# Symbols & Units

Special relativity really only needs to be considered when objects get close to the speed of light, which is defined as exactly 299,792,458 m/s, so about 3 x $10^8$ m/s. To make descriptions and calculations easier, speeds are often given as a fraction of the speed of light, and the letter ß is used for that. It is then called the *speed factor*, but oftentimes it is just called the speed. Note that ß is therefore dimensionless.

| Speed Factor (a.k.a. speed): | $\beta = \frac{v}{c}$ |
|---|---|

It won't be obvious until you start the derivations, but there is an expression that pops up in most equations in relativity. That expression depends on the speed of the object and is given the name *Lorentz factor* and is denoted by the letter γ. It is defined as

| Lorentz Factor: | $\gamma = \frac{1}{\sqrt{1-\beta^2}}$ |
|---|---|

Note that γ is dimensionless. Also note that γ has a minimum value of 1 when ß = 0 and there is a vertical asymptote when ß = 1 (which is the speed of light.) As can be seen in the chart below, ß must be very close to the speed of light for the Lorentz factor to become a big number.

| ***V*** | ***γ*** |
|---|---|
| 8000 m/s (space shuttle) | 1.00 |
| 0.1 c | 1.01 |
| 0.5 c | 1.15 |
| 0.9 c | 2.29 |
| 0.99 c | 7.09 |

In the chart, c is the speed of light and is 3 x $10^8$ m/s, so the speed of the space shuttle in orbit around the earth is about 8000 m/s, which is about 0.000027 c.

Finally, a word about units. While most of the time we will use SI units, sometimes it is convenient to use a different set of units when doing relativity problems. Astronomical distances are so large a very common unit of distance is the "light-year" which is the distance light travels in 1 year. If we use "years" as the unit of time, then the speed of light is 1 ly/y. Likewise a "light-second" is the distance light travels in 1 second, and the speed of light would be 1 ls/s. If you are ever dealing with a problem that involves distances given in ly or ls, then leave it that way and just use time in years or seconds and then the speed of light is simply 1. It makes the calculations far easier since it generally gets rid of a lot of scientific notation.