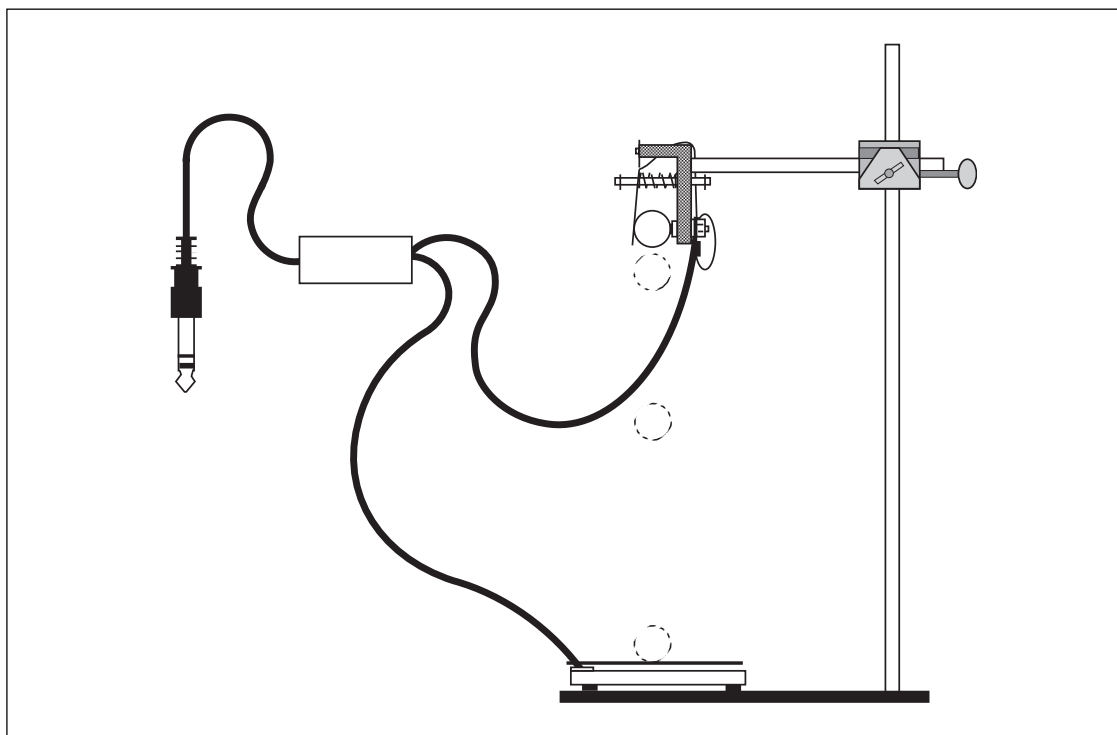


**Instruction Manual and
Experiment Guide for
the PASCO scientific
Model ME-9207B**

012-05760B
4/99

FREE FALL ADAPTER



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\$7.50

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- ① The packing carton must be strong enough for the item shipped.
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- ③ Make certain that the packing material cannot shift in the box or become compressed, allowing the instrument come in contact with the packing carton.

Address: PASCO scientific
10101 Foothills Blvd.
Roseville, CA 95747-7100

Phone: (916) 786-3800
FAX: (916) 786-3292
email: techsupp@pasco.com
web: www.pasco.com

Introduction

The PASCO Model ME-9207B Free Fall Adapter is an automatic release mechanism that plugs into PASCO Photogate Timers, Smart Timer, *ScienceWorkshop*[®] computer interfaces, and other electronic timing devices, allowing you to measure the acceleration due to gravity (g) with 1 percent accuracy. It is also easily adapted for a variety of other mechanics experiments, providing a highly accurate method for starting and stopping the electronic timers. 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 photogate timer. When the thumbscrew is turned, the mechanism pops open, releasing the ball and starting the timer. When the ball strikes the receptor pad, the top plate of the pad is forced against the metal base. This automatically stops the timer. The timer display shows the time it took for the ball to drop from the release mechanism to the pad.

Equipment

Equipment Included:

- Free Fall Adapter: (ball release mechanism, receptor pad, controller box, cable, and phone jack connector)
- 2 steel balls (1.27 cm diameter)
- 2 steel balls (1.91 cm diameter)

Additional Equipment Required:

- clamp (such as the PASCO SE-9446 Buret Clamp)
- rod stand
- electronic timing device (such as the PASCO ME-9403 Photogate Timer, PASCO ME-8930 Smart Timer, PASCO *ScienceWorkshop*[®] computer interface (500 or 700 series and CI-6500))
- metric stick

