




# CIRAS-2 Portable Photosynthesis System

*For Research*

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# CIRAS-2 Portable Photosynthesis System

*Trusted and tested technology*

## Measurement Ranges

CO<sub>2</sub> 0-2,000 μmol mol<sup>-1</sup> (optimal)

CO<sub>2</sub> 0-9,999 μmol mol<sup>-1</sup> (maximum)

H<sub>2</sub>O 0-75 mb

The CIRAS-2 is factory calibrated for CO<sub>2</sub> measurements up to 9,999 μmol mol<sup>-1</sup> as standard. The CIRAS-2 can also be used as a stand-alone CO<sub>2</sub>/H<sub>2</sub>O gas analyzer for laboratory and field applications if required.

## CO<sub>2</sub> and H<sub>2</sub>O Gas Analyzer

### Portability

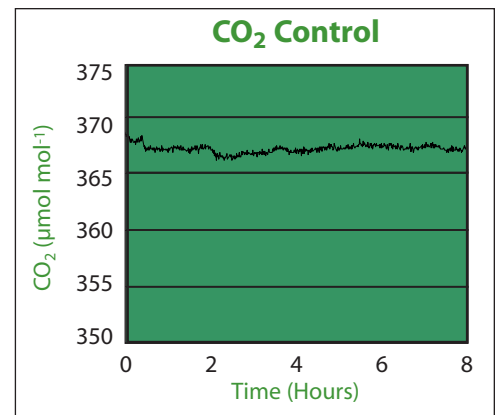
The CIRAS-2 main console is lightweight, compact and extremely rugged for demanding field research. It is powered by two lightweight, rechargeable 12V NiMH battery packs capable of running the entire system up to 6-8 hours (including LED light unit). Batteries can be easily changed in the field without the need to shut down the system.

### True Differential Gas Analyzer

The CIRAS-2 is a true differential system. It features 4 independent, non-dispersive gas analyzers for accurate, simultaneous measurement of both CO<sub>2</sub> and H<sub>2</sub>O, eliminating the problems associated with "gas switching" systems. Also, for enhanced reliability, there are no moving parts such as chopper motors or filter wheels. The analyzers (reference and analysis) include an infrared source, highly polished, gold plated sample cells and detectors. The analyzers act as absorptimeters measuring infrared absorption only. The CIRAS-2 optical bench is temperature controlled and pressure compensated for the most accurate CO<sub>2</sub> and H<sub>2</sub>O measurements under changing ambient conditions.

### Calibration

The design of the CIRAS-2 ensures an inherent calibration stability that has been confirmed by over 25 years experience in gas analysis technology. The CO<sub>2</sub> analyzers do not require recalibration but we do recommend periodic checks to confirm system integrity. There is an integral CO<sub>2</sub> verification facility and external H<sub>2</sub>O calibrator for automated calibration of the H<sub>2</sub>O gas analyzers.



*For high level research, the stability and control of CO<sub>2</sub> is critical. The CIRAS-2 air supply unit is capable of providing stable and accurate CO<sub>2</sub> concentrations for many hours in the field or lab.*



## Independent, Automatic Control of CO<sub>2</sub> and H<sub>2</sub>O

The CIRAS-2 system is capable of providing independent, automatic control of CO<sub>2</sub> and H<sub>2</sub>O to the leaf cuvette (reference) and within the leaf cuvette (analysis). Control of CO<sub>2</sub> and H<sub>2</sub>O can be dynamic or pre-programmed for automatic response curve generation.



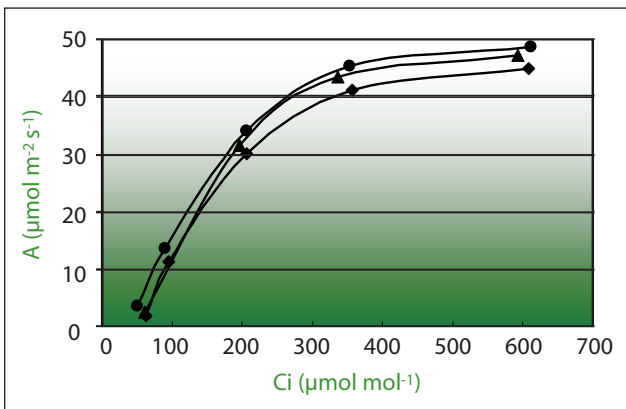
- A. Electrical and gas analysis connectors (for leaf cuvette)
- B. User Interface (USB, RS232 and PCMCIA slot)
- C. Rechargeable 12V NiMH battery pack
- D. CO<sub>2</sub> regulator and cartridge holder
- E. CO<sub>2</sub> cartridge (8g)
- F. Conditioning desiccants for CO<sub>2</sub> and H<sub>2</sub>O control
- G. Water vapor equilibribrator
- H. Auto-zero desiccants

