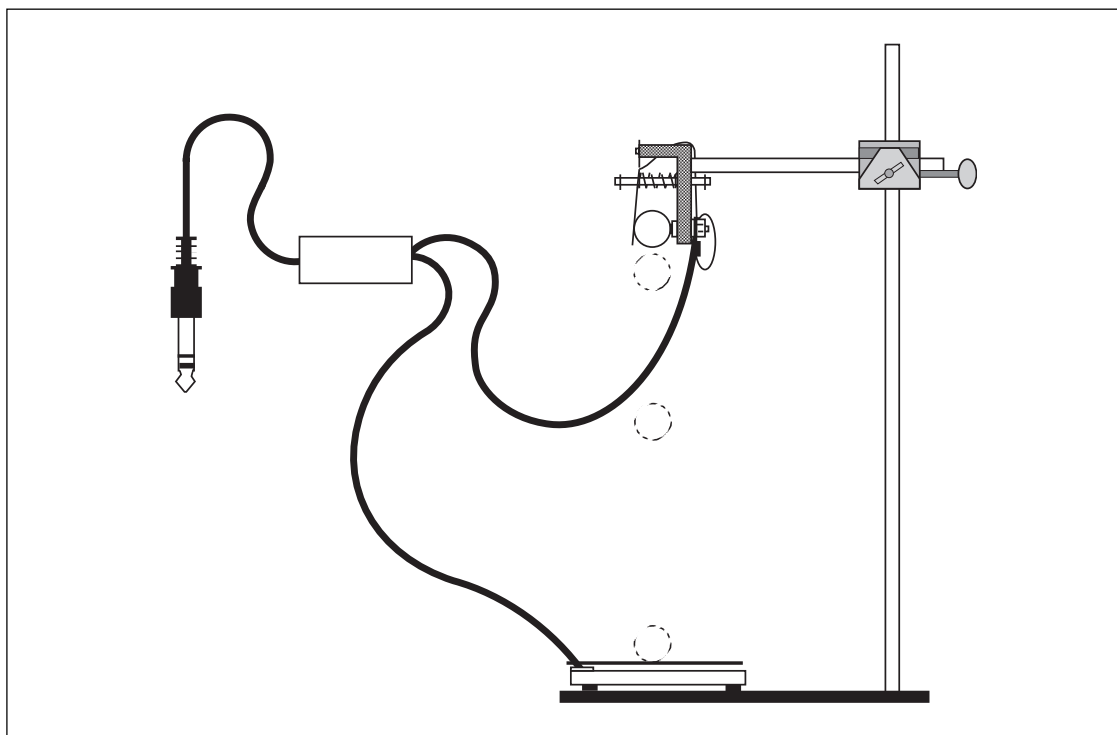


**Instruction Manual and  
Experiment Guide for  
the PASCO scientific  
Model ME-9207B**

012-05760B  
4/99

# **FREE FALL ADAPTER**



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\$7.50



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# Copyright, Warranty, and Equipment Return

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- ① The packing carton must be strong enough for the item shipped.
- ② Make certain there are at least two inches of packing material between any point on the apparatus and the inside walls of the carton.
- 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.

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## Introduction

The PASCO Model ME-9207B Free Fall Adapter is an automatic release mechanism that plugs into PASCO Photogate Timers, Smart Timer, *ScienceWorkshop*<sup>®</sup> 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*<sup>®</sup> computer interface (500 or 700 series and CI-6500))
- metric stick

