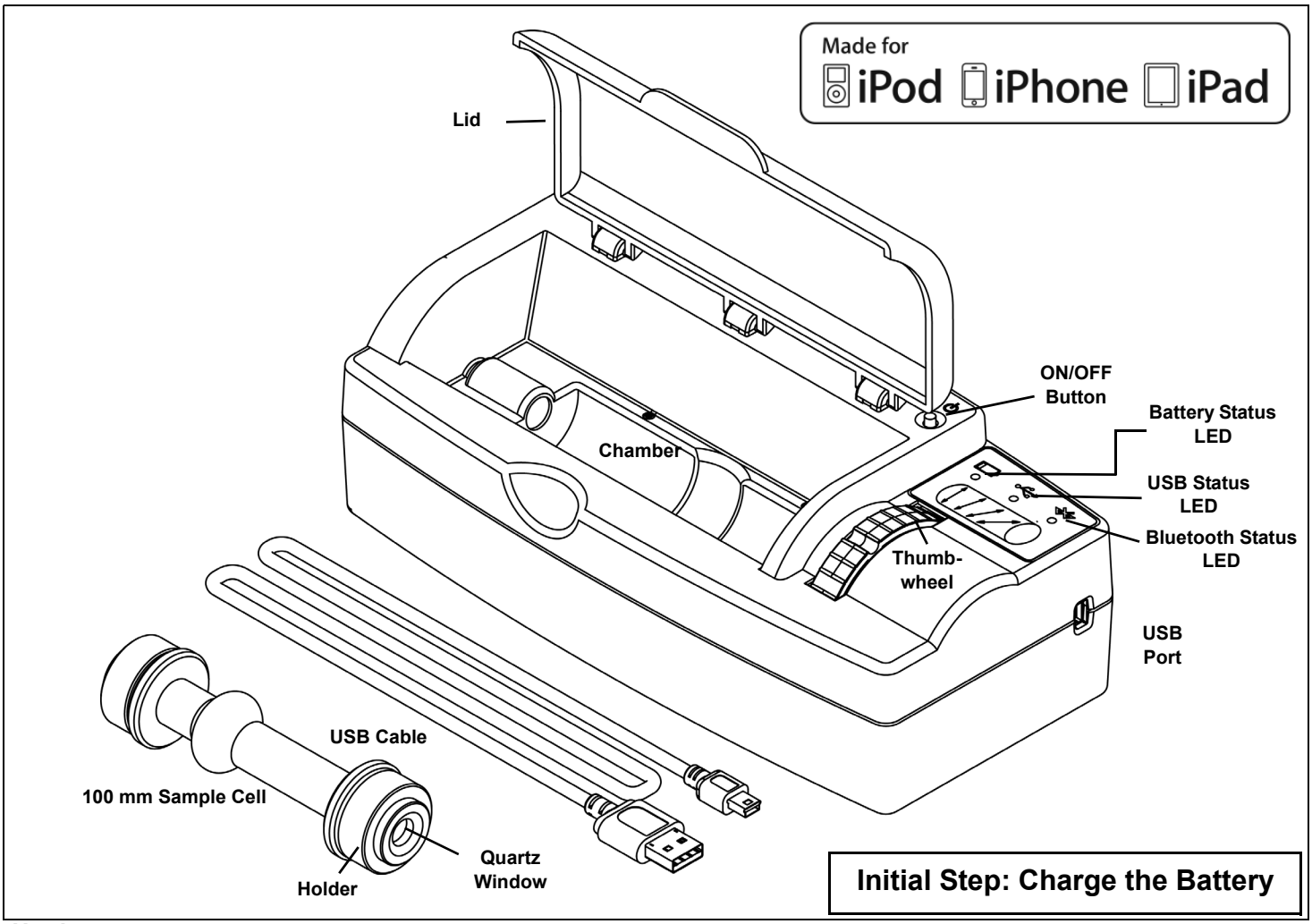
Polarimeter

PS-2235



Hardware

Included Equipment	Part Number
Polarimeter	PS-2235
100 mm Sample Cell	
USB Cable	

Required Item

Data Collection Software (see www.pasco.com/software)

Replacement Item

Replacement Sample Cell	PS-2234

Data Collection Software[1]

PASCO Capstone	SPARKvue*
• Mac OS X • Windows	• Mac OS X • Windows • iOS • Android
(Capstone UI-5400)	(SPARKvue PS-2400)

PASCO

+1 916 786 3800
techsupp@pasco.com

800-772-8700
www.pasco.com

[1]See the PASCO web site at www.pasco.com for more information about PASCO data collection software

**NOTE: SPARKvue also supports a Chromebook device it is connected through USB.*

Charge the Battery

The Polarimeter battery is partially charged at the factory. The battery can be charged using the USB cable connected to a USB port or USB charger. Leave the Polarimeter off while charging. As the battery is charging, the Battery Status LED (light-emitting diode) will blink red. When the battery is fully charged, the Battery Status LED shines green. The charger circuit inside the unit turns itself off when the unit is fully charged, so it can't be overcharged.

