DO NOT TURN THIS PAGE!!!!!

Name: KEY

Physics 50
Fall 2015
Exam 1

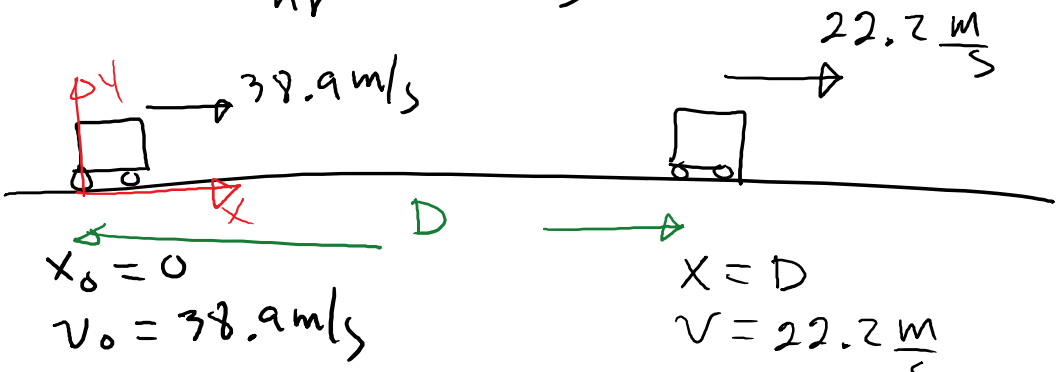
MAKE SURE TO SHOW ALL WORK IN COMPLETE DETAIL. NO CREDIT WILL BE GIVEN IF NO WORK IS SHOWN. EXPRESS ALL ANSWERS IN SI UNITS.

1. The brakes on your car can slow you at a rate of 5.0 m/s^2. (10 pts)

   a) If you're moving at 140 km/h and suddenly see a police car, what is the minimum time in which you can get your car under the 80 km/h speed limit?
   b) Calculate the distance traveled during the braking period.

$v_0 = 140\frac{km}{hr} \times \frac{1hr}{3600s} \times \frac{1000m}{1km} = 38.9\ m/s$

$v = 80\frac{km}{hr} = 22.2\frac{m}{s}$



$x_0 = 0$
$v_0 = 38.9 m/s$

$X = D$
$v = 22.2\frac{m}{s}$
$a = -5\frac{m}{s^2}$

a) $v = v_0 + at$

$22.2 = 38.9 + (-5)t$

$t = 3.34s$

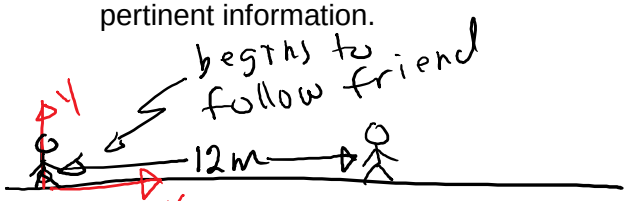
b) $v^2 = v_0^2 + 2a(x - x_0)$

$(22.2)^2 = (38.9)^2 + 2(-5)(D - 0)$

$D = 102m$

2. A bicyclist is finishing his repair of a flat tire when a friend rides by with a constant speed of 4.0 m/s. Three seconds later the bicyclist hops on his bike and accelerates at 2.4 m/s^2 until he catches his friend. (10 pts)

   a) Calculate the time it takes to catch his friend.
   b) How fast is he moving when he catches his friend?
   c) How far did he travel to catch his friend?
   d) Draw the graph of x vs. t for the bicyclist and the friend and label all pertinent information.



