Learn the key concepts of Science topic - Heating effect of current

Hi guys, let's talk about Heating effect of current. Let's first understand about the combination of resistance internak resistance of a cell.

Combination of resistance

Resistors in Series: A circuit is said to be connected in series when the same number of current flows through the resistors. Resistors in series combination, For the circuit, the total resistance is given as: R (total) = $R_1 + R_2 + ... + R_n$

Resistors in Parallel: A circuit is said to be connected in parallel when the voltage is the same across the resistors. If 'n' number of resistors connected in parallel. The following relation gives the total resistance here: $1/R_{(total)} = 1/R_1 + 1/R_2 + 1/R_3 ....1/R_n$

The sum of reciprocals of resistance of an individual resistor is the total reciprocal resistance of the system.

Internal resistance of a cell formula

The electromotive force (EMF) is an unfamiliar concept for most of the students. These things are closely linked to the more familiar concept that is voltage. It will also introduce the concept of the Internal Resistance of a battery. The electromotive force is defined as the potential difference which is across the terminals of the battery, that is we can say when no current is flowing through it. This is said to not seem like this as it would make a difference but we can say that every battery has Internal Resistance.

Definition of Internal Resistance:

Internal resistance is a measure of how much a device, such as a battery or a circuit, resists the flow of electrical current through it. Internal Resistance Formula is a mathematical equation that can be used to calculate the resistance of an object in motion. Internal Resistance is caused by heat loss, friction, and other processes which act to slow down or stop the movement. Internal Resistance Formula is often used in engineering applications when designing engines of trains, cars, trucks. It can also be applied in many other situations. In this unit, we will study what Internal Resistance Formula means, how it's calculated, and give examples with solutions so you understand how Internal Resistance works.

Internal Resistance is Important to study in the Following Ways:

1. In order to improve the efficiency of an electric motor or any other electrical device, it is important to understand how much Internal Resistance that device has and how it can be reduced.
2. Internal Resistance is applied when you study the Internal Resistance of batteries. Internal Resistance is an important concept in electrical engineering, and it can be applied to many types of projects or experiments which involve electricity.
3. Internal Resistance is also vital when designing engines in cars, trucks, or other large vehicles. Internal Resistance can be applied in Internal Combustion Engines (ICE) to improve the performance and fuel efficiency of the engine.

Here are two simplest ways for cell connectivity:

1. **Series Connection:** Series connection is the connectivity of the components in a sequential array of components.
2. **Parallel Connection:** Parallel connection is the connectivity of the components alongside other components.

Cells in Series Connection:

In series, cells are joined end to end so that the same current flows through each cell. In case if the cells are connected in series the emf of the battery is connected to the sum of the emf of the individual cells. Suppose we have multiple cells and they are arranged in such a way that the positive terminal of one cell is connected to the negative terminal of the another and then again the negative terminal is connected to the positive terminal and so on, then we can see that the cell is connected in series.

Equivalent EMF/Resistance of Cells in Series:

If E is the overall emf of the battery combined with n number of cells and E_1 , E_2 , E_3 ... En are the emfs of individual cells. Then $E_1 + E_2 + E_3 + \ldots\ldots E_n$

Similarly, if r_1 , r_2 , r_3 , r n are the internal resistances of individual cells, then the internal resistance of the battery will be equal to the sum of the internal resistance of the individual cells i.e. $r = r_1 + r_2 + r_3 + r_n$

Cells in Parallel Connection:

Cells are in parallel combination if the current is divided among various cells. In a parallel combination, all the positive terminals are connected together and all the negative terminals are connected together.

Equivalent EMF/Resistance of Cells in Parallel:

If emf of each cell is identical, then the emf of the battery combined with n numbers of cells connected in parallel is equal to the emf of each cell. The resultant internal resistance of the combination is: Equivalent EMF/Resistance of Cells in Series and Parallel: Assume the emf of each cell is E and internal resistance of each cell is r. As n number of cells are connected in each series, the emf of each series, as well as the battery, will be nE. The equivalent resistance of the series is nr. As, the number of series connected in parallel equivalent internal resistance of that series and parallel battery is nr/m.

Heating effect of electric current

The heating effect of electric current is widely used in our day-to-day life. The electric iron, kettle, toaster, heater, etc. are used as alternatives to the conventional methods of cooking and laundry. The same is used in electric bulbs which is the alternative of conventional lamps. These devices have revolutionized the world over the years. In this section, we will discuss the concept of the heating effect of electric current and its applications. The heating effect of current was studied experimentally by Joule in 1941. After doing his experiments Joule came to the conclusion that the heat produced in a conductor is directly proportional to the product of square of current (I^2), resistance of the conductor (R) and the time (t) for which current is passed. Thus, **$H \propto I^2RT$**

Electric Power: It is the rate at which work is done or energy is transformed in an electrical circuit. Simply put, it is a measure of how much energy is used in a span of time. Electrical energy can be either kinetic energy or potential energy. In most of the cases, potential energy is considered, which is the energy stored due to the relative positions of charged particles or electric fields. Electrical power is denoted by P and measured using Watt.

SI Unit: watt (W) or joule per second To calculate power, the most simple equation is work done divided by time.

(1) P = W/t Where, W is work done, t is time. The above expression is used mostly for mechanical power. For electric power, another equation is used, when we calculate work through the amount of charge and the potential difference through which the charge is moving.

(2) W = qV Where q = total charge used and V = voltage When we substitute (1) in (2), we understand that power is now the charge multiplied by the voltage divided by the time.

(3) P = qV/t Additionally, we know that current is the charge per second that passes through the circuit at any given time.

(4) q = It Where q = total charge and I = current (ampere) Now, when we substitute (4) in (3), we understand that power is actually the current multiplied by time multiplied by voltage, divided by time. In this case, time gets cancelled from the numerator and denominator, to give us the final equation, which is P = IV. Where, P is the power, V or voltage is the potential difference in the circuit, and I is the electric current. Power can also be written as: $P = V^2/R$ or I^2R Where, V is the voltage, R is the resistance, and I is the electric current.

These can be obtained when we apply the Ohms law, which says that electric current is proportional to voltage and inversely proportional to resistance. In a series circuit, all components are connected end-to-end, forming a single path for current flow. In a parallel circuit, all components are connected across.

This was all about heating effect of current. Stay with us and solve all your queries.