Name____________________________

Physics 120 Quiz #3, January 19, 2007

Motion in the x-direction

$x_f = x_i + v_{ix}t + \frac{1}{2}a_x t^2$

$v_{fx} = v_{ix} + a_x t$

$v_{fx}^2 = v_{ix}^2 + 2a_x \Delta x$

$F_x = ma_x$

Motion in the y-direction

$y_f = y_i + v_{iy}t + \frac{1}{2}a_y t^2$

$v_{fy} = v_{iy} + a_y t$

$v_{fy}^2 = v_{iy}^2 + 2a_y \Delta y$

$F_y = ma_y$

Vectors

magnitude of a vector $= \sqrt{v_x^2 + v_y^2}$

direction of a vector $\rightarrow \phi = \tan^{-1}\left(\frac{v_y}{v_x}\right)$

Useful Constants

$g = 9.8 \frac{m}{s^2}$

Quadratic Equation: $ax^2 + bx + c = 0$; solutions: $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

1. The speedometer of your truck shows that you are traveling at a steady speed of 50mi/hr (~80km/hr). Is it possible that your truck is undergoing accelerated motion? Explain. (2 points)

   Yes it is possible. If you take a curve, at constant speed, your velocity, a vector, is changing direction and thus there the truck is accelerating.

2. In a local bar, a customer slides an empty beer mug down the counter for a refill. The bartender is momentarily distracted and does not see the mug, which slides off the counter and strikes the floor *1.40m* from the base of the counter. Suppose that the height of the counter is *0.86m* above the floor.

   a. Draw the situation described above, being sure to label all quantities, such as directions for your choice of coordinate axes. (2 points)

      Diagram is below

   b. With what velocity did the mug leave the counter? (3 points)

$$x_f = x_i + v_{ix}t + \tfrac{1}{2}a_x t^2 \rightarrow 1.4m = 0m + v_{ix}t \rightarrow t = \frac{1.4m}{v_{ix}}$$

$$y_f = y_i + v_{iy}t + \tfrac{1}{2}a_y t^2 \rightarrow 0m = 0.86m - \tfrac{1}{2} \times 9.8\tfrac{m}{s^2} \times t^2$$

$$\therefore 0m = 0.86m - 4.9\tfrac{m}{s^2} \times \left(\frac{1.4m}{v_{ix}}\right)^2 \rightarrow v_{ix}^2 = 11.2\tfrac{m^2}{s^2} \rightarrow v_{ix} = 3.34\tfrac{m}{s}$$

Thus, $\vec{v}_{ix} = 3.34\tfrac{m}{s}\hat{i}$, *or* $v_{ix} = 3.34\tfrac{m}{s}$ in the positive x – dir.

   c. What was the velocity of the mug just before it hit the floor? (3 points)

$$v_{fx} = v_{ix} + a_x t = 3.34\tfrac{m}{s}$$

$$v_{fy} = v_{iy} + a_y t = 0\tfrac{m}{s} - 9.8\tfrac{m}{s^2}\left(\frac{1.4m}{3.34\frac{m}{s}}\right) = -4.11\tfrac{m}{s}$$

$$\therefore \vec{v}_f = 3.34\tfrac{m}{s}\hat{i} - 4.11\tfrac{m}{s}\hat{j} \text{ or}$$

$$v_f = \sqrt{\left(3.34\tfrac{m}{s}\right)^2 + \left(-4.11\tfrac{m}{s}\right)^2} \;@\; \theta = \tan^{-1}\left(\frac{-4.11\frac{m}{s}}{3.34\frac{m}{s}}\right) = 5.30\tfrac{m}{s} \;@\; \theta = -50.9^o$$

Diagram for Question 2a