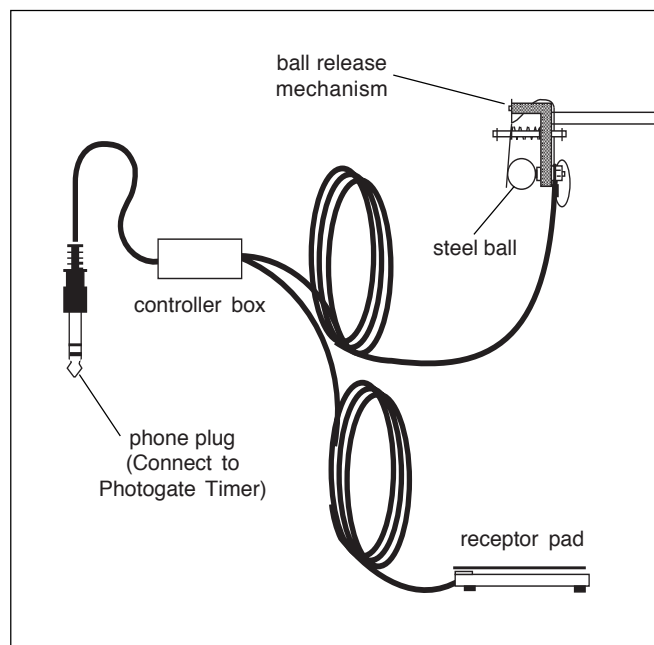


Figure 1. Free Fall Adapter: Included Equipment

# 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*<sup>®</sup> 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).

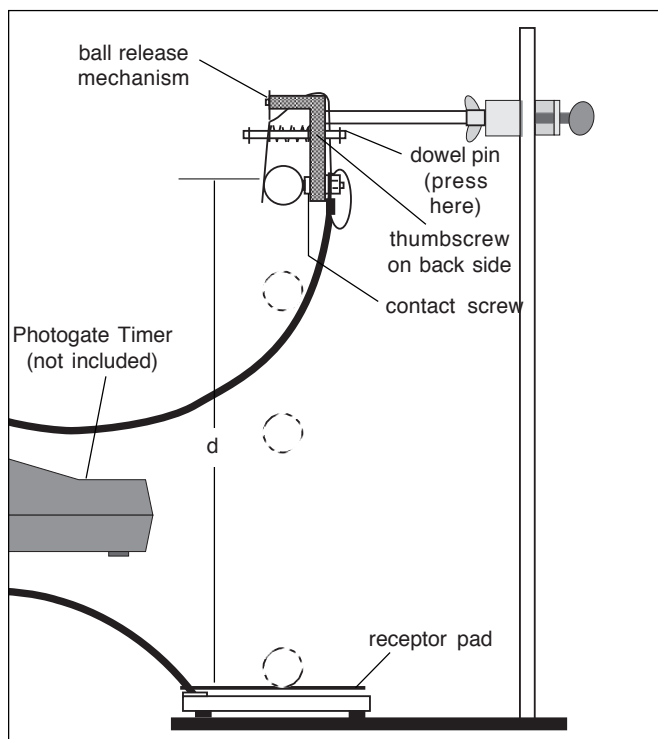


Figure 2. Equipment Setup

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*<sup>®</sup> and DataStudio<sup>™</sup>).
- 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<sub>1</sub>** in Table 1. Repeat the measurement at least four more times and record these values as **t<sub>2</sub>**-**t<sub>5</sub>**. Calculate the average of your five measured times and record this value as **t<sub>avg</sub>**.
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<sub>avg</sub><sup>2</sup>** 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**

<b>d (m)</b>	<b>t<sub>1</sub></b>	<b>t<sub>2</sub></b>	<b>t<sub>3</sub></b>	<b>t<sub>4</sub></b>	<b>t<sub>5</sub></b>	<b>t<sub>avg</sub></b>	<b>t<sub>avg</sub><sup>2</sup></b>



