3. Derived units – with special name or no special names

Non- SI units that are commonly accepted to use with SI units

The system of units used in engineering and science is the Système Internationale d'Unités (International system of units), usually abbreviated to SI units, and is based on the metric system. This was introduced in 1960 and SI has been universally accepted for international use in all fields of engineering and day to day requirements. Therefore, all business and even household transactions are conducted in SI units.

SI system offers the following advantages over other system of units.

1. There is one and only one unit for each physical quantity. Therefore, a table of conversions from one unit to another is not required.

2. The system is coherent with the derived units. The conversion factor from the original unit to the derived unit is simply a multiplication or division by 1.

3. There are no conversions between electrical and mechanical systems e.g. a motor or an automobile engine is now rated as in kW rather than horse power. Energy is now expressed in watt-sec rather than in Joule etc.

There are a several number of quantities and do not necessitate to assign a standard unit to each quantity as these quantities are functionally related through experiments, mathematical derivation or definitions.

1.2 Basic SI Units or Fundamental quantities

These are the minimum number of quantities required to express the units of all other quantities. The following are the considerations for selection of fundamental quantities.

(i) A minimum number of constant should be required to establish relationship between the various quantities involved in the study of the given discipline.

(ii) The measuring units shall be of a practical size.

There are seven fundamental units which are listed below with their name, quantity symbol and unit symbol.

1. Length-metre, l, m

It is defined in terms of wavelengths of a particular radiation from krypton 86.

2. Mass-kilogram, m kg

It is defined equal to the mass of the international prototype kept in Sevres, France.

3. Time-seconds, t, s

It is defined in terms of the duration of a specific number of periods of a particular radiation from the cesium-133 atom.

4. Current-ampere, I, A

It is defined as the constant electric current in two infinite parallel conductors separated from each other by 1 m, produce a force of 2 x 10^{-9} N/m.

5. Temperature-Kelvin, T, K

It is defined as the fraction $\frac{1}{273.16}$ of the thermodynamic temperature of water at which point it is simultaneously a gas, a liquid and a solid (the trip point).

6. Quantity-mol, mol

It is defined as the amount of substance which contains as many elementary particles as there are atoms in 0.012 kg of carbon 12.

7. Light-Candela, I, Cd

It is defined as the light intensity of the freezing point of platinum under specified conditions.

The supplementary units used for two and three dimensional problem related to geometry are:

NB.
Keep in mind that electric current is always through an element and that electric voltage is always across the element or between two points.

Example 1

Determine the total charge entering a terminal between t = 1 s and t = 2 s if the current passing the terminal is $i = (3t^2 - t)\ A$.

Solution $Q = \int_{t=1}^{2} i dt = \int_{1}^{2} (3t - t) dt$

$$\left(t^3 - \frac{t^2}{2}\Big|_1^2\right) = (8 - 2) - \left(1 - \frac{1}{2}\right) = 5.5\ C$$

1.4.3 Power and Energy

Although current and voltage are the two basic variables in an electric circuit, they are not sufficient by themselves. For practical purposes, we need to know how much *power* an electric device can handle. We all know from experience that a 100-watt bulb gives more light than a 60-watt bulb. We also know that when we pay our bills to the electric utility companies, we are paying for the electric *energy* consumed over a certain period of time. Thus, power and energy calculations are important in circuit analysis.

To relate power and energy to voltage and current, we recall from physics that:

Power is the time rate of expending or absorbing energy, measured in watts (W).

We write this relationship as power $p = \frac{dw}{dt}$ ……………… (5)

where *p* is power in watts (W), *w* is energy in joules (J), and *t* is time in seconds (s). From Eqs. (1), (3), and (5), it follows that

$$p = \frac{dw}{dq} = \frac{dw}{dq} \cdot \frac{dq}{dt} = vi \text{ ……………… (6)}$$

or $p = vi$ ……………………………… (7)

The power *p* in Eq. (7) is a time-varying quantity and is called the *instantaneous power*. Thus, the power absorbed or supplied by an element is the product of the voltage across the element and the current through it.

If the power has a + sign, power is being delivered to or absorbed by the element. If, on the other hand, the power has a - sign, power is being supplied by the element. But how do we know when the power has a negative or a positive sign?

Current direction and voltage polarity play a major role in determining the sign of power.

The relationship between current *i* and voltage *v* in is shown Fig. 6(a). The voltage polarity and current direction must conform to those shown in Fig. 6(a) in order for the power to have a positive sign. This is known as the *passive sign convention.*

By the passive sign convention, current enters through the positive polarity of the voltage.

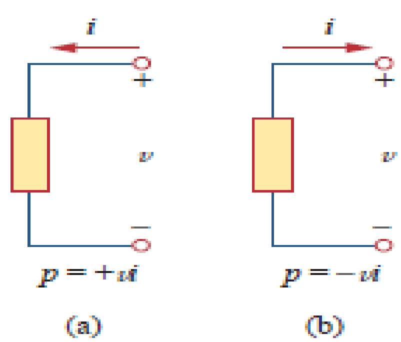

Figure 6: Reference polarity for power using passive sign convection: (absorbing power, (b) supplying power