

leXsolar-ThermalEnergy Ready-to-go



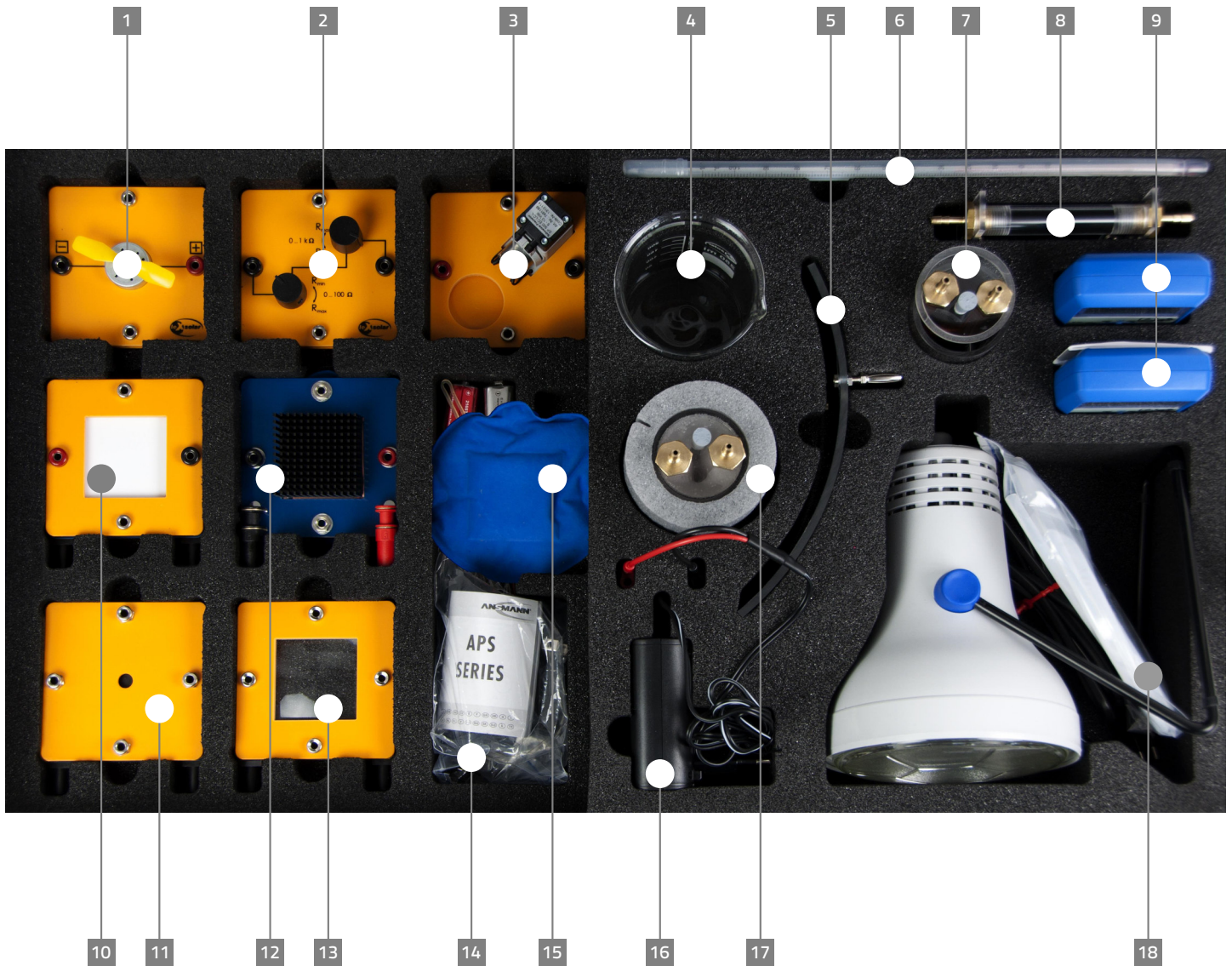
Instructions Manual

Layout diagram leXsolar-ThermalEnergy Ready-to-go 2.0

Item-No.1304

Bestückungsplan leXsolar-ThermalEnergy Ready-to-go 2.0

Art.-Nr.1304



- 1 1100-27 Motor module
1100-27 Motormodul
L2-02-017 Yellow propeller
L2-02-017 Luftschraube (Propeller) gelb
- 2 1100-23 Potentiometer module
1100-23 Potentiometermodul
- 3 1300-09 Pump module with 22
1300-09 Pumpenmodul mit 22
- 4 L2-06-082 Beaker 250 ml
L2-06-082 Becherglas 250 ml