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

## Conclusion

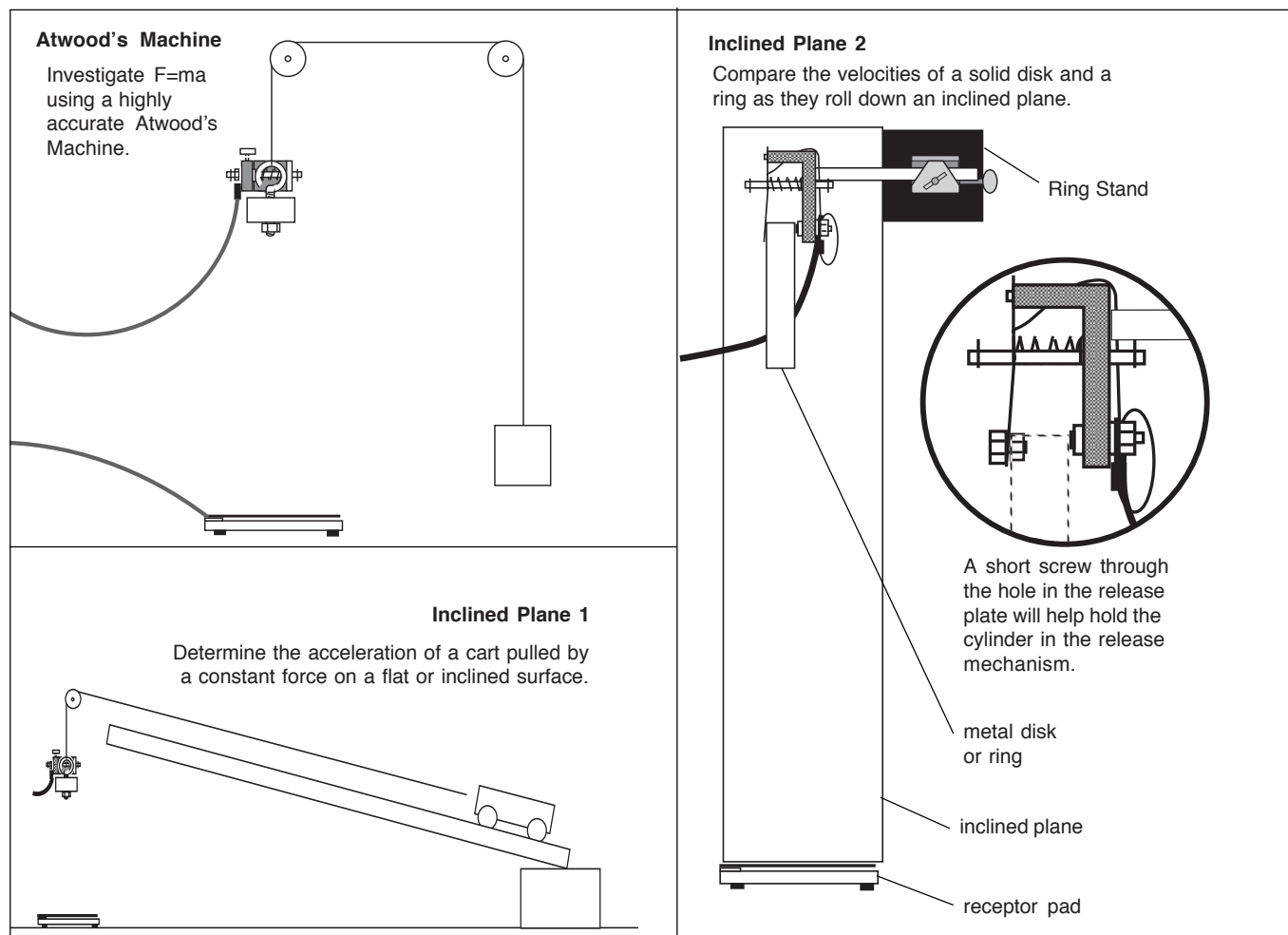
Describe your laboratory experiment and discuss your results. Consider the following questions: (1) Is the acceleration caused by gravity constant? (2) Is the acceleration caused by gravity the same for all objects? Discuss the conditions under which you believe your results to be true. Include a discussion of the errors in your measurements 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?

