Instruction Manual

Manual No. 012-08713A

Force Sensor Balance Stand

Model No. CI-6460

PASCO®
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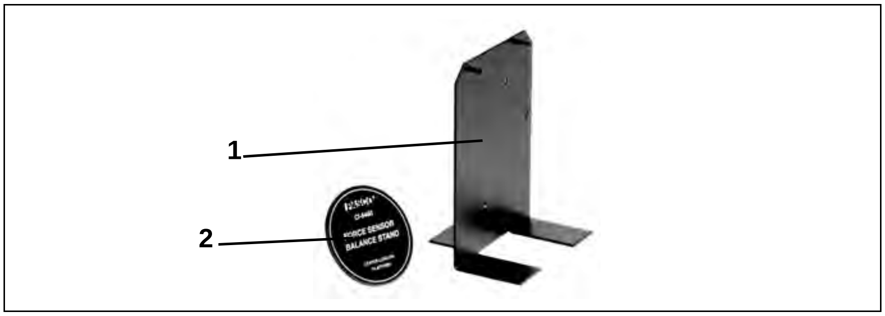
Force Sensor Balance Stand

Model No. CI-6460

Equipment List



Included Equipment	**Replacement Model Number***
1. Force Sensor Balance Stand	CI-6460
2. Balance Pan	648-08700

*Use Replacement Model Numbers to expedite replacement orders.

Additional Equipment Recommended	**Replacement Model Number***
Any PASCO *ScienceWorkshop*® or PASPORT™ interface	Various*,** (See PASCO catalog.)
Force Sensors	CI-6746 or CI-6537 or PS-2104
DataStudio® software	See PASCO catalog.
Mass Set	See PASCO catalog
A computer	NA

*PASPORT sensors require a PASPORT computer interface.

***ScienceWorkshop* sensors require a *ScienceWorkshop* interface. (Do not mix PASPORT and ScienceWorkshop sensors in the same experiment.)

Introduction

The Force Sensor Balance Stand is designed to allow the use of a PASCO Force Sensor as a balance. The sensor is mounted on a bracket and the circular balance pan is screwed directly into the Force Sensor in place of the hook. When used with DataStudio, both weight and mass can be determined with a Force Sensor and a stand. Both *ScienceWorkshop* and PASPORT Force Sensors can be used with the Force Sensor Balance Stand.

The Force Sensor Balance Stand is ideal for usage in experiments exploring buoyancy, gravitational, and normal forces.

Basic Setup:

1. Using the screws provided with the Force Sensor, mount the sensor on the balance stand. See Figure 1 for the appropriate mounting positions.

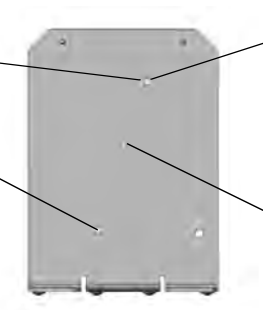


Figure 1: Front view of Force Sensor Balance Stand

2. Unscrew the hook from the top of the Force Sensor. Screw the balance pan into the threaded hole on the top of the Force Sensor.

3. Connect the Force Sensor to either a *ScienceWorkshop* or PASPORT interface. (For software setup, see Appendix A.)

4. Place an object on the balance pan. Try to center the object for best results.

5. In DataStudio, click the **Start** button to display the weight of the object.

6. Use the calculator in DataStudio to create the following equation, which displays the mass in kg: $\mathbf{mass} = \frac{\mathbf{Force}}{\mathbf{9.81}}$

Setup Options

a) Mounting a Force Sensor

The Force Sensor Balance Stand can be used with three different PASCO force sensors (See Figures 2a-2c below.)

Figure 2a: Setup with a PASPORT Force Sensor (PS-2104)

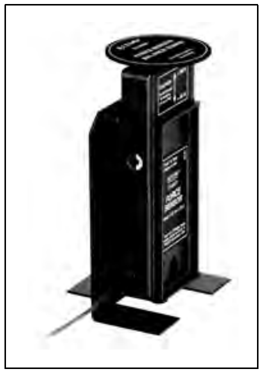
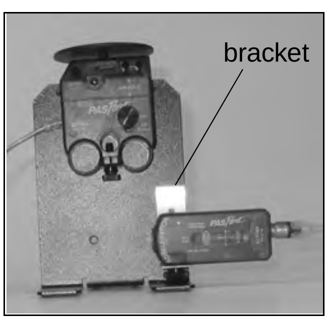


Figure 2b: Setup with a *ScienceWorkshop* Force Sensor (CI-6537)

Figure 2c: Setup with an Economy Force Sensor (CI-6746)

b) Mounting both a Force and Acceleration Sensor

In addition, an acceleration sensor can be mounted to the stand to measure the angle of incline. Depending on the force sensor used, the mounting position will vary. To mount an acceleration sensor, use the bracket and screws provided with the acceleration sensor.



