Name________________________

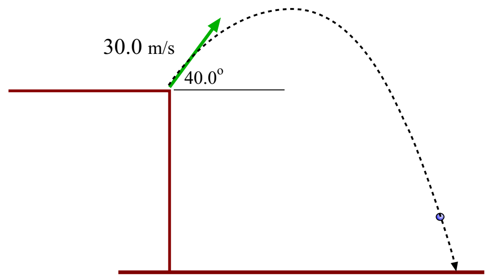
Sept. 24, 2008

Quiz #2 — Fall 2008

Phys 2110 – Sec 3

1. A projectile is fired from a cliff at an initial speed of $30.0\frac{\rm m}{\rm s}$, directed up from the horizontal by 40.0°.

It strikes the ground below 6.73 s later.



a) How high is the cliff?

What is the value of y at $t = 6.37$ s? We have

$v_{0x} = v_0 \cos\theta = 22.98\frac{\rm m}{\rm s}$ and $v_{0y} = v_0 \sin\theta = 19.28\frac{\rm m}{\rm s}$

so the y equation gives

$$v = v_{0y}t - \tfrac{1}{2}gt^2 = (19.28\tfrac{\rm m}{\rm s})(3.67\ {\rm s}) - \tfrac{1}{2}(9.8\tfrac{\rm m}{{\rm s}^2})(6.37)^2 = -92.2\ {\rm m}$$

which tells us that the cliff is $\boxed{92.2\ {\rm m}}$ high.

b) How far did the projectile travel horizontally in its flight?

What is the value of x at $t = 6.73$ s? The x equation gives

$$x = v_{0x}t + 0 = (22.98\tfrac{\rm m}{\rm s})(6.73\ {\rm s}) = 155\ {\rm m}$$

The projectile has traveled a horizontal distance of $\boxed{155\ {\rm m}}$.

c) What was the *speed* of the projectile at impact?

At impact, the x component of the velocity is the same as the initial value: $v_x = 22.98\frac{\rm m}{\rm s}$. The y component is

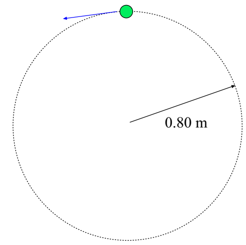
$$v_y = v_{0y} + a_yt = (19.28\tfrac{\rm m}{\rm s}) + (-9.8\tfrac{\rm m}{{\rm s}^2})(6.73) = -46.67\tfrac{\rm m}{\rm s}$$

so the speed is

$$v = \sqrt{v_x^2 + v_y^2} = \sqrt{(22.98\tfrac{\rm m}{\rm s})^2 + (-46.67\tfrac{\rm m}{\rm s})^2} = 52.0\tfrac{\rm m}{\rm s}$$

The speed at impact is $\boxed{52.0\frac{\rm m}{\rm s}}$.

2. A small mass moves at constant speed on a circle of radius 0.80 m such that it makes one revolution every 0.60 s.



a) Find the speed of the mass.

Mass travels a distance $2\pi r$ in time T, so

$$v = \frac{2\pi r}{T} = \frac{2\pi(0.80\ \mathrm{m})}{(0.60\ \mathrm{s})} = 8.38\tfrac{\mathrm{m}}{\mathrm{s}}$$

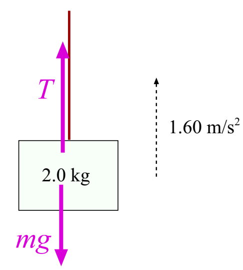
b) Find the acceleration of the mass; give its *magnitude* and *direction*.

Mass has a centripetal acceleration of magnitude

$$a_c = \frac{v^2}{r} = \frac{(8.38\tfrac{\mathrm{m}}{\mathrm{s}})^2}{(0.80\ \mathrm{m})} = 87.7\tfrac{\mathrm{m}}{\mathrm{s}^2}$$

The direction of the acceleration is $\boxed{\text{inward}}$, i.e. toward the center of the circle.

3. If we attach a string to a 2.0 kg mass and pull the mass upward so that its acceleration is $1.6\frac{\mathrm{m}}{\mathrm{s}^2}$ (upward), find the tension in the string.



Forces on the mass are the string tension T upward and gravity mg downward (added to the diagram at the right!). Newton's 2nd law gives

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

Plug in the numbers:

$$T = (2.0\ \mathrm{kg})(9.8\tfrac{\mathrm{m}}{\mathrm{s}^2} + 1.6\tfrac{\mathrm{m}}{\mathrm{s}^2}) = 22.8\ \mathrm{N}$$

Tension in the string is $\boxed{22.8\ \mathrm{N}}$.

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

$$A_x = A\cos\theta \qquad A_y = A\sin\theta \qquad A = \sqrt{A_x^2 + A_y^2} \qquad \tan\theta = A_y/A_x$$

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

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

$$g = 9.80\tfrac{\mathrm{m}}{\mathrm{s}^2} \qquad \mathbf{F} = m\mathbf{a} \qquad v = \frac{2\pi r}{T} \qquad a_c = \frac{v^2}{r} \qquad F_{\mathrm{spr}} = -kx$$