Chapter Five

The Lows of Motions

When several forces act similtaneously on an object, it's accelerates if the met force acting on it is not equal to zero.

If the net force exerted on an object is zero, the acceleration of an object is zero and its velocity remains constant.

When the velocity is constant (or at rest), the object said to be in equilibrium.

The force may be: 1- Contact forces   2- Field forces

Because force is a vector we use the symbol $\vec{F}$ and the rules of vector addition to obtain the net force on an object.

Newton's First Low and Inertial Frames (Law of Inertia)

Newton's first law some times called the (law of inertia). This law can be stated as (if an object does not interact with other objects, it's possible to identify a reference frame in which the object has zero acceleration).

Another statement of newton's first law is that an object at rest remains at rest and an object in motion continues in motion with a constant velocity (that is with a constant speed on a straight line).

Inertia, defind as the tendency of an object to resist any attempt to change its velocity.

Mass

Mass defined as: the resistance an object exhibits to change in it's velocity.
Weight: the magnitude of the gravitational force exerted on the object, various with lacation.
For example: a person who weight 180 Ib on the Earth weight only 30 Ib on the Moon, on the other hand the mass of an object is the same every where.
When a force acting on an object of mass ($\mathbf{m_1}$) produces an acceleration ($\mathbf{a_1}$) and the same force acting on another object of mass ($\mathbf{m_2}$) produces an acceleration ($\mathbf{a_2}$). The ratio of the two masses is defined as the inverse ratio of the magnitudes of the accelerations produced by the force:

$$\mathbf{m_1/m_2 = a_2/a_1}$$

Newton's Second Law

The magnitude of the acceleration of an object is inversely proportional to it's mass.

$$\Sigma \vec{\mathbf{F}} = \mathbf{m} \cdot \vec{\mathbf{a}}$$

Compound form

$$\Sigma \vec{\mathbf{F}}_x = \mathbf{m} \cdot \vec{\mathbf{a}}_x \quad \& \quad \Sigma \vec{\mathbf{F}}_y = \mathbf{m} \cdot \vec{\mathbf{a}}_y \quad \& \quad \Sigma \vec{\mathbf{F}}_z = \mathbf{m} \cdot \vec{\mathbf{a}}_z$$

The unit of force in SI system is (**newton**)
Newton defined as, the force that when acting on an object of mass (1kg) produced an acceleration of ($1m/s^2$). (***1N = 1kg.m/s²***).

In the US customary system, the unit of force is (pound)
Pound is defined as: the force that, when acting on an object of mass (1slug) produces an acceleration of ($1ft/s^2$). (***1Ib = 1slug.ft/s²***) and (***1N = 0.25 Ib***).

The Gravitational Force and Weight:

Gravitational force ($\mathbf{F_g}$): is the attractive force exerted by the Earth on an object and it's directed toward the center of the Earth. It's magnitude called the (the weight) of the object.

Applying newton's second law $\Sigma \vec{\mathbf{F}} = \mathbf{m} \vec{\mathbf{a}}$ to a freely falling object of mass (**m**) with $\vec{\mathbf{a}} = \mathbf{g}$ and $\Sigma \vec{\mathbf{F}} = \mathbf{m\ g}$ we obtain

$$\vec{\mathbf{F}}_g = \mathbf{m} \vec{\mathbf{g}}$$

Where (m) called gravitational mass

Note: the kilogram is the unit of mass not unit of weight.

Newton's third law:

If two ojects interact, the force $\mathbf{F_{12}}$ exerted by aoject (1) on object (2), is equal in magnitude and opposite in direction to the force $\mathbf{F_{21}}$ exerted by object (2) on object (1) ➡

$\mathbf{F_{12}}$ (action force) **= -** $\mathbf{F_{21}}$ (reaction force)