

Glossary

classical velocity addition the method of adding velocities when $v \ll c$; velocities add like regular numbers in one-dimensional motion: $u = v + u'$, where v is the velocity between two observers, u is the velocity of an object relative to one observer, and u' is the velocity relative to the other observer

first postulate of special relativity the idea that the laws of physics are the same and can be stated in their simplest form in all inertial frames of reference

inertial frame of reference a reference frame in which a body at rest remains at rest and a body in motion moves at a constant speed in a straight line unless acted on by an outside force

length contraction L , the shortening of the measured length of an object moving relative to the observer's frame: $L = L_0 \sqrt{1 - \frac{v^2}{c^2}} = \frac{L_0}{\gamma}$

Michelson-Morley experiment an investigation performed in 1887 that proved that the speed of light in a vacuum is the same in all frames of reference from which it is viewed

proper length L_0 ; the distance between two points measured by an observer who is at rest relative to both of the points; Earth-bound observers measure proper length when measuring the distance between two points that are stationary relative to the Earth

proper time Δt_0 . the time measured by an observer at rest relative to the event being observed: $\Delta t = \frac{\Delta t_0}{\sqrt{1 - \frac{v^2}{c^2}}} = \gamma \Delta t_0$, where $\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$

relativistic Doppler effects a change in wavelength of radiation that is moving relative to the observer; the wavelength of the radiation is longer (called a red shift) than that emitted by the source when the source moves away from the observer and shorter (called a blue shift) when the source moves toward the observer; the shifted wavelength is described by the equation $\lambda_{\text{obs}} = \lambda_s \sqrt{\frac{1 + \frac{u}{c}}{1 - \frac{u}{c}}}$ where λ_{obs} is the observed wavelength, λ_s is the source wavelength, and u is the velocity of the source to the observer

relativistic kinetic energy the kinetic energy of an object moving at relativistic speeds: $\text{KE}_{\text{rel}} = (\gamma - 1)mc^2$, where $\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$

relativistic momentum p , the momentum of an object moving at relativistic velocity; $p = \gamma mu$, where m is the rest mass of the object, u is its velocity relative to an observer, and the relativistic factor $\gamma = \frac{1}{\sqrt{1 - \frac{u^2}{c^2}}}$

relativistic velocity addition the method of adding velocities of an object moving at a relativistic speed: $u = \frac{v + u'}{1 + \frac{vu'}{c^2}}$, where v is the relative velocity

ity between two observers, u is the velocity of an object relative to one observer, and u' is the velocity relative to the other observer

relativity the study of how different observers measure the same event

rest energy the energy stored in an object at rest: $E_0 = mc^2$

rest mass the mass of an object as measured by a person at rest relative to the object

second postulate of special relativity the idea that the speed of light c is a constant, independent of the source

special relativity the theory that, in an inertial frame of reference, the motion of an object is relative to the frame from which it is viewed or measured

time dilation the phenomenon of time passing slower to an observer who is moving relative to another observer

total energy defined as $E = \gamma mc^2$, where $\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$

twin paradox this asks why a twin traveling at a relativistic speed away and then back towards the Earth ages less than the Earth-bound twin. The premise to the paradox is faulty because the traveling twin is accelerating, and special relativity does not apply to accelerating frames of reference