Rotational Problems

1. A runner moving at a speed of 8.8 m/s rounds a bend with a radius of 25 m.
   a. Find the centripetal acceleration of the runner.

$v = 8.8\ \frac{m}{s}$ $a_c = ?$ $r = 25\ m$

$a_c = \frac{v^2}{r} = \frac{(8.8)^2}{25} = 3.10\ \frac{m}{s^2}$

2. Racing on a flat track, a car going 32 m/s rounds a curve 56 m in radius.
   a. What is the car's centripetal acceleration?

$a_c = \frac{v^2}{r} = \frac{(32)^2}{56} = 1.83 \times 10^1\ \frac{m}{s^2}$

   b. What would be the minimum coefficient of static friction between tires and road that would be needed for the car to round the curve without skidding?

$F_c = F_{fr}$

$ma_c = \mu mg$

$1.83 \times 10^1 = \mu\ 9.8$

$\mu = 1.87$

3. Sue whirls a yo-yo in a horizontal circle. The yo-yo has a mass of 0.2 kg and is attached to a string 0.8 m long.

$m = .2\ kg$ $r = 0.8\ m$ $T = 1$

   a. If the yo-yo makes 1 complete revolution each second, what force does the string exert on it?

$F_c = ma_c$

$= \frac{m\ 4\pi^2 r}{T^2} = \frac{(0.2)\ 4\ (3.14)(0.8)}{1\ s^2} = 6.31\ N$

4. Friction provides the centripetal force necessary for a car to travel around a flat circular race track. What is the maximum speed at which a car can safely travel around a circular track of radius 80 m if the coefficient of friction between the tire and road is 0.3?

$v = ?$ $r = 80\ m$ $\mu = .3$

$F_c = F_{fr}$

$ma_c = \mu mg$

$\frac{v^2}{r} = \mu g$

$v = 1.53 \times 10^1\ \frac{m}{s}$

5. An early major objection to the idea that Earth is spinning on its axis was that Earth would turn so fast at the equator that people would be thrown off into space. Show the error in this logic by calculating:
   a. the speed of a 97 kg person at the equator. The radius of Earth is about 6400 km

$v = \frac{2\pi\ 6400}{1\ DAY} \times \frac{1000\ m}{1} \times \frac{1\ DAY}{24\ h} \times \frac{1\ h}{3600\ s} = 4.65 \times 10^2\ \frac{m}{s}$

   b. the centripetal force on the person

$F_c = ma_c = 97\ kg\ \frac{465^2}{6400000} = 3.28\ N$

   c. the weight of the person

$W = mg$

$= 97\ (9.8) = 9.51 \times 10^2\ N$