DAY 2: 1D Position, Velocity, Acceleration

1) Logistics: Student info on HW's
   - Name
   - SID
   - Recitation Day and Time; i.e. R 8 am
   - HW #; i.e. RHW1

1D Position, Velocity and Acceleration - Graphically

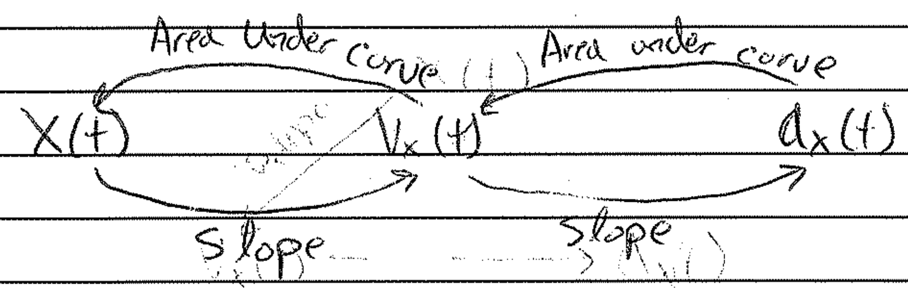
Position: $X(t)$

Velocity: $V_x(t) = \frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{t_f - t_i}$

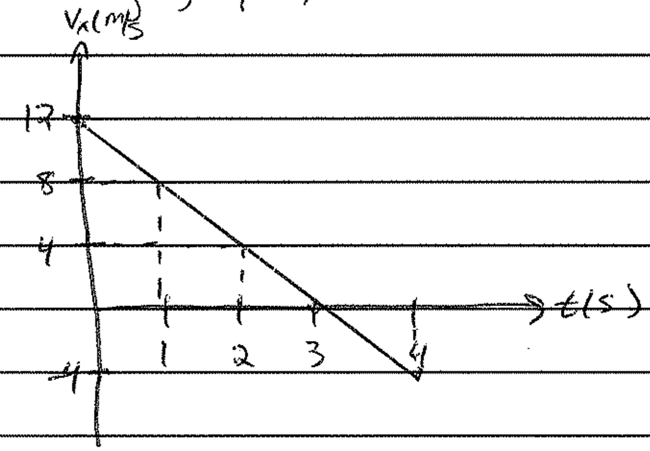
$\Rightarrow$ Slope of position plot is velocity

Acceleration: $a_x(t) = \frac{\Delta V_x}{\Delta t} = \frac{V_f - V_i}{t_f - t_i}$

$\Rightarrow$ Slope of velocity plot is acceleration



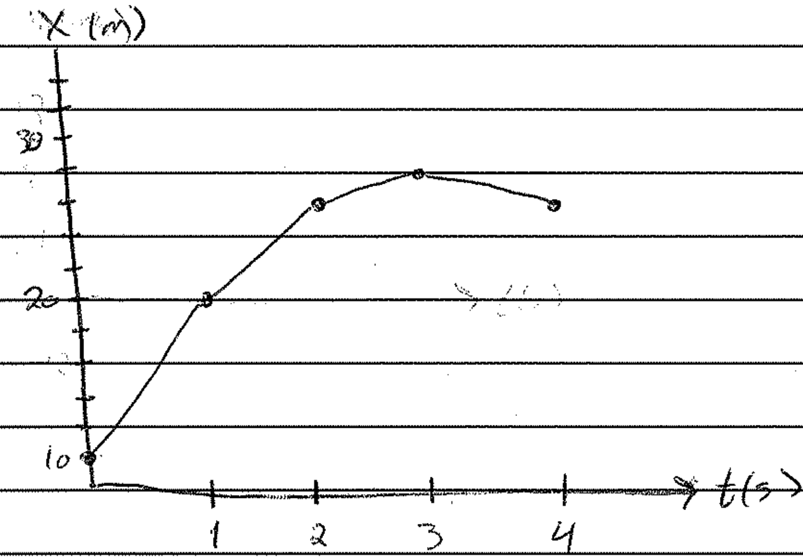
(1) A car starts from $X(0) = 10$ m and moves with the velocity graph,



a) Plot position vs time for $0 \le t \le 4$ and label the cars position @ $t_1 = 1s$, $t_2 = 2s$ $t_3 = 3s$, $t_4 = 4s$

b) Does the car change directions?

c) What is the cars acceleration?



$$a_x = \frac{\Delta v}{\Delta t} = \frac{-4 - 12}{4 - 0} = -4 \, m/s^2$$

@ 1s ⇒ Area Rectangle + Area Triangle $= (l)(w) + \frac{1}{2}(b)(h)$

$= (1)(8) + \frac{1}{2}(1)(4) = 10$

@ 2s ⇒ $(1)(4) + \frac{1}{2}(1)(4) = 6$

@ 3s ⇒ $\frac{1}{2}(1)(4) = 2$

@ 4s ⇒ $\frac{1}{2}(1)(-4) = -2$

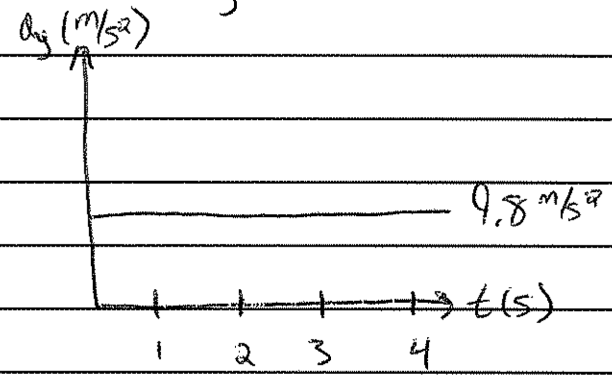
(2) Ball bearings can be made by letting spherical drops of molten metal fall inside a tall tower - called a shot tower - and solidify as they fall.

a) If a bearing needs 4.0 s to solidify enough for impact, how high must the tower be?