## Suggested Additional Experiments

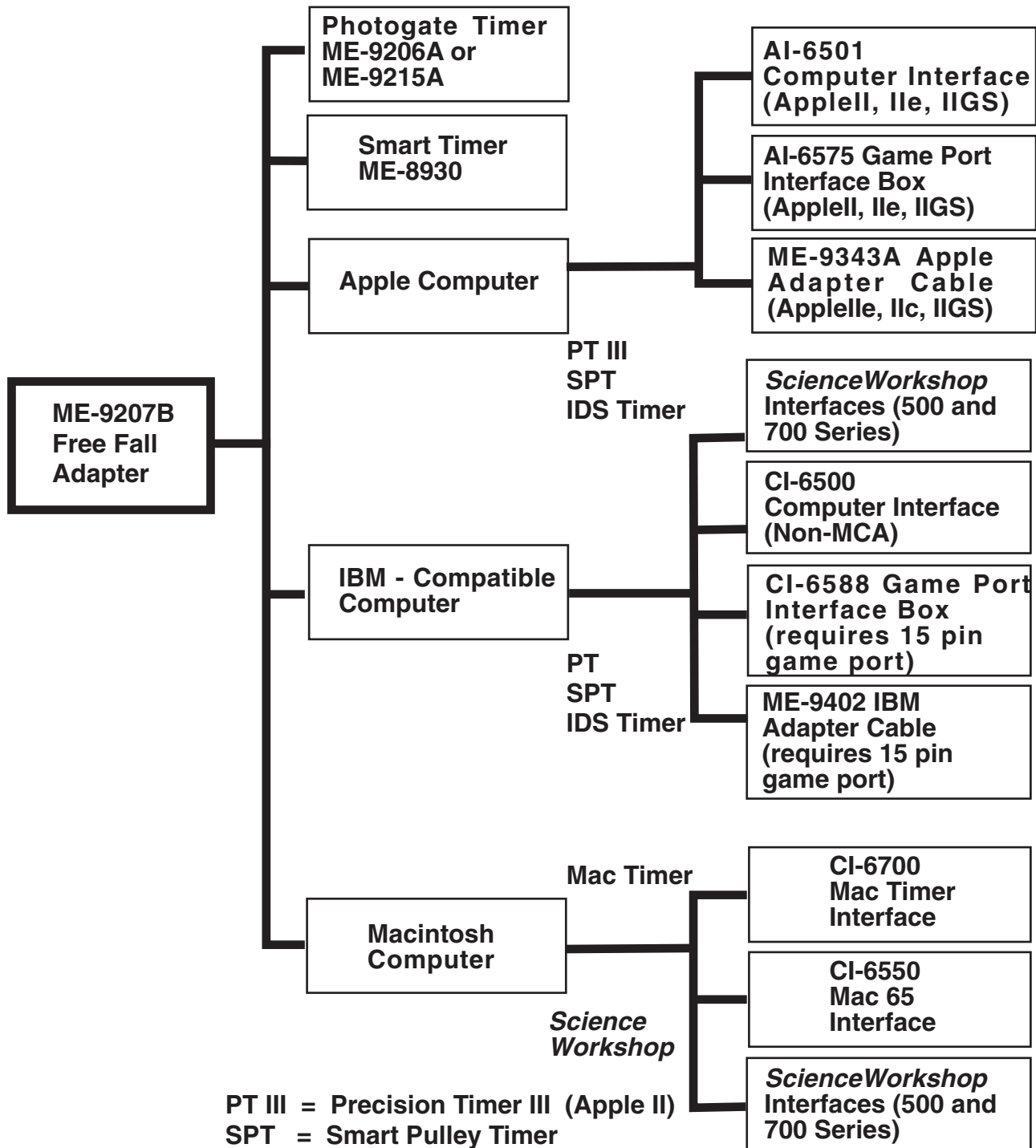
The Free Fall Apparatus can bring high resolution timing to a variety of mechanics experiments. Any *conductive* object can be timed as long as it can be clamped in the release mechanism and is heavy enough to depress the receptor plate when it strikes. The

illustrations below show some examples of experimental setups.

We'd like to thank Giles Shepherd of Everett Community College for suggesting the experiments shown below.



