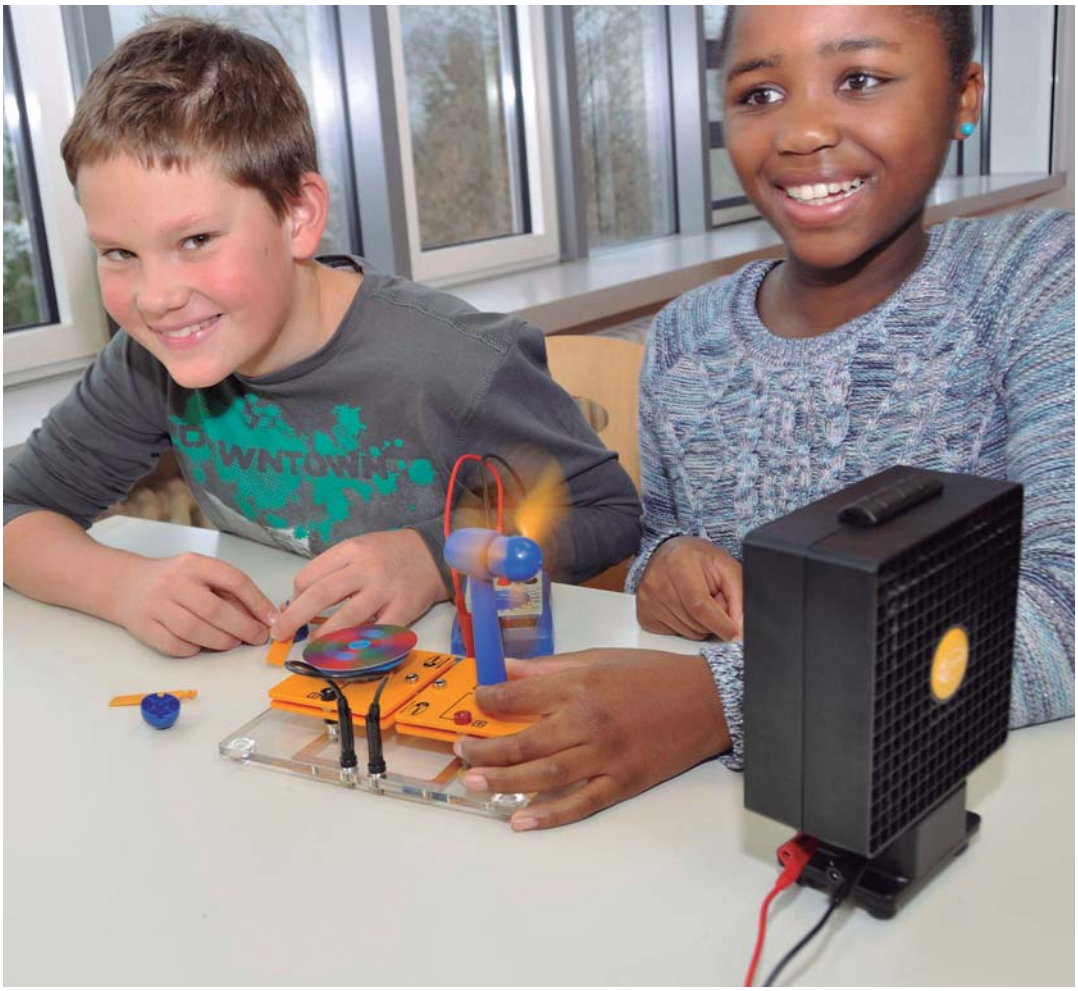
leXsolar-Wind Large



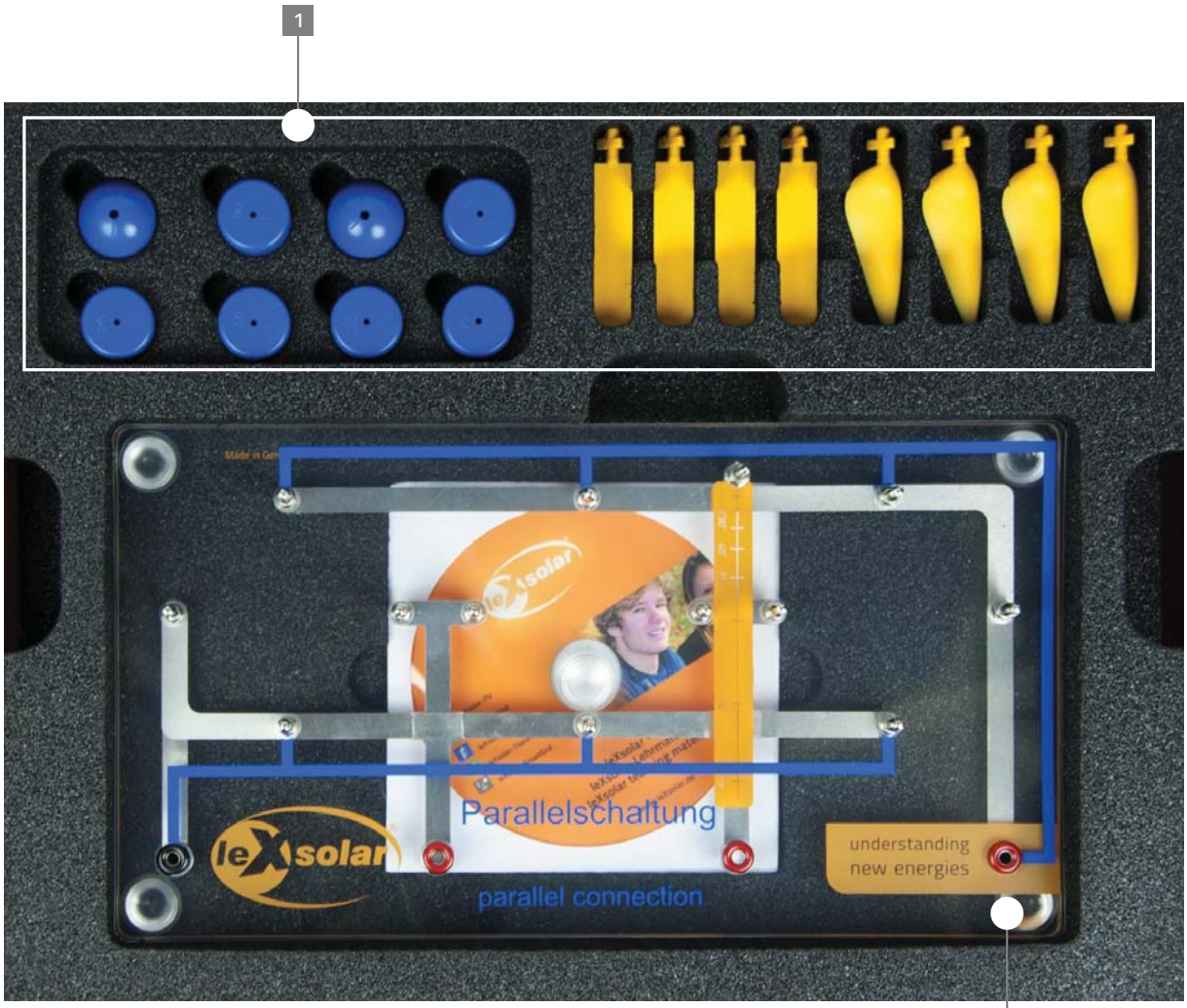
Teacher's Manual

Layout diagram leXsolar-Wind Large 2.0

Item-No.1404

Bestückungsplan leXsolar-Wind Large 2.0

Art.-Nr.1404



1 1400-12 leXsolar-Wind rotor set
(8 blades, 6 hubs, 2 caps)
1400-12 leXsolar-Windrotoren
(8 Flügel, 6 Naben, 2 Kappen)

