# Special relativity

## Exercises

1. If an electron moved at $0.95c$ with respect to an observer what mass would the observer measure the moving electron to have? (rest mass of an electron $=9.1×10^{-31}$)
2. For a proton (rest mass $=1.67×10^{-27}kg$) moving at $0.99c$ find:
	1. non-relativistic momentum
	2. relativistic momentum (hint: use effective mass)
3. If a particle had a half-life of $0.6μs$ at rest calculate the half-life the particle would have if measured by a stationary observer when the particle was travelling at $0.98c$ with respect to the observer.
4. If a spacecraft had a length of $25m$ when measured at rest how long would it appear to a stationary observer if it was moving at $0.9c$ with respect to the observer?
5. Consider a particle moving in the LHC at $0.99c$.
	1. How long would the particle take to make one cycle of the $27km$ radius collider?
	2. If the observer could see a clock travelling with the particle how much time would have passed on the clock as the particle travelled the $27km$ circumference?
	3. How long would the $27km$ circumference appear to be to the moving particle?

## Answers

1. $ m\_{v}=\frac{m\_{o}}{\sqrt{\left(1-\frac{v^{2}}{c^{2}}\right)}}=9.91×10^{-30}kg$
	1. $p=mv=4.96×10^{-19}kgms^{-1}$
	2. $p=\frac{m\_{o}v}{\sqrt{\left(1-\frac{v^{2}}{c^{2}}\right) }}=3.51×10^{-18}kgms^{-1}$
2. $t\_{v}=\frac{t\_{o}}{\sqrt{\left(1-\frac{v^{2}}{c^{2}}\right)}}=3μs$
3. $l\_{v}=l\_{o}\sqrt{\left(1-\frac{v^{2}}{c^{2}}\right)}=10.9m$
	1. $t=\frac{s}{v}=90.9μs$
	2. $t\_{o}=t\_{v}\sqrt{\left(1-\frac{v^{2}}{c^{2}}\right)}=12.8μs$
	3. $l\_{v}=l\_{o}\sqrt{\left(1-\frac{v^{2}}{c^{2}}\right)}=3.8km$