# Appendix A: Options for using the ME-9207B Free Fall Adapter



PT III = Precision Timer III (Apple II)  
 SPT = Smart Pulley Timer  
 PT = Precision Timer (MS-DOS)  
 IDS = Introductory Dynamics System

PASCO has an IBM gameport interface card available, SE-6590

# Appendix B: Connecting to Computer Interfaces

### Using the AI-6575 Apple Gameport Interface:

Connect the ME-9207B Free Fall Adapter into connector 1 on the Gameport interface box as shown in Figure 3.

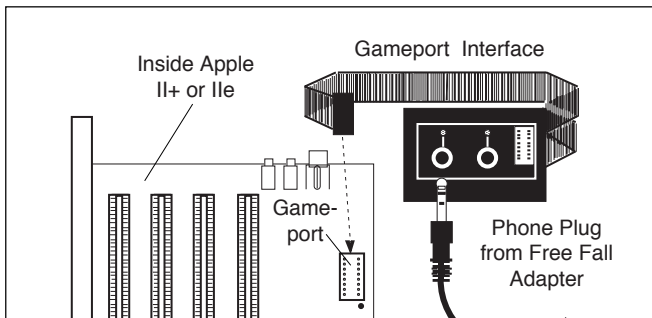


Figure 3

### Using the ME-9343A Adapter Cable:

Connect the ME-9207B Free Fall Adapter into connector 1 on the ME-9343A (the connector with the black shrink-wrap marking) as shown in Figure 4.

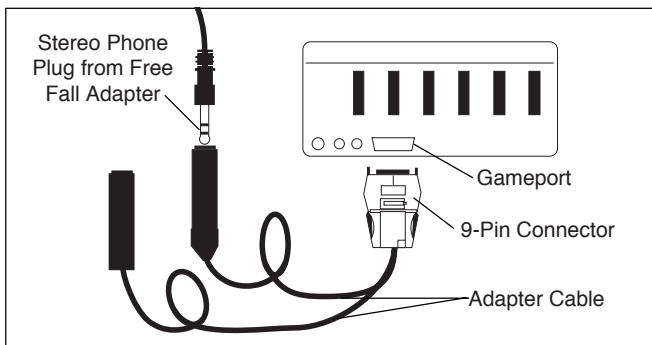


Figure 4

### Using the AI-6501 or CI-6500 Series 6500 Computer Interface:

Connect the Free Fall adapter to digital input 1 on the Series 6500 interface box.

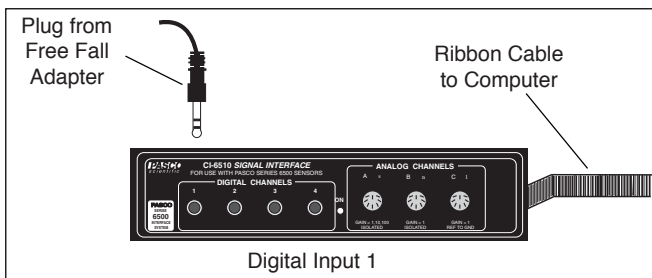


Figure 7

### Using the CI-6588 IBM PC Gameport Interface:

Connect the ME-9207B Free Fall Adapter into connector 1 on the IBM Gameport interface box as shown in Figure 5.

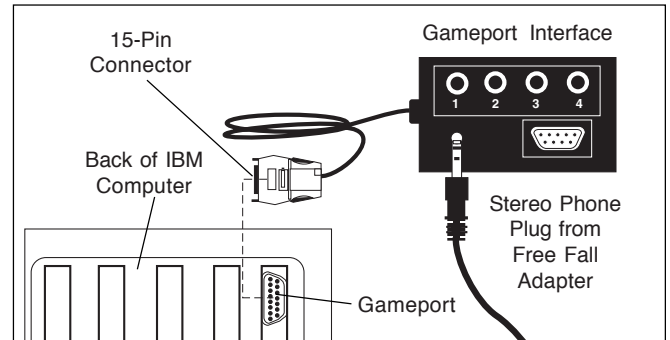


Figure 5

### Using the ME-9402 IBM Adapter Cable:

Connect the Free Fall Adapter into the jack with the black tape.

