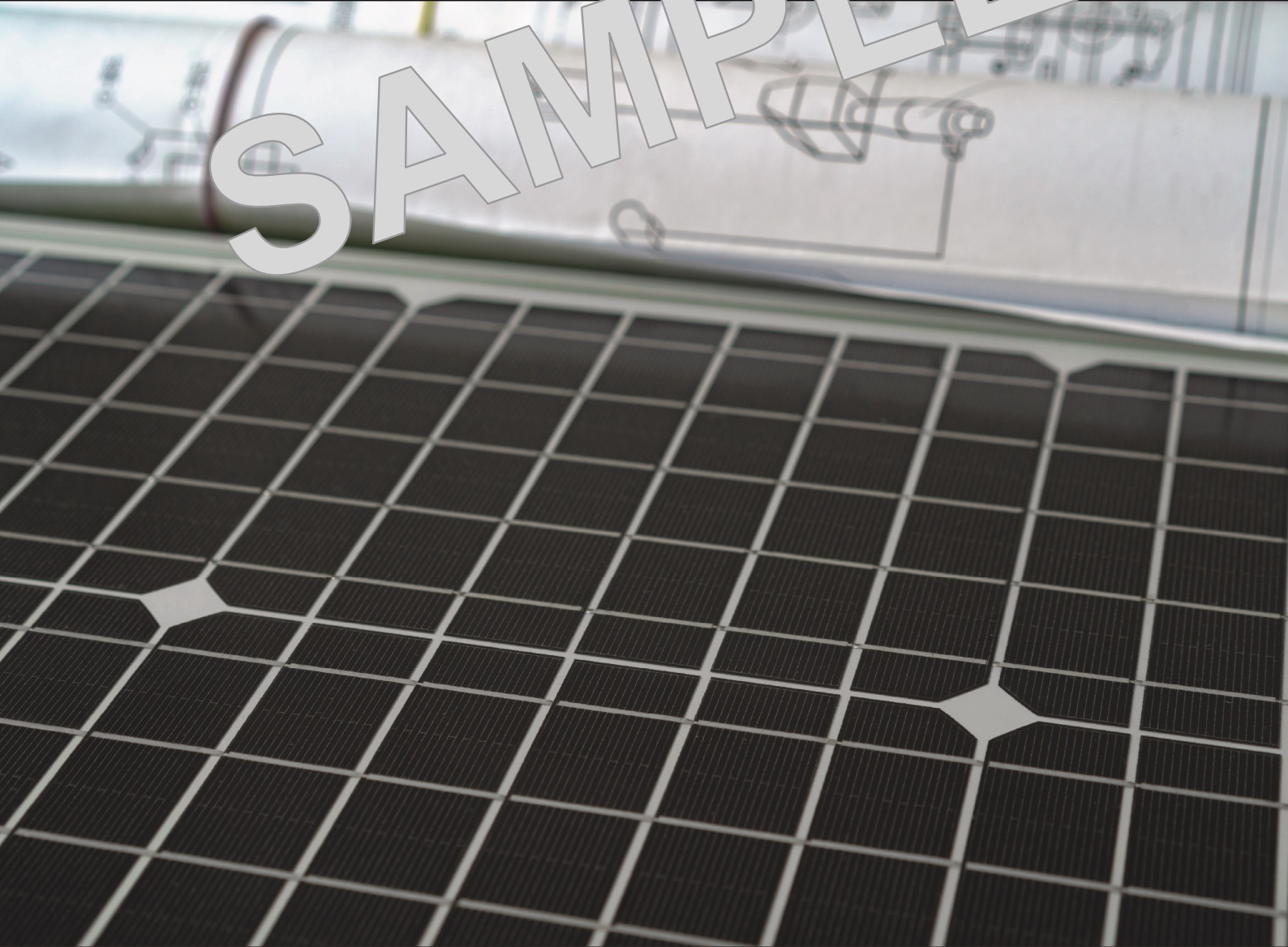


Fundamentals of Photovoltaic Energy

SAMPLE



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Practical Experiments

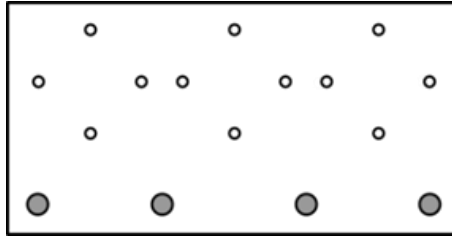
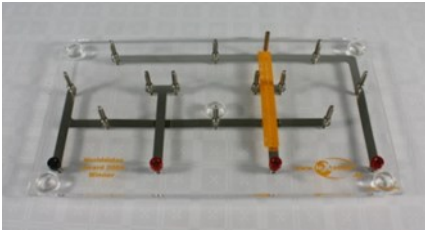
- Worksheet 29 Determination of efficiency of some energy conversions
- Worksheet 30 Rotational direction and speed of a motor
- Worksheet 31 Starting and running current of a motor

Introduction

Description of components

For every component there is the name with article number, a picture, the pictogram for the circuit diagram and operating instructions. With the aid of the article number it is possible to reorder a specific component.

