EXERCISES - CHAPTER II

1. Find the appropriate handy dandy formulae for \( v(t) \) and \( x(t) \) if \( a(t) = kt^3 \).

2. If you drive 50 miles on a straight road in one hour, what is your average velocity? If you turn around immediately and return in one and one quarter hours, what is your average velocity for the entire trip?

3. Suppose the position of a particle were given by

\[
x(t) = 10t^2 + 4t
\]

where \( x \) is in meters for \( t \) in seconds.
   a. What is the average velocity between \( t = 0 \) and \( t = 3 \) s?
   b. At what time is the instantaneous velocity equal to this average velocity? (Is the answer a coincidence?)
   c. What's the value of the acceleration?

4. Suppose a car could accelerate from rest to 60 miles per hour in 10 seconds.
   a. What would be the value of its acceleration, assuming it to be constant?
   b. How far would the car travel in these 10 seconds?
   c. What constant acceleration would be necessary to achieve the same final velocity in one half the distance?

5. In outer space, a rocket ship starts from rest and moves in a straight line with a constant acceleration of \( 100 \text{m/s}^2 \) for 5 seconds. It then continues with zero acceleration for 5 more seconds. How far does it travel in these 10 seconds?

6. You want to throw a ball vertically upwards so that it will go up 50 meters before turning around. What initial velocity do you have to give it?

7. A rocket, initially at rest, is fired at \( t = 0 \) vertically down from a building of height \( H \). The rocket's acceleration, including the effects of gravity, is downwards with increasing magnitude given by \( a(t) = \beta t \), where \( \beta \) is a known constant. When does it hit the ground and how fast is it going when it hits?
8. A ball is thrown vertically upwards with a velocity of 39.2 m/s, from a window 98 m high. How long before the ball hits the ground?

9. A dog is chasing a rabbit. The rabbit is 360 meters from his hole running at 15 m/s. The dog is 22 meters behind the rabbit, running at 16 m/s. Does the rabbit make it to the hole?

10. Two cars start from rest at the origin at $t = 0$. The first has a known, constant acceleration $k$. The second has a weird engine that increases its power so that the car has an increasing acceleration given by $\alpha t^2$, with $\alpha$ a known constant. When will the two cars again be at the same point? Where will they be when they are at the same point?