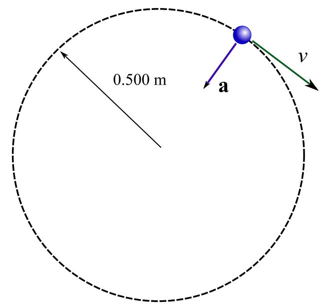
Name________________________________

Feb. 15, 2013

Quiz #2 — Spring 2013

Phys 2110 – Sec 4



1. a) A particle moves in a circle of radius 0.500 m with *constant* speed. If the magnitude of its acceleration is $3.00\frac{\text{m}}{\text{s}^2}$, what is its speed?

Its acceleration is *centripetal*, with $a_c = v^2/r$ so solving for v gives

$$v^2 = ra_c = (0.500\ \text{m})(3.00\tfrac{\text{m}}{\text{s}^2}) = 1.50\ \tfrac{\text{m}^2}{\text{s}^2} \qquad \Longrightarrow \qquad v = \boxed{1.22\tfrac{\text{m}}{\text{s}}}$$

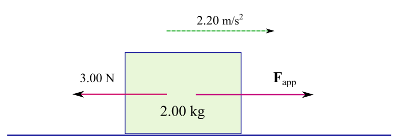
b) How long does it take the particle to make a complete revolution (around the circle)?

Using the relation for circular motion, $v = \frac{2\pi r}{T}$, we get

$$T = \frac{2\pi r}{v} = \frac{2\pi(0.500\ \text{m})}{(1.22\frac{\text{m}}{\text{s}})} = \boxed{2.57\ \text{s}}$$

c) What is the *direction* of the acceleration of the particle? (You can draw it on the picture for clarity.)

It is always toward the center (from the current position of the particle) as indicated on the figure[1].



2. A 2.00–kg mass is acted on by two forces; there is an applied force of magnitude $\mathbf{F}_{\text{app}}$ in one direction and a force of magnitude 3.00 N in the opposite direction. The mass has an acceleration of $2.20\frac{\text{m}}{\text{s}^2}$ in the direction of $\mathbf{F}_{\text{app}}$.

Find the magnitude of $\mathbf{F}_{\text{app}}$.

Noewton's 2nd law sez:

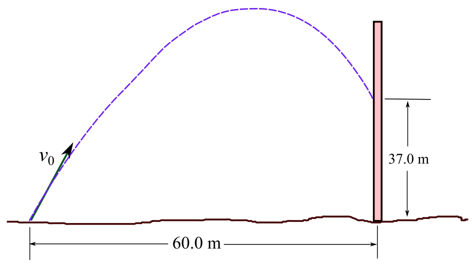
$$F_{\text{net},\,x} = F_{\text{app}} - 3.00\ \text{N} = ma_x = (2.00\ \text{kg})(2.20\tfrac{\text{m}}{\text{s}^2}) = 4.40\ \text{N}$$

This gives

$$F_{\text{app}} = 3.00\ \text{N} + 4.40\ \text{N} = \boxed{7.40\ \text{N}}$$

[1] Canadian particles accelerate toward the centre.

3. A projectile is fired from ground level toward a big vertical wall whose base is 60.0 m away from the firing point. When the projectile strikes the wall it hits at a height of 37.0 m and its time of flight was 3.25 s.



a) Find the components of the initial velocity of the projectile.

With $x_0 = y_0 = 0$, $a_x = 0$ and $a_y = -g$ and $x = 60.0$ m at $t = 3.25$ s, the x equation of motion gives

$$60.0\ \mathrm{m} = v_{x0}(3.25) + 0 \quad \Longrightarrow \quad v_{x0} = \boxed{18.5\tfrac{\mathrm{m}}{\mathrm{s}}}$$

Since $y = 37.0$ m at $t = 3.25$ s, the y equation of motion gives

$$37.0\ \mathrm{m} = v_{y0}(3.25\ \mathrm{s}) - \tfrac{1}{2}(9.80\tfrac{\mathrm{m}}{\mathrm{s}^2})(3.25\ \mathrm{s})^2 \quad \Longrightarrow \quad v_{y0}(3.25\ \mathrm{s}) = 88.8\ \mathrm{m}$$

and this gives

$$v_{y0} = \frac{(88.8\ \mathrm{m})}{(3.25\ \mathrm{s})} = \boxed{27.3\tfrac{\mathrm{m}}{\mathrm{s}}}$$

b) Find the initial speed of the projectile and the angle above the horizontal at which it was fired.

Initial speed was

$$v_0 = \sqrt{v_{x0}^2 + v_{y0}^2} = \boxed{33.0\tfrac{\mathrm{m}}{\mathrm{s}}}$$

and the direction was

$$\tan\theta = \frac{v_{y0}}{v_{x0}} = \frac{27.3}{18.5} = 1.48 \quad \Longrightarrow \quad \theta = \boxed{55.9^\circ}$$

c) Find the speed of the projectile at the time it struck the wall.

At $t = 3.25$ the components of the velocity were

$$v_x = v_{x0} + a_x t = 18.5\tfrac{\mathrm{m}}{\mathrm{s}} + 0 = 18.5\tfrac{\mathrm{m}}{\mathrm{s}}$$

$$v_y = v_{y0} + a_y t = 27.3\tfrac{\mathrm{m}}{\mathrm{s}} - (9.80\tfrac{\mathrm{m}}{\mathrm{s}^2})(3.25\ \mathrm{s}) = -4.55\tfrac{\mathrm{m}}{\mathrm{s}}$$

These give

$$v = \sqrt{v_x^2 + v_y^2} = \boxed{19.1\tfrac{\mathrm{m}}{\mathrm{s}}}$$

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

$$g = 9.80\tfrac{\mathrm{m}}{\mathrm{s}^2} \quad A_x = A\cos\theta \quad A_y = A\sin\theta \quad A = \sqrt{A_x^2 + A_y^2} \quad \tan\theta = \tfrac{A_y}{A_x} \quad a_c = \frac{v^2}{r} \quad v = \frac{2\pi r}{T}$$

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

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