- 5 1300-04 Parabolic reflector
1300-04 Parabolspiegel-Kollektor
- 6 L2-06-016 Laboratory thermometer
L2-06-016 Laborthermometer
- 7 1300-12 Heat exchanger paraffin
1300-12 Wärmetauscher Paraffin
- 8 1300-05 Absorber tube
1300-05 Absorberrohr
- 9 2xL2-06-011 Digital multimeter
2xL2-06-011 Digitalmultimeter
- 10 1300-08 Absorber B/W
1300-08 Absorber S/W
- 11 1300-07 Absorber module for lens
1300-07 Absorbermodul für Linse

- 12 1300-10 Peltier module
1300-10 Peltiermodul
- 13 1300-06 Lens module
1300-06 Linsenmodul
- 14 2xL2-06-014/015 Test leads black/red
2xL2-06-014/015 Messleitung schwarz/rot
- 15 L2-06-125 Cooling pad
L2-06-125 Kühlkissen
- 16 2105-00 Power supply
2105-00 Stromversorgungsgerät
- 17 1300-11 Heat exchanger water
1300-11 Wärmetauscher Wasser
- 18 1300-13 Hose set
1300-13 Schläuche-Set

Version number
Versionsnummer

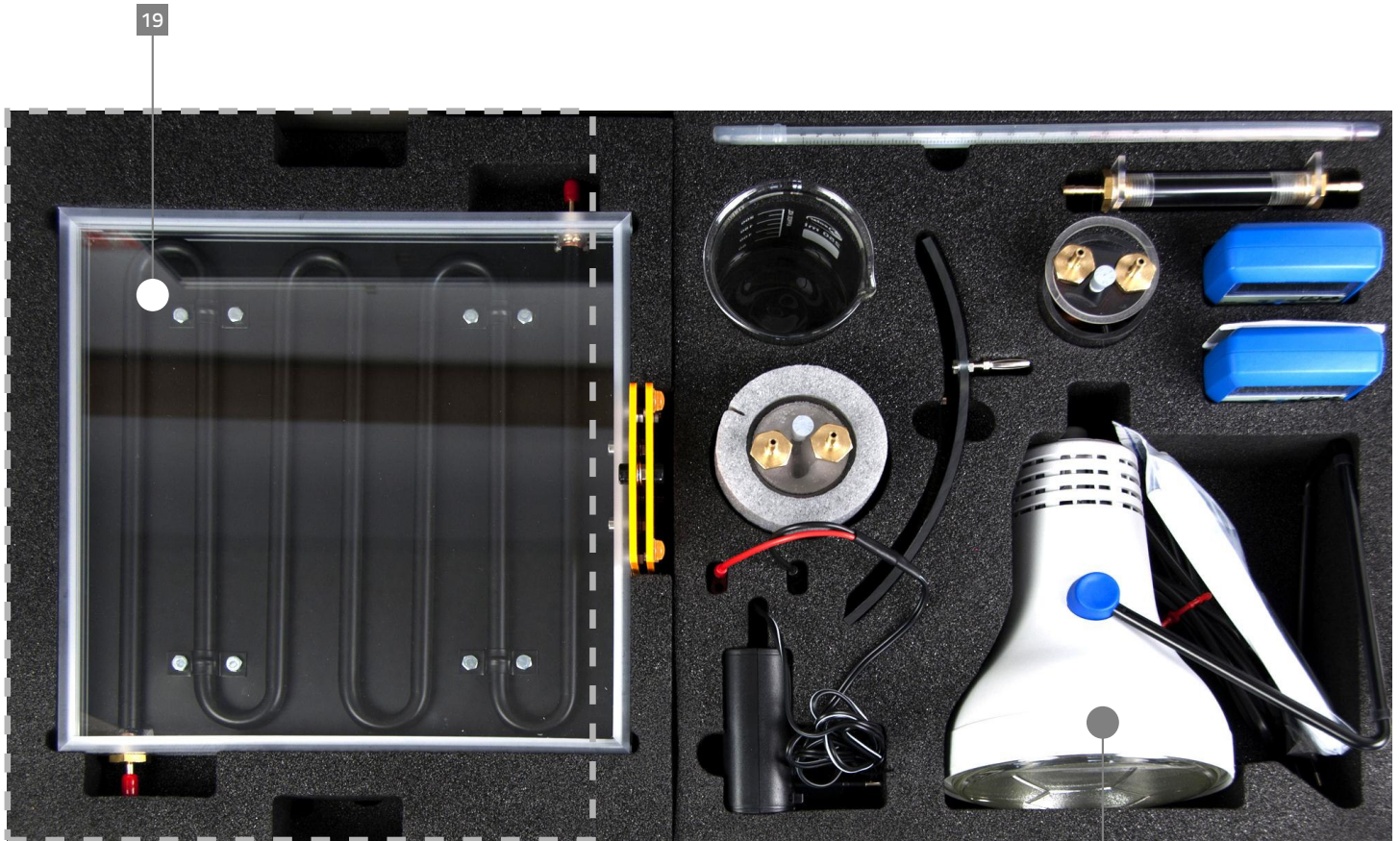
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Layout diagram leXsolar-ThermalEnergy Ready-to-go 2.0

