Centripetal Acceleration and Force

Friday, December 6, 2013 12:15 PM

Ex: A fan makes 50 revolutions in 2.4 minutes. If the tip is 1.3 m from the center what is the tangential velocity?

$V_T = \frac{2\pi r}{T}$

$r = 1.3\,m$

$T = \frac{\text{time}}{\text{rev}} = \frac{2.4\,min}{50\,rev}\left|\frac{60\,s}{1\,min}\right| = 2.88\,s$

$V_T = \frac{2\pi \cdot 1.3}{2.88} = \frac{8.17}{2.88} = 2.84\,m/s$

Ex - A ball is on a 1 m long string. If I spin a tennis ball on a string 10 times/rev

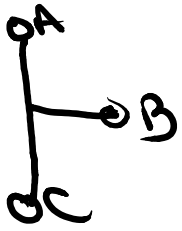
Time it 7.33s

Find the period

$T = \frac{\text{time}}{\text{rev}} = \frac{7.33}{10} = 0.733\,s$

Now suppose the mass is 70 g and length of string is 1 m.

Find the tension in the string at the following points A, B, and C



At A

FBD

$F_{net} = ma$ $(T + F_g = F_c)$

$T + F_g = ma_c$

$T + mg = ma_c$

$T = m\frac{V^2}{r} - mg$

$T = 0.07\frac{8.57^2}{1} - 0.07 \cdot 9.8$

$= 4.46\,N$

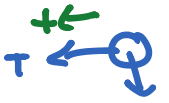
$V_T = \frac{2\pi r}{T}$

$= \frac{2\pi \cdot 1}{0.733}$

$= 8.57\,m/s$

At B

FBD



$F_{net} = ma$

$T = ma$

Fg

$T = mv^2/r$

$= 0.07 \cdot 8.57^2/1$

$= 5.14N$

#C

FBD

$F_{net} = ma$

$F_T - F_g = ma_c$

$F_T = ma_c + mg$

$= 0.07 \cdot \frac{8.57^2}{1} + 0.07 \cdot 9.8$

$= 5.83N$

where would string break → at the bottom (T greatest)

At the top where minimum speed matters

$T + mg = mv^2/r$

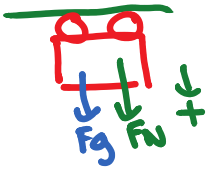
v slows, mv^2/r ↓

SO T must get small (mg can't change)

Roller Coaster Problem

On a roller coaster, a cart has a mass of 1000 kg. It goes around a loop with a radius of 20 m. What is the minimum speed to keep the car on the track?

- What causes the Fc here? FN
- Where would minimum speed be an issue? at top



$F_{net} = ma$

$F_g + F_N = ma_c$

$F_g + F_N = mv^2/r$

minimum → $F_N = 0$

$F_g = mv^2/r$

$mg = mv^2/r$

$g \cdot r = v^2$

$9.8 \cdot 20 = v^2$

$v = 14 m/s$