wires.



Symbols

Conventional symbols used to represent some of the most commonly used electrical components.

Components	*Symbols*
Connecting wires	
Resistor	
Cell	
Battery	
Plug /Key	
Bulb	
Ammeter	
Voltmeter	

Let us do some practice

1. What is meant by saying that the potential difference between two points is 1V?
2. Draw the symbols of the given components used in an electric circuit diagram -- Battery, Cell, Resistor and closed key.
3. Name the device that helps to maintain potential difference across a conductor.
4. Differentiate between Open and closed circuits.

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ELECTRICITY

OHM'S LAW

In 1827, **George Simon Ohm**, a German physicist, derived a relationship between electric current (I) and potential difference (V). This relationship is known as **Ohm's Law.**

Ohm's Law: It states that the current flowing through a conductor is directly proportional to the potential difference applied across its ends, provided the temperature and other conditions remain unchanged.

Mathematically, it is represented as -

Potential difference α current

Here, **V**- Voltage in volts (V)

I – Current in ampere (A)

R–Resistance for a given metal in ohm (Ω)

V α I

V= I R

R=V/ I

Resistance is constant for the given metallic wire at a given temperature.

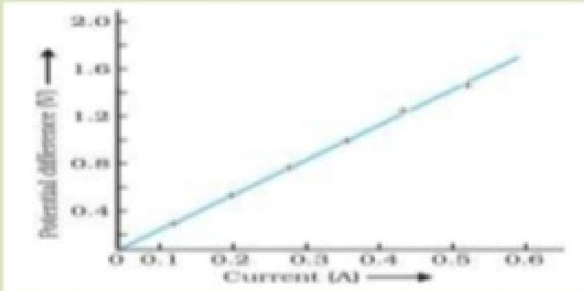
SI unit=ohm or Ω

$$1 \text{ ohm} = \frac{1 \text{ volt}}{1 \text{ ampere}}$$

I= V/R

$$\textbf{Current } \alpha \ \frac{1}{\text{Resistance}}$$

V-I graph for a nichrome* wire.



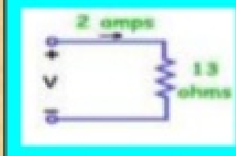
A straight line plot shows that as the current through a wire increases, the potential difference across the wire increases linearly- this is Ohm's Law.

**Nichrome is an alloy of nickel, chromium, manganese & iron.*

Let's practice-

1. State Ohm's Law. What is the relation between I, Vand R? Draw the graph between V and I.

2.. If the resistance of an electric circuit is increased , what will happen to the current ,assuming the voltage remains the same?



3. What is the voltage V in the circuit shown here?

4. If there are10 volts across a 5 ohm resistor, what is the current?

5..Define 1 ohm.

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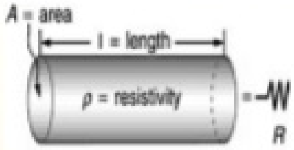
Electricity

RESISTANCE: The property of a conductor to resist the flow of charges through it.

- Ohm's Law states that the ratio of potential difference(V) to current (I) is a constant called Resistance (R)
- Electrical Resistance of a conductor depends on an object's size, shape, and material.



***RESISTANCE* of a conductor at specific temperature ,depends on the following factors:** i. length (ℓ) ii. Area of cross-section (A) iii. Nature of the Material

Length of the Conductor :

The resistance (R) of a conductor is **directly proportional** to its length.

$R \propto \ell$

Long wire has greater resistance than short wire.

Area of cross-section of the Conductor:

The resistance (R)of a conductor is **inversely proportional** to its area of cross-section.

$R \propto 1/A$.

A thick wire has less resistance than a thin wire.

Nature of the material of the conductor:

Insulators have more resistance than conductors.

$R_{insulator}$ is more than $R_{conductors}$.

Temperature (T) of the material:

Resistance increases with temperature.

A cold filament has less resistance than a hot filament. The higher temperature results in higher resistance.

So, $R \propto \ell$

$R \propto 1/A$.

$R \propto \ell/A$

$R = \rho\, \ell/A$ where ρ(rho) is the resistivity of the material of conductor .