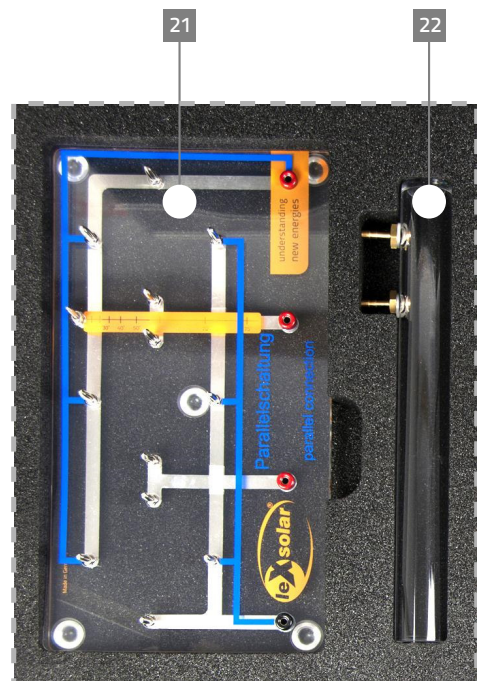
Item-No.1304

Bestückungsplan leXsolar-ThermalEnergy Ready-to-go 2.0

Art.-Nr.1304



- 19 1300-03 Solar colector
1300-03 Solar-Kollektor
- 20 L2-04-080 Lamp
L2-04-080 Lampe
- 21 1100-19 leXsolar-basic unit
1100-19 Grundeinheit groß
- 22 Balancing container with 3
Ausgleichsgefäß mit 3



leXsolar-ThermalEnergy

Student`s manual

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1. Absorptivity and reflectivity of different materials

Task

Find out the differences in absorptivity and reflectivity of thermal radiation for a copper plate with white and black coating.

Setup



Equipment

- Basic module
- Spotlight
- Digital meter
- Absorption module black/white
- Cables

Procedure

1. Put the absorption module black/white into the basic module with the white side facing the spotlight. The distance between absorption module and spotlight should be 15 cm.
2. Connect the digital meter with the absorption module black/white as shown in the figure.
3. Adjust the digital meter to the symbol $^{\circ}\text{C}$ to start the temperature measurement. Also keep a clock ready for time measurements during the experiment.
4. Note down the temperature $T(0)$ at the beginning and start the measurement by turning on the spotlight. Write down the temperature, which is measured electrically on the metal surface, every minute.
5. Turn the spotlight off and let the absorption module black/white cool down until it has returned to its approximate starting temperature.
6. Repeat the measurement with the black side of the absorption module. Take care that the distance to the spotlight is again 15 cm.