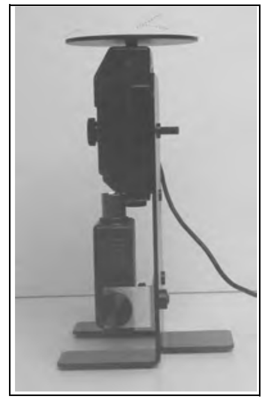
3a) front view

3b) side view

Figure 3a-3b: Setup with a PASPORT Force Sensor (PS-2104) and Acceleration Sensor (PS-2118)

Hold the bracket against the side hole in the Force Sensor Stand. Insert a screw into the back of the Acceleration Sensor and mount to the back of the stand. Insert another screw into the bottom of the Acceleration Sensor to hold the sensor in place.

4a) front view



4b) side view

Figure 4a-4b: Setup with a *ScienceWorkshop* CI-6746 Economy Force and CI-6558 Acceleration Sensor

Note: If you are mounting a CI-6537 Force Sensor, mount the metal bracket to the front of the Force Sensor Stand, as shown in Figure 5.

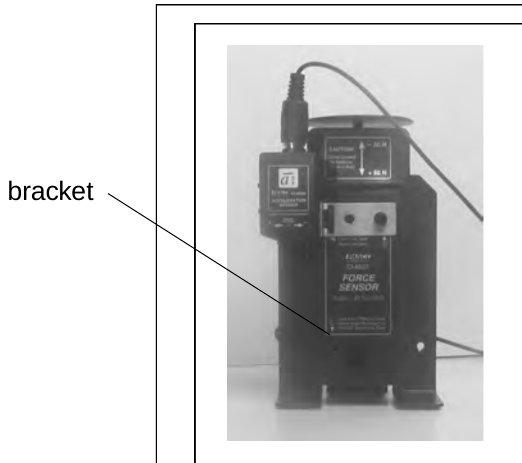


Figure 5: Setup with a CI-6537 *ScienceWorkshop* Force Sensor and CI-6558 Acceleration Sensor:

Experiment 1: Exploring the Buoyancy Force and Archimedes' Principle

Equipment Required:	
Force Sensors (CI-6537, CI-6746, PS-2104))	Computer interface
Force Sensor Balance Stand (CI-6460)	Two Stainless steel rods (ME-8736 or ME-8738 or ME-8741)
Large Rod Base (ME-8735)	Multi-Clamp (SE-9442),
Beaker (SE-7287 or 7288)	Density Set (ME-8569)
Laboratory Jack (SE-9372 or SE-9373 or SE-9374)	String

Procedure:

1. Mount a Force Sensor to the Force Sensor Balance Stand (see page 5).

2. Screw the Balance Pan into the Force Sensor.

3. Place the stand on a laboratory jack.

4. Connect the Force Sensor to a computer interface (For DataStudio Setup instructions, see Appendix A.)

⚠ To avoid the risk of electric shock, keep water and fluids away from sensors, power sources, computers, and electrical apparatus. Observe standard electrical safety precautions in your classroom.

5. Fill the beaker with the desired amount of water.

6. Place the beaker on the Balance Stand; then zero the Force Sensor by pressing the **Tare** button.

Figure 1-1: Experiment Setup

7. Hang another Force Sensor directly above the beaker, as shown in Figure 1-1.

8. Choose a metal cylinder that will fit the beaker.

9. Use the Force Sensor Balance Stand to measure the weight of the cylinder.

10. With thread, hang the cylinder from the upper force sensor.

11. In DataStudio, create a graph which displays the following:

a) Force measured by the upper sensor (apparent weight)

b) Force measured by the lower sensor (buoyancy force)

