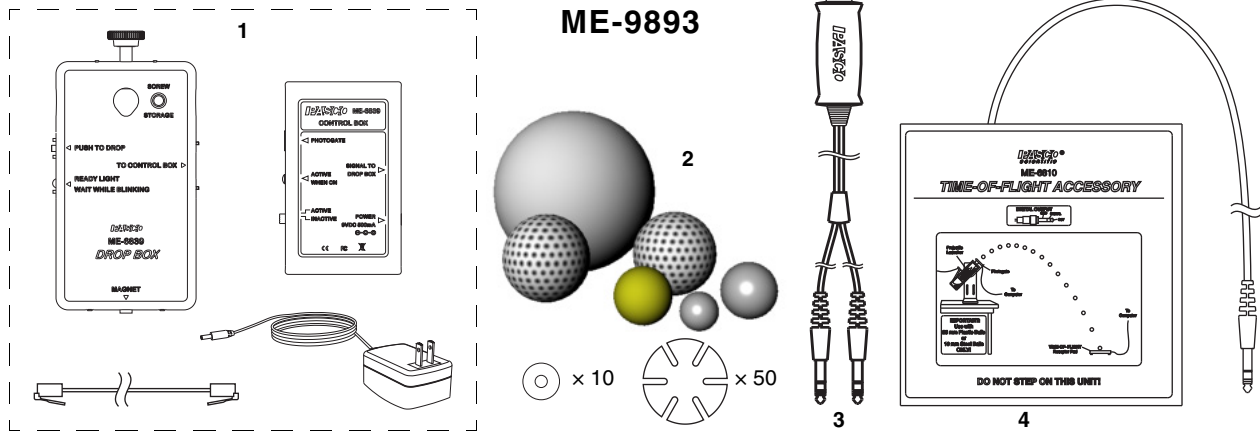




# Discover Free Fall System

## ME-9889

# Discover Free Fall Accessory



**Included Equipment ME-9889**

**Part Number**

1. Drop Box assembly:

ME-6839

- Drop Box, main unit
- Control Box
- AC Adapter
- Cable

2. Free Fall Ball Accessory:

ME-9890

- Release Washers (qty. 10)
- Release Stickers (qty. 50)
- Yellow Nylon Ball (2.5 cm diameter, 10 g)
- Larger Stainless Steel Ball (2.5 cm diameter, 70 g)
- Smaller Stainless Steel Ball (1.6 cm diameter, 16 g)
- Regular Golf Ball (4.4 cm diameter, 50 g)
- Practice Golf Ball (4.2 cm diameter, 6 g)
- Large Hollow Plastic Ball (10 cm diameter, 40g)

**ME-9893**

3. Timer Switch

ME-9819

4. Time-of-Flight Accessory

ME-6810

**Required Equipment**

Timing device (see page 3)

See PASCO catalog

Mounting rods and base (see page 3)

See PASCO catalog

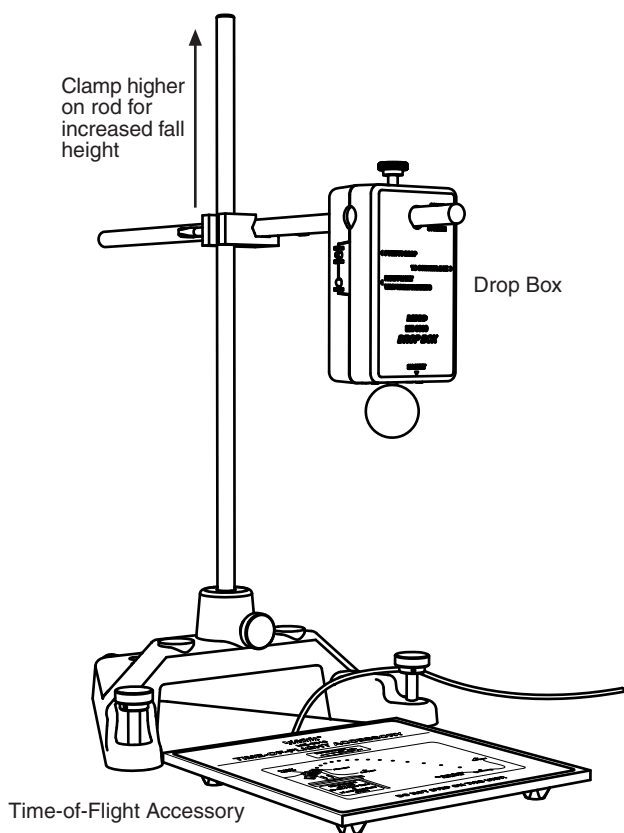


Figure 1: Drop box mounted on a rod stand

## Introduction

The PASCO Discover Free Fall System consists of the ME-6839 Drop Box plus the ME-9893 Discover Free Fall Accessory. The Discover Free Fall Accessory consists of the Free Fall Ball Accessory (ME-9890), the Timer Switch (ME-9819) and the Time-of-Flight Accessory (ME-6810).