## CO<sub>2</sub> Control

A built-in, removable CO<sub>2</sub> regulator and gas cylinder holder allows for the use of pure mini CO<sub>2</sub> cartridges (8 g). Each cartridge is capable of providing automatic control of CO<sub>2</sub> between 0-2,000 μmol mol<sup>-1</sup> for at least 1 full day.

## H<sub>2</sub>O Control

On-board, self-indicating desiccants are used for conditioning the H<sub>2</sub>O concentrations per user selected levels from 0-Dewpoint.



*The CIRAS-2 is an ideal system for automatic generation and measurement of A/Ci curves like the ones to the left on soybean cv. Stressland.*

# User Interface

The CIRAS-2 main console features an innovative user interface that includes a large, full color display (640 x 480) optimized for field use with keypad and touchpad for user inputs. It includes both a USB and RS232 serial port for transfer of stored data and for connection to an external PC. A PCMCIA slot is available for use with data storage cards (unlimited data storage).

## Intuitive System Software

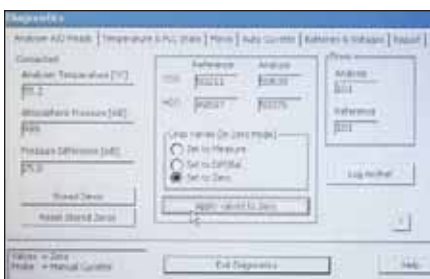
The system can display 15 measured and calculated parameters and graphics simultaneously in real time. The user has full control over presentation of numerical data and graphics with several recording options from simple keypress to fully automated, pre-programmed response curves. Environmental control can be changed dynamically or automatically. Management and output of stored data is very flexible with many different formats available for use with your favorite spreadsheet program. All measured and calculated data are safely stored and can easily be recalculated if required.

## Remote Control Software

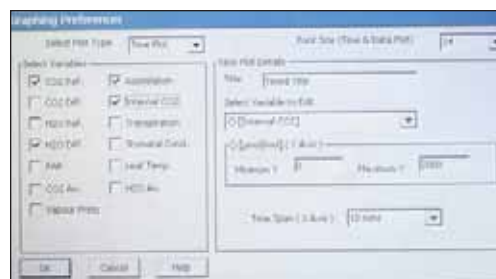


*The remote control software is ideal for laboratory and teaching applications.*

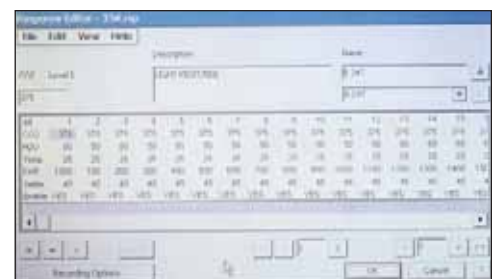
The system is supplied with Windows® software allowing remote control operation of the CIRAS-2 from a PC. Powerful, flexible software allows for simple, individual measurements to more complex, automated and pre-programmable experiments.



*Built-in system diagnostics for checking hardware and controls.*



*Plot up to 4 measurement parameters at once with full control over graphical presentation of data.*



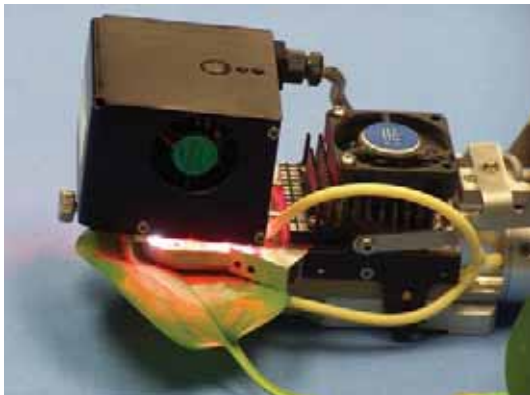
*The response editor allows users to set up automated response curves quickly and easily.*

