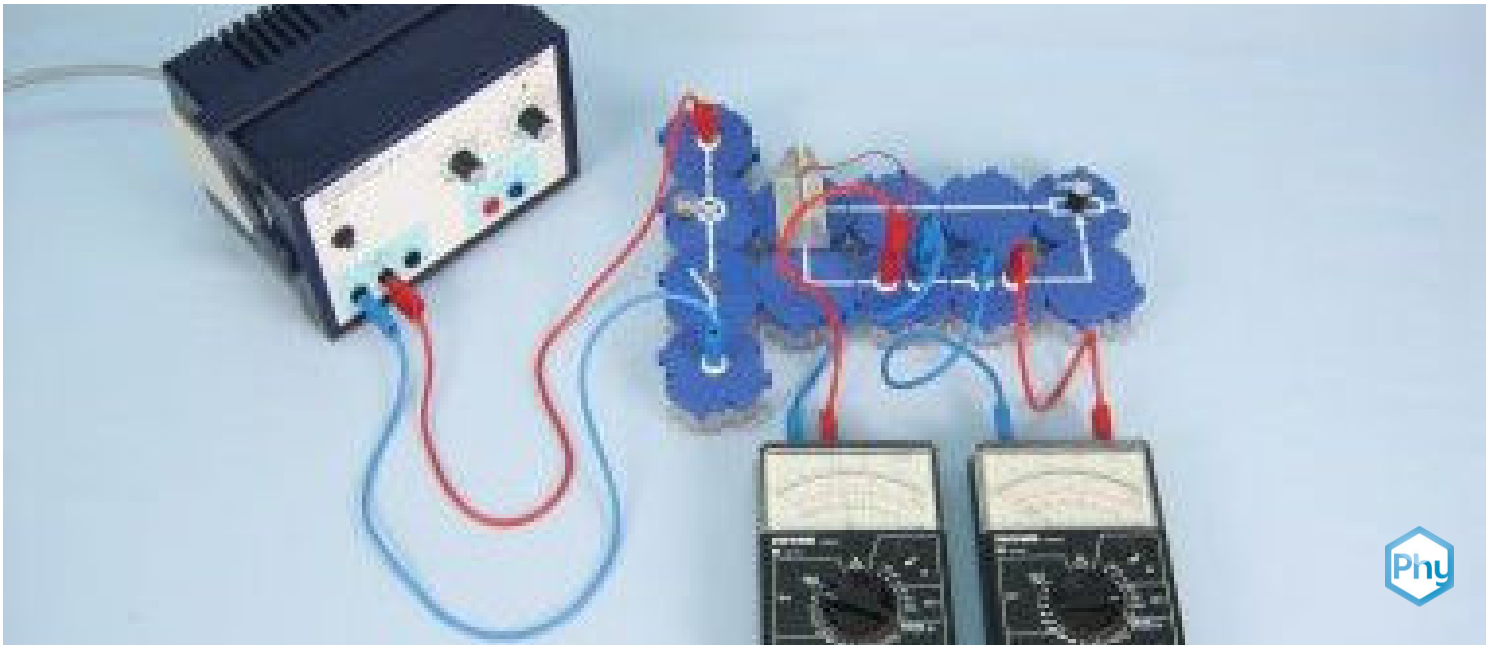
Current-voltage characteristic of a solar cell



Physics | Energy | Renewable energies: Sun

Difficulty level	Group size	Preparation time	Execution time
medium	2	10 minutes	10 minutes

This content can also be found online at:

http://localhost:1337/c/6316174f13aa4c0003fd3aad

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Teacher information

Application

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Experimental setup

The solar cell plays an important role in the development of alternative, non-fossil energy sources. They directly convert light energy into electrical energy. No pollutants are produced in the process and the cells can already be recycled to a large extent.

In this experiment, the effect of a load/pick-up on the voltage and current of the solar cell is investigated. The current-voltage characteristic curve of a solar cell is recorded at different illuminance levels. The maximum power and current are dependent on the illuminance.

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Other teacher information (1/3)

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Prior knowledge

The students should be able to construct a simple electric circuit and understand it together with the individual components. They should have an understanding of the terms voltage, amperage, resistance and power and understand their relationships.

Principle

A solar cell is an electrical component that absorbs radiant energy (e.g. in the form of sunlight) and converts it into electrical energy by means of the photovoltaic effect. Most solar cells are made of silicon.

Other teacher information (2/3)

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Learning objective

The students should learn how the voltage and current behave with different loads on a solar cell. From this, they also calculate the course of the power as a function of the voltage. Since both aspects are considered at different distances from the light source, the students can also determine the effect of the intensity on the previously mentioned physical quantities.