The PASCO Discover Free Fall System allows students to precisely time falling objects. The system includes several balls of various sizes and masses (ranging from about 6 g to 70 g). Other objects of similar mass can also be used.

The object to be dropped is suspended from a magnet. When the timer switch is pushed, the object is released and the timing starts. Timing stops when the object hits the time-of-flight pad. The system includes steel washers and adhesive stickers to allow non-steel objects to be suspended from the magnet.

The timer switch is a push-button device that simultaneously causes the drop box to release the object and triggers the timing device to start timing.

The time-of-flight accessory is a pad that triggers the timing device to stop timing when an object hits it.

## Mounting Options

Mount the drop box on a horizontal rod attached with a right angle clamp to a tall rod. Figure 1 shows a typical setup using a rod stand (ME-8735), a 120 cm vertical rod (ME-8741), a 45 cm horizontal rod (ME-8736), and a right angle clamp (SE-9444). Any similar configuration will work just as well. For a greater fall height, place the rod stand on a table and the time-of-flight pad on the floor.

The drop box can also be attached magnetically to a steel part of the ceiling (see Figure 2). This mounting method works well for maximizing the height from which objects will be dropped.

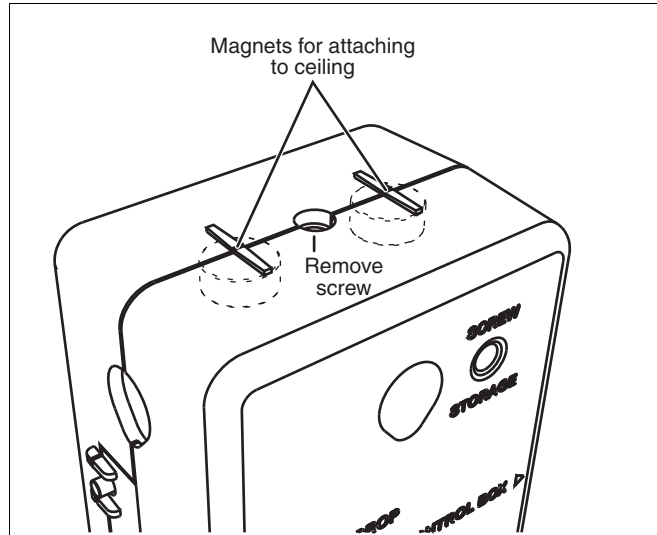


Figure 2: Magnets for attaching to ceiling

## Timing Device Options

In order to time the object, the system must be connected to one of the following timing devices:

- Smart Timer (ME-9830)
- *ScienceWorkshop* 500 or 750 interface connected to a computer running DataStudio.
- PASPORT interface with a Digital Adapter (PS-2159). Any PASPORT interface can be used connected to a computer running DataStudio. The Xplorer GLX (PS-2002) can also be used in standalone mode without a computer.

For more information about these devices, see the PASCO catalog, visit [www.pasco.com](http://www.pasco.com), or contact PASCO Technical Support (see page 10).

## Equipment Set-up

1. Connect the included AC Adapter to the **POWER** jack on the control box.
2. Connect one plug of the timer switch to the **PHOTO-GATE** port on the control box.
3. Use the included cable to connect the **SIGNAL TO DROP BOX** jack on the control box to the **TO CONTROL BOX** jack on the drop box.
4. Mount the drop box as shown in Figure 1.
5. Place the time-of-flight pad directly below the drop box.
6. If the object to be dropped is not steel, attach one of the included washers to it using one of the included stickers (see Figure 3). The sticker is pressure activated; press hard to make it stick permanently.
7. Hang the object from the drop box magnet.
8. Set the **ACTIVE/INACTIVE** switch on the control box to **ACTIVE**.
9. Select one of the timing options (*Smart Timer*, *ScienceWorkshop*, or *PASPORT*) and follow the instructions on pages 5–8 to configure the timing device and take data.



