Unit 1. Kinematics

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Mechanics studies motion and the causes that produce it. Mechanics is the oldest branch of physics and, undoubtedly, the most highly developed. Its models have been applied to other fields, even some unrelated to physics; hence its interest as a basis for understanding other scientific and technical fields.

In the study of mechanics it is first necessary to describe the motion but without taking into account the causes that produce it. Kinematics is the branch of mechanics devoted to pure motion. In this unit we study the kinematics of a particle or material point, a body whose size and shape are not important in solving a particular mechanical problem.

Concepts such as the position vector, displacement vector, average speed and acceleration, and snapshots are reviewed. An important aspect to consider is that the velocity vector is a vector tangent to the trajectory of the particle at each point. We analyze the intrinsic components of acceleration: tangential acceleration and centripetal or normal acceleration. Tangential acceleration takes into account the change in magnitude of the velocity vector, while normal acceleration expresses the variation in the direction of the velocity vector. Normal acceleration is directed toward the centre of curvature of the trajectory at each point and is inversely proportional to the radius of curvature of this trajectory. Obviously, normal acceleration is zero for linear motion, whereas it takes constant values for circular motion because the radius of curvature of the trajectory is constant for this type of motion.

Then we study the case where the object moves in a straight line. This type of motion is known as linear motion and some particular cases are uniform linear motion, in which the acceleration is zero and the velocity is constant, and uniformly accelerated linear motion, wherein the acceleration is constant. Another important type of motion studied in this unit is circular motion, for which we analyze concepts such as angular velocity and angular acceleration and their relationship with linear velocity and linear acceleration, respectively. As examples we study uniform circular motion and uniformly accelerated circular motion. Some important questions to consider are the relationships which exists between angular velocity, linear velocity, angular acceleration and linear acceleration vectors.

The unit ends with the study of parabolic motion such as projectile motion, which allows us to see how, for purposes of analysis, it is possible to treat it as two separate linear motion problems in two perpendicular directions, one in the x direction and the other in the y direction, with only time as the common element. Some issues such as the height and range of a projectile are also analyzed.

It is important to take into account throughout this unit that motion is a relative concept and should therefore always refer to a particular frame of reference chosen by the observer.