Tasks

At two different distances of the solar cell from the light source, the voltage and current strength are measured with increasing load. From this, the current-voltage and power-voltage characteristics of the solar cell are created. It can therefore be realised that the maximum power of the solar cell increases the more it is irradiated, since more electrons are released as the intensity increases.

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Other teacher information (3/3)

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Notes on set-up and procedure

To record the current-voltage characteristic, a potentiometer is used as the load resistance. The internal resistance of the ammeter is **not** negligible as an additional resistance for this measurement. If the potentiometer is turned to the left stop, its resistance is zero, but the displayed voltage is not zero. The value of the voltage depends on the measuring range of the ammeter because the measuring ranges have different internal resistances. The measurement should be taken in the measuring range $30\,mA$ This should not be adjusted during the measurement.

Safety instructions

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The general instructions for safe experimentation in science lessons apply to this experiment.

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Student information

Motivation

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Solar cells - field

Solar cells are an important technology for meeting the world's energy needs from sustainable sources. They convert sunlight into electricity without emitting environmentally harmful substances. For the solar cell, the more direct light the solar cell captures, the more electricity it can produce.

In this experiment, you will learn exactly how the voltage and current behave when the solar cell is loaded. In addition, you will learn what the power of a solar cell depends on.

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Tasks

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Experimental setup

How do the current and voltage change when a solar cell is loaded?

Load the solar cell with a variable resistor. Write down the voltage and current at different values of the load resistance.

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Equipment

Position	Material	Item No.	Quantity
1	Straight connector module, SB	05601-01	2
2	Angled connector module, SB	05601-02	3
3	Interrupted connector module with sockets, SB	05601-04	2
4	Junction module, SB	05601-10	2
5	On-off switch module, SB	05602-01	1
6	Socket module for incandescent lamp E10, SB	05604-00	1
7	Potentiometer module 250 Ohm, SB	05623-25	1
8	Solar cell 3.3 x 6.5 cm, with plugs, 0.5 V, 330 mA	06752-09	1
9	Holder for solar cell 3.3 x 6.5 cm, with plugs	06752-08	1
10	Connecting cord, 32 A, 250 mm, blue	07360-04	2
11	Connecting cord, 32 A, 500 mm, red	07361-01	1
12	Connecting cord, 32 A, 250 mm, red	07360-01	2
13	Connecting cord, 32 A, 500 mm, blue	07361-04	1
14	Filament lamp 6 V/3 W, E10, 10 pcs.	35673-03	1
15	PHYWE Analog multimeter, 600V AC/DC, 10A AC/DC, 2 MΩ, overload protection	07021-11	2
16	PHYWE Power supply, 230 V, DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1

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Set-up

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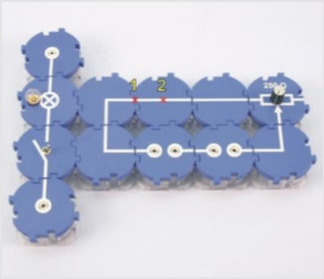
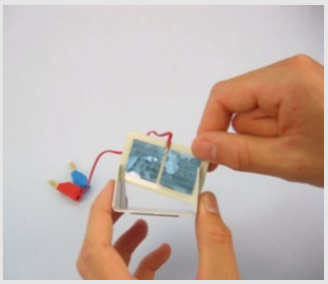
Set up the experiment according to the illustrations.

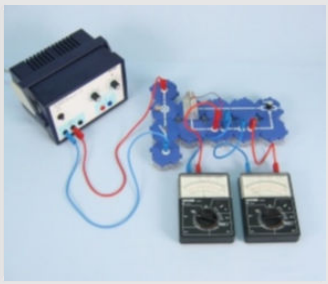
To do this, place the solar cell in the holder on the building blocks.

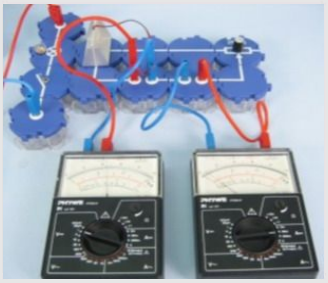
The bulb is first switched off and the potentiometer turned to the left stop.

Use one multimeter (right) as an ammeter and the other multimeter (left), which is connected in parallel to the solar cell, as a voltmeter.









