Special Relativity Part I – Time and Mass dilation, Length Contraction



**Michelson-Morley** – Attempted to find our velocity relative to the “ether” – a supposed medium for light.

**Einstein’s Gedanken –** If we could catch up with a light wave what would we see?

**First Postulate of Relativity:**

The laws of physics are the same in all inertial frames of reference

There is no experiment you can do to ascertain whether you are moving.

(i.e. all motion is relative)

**Second Postulate of Relativity:**

The speed of light is the same no matter what speed the source or observer is going

(i.e the speed of light is a law of physics)

**So if the speed of light is constant regardless of the velocity of the observer and the source, then other things that we don’t think should change, must change. Moving clocks run slower, moving particles gain mass, and a moving reference frame shrinks in the direction of motion. Time, mass and length are all relative.**

**Time Dilation – moving clocks run slower.**

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**Write the derivation here:**

**Solution for velocity:**

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| --- | --- |
| Lorentz Factor: (Approaches infinity as v -> c) c = the speed of light (3.00x108 m/s)v = velocity of moving frame (m/s)  | Moving Clocks run **slower**: (Time dilation) Δto = proper time (un dilated)Δt = dilated timeγ = Lorentz factor |
| Moving objects **gain mass**: (Mass dilation) mo = rest mass (un dilated)m = dilated massγ = Lorentz factor(not in data packet?) | Moving objects **contract in length**: Lo = rest lengthL = contracted lengthγ = Lorentz factor |
| The happiness momentum formula:  p = momentummo = rest mass (un dilated)u = velocity, γ = Lorentz factor | Only the dimension parallel to the velocity shrinks: At rest Moving |

Example 1: If you drive by the school at 40.0 m/s, how long do we see your watch take to register 10.0 seconds? What about 40,000. m/s? .200 c? .500 c?

Example 2: If we see your watch take 12 seconds to register 10. seconds, how fast are you going?

(Show solution for c)

Example 3: A car that is 5.0 m long is going .60 c past us. How long is the car in our frame of reference?

Example 4: What is the speed of an electron if it has a mass of 0.634 MeV. (Its rest mass is 0.511 MeV) (What is its kinetic energy? through what potential was it accelerated?)