Base Unit

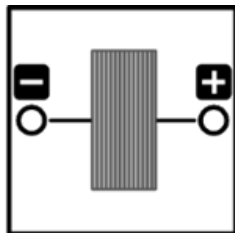


The base unit is a breadboard where up to 3 components can be plugged in a series and parallel connection. The current flows along the wires on the bottom side. To connect the components on the base unit with other components, there are 4 terminals at the lower end.

The printed circuit diagrams show the connections in a series and parallel connection. To change between series and parallel connection, the modules have to be turned by 90°.

To the right of the center, there is the shadow bar with angle scale. This shadow bar can be used to align plugged-in solar modules in a certain angle to a light source. The light should be small and be at a big distance to the base unit in order to create a well-defined shadow.

Solar Module 1100-01 0.5V 420 mA



Specifications:

Material: polycrystalline silicon

Open circuit voltage: 0,5V

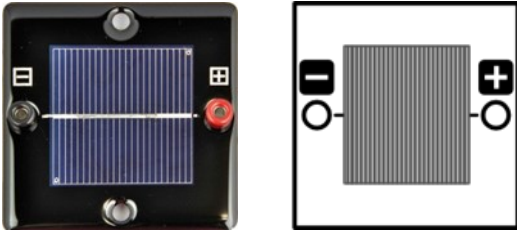
Short circuit current: 420mA

Maximum power: 0,2Wp

Introduction

Description of components

Solar Module 1100-02 0.5V 840 mA



The specifications about open circuit voltage and short circuit current can be found on the back surface.

Specifications:

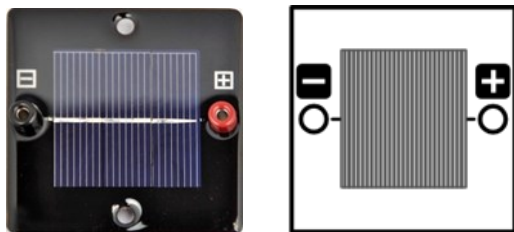
Material: polycrystalline silicon

Open circuit voltage: 0,5V

Short circuit current: 840mA

Maximum power: 0,4Wp

Solar module 1100-07 1,5V 280 mA



This solar module is a serial connection of three solar cells.

Specifications:

Material: polycrystalline silicon

Open circuit voltage: 1,5V

Short circuit current: 280mA

Maximum power: 0,13Wp

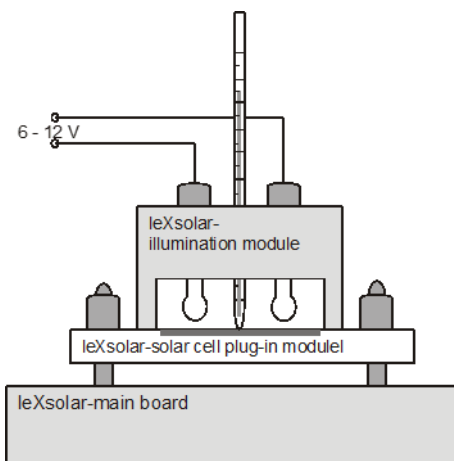
Introduction

Description of components

Lighting module (1100-20) with PowerModule (2105-00)



The lighting module is operated with the PowerModule or any other variable power supply (0... 12V). There are 4 light bulbs inside the lighting module. They can or cannot contribute to the lighting by screw or unscrew. It is not recommended to change the illuminance by changing the voltage since the spectrum of the light will change, which leads to measuring errors. The lighting module has to be set on the solar cell (see figure). Take care that the lighting should lie as long as necessary on the solar cell because of the heat built-up of the solar cell due to heat radiation. Between both connections there is a hole for the laboratory thermometer to measure the temperature of the solar cell. The PowerModule is a compact and intuitively usable voltage source. First, the attached power adapter has to be connected to a power outlet and to the top right input jack. The voltage can be chosen with the „+“ and „-“ -buttons and will be displayed by LEDs. When the desired voltage is chosen, the voltage will be applied by using the yellow on/off- button. In case of a short circuit or currents greater than 2 A the PowerModule will switch off immediately.



