1-Dimensional Kinematics

1 Topics Covered

- (Final Quantity) = (Initial Quantity) + (Change in Quantity)
- (Change in Quantity) = (Rate of Change) x (Time)
- \( v_{avg} = \frac{\Delta x}{\Delta t} \)
- \( a = \frac{\Delta v}{\Delta t} \)
- There are exactly 2.54 centimeters in one inch and exactly 5280 feet in one mile

2 Problems

1. A crazy squirrel is running around in my backyard. He runs in a straight line from a tree to a trash can and back again in 0.5 s. The distance between the tree and the trash can is 1 m.

   (a) During this time period, what is the squirrel’s average speed?
   (b) During this time period, what is the squirrel’s average velocity?

2. Suppose a meteor is accelerating towards the Earth at 100 km/s².

   (a) What is the change in the meteor’s velocity after 10 s?
   (b) If the meteor’s initial velocity was 10,000 km/s towards Earth, what is its velocity after 10 s?
   (c) What is the meteor’s average velocity after 10 s?
   (d) What is the meteor’s change in position after 10 s?
   (e) If the meteor’s initial position was 105,001 km away from Earth, what is its position after 10 s?

3. Suppose an object is moving with a constant acceleration \( a \).

   (a) What is the change in the object’s velocity after \( t \) seconds?
   (b) If the object’s initial velocity was \( v_0 \), what is its velocity after \( t \) seconds?
   (c) What is the object’s average velocity after \( t \) seconds?
   (d) What is the object’s change in position after \( t \) seconds?
   (e) If the object’s initial position was \( x_0 \), what is its position after \( t \) seconds?

4. Achilles and a tortoise are having a race. Achilles knows he is faster than the tortoise, so he gives it a head start. In fact, Achilles can run at 10 m/s, the tortoise can run at 1 m/s, and the tortoise starts 10 m ahead of Achilles.

   (a) Using the kinematic equations you derived in the last question, figure out how long will it take for Achilles to catch up with the tortoise.
   (b) Now think of this problem in a different way. First, how long does it take Achilles to travel the 10 m that initially separate him from the tortoise?
(c) How far does the tortoise move during this time period?

(d) It seems that the tortoise is still in front of Achilles. How long will it take for Achilles to travel the distance than now separates him from the tortoise?

(e) How far does the tortoise move during this time period?

(f) Will Achilles ever catch the tortoise?

5. I gently let a drop of spit fall over the edge of a bridge and begin counting. The spit lands in the river below after 3 s. How high is the bridge?

6. There is a thunderstorm off in the distance. I see a flash of lightning, which is followed five seconds later by the sound of thunder. I want to know how far away the storm is.

   (a) The speed of sound in air is 344 m/s. Convert this to miles per second.

   (b) How far away is this storm? What is a rough rule for estimating the distance between you and a thunderstorm?