Data

Table 1.1 – Development of the temperature on the white side

Time in minutes	0	1	2	3	4	5	6	...
Temperature								



1. Absorption and reflectivity of different materials

Data

Table 2.1 – Development of the temperature on the black side

Time in minutes	0	1	2	3	4	5	6	...
Temperature								

Analysis

1. Enter your results in the depicted diagram.
2. Compare the results of the two parts of the experiment and explain the observed differences.
3. Explain which conclusions can be drawn from your results for the construction of solar thermal collectors.

Diagram

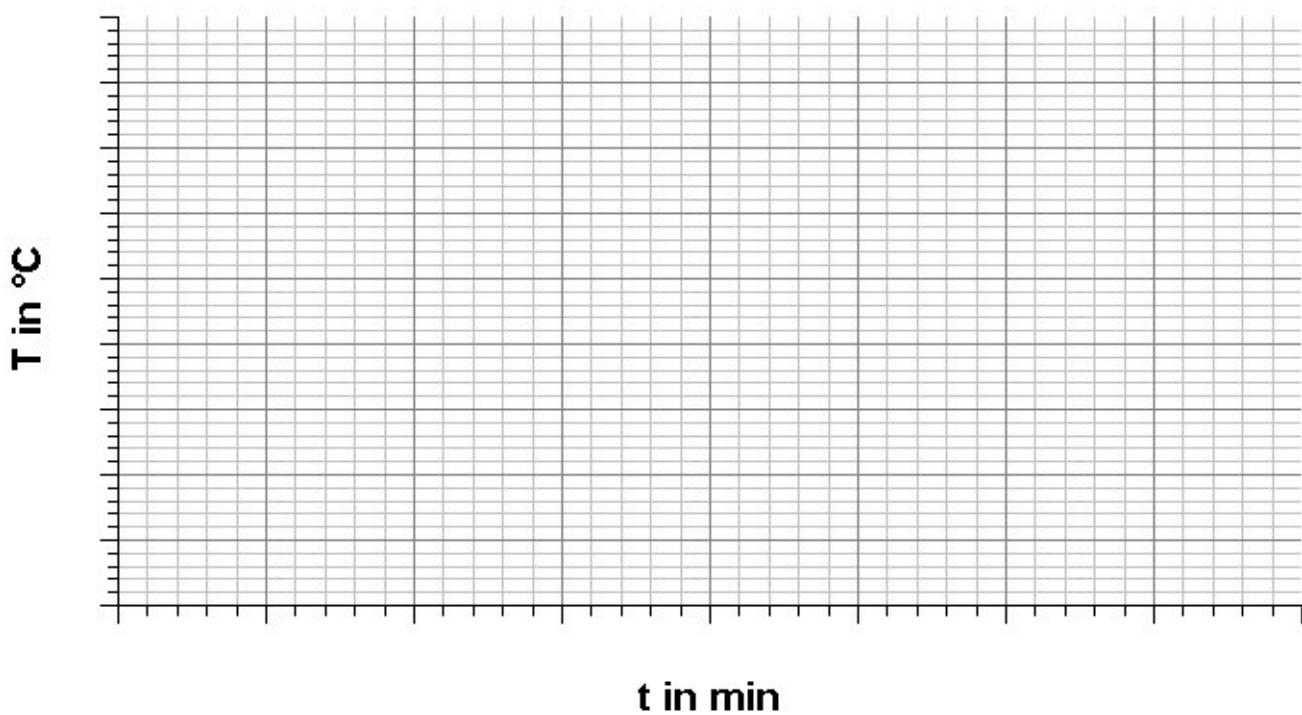


Diagram 1.1 – Development of the temperature at the absorption module black/white.



1. Absorptivity and reflectivity of different materials

Analysis

2.

3.



