**Quiz 3**

Name: 
Section: 4

This quiz is composed of 1 problem (10 points). Answer all parts.

**Problem 1:**
A Rutgers skater, one of the many in our university, accelerates with his board and flies off horizontally from a step and lands at 1.6 m away from the edge of the step. If the step has 0.650 m height, answer the following questions:

a) How much time passed since the skater stop’s touching the step until it lands. (Assume board and human as a single point object) (1pt)

\[ v_y = 0 \quad \text{and} \quad y = 0 \quad \text{so} \quad 0 = y_o + v_{yo}t - \frac{1}{2}gt^2 = y_o - \frac{1}{2}gt^2 \]

\[ \Rightarrow t = \sqrt{\frac{2y_o}{g}} = \frac{2(0.650)}{9.8} = 0.364 \text{ s} \]

b) What is the initial velocity of the skater? (2 pt)

\[ v_y = 0 \quad \text{and} \quad x = x_0 + v_{xo}t + \frac{1}{2}at^2 = v_{xo}t \Rightarrow v_{xo} = \frac{x}{t} = \frac{1.6m}{0.364s} = 4.4 \text{ m/s} \]

\[ v_0 = \sqrt{v_{xo}^2 + v_{yo}^2} = v_{ox} = \sqrt{4.4 \text{ m/s}} \quad \text{horizontally} \]

b) What is the direction of the velocity of the skater when he hits the ground with respect to the floor and what is its magnitude. (3 pts)

\[ v_x = v_{xo} + a_xt = v_{ox} = 4.4 \text{ m/s} \]

\[ v^2 = v_{yo}^2 - 2g(y - y_o) = 2gy_o = v_y = -\sqrt{2gy_o} \]

\[ v = \sqrt{v_x^2 + v_y^2} = \sqrt{v_{ox}^2 + 2gy_o} = \sqrt{(4.4 \text{ m/s})^2 + 2(9.8 \text{ m/s}^2)(0.65 \text{ m})} = 5.7 \text{ m/s} \]

\[ \tan \theta = \frac{v_y}{v_x} \Rightarrow \theta = \arctan \frac{v_y}{v_x} = \arctan \frac{-\sqrt{2gy_o}}{v_x} = \arctan \frac{-\sqrt{2(9.8 \text{ m/s}^2)(0.65 \text{ m})}}{4.4 \text{ m/s}} \approx -39.9^\circ \quad \text{below x-axis} \]

d) As most skaters, our fellow, was listening to music using his phone, while skating. Unfortunately, while he was performing his act, his phone, leaves his hand, the exact moment he lands on the floor. The phone's initial height above the floor, when it flew off the hand, was y = 1.7 m and x = 1.6 m away from the edge of the step. Where does the phone land with respect to the step edge? (Use as initial velocity for the phone your result in part c) (4 pts)

\[ 0 = y = y_o + v_{yo}t - \frac{1}{2}gt^2 \Rightarrow t = \frac{-v_y \pm \sqrt{v_y^2 - 4(-\frac{1}{2})(-1.7)}}{2(-\frac{1}{2})} = -0.885 \text{ s} \quad \text{or} \quad 0.15 \text{ s} \quad \text{physical answer} \]

\[ x = x_0 + v_{xo}t + \frac{1}{2}at^2 = x_0 + v_{xo} - \frac{1}{2} \text{gt}^2 = 1.6 \text{ m} + (4.4 \text{ m/s}) \cdot (-0.885) = 3.0 \text{ m} \]

Skate Safely
**Quiz 3**

Name: 
Section: 5

This quiz is composed of 1 problem (10 points). Answer all parts.

**Problem 1:**

A Rutgers skater, one of the many in our university, accelerates with his board and flies off horizontally from a step and lands at 1.4 m away form the edge of the step. If the step has 0.50 m height, answer the following questions:

a) How much time passed since the skater stop's touching the step until it lands. (Assume board and human as a single point object) (1pt)

\[ v_{y0} = 0 \text{ and } y_0 = 0 \text{ so } 0 = y = y_0 + v_{y0}t - \frac{1}{2}a_t^2 = y_0 - \frac{1}{2}a_t^2 \]

\[ t = \frac{-2y_0}{g} = \frac{-2(0.50m)}{9.8m/s^2} = 0.32s \]

b) What is the initial velocity of the skater? (2 pt)

\[ v_{y0} = 0 \text{ and } x = x_0 + v_{x0}t + \frac{1}{2}a_x t^2 = v_{x0}t \Rightarrow v_{x0} = \frac{x}{t} = \frac{1.4m}{0.32s} = 4.4m/s \]

\[ v_0 = \sqrt{v_{x0}^2 + v_{y0}^2} = v_{x0} = 4.4m/s \text{ horizontally} \]

(c) What is the direction of the velocity of the skater when he hits the ground with respect to the floor and what is it's magnitude. (3 pts)

\[ v_x = v_{x0} + at = v_{x0} = 4.4m/s \]

\[ t = \frac{v_f - v_0}{a} = \frac{-1.8m/s}{3.1m/s} = -0.58s \]

\[ v_y = v_{y0} - gt = v_{y0} - 9.8m/s^2 \cdot 0.58s = -5.7m/s \]

\[ v = \sqrt{v_x^2 + v_y^2} = \sqrt{(4.4m/s)^2 + (-5.7m/s)^2} = 7.1m/s \]

\[ \tan \theta = \frac{v_y}{v_x} \Rightarrow \theta = \arctan \left( \frac{v_y}{v_x} \right) = \arctan \left( \frac{-5.7m/s}{4.4m/s} \right) = -63^\circ \text{ below } x \text{ axis} \]

(d) As most skaters, our fellow, was listening to music using his phone, while skating. Unfortunately, while he was performing his act, his phone, leaves his hand, the exact moment he lands on the floor. The phone's initial height above the floor, when it flew off the hand, was \( y = 1.8 \text{ m} \) and \( x = 1.4 \text{ m} \) away from the edge of the step. Where does the phone land with respect to the step edge? (Use as initial velocity for the phone your result in part c) (4 pts)

\[ 0 = y = y_0 + v_{y0}t - \frac{1}{2}a_t^2 \Rightarrow t = \frac{-v_{y0} \pm \sqrt{v_{y0}^2 - 4(y_0)}}{2(\frac{1}{2})} \]

\[ t = \frac{-v_{y0} \pm \sqrt{v_{y0}^2 - 4(y_0)}}{2} \]

\[ x = x_0 + v_{x0}t + \frac{1}{2}a_x t^2 = x_0 + v_{x0}t = x_0 + v_{x0} \cdot \frac{-v_{y0} - \sqrt{v_{y0}^2 - 4(y_0)}}{2} \]

\[ = 1.4m + (4.4m/s) \cdot \frac{-0.76s}{2} \]

\[ = \frac{-3.0}{m} \]

Skate Safely