VIDYA BHAVAN, BALIKA VIDYAPEETH

SHAKTI UTTHAN ASHRAM, LAKHISARAI, PIN:-811311

SUBJECT:- PHYSICS CLASS:- XTH DATE:- 22/01/XXII

SUBJECT TEACHER:- MR. NEEL NIRANJAN

CHAPTER 1. (ELECTRICITY) (BASED ON NCERT PATTERN)

Heating Effect of Electric Current:

When electric current is supplied to a purely resistive conductor, the energy of electric current is dissipated entirely in the form of heat and as a result, resistor gets heated. The heating of resistor because of dissipation of electrical energy is commonly known as Heating Effect of Electric Current. Some examples are as follows : When electric energy is supplied to an electric bulb, the filament gets heated because of which, it gives light. The heating of electric bulb happens because of heating effect of electric current.

Cause of Heating Effect of Electric Current:

Electric current generates heat to overcome the resistance offered by the conductor through which it passes. Higher the resistance, the electric current will generate higher amount of heat. Thus, generation of heat by electric current while passing through a conductor is an inevitable consequence. This heating effect is used in many appliances, such as electric iron, electric heater, electric geyser, etc.

Joule's Law Of Heating:

Let, an electric current, I is flowing through a resistor having resistance = R.
The potential difference through the resistor is = V.
The charge, Q flows through the circuit for the time, t
Thus, work done in moving of charge (Q) of potential difference (V),
$W = V \times Q$

Since this charge, Q flows through the circuit for time t
Therefore, power input (P) to the circuit can be given by the following equation :
$P = WT$
$P = V \times Qt$ .....(i)
We know, electric current, $I = Qt$
Substituting $Qt = I$ in equation (i), we get,
P = VI ...(ii)
i.e., P = VI

Since, the electric energy is supplied for time ?, thus, after multiplying both sides of equation (ii) by time t, we get,
$P \times t = VI \times t = VIt$ ……(iii)
i.e., P = VIt
Thus, for steady current I, the heat produced (H) in time t is equal to VIt
H = VIt i.e., H = VIt
We know, according to Ohm's Law,
V = IR
By substituting this value of V in equation (iii), we get,
$H = IR \times It$
$H = I^2Rt$ ……(iv)

Electric power (P):

The electric work done per unit time is called electric power.
Electric Power = $\text{Electric work done} / \text{time taken}$
or $P = W/t$
Electric power is also defined as the electric energy consumed per unit time.
$P = Et$
S.I. unit of electric power is Watt. When one joule of energy is used for one second, electric power is equal to one watt.

Derivation of formula for electric power:

We know that electric work done, W = V × I × t
P = VI
Electric power in watts = Volts × ampere
Also V = IR …[According to Ohm's Law]
So P = IR × I
$P = I^2R$
We know that $I = \frac{V}{R}$
$P = \left(\frac{V}{R}\right)^2 \times R = \frac{V^2}{R}$ Watt
The maximum value of electric current that can pass through an electric appliance without damaging electric appliance is called current rating of electric appliance.

Electric Fuse:

Electric fuse is used to protect the electric appliances from high voltage if any. Electric fuse is made of metal or alloy of metals, such as aluminum, copper, iron, lead, etc. In the case of flow of higher voltage than specified, fuse wire melts and protect the electric appliances.
Fuse of 1A, 2A, 3A, 5A, 10A, etc., used for domestic purpose.
Suppose, if an electric heater consumes 1000W at 220 V.
Then electric current in circuit
$I = \frac{P}{V}$
$I = \frac{1000\text{W}}{220\text{V}}$ = 4.5 A
Thus, in this case of 5A should be used to protect the electric heater in the flow of higher voltage.