# PLC6 (U) Automatic Universal Leaf Cuvette

The PLC6 (U) Automatic Universal Leaf Cuvette is lightweight, versatile and ideal for field measurements. It is constructed from carefully selected materials for best results. Automatic temperature control is integral to the cuvette. It features 2 miniature PAR sensors located within the cuvette at the leaf surface for accurate measurement of PAR (Photosynthetically-Active Radiation). Accurate leaf temperature control and measurement is ensured by an IR sensor fitted at the base of the cuvette. A remote recording switch is also available on the cuvette handle for conveniently recording measurements.

## Automatic Temperature Control

Peltier elements are mounted to the cuvette head along with a heat sink and fan. The control range is approximately 8 °C below ambient to +40 °C. In addition, temperature control can be disabled completely or set up to track ambient if required.



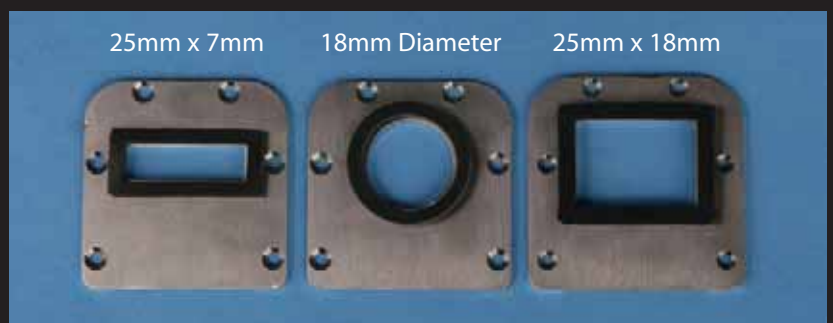
LED light unit fitted to the PLC6 (U).

## Automatic Light Control

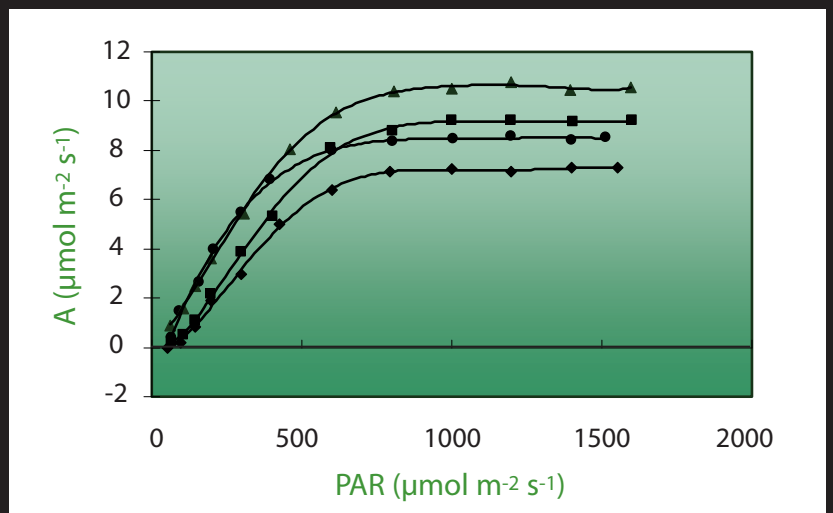
An optional LED light unit is available for the PLC6 (U) featuring automatic control of cuvette light intensity. This is particularly useful for light response curves in the field or lab. If required, the light unit can be removed for ambient measurements. For unattended operation, the CIRAS-2 can be pre-programmed to automatically control light intensity at user defined levels (0-2,000  $\mu\text{mol m}^{-2} \text{s}^{-1}$ ).



PLC6 (U) Automatic Universal Leaf Cuvette



The PLC6 (U) is supplied with 3 bead plates for different sized leaves.