Battery Life

On a full charge, the Polarimeter will typically run for over eight hours during data collection before it needs to be charged.

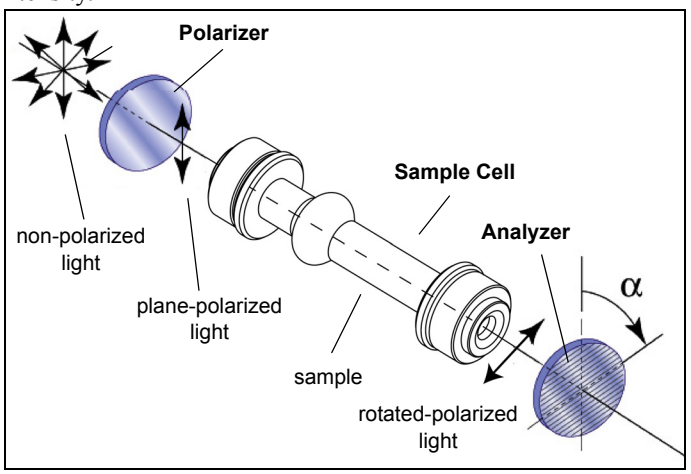
Introduction

The Polarimeter is specifically designed for measuring the angle of rotation of plane-polarized light that is caused by optically active substances. The Bluetooth and USB connectivity enable its use with tablets and computers.

Theory of Operation

At one end of the chamber is a fixed polarizer disk in front of the LED light source. At the other end of the chamber is a rotatable polarizer disk - called the analyzer - and the photo-detector. The analyzer can be turned using the thumb-wheel. An optical encoder records the position of the analyzer (rotatable polarizer), and the photo-detector measures the intensity of light transmitted through the substance in the Sample Cell.

Plane-polarized light from the end of the chamber with the fixed polarizer enters the Sample Cell and passes through the optically active substance. The substance rotates the plane polarized light clockwise or counter-clockwise by a specific amount. As the thumb-wheel of the analyzer is turned, the encoder on the analyzer measures the angle, and the photo-detector records light intensity.



The data collection software produces a graph of light intensity compared to angle, and can be used to analyze the data to determine various properties of the optically active substance.

The Sample Cell is precisely designed so that the distance inside the cell between the two quartz windows is 100 millimeters (mm). Therefore, the path length of the substance inside the Sample Cell is 100 mm (1 decimeter).

Polarimetry

Since 1812, it has been know that certain molecules are optically active and can rotate plane-polarized light. For example, table sugar is an optically active substance. Table sugar has a tetrahedral carbon atom which has four different groups attached to it. This carbon is known as a *chiral* center, a *stereogenic* center, or an *asymmetric* carbon. Chiral centers can be organic or inorganic. The geometry of the chiral center allows the formation of mirror image molecular forms under the right conditions. One of the molecular forms is able to rotate plane-polarized light to the right (dextrorotary), and the other mirror image molecular form is able to rotate plane-polarized light to the left (levorotary) by the same angle.

Experimentation is the only way to determine which form of molecule is which. The procedure consists of preparing a solution of known concentration and placing it between two polarizing filters. A polarimeter measures the amount and direction of rotation of the plane-polarized light.

Specific angle. $[\alpha]_{\lambda}^{T}$, is a fundamental property of chiral substances. The expression of the specific angle to which the substance causes plane-polarized light to rotate at a particular temperature, wavelength, path length, and concentration, is as follows.

$$[\alpha]_{\lambda}^{T} = \frac{\alpha}{lc}$$

where α is the measured rotation in degrees (clockwise or counterclockwise), T is the temperature (degrees Celsius), λ is the wavelength of the light source (nanometers), l is the path

length (decimeters) of the solution in the Sample Cell, and *c* is the concentration of the solution (gram/milliliter).