$x_{01} = 0$
$v_{01} = 0$
$a_1 = 2.4 \frac{m}{s^2}$

$x_{02} = 12\,m$
$v_{02} = 4 \frac{m}{s}$
$a_2 = 0$

$x_1 = x_2$

$x_{01} + v_{01}t + \frac{1}{2}a_1t^2 = x_{02} + v_{02}t + \frac{1}{2}a_2t^2$

$1.2t^2 = 12 + 4t$

$1.2t^2 - 4t - 12 = 0$

$t = 5.24\,s$

b) $v_1 = v_{01} + a_1t$

$= 0 + 2.4(5.24)$

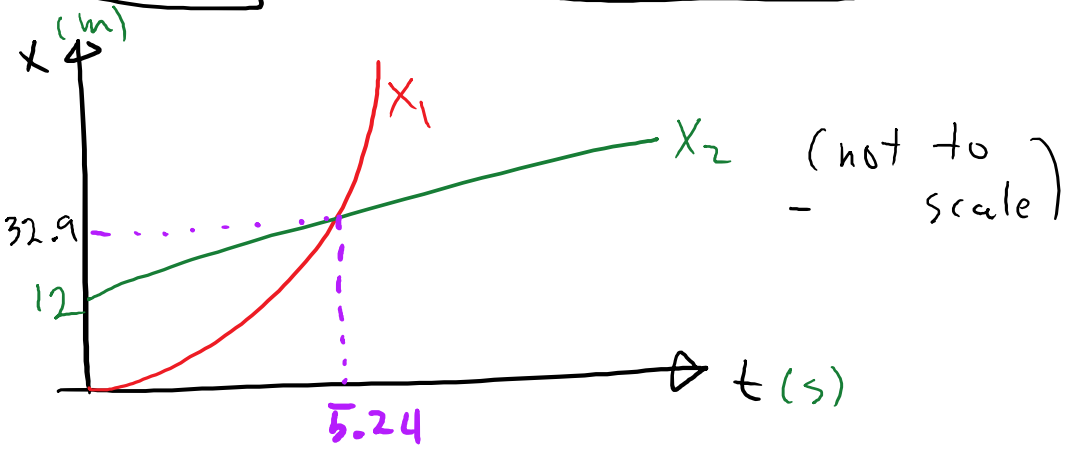
$= 12.6 \frac{m}{s}$

c) $x_1 = 1.2t^2$

$x_1 = 1.2(5.24)^2$

$x_1 = 32.9\,m$

d)

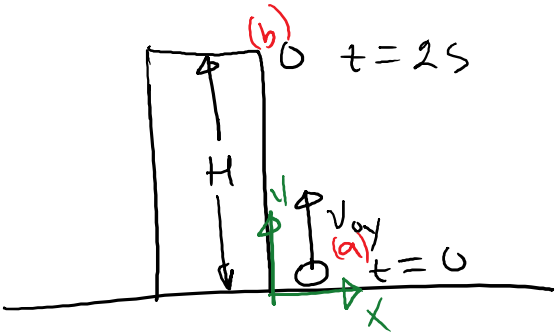


3. A rock is thrown vertically upward from ground level at t = 0. At t = 2.0 s it passes the top of a tall tower, and 1.3 s later it reaches the maximum height. (10 pts)

   a) Calculate the height of the tower.
   b) Calculate the velocity of ball when it returns to ground.
   c) Draw the graph of x s. t, v vs. t, and a vs. t for the motion of the rock from when it's launched until it hits ground.

(c) $v_y = 0$, $t = 3.3\ s$

(b) $t = 2\ s$



a) (a) → (c)

$v_y = v_{oy} + a_y t$

$0 = v_{oy} + (-9.8)(3.3)$

$v_{oy} = 32.3\ \frac{m}{s}$

(a) → (b)

