Circular Motion II

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Circular Acceleration

- Centripetal Acceleration
- Centripetal => “center seeking”
  - $$a_c = \frac{v^2}{r}$$
- Substituting for v…
  - $$a_c = \frac{v^2}{r} = \frac{(r\omega)^2}{r} = r\omega^2$$

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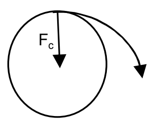
Circular Forces

- Centripetal Force
  - force applied to the object to keep it moving in a circle.

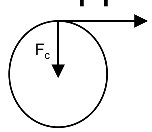
$$F_c = ma_c = \frac{mv^2}{r}$$

$$= mr\omega^2$$

- What direction will the object move once the centripetal force disappears?



or



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Circular Forces: Application

- A car moves around a curve that has a radius of 45.0 m. If the concrete pavement is dry (μ = 0.8), what is the maximum speed that the car can move around the curve without skidding?

  - What is keeps the car from skidding off the track?
    - Friction

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Circular Forces: Application

- So the force of friction must apply the centripetal force or:

$$F_f = F_c \Rightarrow \mu F_N = \frac{mv^2}{r} \Rightarrow \mu mg = \frac{mv^2}{r}$$

- Solving for velocity, we get:

$$v^2 = \mu gr \Rightarrow v = \sqrt{\mu gr} \Rightarrow v = \sqrt{.8(9.8)(45)}$$

$$v = 18.8 \text{ m/s}$$

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Vertical Circles

- Draw a free body diagram for a roller coaster car traveling in a vertical loop.

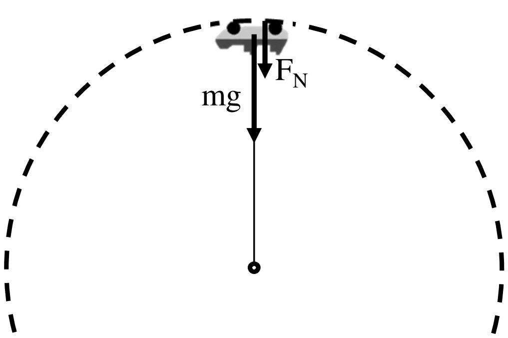
$$F_{net} = F_N + mg$$

Since both forces are pointing toward the center, we can call the net force the centripetal force

$$F_c = F_N + mg$$

If the car travels just fast enough to make it around the loop, then the track will not need to provide any force, $F_N = 0$

$$F_c = mg$$



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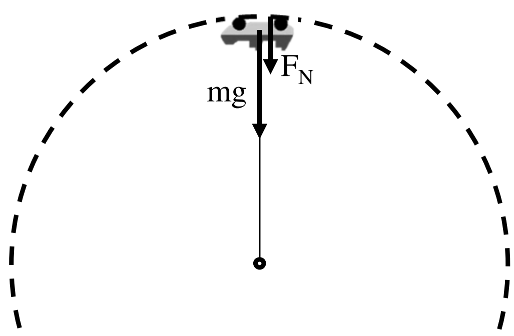
Vertical Circles

- Substituting and rearranging, we can find the minimum velocity that the car travel to just make it around the loop:



$$F_c = mg$$

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

$$v^2 = gr$$

$$v = \sqrt{gr}$$

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Rotary Motion: Acceleration

- Angular Acceleration (α)
  - rate of change of angular velocity

$$\alpha = \frac{\Delta\omega}{\Delta t}$$

- Angular and Linear Acceleration
  - Like linear velocity, linear acceleration also varies with the distance from the center of motion, therefore:

$$a_t = r\alpha$$

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Linear vs. Rotary

- All rotary equations follow the same format as their linear counterparts

Linear	Rotational
$x = x_o + v_o t + \frac{1}{2} a t^2$	$\theta = \theta_o + \omega_o t + \frac{1}{2} \alpha t^2$
$v = v_o + at$	$\omega = \omega_o + \alpha t$
$v^2 = v_o^2 + 2a(x - x_o)$	$\omega^2 = \omega_o^2 + 2\alpha(\theta - \theta_o)$

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Sample Problem

- The blades of a fan running at low speed turn at 275 rpm. When the fan is switched to high speed, the rotation rate increases uniformly to 360 rpm in 5.03 s.
  - What is the magnitude of the angular acceleration of the blades?
  - How many revolutions do the blades go through while the fan is accelerating?

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Sample Problem

- What is the magnitude of the angular acceleration of the blades?

- How many revolutions do the blades go through while the fan is accelerating?

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