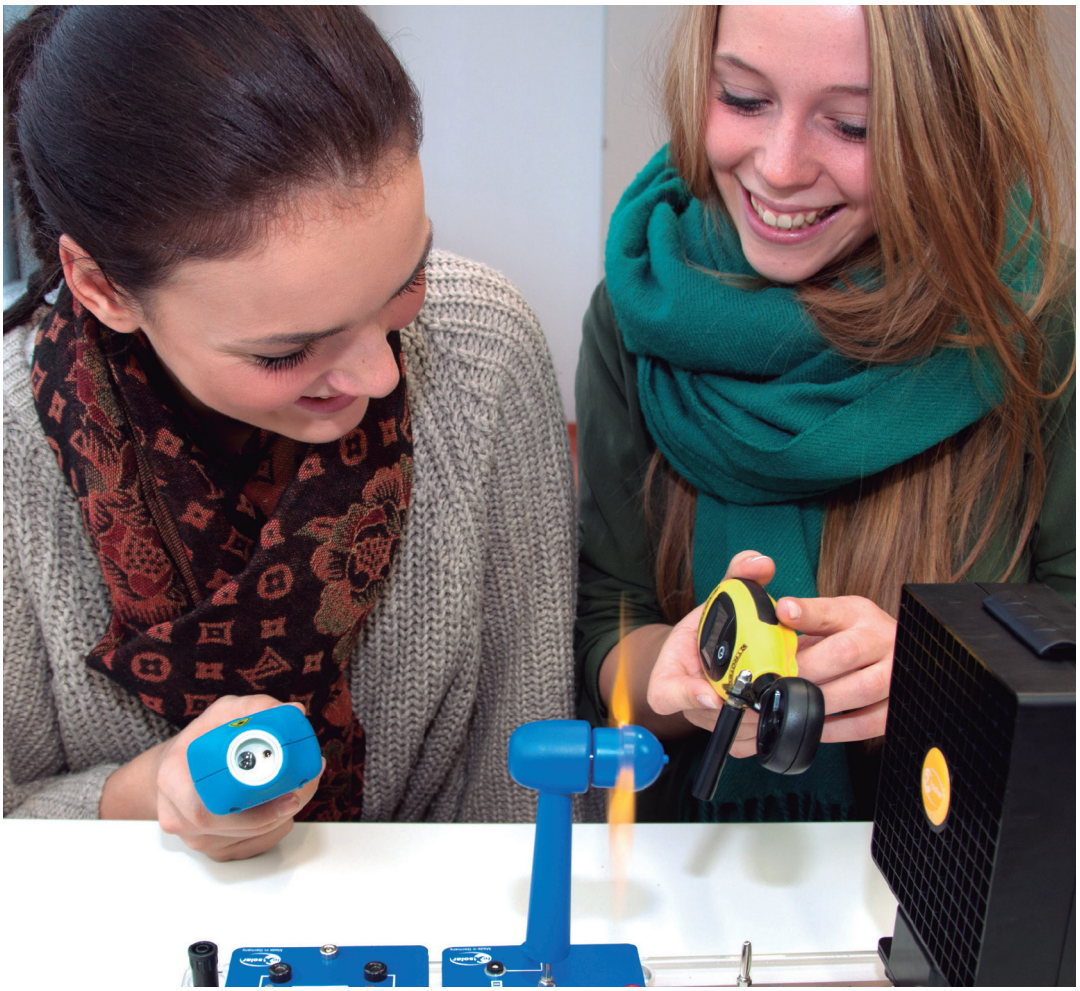
leXsolar-Wind Professional



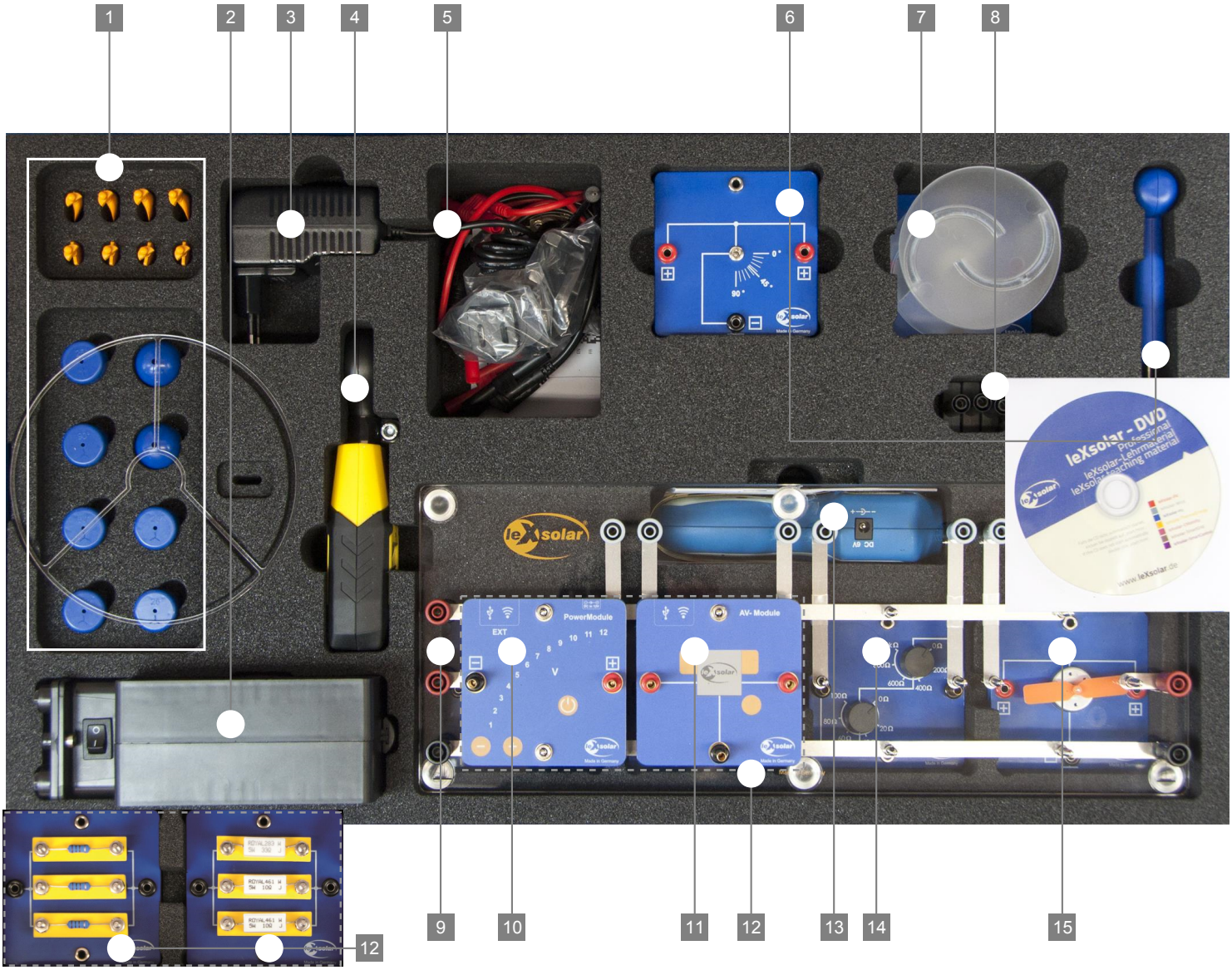
Experimental handbook

Layout diagram leXsolar-Wind Professional

Item-No.1406

Bestückungsplan leXsolar-Wind Professional

Art.-Nr.1406



1 1400-12 leXsolar-Wind rotor Set
1400-12 leXsolar-Windrotoren

2 1400-19 leXsolar-Wind machine
1400-19 leXsolar-Winderzeuger

3 Power supply for 10
Stromversorgung für 10

4 1400-20 Anemometer Pro
1400-20 Windgeschwindigkeitsmesser Pro

5 L2-04-066/067 Test lead red/black 25 cm
L2-04-066/067 Messleitung rot/schw. 25 cm
L2-04-059/060 Test lead red/black 50 cm
L2-04-059/060 Messleitung rot/schw. 50 cm

6 1118-03 leXsolar-Wind turbine module Pro
1118-03 leXsolar-Windturbinenmodul Pro

7 1118-14 Savonius rotor module Pro
1118-14 Savoniusrotormodul Pro

8 3xL2-05-068 Safety short-circuit plug
3xL2-05-068 Sicherheits-Kurzschlussstecker