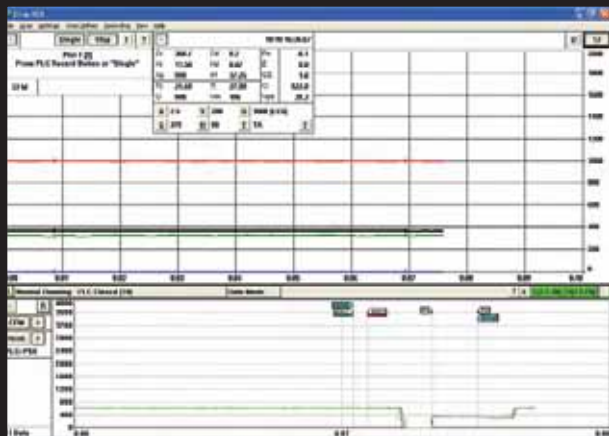
Light response curves of 4 different highbush blueberry cultivars.



# Chlorophyll Fluorescence Module (CFM)



*Our modified LED light unit includes full chlorophyll fluorescence detection capabilities while retaining all normal functionality as an actinic light source for gas exchange measurements. The modified unit provides the modulation beam, saturating pulses, far-red illumination and fluorescence detection required for chlorophyll fluorescence measurement in a remarkably compact, solid-state and lightweight unit. It does not require additional power sources for operation.*



*Simultaneous measurement of photosynthesis and chlorophyll fluorescence can be made directly on the CIRAS-2 in both the field and laboratory or remotely from a PC using the remote control software.*

## Chlorophyll Fluorescence Adaptation

Many of our leaf cuvettes can be adapted to work with other available fluorometers for simultaneous measurement of leaf gas exchange and chlorophyll fluorescence. Contact PP Systems for details.



The CIRAS-2, with optional integrated Chlorophyll Fluorescence Module (CFM), is a powerful tool for photosynthesis research. The CFM has been developed in cooperation with Hansatech Instruments for complete integration with the CIRAS-2 gas exchange systems. The CFM provides measurement of chlorophyll fluorescence using the pulse amplitude modulation (PAM) technique. The pulsed fluorescence that is induced by the modulation beam is used to probe the efficiency of light-use for photosystem II photochemistry.



*The CIRAS-2 shown above with integral Chlorophyll Fluorescence Module (CFM) signal conditioning interface.*

The following parameters are measured and calculated on demand by the CIRAS-2:  $F_o$ ,  $F_m$ ,  $F_v$ ,  $F_v/F_m$  (Max Yield),  $F_s$ ,  $F_m'$ ,  $F_o'$ ,  $\phi PSII$  or  $\Delta F/F_m'$  (Yield),  $qP$ ,  $qNP$ ,  $NPQ$ ,  $PAR$ ,  $TEMP$  and  $ETR$ .

## CFM Technical Specification

<b>Modulating Beam</b>	627 nm (Red)
<b>Actinic Light</b>	Red and White LED's Range: 0-2,000 $\mu\text{mol m}^{-2} \text{s}^{-1}$
<b>Saturation Light</b>	Red and White LED's Range: 0-6,000 $\mu\text{mol m}^{-2} \text{s}^{-1}$
<b>Far Red Light</b>	2 x 735 nm LED's
<b>Detector</b>	PIN photodiode with > 700 nm filter
<b>Detector Method</b>	Rapid pulse peak tracking
<b>Leaf Area</b>	2.5 $\text{cm}^2$

# CIRAS-2 Accessories

PP Systems has long been recognized for our design of leaf cuvettes (Parkinson Leaf Cuvettes) and chambers for measurement of leaf and canopy gas exchange, soil respiration and chlorophyll fluorescence. We offer a full range of accessories adding to the measurement capability of the CIRAS-2 Portable Photosynthesis System. Leaf cuvettes (broad, narrow and conifer) are also available for measurement under ambient conditions (without temperature control) and can be supplied with optional light units if required.



*Head plates can be supplied to easily convert from conifer to narrow style leaf cuvette.*

## Leaf Cuvette Adapters for CIRAS-1 Users

Adapters are available to allow older "CIRAS-1" style leaf cuvettes to be used with the CIRAS-2 Portable Photosynthesis System. Contact PP Systems for more details.

