Circular Motion Problem Set III

Do all work in your journal. Be sure to list givens and unknowns, draw an FBD, write an equation for net force, and solve in the appropriate format.

1. A bored astronaut twirls a 2.7 kg tool on the end of a string that is 0.8 meters long. If it goes around every 2 seconds, how much tension is there on the string?

2. A roller coaster hits the bottom of a hill going 22 m/s. The person in the car has a mass of 58 kg, and the radius of the curve is 12.5 meters. a) How much normal force is acting on the rider?

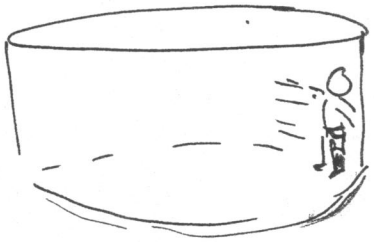
   b) What is the upward acceleration acting on the rider?

3. The same person is riding a Cajun Cliffhanger type ride. It has a radius of 4.5 meters and goes around every 3 seconds.

   a) What is the normal force acting on her now?

   b) What is her acceleration?

   c) What is the coefficient of friction between her and the wall?

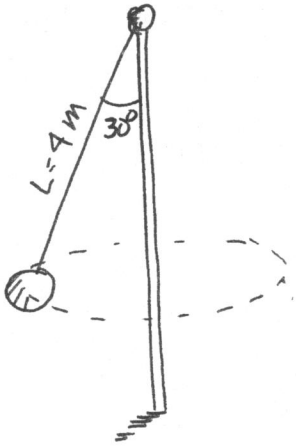


4. A 1.1 kg tetherball is moving in a circle every 2.5 seconds. The length of the rope is 4 meters and the angle between the rope and the pole is 30 degrees.

   a) What is the radius of the circle?

   b) What is the velocity of the tetherball?

   c) What is the tension in the rope?



 www.geniconsulting.org email: larrygeni@gmail.com

Helpful Hints

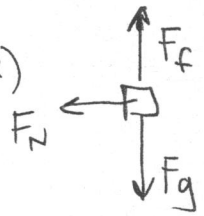
Use ***only*** when you are stumped. Pay attention to when you need help so you can ask good questions in class when we go over this.

① $F_T = F_c = \frac{mv^2}{R}$ $\qquad v = \frac{2\pi R}{T}$

② a) $\Sigma F = F_N - F_g = F_c = \frac{mv^2}{R}$

b) $F = ma$

③ a)



$\Sigma F = F_N = F_c = \frac{mv^2}{R}$ $\qquad v = \frac{2\pi R}{T}$

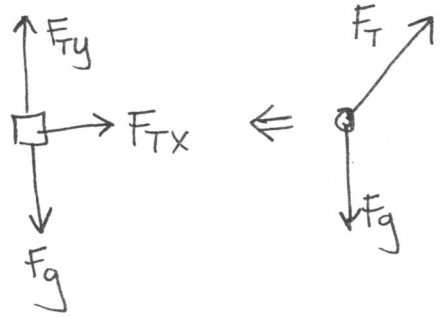
b) $F = ma$

c) $\mu = \frac{F_f}{F_N} = \frac{F_g}{F_N}$

④ a)

b) $v = \frac{2\pi R}{T}$

c)



$\Sigma F = F_{Tx} = F_c = \frac{mv^2}{R}$

www.geniconsulting.org
email: larrygeni@gmail.com

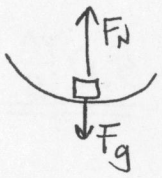
Circular Motion III Answers

(1) $m = 2.7\,kg$
$R = 0.8\,m$
$T = 2\,sec$
$F_T = ?$

$F_c = F_T = \frac{mV^2}{R}$ but $V = \frac{2\pi R}{T} = \frac{2\pi(0.8m)}{2\,sec} = 2.51\,\frac{m}{s}$

So $F_T = \frac{(2.7\,kg)(2.51\,\frac{m}{s})^2}{0.8\,m} = \underline{21.3\,N}$

(2) $V = 22\,\frac{m}{s}$
$m = 58\,kg$
$R = 12.5\,m$
a) $F_N = ?$



$\Sigma F = F_N - F_g = \frac{mV^2}{R}$

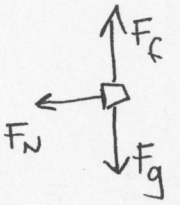
So $F_N = F_g + \frac{mV^2}{R} = mg + \frac{mV^2}{R}$

$= (58\,kg)(9.8\,\frac{m}{s^2}) + \frac{(58\,kg)(22\,\frac{m}{s})^2}{12.5\,m}$

$F_N = \underline{2814\,N}$

b) $a_c = ?$ $\quad a_c = \frac{V^2}{R} = \frac{(22\,\frac{m}{s})^2}{12.5\,m} = \underline{38.7\,\frac{m}{s^2}}$

(3) $m = 58\,kg$
$R = 4.5\,m$
$T = 3\,sec$
a) $F_N = ?$



$\Sigma F = F_N = \frac{mV^2}{R}$ but $V = \frac{2\pi R}{T} = 9.4\,\frac{m}{s}$

So $F_N = \frac{(58\,kg)(9.4\,\frac{m}{s})^2}{4.5\,m} = \underline{1145\,N}$

b) $a = ?$ $\quad a = \frac{F_N}{m} = \frac{1145\,N}{58\,kg} = \underline{19.7\,\frac{m}{s^2}}$

c) $\mu = ?$ $\quad \mu = \frac{F_f}{F_N}$ but $F_f = F_g = mg = (58\,kg)(9.8\,\frac{m}{s^2}) = 568\,N$

So $\mu = \frac{568\,N}{1145\,N} = \underline{0.50}$