Time Dilation.

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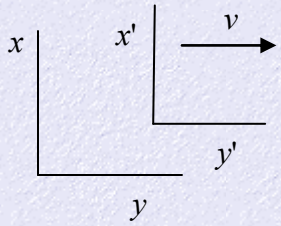
Introduction.

In this article we will show how a clock, which travels with a velocity v m/sec to the right, ticks slower than a clock which is at rest.

Moving frame and frame at rest.



The second frame is moving to the right with a velocity v m/sec.

According to the Lorentz transformation formulae the relation between time, in the frame at rest and moving frame, is:

$$t' = \frac{t - \frac{v}{c^2}x}{\sqrt{1 - \frac{v^2}{c^2}}}$$

Thus the clock is moving with velocity v m/sec to the right. Now we consider two events in the moving frame of t_a' and t_b'. The clock is then, in the frame in rest, on the locations x_a and x_b. In the moving frame the clock is, obviously, at rest.

$$t_a' - t_b' = \frac{t_a - \frac{v}{c^2}x_a}{\sqrt{1-\frac{v^2}{c^2}}} - \frac{t_b - \frac{v}{c^2}x_b}{\sqrt{1-\frac{v^2}{c^2}}} \quad \text{is} \quad t_a' - t_b' = \frac{t_a - t_b}{\sqrt{1-\frac{v^2}{c^2}}} - \frac{\frac{v}{c^2}(x_a - x_b)}{\sqrt{1-\frac{v^2}{c^2}}}$$

So the clock moves from x_a to x_b in the time $t_a - t_b$ according to $x_a - x_b = v.(t_a - t_b)$
Hence:

$$t_a' - t_b' = \frac{t_a - t_b}{\sqrt{1 - \frac{v^2}{c^2}}}.(1 - \frac{v^2}{c^2}) = (t_a - t_b).\sqrt{1 - \frac{v^2}{c^2}}$$

or

$$t_a - t_b = \frac{t_a' - t_b'}{\sqrt{1-\frac{v^2}{c^2}}} \text{ or } t = \frac{t'}{\sqrt{1-\frac{v^2}{c^2}}}$$

So when the time difference, in the moving frame, is one second then the time difference in the frame at rest, is longer, depending on the velocity v. Thus from the point of view from the frame at rest, the clock in the moving frame is ticking slower than a clock in the frame at rest.

Note: This is also valid for an atomic clock. An atomic clock is an electromagnetic system. As all living objects are build up out of atoms, so electromagnetic systems, the aging of cells depends on the behavior of these atoms; the conclusion could be drawn that if the atomic clock slows down, that is the number of ticks becomes less, when it moves with high speed, then the aging of the cells will slow down as well and the living object lives longer with respect to a living object in a frame at rest.