2 1100-19 leXsolar-Base unit Large
1100-19 leXsolar-Grundeinheit groß

Version number
Versionsnummer

L3-03-132_25.07.2016

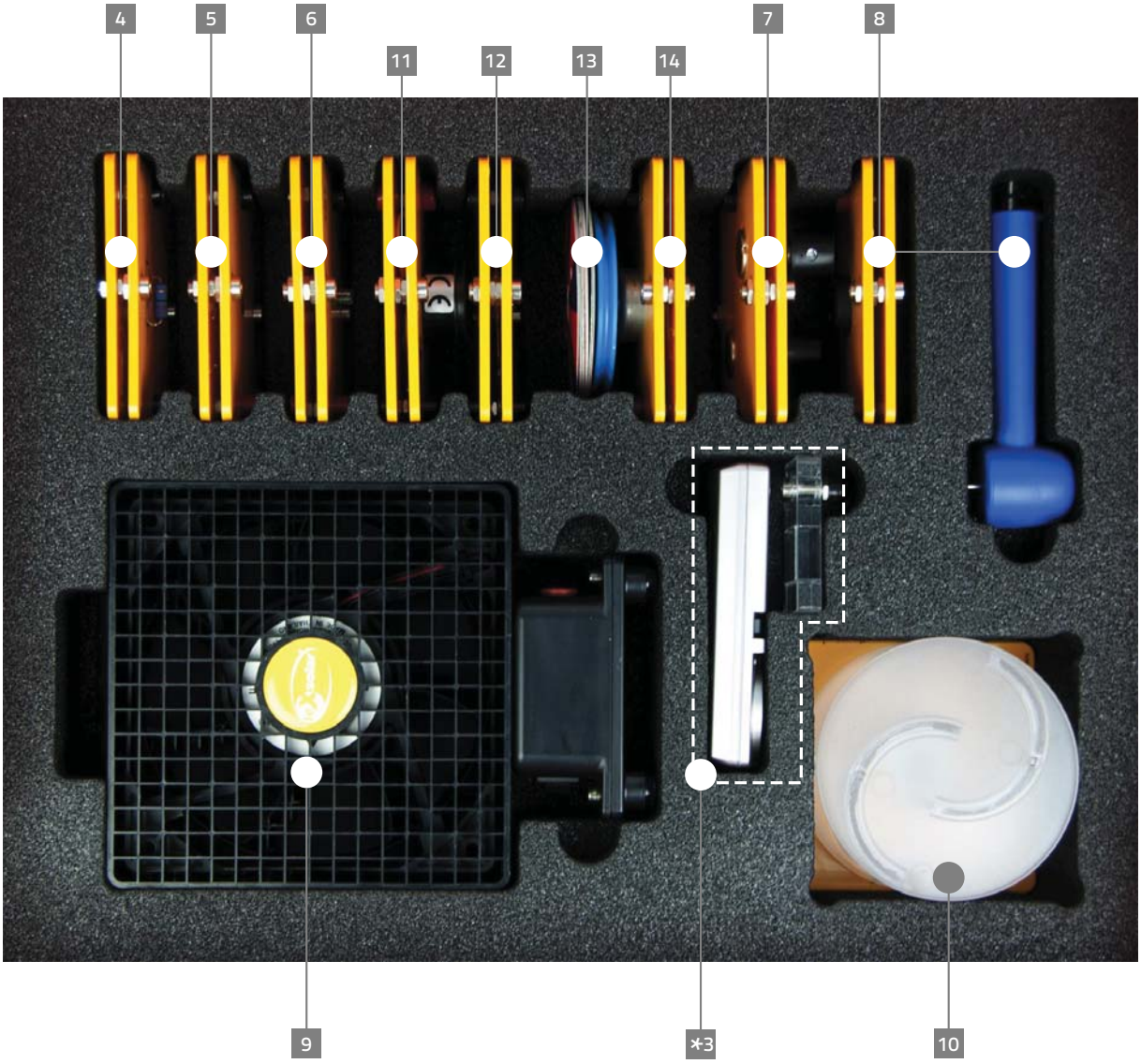
CE RoHS2

Layout diagram leXsolar-Wind Large 2.0

Item-No.1404

Bestückungsplan leXsolar-Wind Large 2.0

Art.-Nr.1404



4 1100-22 Resistor module
1100-22 Widerstandsmodul

5 1400-08 LED-module 2mA, red
1400-08 LED-Modul 2 mA, rot

6 1400-07 Capacitor module 220 mF, 2.5V
1400-07 Kondensatormodul 220 mF, 2.5V

7 1100-23 Potentiometer module
1100-23 Potentiometermodul

8 1400-22 Wind turbine module
1400-22 Windturbinenmodul

9 1400-19 leXsolar-Wind machine
1400-19 leXsolar-Winderzeuger

10 1400-01 Savonius rotor module
1400-01 Savoniusrotormodul

Optional expansions
Optionale Erweiterungen

*3 1400-02 Anemometer with mount
1400-02 Windgeschwindigkeitsmesser mit Ständer

11 1100-25 Buzzer module
1100-25 Hupenmodul

12 1100-26 Light bulb module
1100-26 Glühlampenmodul

13 1100-28 Color discs with mount Set 1
1100-28 Farbscheiben Set 1

14 1100-27 Motor module without gear
1100-27 Motormodul ohne Getriebe

CE RoHS2

leXsolar-Wind Large

Teacher`s Manual

Contents

This booklet contains instructions for experiments as well as the corresponding templates for the evaluation and sample solutions of the following experiments:

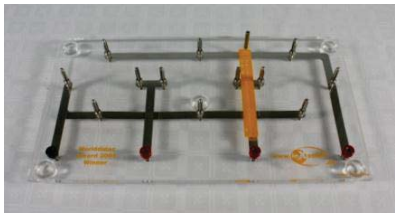
Pages 5 to 12 contain more detailed explanations of the instructions and execution of experiments.

