FreeFall
Student Activity Guide

Introduction: What influences how an object falls to the ground? Do the same factors need to be taken into consideration for a golf ball dropped from your hand, an open parachute, and a meteor from when it enters the earth's atmosphere until it meets the ground?

Activity One

1. List all of the factors that you think influence how fast an object is moving when it is released from a distance above the ground. Don't try to distinguish when these factors are important in this step:

2. For each pair of objects, which one will be traveling at a higher velocity when it hits the ground? Or will both be traveling at about the same speed?

empty ball/ball with sand ____

closed parachute/open parachute ______________________________________

empty ball/ball with sand with parachutes ____________________________

Teacher Demonstration:

Your teacher will drop the following pairs of objects simultaneously. Predict which will be traveling faster when it hits the ground. Then record Your observations of the teacher demonstration.

A textbook or a piece of paper _________________________

Observations:

A textbook or a crumpled piece of paper _________________________

Observations:

An empty film canister or a filled film canister ___________________________

Observations:

Summarize what you have learned about falling objects:

Activity Two. The Picket Fence

Introduction: In this activity you will use a CBL, photogate and a Picket Fence to explain the motion of falling objects. The picket fence is a plexiglass strip divided into alternating dark and clear strips of equal width. When the strip moves through a photogate interfaced to a CBL and calculator, time intervals are measured for the passage of successive dark strips through the gate. The raw data can then be converted to graphs of distance vs. time, velocity vs. time and acceleration vs. time.

Procedure:

1) Before performing the lab, answer the following:

a) For an object like the picket fence, will the motion be constant velocity, constant acceleration or something else?

b) For an object with a parachute attached, will the motion be the same or different than in a)? If different, how so?

2) Position a photogate on its stand sideways so that it extends over a table end. Put a soft object (bookbag?) on the floor below the gate. Connect the photogate to the CBL using channel 1 (CH1) . Connect the CBL to a calculator using the linking cable. Turn the CBL on, then the calculator.

Open the program menu by touching the PRGM key on the calculator. Select the program TIMER. At the opening screen, press ENTER. The next screen just reminds you to connect the photogate, so press ENTER. From the next menu choose 2. CHECK GATE and follow the instructions.

Then choose 1. TIMING MODES. From the next menu choose 1. MOTION, then 1. SELECT DEVICE, then 1. VERNIER PICKET, then 2. COLLECT DATA.

Position the Picket Fence just above the photogate, hit ENTER to Arm Gate and drop the Picket Fence through the gate.

At this point, the program will allow you to view the d-t, v-t , and a-t graphs individually. Show your instructor the d-t graph. Sketch each graph in turn and include a rationale for the shape of each graph.

Then choose the STATS option from the menu and copy down the first and third screens as shown. Finally, use the RETURN options until you QUIT the program. Then click on the STAT button on the calculator. Choose the Edit option and record the values found in lists 1, 2, 4 and 6.

Now delete the zeros in the first row of L_1 and L_2. Then choose STAT followed by CALC, then B:PwrReg. The calculator returns to the screen with PwrReg. Type L_1, L_2, hit enter and record the data.

Share your data with the class.

Activity Three. STELLA FreeFall Model

In this activity, you will modify a previous STELLA model to represent your new knowledge about free-fall.

Open the velocity - acceleration model previously saved. Edit the model so that it shows free-fall. This will involve several changes.

1. Since acceleration due to gravity is negative, we will be taking “stuff” out of the stocks. This means that the flows must be biflows. Double click on each flow and when the dialogue box appears, click in the biflow circle.
2. We are now starting with an initial height, so change the initial Distance value to something larger than zero.
3. Our initial velocity is still zero, but the velocity will be negative (Why?). Open the dialogue box for the velocity box and un-’X’ the Non-negative box.
4. Change the acceleration to -9.81 {m/s^2}

Question 3.1: Run the model and sketch the graphs below.

Question 3.2: What differences exist between your STELLA graphs and those that were on the calculator? Why?

Question 3.3: Which set of graphs is preferred? Why?

The acceleration due to gravity on the Moon is 1/6 that of Earth. We want to compare the effects of the two different gravities. STELLA allows comparative graphs, but only of one variable. Open the graph dialogue box, click on the comparative box and choose Distance for this graph. Then make a new page for the velocity graph (see the arrows and word new in the lower right corner of the dialogue box) and make this comparative as well. Finally, create a third page for comparing accelerations. Run the model for the current settings, then adjust your model for the Moon and run again. Two lines should appear on each graph.

Question 3.4: Record your comparison below.

Activity Four: The Wrench and Helicopter Problem

This problem is similar to the car- truck problem except that now both objects start with the same velocity, but only one is affected by acceleration. Also, the problem uses your newfound knowledge about freefall.

Problem:

A wrench falls from a helicopter which is rising steadily at 6.0 m/s. After 2.0 s

a. what is the velocity of the wrench?

b. how far below the helicopter is the wrench?

Hint for building the model: Make separate stocks for the helicopter's distance and the wrench's distance. Then have the appropriate flows based on your earlier models. Remember the wrench is accelerating and in free-fall, but the helicopter is not. The graph should show the distance traveled by both the helicopter and the wrench.