Procedure (1/2)

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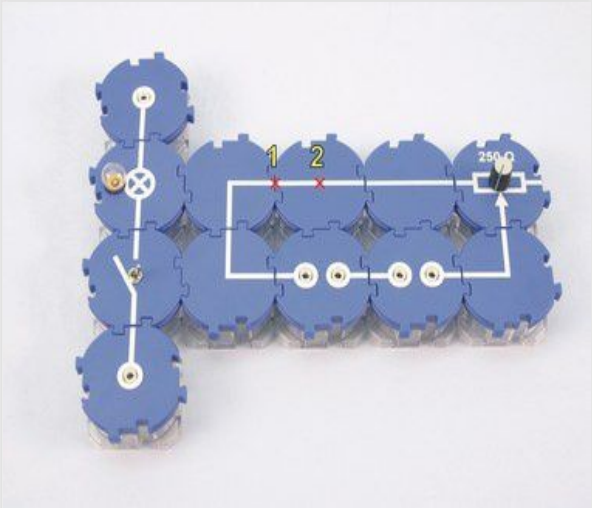

Marking: Position 1 and Position 2

- Switch on the light bulb and set the solar cell to position 1. Set the measuring range of the ammeter to $30\,mA$.
- Turn the potentiometer slowly to the right stop, initially only observe the voltage and current qualitatively. Turn potentiometer to the left stop again and measure voltage and current.
- **1st task:** Slowly turn the potentiometer to the right stop and take readings: in the voltage range up to $0,4\,V$ measure about three pairs of values for voltage and current, then measure voltage in steps of $0,01\,V$ and record the measured values. Note down the measurement results in Table 1.

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Procedure (2/2)

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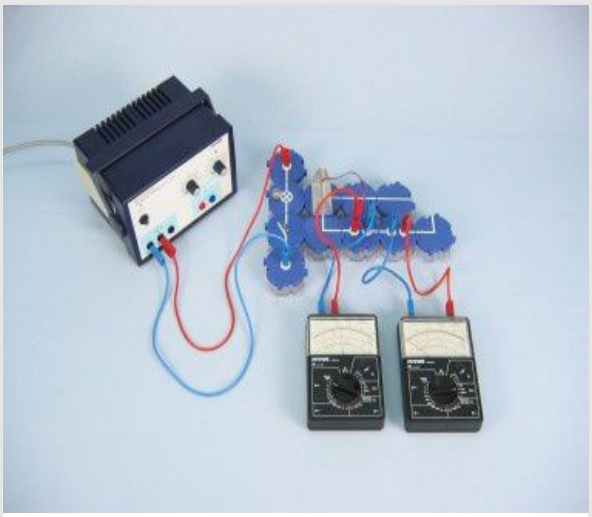

Circuit with potentiometer removed

- **2nd task:** Repeat this measurement for position 2, but do not change the measuring range. Note your resulting measurement results in Table 2 in the report.
- Remove the potentiometer from the circuit (see figure) and measure the voltage at $I = 0\ A$ for both positions of the solar cell.
- Switch off the light bulb at the end of the measurement.

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Report

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Table 1

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Write down your measurements for position 1 and then calculate the power in each case. $P = U \cdot I$.

Measurement	1	2	3	4	5	6	7	8
$U\,[V]$								
$I\,[mA]$								
$P\,[mW]$								

Table 2

PHYWE

Write down your measurements for position 2 and then calculate the power in each case. $P = U \cdot I$.

Measurement	1	2	3	4	5	6	7	8
$U\,[V]$								
$I\,[mA]$								
$P\,[mW]$								

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Task 1

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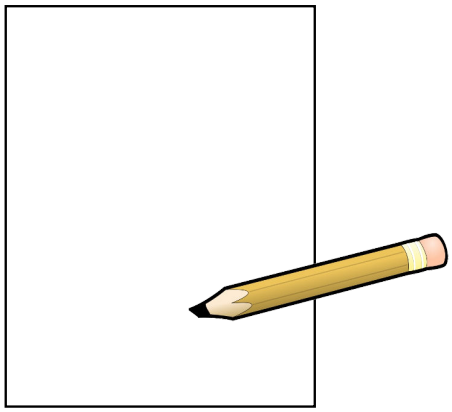
- Carry the current I for both positions (1 & 2) in a diagram against the voltage U (x-axis).
- In a second diagram, additionally plot the power P for the two positions against the voltage U .



Task 2

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How does the maximum power change with the load?

- It initially rises with increasing load, then reaches a peak and then quickly drops.
- No correlation between the load and the performance can be read from the graph.
- It is constant at first and then drops to zero.
- It initially drops with increasing load, then reaches a low point and then rises again quickly.

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Task 3

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Drag the words into the correct boxes!

The _____ remains constant as the load increases and then drops steeply to zero. Furthermore, it can be seen that the current intensity also _____ with increasing _____ and thus decreasing intensity of the light. The _____ is approximately at the same _____ at which the current intensity starts to drop steeply to zero.

- current intensity
- distance
- load
- maximum power
- decreases

Check

Slide	Score / Total
Slide 18: Relationship between performance and load	0/1
Slide 19: Behaviour current	0/5
Total	**0 / 6**

Solutions | Repeat | Export text

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