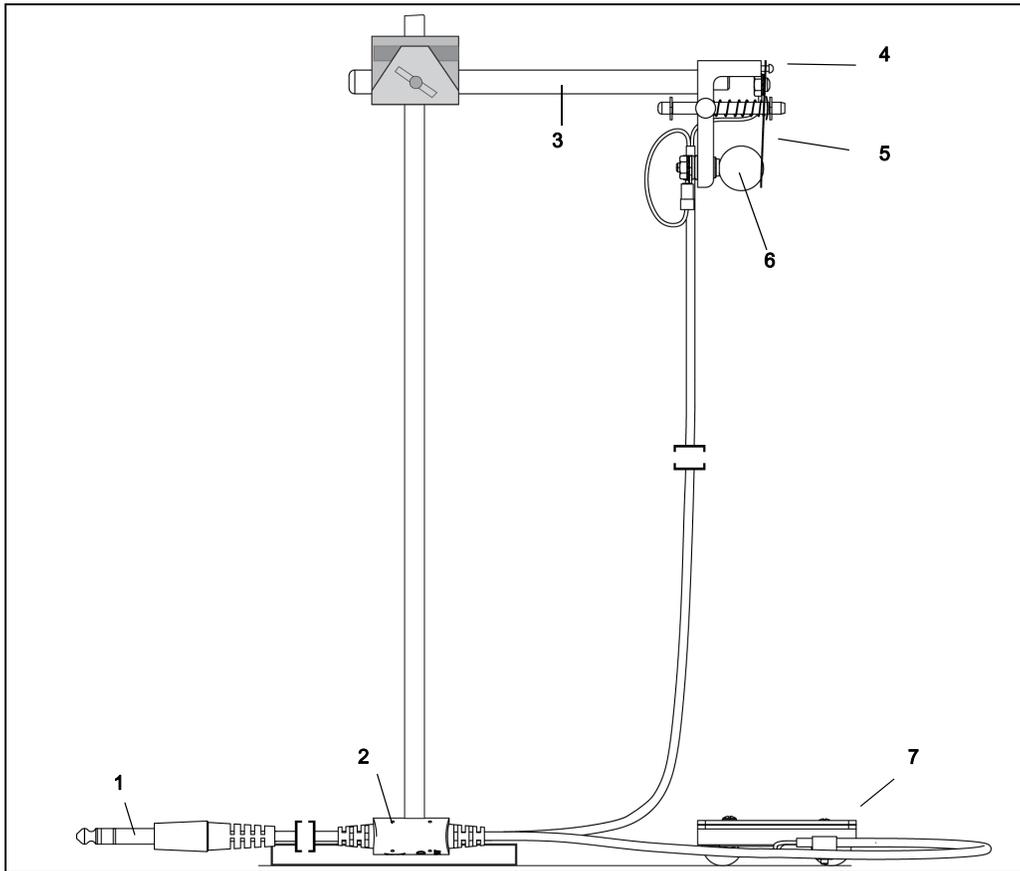


# Free Fall Adapter

ME-9207B



1. Phone plug	5. Release plate
2. Controller	6. Steel ball
3. Adapter support rod	7. Receptor pad
4. Ball release mechanism	

### Included Equipment

Free Fall Adapter

Steel Balls, 2, 15.87 mm diameter (0.625 in)

Steel Balls, 2, 19.05 mm diameter (0.750 in))

### Part Number

ME-9207B

Recommended Equipment	Part Number
Right Angle Clamp	SE-9444
Base and Support Rod	See <a href="http://www.pasco.com">www.pasco.com</a>
Meter stick or tape measure	SE-8827 or SE-8712A
PASCO Timer	ME-8930 or ME-9215B

OR

PASCO Interface and Data Collection Software	See <a href="http://www.pasco.com">www.pasco.com</a>
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NOTE: If you use a PASCO PASPORT-only Interface (such as the PS-2100A USB Link) you will need a PS-2159 PASPORT Digital Adapter

## Introduction

The PASCO Model ME-9207B Free Fall Adapter is an automatic release mechanism that plugs into a PASCO Photogate Timer, Smart Timer, or PASCO computer interfaces, allowing you to measure the acceleration due to gravity ( $g$ ) with one percent accuracy. It is also easily adapted for a variety of other mechanics experiments, providing a highly accurate method for starting and stopping an electronic timer. Some examples of these other uses are provided at the end of this manual.

