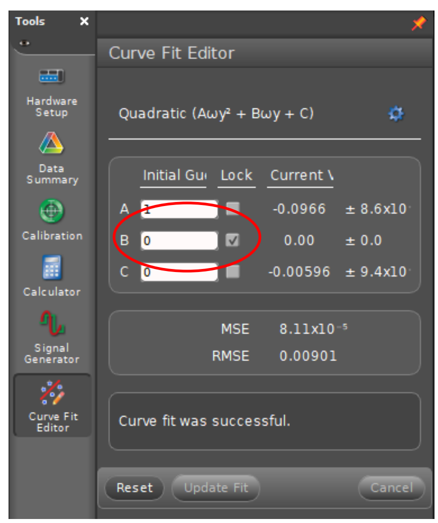
Centripetal Acceleration and Force

1. Take your Smart Cart out of the box.
2. Turn it on and open your choice of software: SPARKvue or Capstone.
3. Wirelessly connect to the Smart Cart.
4. Make a graph of Acceleration-x (from the Smart Cart Acceleration Sensor) vs. Angular Velocity-y (from the Smart Cart Gyro Sensor). Add a second plot area with the Force vs. Angular Velocity-y.
5. Install the rubber bumper on the Smart Cart Force Sensor. With the cart sitting still, with nothing touching the rubber bumper on the Force Sensor, zero the Acceleration-x, Angular Velocity-y, and the Force in the software.
6. Set up a board or track on a rotatable chair as shown in the picture. Set the end stop near the end of the track and place the cart's rubber bumper (Force Sensor end) against the end stop.

7. Spin the chair and start recording. Let the chair spin down to a stop and then stop recording.
8. Apply a curve fit to the data to determine how the centripetal acceleration and force are related to the angular velocity. For the quadratic fit, open the curve fit editor at right in Capstone and lock the coefficient B = 0.

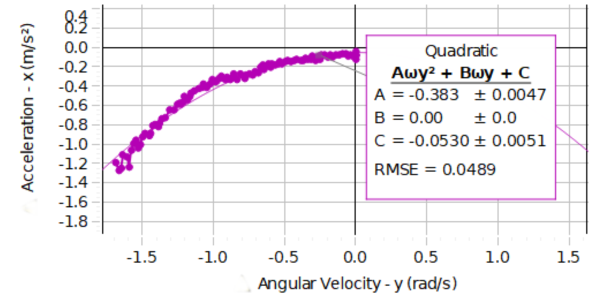
   This forces the fit to $A\omega^2 + C$. From the curve fit, what is the radius?
9. In which direction are the centripetal acceleration and the centripetal force?

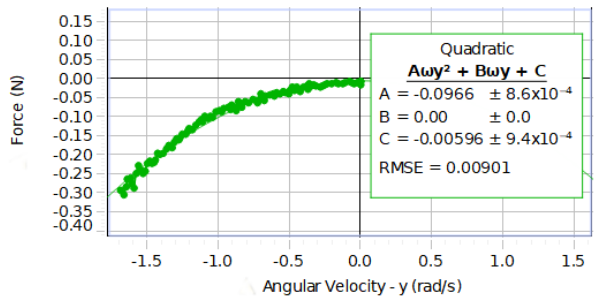


Further Study

1. Move the end stop 5 cm closer to the center of rotation. Repeat the experiment.
2. Continue to move the end stop closer to the center in 5 cm increments.
3. How does the centripetal force depend on the radius?

Sample Data





Both the centripetal acceleration and the centripetal force are pointing toward the center of the circle (they are negative) and are proportional to the square of the angular velocity.

$a = -0.383\omega^2 - 0.0530$
$F = -0.0966\omega^2 - 0.00596$
$m = 0.25$ kg

$F = ma = 0.25(-0.383\omega^2 - 0.0530) = -0.096\omega^2 - 0.013$

The radius is 0.383 m because $a = r\omega^2$.