Physics A - PHY 2048C

Dynamics of Circular Motion

10/09/2019

My Office Hours:
Thursday 2:00 - 3:00 PM

212 Keen Building

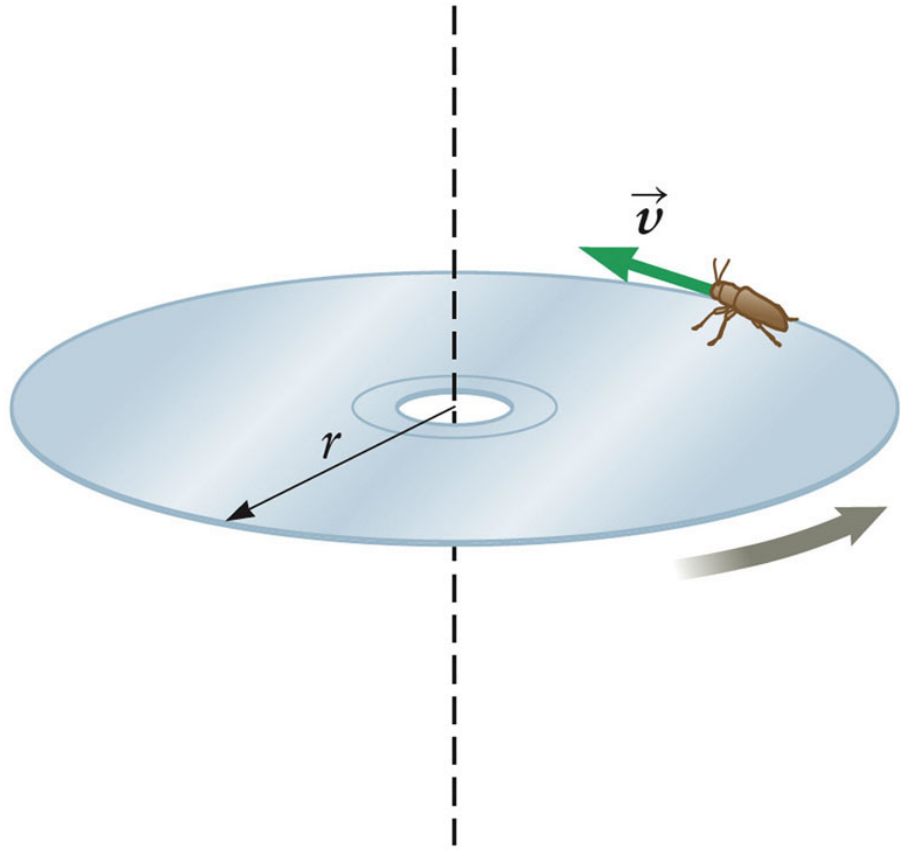
Warm-up Questions

1. Did you read Chapters 8.1 - 8.5 in the textbook?
2. In uniform circular motion, which of the following are constant: speed, velocity, angular velocity, centripetal acceleration, magnitude of the net force?
3. Tarzan swings through the jungle on a vine. At the lowest point of his swing, is the tension in the vine greater than, less than, or equal to the gravitational force on Tarzan?

Outline

Uniform Circular Motion

Circular motion is an example of non-uniformly accelerated motion, i.e. $\vec{a} \neq \text{constant}$.



