# Hypothetical darkstar distance traveled calculation method:

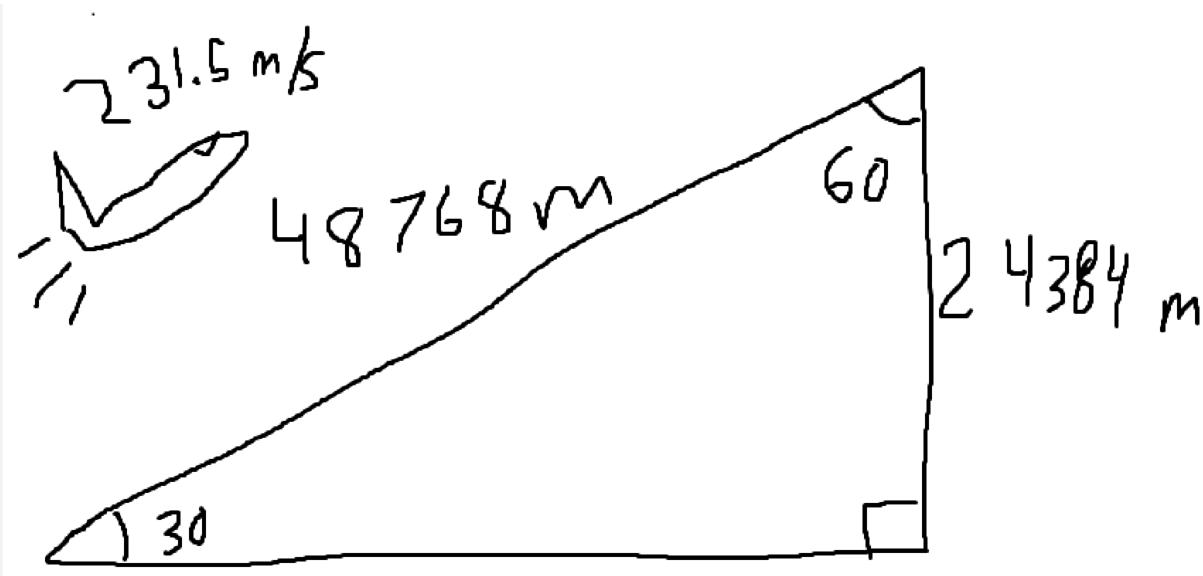
## Assumptions:

All calculations will be done using the conventional units of meters and seconds:

The majority of these assumed conditions are similar to the SR-71 aircraft, the current fastest manned aircraft designed by the United States military.

- The aircraft takes off at a 30 degree angle of attack
- The aircraft climbs at a speed of 231.5 meters per second (or 517mph) until it reaches an altitude of 24384 meters (or 80000 feet)

- Once after reaching an altitude of 24384 meters, the aircraft accelerates from its current speed of 231.5 meters per second at a rate of 20 meters/second^2
- The aircraft continues to accelerate until it reaches its maximum speed 3430 meters per second (Mach 10) as seen in the movie
- We're going to fly for over 371 seconds. Nobody flies in a high tech aircraft for less than 7 minutes and then gets off -_- jeez.




Calculations:

Assume "seconds" = amount of seconds the darkstar flies

For calculating the distance traveled by the darkstar in a given amount of time in seconds, we will be taking in account velocity functions.

Step 1: Since the aircraft travels at 231.5 m/s, the velocity function for this aspect can simply be f(x) = 231.5

The aircraft must travel a total distance of 48768 meters to reach an altitude of 24384 meters. This is known by using the 30 60 90 triangle rule shown in the diagram above. For the aircraft to reach this altitude, it must travel for 48768/231.5 seconds which equates to 210.665 seconds. So when the aircraft travels for 210.665 seconds at a constant velocity of 231.5 m/s, the distance can be represented as a definite integral of the velocity function.

$$\int_0^{210.665} 231.5\,dx$$

Step 2: Once the aircraft reaches its max altitude of 24384 meters, it will accelerate at 20 m/s^2. The velocity function with respect to the acceleration would be 20x. In order to find the distance traveled based on this velocity function, we must also subtract 210.665 seconds from our input since this integral expression is adding onto the expression from step 1, thus requiring us to account for all x's past 210.665 seconds or the time it takes to reach its maximum altitude. Finally, we add 231.5 to its velocity since the aircraft's initial velocity before accelerating is already 231.5 meters per second.

Once the aircraft starts accelerating at our given rate of 20 m/s^2, it takes around 160 seconds to reach mach 10 (3430 m/s), so that brings our acceleration window from 211 seconds to 371 seconds in-flight.

$$\int_{211}^{371} (20\,(x - 210.665) + 231.5)\,dx$$

Step 3: Once the aircraft reaches Mach 10 or 3430 m/s, it maintains this speed. Therefore the velocity is just f(x) = 3430 for any given time after it has finished accelerating. We retrieve the distance traveled between 371 seconds and s seconds in flight by integrating again.

Let s = the amount of seconds the darkstar flies (s should be greater than 371)

$$\int_{371}^{s} 3430\, dx$$

Step 4: Now that we have accounted for the aircraft's distance traveled first during liftoff, then during acceleration, and finally during its coast phase at mach 10, we simply add all those expressions together.

$$\left(\int_{0}^{210.665} 231.5\, dx + \int_{211}^{371} (20\,(x - 210.665) + 231.5)\, dx + \int_{371}^{s} 3430\, dx\right)$$

Step 5: Now most people don't really like to comprehend meters. I'm almost American so I like to convert to miles traveled. In order to convert meters to miles traveled, we simply multiply by 0.000621371. That leaves our final equation to calculate our distance as:

$$0.000621371\left(\int_{0}^{210.665} 231.5\, dx + \int_{211}^{371} (20\,(x - 210.665) + 231.5)\, dx + \int_{371}^{s} 3430\, dx\right)$$

Final notes: If the user inputs a seconds value under 371 seconds, then the end integral(s) is truncated accordingly. For example, if the aircraft traveled for only 300 seconds, the last integral would be truncated since it would stop before reaching mach 10. If it only traveled 200 seconds for instance, both the end and middle integrals get truncated since it never reaches its maximum altitude, therefore eliminating the need to calculate the acceleration and cruise phase distance of the aircraft.

Let me know if I made any errors!

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