Relativity, Length Contraction, and Time Dilation (SwiftStudy Printable)

Key Formulas

$$l = l_0\sqrt{1 - \left(\frac{v}{c}\right)^2}$$

l	length	m
l_o	proper length	m
v	velocity	m/s
c	speed of light = 3 × 10^8 m/s	

$$t = \frac{t_0}{\sqrt{1 - \left(\frac{v}{c}\right)^2}}$$

t	time	s
t_o	proper time	s
v	velocity	m/s
c	speed of light = 3 × 10^8 m/s	

Tips to Remember

- Many students find that distinguishing between length and proper length in a problem is the most challenging part. The proper length (l_o) is an object's length when it isn't moving. Or, more technically, it's the object's length in its own reference frame. (The object never moves with respect to itself, since wherever it goes, there it is.) The length l is the shorter length that an observer who thinks the object is moving will perceive.
- The distinction between time (t) and proper time (t_o) is similar. The proper time is the length of time that passes between two eents that occur in the same place, and the events happen in the same place if the object isn't moving, i.e., is in its own reference frame. The time t is the longer time between two events that an observer who thinks the object is moving will perceive. Textbook values of quantities such as half-life, particle lifetime, etc., will be proper times, because they will assume the measurements are made in a stationary reference frame.
- Sometimes problems will refer to a particle's speed in words like "95% of the speed of light." In these cases you don't have to calculate 95% of 3 × 10^8. It's much easier to use $0.95c$ for v, so the fraction v/c will simply reduce to 0.95.