**Chapter 1**

**(Measurements)**

To describe natural phenomena, we must make measurements of various aspects of nature. Each measurement is associated with a physical quantity, such as the length of an object. The laws of physics are expressed as mathematical relationships among physical quantities.

In 1960, an international committee established a set of standards for the fundamental quantities of science. It is called the SI (System International), and its fundamental units of length, mass, and time are the meter, kilogram, and second, respectively. Other standards for SI fundamental units established by the committee are those for temperature (kelvin), electric current (ampere), luminous intensity (candela), and the amount of substance (mole).

In mechanics, the fundamental quantities are length, mass, and time.

All other quantities in mechanics can be expressed in terms of these three.

Most other variables are derived quantities, those that can be expressed as a mathematical combination of fundamental quantities. Common examples are area (a product of two lengths) and speed (a ratio of a length to a time interval). Another example of a derived quantity is density.

The density ρ (Greek letter rho) of any substance is defined as its mass per unit volume:

**ρ=m/V**

The density of a substance is the relationship between the mass of the substance and how much space it takes up (volume).

**1-2: Conversion of Units**

Sometimes it is necessary to convert units from one measurement system to another, or to convert within a system, for example, from kilometers to meters. Equalities between SI and U.S. customary units of length are as follows:

1 mile = 1 609 m = 1.609 km 1 ft = 0.304 8 m = 30.48 cm

1 m = 39.37 in. = 3.281 ft 1 in. = 0.025 4 m = 2.54 cm

Example (1-2): suppose we wish to convert 15 in. to centimeters. Because 1 in. is deﬁned as exactly 2.54 cm, we ﬁnd that

1-3: Systems of coordinates

Sometimes it is more convenient to represent a point in a plane by its plane polar coordinates (r, θ), as shown in following figure. In this polar coordinate system, r is the distance from the origin to the point having cartesian coordinates (x, y), and θ is the angle between r and a ﬁxed axis. We can obtain the cartesian coordinates, using the equations

x = r cos θ ; y = r sin θ ; tan θ = y / x ; r = (x2+y2)1/2

Example(1-3): The cartesian coordinates of a point in the x y plane are (x, y) = ( - 3.50, - 2.50) m, Find the polar coordinates of this point.