Lab 3-1: Centripetal Acceleration

Purpose:
1. To analyze the motion of an object moving in a circle at constant speed through the use of a digital camcorder.
2. To produce position, velocity and acceleration graphs by components.
3. To see the relationship between the directions of the r, v, and a vectors for an object moving in a circle at constant speed

Procedure:

Part 1: Getting the Data

1. A bicycle wheel with a small target taped to its rim and mounted on a stand will be spun and videotaped. This video will be converted into a small computer file, which will be analyzed using Logger Pro.
2. Make sure that the LabPro is NOT plugged into the computer. Open up Logger Pro. Under **Insert**, choose **Movie...**. Choose the correct movie. It will open up in the middle of the screen of Logger Pro.
3.  Enable video analysis by clicking on the box on the bottom right of the movie that looks like the button to the left.
4.  Set the scale of the movie by clicking on the "Set Scale" button (upper right corner). You can either click and drag across the diameter of the wheel or the radius, and then put in the appropriate length.
5.  Set the origin by clicking on the "Set Origin" button (upper right corner), and then clicking on the center of the wheel.
6.  Now to record the actual position of the target for each frame of the movie, click on the "Add Point" button (upper right corner.) Carefully center the mouse on the target, and click. Logger Pro will record the x and y coordinates of the mouse click, and the movie will automatically go to the next frame. Do this for the whole movie.
7. To clean up the window, under **Page**, choose **Auto Arrange**. You should now see the position vs. time graph on the main screen. Save your work, just in case.

Part 2: Data Manipulation

8. Logger Pro will automatically have the position and velocity columns for both the x and y components. You will have to add two new calculated columns to create the acceleration graphs for each component. Label them "X Acceleration" and "Y Acceleration" with the short names of "Ax" and "Ay". (double click on one of the velocity column headings for inspiration on the correct equation.) Remember units!
9. Right now, you have all the motion information by components. You will have to add three more new calculated columns to analyze the magnitudes of the position, velocity and acceleration over time. Label these "Radius," "Speed" and "Acceleration" and use the short names "r", "v" and "a." Remember units!
10. Save your work again, just in case.
11. On the graph, show "X," "Y" and "r" by clicking on the vertical axis and choosing "More." You should have two curves and one horizontal line.
12. Insert a new graph, and show "Vx," "Vy" and "v". Again, you should have two curves and one horizontal line. Auto Arrange to clean up the window.
13. Insert a third graph, and show "Ax," "Ay" and "a". Again, you should have two curves and one horizontal line. Auto Arrange to clean up the window.
14. Copy and paste the graphs into the space below.
15. Pick two times when the target is in two different quadrants, and record the components of the position, velocity and acceleration in the data table below.

Data:

time (s)	*X (m)*	*Y (m)*	*V_x (m/s)*	*V_y (m/s)*	*a_x (m/s^2)*	*a_y (m/s^2)*

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Calculations: (*Show work here, and record results in the table below*.)

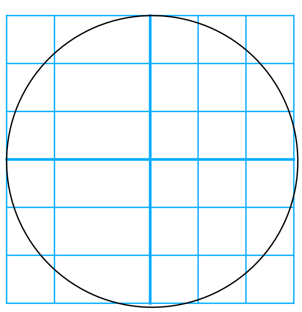
1. In unit-vector form, determine the position, velocity and acceleration vectors for the times you have data. (Actually, there is no work to show on this one, just write them in the table below.)

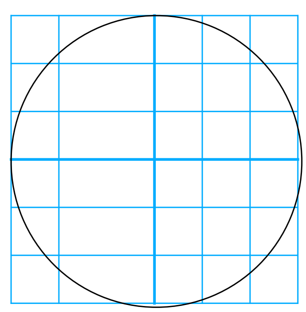
2. For each of the six vectors, calculate the direction of the vector. Use 0-360°.

3. For each of the six vectors, calculate the magnitudes of the vectors.

component form	*magnitude*	*direction*	*component form*	*magnitude*	*direction*
r =	r =	@	**r** =	r =	@
v =	v =	@	**v** =	v =	@
a =	a =	@	**a** =	a =	@

4. For both positions, sketch the position, velocity and acceleration vectors on the circles below.





Questions:

1. Were the radius, speed and magnitude of the acceleration constant? (What were they?)

2. Were the position, velocity or acceleration of the target constant? Explain.

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3. What was true about the relative directions of the position, velocity and acceleration vectors as time went on? What about the magnitudes?

4. In class we derived an equation for centripetal acceleration. Compare your lab results to this equation.