

Free-Fall Acceleration

MATERIALS LIST

- 3 wooden blocks of different masses
- balance
- C-clamp
- LabPro® or CBL 2™ interface
- masking tape
- meterstick
- support stand with V-clamp
- thin foam pad
- TI graphing calculator with link cable
- Vernier motion detector

You can use a motion detector and a LabPro or CBL 2 interface instead of a recording timer to determine velocity and acceleration. The motion detector measures the position of an object by sending sound waves toward the object and measuring the time that the waves take to echo back to the sensor.

SAFETY



- Tie back long hair, secure loose clothing, and remove loose jewelry to prevent its getting caught in moving or rotating parts.
- Attach masses securely. Falling or dropped masses can cause serious injury.

PROCEDURE

Preparation

Follow Preparation steps 1–2 for the Skills Practice Lab “Free-Fall Acceleration” in the chapter “Motion in One Dimension.”

Apparatus Setup

3. Connect the LabPro or CBL 2 interface to the calculator with the unit-to-unit link cable. Connect the motion detector to either of the two DIG/SONIC ports on the interface.
4. Set up the apparatus as shown in **Figure 1**. Place the ring stand near the edge of the lab table. Use the C-clamp to clamp the base of the ring stand securely to the table. Position the clamp so that it protrudes as little as possible.
5. Using the V-clamp, securely clamp the motion detector to the ring stand so that the detector faces down, over the edge of the table. Make sure the motion detector is far enough away from the edge of the table so the signal will not hit the tabletop, clamp, or table leg. Cover the floor

under the motion detector with a foam pad to reduce feedback.

6. Use a meterstick to measure a distance 0.5 m below the motion detector, and mark the point with tape on the ring stand. This point is the starting position from which the blocks will be dropped from rest.
7. Start the program DataMate® on your graphing calculator. Press CLEAR to reset the program.
8. Test to be sure the motion detector is positioned properly.
 - a. Read the measurement displayed on the calculator screen for the distance between the motion detector and the floor. If the reading seems unusually low, adjust the motion detector to make sure the signal is not hitting the table.
 - b. Hold the wooden block directly beneath the motion detector, and move the block up and down. Note the distance measurement displayed on the calculator. Make sure the motion detector is not “seeing” other objects, such as the stand base, the tabletop, or the table leg.

Speed and Acceleration of a Falling Object

9. Measure the mass of the first wooden block, and label the block with tape. Record the mass in your data table. Hold the block horizontally between your hands, with your hands flat. Position the block directly below the motion detector and level with the 0.5 m mark.
10. When the area is clear of people and objects, one student should select START to begin data collection. When the motion detector begins to click, the student holding the block should wait two seconds and then release the block by pulling both hands out to the side. Releasing the block this way will prevent the block from twisting as it falls, which may affect your results.
11. When the motion detector has stopped clicking, the graph selection screen will appear on the calculator. Press ENTER to plot a graph of the distance in meters against time in seconds. (Note: If the graph has spikes or black lines, repeat the trial to obtain a smooth graph.)