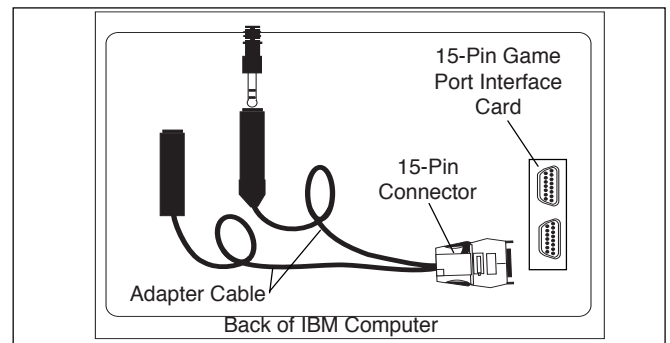


Figure 6

### Using the ScienceWorkshop 500 Computer Interface

Connect the Free Fall Adapter to digital input 1 on the interface.

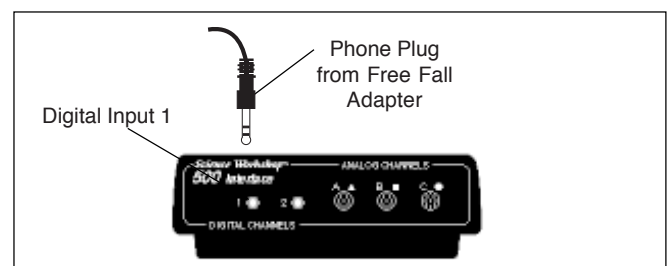


Figure 8

# Appendix C: Technical Data

## Timer Specifications for the Free Fall Adapter

The PASCO ME-9207B Free Fall Adapter can be used with any timer that will:

1. Provide 5 VDC at 50 mA.
2. Provide a minimum resolution of 1 ms.
3. Begin counting on the negative slope of a pulse and stop counting on the positive slope of the pulse.

The connections for the stereo phone jack are indicated in Figure 6. The schematic is shown below.