c) Weight of the cylinder

12. In DataStudio, click the **Start** button to begin data collection.

13. Use the lab jack to raise the beaker until the cylinder is fully submerged in the water.

14. To end data collection, click the **Stop** button in DataStudio.

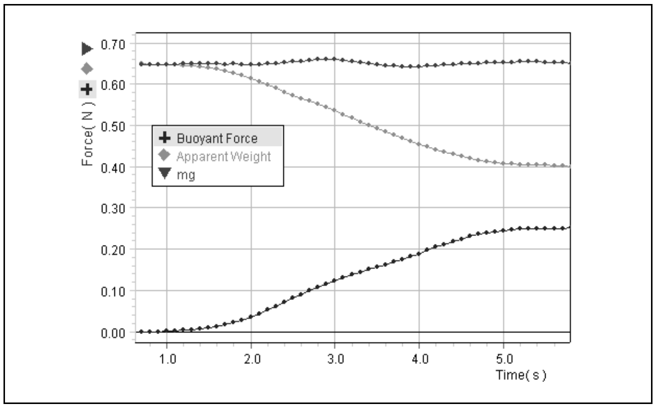
Analysis:

1. What happens to the apparent weight as the cylinder is submerged? Explain.

2. What happens to the buoyancy force as the cylinder is submerged? Explain.

3. How are the apparent weight, buoyancy force, and cylinder weight related to one another? Explain.

Sample Data with a PASPORT Force Sensor



Experiment 2: Exploring the Relationship Between the Normal Force and Angle

Equipment Required:	
Force Sensor Balance Stand (CI-6460)	Force Sensor (CI-6537, CI-6746, or PS-2104)
Acceleration Sensor (CI-6558, or PS-2118 or PS-2119)	Dynamics Track (ME-6958) or flat board
Computer interface	DataStudio software
500 g mass (SE-8759)	

Purpose:

To investigate the relationship between the normal force and the track angle.

Procedure:

1. Attach a Force and Acceleration Sensor to the Balance Stand by following the instructions in the Setup Options section (pages 5-6).

2. Plug each sensor into a computer interface. (For more information, see Appendix A).

3. Place the stand in the middle of the Dynamics Track.

4. Place the 500 g mass on the pan of the stand. Use a small piece of tape under the mass to secure it to the stand.

Figure 2-1:Experiment Setup

5. In DataStudio, create a calculation for the angle:

$$angle = \arctan\left[\frac{\text{acceleration parallel to inclined plane}}{\text{acceleration perpendicular to inclined plane}}\right]$$

or

$$angle = \arcsin\left[\frac{\text{acceleration parallel to the inclined plane}}{9.81\ m/s^2}\right]$$

6. In DataStudio, create a calculation for the normal force:

$$normal\ force = weight * \cos(angle)$$

7. Create a graph with the normal force on the vertical axis and angle on the horizontal axis.

8. Click the **Start** button to begin data collection.

9. Slowly raise the track end from one end to change the angle.

10. When the angle is about 20 degrees, click the **Stop** button to end the data collection.

Analysis and Conclusions

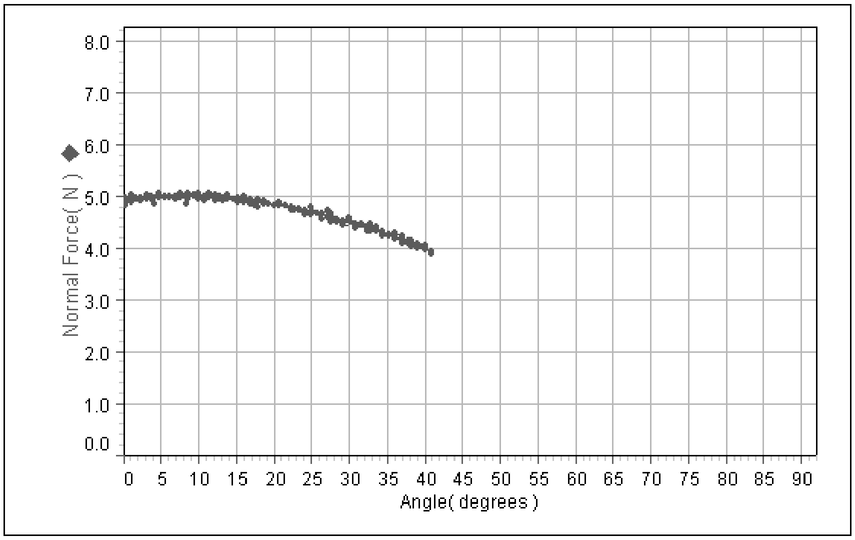
1. What is the relationship between the normal force and the track angle?

