https://www.youtube.com/watch?v=Y3xnVti7htQ

Minute Physics:
https://www.youtube.com/watch?v=ajhFNcUTJI0

Fundamental Principles

September 8, 2015 1:27 PM

In 1905, at the age of 26, Albert Einstein published his special theory of relativity;

This theory is based on two basic postulates

1. The laws of physics are the same in all inertial reference systems

2. The speed of light in a vacuum is always measured to be $3x10^8$m/s

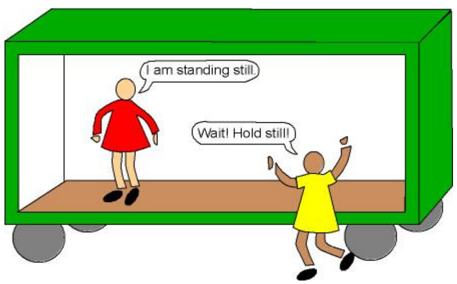
Frame of Reference
Coordinate system that allows description of time and position of points relative to a body. The axes, or lines emanate from a position called the origin. As a point moves, its velocity can be described in terms

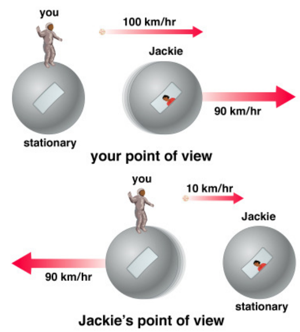
of changes in displacement and direction.

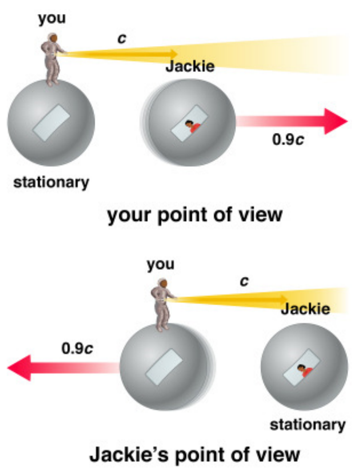
Reference frames are chosen arbitrarily. For example, if a person is sitting in a moving train, the description of the person's motion depends on the chosen frame of reference. If the frame of reference is the train, the person is considered to be not moving relative to the train; if the frame of reference is the Earth, the person is moving relative to the Earth.

Inertial Frame of Reference

Measurements in one inertial frame can be converted to measurements in another by a simple transformation (the Galilean transformation in Newtonian physics and the Lorentz transformation in special relativity).



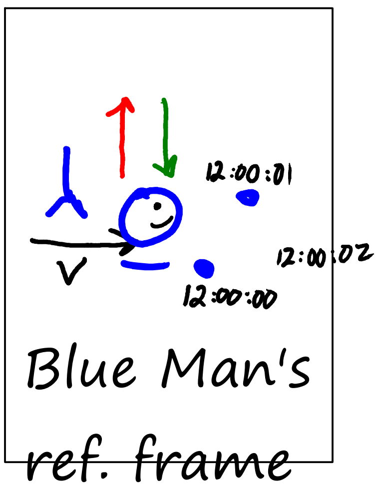


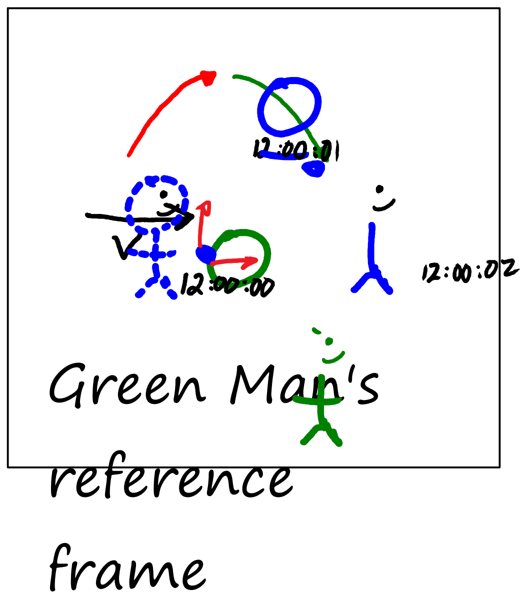


We cannot add velocities in special relativity like we did in Newtonian Mechanics.