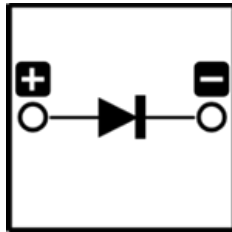
Specifications:

Lighting modules	PowerModule
Operating voltage: 0-12V	Output voltage: 0-12 V
Maximum power: 4W	Output power: max. 24 W
Maximum illuminance: 200W/m ²	Adjustable in 0.5 V steps
Aperture of the light source: 6x6cm	Overcurrent detection >2 A and automatic shutoff
	Input voltage: 110-230 V, 50-60 Hz (with enclosed power adapter)

Introduction

Description of components

Diode module 1100-21



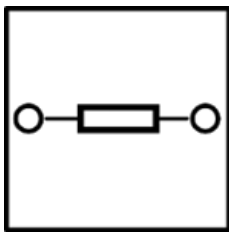
Specifications:

Schottky diode

$U_{\text{forward}} = 0.33 \text{ V}$

Maximum current: 200 mA (500 mA Peak <1 s)

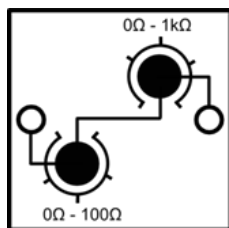
Resistor module 1100-22



Specifications:

Maximum power: 2W

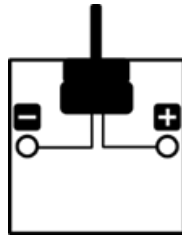
Potentiometer module 1100-23



Introduction

Description of components

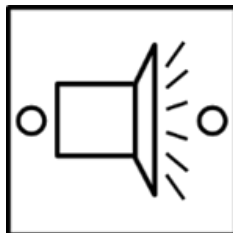
Gear motor module (1100-24) with mit hook weight 20g (L2-05-024)



Specifications:

Starting current: @ 20mA
Starting voltage: @ 0,35V
Minimum operating current: 10mA
Maximum voltage: 4V

Horn module 1100-25



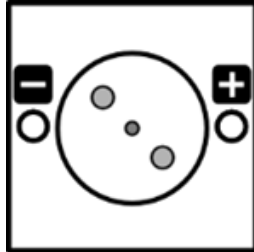
Specifications:

Starting voltage: 0.7V
Starting current: 0.3mA

Introduction

Description of components

Motor module without gear (1100-27) with color disks– Set 1 (1100-28)

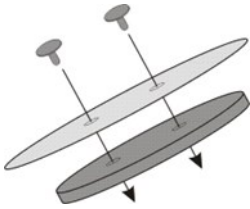


Specifications:

Starting current: 20mA

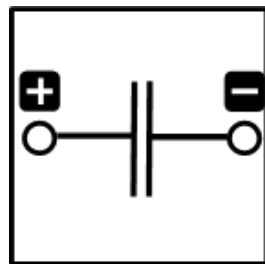
Starting voltage: 0.35V

The color disks are: red-green-blue, red-blue, red-green, green-blue and 3 black-white color disks. The color disks are fix at the motor module by use of the plastic disk. The plastic disk holds 2 clips, which fix the disk at the plastic disk (see figure).



In the center of the plastic disk is a hole, which will be placed on the pin of the motor.

Capacitor module 1400-07



The capacitor module has a capacity of 220 mF and is able to apply a maximum voltage of 2.5 V. Do not apply a higher voltage than 2.5 V during charging. If you want to discharge the capacitor quickly, it can be short-circuit since there are fuses inside the module which avoid high currents.

To charge the capacitor quickly, it is possible to connect it directly with the PowerModule. Power on the PowerModule at a voltage of 0.5 V and increase the voltage by 0.5 V every 10 s. Charge the capacitor at the end voltage for 30 s.

Specifications:

Capacity: 220 mF

Voltage: 2,5 V

Introduction

Description of components

Solar cell cover set 1100-29



Specifications:

Size: 3x3cm

Colour filters 1100-30



Introduction

Understanding the base unit

Task

Examine the different circuits to learn more about the base unit.

