Galilean Transformation:

In Galilean Transformation System we consider two Cartesian coordinate systems as shown in Fig-1. Where system-2 has a constant velocity "v" with respect to system-1 in the direction of common x-axis.

Considering axes are parallel and are in the same direction. Neither system

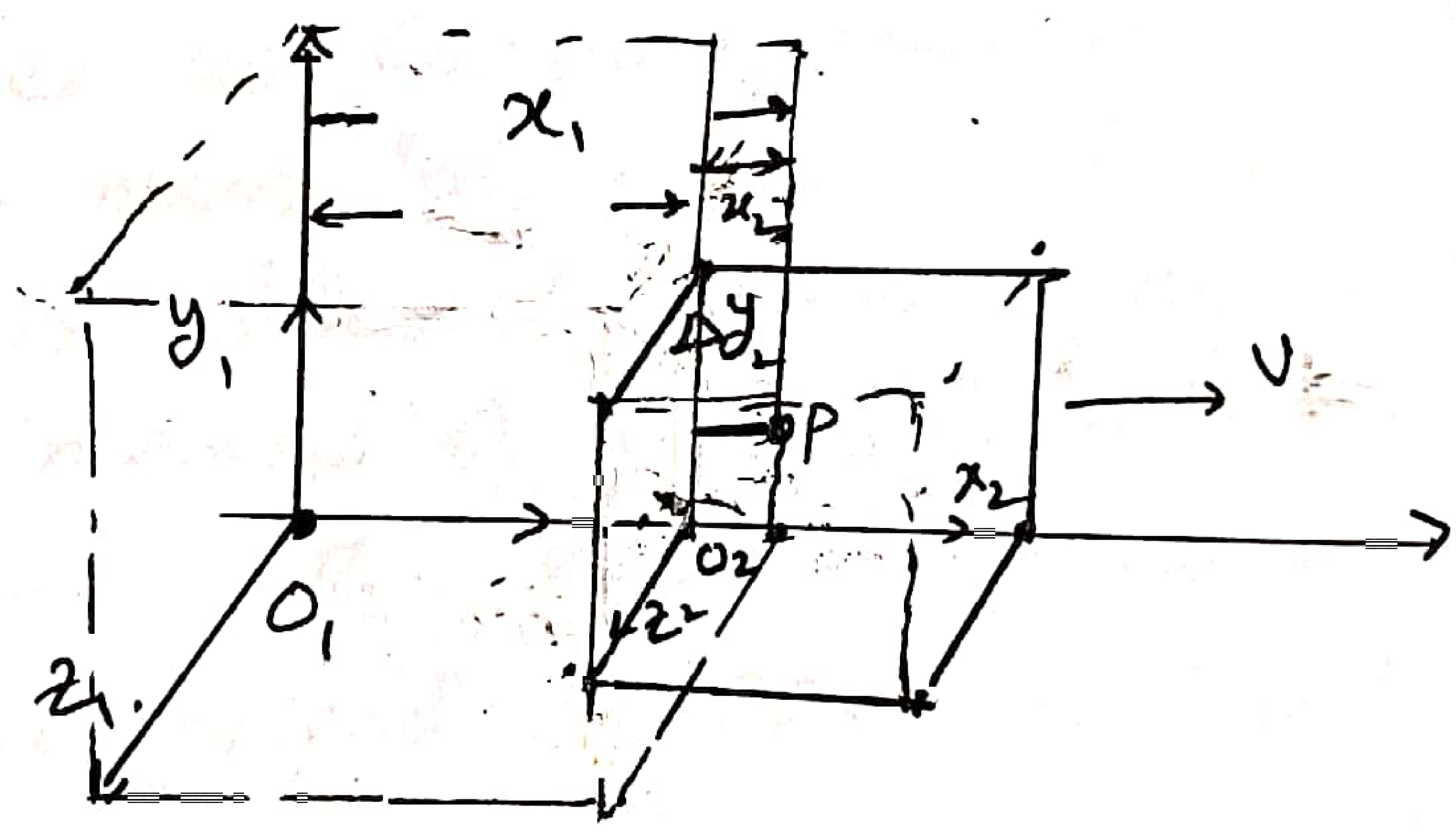


Fig-1: Two Cartesian Coordinate systems one moving with velocity "v" with respect to the other in the +ve x-direction. The two systems overlap when the origins O_1 & O_2 coincide.

is accelerated. The two systems are related

$$x_1 = x_2 + vt \quad , \quad x_2 = x_1 - vt$$
$$y_1 = y_2 \quad \& \quad y_2 = y_1$$
$$z_1 = z_2 \qquad z_2 = z_1$$

