10. What is the chance of a light car safely rounding an icy curve compared to a heavy car? (Everything else like speed, tires, etc. being equal)

Same, Friction eq (when $F_F = F_c$) → $V_t = \sqrt{\mu \cdot g \cdot r}$

11. A penny is placed at the outer edge of a 33 1/3 rpm record of radius 15 cm.
    a. What provides the centripetal force? Static friction
    b. What is the tangential speed of the penny?

$a_c = r\omega^2 = \frac{V_t^2}{r}$ $a_c = (.15m)(3.49\ rad/s)^2 = 1.83\ m/s^2 = \frac{V_t^2}{.15m}$ $= .52\ m/s$ $33.33\ \frac{rev}{min} \times \frac{2\pi rad}{360} \times \frac{1\ min}{60\ sec}$

12. A 650 kg car rounds a corner at a speed of 12 m/s. The centripetal force acting on the car was 4050 N. What was the radius of the curve?

$4050N = \frac{(650kg)(12m/s)^2}{r}$ $r = 23m$

13. An athlete swings a 5.00 kg ball in a horizontal circle at the end of a 0.80 m rope. She does this so the ball makes one complete revolution every 0.6 seconds.
    a. What is the speed of the ball?

$V_t = \frac{C}{t} = \frac{2(\pi)(.80m)}{.6s} = 8.4\ m/s$

    b. If the rope can withstand a maximum of 500 N of tension, what is the maximum speed she can spin the ball without breaking the rope?

$\vec{T} = \vec{F_c} = \frac{mV_t^2}{r}$ → $\vec{V_t} = \sqrt{\frac{T \cdot r}{m}}$ = $\vec{V_t} = \sqrt{\frac{500N \cdot .80m}{5kg}}$ $\vec{V_t} = 8.9\ m/s$

14. NASA sends a satellite to orbit a star. When the satellite is 2.7×10^7 m from the center of the star, the satellite is traveling at 97,500 m/s.
    a. What is the mass of the star?

3.85×10^{27} kg ← $\vec{F_g} = \frac{G m_1 m_2}{r^2} = \vec{F_c} = \frac{m_1 V_t^2}{r}$ → $m_2 = \frac{V_t^2 r^2}{G r}$ → $m_2 = \frac{V_t^2 \cdot r}{G}$

    b. What is the mass of the satellite?

(cannot be determined (cancels out))

15. A 23,000 kg satellite is orbiting 15,000 km above the earth's surface. (Mass of earth = 5.98×10^{24} kg, Radius of Earth = 6.38×10^6 m)
    a. How fast is it moving?

$\vec{F_g} = \vec{F_c}$ $\frac{G m_1 m_2}{r^2} = \frac{mV_t^2}{r}$ $\vec{V_t} = \sqrt{\frac{m_2 \cdot G}{r}} = \sqrt{\frac{(5.98 \times 10^{24} kg) \cdot (6.67 \times 10^{-11})}{(6.38 \times 10^6 m + 15{,}000{,}000 m}}$ $\vec{V_t} = 4300\ m/s$

    b. If a golf ball of mass 0.1 kg were to travel in the same orbit, what would be its velocity?

Same, mass of orbiting object does not matter

16. A 600 kg car can safely navigate a turn with a radius of 14 m if μ = 0.88. What is the maximum speed with which can occur?

11 m/s $\vec{F_c} = \vec{F_F} = \mu \cdot F_n = \mu \cdot mg = \frac{mV_t^2}{r}$ → $\vec{V_t} = \sqrt{\mu \cdot g \cdot r}$ $\vec{V_t} = \sqrt{.88 \cdot 10m/s^2 \cdot 14m}$

17. A 1200 kg car can navigate a 35 m radius curve at a speed of 15 m/s.
    a. What is the speed the same car can travel around a curve with a 48 m radius?

17.6 m/s $\vec{F_F} = \vec{F_c} = \frac{mV_t^2}{r} = \vec{F_F} = \frac{1200kg \cdot 15m/s^2}{35m} = 7714N$ → $\vec{F_F}$ stays same → $V_t = \sqrt{\frac{F_F \cdot r}{m}} = \sqrt{\frac{7714N \cdot 48m}{1200kg}}$

    b. If it became icy (no friction), at what angle would the 48 m curve have to be banked in order to still navigate it successfully?