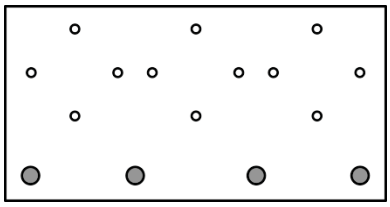
I General information

Identification of the components

In the following schedule every component of the leXsolar-Wind Large is listed. 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.

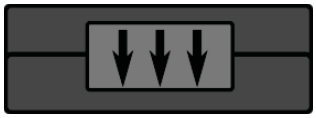
Base unit 1100-19





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°.

Wind machine 1400-19

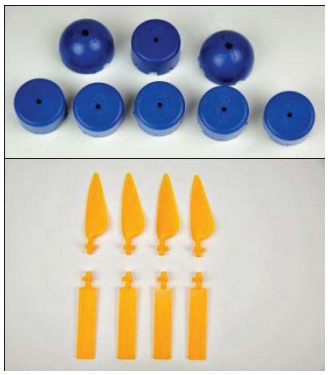


The wind machine is used to control the wind conditions during an experiment with the wind turbine. For those experiments the wind machine has to be connected to the PowerModule (voltage source). For this the negative (positive) pole of the PowerModule has to be connected to the black (red) connection. Towards the connections there is also a seperate on/off-switch. The wind direction is marked with arrows on the upside. The use of the wind machine is only permitted with the PowerModule or a stabilized voltage source. Furthermore, the wind machine has to be protected from intense hits. Otherwise, the rotor blade within the device could break. Misuse leads to termination of warranty.

Technische Daten:

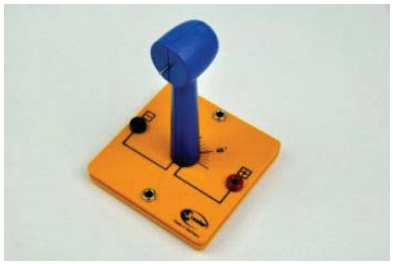
- Maximale Spannung: 12V DC (stabilisiert)
- Windgeschwindigkeit: 0 – 7m/s

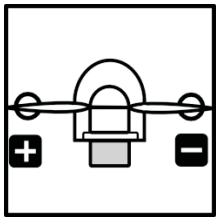
Wind rotor set 1400-12



With the available components, rotors with 2, 3 or 4 blades and with a flat or an optimized profile can be created. There is a hub for 4 blades with a pitch angle of 25° and hubs for 3 blades with pitch angles of 20°, 25°, 30°, 50° and 90°.

Wind turbine module 1400-22

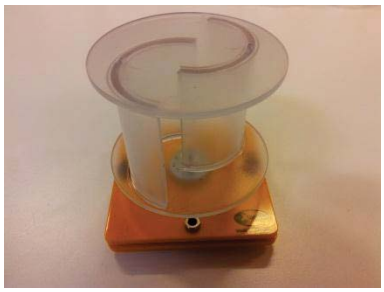


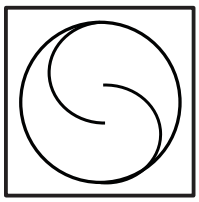


At first the blue wind turbine has to be plugged into the module. The rotor has to be racked at the generator shaft to get a model of a wind turbine. The rotor must not touch the casing to avoid friction, which would considerably impede its rotation. The generator produces a direct current, with its polarity marked on the module. Additionally an angle scale is printed on the module, so it is possible to adjust a certain wind angle.

It is not allowed to touch the rotor during movement due to risk of injury. The rotor may only be touched, when it does not turn!

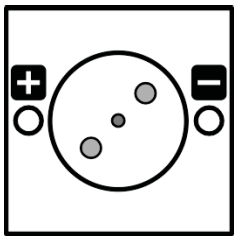
Savonius rotor module 1400-01





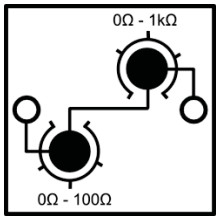
The Savonius rotor module is a model of a wind turbine with vertical rotation axis. The start-up speed amounts to 2 m/s. The open circuit voltage amounts to 0.4 V when there is a wind speed of 5 m/s.

