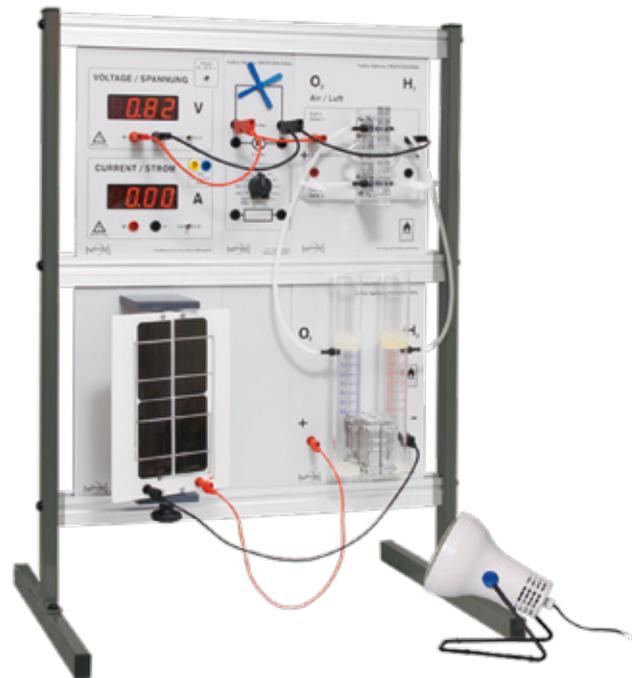


# Dr FuelCell® Professional

Training and Demonstration Unit for Solar & Hydrogen Technology

The Dr FuelCell® Professional provides support in the form of pre-configured demonstration experiments for presentation to the class. Based on solar hydrogen technology, the single modules reproduce a complete energy cycle.



## Hands-on Teaching of Fuel Cell Technology

Dr FuelCell® Professional provides support in the hands-on teaching of solar hydrogen technology. Various modules reproduce a complete energy cycle. Single technologies, such as solar and fuel cell technology, can therefore be examined in detail and portrayed within the context of the overall concept.

The large components and easy-to-read displays are ideal for group presentations and demonstrations of experiments. Due to the user-friendly design, the Professional can also be operated by students.

## Diverse Applications

The solar panel included in the package supplies the energy for hydrogen production in the electrolyzer. It is stored intermediately in measuring cylinders and converted to electric power in the fuel cell. The load module and the optional measuring unit enable specific loads to the fuel cell and visualization of the measuring results. The various modules are mounted in a stable rack.

Instructors can use Dr FuelCell® Professional and the detailed learning and teacher's guides for the hands-on teaching of content from the subjects of physics, chemistry and technology:

- » Molecules and chemical reactions
- » Reaction speeds
- » Thermodynamics
- » Electrochemistry
- » Energy conversion and efficiency
- » Measuring and interpreting characteristic curves

- » Custom experiment setups due to modular concept
- » Complete demonstration unit, no additional components or chemicals needed<sup>1</sup>
- » Large modules and displays for presentation to groups
- » Robust components in stable rack
- » Easy introduction due to pre-configured experiments
- » Curriculum oriented documentation (Grades 9–12)
- » Easy and fast installation without extensive preparation

<sup>1</sup> Not included: distilled water

# Components

Dr FuelCell® Professional

The simple design of the Professional ensures transparency when demonstrating experiments. Discover the features of the components.

## Solar Panel



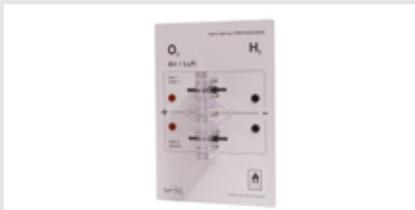
The 4-cell solar panel is used for experiments in photovoltaics and for generating electric energy for the electrolyzer. It can be turned in the frame for easier alignment to the light source.

## Electrolyzer



The electrolyzer separates water into hydrogen and oxygen. Due to PEM technology, it is operated with distilled water and requires no caustic solutions or acids. The integrated graduated gas storage canisters visualize the classic water separation experiment, as with the Hoffmann apparatus.

## Fuel Cell



The powerful double fuel cell is used to generate electricity from hydrogen and oxygen. The two fuel cells can be connected parallel and in series. It is based on PEM technology, which is the most widespread technology used in the development of fuel cell applications, e.g. for motor vehicles or stationary power supply systems.

## Load Module



The load module is used for the specific loads to the fuel cell and solar panel by a motor, a lamp or 10 selectable resistors. The resistors are optimized for measuring the characteristic curve of the solar panel and fuel cell.

## Measuring Unit



The measuring unit has two measuring ranges for current and voltage. The measured values are clearly readable on large LED displays. In addition, analog data output enables further processing of the measured data.



The Dr FuelCell® Science Kit is the ideal experiment set to supplement the Professional. Based on the same concept, students can further explore the demonstrated experiments on their own.