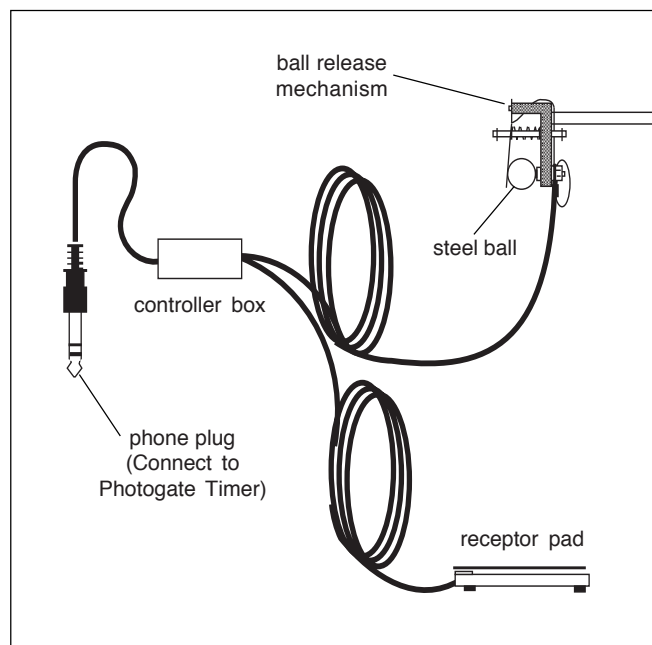


Figure 1. Free Fall Adapter: Included Equipment

Operation

Connecting the Free Fall Adapter to the Electronic Timing Device

The Free Fall Adapter connects to any electronic timing device by inserting the phone plug into a phone jack on the device. See Appendix A for a diagram of many of the connection options. See Appendix B for illustrated connection instructions for several of these timing devices.

Options for Electronic Timing

Options for electronic timing for the Free Fall Adapter include the PASCO Photogate Timers (Model 9206A, or 9215A), Smart Timer (ME-8930), and *ScienceWorkshop*[®] computer interface (Series 500, 700, and CI-6500)V. If you wish to use this adapter with other timers, please see the *Technical Information* section (Appendix C) for power supply, output signal, and connector specifications.

Equipment Setup

1. Clamp the ball release mechanism to a lab stand, or any other device that will hold it vertical and at the desired height over the floor or table (Figure 2).

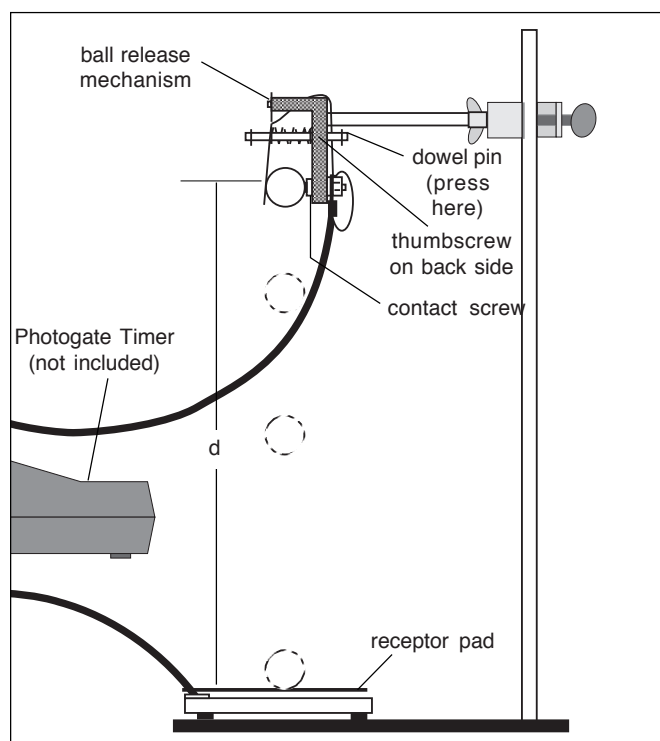


Figure 2. Equipment Setup

For best results, the drop height (d) should be the full two meters allowed by the cable. Shorter heights will work fine, but accuracy is reduced proportionally.

2. Position the ball receptor plate directly under the ball. (You might want to place the receptor plate in a shallow box so the ball doesn't roll away after it falls.)
3. Insert one of the steel balls into the release mechanism, pressing in the dowel pin so the ball is clamped between the contact screw and the hole in the release plate. Lightly tighten the thumbscrew to lock the ball in place.
4. Plug the phone jack into a port on your electronic timing device.

Data Collection

The process for data collection varies with the electronic timing device. The process for a few of these devices is listed below:

PASCO Photogate Timer (ME-9206A or ME-9215A)

1. Turn the timer ON and set it in the GATE mode.
2. Tap the receptor pad to reset the Free Fall Timer electronics.
3. Press the RESET button to reset the timer.
4. Loosen the thumbscrew to release the ball. It should hit in the center of the receptor pad. If not, reset the timer, reposition the pad, and try it again.
5. Read the time on the digital display of the timer. This is the time it took for the ball to fall a distance d , as shown in Figure 2.

