

**State Any Assumptions You Need To Make – Show All Work – Circle Any Final Answers**  
**Be Sure to Write Down Equations – Feel Free to Ask Any Questions**  
**Use Your Time Wisely – Work on What You Can**

**The Tortoise and the Hare by Aesop SIXTH CENTURY B.C. GREECE (50,000 points)**

1.) The wily Tortoise challenges the arrogant Hare to a 5.000 kilometer (5000. meter) race – the Hare, of course, agrees. *How hard can this be?* the Hare thinks. Especially since the Tortoise can only move at 0.300 m/s. The Hare, on the other hand, knows he can easily run at 17.0 m/s. (a) How long does the Tortoise take to run the race? *Give the answer in seconds, then minutes.*

$$v = \frac{d}{t}$$

$$t = \frac{d}{v} = \frac{5000.m}{0.300m/s} = 16,670 \text{ sec} = 277.8 \text{ min}$$

(b) So... how long a nap can the Hare take, if he expects to beat the Tortoise by a second after he wakes up? *Give the answer in seconds, then minutes.*

$$t = \frac{d}{v} = \frac{5000.m}{17.0m/s} = 294.1 \text{ sec}$$

$$t_{\text{nap}} = 16,670 \text{ sec} - 294.1 \text{ sec} = 16,375 \text{ sec} = 272.9 \text{ min}$$

(c) Of course the Hare oversleeps and loses the race. Mad as a March Hare now, the Hare demands a rematch. The Tortoise agrees, but this time they will drive cars. The Tortoise drives 5000. meters in a used 1960 American Rambler station wagon at a constant speed of 17.0 m/s. How long does the Tortoise take to drive the race? *Give the answer in seconds, then minutes.*

**same time as Hare in (b), t = 294.1 sec**

(d) The Hare is driving a new 2002 Corvette at a constant acceleration starting from rest. This is the classic pursuit problem – the Corvette is going twice as fast as the Rambler when the Hare catches up to the Tortoise. What is the acceleration *a* if the Hare miscalculates once again and reaches the finish line exactly at the same time as the Tortoise (therefore ending in a tie and not a win)?

$$v = v_0 + at = at$$

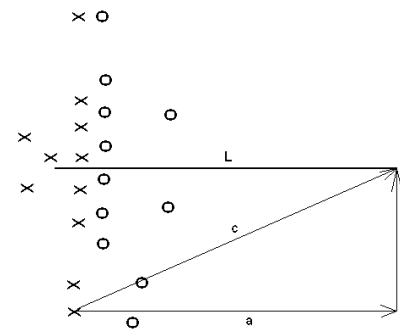
$$a = \frac{v}{t} = \frac{34.0m/s}{294.1 \text{ sec}} = 0.1156m/s^2 \text{ OR } a = \frac{v^2}{2x} = \frac{(34.0m/s)^2}{2(5000.m)} = 0.1156m/s^2$$

(e) Watching *50 Years of Late Night Television on NBC* as I write this, David Letterman once dropped watermelons from atop a five story building. How fast would a watermelon be going if dropped from rest from 17.0 meters above the ground?

$$v^2 = v_0^2 - 2g(y - y_0) = 2gy_0$$

$$v = \sqrt{2gy_0} = \sqrt{2(9.81m/s^2)(17.0m)} = -18.26m/s$$

**This is the NFL Week 3, No... I Meant Week 2 (50,000 points)**



2.) The reason most people can't figure out the X's and O's of football diagrams, is that IT'S PHYSICS!  
 Suppose the little guy X at the bottom of the diagram goes out in an "L" pattern. He runs a distance  $a = 15.0 \text{ m}$  in the x-direction and  $b = 10.0 \text{ m}$  in the y-direction. (a) Find the length of the resultant vector *c*.

$$c = \sqrt{a^2 + b^2} \text{ OR}$$

$$A = \sqrt{A_x^2 + A_y^2} = \sqrt{(15.0m)^2 + (10.0m)^2} = 18.03m$$

(b) Find the standard angle  $\theta$  that the vector *c* makes with the horizontal.

$$\theta = \tan^{-1}\left(\frac{A_y}{A_x}\right) = \tan^{-1}\left(\frac{10.0m}{15.0m}\right) = 33.7^\circ$$

(c) Mr. X runs his "L" pattern at 8.00 m/s. Find the resultant velocity vector  $\vec{v}$  that Mr. X makes. *Give the answer in Standard Form.*

$$d = 15.0m + 10.0m = 25.0m$$

$$v = \frac{d}{t}; t = \frac{d}{v} = \frac{25.0m}{8.00m/s} = 3.125 \text{ sec}$$

$$v = \frac{d}{t} = \frac{18.03m}{3.125 \text{ sec}} = 5.770m/s$$

$$\vec{v} = 5.770m/s @ 33.7^\circ$$

(d) Mr. Star Quarterback passes the football to Mr. X a horizontal distance of 17.0 meters in 1.08 seconds, launching the ball at a  $30^\circ$  angle. Mr. X catches the ball at the same height that Mr. Star Quarterback throws it. Find the initial velocity vector  $\vec{v}_0$ . Give the answer in Standard Form.

$$\begin{aligned} v_{0x} &= \frac{x}{t} = \frac{17.0m}{1.08 \text{ sec}} = 15.74m/s \\ v_{0x} &= v_0 \cos \theta \\ v_0 &= \frac{v_{0x}}{\cos \theta} = \frac{15.74m/s}{\cos 30^\circ} = 18.17m/s \\ \vec{v}_0 &= 18.17m/s @ 30.0^\circ \end{aligned}$$

(e) The ball is released 1.70 meters above the grass. What is the maximum height of the football?

$$\begin{aligned} h &= \frac{v_0^2 \sin^2 \theta}{2g} = \frac{(18.17m/s)^2 (\sin 30^\circ)^2}{2(9.81m/s^2)} = 4.207m \\ y_{\max} &= y_0 + h = 1.70m + 4.207m = 5.907m \end{aligned}$$

**This can also be done with the 1<sup>st</sup> or 4<sup>th</sup> kinematic equations, but you have to find  $v_{0y}$ .**