## Leaf Gas Exchange



### PLC5 (N) Automatic Narrow Leaf Cuvette

*For measurement on grasses and cereal crops. It features integral, automatic control of temperature. An optional LED light unit is available for automatic control of light from 0-1,100  $\mu\text{mol m}^{-2} \text{s}^{-1}$ . Window Area: 80mm (L) x 30mm (W).*



### PLC5 (C) Automatic Conifer Leaf Cuvette

*For measurement on conifers and pine needles. The window is hemispherical making it suitable for 3D structures. It features integral, automatic control of temperature. An optional LED light unit is available for automatic control of light from 0-1,500  $\mu\text{mol m}^{-2} \text{s}^{-1}$ . Window Area: 80mm (L) x 50mm (Diameter).*



## Canopy Photosynthesis

A complete range of chambers are available for use with the CIRAS-2 for measurement of closed (CPY-2) and open (CPY-3) CO<sub>2</sub> flux on single plants or low lying vegetation. All chambers are transparent and fitted with an air mixing fan and sensors for measurement of PAR and air temperature. For open system measurement using our CPY-3 range of chambers, a suitable air supply unit is required which is built into our Control Interface Module (CIM).



*CPY-3 chamber for low lying vegetation.*



*The CPY-2 is designed for closed system measurement of canopy CO<sub>2</sub> flux.*



*CPY-3 chamber for tall vegetation. Our Control Interface Module (CIM) with required air supply unit is also shown in the background.*

## Soil Respiration

The SRC-1 Soil Respiration Chamber can be used for rapid, accurate measurement of soil CO<sub>2</sub> flux in the field. The closed system method of measuring soil respiration was first introduced by Dr. Keith J. Parkinson in 1981. The SRC-1 with known chamber volume is placed on the soil surface and monitors the rate of increase in CO<sub>2</sub> over time making it an ideal system for rapid screening of soil respiration (0-9.99 g CO<sub>2</sub> m<sup>-2</sup> h<sup>-1</sup>). The chamber is constructed of rugged PVC with a stainless steel ring providing a good seal.



*The CIRAS-2 shown with the SRC-1 Soil Respiration Chamber and STP-1 Soil Temperature Probe.*

## Environmental Sensors

A range of environmental sensors can be used with the CIRAS-2 for general monitoring applications in the field and laboratory.



### PAR Sensor

*For measurement of PAR ( $\mu\text{mol m}^{-2} \text{s}^{-1}$ )*



### TRP-2 Temperature/PAR Probe

*For measurement of temperature ( $^{\circ}\text{C}$ ) and PAR ( $\mu\text{mol m}^{-2} \text{s}^{-1}$ )*

# Our Mission:

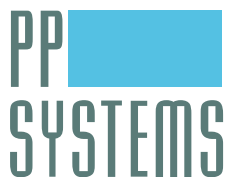
*Aiding scientific research with versatile, proven technology.*

PP Systems is proud to have supported the technology needs of plant and soil scientists for over 25 years. Our photosynthesis systems have been proven and tested by thousands of researchers from over 100 countries worldwide. We are recognized as a leader in the design and manufacture of photosynthesis measurement instrumentation for high level research.

Many scientists consider the CIRAS-2 system to be the benchmark gas exchange system for field research. Field expertise combined with proven technology results in the widest range of accessories for measurement of leaf gas exchange, soil respiration, canopy photosynthesis and chlorophyll fluorescence.

## Distributor

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## Technical Specifications

### Main Console

#### Analysis Method (Gas Analyzers)

Non-dispersive infrared, configured as an absolute absorptiometer with microprocessor control of linearization.

The analyzers simultaneously measure absolute CO<sub>2</sub> and H<sub>2</sub>O of the reference and analysis gas streams. The CIRAS-2 has 4 independent analyzers for true differential measurement.

#### Measurement Range

CO<sub>2</sub>: 0-2,000  $\mu\text{mol mol}^{-1}$  (Optimal Range)  
0-9,999  $\mu\text{mol mol}^{-1}$  (Maximum Range)

H<sub>2</sub>O: 0-75 mb

Corrections are made for temperature, pressure and foreign gas broadening.

#### Precision (Absolute)

CO<sub>2</sub>: 0.2  $\mu\text{mol mol}^{-1}$  at 300 ppm  
0.5  $\mu\text{mol mol}^{-1}$  at 1,750 ppm  
3.0  $\mu\text{mol mol}^{-1}$  at 9,999 ppm

H<sub>2</sub>O: 0.015 mb at 0 mb  
0.020 mb at 10 mb  
0.030 mb at 50 mb

#### Linearity

Better than 1.0% throughout the range, with calibration at 2,000 ppm CO<sub>2</sub> or 40 mb H<sub>2</sub>O.