Motor module (1100-27) with color discs (1100-28)



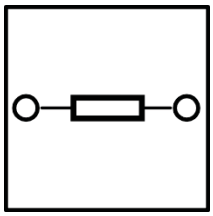
The motor module contains a DC-motor, which rotates in a certain direction depending on the applied voltage. It needs a minimal voltage of 0.35 V to rotate. With the blue plastic disc, you are able to connect the color discs with the motor module. Optical illusions, like the additive color mixing, can be illustrated.

Potentiometer module 1100-23



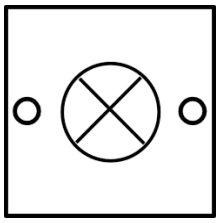
The potentiometer module holds a 0-100-Ω-potentiometer and a 0-1-kΩ-potentiometer. Both are serially conneted, so that the potentiometer can attain resistances between 0 Ω bis 1100 Ω. The measuring error amounts to 5 Ω for the small resistor and 20 Ω at other one. The maximum current amounts to 190 mA.

Resistor module 1100-22



The resistor module contains an ohmic resistor of 33 Ω with a derivation of 5 %. The maximum power dissipation can amounts to 2W.

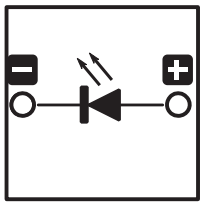
Light bulb module 1100-26



<u>Specifications:</u>

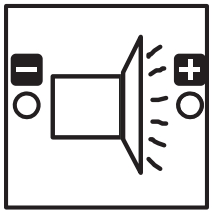
Light bulb P_{typ} = 200 mW (at 3.5 V)
Fuses work up to maximum voltage of 6 V

LED-module 1400-08



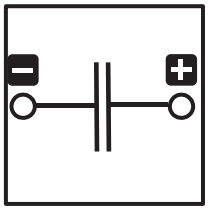
Inside the LED-module, there is a red LED with a wavelength emission of 697 nm. There has to be a minimum voltage of 1.7 V to light up the LED.

Horn module 1100-25



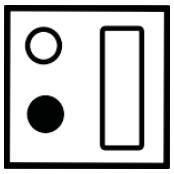
The horn starts making a noise from 0.7 V.

Capacitor module 1400-07



The capacitor module has a maximum capacity of 220 mF and a miximum voltage of 2.5 V. It is protected automatically against an overvoltage.

Anemometer (L2-06-027) with stator (1400-16)

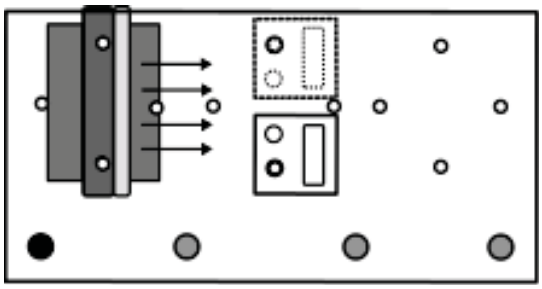


The anemometer can measure the wind speed and displays it in different units. The device can be switch on /off by holding the left button (red circle) for 2 seconds. The unit starts blinking, if the left button is held für 4 seconds. Now, you can change the unit with the right button (plus symbol). The unit can be confirmed by pushing the left button.

Handling and usage instructions

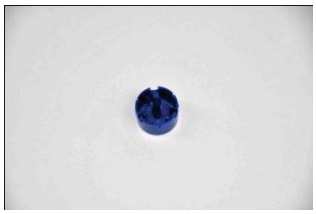
There are some instructions and guidelines on handling the equipment and components to take note of when carrying out experiments with lexsolar-Wind.

Measuring the wind speed (anemometer extension):

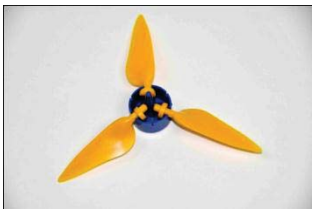


To measure the wind speed you have to remove the wind turbine from the base unit. Afterwards you plug in the holder for the wind measurement device as you can see in the sketch. For a more precise measurement you can calculate the average from the left and the right measuring point.

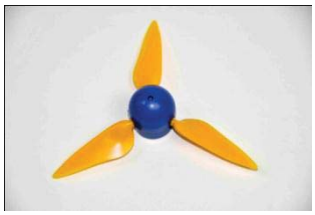
Installing and replacing the rotor blades



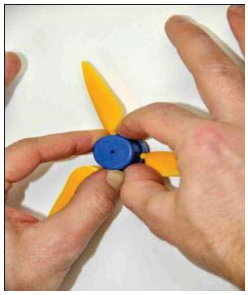
First, a hub with the desired rotor blade pitch and the number of blades should be selected. (The hubs are labeled on the back.) The Two-blade rotor and the Four-blade rotor can both be constructed with the Four-blade hub.



