Velocity as a Vector and Projectile Motion

Directions: You must show your work (including formulas, vectors diagrams, etc.) for credit.

1. Captain Pablo anchors *Robinson Cruise-0* at Ayala Cove at Angel Island. He then climbs aboard his dinghy to take Ms. D for lunch at S*am's Café* in Tiburon that requires motoring his dinghy directly across the treacherous waters of Racoon Strait.

a) If the current is 7 km/h and the dinghy heads 90° to the current at 15 km/h, what is the resultant speed of the dinghy?

$v = $ _____

b) Relative to the shore, what angle does Pablo cross the river?

$\theta = $ _____

c) If Pablo angles upstream at 12 km/h (relative to the water), how fast and in what direction (relative to the bank) should the dinghy be headed so that Pablo ends up directly across Racoon Strait?

$v = $ _____

$\theta = $ _____

2. Asked to film a demonstration for the MythBusters, Mr. Robinson falls out of the helicopter and lands safely in a swimming pool. If the helicopter is traveling 30 meters above the ground at a constant velocity of 25 m/s,

a) How long does it take Mr. Robinson to land in the pool?

$t = $ _____

b) Assuming no air resistance, what was the horizontal distance between Mr. Robinson and the helicopter?

$d_x = $ _____

3. Hot Shot fires a slingshot pellet directly at a target that is far enough away to take 0.6 second to reach.

a) How far below the target does the pellet hit? $d_y = $ _____

b) How high above the target should Hot Shot aim? $d_y = $ _____

4. Unlike the rich kids from San Mateo whose coaches have radar guns, Vijay lives in the ghetto in Vizag and wants to become a big league pitcher like Tim Lincecum. Instead of using a radar gun, Vijay uses his knowledge of physics to figure out the speed of his pitches. He scrounges up some scrap lumber and builds a platform so that when he pitches his hand is 8 feet off the ground at the release point. He pitches a fastball on the platform level to the ground that lands 106 feet away and a deceptive changeup that lands 85 feet away. Use $g = 32$ ft/s^2 and 1 mi/h = 1.47 ft/s to find the following.

a) How long does it take the ball to hit the ground?

$t =$ _____

b) What is the speed of his changeup in feet per second?

$v =$ _____

c) What is the speed of his fastball in miles per hour?

$v =$ _____

5. A steel ball is released on a Bull's Eye Ramp from rest with a mechanism designed by one of Mr. Robinson's students. The ball rolls down an incline and rolls horizontally off the flat portion of the ramp to a target soup can on the floor. Analyze the horizontal and vertical components of the speed (*not* velocity) of the ball in each of the four sections. Denote v_x, v_y, and a for each section as + (increasing), – (decreasing), c (constant), or 0.

Section I	Section II	Section III	Section IV
$v_x =$	$v_x =$	$v_x =$	$v_x =$
$v_y =$	$v_y =$	$v_y =$	$v_y =$
$a =$	$a =$	$a =$	$a =$

6. Normally, when a pitching machine pitches a ball horizontal to the ground the path of the ball is a nice smooth _____ . Is it possible for the same pitching machine to pitch the ball 100 km/h and yet have the ball fall straight down to the ground? Explain why or why not. Hint: Your explanation should include a vector diagram as well as a written explanation.