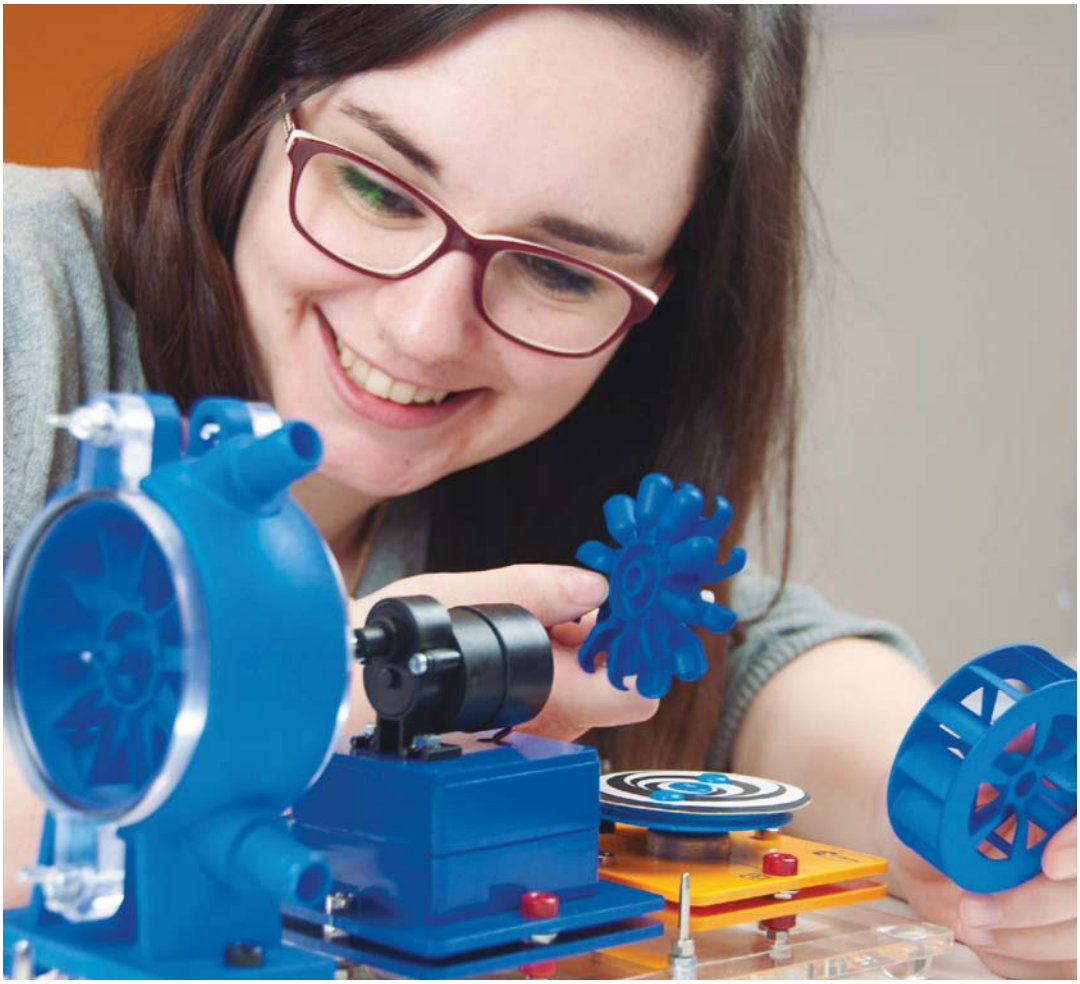
leXsolar-Hydropower Ready-to-go

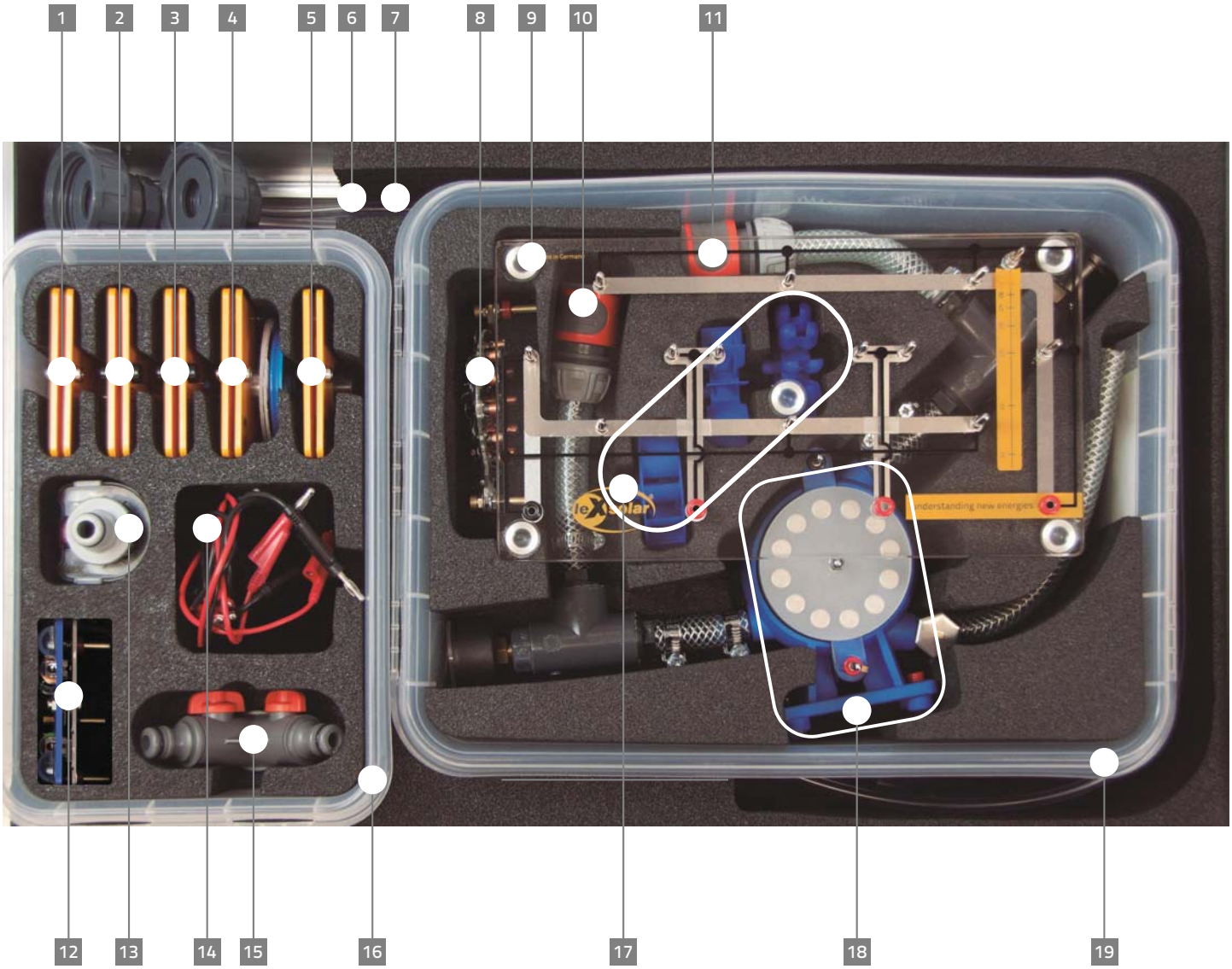


Teacher's manual

www.lexsolar.de/feedback

Layout diagram leXsolar-Hydropower Ready-to-go
Item-No.1905

Bestückungsplan leXsolar-Hydropower Ready-to-go
Art.-Nr.1905



1 1100-26 Light bulb module
1100-26 Glühlampenmodul

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

3 1100-22 Resistor module
1100-22 Widerstandsmodul

4 1100-27 Motor module without gear with 1100-28 Color discs - Set 1
1100-27 Motormodul mit 1100-28 Farbscheiben-Set I

5 1100-25 Buzzer module
1100-25 Hupenmodul

6 1900-08/09/10 Flow set 4/8/12 mm
1900-08/09/10 Durchfluss-Set 4/8/12 mm

7 1900-12 Connection set
1900-12 Anschlussset

8 1905-02 Induction generator 12 fold
1905-02 Induktionsgenerator 12-fach

9 1100-19 leXsolar-Base unit
1100-19 leXsolar Grundeinheit groß

10 1900-06 Manometer set 4 bar
1900-06 Manometer Set 4 bar

11 1900-05 Manometer set 2 bar
1900-05 Manometer Set 2 bar

12 9100-03 AV-Modul
9100-03 AV-Modul

13 L2-02-066 Water flow meter
L2-02-066 Wassermengenzähler

14 L2-06-012 Test lead 25 cm, black
L2-06-012 Messleitung 25 cm, schw.
L2-06-013 Test lead 25 cm, red
L2-06-013 Messleitung 25 cm, rot
L2-06-014 Test lead 50 cm, black
L2-06-014 Messleitung 50 cm, schw.
L2-06-015 Test lead 50 cm, red
L2-06-015 Messleitung 50 cm, rot