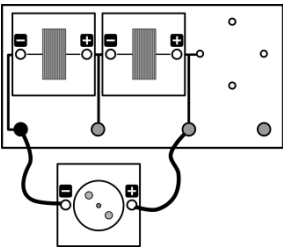
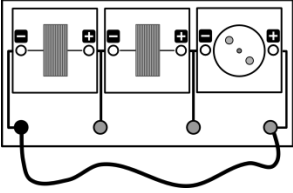
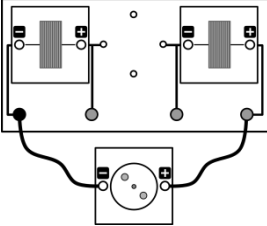
Required Devices

- base unit
- 3 small solar cells
- motor
- 3 cables

Procedure

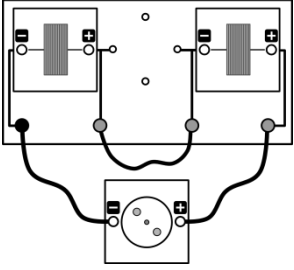
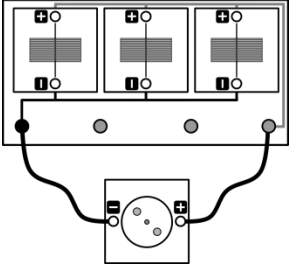
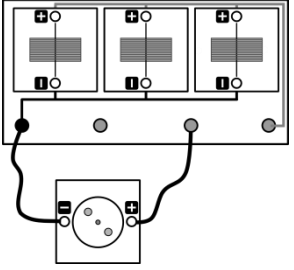
1. Set up the circuits 1 – 6 and check each time, if the motor rotates.
2. Examine the base unit for each circuit and draw the circuit diagram. Decide, whether it is a series or parallel connection.
3. Describe the energy conversions and the physical processes during the experiment with circuit 1.