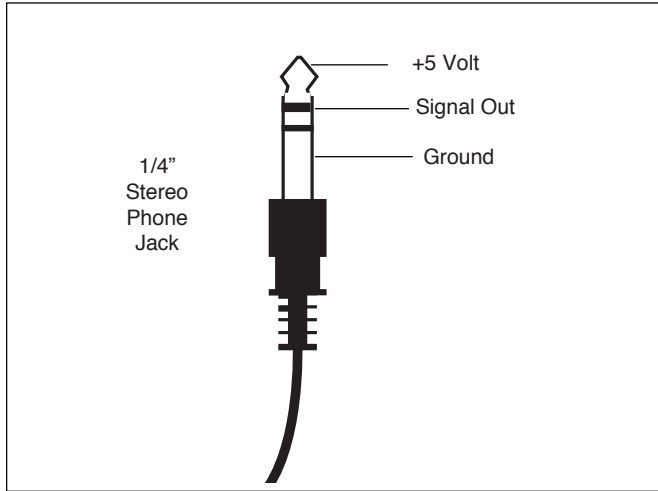
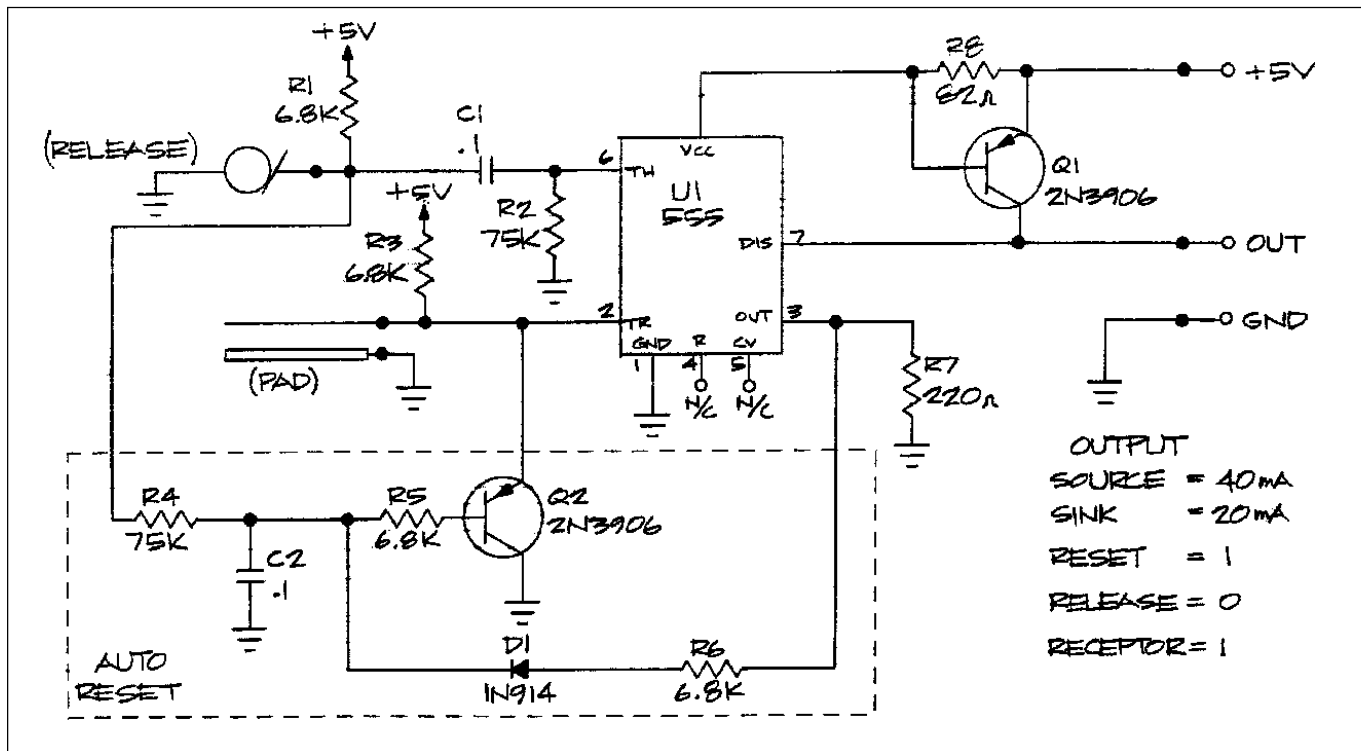


Figure 9. Stereo Phone Jack Connections

►NOTE: All resistors are 1/4 W, 5% unless otherwise noted.



Schematic Model ME-9207B Free Fall Adapter (956-03527A)

# Technical Support

## Feedback

If you have any comments about the product or manual, please let us know. If you have any suggestions on alternate experiments or find a problem in the manual, please tell us. PASCO appreciates any customer feedback. Your input helps us evaluate and improve our product.

## To Reach PASCO

For technical support, call us at 1-800-772-8700 (toll-free within the U.S.) or (916) 786-3800.

fax: (916) 786-3292

e-mail: [techsupp@pasco.com](mailto:techsupp@pasco.com)

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

## Contacting Technical Support

Before you call the PASCO Technical Support staff, it would be helpful to prepare the following information:

- ▶ If your problem is computer/software related, note:
  - Title and revision date of software;
  - Type of computer (make, model, speed);
  - Type of external cables/peripherals.
- ▶ If your problem is with the PASCO apparatus, note:
  - Title and model number (usually listed on the label);
  - Approximate age of apparatus;
  - A detailed description of the problem/sequence of events (in case you can't call PASCO right away, you won't lose valuable data);
  - If possible, have the apparatus within reach when calling to facilitate description of individual parts.
- ▶ If your problem relates to the instruction manual, note:
  - Part number and revision (listed by month and year on the front cover);
  - Have the manual at hand to discuss your questions.

