Chapter One: Introduction

What is mechanics? It can be defined as the science that describes and predicts the states of rest and motion of bodies under the influence of forces. It is divided into three sections:

1. Mechanics of solid bodies, which is divided into static and dynamic, where the former deals with bodies at rest.

2. Mechanics of solid bodies capable of transformation. In this section of the study of body mechanics, it is assumed that they are completely solid, and yet they are not absolutely solid, but they transform and deform under the loads to which they are subjected. However, these deformations are usually small and will not affect the states of equilibrium or motion under study.

3. The third type of mechanics is fluid mechanics, which is divided into the study of incompressible fluids and compressible fluids. An important subsection of the study of incompressible fluids is hydraulics (driven or driven by water), which deals with problems that deal with fluids.

1-2 Basic principles and concepts

The basic principles used in mechanics are space, time, mass and force. These principles or concepts cannot be known in reality but must be accepted on the basis of experience and used as a mental framework and reference for our study of mechanics.

The concept of space (vacuum) means the observation of the location of a point which can be known by the three lengths measured from a given reference point or origin by three given directions. These lengths are known as the coordinates of the point B.

To describe an event, it is not enough to show its location in space. The time of the event must also be given.

The concept of mass is used to distinguish and compare bodies on the basis of certain basic mechanical experiments. If we have two bodies of the same mass, for example, they will be attracted by the earth in the same way. They will also be attracted by the earth in the same way. They will also exhibit the same resistance to change by translational motion.

Force represents the action of one body on another and can be induced by physical contact or from a distance, as in the case of gravitational or magnetic forces. Force is characterized by its point of application, its magnitude and its direction and force is represented by a vector.

Newton's three basic laws: were formulated by Isaac Newton and can be summarized as follows:

First law:

If the net force acting on a particle is zero, then the particle will remain at rest (if it is originally at rest) or will move with a constant velocity in a straight line (if it is originally in motion).

That is, a free particle will always move with a constant velocity (if it is in motion) or will remain at rest (velocity equals zero) if it is originally at rest unless it is subjected to an external force that acts to change its state of motion.

The second law: If the net force acting on a particle is not zero, the particle will have an acceleration with the magnitude of that net force and in the direction of that net force. The law can be stated as follows:

$$\mathbf{F=ma} \quad \ldots\ldots(1)$$

Where F, m, a represent the resultant force acting on the particle, the mass of the particle, and the acceleration of the particle expressed in a given system of units.

$$F = m\,a\ (N = \frac{kg.m}{\sec^2})$$

N is the unit of force measured in Newtons.

The third law:

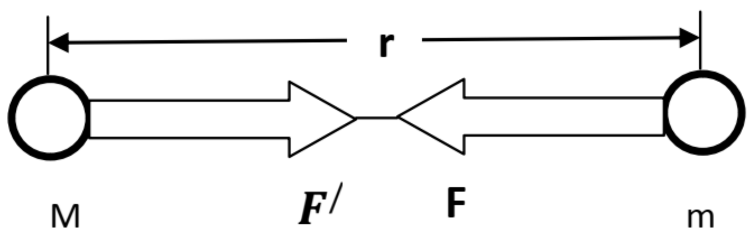
The forces of action and reaction between solid bodies that are in contact will have the same magnitude, the same line of action, and opposite direction.

Newton's law of gravitation: This law states that if there are two bodies of mass M and m that attract each other with equal and opposite forces, which are (Figure 1-1) and which are given by the following formula:

$$g = G\frac{M\ m}{r^2}$$

Where r is the distance between the two bodies and G is a constant, which is called the gravitational constant.

الشكل:- (1-1)



Newton's third law which means that action and reaction are equal and opposite and have the same line of action. The practical case of greatest importance is that of the attraction of the Earth to a particle placed on the surface of the Earth. The force induced by the Earth on the particle is hereafter known as the weight W of the particle and taking M equal to the mass of the Earth, m will equal the mass of the particle and r equals the radius of the Earth and when the value of the constant is:

$$g = \frac{GM}{r^2}$$

The value W of the particle weight of mass m can be expressed as follows:

$$W = m\ g$$

Since the Earth is not truly spherical, the acceleration value varies with the location of the assumed point, and since the point remains on the Earth's surface, the accurate and sufficient condition in most engineering calculations is to assume an acceleration value equal to 9.8 m/s2.

Linear momentum:

The momentum of a particle is defined as the product of its mass (m) and its velocity (v).

$$p^{\rightarrow} = m\, v$$

Law of conservation of linear momentum

If we have a system consisting of two isolated bodies (A1, A2) and there is a mutual interaction between them, where each of them has the following values for mass, velocity and momentum: (m1, v1, p1), (m2, v2, p2), then before the collision the equation that expresses the system is as follows:

$$p^{\rightarrow} = p_1^{\rightarrow} + p_2^{\rightarrow} = m_1\, v_1^{\rightarrow} + m_2\, v_2^{\rightarrow}$$

In the case after the collision (i.e. after time t), the equation expressing the system is as follows:

$$p^{\rightarrow\prime} = p_1^{\rightarrow\prime} + p_2^{\rightarrow\prime}$$

$$= \; m_1\, v_1^{\rightarrow\prime} + m_2 v_2^{\rightarrow\prime}$$

We will assume that the mass does not depend on the state of motion, knowing that the experiment proved that the momentum is equal before and after the collision ( ), i.e.:

$$m_1\, v_1^{\rightarrow} + m_2\, v_2^{\rightarrow} = \; m_1\, v_1^{\rightarrow\prime} + m_2 v_2^{\rightarrow\prime}$$