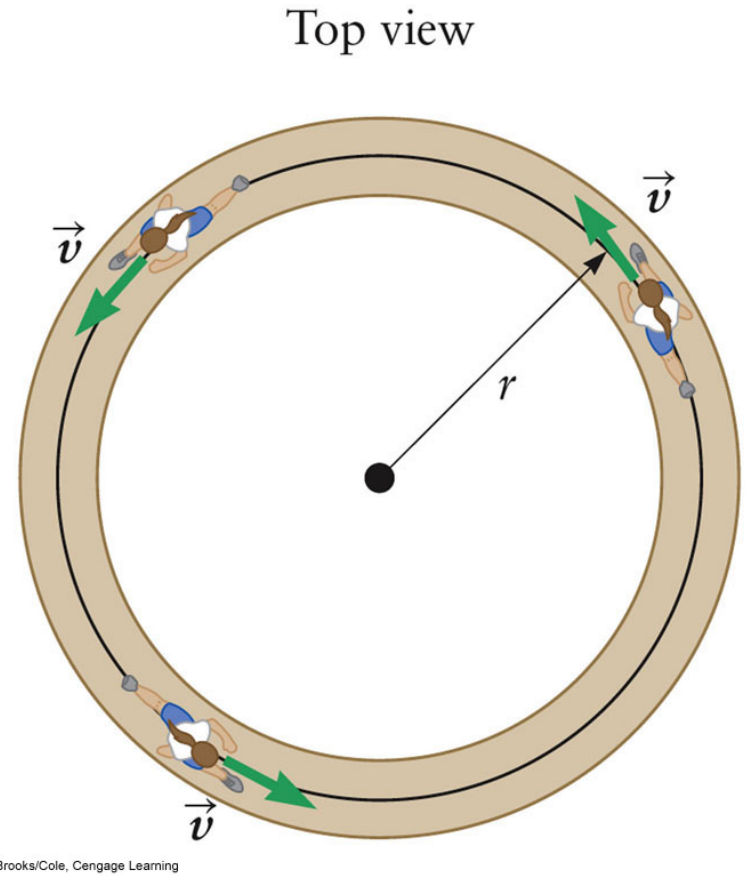
Uniform Circular Motion

Circular motion is an example of non-uniformly accelerated motion, i.e. $\vec{a} \neq \text{constant}$.

Assume constant speed:

- The direction of the velocity is continually changing.
- The vector is always tangent to the circle.

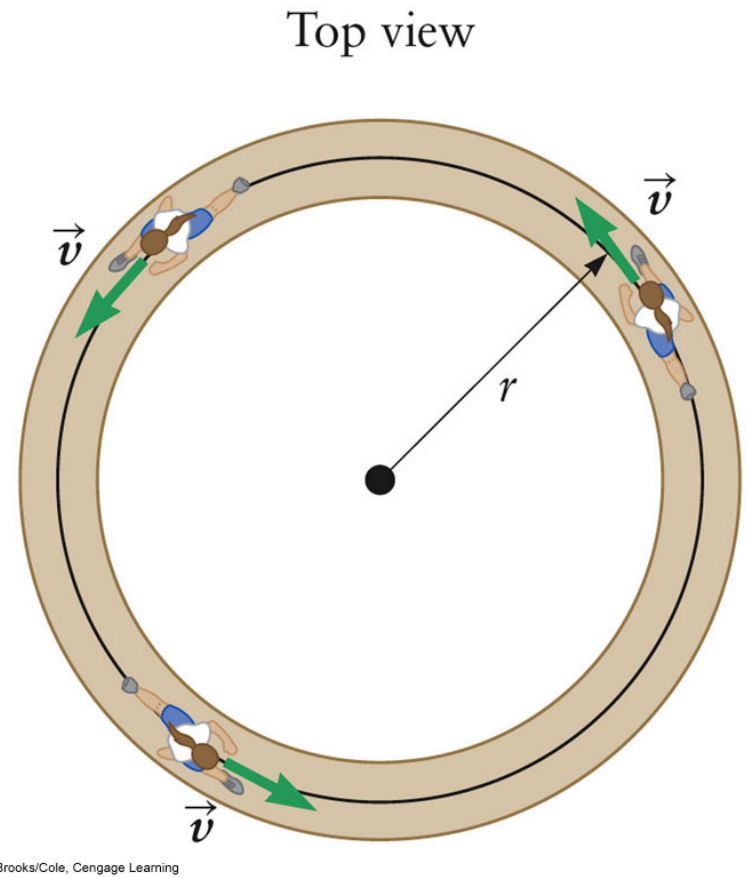
Uniform circular motion assumes constant speed.



Uniform Circular Motion

Circular motion is an example of non-uniformly accelerated motion, i.e. $\vec{a} \neq \text{constant}$.

Examine one trip around the track.