After that, the rotor blades are installed. During the insertion of the blades, make sure that they are installed with the rounded side up.



After installation of the rotor blades, the hub-cap will be mounted and lightly pressed against the hub.

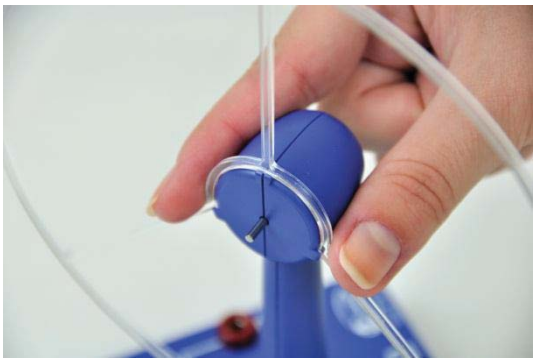


To replace the blades, a small nose is located at head of the hub. If the nose is pressed lightly on a hard surface, the hub-cap can be removed easily.

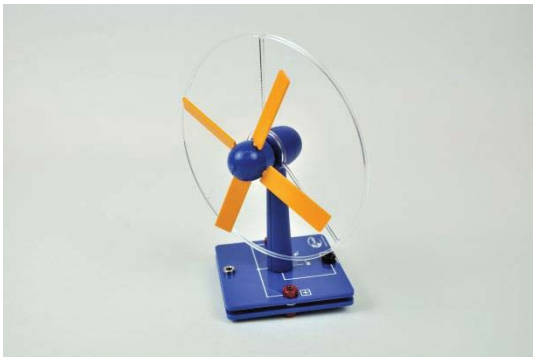
Handling of the fingerguard of the wind turbine 1400-22

1) As you can see in the picture, the wind turbine has three small retainer to fix the fingerguard.

2) The fingerguard will be attached at the top of the wind turbine and pressed firmly at the lower retainers.



3) Afterwards, the wind rotor will be fixed at the wind turbine.

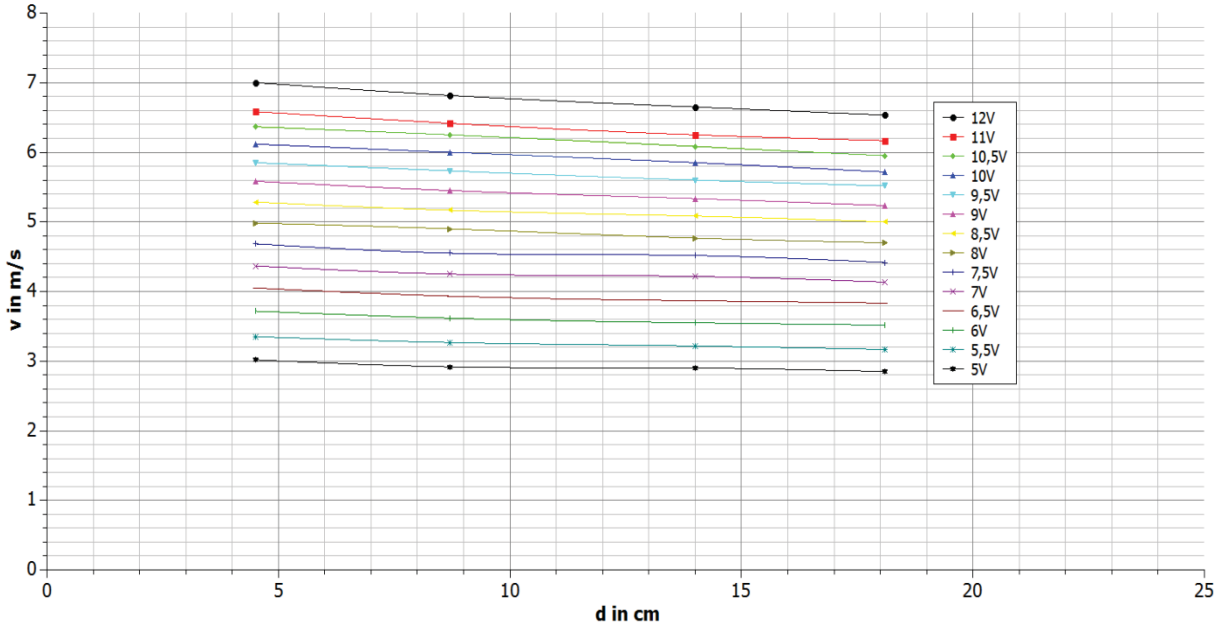


Advice: The fingerguard protects the finger against touching the rotor at the side. Do not touch the rotor from the front side because of injury risk!