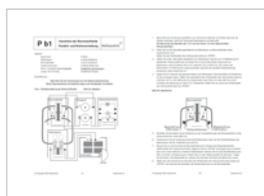
# Supplementary Material

The instruction material for Dr FuelCell® Professional includes a collection of pre-configured demonstration experiments and four textbooks for the lower and upper secondary level.



Instruction material

Three textbooks contain teacher's guides for more than 20 experiments in physics, chemistry and technology, worksheets with short articles and written assignments, detailed instructions with information on the experiments and possibilities for the analysis and interpretation of measured data.



Teacher's guide

The fourth book, "Principles and Applications", includes articles with background information that can be used independently in classes.

The accompanying CD-ROM includes two videos and two PowerPoint presentations on the principles and applications of fuel cell technology.



CD-ROM

### Examples of experiments:

- » Current/voltage characteristic curves of solar panel and fuel cell
- » Faraday's first law
- » Electrolysis
- » Faraday and energy efficiency of an electrolyzer and of a fuel cell
- » Thermodynamics: electrochemical processes
- » Series and parallel connection of fuel cells
- » Water = 2 parts hydrogen + 1 part oxygen

# Product Options

Dr FuelCell® Professional		
<b>Demo</b>		<b>Complete</b>
Features numerous hands-on experiments for classes in physics, chemistry and technology		Features full range of experiments and visualization of measured data through an additional measuring unit
<ul style="list-style-type: none"> <li>» Solar Panel</li> <li>» Electrolyzer</li> <li>» Double Fuel Cell</li> <li>» Load Module</li> <li>» Instruction Material with Teacher's Guide</li> </ul>		<ul style="list-style-type: none"> <li>» Solar Panel</li> <li>» Electrolyzer</li> <li>» Double Fuel Cell</li> <li>» Load Module</li> <li>» Measuring Unit</li> <li>» Instruction Material with Teacher's Guide</li> </ul>
Item No. 391		Item No. 392
Accessories		
Lamp	Lighting fixture & special bulb for simulating sunlight, not available for 110 volts	Item No. 314



### Dr FuelCell® Classroom Bundle II

- Included**
- 6 x Dr FuelCell® Science Kit Basic\*
  - 1 x Dr FuelCell® Science Kit Instruction Material
  - 1 x CD-ROM

Item No. 916

\*without Instruction Material

# Technical Data

## Dr FuelCell® Professional Complete

All Professional packages include the main components and all necessary accessories for the experiments, such as tubes, plugs, cables and a stop watch.

Dimensions (W x H x D)	600 mm x 840 mm x 460 mm
Weight	ca. 10.1 kg
Permissible ambient temperature during operation	+10 ... +35 °C
Language versions	The instruction material and the CD-ROM are available in German and English.

## Solar Panel

Dimensions (W x H x D)	200 mm x 310 mm x 130 mm
Terminal voltage	2.3 V (*)
Short circuit current	1,000 mA (*)
In the operating point with a load resistance of 2 Ω	
Current	1,000 mA (*)
Voltage	2 V (*)
Output	1.7 W (*)

(\*) Typical measured values with a 120 watt PAR lamp from Heliocentris, at a distance of 20 cm.

## Electrolyzer

Dimensions (W x H x D)	200 mm x 297 mm x 125 mm
Storage volume for hydrogen and oxygen	64 ml each
Operating voltage	1.4 ... 1.8 V
Electric current	max. 4,000 mA
Hydrogen production	max. 28 ml / min

## PEM Fuel Cell

Dimensions (W x H x D)	200 mm x 297 mm x 115 mm
Voltage in parallel connection	0.4 ... 0.9 V
Voltage in series connection	0.8 ... 1.8 V
Current in parallel connection	max. 3,000 mA
Rated output in series connection	1.7 W

## Load Module

Dimensions (W x H x D)	100 mm x 297 mm x 100 mm
Operating voltage of motor	max. 3 V
Current consumption of motor	max. 130 mA
Operating voltage of lamp	max. 2 V
Measured resistance (in Ω)	0.3 / 0.5 / 1 / 2 / 3 / 5 / 10 / 20 / 50 / 100 / open

## Measuring Unit

Dimensions (W x H x D)	200 mm x 297 mm x 100 mm
Ammeter	0 ... 2 A and 0 ... 20 A
Voltmeter	0 ... 2 V DC and 0 ... 20 V DC
Power supply of measuring unit	9-12 V DC (included in scope of delivery)

The output of the fuel cell depends on various influencing factors and decreases over the life of the product. All information on the output applies at the time of delivery.

The systems use hydrogen, a highly flammable gas. This requires compliance with local laws and safety regulations for transport, storage and operation. Read the operating manual carefully before setting up and operating the system.

We reserve the right to make changes without prior notice.

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