Relativity of Simultaneity:
In Newtonian mechanics, there is a universal time scale which is the same for all observers and the laws of mechanics are the same in all inertial frames of reference. According to Einstein, time interval measurements depend on the reference frame in which the measurement is made.
This is from postulate #2

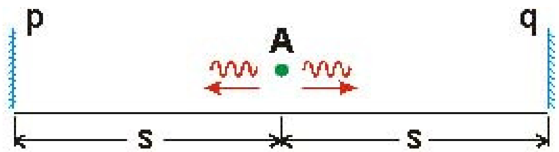
Simultaneity for Newtonian Mechanics:
A blue person walking along at velocity, v, throws a ball up exactly at 12:00:00pm. It takes the ball 1 second to get to the top of the throw and 1 second to come back down to the hand. Now a stationary green person was watching the blue person toss the ball and saw something different. They saw the ball travel in an arc BUT it was still caught at exactly 12:00:02pm. The ball travelled farther but the ball was also travelling faster so it could travel the extra distance in the same amount of time. Both events happened simultaneously.



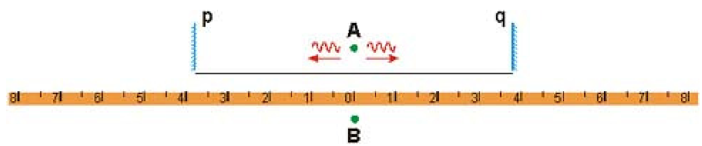


Simultaneity for Einsteinian Mechanics:
We will now consider two observers A and B making observations of two8 events. Think of the term "event" as meaning something which takes a very short time. In other words, an event defines a very precise point in space and time or a

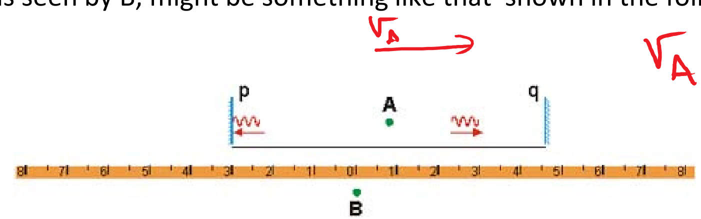
point in space-time as Einstein would have said. The events will be the arrival of two flashes of light at two mirrors. Observer A has a long support on which are mounted two mirrors, p and q, as shown below. The two mirrors are equidistant from A.



A sends a flash of light towards each mirror (flashes sent at the same time).
The light flashes are reflected and arrive back at A at the same time.
A must therefore conclude that the two events, light hitting mirror p and light hitting mirror q, were simultaneous.
Now we will consider another observer's view of the same situation.



B is very close to A.
B has his/her own ruler and watch (the diagram shows B's ruler).
We will first assume that A and B have zero relative speed. It is hoped that the reader will agree that if the experiment is repeated, B will also conclude that the two events occurred simultaneously.
We will now consider that A and B have a very large relative speed. Again, we will imagine that at the instant the flashes are sent, A and B are very close to each other.
A short time later, the situation, as seen by B, might be something like that shown in the following diagram.



v_A is close to "C"

As B sees things, mirror p is moving towards the light source and mirror q is moving away from the light source. In B's frame of reference, therefore, the light going towards mirror p will have a shorter distance to travel before it reaches the mirror than the light going the other way.
Remembering that the speed of light is the same for all inertial observers, we can see that B will consider that the light hits p before it hits q.
B must therefore conclude that the two events, light hitting mirror p and light hitting mirror q, were NOT simultaneous.
A and B are both right; simultaneity is relative.

As Einstein stated in his first postulate,
The laws of physics are the same in all inertial reference systems. That is, basic laws of physics have the same mathematical form for all observers moving at constant velocity with respect to each other. There is no preferred inertial frame of reference.