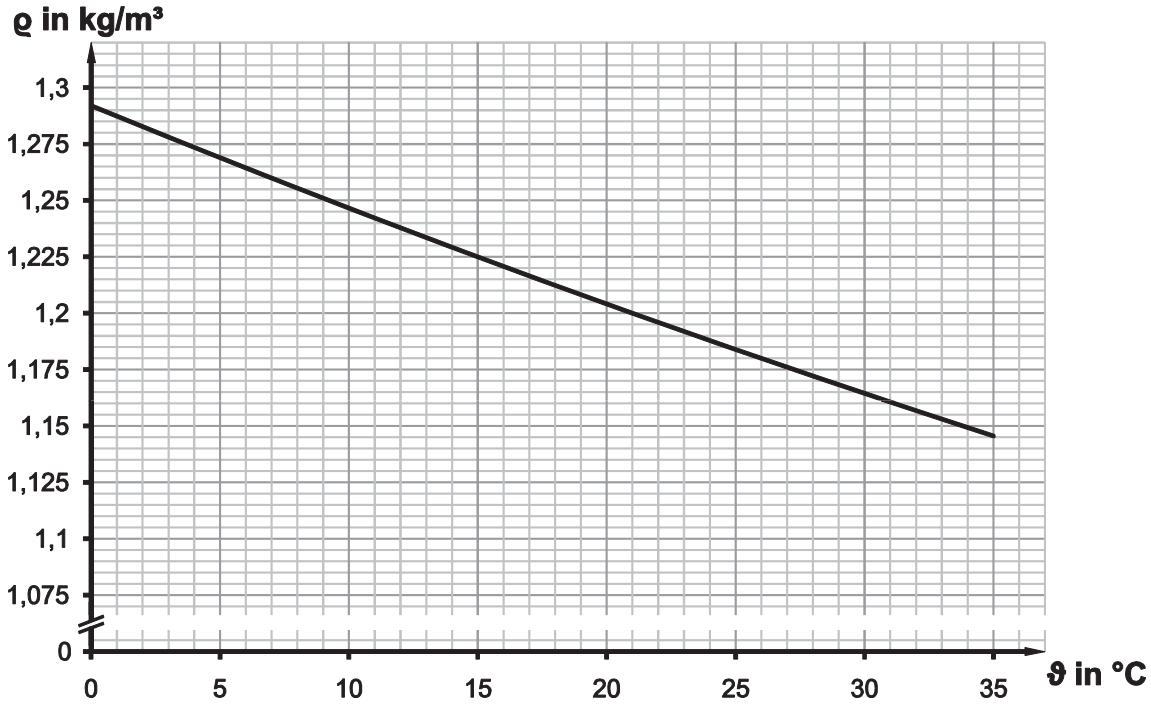
Charts for the experiments

The following are the charts needed to determine the wind speed of individual experiments if the anemometer is not in use.

Wind speed at constant voltage at the wind machine depending on the distance



Air density (depending on the ambient temperature)



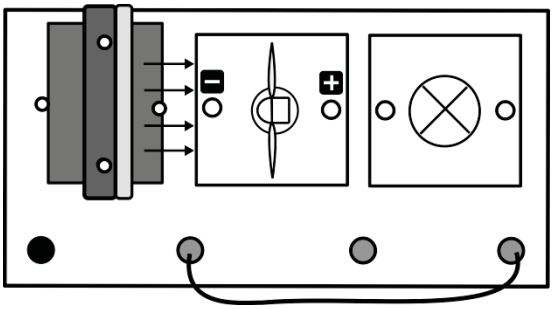
1.1 Influence of the wind speed on a wind turbine (phenomenologically)

Exercise

Examine the brightness of a light bulb, which is powered by a wind turbine.

Caution injury risk: Do not touch the moving rotor!

Experimental setup



Equipment needed

- leXsolar base unit
- Wind machine with PowerModule (variable)
- Wind turbine module (with three rotor blades, 25°, optimized profile)
- Light bulb module
- Cable

Preliminary remark

In this experiment you can examine how electricity generated by the wind turbine changes when the wind speed changes. The variation of wind speed is done by changing the voltage at the wind machine.

Execution

1. Set the experiment up according to the experiment set-up.
2. Change the voltage at the wind machine with the PowerModule. Start with 12V.
3. Observe how the brightness of the light-emitting diode changes and enter your observations in the table. Color in the corresponding number of fields.