#### Stability (CO<sub>2</sub> Analysis)

Automatic Zero at regular intervals corrects for sample cell contamination, source and detector ageing and pre-amplifier gain changes.

#### Response Time

Electrical: 0.5 seconds  
Display/Analog Output: 1.6 seconds  
Pneumatic: < 5 seconds

#### Air Sampling

Adjustable up to 100 cm<sup>3</sup> min<sup>-1</sup> using integral DC pumps. Both analysis and reference pumps fitted with mass flow controllers. The analyzer may be used in open and closed systems.

#### Environmental Sensor Inputs

3 input channels are available for use with PP Systems' environmental sensors.

#### Analog Output (CO<sub>2</sub>/H<sub>2</sub>O)

8 bit D/A converter giving 0.5% resolution. Output voltage 0-5V. Both minimum and maximum voltage are defined by user.

#### RS232 Output

Stored/current data output in standard ASCII format.

#### Real Time Clock

Accuracy: Better than 1 min/month at 25 °C.  
Operating Temperature: 0-70 °C.

#### Recording Options

By PC or by the instrument. Automatic logging at user selectable intervals between 10 seconds and 1 hour, controlled by internal real-time clock.

#### Instrument Status Detection

Indication of instrument malfunction, including low battery voltage (< 10.5V) through the RS232 output. Auto restart if momentary failure.

#### Power Supply

Internal, rechargeable 12V NiMH batteries providing up to 8 hours continuous use. Batteries can easily be changed without shutting down the system.

#### Integral Cuvette Air Supply Unit

0-470 cm<sup>3</sup> min<sup>-1</sup> measured and controlled by a mass flow meter.

#### Automatic Control Range

CO<sub>2</sub>: 0-2,000  $\mu\text{mol mol}^{-1}$   
H<sub>2</sub>O: 0- Dewpoint

#### Operating Environment

0-50 °C, non-condensing. In dirty environments, external air filtration is required.

### Housing

High impact aluminum case with easy access for battery change and system maintenance.

### Dimensions

28 cm W x 16 cm D x 24 cm H  
28 cm W x 16 cm D x 26 cm H (with CFM)

### Weight

7.2 kg  
7.6 kg (with CFM)

### User Interface

#### Display

7.2" VGA transfective color STN LCD.  
Optimized for field use.

#### User Input

24 keys plus touchpad for data input, virtual keyboard, display contrast

#### Communication Ports

RS232 and USB

#### PCMCIA

Type 1. For additional data storage.  
Memory dependent upon RAM card used.

### PLC6 (U) Automatic Universal Leaf Cuvette

#### Cuvette Materials

Components: Aluminum alloy  
Window: Glass IR interference filter  
Leaf gasket: Closed cell foam  
Impeller: Stainless steel

#### Window Sizes/Leaf Area Exposed

18mm diameter /2.5 cm<sup>2</sup>  
25mm x 18mm /4.5 cm<sup>2</sup>  
25mm x 7mm /1.75 cm<sup>2</sup>

#### Boundary Layer Resistance

0.15-0.46 m<sup>2</sup> s<sup>-1</sup> mol<sup>-1</sup>

#### Air Temperature Sensor

Precision Thermistor  
Software linearization: +/- 0.10 °C from 0-60 °C  
Accuracy: +/-0.3 °C at 25 °C

#### Leaf Temperature Sensor

Radiation sensor for non-contact measurement and control  
Accuracy: +/-0.3 °C at 25 °C

#### PAR Sensor

Filtered silicon cell (fully cosine corrected)  
Response: 400-700 nm  
Range: 0-3,000  $\mu\text{mol m}^{-2} \text{s}^{-1}$   
Precision: 10  $\mu\text{mol m}^{-2} \text{s}^{-1}$

#### Temperature Control

Peltier elements mounted to the cuvettes and fitted with heat sink and fans  
Control Range: Approx. 8 °C below ambient up to 40 °C

#### Light Control (Optional)

LED (red and white) light unit  
Control Range: 0-2,000  $\mu\text{mol m}^{-2} \text{s}^{-1}$

#### Cuvette Dimensions

Length: 36 cm  
Handle: 3.8 cm Diameter

#### Weight

0.75 kg

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