15 1900-07 Intake connector
1900-07 Zulaufverbinder

16 L3-01-197 Container box 6L
L3-01-197 Auffang-Box 6L

17 1900-03 Turbines set
1900-03 Turbinenset

18 1900-02 Water turbine casing
1900-02 Wasserturbinengehäuse

19 1900-11 Flow box
1900-11 Durchfluss-Box

Version number
Versionsnummer

III-01.24_L3-03-272_30.08.2016

CE RoHS2

leXsolar-Hydropower Ready-to-go

Teachers's manual

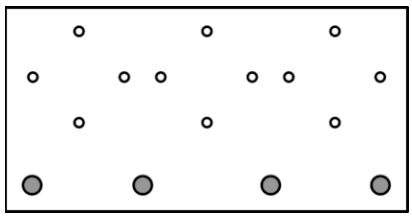
Content

II. General information

Identification oft he components

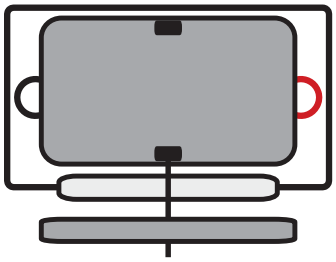
In the following schedule every component of the leXsolar-Hydropower Ready-to-go is listed. For every component there is the name with article number, a picture, the pictogram for the circuit diagram and operating instructions. With the aid of the article number it is possible to reorder a specific component.

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°.

Water turbine casing 1900-02 with induction generator 12 folds 1905-02 and turbine set 1900-03



The turbine casing has 2 inflows and 1 outflow. The three different turbines of the turbine set can be inserted in the turbine casing.
The turbine set consists of water wheel, cross-flow and pelton turbine. While experimenting with water wheel and cross-flow turbine the upper inflow is used. Using the pelton turbine the water should be running through the lower inflow.
A shaft conects the turbine with the white magnet disk on the outside of the casing. On top of it the induction generator can be attached. The generator is made out of coils, diodes and capacitors. Is the turbine spinning, the magnet disk is spinning as well. This causes a change in the magnetic field in the coils and a voltage is induced. The sinusoidal voltage is rectified by the diods and straightened by the capacitors.

Manometer set 2 bar 1900-05
Manometer set 4 bar 1900-06

The manometer sets display the pressure the water has flowing into the turbine. The 4 bar manometer is installed on the lower inflow, the 2bar set on the upper inflow.

Intake connector 1900-07

The intake connector joins the upper and the lower inflow. Adjusting the valves, it can be controlled via which inflow the water should be provided.

Water volumeter L2-02-066

The water volumeter is plugged ontop of the intake connector. It has various programmes, which can be chosen by pressing the orange button. For the following described experiments it is always used the “liters per min” mode.

Fabric hose 12/18mm L2-02-062

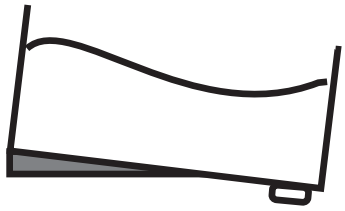
The fabric hose has the function to connect the water turbine complex with the water supply in the house. With one end he has to be adjusted on top of the water volumeter, the other end to a water supply.

Flow set 4mm 1900-08
Flow set 8mm 1900-09
Flow set 12mm 1900-10




Each flow set consist of a 1m long hose and a connecting piece. The flow sets varaiate in their inside diameter of 4mm, 8mm und 12mm. With the connecting piece the flow set can be screwed to the bottom of the flow box. For marking the hight, every hose hase a O ring, which can be pulled to the required place.

Flow box 1900-11

The Flow box has a drain where the flow sets can be screwed onto. It has an inclined bottom so the water can drain continuously.

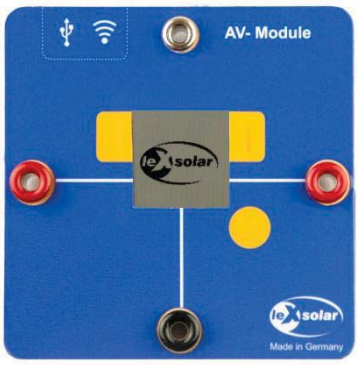
Collection box 6L L3-01-197

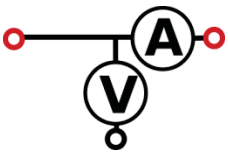

The collection box is made to catch the outflowing water of the flow sets.

