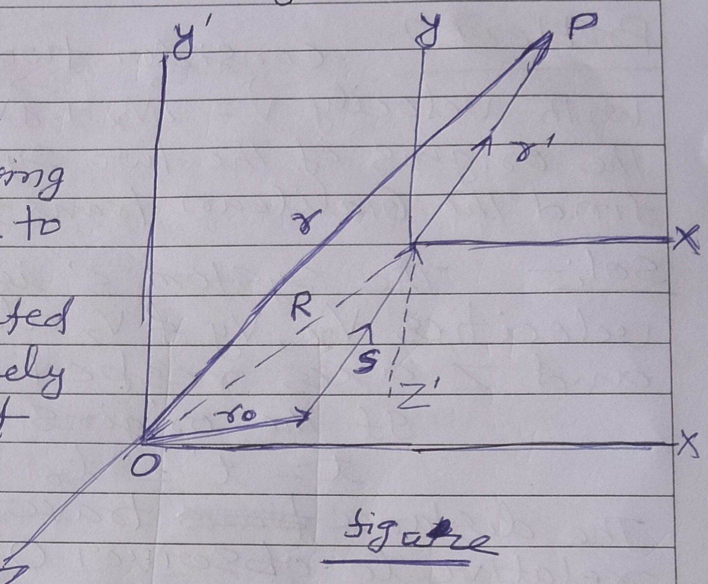
1.) Prove that the Galilean transformation of a position vector is expressed as $r = r_0 + r' + vt$, where v is the linear velocity of the frame O' and r_0 is the position vector of origin O' as measured by O at $t' = 0$.

Sol:-
Consider two frames S & S', the latter moving with velocity v relative to former. Let O and O' be the observers situated in S and S' respectively observing the event happening at P.



figure

If $\vec{r}$ and $\vec{r'}$ are the position vector of the point P at any constant. Then we have from figure.

$$\vec{r} = \vec{r'} + \vec{R} \quad \text{——} \quad (1)$$

when R is the position vector of observer O' relative to O after time t.
If $r_0 \; (= \vec{OQ})$ is the position vector of the observer O' relative to O at $t = 0$, then from fig, we have

$$\vec{R} = \vec{OQ} + \vec{QO'}$$
$$= \vec{r_0} + \vec{vt} \quad \text{——} \quad (2)$$

Since the distance traversed ($\vec{QO'}$) by the observer O' in time t is vt where v is the velocity of O' relative to O.

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Putting Value of R from (2) in (1),
we get $\vec{r} = \vec{r}' + \vec{r}_0 + \vec{v}t$

$$\vec{r} = \vec{r}_0 + \vec{r}' + \vec{v}t \quad \text{——} \quad (3)$$

(Since $t = t'$)

Problem 2 Consider two System S & S', moving with velocity $\vec{V} = \vec{i}V_x + \vec{j}V_y + \vec{k}V_z$ relative to S. If The origins of The two systems coincide at $t = t' = t_0$ find The Galilean transformation equations.

Sol:- The system S' is moving relative to S with velocities V_x, V_y & V_z along +ve directions of x, y and z axes respectively.

If The origins of two frames Coincide at $t = t' = t_0$ Then

The distance ~~trans~~ traversed by observer O' in S' relative to observer O in S at any instant t along axis of $x = V_x(t - t_0)$

The distance traversed by O' is relative to O at any instant t along ~~with y axis~~ axis of $y = V_y(t - t_0)$,

The distance traversed by O' relative to O at any instant t along z axis $= V_z(t - t_0)$

Thus The Galilean transformation eqns are given by

$$x' = x - V_x(t - t_0)$$
$$y' = y - V_y(t - t_0)$$
$$z' = z - V_z(t - t_0)$$

Proved