Modern Physics

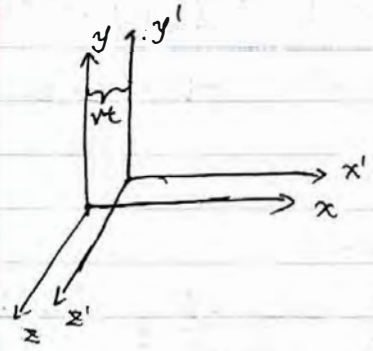
Chapter 1

1. Classical Relativity

$$\vec{F} = m\frac{d\vec{v}}{dt} = m\vec{a}$$

Newton's Laws of motion only work correctly in inertial reference frames, that is, reference frames in which the Law of inertia holds

invariant, unchanged in any reference frames that moves with constant velocity relative to an inertial frame.



v — relative velocity of x' to x (constant)
u_x — velocity of x
u_x' — velocity of x'

$$x = x' + vt \qquad y = y' \qquad z = z \qquad t = t'$$
$$u_x = u_x' + v \qquad u_y = u_y' \qquad u_z = u_z'$$

$$\frac{du_x}{dt} = \frac{d}{dt}(u_x' + v) \Rightarrow a_x = a_x' \quad (\because \frac{dv}{dt} = 0)$$

$$\therefore \vec{F} = m\vec{a} = \vec{F}'$$

Theorem: Any reference frame that moves at constant velocity with repect to an inertial frame is also an inertial frame. Newton's laws of mechanics are invariant in all reference systems connected by a Galilean transformation.

Ex 1: Two equally matched rowers race each other over courses. Each oarsman rows at speed c in still water; the current in the river moves at speed v, Boat 1 goes from A to B, a distance L, and back. Boat 2 goes from A to C, also a distance L, and back. Which boat wins the race?