9 1400-13 leXsolar-Base unit Pro
1400-13 leXsolar-Grundeinheit Pro

10 9100-05 PowerModule
9100-05 PowerModul

11 9100-03 AV-Module
9100-03 AV-Modul

12 2x 1800-01 Resistor module (triple) Pro with
3x 1800-04 Resistor plug element 100 Ohm
2x 1800-05 Resistor plug element 10 Ohm
1x 1800-06 Resistor plug element 33 Ohm
2x 1800-01 Widerstandsmodul 3-fach Pro mit
3x 1800-04 Widerstands-Steckelement 100 Ohm
2x 1800-05 Widerstands-Steckelement 10 Ohm
1x 1800-06 Widerstands-Steckelement 33 Ohm

13 L2-06-062 Rotational-speed sensor
L2-06-062 Digital-Drehzahlmessgerät

14 1118-04 Potentiometer module Pro
1118-04 Potentiometermodul Pro

15 1118-02 Motor module Pro with
L2-02-017 Propeller
1118-02 Motormodul Pro mit
L2-02-017 Propeller

Version number
Versionsnummer

L3-03-180_18.10.2017

CE RoHS

leXsolar-Wind Professional

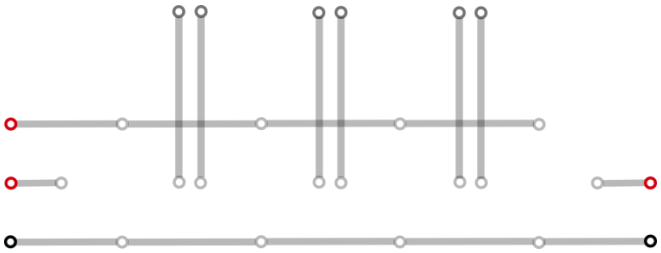
Experiment handbook

Content

1 Description of the experimental components

In the following schedule every component of the leXsolar-Wind Professional case 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 Professional 1400-13



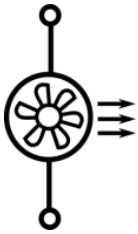
The base unit is a breadboard where up to 4 components can be plugged in a series and parallel connection. The current flows along the wires on the bottom side. At the head there are bypass slots to connect the components in the desired way.

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. Misuse leads to termination of warranty.

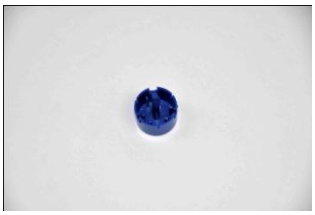
Specifications:

- Maximum voltage: 12 V DC (stabilized)
- Wind speed: 0 – 7 m/s

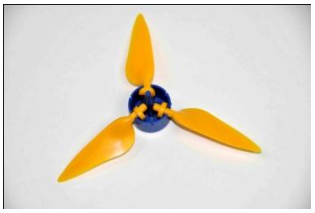


Wind rotor set 1400-12

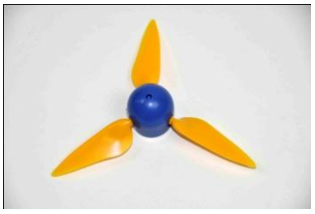
With the available components, rotors with 2, 3 or 4 blades and with a flat or an optimezed profile can be created. There is a hub for 4 blades with a pitch angle of 25° and hubs for 3 blades with pitch angles of 20°, 25°, 30°, 50° und 90°. To assemble you should proceed in the following way:



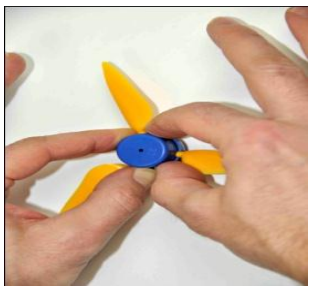
First, a hub with the desired rotor blade pitch and the number of blades should be selected. (The hubs are labelled on the back.) The Two-blade rotor and the Four-blade rotor can both be constructed with the Four-blade hub.



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

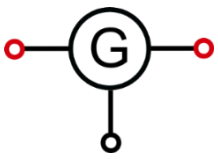


After installation of the rotor blades, the hub-cap will be mounted and lightly pressed against the hub.



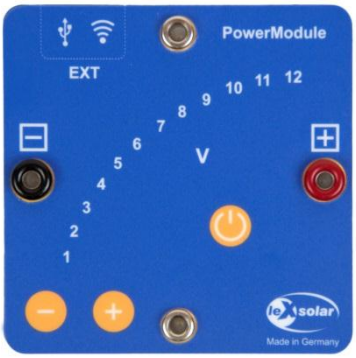
To replace the blades, a small nose is located on the head of the hub. If the nose is pressed lightly on a hard surface, the hub-cap can be removed easily.