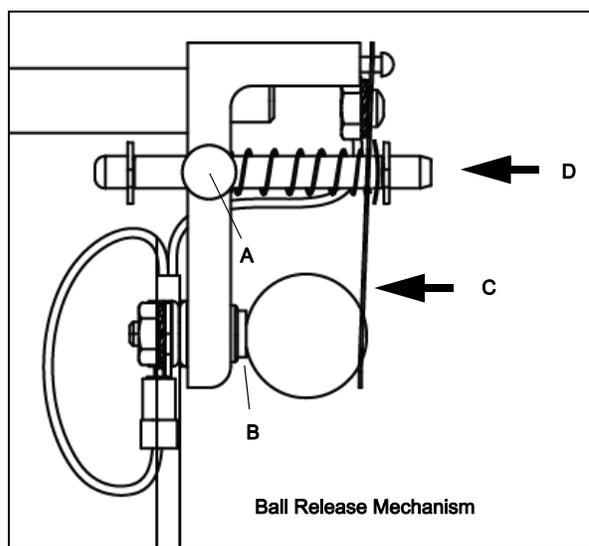
In the basic free fall experiment, a steel ball is clamped into the spring loaded release mechanism. The ball is in series with the triggering circuit for the timing device. When the thumbscrew is loosened, the mechanism pops open, releasing the ball and starting the timing device. When the ball strikes the receptor pad, the top plate of the pad is forced against the metal base. This automatically stops the timing. The timing device displays the time it took for the ball to drop from the release mechanism to the pad.

## Operation

### Equipment Setup

The Ball Release Mechanism holds a steel ball between the Release Plate and the Contact Screw. The Dowel Pin is pushed into place to hold the Release Plate. A thumbscrew holds the dowel pin in place. A spring on the dowel pin pushes the release plate away from the ball when the thumbscrew is loosened. See the table.

1. Clamp the ball release mechanism to a support rod, or any other device that will hold it vertical and at the desired height over the floor or table.
2. Loosen the thumbscrew slightly. See A.
  - For best results, the drop height ( $y$ ) should be the full two meters allowed by the cable. Shorter heights will work fine, but accuracy is slightly reduced.
3. Insert one of the steel balls into the release mechanism between the contact screw and the hole in the



release plate. See B. Press the release plate against the ball to hold it in place. See C.

- Press against the end of the dowel pin so the spring on the dowel pin is compressed and the ball is clamped between the hole in the release plate and the contact screw. See D. Tighten the thumbscrew.

A. Thumbscrew	C. Release plate
B. Contact screw	D. Dowel pin

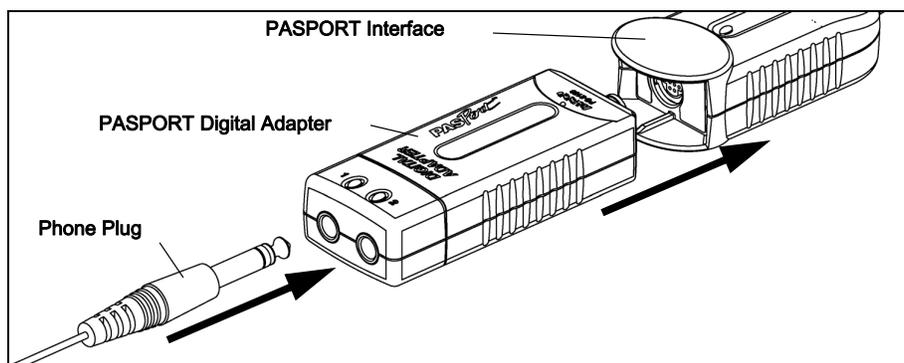
- Position the ball receptor pad directly under the ball.
  - NOTE: You may want to place the receptor pad in a shallow box so that the ball doesn't roll away after it falls and hits the pad.
- Connect the phone plug to your timing device.

## Connecting to a Timing Device

The Free Fall Adapter connects to an electronic timing device by inserting the phone plug into a phone jack on the device.

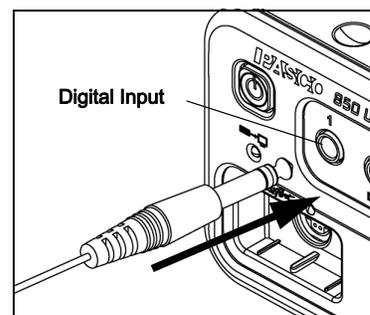
### PASPORT-only Interface

If the device is a PASPORT-only PASCO Interface, first insert the phone plug into a PS-2159 PASPORT Digital Adapter, and then connect the Digital Adapter to the interface.



### Smart Timer, Photogate Timer, or PASCO Interface with Digital Input

If the device or interface has a one-quarter inch (6.3 mm) phone jack, insert the phone plug into the phone jack on the timing device or interface.



## Collecting Data

The process for collecting data varies with the timing device.

### PASCO Photogate Timer (ME-9215B)

- Turn on the timer and set it to GATE mode.
- Tap the receptor pad to reset the Free Fall Adapter electronics.

3. Press the RESET button to reset the timer.
4. Loosen the thumbscrew on the Free Fall Adapter to release the ball.
  - NOTE: The ball should hit in the center of the receptor pad. If not, reset the time, reposition the pad, and try again.
5. Read the time on the digital display. This is the time it took for the ball to fall from the release mechanism to the receptor pad.

#### **PASCO Smart Timer (ME-8930)**

1. Turn on the timer.
2. Press the Select Measurement button repeatedly until Time is displayed.
3. Press the Select Mode button repeatedly until the Stopwatch mode is displayed.
4. Press the Start/Stop button once.
  - RESULT: An asterisk will appear on the display indicating that the Smart Timer is ready to collect data.
5. Loosen the thumbscrew on the Free Fall Adapter to release the ball.
6. Read the time on the digital display
7. To prepare for another measurement, put the ball back in the ball release mechanism. Press the Start/Stop button on the Smart Timer.