Evaluation

Voltage at the wind machine	4V	6V	8V	10V	12V	Example
The light bulb lights up…						bright / weak / not at all

Now complete the sentences:

With a higher voltage at the wind machine, the wind speed increases.

The higher the wind speed, the brighter the light bulb.

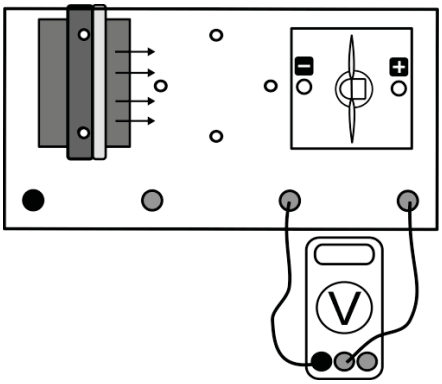
1.2 Influence of wind speed on the wind turbine (voltage measurement)

Exercise

Examine the voltage at the turbine when the wind speed at the wind turbine is changed.

Caution injury risk: Do not touch the moving rotor!

Experimental setup



Equipment needed

- leXsolar base unit
- Wind machine module with PowerModule
- Wind turbine module (with three rotor blades, 25°, optimized profile)
- Cable
- Voltmeter

Execution

1. Set the experiment up according to the experiment set-up.
2. Change the wind speed by variation of the voltage of the PowerModule V_{Pow}. Note your observations.
3. Now measure the voltage V_{gen} at the turbine at different wind speeds and enter your values in the table.
4. You can determine the values for the speed with the wind force transducer or read it off the respective chart (see page 12).

Observation

- The lower the voltage of the PowerModule, the lower the voltage generated at the wind turbine

- Thus, the lower the wind speed, the lower the voltage generated at the wind turbine

Measurements

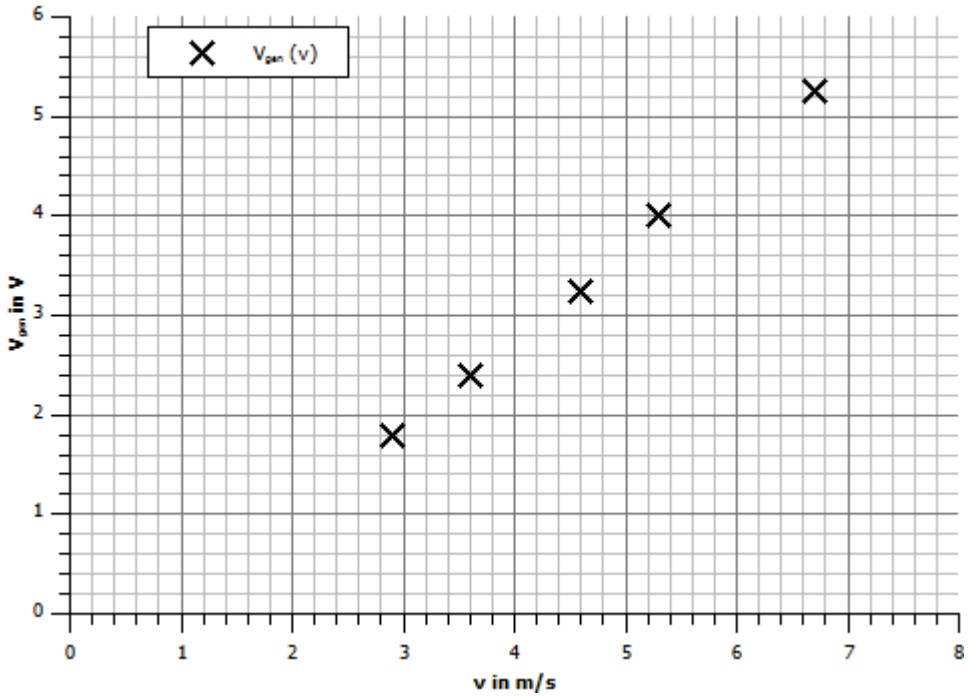
V_{Pow} in V	12	9	7.5	6	5
v in m/s	6.7	5.3	4.6	3.6	2.9
V_{gen} in V	5.25	4	3.25	2.4	1.8

1.2 Influence of wind speed on the wind turbine (voltage measurement)

Evaluation

1. Enter your measurements in the specified charts.
2. Describe the correlation between the wind speed and the voltage at the wind turbine?

Diagrams



Evaluation

2.

At higher wind speeds a higher voltage is generated at the wind turbine. (A linear correlation between voltage and wind speed can be assumed.)