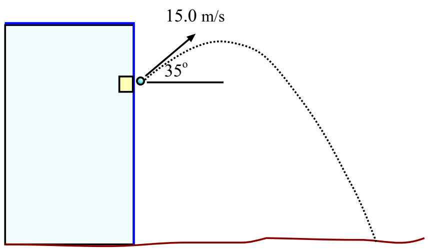
Name________________________________

Feb. 12, 2010

Quiz #2 – Spring 2010

Phys 2110 – Sec 3



1. A rock is thrown out the window of a building with speed $15.0\frac{\text{m}}{\text{s}}$; it is launched at an angle of 35.0° above the horizontal. It lands on the ground after 3.00 s in flight.

a) From what height was the rock launched?

Put the origin at the launch point with y axis going up. We have

$$v_{0x} = v_0 \cos\theta = (15.0\tfrac{\text{m}}{\text{s}})\cos 35^\circ = 12.29\tfrac{\text{m}}{\text{s}} \qquad v_{0y} = v_0 \sin\theta = (15.0\tfrac{\text{m}}{\text{s}})\sin 35^\circ = 8.604\tfrac{\text{m}}{\text{s}}$$

At $t = 3.00\ \text{s}$ the value of y is

$$y = v_{0y}t - \tfrac{1}{2}gt^2 = (8.604\tfrac{\text{m}}{\text{s}})(3.00\ \text{s}) - \tfrac{1}{2}(9.8\tfrac{\text{m}}{\text{s}^2})(3.00\ \text{s})^2 = -18.3\ \text{m}$$

so the rock was launched from a height of $\boxed{18.3\ \text{m}}$.

b) How far did the rock land from the base of the building?

The value of x at $t = 3.00\ \text{s}$ is

$$x = v_{0x}t = (12.29\tfrac{\text{m}}{\text{s}})(3.0\ \text{s}) = 36.9\ \text{m}$$

so the rock lands $\boxed{36.9\ \text{m}}$ from the base of the building.

c) What was the *speed* of the rock when it landed? When the rock landed, the velocity components were

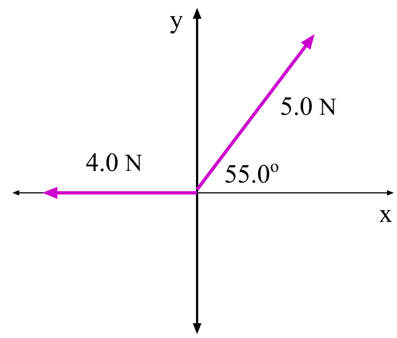
$$v_x = v_{0x} + (0)t = 12.29\tfrac{\text{m}}{\text{s}} \qquad v_y = v_{0y} + a_y t = 8.604\tfrac{\text{m}}{\text{s}} - (9.8\tfrac{\text{m}}{\text{s}^2})(3.0\ \text{s}) = -20.8\tfrac{\text{m}}{\text{s}}$$

The *speed* is the magnitude of the velocity vector at this time, so

$$v = \sqrt{v_x^2 + v_y^2} = \sqrt{(12.29\tfrac{\text{m}}{\text{s}})^2 + (-20.8\tfrac{\text{m}}{\text{s}})^2} = 24.2\tfrac{\text{m}}{\text{s}}$$

2. Two forces act on a mass as shown. (A force of magnitude 4.00 N acts in the $-x$ direction and a force of magnitude 5.00 N acts at 55.0° from the $+x$ axis.

What is the magnitude and direction of the net force on the mass?



x component of net force is

$$F_{\text{net},\,x} = -4.00\ \text{N} + 5.00\ \text{N}\cos 55^\circ = -1.132\ \text{N}$$

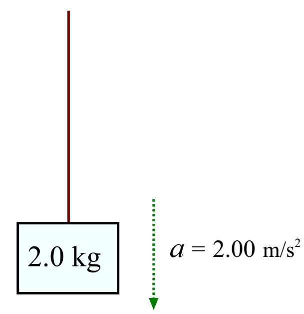
y component of net force is

$$F_{\text{net},\,y} = 5.00\ \text{N}\sin 55^\circ = 4.096\ \text{N}$$

Magnitude and direction of the net force are

$$F_{\text{net}} = \sqrt{F_x^2 + F_y^2} = 4.25\ \text{N} \qquad \tan\theta = \frac{(4.096)}{(-1.132)} = -3.62 \qquad \Longrightarrow \qquad \theta = 105^\circ$$

3. A 2.00 kg mass hangs from a string; if the acceleration of the mass is $2.00\frac{\text{m}}{\text{s}^2}$ *downward*, what is the tension in string?



With "up" as the positive direction, $a = -2.00\frac{\text{m}}{\text{s}^2}$. Forces on the mass are tension T upward, gravity mg downward. Newton's 2nd law gives

$$T - mg = ma \qquad \Longrightarrow \qquad T = mg + ma = m(g + a)$$

Plug in:

$$T = (2.00\ \text{kg})(9.8\tfrac{\text{m}}{\text{s}^2} - 2.00\tfrac{\text{m}}{\text{s}^2}) = 15.6\ \text{N}$$

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

$$v = v_0 + at \qquad x = x_0 + v_0 t + \tfrac{1}{2}at^2 \qquad v^2 = v_0^2 + 2a(x - x_0) \qquad x - x_0 = \tfrac{1}{2}(v_0 + v)t$$

$$g = 9.80\tfrac{\text{m}}{\text{s}^2} \qquad 1\ \text{kg} = 10^3\ \text{g} \qquad \text{Neglect air resistance!}$$

$$\mathbf{F} = m\mathbf{a} \qquad W = mg \qquad a_c = \frac{v^2}{r} \qquad F_{\text{spr}} = -kx$$