Hose clamp L2-05-131
Hose clamp with rotary knob and hexagon scew, stainless steel L2-05-135


The hose clamps fix and seal the hoses on the turbine casing. They are permanently mounted. The hose for the outflow is hold by a hose clamp with roary knob. When beginning the experiments, this clamp should be used to to turn the hose facing downwards.

AV-Modul 9100-03





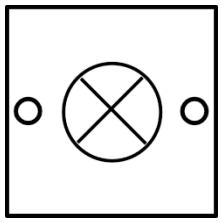
The AV-Module is a combined voltage and current meter. It holds 3 buttons, whose features are described in the display respectively. By pushing a random button the module will switch on. In the disabled state the display shows the leXsolar emblem. When the display does not show anything or the word „Bat“ 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.
11
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) and 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)

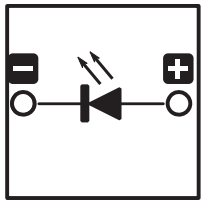
Light bulb module 1100-26



Specifications:

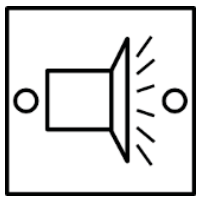
Light bulb P_{typ} = 200 mW (at 3.5 V)
Fuses work up to maximum voltage of 6 V

LED- module 2mA 1400-08



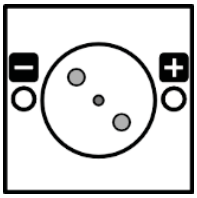
Inside the LED-module, there is a red LED with a wavelength emission of 697 nm. There has to be a minimum voltage of 1.7 V to light up the LED.

Horn module 1100-25

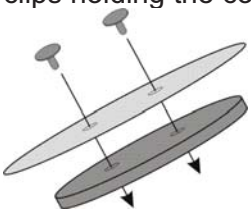


The horn starts making a noise from 0.7 V and 0,3 mA.

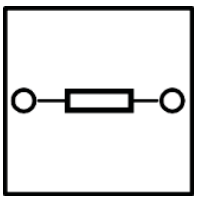
Motor module (1100-27) with color discs (1100-28)



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. As shown in the picture there are two clips holding the color discs in place. Optical illusions, like the additive color mixing, can be illustrated.



Resistor module 1100-22

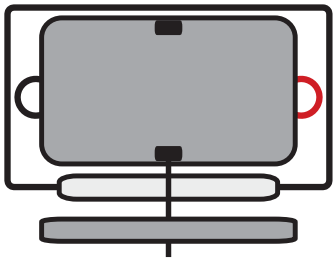


The resistor module contains an ohmic resistor of 33 Ω with a derivation of 5 %. The maximum power dissipation can amounts to 2W.

Handling instructions for the water turbine complex

Symbol:

In the experiments the water turine casing is always used together with the induction generator, a turbine, the intake connector and the water volumeter. In the following there will be only one symbol used for the whole water turbine complex:



Assembling:

Take the water turbine casing. Attach the induction generator to it. Observe to the correct polarity (black sleeve to black plug and red sleeve to red plug.
Loosen the hose clamp on the outflow. Turn the hose until it is facing downwards and tighten the clamp again.
Find the intake connector and join the upper and lower inflow with it. On top the intake connector the water volumeter and the fabric hose is pinned on. Pay attention that all connections are well sealed. That is given, when they snap together with a click.
Control if the valves on the inflows and on the water volumeter are closed (valves are standing crosswise to the hose.)

The transparent disk on the backside of the water turbine casing can be taken of. Therefore loosen the wing screws. Now you can put one of the turbines in the casing. Push it onto the shaft with its flat side facing forward. Place the transparent disk back on it and tighten up the wing screws. Note that the sealing ring is sitting correctly in its groove.
Now you can stick it onto the unit base and start experimenting.

Disassambling:

Disassabling the water turbine complex works the same way as putting it together. Only pay attention that the intake connecter opens when the closure is pulled backwards, while the water volumeter and the connection of the fabric hose opens by screwing.

Important evidences:

1. Bevor starting the experiments, it hast o be checked if all components that are used with wate are properly sealed. In particular this is regarding all connections on the water turbine casing.