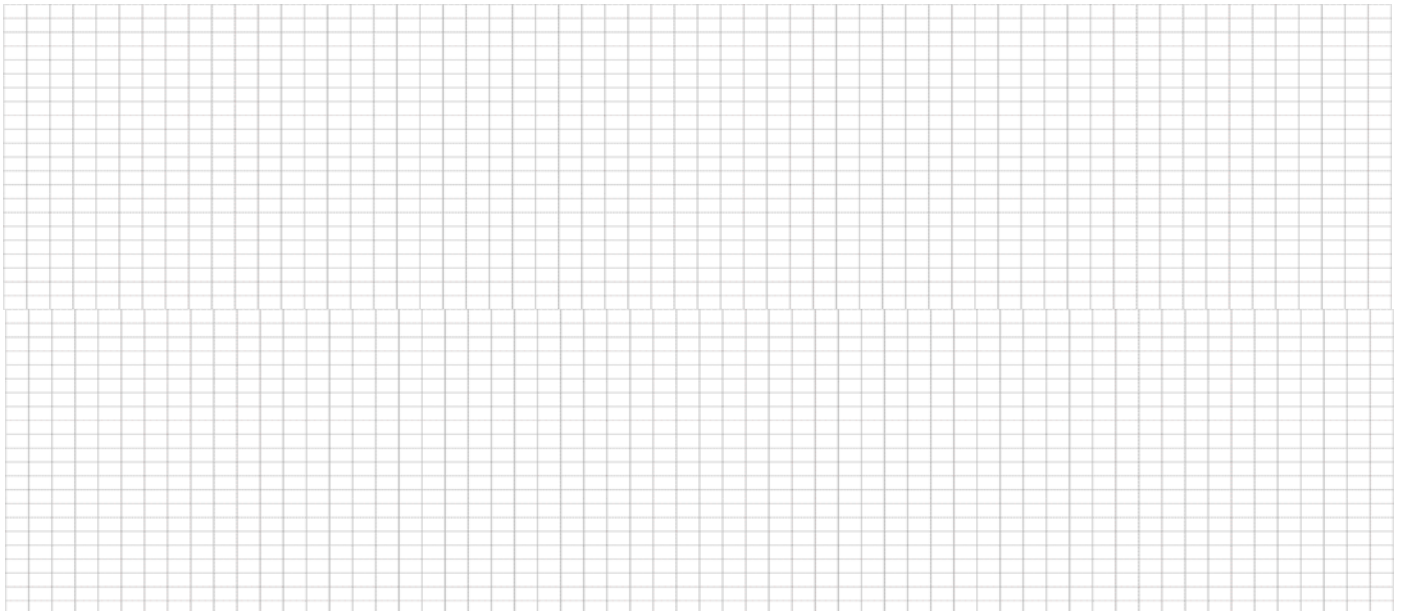
Evaluation

Circuit 1	Circuit 2	Circuit 3
 <p data-bbox="130 1563 459 1594">Does the motor rotate?</p> <p data-bbox="130 1621 418 1675"><input type="checkbox"/> yes <input type="checkbox"/> no</p>	 <p data-bbox="513 1554 842 1585">Does the motor rotate?</p> <p data-bbox="513 1612 791 1666"><input type="checkbox"/> yes <input type="checkbox"/> no</p>	 <p data-bbox="890 1554 1219 1585">Does the motor rotate?</p> <p data-bbox="890 1612 1168 1666"><input type="checkbox"/> yes <input type="checkbox"/> no</p>
<p data-bbox="130 1733 204 1765">It is a:</p> <p data-bbox="130 1787 424 1841"><input type="checkbox"/> series connection</p> <p data-bbox="130 1868 456 1921"><input type="checkbox"/> parallel connection</p>	<p data-bbox="513 1733 587 1765">It is a:</p> <p data-bbox="513 1787 823 1841"><input type="checkbox"/> series connection</p> <p data-bbox="513 1868 842 1921"><input type="checkbox"/> parallel connection</p>	<p data-bbox="890 1733 963 1765">It is a:</p> <p data-bbox="890 1787 1200 1841"><input type="checkbox"/> series connection</p> <p data-bbox="890 1868 1219 1921"><input type="checkbox"/> parallel connection</p>

Introduction

Understanding the base unit

Circuit 4	Circuit 5	Circuit 6
 <p data-bbox="140 768 467 801">Does the motor rotate?</p> <p data-bbox="140 824 416 880"><input type="checkbox"/> yes <input type="checkbox"/> no</p>	 <p data-bbox="518 768 845 801">Does the motor rotate?</p> <p data-bbox="518 824 794 880"><input type="checkbox"/> yes <input type="checkbox"/> no</p>	 <p data-bbox="898 768 1225 801">Does the motor rotate?</p> <p data-bbox="898 824 1174 880"><input type="checkbox"/> yes <input type="checkbox"/> no</p>
<p data-bbox="140 920 212 954">It is a:</p> <p data-bbox="140 976 448 1021"><input type="checkbox"/> series connection</p> <p data-bbox="140 1066 467 1111"><input type="checkbox"/> parallel connection</p>	<p data-bbox="518 920 590 954">It is a:</p> <p data-bbox="518 976 826 1021"><input type="checkbox"/> series connection</p> <p data-bbox="518 1066 845 1111"><input type="checkbox"/> parallel connection</p>	<p data-bbox="898 920 970 954">It is a:</p> <p data-bbox="898 976 1206 1021"><input type="checkbox"/> series connection</p> <p data-bbox="898 1066 1225 1111"><input type="checkbox"/> parallel connection</p>



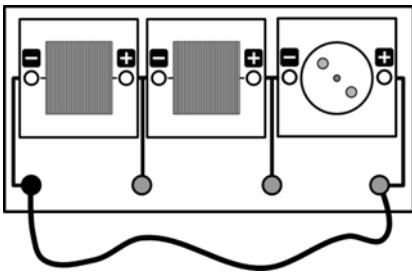
Optical Illusions

The basic setup for experiments with the colour disks

Task

Examine the optical illusions of the color disks.

Setup



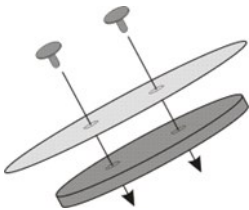
Required Devices

- 1 base unit
- 1 large solar cell
- 1 large solar module
- 1 motor module
- 1 cable

Procedure

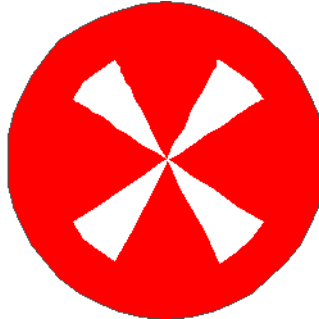
Set up the experiment according to the circuit diagram.

Now clip the rotation disk onto the motor. The cardboard disk is secured by two colored plastic clips.



If necessary you can use a plug to take the clips off the rotation disk. Carefully press the plug against the clip from underneath.

Cardboard Disc



Procedure

Rotate the disk. Place your hand above it so that there is a shadow over one half! Your results will help you understand the color system better.

Color: Which color does the disk have? _____

Brightness: On the shaded side the color seems...

brighter than on the illuminated side

as bright as on the illuminated side
darker than on the illuminated side

Hue: The color in the middle of the disk seems...

paler than at the edge
the same as at the edge
stronger than at the edge

The full version of this curriculum is available upon purchase of the kit.

Please see contents for a full list of experiments from the full version.