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

The acceleration of an object in circular motion is directed radially inward, or the object would not demonstrate uniform circular motion. A small-arc vector analysis demonstrates this:

\[ \Delta v = v_f - v_i \]

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

\[ a_c = \frac{v_f^2}{r} \quad a_c = r \omega^2 \]
### Centripetal Acceleration Math

Two ways of quantifying $a_c$ (m/s²), using tangential speed, OR angular speed:

<table>
<thead>
<tr>
<th>AP Equation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$a = \frac{v^2}{r}$</td>
<td>$v_t$ = tangential speed (m/s)</td>
</tr>
<tr>
<td>$a_c = r\omega^2$</td>
<td>$\omega$ = angular speed (rad/s)</td>
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### 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:
   
   \[\omega = \frac{25 \text{ rpm} \times 0.105 \text{ rad/s}}{1 \text{ rpm}} = 2.625 \text{ rad/s}\]

   \[a_c = r\omega^2 = 0.45 m \times (2.625 \text{ rad/s})^2 = 3.1 m/s^2\]

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

   \[\omega = \frac{\theta}{t} = \frac{2\pi \text{ rad}}{3.3 s} = 1.904 \text{ rad/s}\]

   \[a_c = r\omega^2 = 0.63 m \times (1.904 \text{ rad/s})^2 = 2.3 m/s^2\]