LAB A9: *CIRCULAR MOTION AT THE STATE FAIR*

10/16/03

GOAL: To investigate the physics of circular motion on a ride at the state fair. To determine the acceleration of a ride by at least two different methods and to determine the ratio of a rider's apparent weight to true weight.

PROCEDURE

You will be provided with a set of accelerometers for data-taking at the state fair. The accelerometers will be used to measure

a) horizontal and vertical accelerations
b) angles
c) distances

Each person measures her/his own value(s) for all timings, angles, distances, and accelerations. In addition, you need to bring with you

a) pen and the state fair data sheet
b) a watch (with a sweep second hand or a digital watch with stop/start capabilities)

The above apparatus will be used to collect sufficient data in order to determine:

a) ride period (time/revolution)
b) physical dimensions of the ride (both horizontal and vertical if appropriate)
b) speed of the ride (in m/s)
c) centripetal acceleration
d) ratio of apparent weight of (i.e., the normal force felt by) a rider to the rider's true weight

Practice using your horizontal accelerometer on the bus ride to the fair!!!

RESULTS

One possible way of organizing your results follows. You need not necessarily do it this way, although any complete lab report should include these as a minimum. Be as creative as you can.

A) A picture and a word description of the ride; direct measurements (period, radius, height, etc.) should be incorporated in the picture and/or description
B) All relevant force diagram(s) and net force equations
C) Comparison of directly measured and indirectly determined centripetal accelerations
D) Ratio of Apparent Weight to True Weight of rider
E) Physiological sensations of rider
F) Miscellaneous extras
G) Conclusion

In general, you should average your data and your partner's data and use only these averages throughout the analysis. Justification must be provided if you choose to not use some data.

As part of your lab report, you and your partner are expected to sign a statement declaring that each of you contributed equally (50%) to the work done in preparing the report.

A) MEASUREMENTS

Draw a large diagram of the ride you experienced, and label it with symbols (same as those used in your lab write-up) for the relevant length measurements. Then briefly describe your ride. Describe briefly how you determined the length measurements. Describe briefly how the ride period was obtained and under what circumstances. Always start with symbols representing the raw data measured, show how it will be used to derive or calculate other quantities, and then put in the numbers.

B) FORCE DIAGRAMS and NET FORCE EQUATIONS

Some rides may require only one force diagram (i.e., the same force diagram applies throughout the ride). Other rides (especially ones that involve both vertical and horizontal motion) may require different force diagrams for different parts of the ride.

Draw the relevant force diagram(s) for your ride.
Write the appropriate net force equations for your ride.

C) ACCELERATION

For most rides, you should be able to determine the centripetal acceleration in at least two ways:
(1) by calculating it using $a_c = v^2/r$, where v and r are the linear speed and radius of the ride, respectively.
(2) by measuring it directly using the appropriate accelerometer.

D) RATIO OF APPARENT WEIGHT TO TRUE WEIGHT

Use your net force equations to solve for the ratio of a rider's apparent weight to true weight (in terms of the centripetal acceleration a_c and any important ride parameters, such as the angle of tilt). Then, using your formula and the values for centripetal acceleration calculated or measured previously, calculate the ratio of the rider's apparent weight to true weight. Your apparent weight might be exerted on a floor, a wall, or a seat. Some rides may have more than one normal force; for example, a normal force due to a seat and a normal force due to the back of the seat.

E) PHYSIOLOGICAL SENSATIONS

Describe the physiological sensations that you experienced on the ride and how they did or did not match what was expected purely from Newton's first law, the force diagram, and the net force equation analysis. For example, where did you feel heaviest (and lightest)? This should then be compared to your results in part D. If, at some point during the ride you were upside down, could you tell?

F) MISCELLANEOUS EXTRAS

You will be given guidelines in class as to the minimum expectations for a B grade on your lab report. If you want a higher grade you will have to go beyond those minimum expectations. Use the ride problems in Walker (chapter 6) and on the sheet titled “Circular Motion Problems at the State Fair” as examples of other things you might do. It might be appropriate to determine a friction coefficient, the ride speed for which you would feel weightless, etc.

G) CONCLUSION