Uniform Circular Motion

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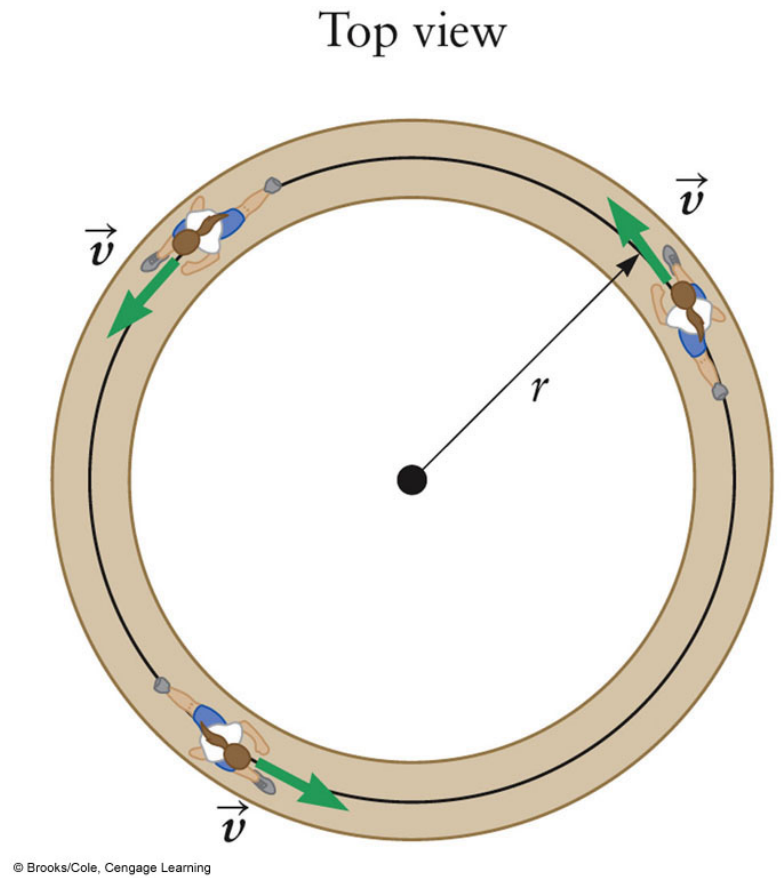
Examine one trip around the track.

The distance traveled is the circumference of the circle:

$$\text{circumference} = 2\pi r$$



Uniform Circular Motion

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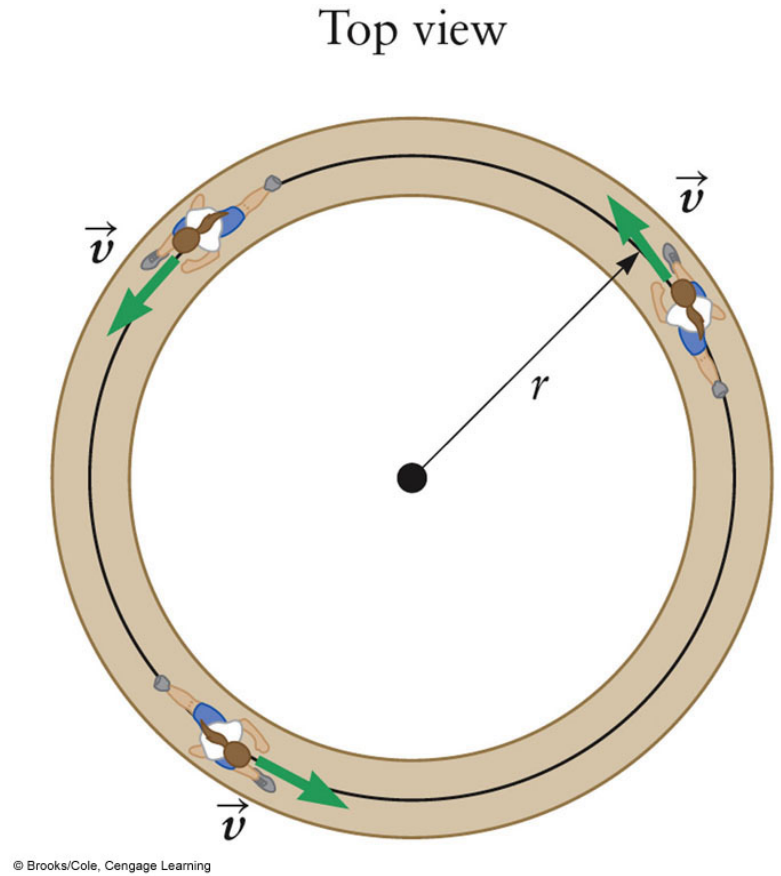
Examine one trip around the track.

The period of the motion is:

$$T = \frac{2\pi r}{v},$$

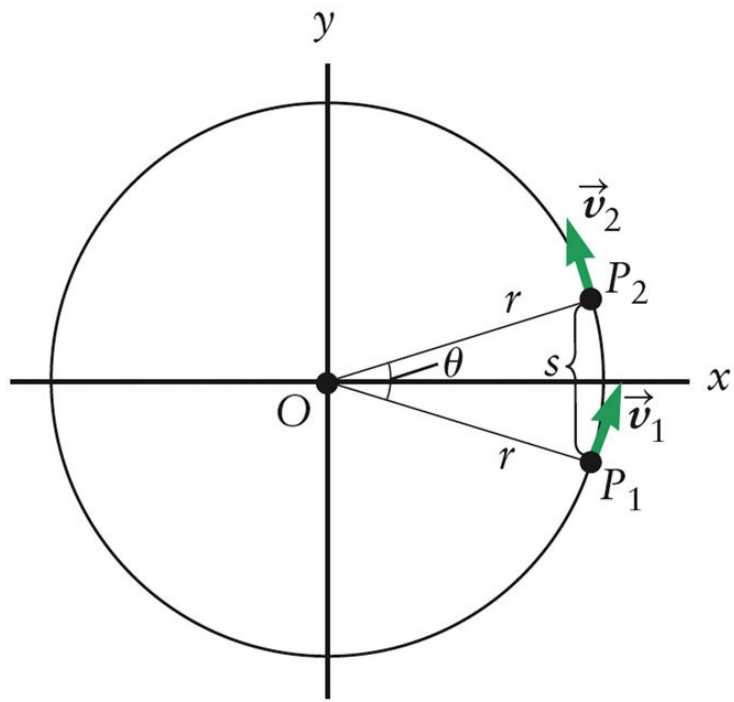
where r is the radius and v is the speed of the motion.

