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## Lorentz Transformation equations

D-1 (H.S) - Paper I

Q:- State the postulates of the special theory of relativity and deduce from them the Lorentz transformation equations.

Ans:- The postulates of spl. relativity theory :-

(i) The laws of physics are the same in all inertial systems. No preffered inertial system exists.

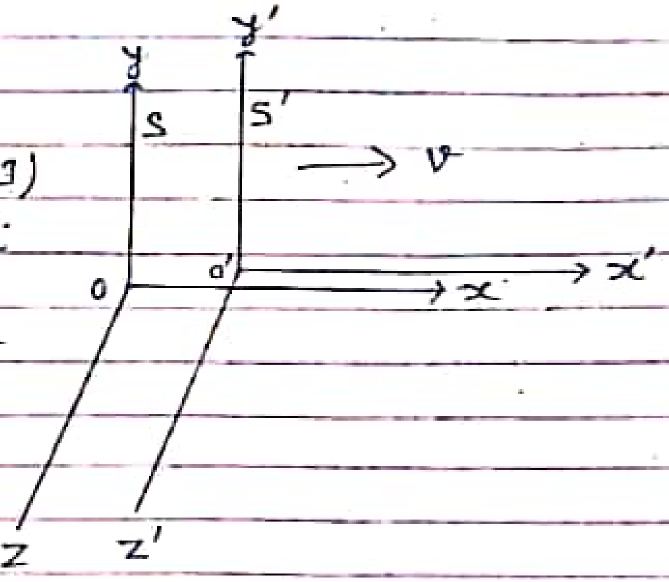
(ii) The speed of light in free space has the same value c in all inertial systems.

Lorentz transformation eqs. - The eqn in relativity physics which relate to the space and time co-ordinates of two co-ordinate systems moving with a uniform velocity relative to one-another are called Lorentz transformation.

Let us consider two observers O & O' located in two separate inertial co-ordinate system S & S' respectively. The system S' moves with a uniform velocity v to the right along the x-axis relative to S. This is equivalent to the motion of S to the left with a velocity v relative to S'.

Any event in S must have a single & unique interpretations in the system S. Therefore, the ~~two~~ transformation equations in space co-ordinates and in time must be linear. It is easy and resonable to guess that the ~~single~~ simple linear equations between

$x$ & $x'$ must be of the form




$$x' = k(x - vt) \quad \text{——— (1)}$$

where $k$ is a constant of proportionality that is independent of $x$ & $v$ but $t$ may depend upon $v$. The corresponding eq^n. for $x$ in terms of $x'$ & $t'$ can be written as

$$x = k(x' + vt') \quad \text{——— (2)}$$

There is obviously no difference between the corresponding co-ordinates $y, y'$ and $z, z'$ as they are perpendicular to the direction of $v$. So, we have

$$y' = y \quad \text{——— (3)}$$

$$z' = z \quad \text{——— (4)}$$

The time co-ordinates $t$ and $t'$ are however not the same. Substituting the value of $x'$ from eq^n. (1) in eq^n (2) we have

$$x = k\left[k(x - vt) + vt'\right]$$

$$= k^2(x - vt) + kvt'$$

$$= k^2 x - k^2 vt + kvt'$$

$$kvt' = x(1 - k^2) + k^2 vt$$

$$t' = kt + \left(\frac{1 - k^2}{kv}\right)x \quad \text{——— (5)}$$

To be continued ....