Figure 3: Attaching a washer to a non-steel object

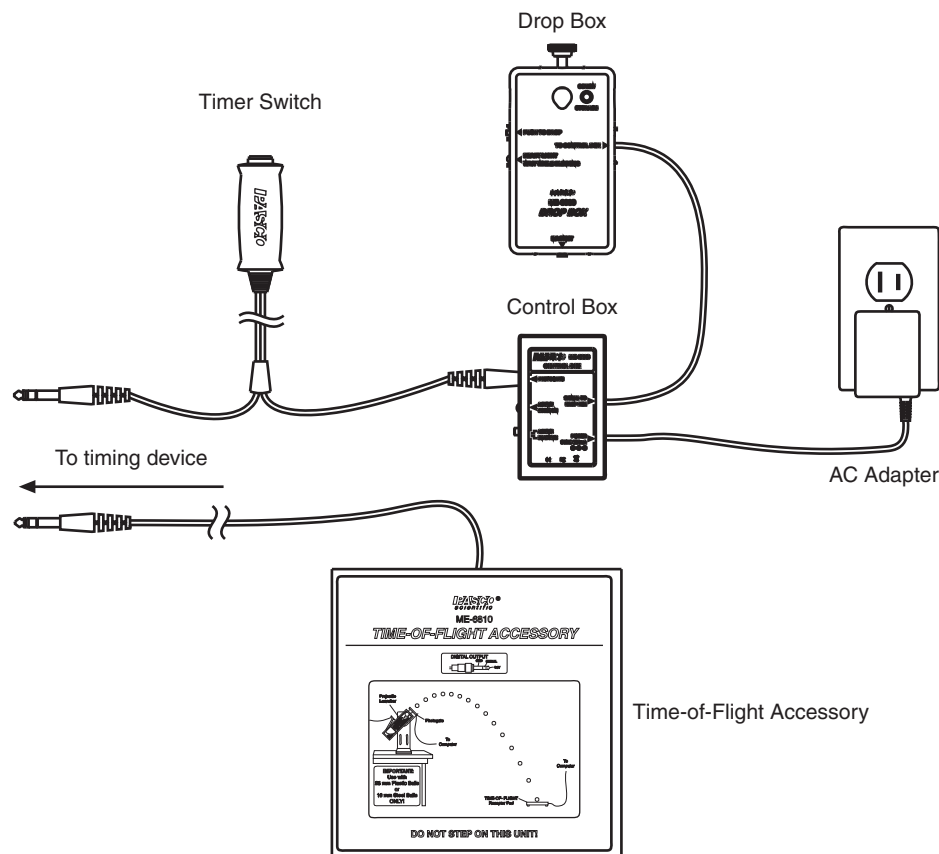


Figure 4: Equipment Set-up

## Test Drop

1. Press the **PUSH TO DROP** button on the drop box.
  - If the object drops immediately, no adjustment is necessary.
  - If the object does not drop or drops after a delay, add a sticker to the object to increase the space between the steel part of the object and the drop box magnet.
2. Hang the object from the drop box and retest if necessary.

## Timing Option 1: Smart Timer

### Set-up

1. Connect the Smart Timer's AC adapter to its power port.
2. Turn on the Smart Timer.
3. Connect the remaining plug of the timer switch to channel **1** of the Smart Timer.
4. Connect the time-of-flight pad to channel **2** of the Smart Timer.
5. On the Smart Timer, press the **1 Select Measurement** button once to select **Time**.
6. Press the **2 Select Mode** button several times to select **Two Gates** mode.

### Data Collection

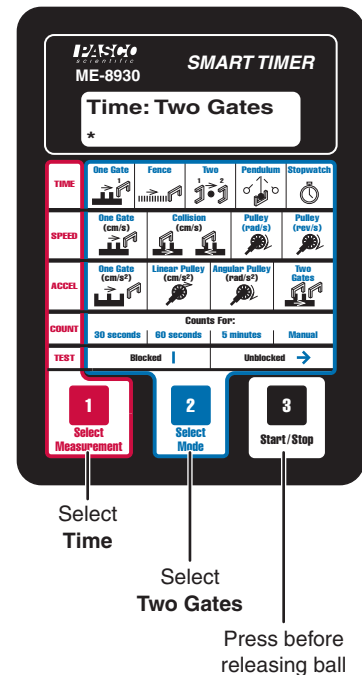
1. On the Smart Timer, press the **3 Start/Stop** button.

