

5. (12 points) Suppose you had to explain Einstein's Theory of Special Relativity to a senior in high school. What would you say (briefly, in no more than 2 paragraphs)?

Einstein began by assuming that the laws of nature are the same for everyone moving at constant velocity and that the speed of light was the same for all observers. These two assumptions or postulates revealed some serious problems with Newton's ideas of how things move. For instance, it became clear that the concept of simultaneity needed to be redefined.

In order to fix the problems with Newtonian mechanics, Einstein realized that 1) moving objects contract in the direction of motion, 2) a moving clock ticks more slowly than a stationary one (assuming that you are in the coordinate system of the stationary clock). 3) a moving particle's mass increases, and 4) velocities of objects don't add in the Newtonian way. A consequence of 3) was the famous formula $E=mc^2$. A final outcome of Special Relativity was that time and space were now joined together to create a flat 4-dimensional world called spacetime.

6. (12 points) Define 4 of the following concepts: Kinetic energy, potential energy, momentum, bound orbits, Newton's Laws.

Kinetic Energy - energy of motion: $\frac{1}{2}mv^2$

Potential Energy - energy stored for later conversion into kinetic energy.

Momentum: a quantity in physics defined as the mass times the velocity

Bound orbits: Orbits on which objects travel repeatedly around another object. Their shapes are elliptical (a circle is considered an ellipse of eccentricity 0)

Newton's Laws: 1) objects in motion stay in motion at constant velocity unless a force acts on them

2) $F=ma$ 3) for every action there is an equal & opposite reaction