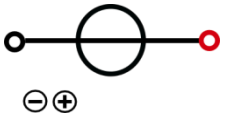
Wind turbine module 1118-03



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!

PowerModule 9100-05



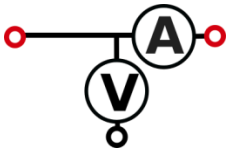


The PowerModule is a compact and intuitively usable voltage source. First, the attached power adapter has to be connected to a power outlet and to the top right input jack. The voltage can be chosen with the „+“- and „-“ -buttons and will be displayed by LEDs. When the desired voltage is chosen, the 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:

- Output voltage: 0-12 V
- Output power: max. 24 W
- Adjustable in 0.5 V steps
- Overcurrent detection >2 A and automatic shutoff
- Input voltage: 110-230 V, 50-60 Hz (with enclosed power adapter)

AV-Module 9100-03



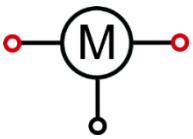
The AV-Module is a combined voltage and current meter. It holds 3 buttons, whose features are described in the display respectively. By pushing a random button the module will switch on. In the disabled state the display shows the leXsolar emblem. When the display does not show anything or the word „Bat“ is shown, it is necessary to change the batteries in the back (2 x AA batteries 1.2 to 1.5V; Take care of the polarity marked on the bottom of the battery case! Do not touch the button while inserting the batteries).
With the top right button the measuring mode can be switched between voltage mode, current mode or combined voltage-current mode. Both measurement mode and required cable connection will be indicated by the circuit symbols on the display. Take care that in voltage mode no current is applied to the right jack. In the combined mode the voltage can be measured with the right jack as well as with the left one. The influence of the internal resistance of the current measurement is compensated internally. The measured values are signed. When the positive pole is connected to a red jack and the negative pole is connected to the black jack, the value of the voltage will be positive. When current is applied from the left to the right, the current value will be positive, as well. The other way around, the algebraic sign changes.
After 30 min without pushing a button or after 10 min of measuring a constant value, the module will switch off automatically. It can measure voltages up to 12 V and currents up to 2 A. In case of exceeding one of the values, the module interrupts the current flow and shows “overcurrent“ or “overvoltage”. This error message can be confirmed by touching a button. The module will resumes measuring, when the values attain acceptable values.

Specifications:

Voltage metering:
- range: 0...12 V
- accuracy: 1 mV
- automatic shutoff in case of overvoltage >12 V

Current metering:
- range: 0...2 A
- accuracy: 0,1 mA (0...199 mA) und 1mA (200 mA...1 A)
- automatic shutoff in case of overcurrent >2 A
- internal resistance <0,5 Ohm (0...200 mA); <0,2 Ohm (200 mA...2 A)

Motor module (1118-02) with yellow propeller (L2-02-017)

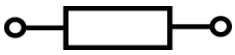


The motor module acts as a consumer in Wind experiments.

Potentiometer module 1118-04

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 200 mA.

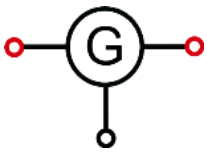
Resistor module (triple) with resistor plug elements 1800-01



Parallel connection and series connection of resistors are possible. For parallel connection use one resistor module (triple) with three slots. For series connection use two resistor modules (triple). The following resistor plug elements are included:

2 x R=10Ω 1800-05
1 x R=33Ω 1800-06
3 x R=100Ω 1800-04

Savonius rotor (with generator module) 1118-14



Start-up wind speed: ca. 3.3 m/s

Nominal voltage at wind speed of 5 m/s: 0.4 V

Wind force transducer with mount 1400-20

Wind speed: 1.1-30.0 m/s
Resolution: 0.001m/s

R.p.m. counter L2-06-062

Laser class: 2
Output: < 1 mW
Wavelength: 630 - 670 nm

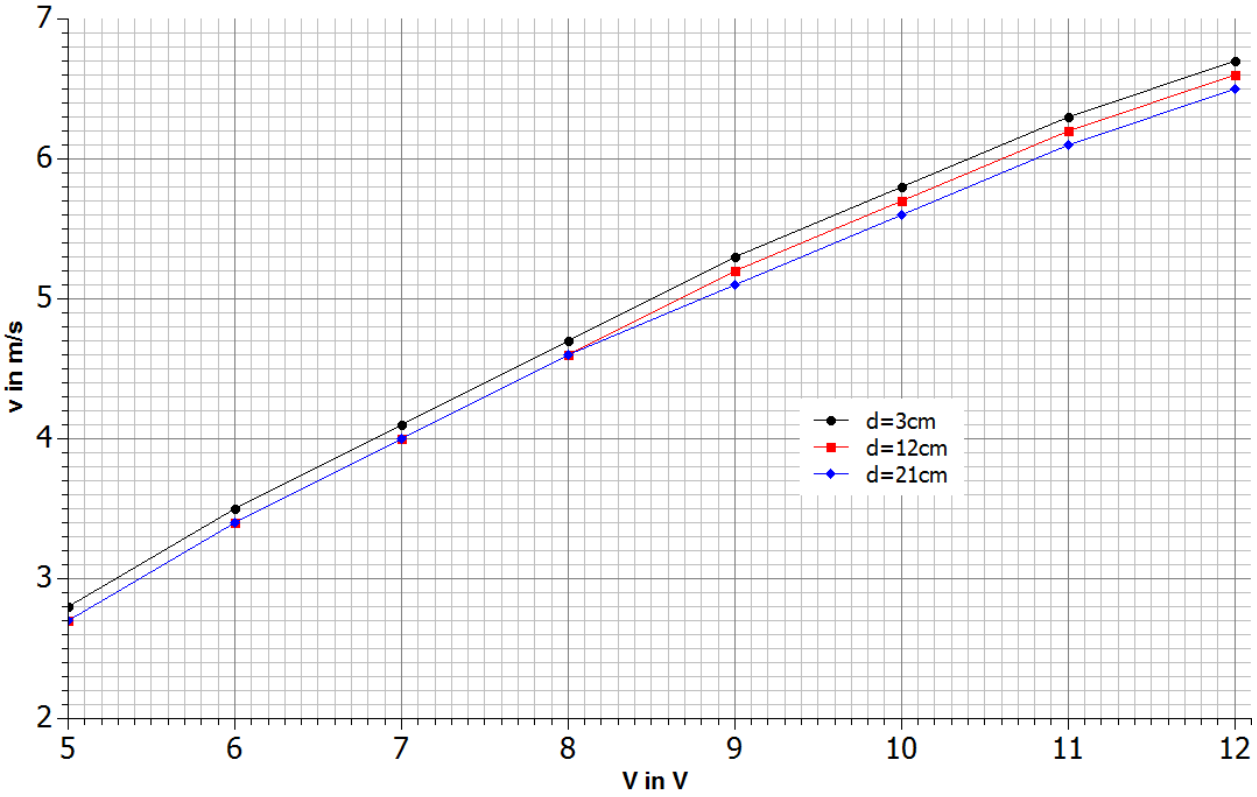
Measuring range: 2 ... 99999 BpM; 0.1 (2...999 BpM); 1
(1000...99999 BpM) ± 0.05 % + 1 dgt.

Measuring sequence: 2x/sec. over 120 BpM
Measuring distance: 50 mm ... 500 mm
Total Bpm: 1 ... 19 999 BpM; 0.1 BpM