Result: The Smart Timer beeps and an asterisk (\*) appears on the display to indicate that it is ready to start timing.

2. Press the timer switch button.

Result: The object is released from the drop box. When the object hits the time-of-flight pad, the Smart Timer displays the fall time.

To time another object: hang the object from the drop box, wait until the LED on the drop box stops blinking, and repeat steps 1 and 2.



## Timing Option 2: *ScienceWorkshop* Interface

### Set-up

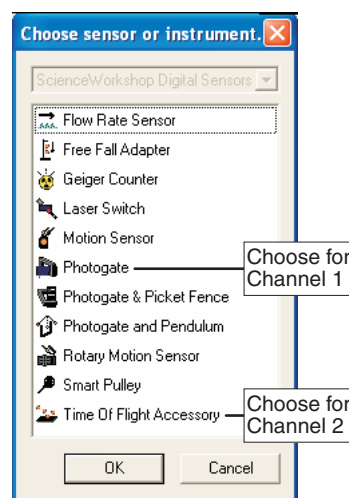
1. Connect your ScienceWorkshop interface to your computer (refer to the instructions that came with the interface).
2. Start DataStudio. If you see the **Welcome to DataStudio** window, select **Create Experiment**.
3. Connect the remaining plug of the timer switch to Channel 1 of the interface.
4. Connect the time-of-flight pad to Channel 2 of the interface.
5. In the **Experiment Setup** window, click Channel 1 on the picture of the interface.

Result: The **Choose Sensor or Instrument** window appears.

Note: If you do not see the **Experiment Setup** window, click the **Setup** button. If you do not see a picture of your interface in the window, click the **Choose Interface** button and select your interface.

6. In the **Choose Sensor or Instrument** window, double-click **Photogate**.
7. In the **Experiment Setup** window, deselect the **Velocity In Gate** measurement.
8. In the **Experiment Setup** window, click Channel 2 on the picture of the interface.

Result: The **Choose Sensor or Instrument** window appears.



9. In the **Choose Sensor or Instrument** window, double-click **Time Of Flight Accessory**.
10. In the Summary Bar (on the left side of the screen), double-click **Table**.

Result: A table appears configured to display Elapsed Time.

Note: If you do not see the Summary Bar, click the **Summary** button.

### Data Collection

1. In DataStudio, click the **Start** button.

Result: DataStudio's experiment clock starts running, indicating that it is ready to collect data.

2. Press the timer switch button.

Result: The object is released from the drop box. When the object hits the time-of-flight pad, the table in DataStudio displays the fall time.

To time another object: hang the object from the drop box, wait until the LED on the drop box stops blinking, and repeat steps 1 and 2.

When you have finished timing all objects, click the **Stop** button.

## Timing Option 3: PASPORT Interface with Computer

### Set-up

1. Connect your PASPORT interface to your computer (refer to the instructions that came with the interface).
2. Connect the remaining plug of the timer switch to channel **1** of your Digital Adapter (PS-2159).
3. Connect the time-of-flight pad to channel **2** of the Digital Adapter.
4. Connect the Digital Adapter to the PASPORT interface.

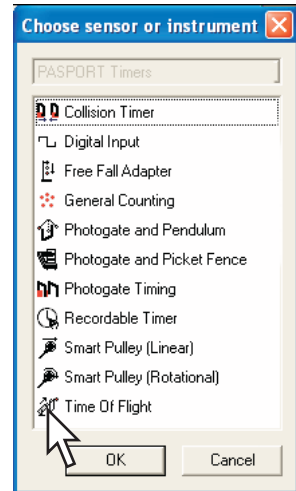
Result: DataStudio starts automatically and the **Choose Sensor or Instrument** window appears.

5. In the **Choose Sensor or Instrument** window, double-click **Time Of Flight**.

Result: A table appears configured to display Elapsed Time.

Note: This table is also configured to show Initial Velocity, which is not relevant in this case. Follow the next step to remove Initial Velocity.

6. Click once on the blank cells of the Initial Velocity column. Click the Remove button (✖) to delete the column.



### Data Collection

1. In DataStudio, click the **Start** button.

Result: DataStudio's experiment clock starts running, indicating that it is ready to collect data.

2. Press the timer switch button.

Result: The object is released from the drop box. When the object hits the time-of-flight pad, the table in DataStudio displays the fall time.

