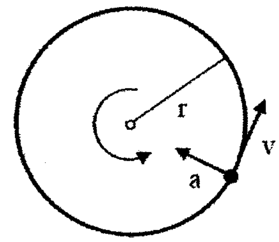
Circular Motion WS

1. If the radius of a merry-go-round is 5.0 m and it makes 15 revolutions per minute, find its centripetal acceleration.



$f = 15\ rpm = 0.25\ rev/s$

$T = \frac{1}{f} = \frac{1}{.25} = 4\ s$

$v = \frac{2\pi r}{T} = \frac{2\pi(5)}{4}$

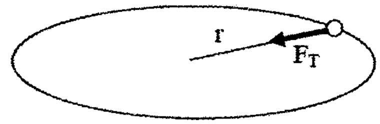
$v = 7.85\ m/s$

$a = \frac{v^2}{r}$

$= \frac{(7.85)^2}{5}$

$a = 12.3\ m/s^2$

2. You are twirling a rock on a string (assume gravity has no effect on the rock). The mass of the rock is .10 kg, the length of the string is 1.0 m, and it takes 1.0 s to make one revolution. What is the tension force in the string?



$F_{net} = \frac{mv^2}{r}$ only force pointing towards center is F_T, so $F_{net} = F_T$

$F_T = \frac{mv^2}{r}$ $v = \frac{2\pi r}{T} = \frac{2\pi(1)}{(1)} = 6.28\ m/s$

$= \frac{(.1)(6.28)^2}{1} = 3.9N$

3. A car rounds a curve on a flat road (not banked). The radius of the circular curve is r = 100. m, and the speed of the car is v = 30. m/s (about 68 mph). How large a static friction coefficient (μ_s, not μ_k!) is needed for the car to not skid off the road?

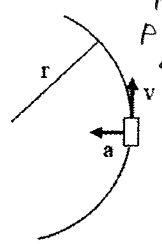
$F_{net} = \frac{mv^2}{r}$

$F_f = \frac{mv^2}{r}$

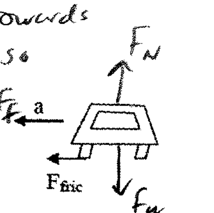
$\mu mg = \frac{mv^2}{r}$

$\mu(9.8) = \frac{(30)^2}{100}$

$\mu = 0.92$



F_f is only force pointing towards center, so $F_{net} = F_f$



$F_f = \mu F_N$
$= \mu F_g$
$= \mu mg$

4. An athlete whirls a 7.00-kg hammer tied to the end of a 1.30-m chain in a horizontal circle. The hammer makes on revolution in 1.00 s.
   a. What is the centripetal acceleration of the hammer?

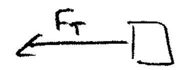
$a = \frac{v^2}{r}$ $v = \frac{2\pi r}{T}$

$= \frac{(8.168)^2}{1.3}$ $= \frac{2\pi(1.3)}{1}$

$= 8.168\ m/s$

$a = 51.3\ m/s^2$

b. What is the tension in the chain?



$F_{net} = F_T = \frac{mv^2}{r}$

$F_T = (7)(51.3)$

$F_T = 359.1\ N$

5. A coin is placed on a vinyl stereo record making 33 and 1/3 revolutions per minute.
   a. In what direction is the acceleration of the coin?

towards the center

   b. Find the magnitude of the acceleration when the coin is placed 5.0, 10.0, and 15.0 cm from the center of the record.

$a = \frac{v^2}{r}$ $\quad v = \frac{2\pi r}{T}$

$f = 33.33$ rev/min

$f = .5555$ rev/s

$T = 1.8$ s for 1 rev.

	$r = .05$ m	$r = .1$ m	$r = .15$ m
v	.1745 m/s	.3491 m/s	.5236 m/s
a	.61 m/s²	1.22 m/s²	1.83 m/s²

6. According to the Guinness Book of World Records, the highest rotary speed every attained was 2010 m/s (4500 mph). The rotating rod was 15.3 cm (6 in.) long. Assume that the speed quoted is that of the end of the rod.
   a. What is the centripetal acceleration of the end of the rod?

$a = \frac{v^2}{r}$

$= \frac{(2010)^2}{.153}$

$= 2.64 \times 10^7\ m/s^2$

   b. If you were to attach a 1.0-g object to the end of the rod, what force would be needed to hold it on the rod?

$F = ma_c$

$= (.1 \times 10^{-3}\ kg)(2.64 \times 10^7\ m/s^2)$

$= 2640\ N$