Modeling a Falling Parachute

Math/Physics
High
Regressions / Data Collection

Objectives: Why a person would jump from a perfectly good airplane is a mystry that confounds many people. And yet skydiving is one of the fasting growing sports in the country. As more and more people take the plunge, it becomes increasingly more important to understand the physics behind the sport. In this experiment you will construct a model parachute and then gather data to study the motion of the parachute.

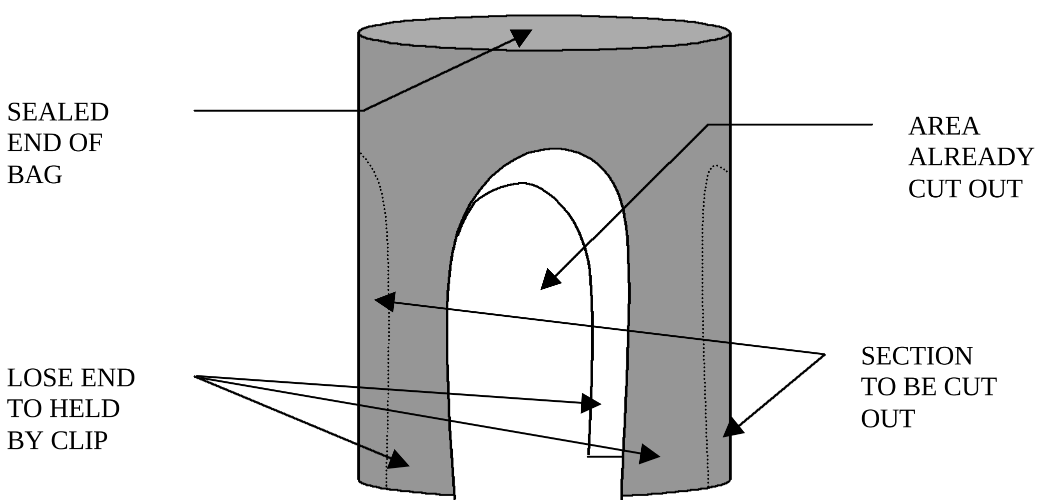
Related Key Words: free fall terminal velocity friction cross area Newton's Laws of Motion acceleration

Materials:
CFX-9850 graphing calculator with link cord
CASIO EA-100 CASIO Data Analyzer (CDA)
Vernier Ultrasonic Motion Detector,
Small kitchen garbage bag (parachute)
Small binder clip (parachutist)

Purpose: To determine the terminal velocity of your parachute and relate this event to Newton's Laws of Motion.

Set Up:

1. Construct parachute by cutting out four equal size parabolas from a medium sized trash bag. Consider the bag to be a cylinder. From that cylinder cut away four parabolas from the open end (bottom) toward the closed end (top). Consider the size of the bag and size and shape of your curve carefully. Use the binder clip to connect the four plastic strips at the bottom of the bag together. Paper clips may be added to insure a constant free fall rate. Students should try several practice runs before collecting data.



2. Turn on the EA-100
3. Connect the Ultrasonic Motion Detector to the SONIC port on the right side of the EA-100.
4. Set up the EA-100. Press [SHIFT], then [MODE]. Keep pressing the DataLOG key until the screen displays 50.0 mSec, then press [TRIGGER]. Keep pressing the [DataLOG] key until it displays 30, then press

[TRIGGER]. Press the [DataLOG] key until it displays 1, then press [TRIGGER]. The screen should now display READY in the upper left-hand corner.

5. Place the motion detector on the floor so that it is facing upward.

Procedures:

STEP 1— Two people will be needed to do the experiment. One to drop the parachute and the other to start the EA-100.

STEP 2— Hold the parachute above the motion detector so that the binder clip is at least 1.5 meters high. (You may need to stand on a chair or crate to reach this height).

STEP 3— Press [TRIGGER] on the EA-100 and drop the parachute immediately after pressing [TRIGGER].

STEP 4— The EA-100 will collect the data and the motion detector will stop clicking when it is finished.

STEP 5— Link the EA-100to the CFX-9850 and go into the PROGRAM icon. Run the RECEIVE program. The CFX-9850 will display DONE when the transfer of data is complete.

STEP 6— The parachute may not fall straight down so it may be necessary to redo the experiment. You can press [SHIFT] and [HALT] to restart the EA-100 to the READY mode.

DATA

The data is stored in List 1 and List 2 in the Statistics menu. The time, in seconds, is stored in List 1 and the height in meters is stored in List 2.

1. Press F6 to set up the StatGraph. Set the Graph Type to Scatter, Xlist to List 1, and Ylist to List 2.
2. Press EXIT and then F1 to draw the scatter plot.
3. Use the TRACE to find the coordinates of any two points in the scatter plot. Record the times and the corresponding heights.

Time 1: _________________________ Height 1: _________________________

Time 2: _________________________ Height 2: _________________________

4. Find the slope of the line that passes through the points. Then use the slope and one of the points to determine the equation of the line through the points.

Slope = __________________________

Equation = ______________________________

5. Use the equation you found in number 4 to find the initial height of the parachute and how long it will take the parachute to hit the ground.
6. Now find the linear regression on the CFX-9850. Does the line appear to be a good fit?
7. Press F5 to copy the regression equation into the graphing screen.
8. Go to the graphing menu and enter in the equation you found in number 4.
9. Compare the slopes and the y-intercepts of the two linear models. Explain why any differences occur.

CONCLUSION: Write a paragraph describing your conclusions about the activity. Include sources of error, possible improvements to procedures, and applications to the "real" world.

Extensions:

Have students experiment with different masses (# of paper clips) to see if there is an effect on the data.