2. For experimenting a secure water outflow is needed. For example a sink or collection tank would be suitable

3. Ensure that all plug in connections are well and dense connected and the valves are closed at the beginning.

4. Pay attention that the base unit is not standing on a conductive ground. A drip off made out of stainless steel next to the sink is not suitable and should be covered with an additional base.

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Learning objectives

Experiment 1.1: Power and flow velocity depending on different heights

- The students learn how the falling height is defined.
- The students measure the time the water takes to drain completely.
- Out of that they are calculating flow velocity, potential energy and power.
- The students learn that power and flow velocity increase with increasing hose diameter.

Experiment 1.2: Flow rate depending on different hose diameters

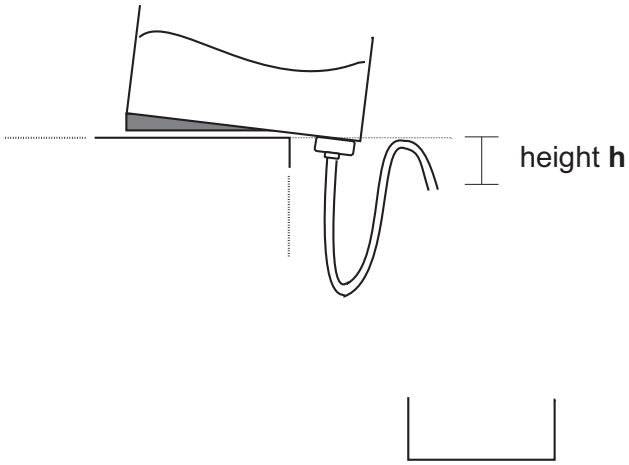
- The students measure the time the water takes to drain completely.
- They are calculating flow velocity and power.
- The students understand that flow velocity increases with wider hose diameters. Moreover they observe that this is not happening linear but you have to respect the friction loss of the water.
- The students transfer their gained knowledge from the experiment into reality.

1.1 Power and flow velocity depending on different heights

Exercise

Observe power and velocity of water that is running through a hose depending on the height difference.

Setup



Required devices

- Flow box
- Collection box
- Flow set 12 mm
- Flow set 8 mm

- Stopp watch
- Ruler

Execution

1. Find a suitable setup to place the two boxes with a height difference of about 0.5 meter. The flow box has to stand on top with the connection for the flow sets sticking out over an edge. Screw the 12 mm Flow Set on to it.
2. Measure with a ruler the first height (10 cm) from the free end of the hose. Mark this point by pulling the O-ring to that place.
3. Fill 5 liters of water into the upper box. Be careful that the free end of the hose is laying higher than water level, so the water cannot flow out immediately.
4. Lower the end of the hose until the water level is standing 1cm away from the end. Close the hose with your thumb.
5. Place the hose with the O-ring mark on the edge of the table with the free end you are closing facing downwards.
6. As soon as you take your thumb away, the water will begin to flow. Make sure that the collection box is well positioned to catch the water.
7. Measure with a stop watch the time it takes from the moment you take your thumb away and the water starts to run until the hose sucks in air. Write it down in the table.
8. Take measurements for all heights given in the table and repeat the experiment with the 8mm flow set.
9. Calculate the missing values.
10. Draw a diagram showing flow velocity and power depending on the height.

1.1 Power and flow velocity depending on different heights

Measurements

Hose with **12 mm** diameter

Cross-sectional area oft he hose with 12 mm inside diameter: $A_{12\,mm} = 113{,}01\,mm^2$

Height **h** in **cm**	10	20	30	40
time $t_{12\,mm}$ in **s**	55	40	35	27
Flow velocity $v_{12\,mm}$ in **m/s**	0,80	1,11	1,26	1,64
Potentiell enery E_{pot} in **J**	4,9	9,81	14,7	19,6
Power $P_{12\,mm}$ in **W**	0,09	0,25	0,42	0,73

Hose with **8 mm** diameter

Cross-sectional area oft he hose with 8 mm inside diameter: $A_{8\,mm} = 50{,}27\,mm^2$

Height **h** in **cm**	10	20	30	40
time $t_{12\,mm}$ in **s**	152	116	95	74
Flow velocity $v_{12\,mm}$ in **m/s**	0,29	0,38	0,47	0,60
Potentiell enery E_{pot} in **J**	4,9	9,81	14,7	19,6
Power $P_{12\,mm}$ in **W**	0,03	0,08	0,15	0,27