#### **PASCO Interface Setup**

1. Connect the phone plug to a PASCO interface.
2. Connect the PASCO interface to a computing device.
3. Start the data collection software.

#### **Software Setup**

For information about collecting, recording, displaying and analyzing data, refer to the User's Guide or Online Help System for the software.

1. Set up the Free Fall Adapter in the data collection software.
2. Open a display such as a Digits display to show the time of fall for the ball.
3. Start recording data.
4. Loosen the thumbscrew on the Free Fall Adapter to release the ball.
5. Stop recording data after the ball hits the receptor pad. Read the time on the Digits display.

## Troubleshooting

### In Case of Difficulty

If the timing device does not begin timing when the ball is released, or fails to stop timing when the ball hits the receptor pad, check the following:

1. Check that the ball makes good electrical contact with the contact screw and the release plate. If necessary, clean the contact screw, release plate, and ball. CAUTION: Do not use a solvent to clean the items.
2. Check that the top of the receptor pad does not touch the metal base of the receptor pad but is within 1 or 2 millimeters so that it will contact the metal based when the ball strikes it.

### Problem with the PASCO Photogate Timer

If the timer readout has missing or extra segments in the display, or the timer will not count or keeps counting even after checking the conditions above, then the batteries probably need replacing.

### More Information

See the PASCO catalog or web site for more information.

[www.pasco.com](http://www.pasco.com)

For further help, contact PASCO Technical Support.

## Technical Support

For assistance with any PASCO product, contact PASCO at:

<b>Address:</b>	PASCO scientific 10101 Foothills Blvd. Roseville, CA 95747-7100
<b>Phone:</b>	916-786-3800 (worldwide) 800-772-8700 (U.S.)
<b>Web:</b>	<a href="http://www.pasco.com">www.pasco.com</a>
<b>Email:</b>	<a href="mailto:support@pasco.com">support@pasco.com</a>

### Limited Warranty

For a description of the product warranty, see the PASCO catalog or [www.pasco.com/legal](http://www.pasco.com/legal).

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The European Union WEEE (Waste Electronic and Electrical Equipment) symbol (to the right) and on the product or its packaging indicates that this product must not be disposed of in a standard waste container.



## Experiment: Measuring Acceleration Due to Gravity, g

### Introduction

The equation of motion for a body starting from rest and undergoing constant acceleration as it falls can be expressed as

$$y = \frac{1}{2}at^2$$

In the equation,  $y$  is the vertical distance the object travels from its starting point,  $a$  is the acceleration, and  $t$  is the time for the object to fall.

Here are several questions:

- Is the acceleration due to gravity constant? If it is, then the distance an object falls will be directly proportional to the square of the elapsed time of fall, as in the above equation.
- If the acceleration is constant, what is its value? Is it the same for all objects or does it vary with mass or size of the object?

### Procedure

1. Set up the Free Fall Adapter as described in the Operation section of this manual. Use the 15.87 mm diameter steel ball.
2. Set  $y$ , the height from which the ball drops, to approximately 2.0 meters.
3. Measure the distance from the bottom of the ball to the top of the receptor pad as accurately as possible and record the distance in the Data Table.
4. Follow the instructions for your timing device as described in the Operation section. Record the first measured time as  $t_1$  in the Data Table.
5. Repeat the measurement four more times and record your values in the Data Table. Calculate the average of the five times and record this value as the average time.
6. Set the vertical distance,  $y$ , to 1.75, 1.50, 1.25, 1.00, 0.75, and 0.50 meters and repeat the data recording steps for each new value of  $y$ . Be sure to measure the distance carefully.
7. Repeat the steps for the 19.05 mm diameter steel ball.

**Data Table (15.87 mm diameter ball)**

Trial	y (m)	$t_1$	$t_2$	$t_3$	$t_4$	$t_5$	$t_{\text{avg}}$	$t_{\text{avg}}^2$
1								
2								
3								
4								
5								
6								
7								

**Data Table (19.05 mm diameter ball)**

Trial	y (m)	$t_1$	$t_2$	$t_3$	$t_4$	$t_5$	$t_{\text{avg}}$	$t_{\text{avg}}^2$
1								
2								
3								
4								
5								
6								
7								

**Analysis**

For each ball, plot a graph of  $y$  versus  $t_{\text{avg}}^2$ , with  $y$  as the dependent variable ( $y$ -axis). Within the limits of your experimental accuracy, do your data points define a straight line for each ball? Was the acceleration constant for each ball?

If your graphs were linear, measure the slope of each graph. Using your measured slopes, and the equation shown in the introduction, determine the acceleration due to gravity. Be sure to include the units. Was the acceleration the same for each ball?

**Conclusion**

Describe your laboratory experiment and discuss your results. Consider the following questions: (1) Is the acceleration due to gravity constant? (2) Is the acceleration due to gravity the same for all objects? Discuss the conditions under which you believe your answers to be true. Include a discussion of the errors in your measurement and how they affect your conclusions. How linear was your graph? How might you alter your technique, or the experiment, in order to reduce experimental errors?