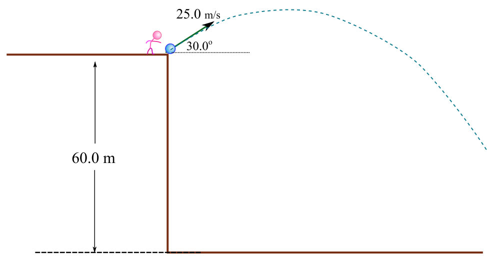
Name________________________

Sept. 24, 2011

Quiz #2 — Fall 2012

Phys 2110 – Sec 5

1. The thin little man on the last quiz now shoots a rock off the 60.0–m cliff at a speed of $25.0\frac{\text{m}}{\text{s}}$ at an angle of 30.0° above the horizontal.



a) Find the *speed* with which the rock strikes the ground below.

The initial velocity components of the rock are

$$v_{x0} = v_0 \cos\theta = (25.0\tfrac{\text{m}}{\text{s}})\cos 30^\circ = 21.7\tfrac{\text{m}}{\text{s}} \qquad v_{y0} = v_0 \sin\theta = (25.0\tfrac{\text{m}}{\text{s}})\sin 30^\circ = 12.5\tfrac{\text{m}}{\text{s}}$$

At impact the x-velocity is the same, as there is no x-acceleration. The y-velocity at impact can be gotten from the equation which doesn't need the time t:

$$v_y^2 = v_0^2 + 2a_y(y - y_0) \qquad \Longrightarrow \qquad v_y^2 = (12.5\tfrac{\text{m}}{\text{s}})^2 + 2(-9.80\tfrac{\text{m}}{\text{s}^2})(-60.0\text{ m}) = 1.33\times 10^3\,\tfrac{\text{m}^2}{\text{s}^2}$$

which gives

$$v_y = -36.5\tfrac{\text{m}}{\text{s}}$$

where we have chosen the *minus* sign for the solution because the rock is clearly *falling* when it hits the ground. Then for the speed we get

$$v = \sqrt{v_x^2 + v_y^2} = \sqrt{(21.7\tfrac{\text{m}}{\text{s}})^2 + (-36.5\tfrac{\text{m}}{\text{s}})^2} = \boxed{42.5\tfrac{\text{m}}{\text{s}}}$$

b) Find the time that the rock spends in flight.

For this we can use the equation for v_y,

$$v_y = v_{y0} + a_y t \qquad \Longrightarrow \qquad t = \frac{v_y - v_{y0}}{a_y} = \frac{-36.5\frac{\text{m}}{\text{s}} - 12.5\frac{\text{m}}{\text{s}}}{(-9.80\frac{\text{m}}{\text{s}^2})} = \boxed{5.00\text{ s}}$$

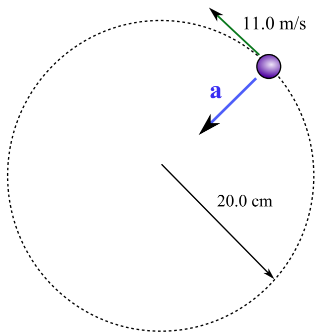
c) Find the horizontal distance traveled by the rock during its flight.

Find the value of x at the time we found in part (b):

$$x = v_{x0}t = (21.7\tfrac{\text{m}}{\text{s}})(5.00\text{ s}) = \boxed{108\text{ m}}$$

2. A particle moves in a circle of radius 20.0 cm at a constant speed of $11.0\frac{\text{m}}{\text{s}}$.

Give the magnitude and direction of its acceleration; for the direction of **a**, you can indicate it on the figure to the right with an arrow.



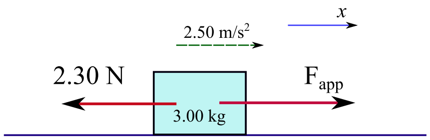
The mass is moving in a circle at constant speed, so the magnitude of its acceleration is

$$a = a_c = \frac{v^2}{r} = \frac{(11.0\frac{\text{m}}{\text{s}})^2}{(0.200\ \text{m})} = \boxed{6.05 \times 10^2\,\frac{\text{m}}{\text{s}^2}}$$

and the direction of a is always **toward the center**; this is indicated on the figure.

3. As a 3.00 kg mass is dragged along a surface by an applied force F_{app}, it experiences a force of magnitude 2.30 N opposite the motion.

Find the value of F_{app} needed so that its acceleration is $a_x = 2.50\frac{\text{m}}{\text{s}^2}$.



Newton's second law gives

$$F_{x,\text{net}} = F_{\text{app}} - 2.30\ \text{N} = ma_x = (3.00\ \text{kg})(2.50\tfrac{\text{m}}{\text{s}^2}) = 7.50\ \text{N}$$

This gives

$$F_{\text{app}} = 2.30\ \text{N} + 7.50\ \text{N} = \boxed{9.80\ \text{N}}$$

You must show all your work and include the right units with your answers!

$$v_x = v_{x0} + a_x t \qquad x = x_0 + v_{x0}t + \tfrac{1}{2}a_x t^2 \qquad v_x^2 = v_{x0}^2 + 2a_x(x - x_0) \qquad x - x_0 = \tfrac{1}{2}(v_{x0} + v_x)t$$

$$v_y = v_{y0} + a_y t \qquad y = y_0 + v_{y0}t + \tfrac{1}{2}a_y t^2 \qquad v_y^2 = v_{y0}^2 + 2a_y(y - y_0) \qquad y - y_0 = \tfrac{1}{2}(v_{y0} + v_y)t$$

$$g = 9.80\tfrac{\text{m}}{\text{s}^2} \qquad \mathbf{v}_{A/B} + \mathbf{v}_{B/C} = \mathbf{v}_{A/C} \qquad a_c = \frac{v^2}{r} \qquad \mathbf{F}_{\text{net}} = m\mathbf{a} \qquad F_{\text{spr}} = -kx \qquad f_s^{\text{max}} = \mu_s n$$