PASCO Smart Timer (ME-8930)

1. Press the **Select Measurement** button repeatedly until Time is displayed.
2. Press the **Select Mode** button repeatedly until the Stopwatch mode is displayed.

Data Collection, continued

3. Press the **Start/Stop** button once.
Result: An asterisk will appear on the display indicating that the Smart Timer is ready to collect Time of Fall data.
4. Loosen the thumbscrew to release the ball. It should hit in the center of the receptor pad. If not, reset the timer, reposition the pad, and try it again.
Result: The Smart Timer will display the time of fall in seconds.
5. Read the time on the digital display of the timer. This is the time it took for the ball to fall a distance **d**, as shown in Figure 2.
6. To prepare to take another measurement, reposition the ball in the ball release mechanism, and press the **Start/Stop** button to reset the Smart Timer.

PASCO *ScienceWorkshop* Computer Interfaces (Series 500 and 700)

1. Set up the Free Fall Adapter to be recorded in your data acquisition software.
Note: Refer to the User Manual or on-line help for details.

Note: In *ScienceWorkshop*, you can specify the distance **d** for automatic calculation of acceleration due to gravity (**g**). In DataStudio, **g** is calculated automatically assuming **d** = 1 meter.

2. Open an appropriate display for the data (such as the Digits display in *ScienceWorkshop*[®] and DataStudio[™]).
- Note:* In *ScienceWorkshop* and DataStudio, the acceleration due to gravity is automatically displayed if the appropriate display has been opened.
3. Start recording data.
4. Loosen the thumbscrew to release the ball. It should hit in the center of the receptor pad. If not, reposition the pad, and try it again.
Result: The time of fall (s) will be displayed. Acceleration due to gravity (**g**) (m/s/s) will also be displayed if the appropriate display and conditions have been set up as described above.

Troubleshooting

In Case of Difficulty

If the timer 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, or whatever object you are timing, makes electrical contact between the contact screw and the flat-spring of the ball release. If necessary, clean the contact, flat-spring, and ball. (An object made of plastic, wood, or another nonconductive material won't trigger the timer when released.)
2. Check that the target pad does not touch the metal base of the receptor pad but is close enough (1 to 2 mm) so that it will contact the metal base when the falling object strikes it.

Problem with PASCO Photogate Timer:

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

Problem with PASCO Computer Interfaces:

- Recent upgrades in the Precision Timer III and Smart Pulley Timer software allow the user to choose either our original ME-9207 or our newer ME-9207A Free Fall Adapter. The instruction for using the two models differs due to changes in the circuitry. For further information on using the ME-9207 Free Fall Adapter with your software, or to obtain a current edition of the software, contact the technical support department at PASCO (1-800-772-8700).

Experiment: Measuring g

Introduction

The equation of motion for a body starting from rest and undergoing constant acceleration can be expressed as: $x = \frac{a^2}{2}$

where x is the distance the object has traveled from its starting point, a is the acceleration, and t is the time elapsed since the motion began.

In order to measure the acceleration caused by gravity, several questions must be answered:

- Is the acceleration constant? If it is, then the distance an object falls will be proportional to the square of the elapsed time, as in the above equation.
- If the acceleration is constant, what is the value of the acceleration? Is it the same for all objects or does it vary with mass or size of the object, or with some other quality of the object? If it is not constant, how does it vary with time?

In this experiment you will answer these questions by carefully timing the fall of a steel ball from various heights.

Procedure

1. Set up the Free Fall Timer as described in the SETUP and OPERATION section of this manual. Use the 13 mm diameter steel ball.
2. Set d , the height from which the ball drops, to approximately 2.0 meters. Measure the distance as accurately as possible and record the distance in Table 1. Follow the instructions for the Timer or Computer Interface as given in the "Operations" section. Record the measured time as t_1 in Table 1. Repeat the measurement at least four more times and record these values as t_2 - t_5 . Calculate the average of your five measured times and record this value as t_{avg} .
3. Set d to 1.75, 1.50, 1.25, 1.00, 0.75 and 0.50 m, repeating step 2 for each value of d . (The actual value of d need not correspond exactly to the listed values, but be sure you measure it carefully.)
4. Repeat steps 2 and 3 using the 16 mm steel ball.

Analysis

For each ball, plot a graph of d versus t_{avg}^2 with d as the dependent value (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?

Table 1 Data and Calculations

d (m)	t_1	t_2	t_3	t_4	t_5	t_{avg}	t_{avg}^2