To time another object: hang the object from the drop box, wait until the LED on the drop box stops blinking, and repeat steps 1 and 2.

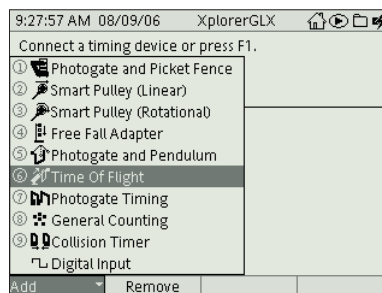
When you have finished timing all objects, click the **Stop** button.

## Timing Option 4: Xplorer GLX in Standalone Mode

### Set-up

1. Connect the remaining plug of the timer switch to channel **1** of the Digital Adapter.
2. Connect the time-of-flight pad to channel **2** of your Digital Adapter (PS-2159).
3. Turn on the GLX
4. Connect the Digital Adapter to the GLX.

Result: The Timers list appears.



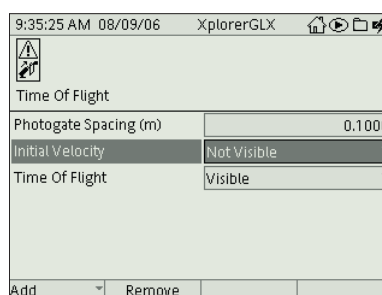
**Timers List**

5. Press the down arrow several times to highlight **Time Of Flight**. Press  $\downarrow$ .

Result: The Timing screen appears.

6. Press the down arrow to highlight **Initial Velocity**. Press  $\downarrow$  to set it to **Not Visible**.

7. Press  $\uparrow$ ,  $F2$  to open the Table display.



**Timing Screen**

### Data Collection

1. Press  $\rightarrow$ .

Result: The clock icon ( $\odot$ ) appears at the top of the screen to indicate that the GLX is ready to collect data.

2. Press the timer switch button.

Result: The object is released from the drop box. When the object hits the time-of-flight pad, the GLX displays the elapsed time.

To time another object: hang the object from the drop box, wait until the LED on the drop box stops blinking, and repeat steps 1 and 2.

When you have finished timing all objects, click  $\rightarrow$ .

No Data	
Time Of Flight (s)	----
1	
2	
3	
4	
5	
6	
7	
8	

**Table Display**



## Suggested Experiments

### Fall Time of Different Objects

Keeping the drop-height constant, measure the free-fall time of different objects. Measure the drop height from the time-of-flight pad to the *bottom* of the object when it is hanging from the drop box. (You will need to adjust the drop box position slightly for different sized balls.) Time each ball several times to make sure you get an accurate measurement.

Compare objects of various size, mass, and density.

If the *only* force acting on the balls is gravitational force, you would expect the fall time to be the same for every ball. Do you find this to be the case?

### Fall Time Versus Height

Time a stainless steel ball dropping from several different heights. Use as wide a range of heights as possible.

Plot fall time ( $t$ ) versus height ( $h$ ). Is the relationship linear?

Plot  $t^2$  versus  $h$ . Is that relationship linear?

For an object falling with constant acceleration,  $a$ , the relationship between  $t$  and  $h$  is given by

$$t^2 = \frac{2}{a}h$$

Use your data to find  $a$ .

Repeat the procedure with the large hollow ball. Does it accelerate at a constant rate? How can you tell?

## Technical Support

For assistance with any PASCO product, contact PASCO at:

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

Phone: 916-786-3800 (worldwide)  
800-772-8700 (U.S.)

Fax: (916) 786-7565

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

Email: [support@pasco.com](mailto:support@pasco.com)

### Limited Warranty

For a description of the product warranty, see the PASCO catalog.

### Copyright

The PASCO scientific 012-09864C *Discover Free Fall System Instruction Manual* is copyrighted with all rights reserved. Permission is granted to non-profit educational institutions for reproduction of any part of this manual, providing the reproductions are used only in their laboratories and classrooms, and are not sold for profit. Reproduction under any other circumstances, without the written consent of PASCO scientific, is prohibited.

### Trademarks

PASCO, PASCO scientific, DataStudio, PASPORT, ScienceWorkshop, Xplorer, and Xplorer GLX are trademarks or registered trademarks of PASCO scientific, in the United States and/or in other countries. All other brands, products, or service names are or may be trademarks or service marks of, and are used to identify, products or services of, their respective owners. For more information visit [www.pasco.com/legal](http://www.pasco.com/legal).