$y = y_0 + v_{oy} t + \frac{1}{2} a_y t^2$

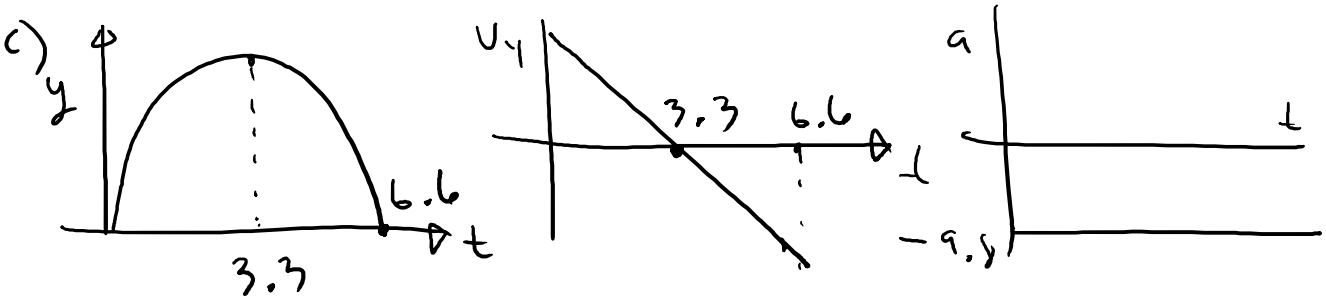
$H = (32.3)(2) - 4.9(2)^2$

$H = 45\ m$

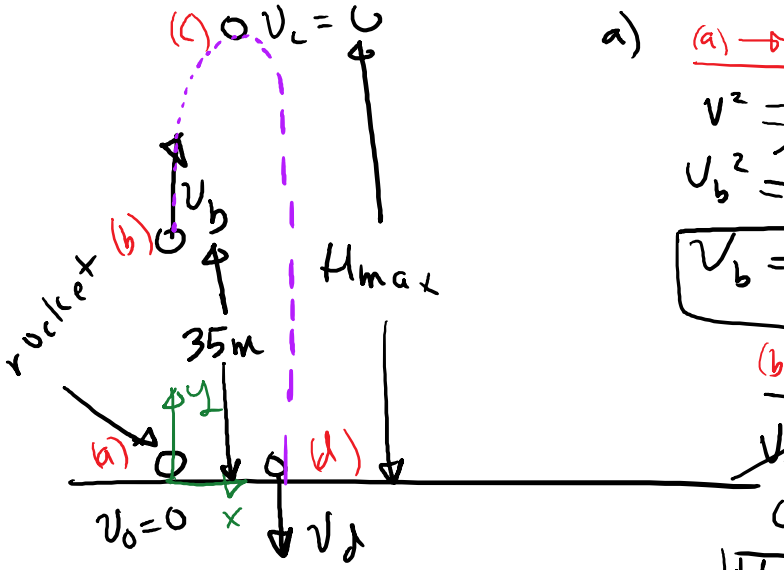
b) $v_y = -v_{oy} = -32.3\ \frac{m}{s}$

By symmetry!

c)



4. A model rocket starting from rest blasts off and moves upward with an acceleration of 15 m/s^2 until it reaches a height of 35 m, at which point its engines shut off, and it continues its flight in free-fall. (15 pts)
   a) Calculate the maximum height of the rocket.
   b) Calculate the speed of the rocket just before hitting the ground.
   c) What is the total duration of the rocket's flight.



a) (a) → (b)

$v^2 = v_0^2 + 2a_y(y - y_0)$

$v_b^2 = 2(15)(35 - 0)$

$v_b = -32.4 \frac{m}{s}$

(b) → (c)

$v_y^2 = v_{0y}^2 + 2a_y(y - y_0)$

$0 = (32.41)^2 + 2(-9.8)(H_{max} - 35)$

$H_{max} = 88.6\,m$

b) (b) → (d)

$v_y^2 = v_{0y}^2 + 2a_y(y - y_0)$

$v_y^2 = (32.41)^2 - 19.6(0 - 35)$

$v_y = -41.7\,m/s$

c) (a) → (b)

$v_y = v_{0y} + a_y t_1$

$32.41 = 0 + 15t_1$

$t_1 = 2.16\,s$

(b) → (d)

$v_y = v_{0y} + a_y t$

$-41.7 = 32.41 - 9.8t_2$

$t_2 = 7.56\,s$

$t_T = t_1 + t_2 =$ 9.72 s