Simple Cases of Time Dilation

Assume that you are studying high energy subatomic particles that are coming down from space and these particles interact with the atoms of Earth’s upper atmosphere, these will then produce some unstable particles called mouns. A moun’s half life at rest is about $2.20 \times 10^{-6}$ seconds. If a moun is moving at a speed of $0.995c$ relative to the earth, what will you a earthling measure the mean lifetime to be?

_Hints: use of time dilation, you must know what the proper time is just plug it into the time dilation equation._

Assume that an airplane(blackbird) flies from San Francisco to New York which has a total distance of about 4800 km. Lets assume that the pilot continues at a constant speed of 500 m/s, ignoring acceleration. How much time does the round trip take as measured by an observer on the ground? What about the time measured by the pilot? Why do you expect the time difference to be so small?

_Hints use time dilation, When you evaluate the airplanes frame of reference, you may want to decide on using a binomial expansion of the radical, just keep the first two terms of the expansion and all other terms will be too small to worry with._

Classic Example of Length Contraction.

If a spaceship flies by earth at a speed of $0.985c$, one of the pilots knows that the ships head to tail length is roughly 575 meters long. What would an observer on earth tell of the length?

_Hint, the length is along the motion of the ship, thus length contraction will be applied. What do you think will haven if the length was not in the direction of relative motion?_

Lorentz Transformation

Assume that a spaceship is moving away from planet earth with an estimated speed of about $0.910c$ and fires a shuttle bus in the same direction of travel with a estimated speed of $0.720c$ relative to the mother spaceship. What would be the shuttle’s relative velocity to the earth? If another junior spaceship is trying to catch up the mother ship, lets assume that this junior ship has a super engine that will give it $0.998c$ relative to the earth, then what is the junior spaceships speed relative to the mother ship?