A compound will consistently have the same specific rotation under identical experimental conditions. To determine the specific rotation of the sample, use Biot's Law:

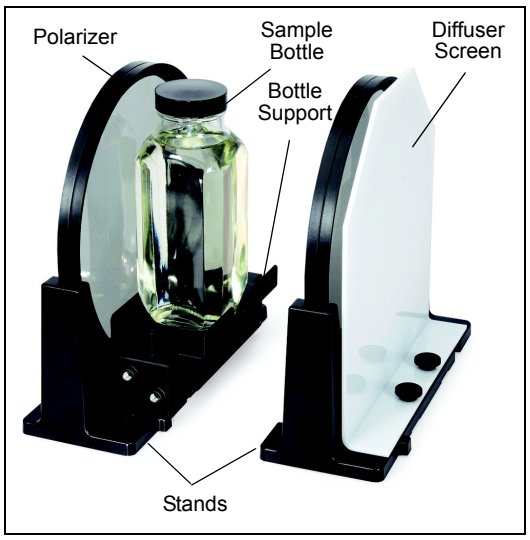
$$[\alpha] = \frac{\alpha}{lc}$$

Polarimetry makes it possible to determine the purity of solutions of known compounds and identify unknown substances from a short list.

Polarizer Demonstrator Accessory

The PASCO Model OS-8172 Polarizer Demonstrator Accessory works with the Polarizer Demonstrator (OS-9477A) to show the property of optical activity - the ability to rotate plane-polarized light. The equipment is large enough to use in front of many people.

The Polarizer Demonstrator Accessory includes a bottle support, two rectangular sample bottles with lids, a diffuser screen, and thumbscrews for attaching the bottle support and diffuser screen to the Polarizer Demonstrator stands.



Fill a sample bottle with an optically active substance such as corn syrup and place it on the bottle support between the two polarizers. Shine a light through the diffuser screen, polarizer, and the sample bottle. Adjust the second polarizer to measure the angle of rotation.

Specifications

Encoder Resolution

The encoder wheel is a bi-directional quadrature-enabled 1,000 cycles per revolution (360°) device. The processor that monitors the encoder generates a pulse for each edge of the quadrature encoder that is detected, thus effectively quadrupling the number of cycles per revolution to 4,000 cycles per revolution. The encoder resolution is 360°/4,000 or 0.09°.

Accuracy

The analyzer polarizer, the polarizer shaft, and the encoder are mechanically attached to each other, and the encoder is firmly attached to the body of the Polarimeter. Since accuracy is determined by the stability of the mechanical assembly, accuracy should be close to the encoder resolution, or 0.09°.

Light Source

The LED light source has an output between 585 nm and 596 nm, or an optimal output of 589 nm. The LED has a built-in lens that directs the light output to an exit cone that is ±15° off the center axis which increases the amount of usable light that is directed along the optical axis. A second lens installed in front of the LED further enhances the amount of light directed into the Sample Cell.

Connecting the Polarimeter to a Tablet or Computer via Bluetooth

For information about Polarimeter and Bluetooth, see the PASCO web site page www.pasco.com/polarimeter. Check "User Resources" for information about using Bluetooth to connect the Polarimeter to the iOS device or an Android™ tablet, or to a Windows or Macintosh computer.

Connecting the Polarimeter to a Computer with a USB Cable

1. Connect the small end of the included USB cable into the USB port on the right end of the Polarimeter
2. Connect the other end of the USB cable to a USB port on the computer, or into a USB hub connected to the computer.
3. To turn on the Polarimeter, briefly press and hold the ON/OFF button on the top. After all three status LEDs blink in sequence, release the ON/OFF button.
4. The USB Status LED will shine green. (NOTE: The Bluetooth Status LED will slowly blink blue. The Battery Status LED may also blink to indicate that the battery is charging through the USB cable.)

Usage

Prepare the Sample Cell

Unscrew the holder at one end of the 100 mm Sample Cell. Remove the holder and the quartz window from the cell. Fill the sample cell to the top with the substance to be examined. Carefully return the quartz window and the holder to the end of the sample cell, and screw the holder into place.

Gently tap or shake the Sample Cell so that any bubbles in the sample move to the "bulge" section of the Sample Cell. Be especially careful to remove any bubbles in the ends of the cell.

Insert the Sample Cell

Open the lid of the Polarimeter and place the Sample Cell in the chamber. The Sample Cell is an exact fit for the length of the space in the chamber. The direction of the Sample Cell in the chamber does not make a difference. Close the lid.