1. Period does not depend on location of the object.
2. Speed depends on the radius of circle of motion and thus on location.



Uniform Circular Motion

Although the speed is constant, the velocity is not constant.



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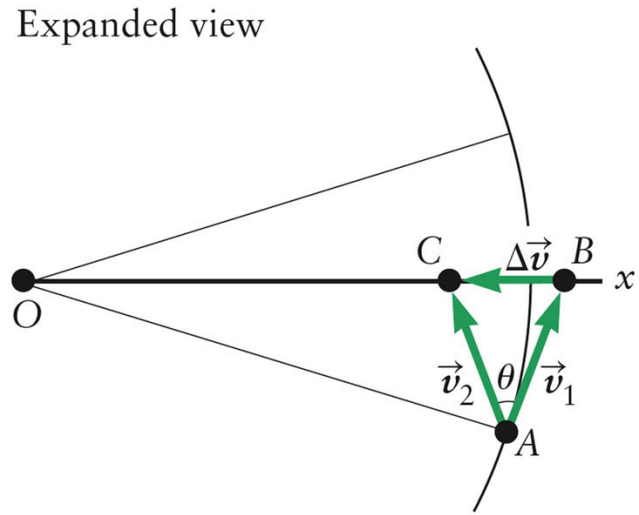
Uniform Circular Motion

Although the speed is constant, the velocity is not constant.

The direction of the acceleration is:

- always directed toward the center of the circle.



Uniform Circular Motion

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The direction of the acceleration is:

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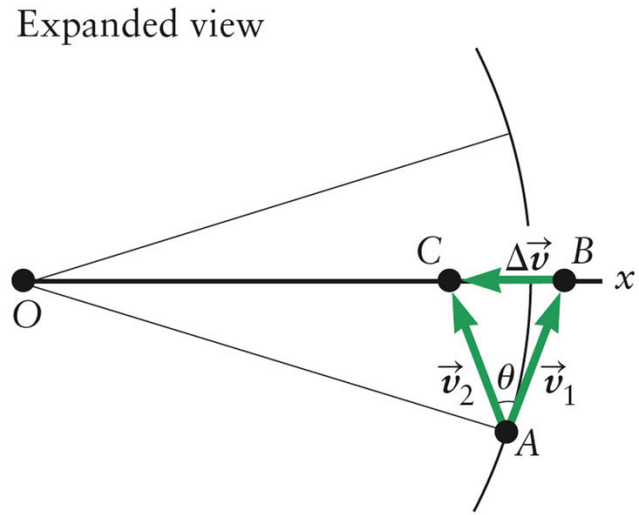
- called *centripetal acceleration.* (center-seeking acceleration)



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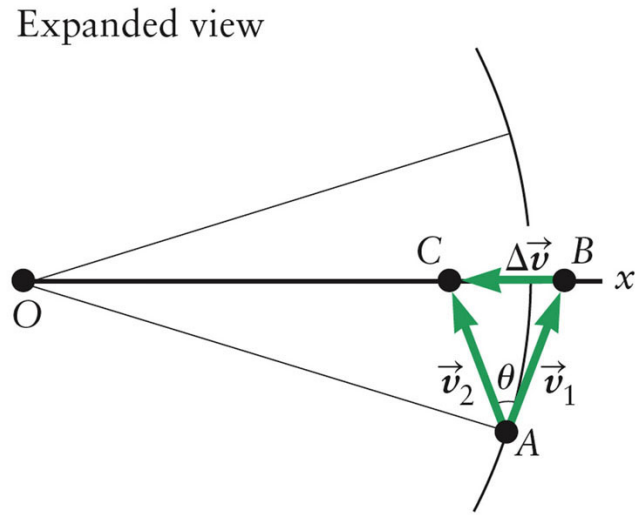
- Magnitude:

$$\vec{a} \approx \vec{a}_{\text{ave}} = \frac{\Delta \vec{v}}{\Delta t}$$

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



Ladybug Revolution

http://phet.colorado.edu/en/simulation/rotation

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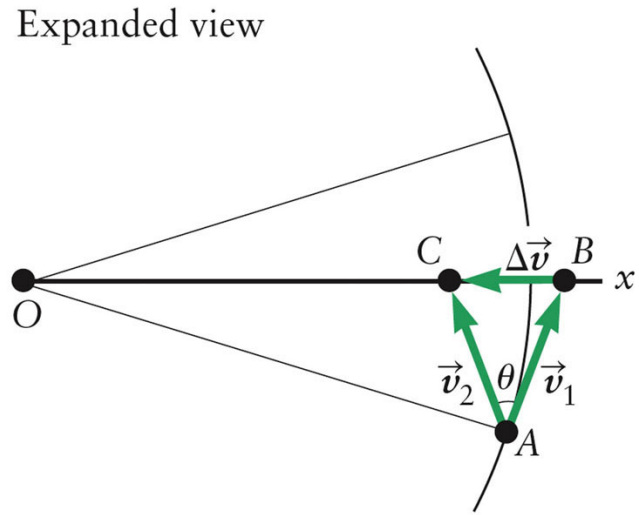
- Apply Newton's Second Law:

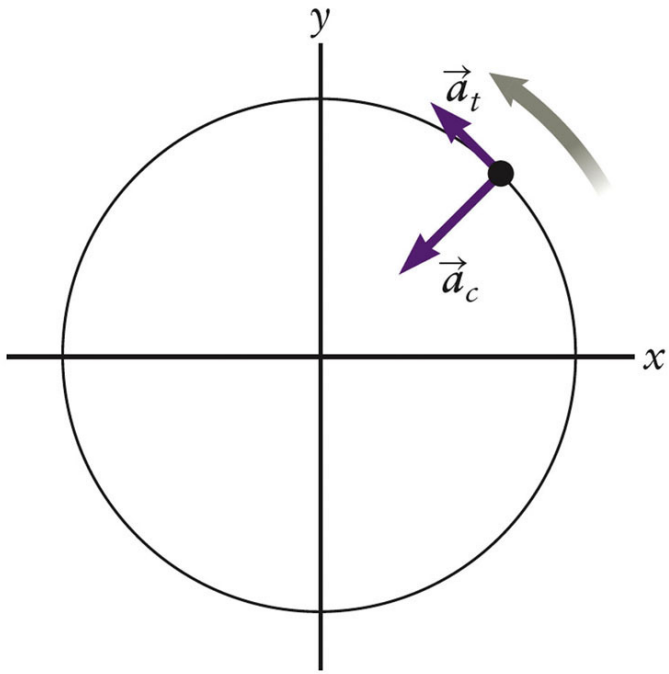
$$|\vec{F}| = m|\vec{a}| = m|\vec{a_c}| = \frac{m v^2}{|\vec{r}|}$$



Non-Uniform Circular Motion

If the speed is also changing, there are two components to the acceleration:

1. One component is tangent to the circle, a_t.
2. The other component is directed toward the center of the circle, a_c.



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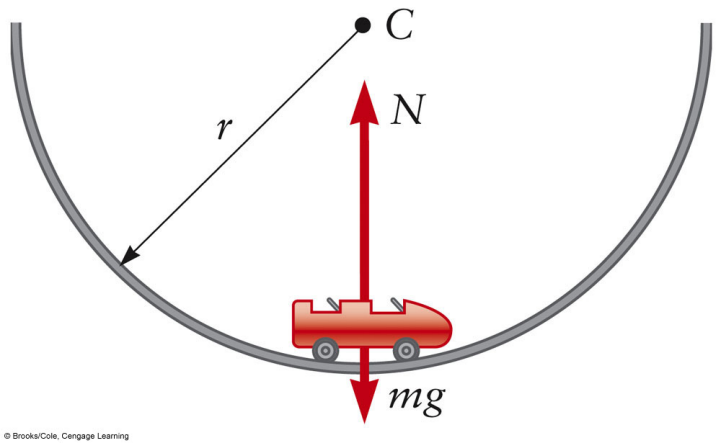
Example: Roller Coaster

- At the bottom:

$$\Sigma F = N - mg = \frac{m v^2}{r}$$



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- At the bottom:

$$\Sigma F = N - mg = \frac{m v^2}{r}$$

- At the top:

$$\Sigma F = N + mg = \frac{m v^2}{r}$$