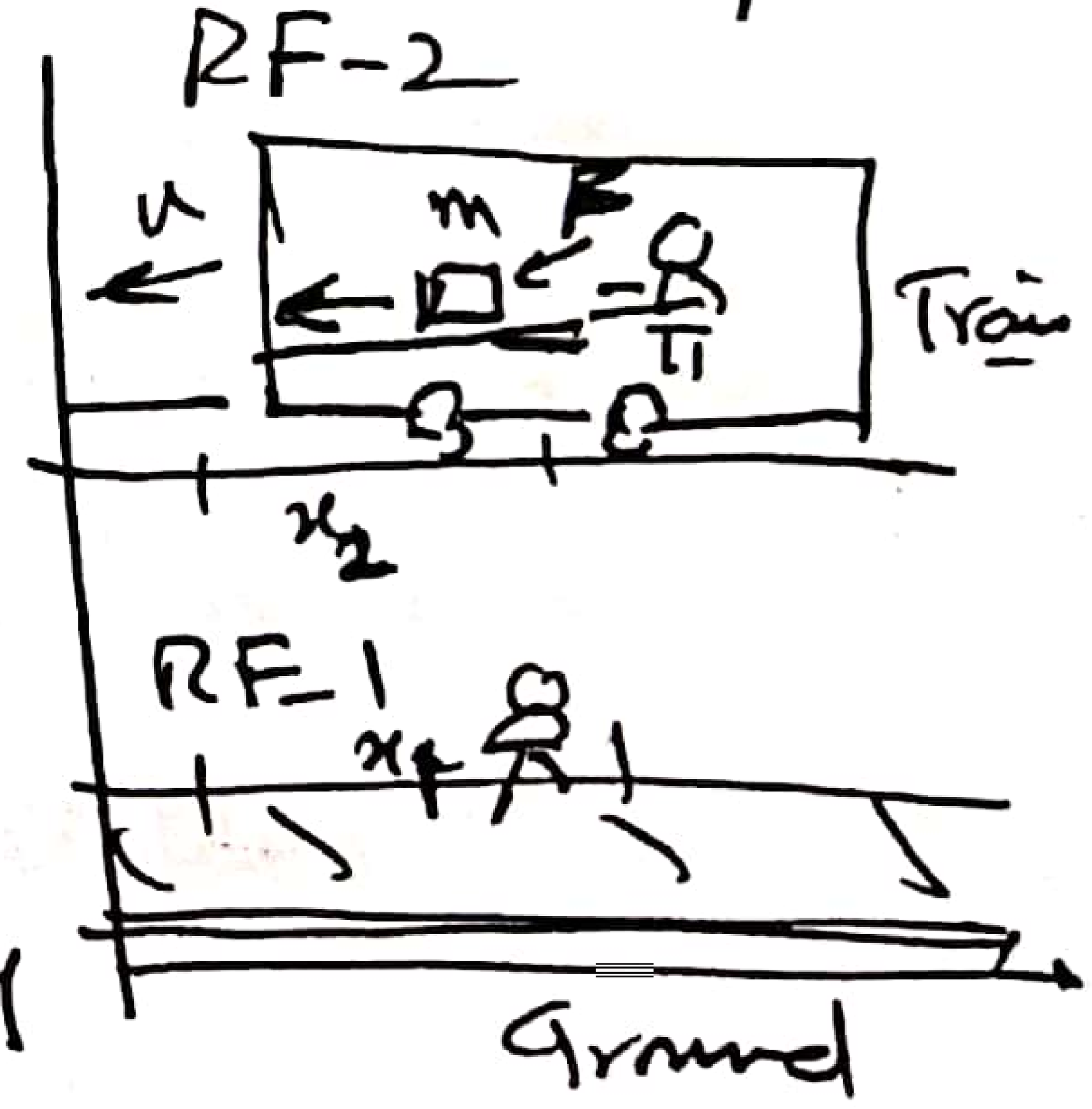
Contd.

Invariance of $\bar{F} = m\bar{a}$ Law:

Let us write down the equations for a simple experiment that the passenger performs, first when the train is stopped and then when the train is moving with a constant velocity/speed.

We shall see that equation of motion in RF-1 are of the same as those of in RF-2.

Let us consider that a passenger is given mass "m" on which he exerts a known force F in the direction of the track by means of a calibrated spring in the RF-2. The RF-1 is fixed with respect to the ground & RF-2 is fixed with respect to the train.



We assume that the force "F" applied a $F = ma$ as observed by RF-1 observe we deduce the corresponding law in in RF-2 when the train is stopped we can assume that two frames overlap at $x_1 = x_2$

Contd,

$F_1 = ma_1$, $F_2 = ma_2$

$$F = m\frac{d^2x_1}{dt^2} = m\frac{d^2x_2}{dt^2} \quad \text{—(1)}$$

$F = ma$ applies in both systems when the train is moving with uniform velocity "v" then

$$x_1 = x_2 + vt \quad \text{—(2)}$$

$$F = m\frac{d^2x_1}{dt^2} = m\frac{d^2}{dt^2}(x_2 + vt) \quad \text{—(3)}$$

$$F = \frac{d^2x_1}{dt^2} = m\frac{d^2x_2}{dt^2} \quad \text{—(4)}$$

$\because \frac{d^2(vt)}{dt^2} = 0$

$v =$ constant.

Hence $F_2 = F_1$ & this law $F = ma$ applies in both systems.

We therefore say that the Law $F = ma$ of Classical mechanics applies in both frame of refrences or that it is invariant under Galilean Transformation.

Similarly $F = m\frac{d^2y_1}{dt^2}$ —(5)

$$F = m\frac{d^2y_2}{dt^2} \quad \text{—(6)}$$

As: $y_1 = y_2$