2. Draw a force diagram of the mass when the angle was 0, 10, and 15 degrees.

3. For each of the three force diagrams, calculate value of the normal force.

4. What will the value of the normal force be when the angle is 90 degrees? Explain.

Sample Data



Appendix A: DataStudio Setup Instructions

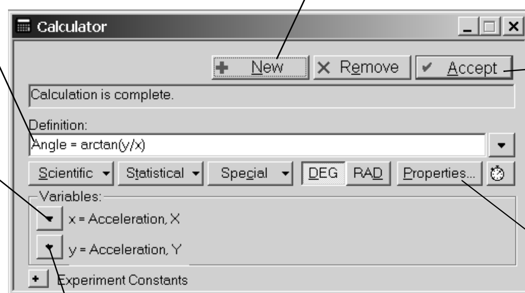
The instructions below outline the recommended experiment setup for PASPORT and *ScienceWorkshop* sensors. Follow the steps specific for the type of sensor and interface (i.e. PASPORT or *ScienceWorkshop*).

Procedure	Steps
PART I: Plug the sensors into the interface:	**PASPORT: a)** Plug the Force Sensor(s) and/or Acceleration Sensors into a PASPORT interface. **b)** Connect the PASPORT interface (i.e. USB Link, PowerLink, etc.) to a USB port on your USB-compatible computer. **c)** When the PASPORTAL window opens, select "Launch DataStudio." OR **ScienceWorkshop: a)** Plug the Force Sensor(s) and/or Acceleration Sensors into an analog channel(s) on a *ScienceWorkshop* interface. **b)** Launch DataStudio.
PART II: Set up your experiment	**PASPORT: a)** Click the **Setup** button to open the Experiment Setup window. **b)** Use this window to setup or change sensor settings, such as the sample rate or measurement units. **ScienceWorkshop: a)** In the Welcome to DataStudio window, double click "Create Experiment." **b)** In the Sensors list, click and drag the Force Sensor icon(s) to analog channels on the picture of the interface (i.e. to the same letters in which you have the sensors connected.) **c)** (Optional): If using an Acceleration Sensor, click and drag the Acceleration Sensor icon to the picture on the interface.
PART III: Create the force or acceleration equations	**a)** Create an equation for the normal force: F= force*cos(angle) where "force" is the force in Newtons and "angle" is the track angle in degrees. **b)** Create an equation for the angle: angle=arctan (y,x) where "y" is acceleration parallel to the inclined plane and "x" is acceleration perpendicular to the inclined plane. (Note: Keep the **DEG** button depressed.) (For instructions on creating equations, see Appendix B or the DataStudio online help.)]
PART IV: Collect Data	**a)** In the Displays list, double click on a Graph display. **b)** From the Data list, drag the force icon over the y-axis in the graph. **c)** From the Data list, drag the angle icon over the x-axis in the graph and release the mouse. **d)** Click the **Start** button on the main toolbar.

Appendix B: Creating Equations in DataStudio

Step 1: Create a new equation. On the main toolbar, click the **Calculate** button to open the Calculator dialog. In the Calculator dialog, click the **New** button.

Step 2: Type in and/or build the equation. (Use the Scientific, Statistical, and Special menus, and the trigonometric functions to build the equation.) Click the **Accept** button.



Step 3: Define the dependent variables. Under "Variables," use the down arrow to select a variable or constant, etc. and click OK. (Example: For "x" select "Data Measurement." In the pop-up, select "acceleration, x" and click OK.)

Step 4: (Optional): Enter any experiment constants. Use the **(+)** button to create an experiment constant. Click **New**, then enter the name, value and units for the constant. Click the **Accept** button. Go back to the Variables menu and select "experiment constant". Click OK.

Step 5: Label the units. Click on the **Properties** button to open the Data Properties dialog and enter the name and units. (Example: In the Data Properties dialog, select "acceleration, x" in the name box and "m/s/s" in the units box.)

Step 6: Save the equation. Click the **Accept** button.

Note: Each time you build a new equation, click the **New** button. To edit a completed equation, double click on the equation in the Data list, make your changes, and click the **Accept** button to save your changes.

Appendix C: Technical Support

For assistance with the CI-6460 Force Sensor Stand or any other PASCO products, contact PASCO as follows:

Address: PASCO scientific

10101 Foothills Blvd.

Roseville, CA 95747-7100

Phone: (916) 786-3800

FAX: (916) 786-3292

Web: www.pasco.com

Email: techsupp@pasco.com

Appendix D: Copyright and Warranty Information

Copyright Information

Limited Warranty

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