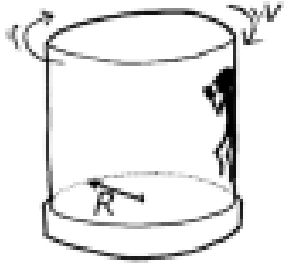
NAME _____ DATE _____

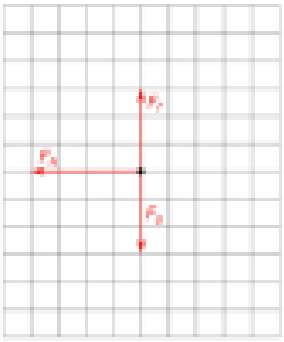
Scenario

Carlos (mass m) enters the carnival ride called the "Rotor." The ride begins to rotate, and once Carlos has reached speed v, the floor drops out and he does not slip.



Using Representations

PART A: The dot at right represents the student on the ride after the floor has dropped out. Draw a free-body diagram showing and labeling the forces (not components) exerted on the student. Draw the relative lengths of all vectors to reflect the relative magnitudes of all the forces. Each force must be represented by a distinct arrow starting on and pointing away from the dot.



Create an Equation

PART B: Derive an equation for the normal force on Carlos after the floor has dropped out. For each line of the derivation, explain what was done mathematically (i.e., annotate your derivation). Express your answer in terms of m, v, R and physical constants as appropriate.

$\Sigma F_r = ma_r$	The sum of the forces in the horizontal direction is equal to Carlos's mass times his centripetal acceleration.
$F_N = \frac{mv^2}{R}$	The only force on Carlos horizontally is the normal force from the wall pushing him in toward the center of the circle.

Data Analysis

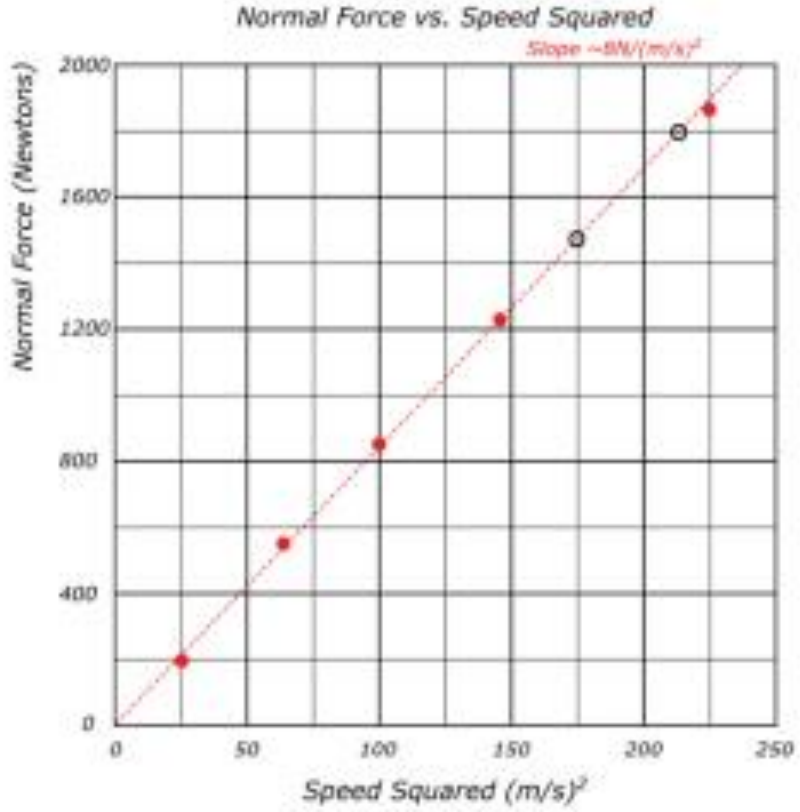
On the next ride, Carlos takes a force sensor and places it between himself and the wall of the ride and collects the following data about the force from the wall and the speed of the ride:

Force from the Wall (N)	*Speed of the Ride (m/s)*	Speed of the Ride Squared $(m/s)^2$
100	5	25
540	8	64
840	10	100
1,225	12	144
1,850	15	225

PART C: Which quantities should be graphed to yield a straight line whose slope could be used to determine the radius of the ride? Justify your answer. You may use the remaining columns in the table above, as needed, to record any quantities (including units) that are not already in the table.

Carlos should graph the normal force from the wall vs. the speed squared.

PART D: Plot the graph on the axes below. Label the axis with the variables used and appropriate numbers to indicate the scale. Draw a best-fit line and find the slope of the line.



$$slope = \frac{rise}{run} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{1{,}800\text{ N} - 1{,}480\text{ N}}{212.5\left(\frac{m}{s}\right)^2 - 175\left(\frac{m}{s}\right)^2} = \frac{320\text{ N}}{37.5\left(\frac{m}{s}\right)^2} = 8.5\frac{N}{\left(\frac{m}{s}\right)^2}$$

PART E: Using the slope calculated in Part D, determine the radius of the ride if Carlos's mass is 50 kg.

The slope of the line is approximately 85 N/(m/s)². This will be equal to Carlos's mass divided by the radius of the ride. So, 85 N/(m/s)² = 50 kg/R. R should be approximately 6 meters.