VKSU

Fundamentals of Dynamics

Frame of Reference

Introduction :- A System of Coordinate axes which defines the Position of a Particle in two or Three dimensional Space is called a Frame of reference. The Simplest frame of reference is the familier Cartesian System of Coordinates. In Cartesian System of Coordinates, the Position of the Particle is Specified by its Three Coordinates x, y, z along the Three Perpendicular axes.

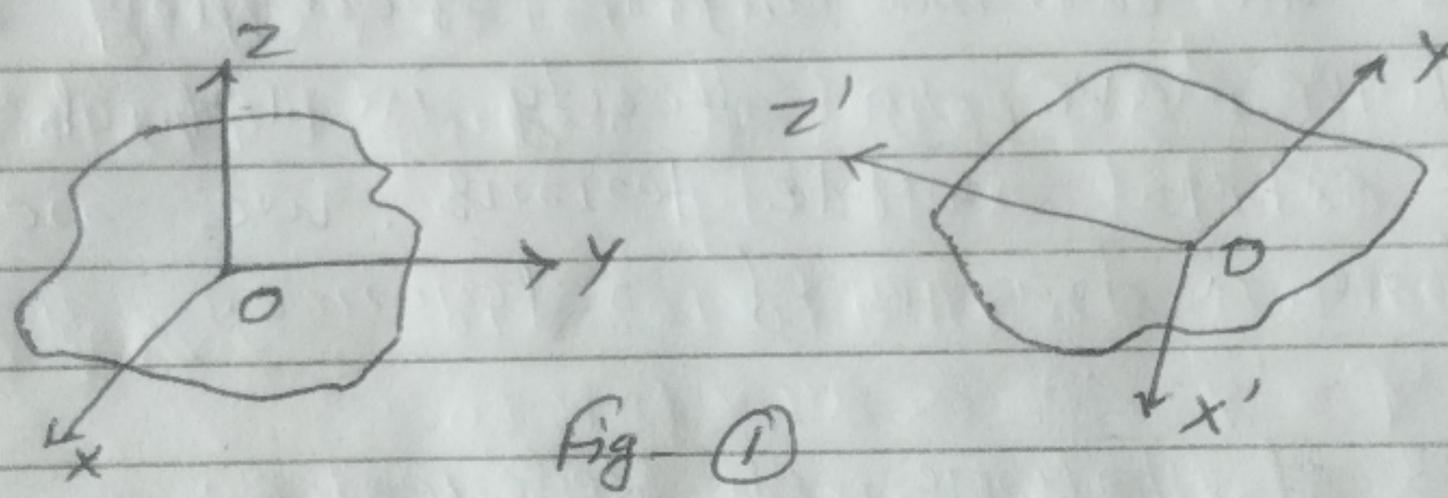

fig- (1)

In fig (1) we have indicated two observers O and O' and a Particle P. These observers use frames of reference XYZ and X'Y'Z', respectively. If O and O' are at rest, They will observe The Same motion of P. But if O and O' are in relative motion, Their observation of The Motion of P will be different.

VKSU

Example —

Let us Consider The following figure (2):

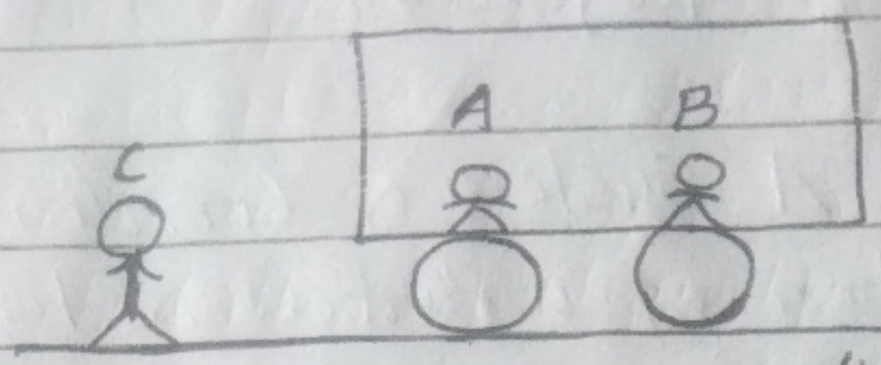

fig-2

If we ask A what velocity of B is, he will say it is at rest. But if we ask The Same Question to C, he will Say B is moving with a velocity V in The Positive X- direction.

So we Can See before Specifying The velocity we have to Specify in Which frame we are or in Simple terms, we need to define a frame of reference.

Types of Frame of Reference:

Once we have Chosen our reference They Can be of two types:

1) Inertial frame of Reference :-

A frame of reference travelling with uniform velocity with another frame is called inertial frame. The acceleration of frame is Zero. A reference frame is a Coordinate System in which Newtons first law of motion holds good is Known as inertial frame of reference.

VKSU

In an inertial frame, a body continues in its state of rest or of uniform motion in a straight line as long as no external force acts on it. All frames of reference moving with a constant velocity w.r.t. an inertial frame are also inertial frames of reference. So, inertial frame of reference can be also called as un-accelerated frame of reference.

Example :-
Gravitational force, Electro-magnetic force, frictional force, viscous force etc.

2.) Non-Inertial frame of Reference:
A frame of reference travelling with non-uniform velocity with another frame is called Non-inertial frame. The acceleration of frame is Non-zero. Such frames of reference having an accelerated motion relative to an inertial frame are called Non-inertial frames of reference.
Since a uniformaly rotating frame has a centripetal acceleration, it is also a non-inertial frame.

For example, a non inertial frame is either a frame having uniform linear accelerations or a frame which is uniformly rotating.

Example Earth - A Non-Inertial frame.

Earth is not an inertial frame. It is a non-inertial frame. The earth is a rotating sphere as it is rotating about its own axis.

It has a Centripetal acceleration due to rotation. In addition, earth also revolves round the Sun in a Period of one year in an orbit of radius 1.49×10^8 Km.

∴ Its orbital velocity.

$$V = \frac{2\pi r}{T} = \frac{2\pi \times 1.49 \times 10^8 \times 10^3}{365 \times 24 \times 60 \times 60} = 3 \times 10^4 \ ms^{-1}$$

And Centripetal acceleration of the earth due to revolution.

$$a_c = \frac{V^2}{r} = \frac{(3 \times 10^4)^2}{1.49} \times 10^8 \times 10^3$$

$$= 6 \times 10^{-3} \ m/s^2$$

Thus, the reference frame attached to the earth is an accelerated frame and is therefore its a non-inertial.

⟹