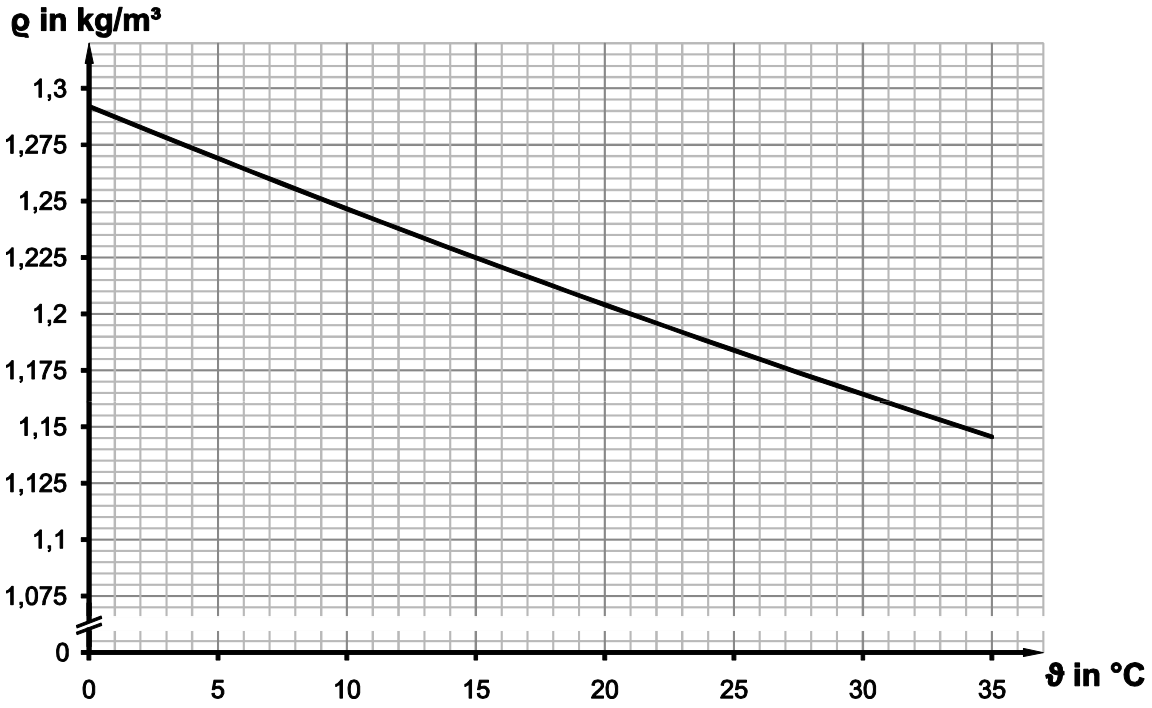
Diagrams for the experiments

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

Wind speed at the wind generator



Air density (depending on the ambient temperature)

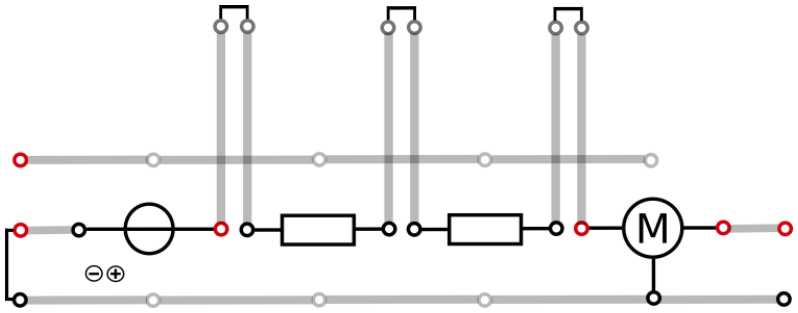


B.1 Setup of a simple circuit

Task

Set up a simple electrical circuit.

Setup



Required devices

- base unit
- 1 PowerModule (V=5V)
- 2 resistor module, triple
- 2 resistor plug elements (R=100Ω)
- 1 motor module

Execution

1. Set up the experiment according to the circuit diagram.
2. Open and close the electrical circuit by:
   a) Plug in/plug off a cable.
   b) Plug in/plug off a current bridge.
   c) Plug in/plug off a resistor
3. Note your observations.

Observation

The motor stops turning when the electrical circuit is interrupted. It is not an issue in which way the circuit is broken.

Evaluation

1. Formulate reasons for the behavior of the motor.

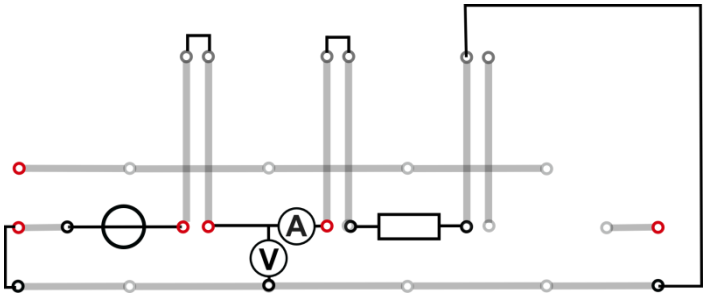
The motor needs a certain voltage and current to turn. When the circuit is interrupted no current is flowing and therefore the motor stops turning.

B.2 Ohm`s law

Task

Investigate Ohm`s law with several resistors.

