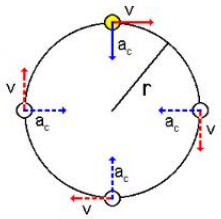
5.3 - Centripetal Acceleration

Add derivation Rabbit Hole (see 5.3 in Master Booklet.



Reconcile explanation. - GIFs?

Uniform Circular Motion

Def: when an object travels at a constant speed along a circular path.

Example: a car going around a track at constant speed.

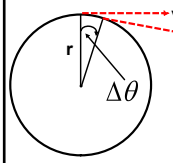
Demo: an object on the edge of a bike wheel.

Centripetal Acceleration (a_c)

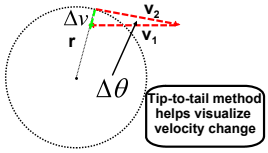
The acceleration of an object in circular motion is towards the center of the circle.

Centripetal ("center-seeking") acceleration must be directed radially inward, or the object would not demonstrate uniform circular motion.

A small-arc vector analysis demonstrates this:



$$\Delta v = v_2 - v_1$$

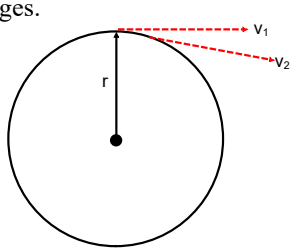


Tip-to-tail method helps visualize velocity change

Centripetal Acceleration, Once More with Feeling!

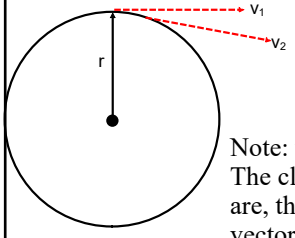
The acceleration of an object in circular motion is directed radially inward.

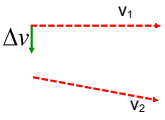
Assume an object is in circular motion, at some speed. Thus, its velocity constantly changes as its direction changes.



Vector Addition

In order for the velocity vector to change, an acceleration (change in velocity) must happen. When the acceleration is straight toward the center, then the resulting velocity vector is tangent to the circle some time later.





Note: this drawing is not to scale. The closer velocity comparisons are, the more the acceleration vector will point to the center.

Alphabet Soup

Conceptually, if all else fails, try to piece together the bits of circular motion via the a_c equations:

$$a_c = \frac{v_t^2}{r} \qquad a_c = r\omega^2$$

Centripetal Acceleration Math

Two ways of quantifying a_c (m/s^2), using tangential speed, OR angular speed:

AP Equation $a_c = \frac{v_t^2}{r}$	v_t = tangential speed (m/s) r = radius (m)
$a_c = r\omega^2$	ω = angular speed (rad/s)

Centripetal Acceleration Examples

1. What centripetal acceleration would an ant on a 45 m radius bike wheel experience if the wheel rotated at 25 rpm?

Convert rpm to rad/s:

$$\omega = 25\,rpm \bullet \frac{0.105\,rad/s}{1\,rpm} = 2.625\,rad/s$$

$$a_c = r\omega^2 = 0.45\,m \bullet (2.625\,rad/s)^2 = 3.1\,m/s^2$$

Centripetal Acceleration Examples

2. A 0.63 m radius pulley makes a rotation every 3.3 seconds. What centripetal acceleration does a point on the edge experience?

$$\omega = \frac{\theta}{t} = \frac{2\pi\,rad}{3.3\,s} = 1.904\,rad/s$$

$$a_c = r\omega^2 = 0.63\,m \bullet (1.904\,rad/s)^2 = 2.3\,m/s^2$$

Homework 5.3

Preview 5.4

Problems 5.3 in your Booklet
Due: Next Class