$V_t = 17.6\ m/s$ → $\vec{V_t}^2 = r g \cdot \tan\theta$ → $\theta = \tan^{-1}\left(\frac{V_t^2}{r g}\right) = 32°$

18. A 1200 kg car travels at 30 m/s around a banked curve with a radius of 40 m. What is the angle of the bank?

$\vec{V_t}^2 = r g \cdot \tan\theta$ $\theta = \tan^{-1}\left(\frac{V_t^2}{r g}\right) = \tan^{-1}\left(\frac{(30m/s)^2}{40m \cdot 10m/s^2}\right)$ $\theta = 66°$

Circular Motion Practice Problems

1. A figure skater begins spinning counterclockwise at an angular speed of 4.0π rad/s. During a 3.0 s interval, she slowly pulls her arms inward and finally spins at 8.0π rad/s. What is her average angular acceleration during this time interval?

   $\omega_i = 4.0\pi$ rad/s $t = 3.0$ s $\omega_f = \omega_i + \alpha t$ 8.0π rad/s $= 4.0\pi$ rad/s $+ (\alpha)(3.0s)$
   $\omega_f = 8.0\pi$ rad/s 4.2 rad/s²

2. A remote controlled car's wheel accelerates at 25 rad/s². If the wheel begins with an angular speed of 10.8 rad/s:
   a. What is the wheel's angular speed after 4 turns?

      $4 rev = \frac{2\pi rad}{1 rev} = 25$ rad $\omega_f^2 = (10.8 rad/s)^2 + 2(25 rad/s^2)(25 rad) = 37$ rad/s

   b. How long does it take for the 4 turns?

      $\Delta\theta = \omega t + \frac{1}{2}\alpha t^2 \rightarrow 25 rad = (10.8 rad/s) + \frac{1}{2}(25 rad/s^2) t$ $t = 1.1s$

3. What is the tangential velocity of a squirrel that runs 3m along the outside edge of a merry-go-round of radius 2 m in 10s? $V_t = \frac{3m}{10s} = .3 m/s$
   a. What is the angular displacement of the squirrel?

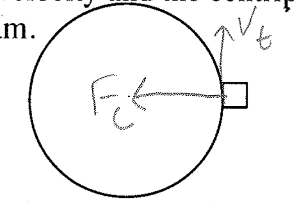
      $\Delta\theta = \frac{s}{r}$ $\Delta\theta = \frac{3m}{2m} = 1.5$ rad

   b. What is the angular speed of the squirrel?

      $V_t = r\omega$ → $.3 m/s = (2m)\omega = .15$ rad/s

   c. What is the tangential speed of the squirrel?

4. Draw and label the tangential velocity and the centripetal force on the object that is moving counterclockwise in the diagram.



5. A 2 kg object is twirled in a circle at a speed of 5 m/s by a force of 100 N. What is the circle's radius?

   $F_c = \frac{mV_t^2}{r}$ $100N = \frac{(2kg)(5m/s)^2}{r} = 0.5m$

6. By what factor does the centripetal force change if:
   a. The mass is cut in half? ×.5
   b. The velocity is doubled? ×4
   c. The radius is tripled and the mass is doubled? ×2/3

7. If friction provides the centripetal force for a car traveling around a corner, what is the maximum velocity of a car rounding a corner with a radius of 15 m and a μ = 0.6?

   $F_f = 0.6(m)(9.8 m/s^2) = \frac{m(V_t)^2}{(15m)}$ $V_t = 9.4$ m/s $\vec{F_f} = F_c$ $\mu F_n = \frac{mV_t^2}{r}$ $\mu mg =$

8. A 5 kg rock is twirled in a circle with a radius of 3 m at a speed of 15 m/s. What is the centripetal force?

   375N

9. You are riding in a friend's car when they quickly turn a corner causing your head to hit the door window. While laughing, you friend tells you, "Your head hit the window because the centrifugal force caused it to!" Is this statement correct?

   NO, inertia cased you to move outward.