

Parachute Problem

MA112 Prof. Leise

Names:

Hand in one neat solution per group of at most three at the end of class.

Here is part of an email sent to me by a good friend and avid skydiver who lives in Houston, TX (the “pro-track” is a recorder on his helmet when he makes jumps):

“Okay, I finally remembered to bring my pro-track in to work with me. For clarity I'll explain a bit. All altitudes are given in feet and are AGL (Above Ground Level...as opposed to MSL which is Mean Sea Level) due to the fact that, for a skydiver, it's much more useful to know your altitude above the ground. EXIT is the altitude at which I exited the plane and DEPLOY is the altitude at which the parachute deployed. It should be noted here that the pro-track tends to record low values for deployment altitudes because it records the altitude at which you are under a completely opened canopy. Canopies usually take about 500 feet to deploy but can often take longer if they're packed for a slow opening. Also different canopies have different opening characteristics and some tend to open more quickly than others. A slow opening is a soft opening and is appropriately called a snivel because you look up above you and you see the partially open canopy sniveling around trying to open completely. It can be a little disconcerting the first few times you experience a long snivel but once you've had a snappy opening or two you learn to appreciate a good snivel! A sniveling opening will probably take 700 to 800 feet. So, when you see a low value for my deployment altitude there was probably some sniveling involved. Yup, that's my story and I'm sticking to it. I never pull low!”

Jump: 75 (Colorado Springs)

exit: 14,000 ft
deploy: 2800 ft
freefall time: 58 sec
avg speed: 145 mph
max speed: 162 mph

1. Write down a differential equation with initial conditions that models his jump, assuming that air resistance is proportional to velocity squared.
2. Determine the air resistance coefficient while in freefall (before deploying his parachute) by using his terminal freefall speed of 162 mph. (Be careful with units!)
3. Solve the differential equation for the velocity.
4. Integrate the velocity to get the height function. Maple doesn't put the absolute values inside the **ln** function, so you need edit the solution by including **abs** after each **ln**.
5. Solve for the predicted time of parachute deployment by finding when the height is 2800 feet. How does this value compare to his actual value of 58 seconds?
6. Find the average speed between exit and deployment. How does this value compare to his actual value of 145 mph? (Check units!)
7. How well does the differential equation model the freefall part of his jump? What important physical factors are we neglecting in this model? (There are lots—list at least three major ones.)