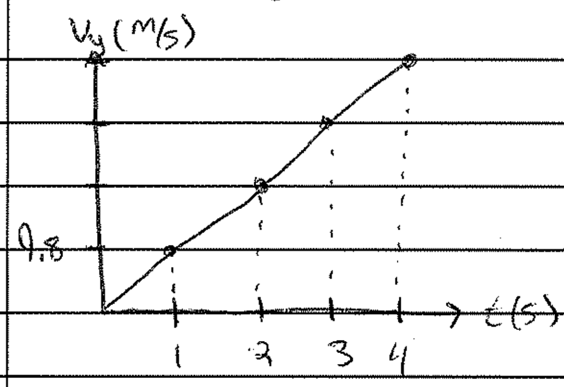
b) What is the bearing's impact velocity?

⇒ Acceleration due to gravity ⇒ $a_y = 9.8\ m/s^2$

Plot $a_y(t)$



⇒ The metal starts from rest ⇒ $V_y(0) = 0$



Position @

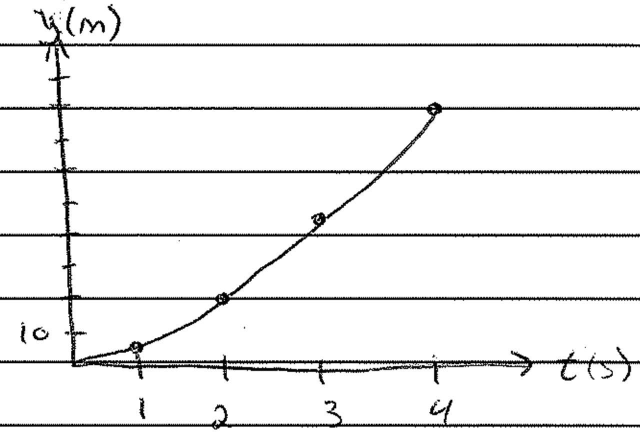
1s ⇒ $\frac{1}{2}(1)(9.8) = X_1$

2s ⇒ $X_2 = X_1 + (1)(9.8) + \frac{1}{2}(1)(9.8)$
$= 2X_1 + 9.8 = 2(9.8)$

3s ⇒ $X_3 = X_2 + (2)(9.8) + \frac{1}{2}(1)(9.8)$
$= 4(9.8) + \frac{1}{2}(9.8)$

4s ⇒ $X_4 = X_3 + (3)(9.8) + \frac{1}{2}(1)(9.8)$
$= 8(9.8)$

(2)

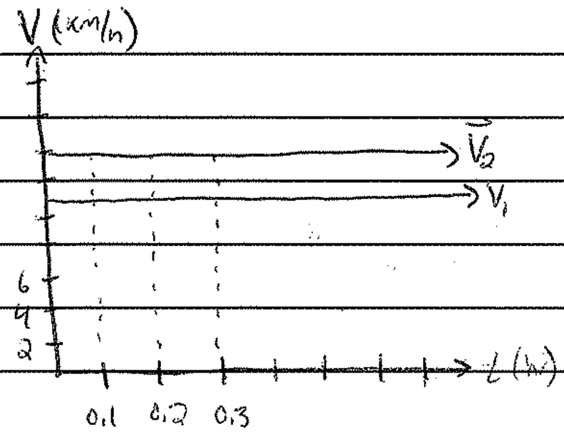


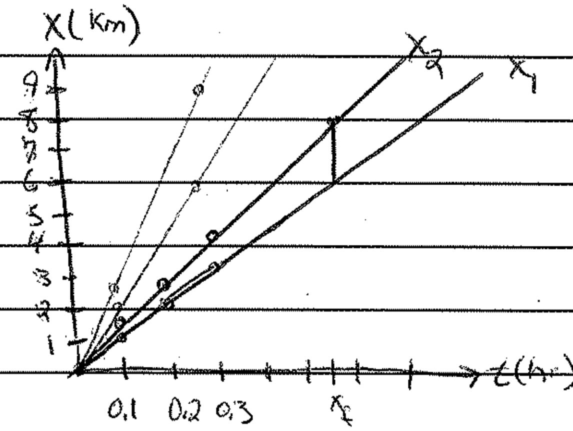
(a) Tower must be ≈ 80 m tall

(b) Hits the bottom @ $V_f = 4(9.8)$ m/s

In an 8.00 km race, one runner runs @ a steady 11.0 km/h and another runs @ 14.0 km/h. How far from the finish line is the slower runner when the faster runner finishes the race

$|\vec{V}_1| = 11.0$ km/h
$|\vec{V}_2| = 14.0$ km/h





$t = 0.1$ hr ⇒ $X_1 = (11)(0.1) = 1.1$ $\quad X_2 = (14)(0.1) = 1.4$
$t = 0.2$ hr ⇒ $X_1 = (11)(0.2) = 2.2$ $\quad X_2 = (14)(0.2) = 2.8$
$t = 0.3$ hr ⇒ $X_1 = (11)(0.3) = 3.3$ $\quad X_2 = (14)(0.3) = 4.2$

X_2 is about 2 km behind X_1 when X_1 reaches the finish.