Setup



Required devices

- base unit
- 1 PowerModule (6V)
- 1 resistor module, triple
- 3 resistor plug elements
  (R=100Ω, R=33Ω, R=10Ω)
- 1 AV-Module

Execution

1. Set up the experiment according to the circuit diagram.
2. Measure voltage and current for various resistances. Use the AV-Module in voltage-current-mode.
   - R=100Ω
   - R=33Ω
   - R=10Ω
3. Note your measured data in the table and calculate each the ratio V/I.

Measurement

R (Ω)	100	33	10
V (V)	6.0	5.9	5.9
I (mA)	62.3	184.6	592.5
V/I (Ω)	96.6	32.3	10.0

Evaluation

1. Deduce a connection between resistance R and ratio V/I. Which lawfulness can be derived?

The resistance R is matching the ratio V/I. Therefore the equation of Ohm`s law can be deduced:

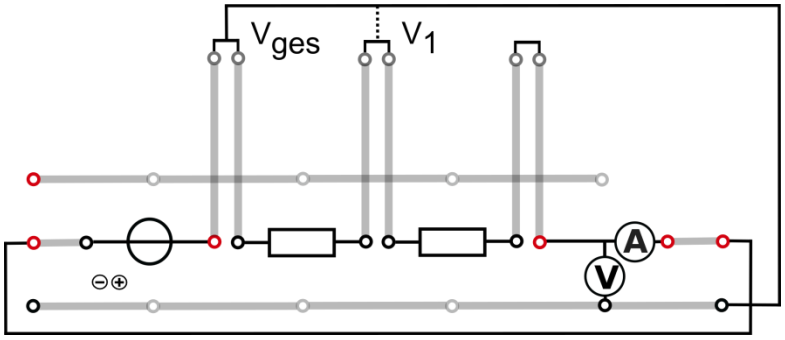
R=V/I

B.3 Series connection of ohmic resistances

Task

Examine the series connection of ohmic resistances.

Setup



Required devices

- base unit
- 1 PowerModule
- 2 resistor modules, triple
- 4 resistor plug elements
  (2x R=100Ω, 1x R=10Ω, 1x R=33Ω)
- 1 AV-Module

Execution

1. Set up the experiment according to the circuit diagram. Start with a series connection of 2x100Ω.
2. Measure each voltage and current over both resistances (V_{tot}) and the single voltage (V_1, V_2) for the following circuits:
   - R_1=100Ω / R_2=100Ω
   - R_1=100Ω / R_2=10Ω
   - R_1=33Ω / R_2=10Ω

Note: To measure the resistance V_1, respectively V_2 the resistor plug elements have to be switched. Use the AV-Module in current-voltage-mode.

3. Note your measured data in the table.

Measurement

	R_1=100Ω / R_2=100Ω	R_1=100Ω / R_2=10Ω	R_1=33Ω / R_2=10Ω
V_1 (V)	2.52	4.57	3.85
V_2 (V)	2.51	0.45	1.14
V_{tot} (V)	5.03	5.02	4.99
I (mA)	26.10	47.30	119.40
$R_{tot}=V_{tot}/I$ (Ω)	192.7	106.1	41.8

B.3 Series connection of ohmic resistances

Evaluation

1. Calculate each the ratio $R_{tot}=V_{tot}/I$ and note your values in the table above.
2. Calculate each the sum of the single voltages ($V_1 + V_2$) and compare it to the voltage over both resistances (V_{tot}).
3. What is the influence of the resistance on the current I and the voltages $V_1 + V_2$, respectively V_{tot}?
4. What is the connection between the total resistance R_{tot} and the single resistances?
5. Formulate a law for the calculation of the total resistance in a series connection of resistances.

2.

	$V_1 + V_2$	V_{tot}
R_1=100Ω / R_2=100Ω:	5.03	5.03
R_1=100Ω / R_2=10Ω:	5.02	5.02
R_1=33Ω / R_2=10Ω:	4.99	4.99

→ $V_{tot}= V_1+V_2$

3.

The higher the resistance, the lower the current.

The higher the sum of the resistances, the lower the current

If both resistances are equal, the voltage over the resistances is also equal.

If one resistance is higher, a higher voltage can be measured at the higher resistance.

The total voltage remains constant.

4. + 5.

The total resistance is nearly matching the sum of the single resistances.

Therefore the equation for the total resistance in a series connection can be written as:

$R_{tot}= R_1+ R_2+…+R_n$ (n…number of resistances)

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