Resistivity

- It is numerically equal to the resistance of a conductor of unit length and unit area of cross-section.
- SI unit = ohm-metre (Ω m)
- It does not depend on the length or the thickness (area) but depends on the nature of the substance and temperature. For different substances their resistivity is also different. e.g.
  - $\rho_{silver} = 1.60 \times 10^{-8}\ \Omega$ m
  - $\rho_{tungsten} = 5.20 \times 10^{-8}\ \Omega$ m
  - $\rho_{glass} = 10^{10} - 10^{14}\ \Omega$ m
  - $\rho_{insulator} > \rho_{alloy} > \rho_{conductor}$

1. Metals and alloys have low resistivity in the range of $10^{-8}\ \Omega$ m to $10^{-6}\ \Omega$ m. So they are Good conductor of electricity. Tungston (W) is used for filament of electric bulbs and Copper (Cu) and Aluminium (Al) are used for transmission lines.
2. Insulators have resistivity of the order of 10^{12} to 10^{17} Ωm e.g. Rubbers and glass..
3. Alloys have higher resistivity than that of its constituent metals. so they are used for the heating devices like Electric Iron and Geysers.

Let us practice now:

1. What are the factors on which resistance of a conductor depends?
2. A wire of length l and resistance R is stretched to get the radius of cross-section halved .What is the new resistance of the wire after stretching?
3. Why are copper used as connecting wires?
4. What is the resistance of a connecting wire ?
5. Why are conductors of heating devices made of an alloy rather than a pure metal?

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ELECTRICITY

Heating Effect of Electric Current:

If an electric circuit is purely resistive, the source of energy continually gets dissipiated entirely in the form of heat. This is known as Heating Effect of Electric Current.

Consider a current I flowing through a resistor of resistance R. Let the potential difference across it be V. Let t be the time during which a charge Q flows across. The work done in moving the charge Q through a potential difference V is VQ. Therefore, the source must supply energy equal to VQ in time t. Hence the power input to the circuit by the source is :

$P = V \times Q/t = VI$

The energy supplied to the circuit by the source in time t, $E = P \times t$ or $E = VIt$ (where $P = VI$)

Since energy is equivalent to the heat produced therefore, $E = H$ $\Rightarrow H = VIt$

OR **$H = I^2Rt$** (Using Ohm`s law, $V = IR$). This is known as Joule`s law of Heating.

Joule`s Law of Heating : It states that the heat produced in a resistor is

i) directly proportional to square of current,

$H \alpha I^2$

ii) directly proportional to resistance for a given current, $H \alpha R$

iii) directly proportional to the time for which the current flows through the conductor,

$H \alpha t$

So, **$H = I^2Rt$**

Electric Power: The rate at which electric energy is consumed or dissipiated in an electric circuit.

$P = VI$

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

S.I. unit of power = watt (W)

1 watt = 1 volt x 1 ampere

*Commercial unit of electric energy is kilo watt hour (kWh)

1 kWh = 3.6×10^6 J

1 kWh = 1 unit of electric energy.

Relationship between Commercial unit and S.I. unit of energy :

1 kWh = 1000 watt x 3600 seconds

= 3.6×10^6 watt second

= 3.6×10^6 joule (J)

1 kWh = 3.6×10^6 J

Example: An electric bulb is connected to a 220V generator. The current is 0.50A. What is the power of the bulb ?

Solution: $P = VI$

$= 220\ V \times 0.50\ A$

$= 110\ J/s = 110\ W$.

Applications of Heating Effect of Electric Current :

1.Heating effect is desirable in devices like electric heater, electric iron, electric bulb, electric fuse etc.

2.In electric bulb, most of the power consumed by the filament appears as heat and a small part of it is radiated in the form of light.

Filament of electric bulb is made up of tungsten as

i) it does not oxidise readily at high temperature.

ii) it has high melting point (3380 °C).

The bulbs are filled with chemically inactive gases like nitrogen and argon to prolong the life of filament.

Electric Fuse:

It is a safety device that protects our electrical appliances in case of short circuit or overloading.

*Fuse wire is made up of a metal or an alloy of appropriate melting point (low), for e.g, aluminium, copper, iron, lead etc.

*Fuse is always connected in SERIES with live wire.

*Current capacity of fuse is slightly higher than that of the appliance.

Let us Practice now :

1. Explain the Joule`s law of heating.
2. How does fuse wire protect electrical appliances?
3. Why is the tungsten used almost exclusively for filament of electric lamps ?
4. A fuse wire is connected to a live wire. (True/False)
5. Which uses more energy : a 250W TV set in 1 hour or a 1200W toaster in 10 min ?