Calibration

1. Pour distilled water into the 100 mm (1 dm) Sample Cell and insert it in the Polarimeter's chamber. Close the lid.
2. Start data collection and slowly rotate the analyzer with the thumb-wheel so you have data to cover 0° to 360°. For better analysis, you may want to take multiple passes in this data range.
3. Stop data collection.
4. Record the first angle above 0° where the light intensity is at a maximum.

To improve the accuracy of this selection, you may wish to apply a Gaussian fit.

The recorded angle indicates the position where the polarizer and analyzer are aligned without an optically active substance in the Sample Cell.

Data Collection

1. Pour your sample into the 100 mm (1 dm) Sample Cell and put the Sample Cell in the Polarimeter's chamber. Close the lid.
2. Start data collection and slowly rotate the analyzer with the thumb-wheel so you have data to cover 0° to 360°. For better analysis, you may want to take multiple passes in this data range.
3. Stop data collection.
4. Record the first angle above 0° where the light intensity is at a maximum.

To improve the accuracy of this selection, you may wish to apply a Gaussian fit.

The recorded angle indicates the position where the polarizer and analyzer are aligned with an optically active substance in the sample cell.

The difference between the recorded angles represent the observed angle of rotation for your sample

Experiment Suggestions

Explore the optical activity of inorganic, organic and biochemical compounds.

- Chiral compound (inorganic and organic) purity by optical rotation.
- Solution concentration by optical rotation.
- Determine enantiomeric excess in a mixture of dextro- and levo-rotatory compounds.
- Kinetics studies where the reactants or products are optically active.

For more resources go to **www.pasco.com/polarimeter**

Battery

Replacement

If the Polarimeter fails to recharge, the battery may need to be replaced. Contact PASCO Technical Support for more information about battery replacement. It is recommended that the unit be returned to PASCO for battery replacement, if needed.

Troubleshooting the Polarimeter

- If the Polarimeter loses Bluetooth connection and will not reconnect, try cycling the ON/OFF button. Press and *briefly* hold the button until the status LEDs blink in sequence, and then release the ON/OFF button to turn on the Polarimeter.
- If the Polarimeter stops communicating with the computer software or tablet application, try restarting the software or application. If the problem remains, try cycling the ON/OFF button.
- As a last resort, push a pin into the Reset port on the bottom of the Polarimeter.

Technical Support

For assistance with any PASCO product, contact PASCO at:

Address:	PASCO scientific 10101 Foothills Blvd. Roseville, CA 95747-7100
Phone:	+1 916 462 8384 (worldwide) 877-373-0300 (U.S.)
Web:	www.pasco.com
Email:	support@pasco.com

For more information about the product and the latest revision of this Reference Guide, visit the PASCO web site at www.pasco.com and enter "Polarimeter" or the product number (PS-2235) in the Search window.

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iPod touch, iPhone and iPad
“Made for iPod”, “Made for iPhone” and “Made for iPad” means that an electronic accessory has been designed to connect specifically to iPod, iPhone, or iPad, respectively, and has been certified by the developer to meet Apple performance standards. Apple is not responsible for the operation of this device or its compliance with safety and regulatory standards.

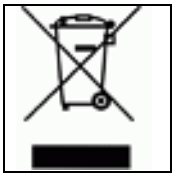
iPad, iPad Air, and iPad mini are trademarks of Apple, Inc, registered in the U.S. and other countries.

FCC Statement
This Class A digital device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

CE Statement
This device has been tested and found to comply with the essential requirements and other relevant provisions of the applicable EU Directives.

Product End of Life Disposal Instructions:
This electronic product is subject to disposal and recycling regulations that vary by country and region. It is your responsibility to recycle your electronic equipment per your local environmental laws and regulations to ensure that it will be recycled in a manner that protects human health and the environment. To find out where you can drop off your waste equipment for recycling, please contact your local waste recycle/disposal service, or the place where you purchased the product.

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.



Battery Disposal Instructions:
Batteries contain chemicals that, if released, may affect the environment and human health. Batteries should be collected separately for recycling, and recycled at a local hazardous material disposal location adhering to your country and local government regulations. To find out where you can drop off your waste battery for recycling, please contact your local waste disposal service, or the product representative.

The Lithium Polymer (Li-Poly) rechargeable battery used in this product is marked with the International symbols to indicate the need for the separate collection and recycling of batteries.

Li-Poly