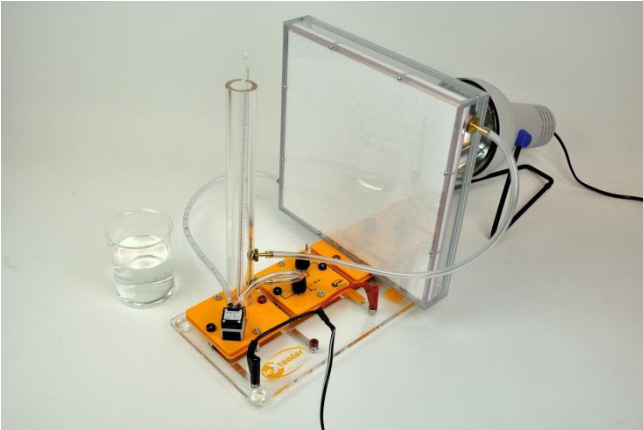
8. Variation of the flow speed

Task

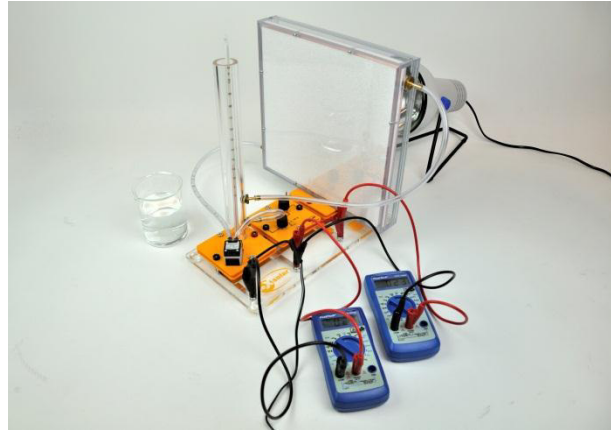
Find out at what flow speed through the solar thermal circulation the solar collector works most effectively.

Setup

8.1 Voltage control at the power supply unit



8.2 Voltage control with voltage divider circuit



Equipment

- Basic module
- Pump module
- Balancing container
- Solar thermal collector
- Potentiometer module
- Spotlight
- Hoses
- Liquid thermometer
- Power supply unit
- Beaker
- Digital meter with cables and temperature sensor

Preparation

Put the solar thermal collector and the pump module with the balancing container onto the basic module as shown in figure 8.1 and connect the modules with the enclosed hoses. Take care that the left pump connection is plugged into the lower connection of the collector and that the right connection is plugged into the balancing container. Afterwards, connect the balancing container with the upper connection of the collector in order to close the water circuit.

Procedure

Variation A – Setting at the power supply unit: Set the voltage necessary for the experiment directly at the power supply unit. The voltage control here, however, is not continuously variable.



8. Variation of the flow speed

Procedure

Variation B – With voltage divider circuit:

1. Put the potentiometer module onto the last empty slot of the basic module so that it is connected in series to the pump.
2. Connect digital meters for the voltage measurement, one each in parallel with the pump and the potentiometer (measurement range 20 V).
3. Now fill water into the balancing container with the aid of the beaker and connect the power supply unit via the pump and the potentiometer (12 V) (see figure 8.2).
4. Turn the potentiometer to control the pump flow continuously. The pump then transports water into the circulation.

Advice: If necessary, add some water with the beaker until a stable water circuit with approx. 200 ml liquid is reached. To remove remaining air inclusions from the collector, you can carefully tilt it.

5. To start the experiment, put the liquid thermometer into the balancing container and keep a clock ready for time measurements. A voltage of 5 V is set at the pump.
6. Position the spotlight in front of the collector (15 cm distance) and turn it on. Measure the temperature development inside the balancing container during heating up of the collector and enter the respective values into the table.
7. Repeat the experiment with a voltage of 9 V, if you directly set it on the power supply unit, or with 10 V, if you use the potentiometer. Enter these values into the table also.

Data

Table 8.1 – Heating up at 5 V

Time in minutes	0	2	4	6	8	10	12	...
Temperature in C°								

Table 8.2 – Heating up at 9 V (10 V, respectively)

Time in minutes	0	2	4	6	8	10	12	...
Temperature in C°								

Analysis

1. Transfer your results from the table into the shown diagram.
2. Compare the results from both parts of the experiment by describing the development of the temperature for both cases.

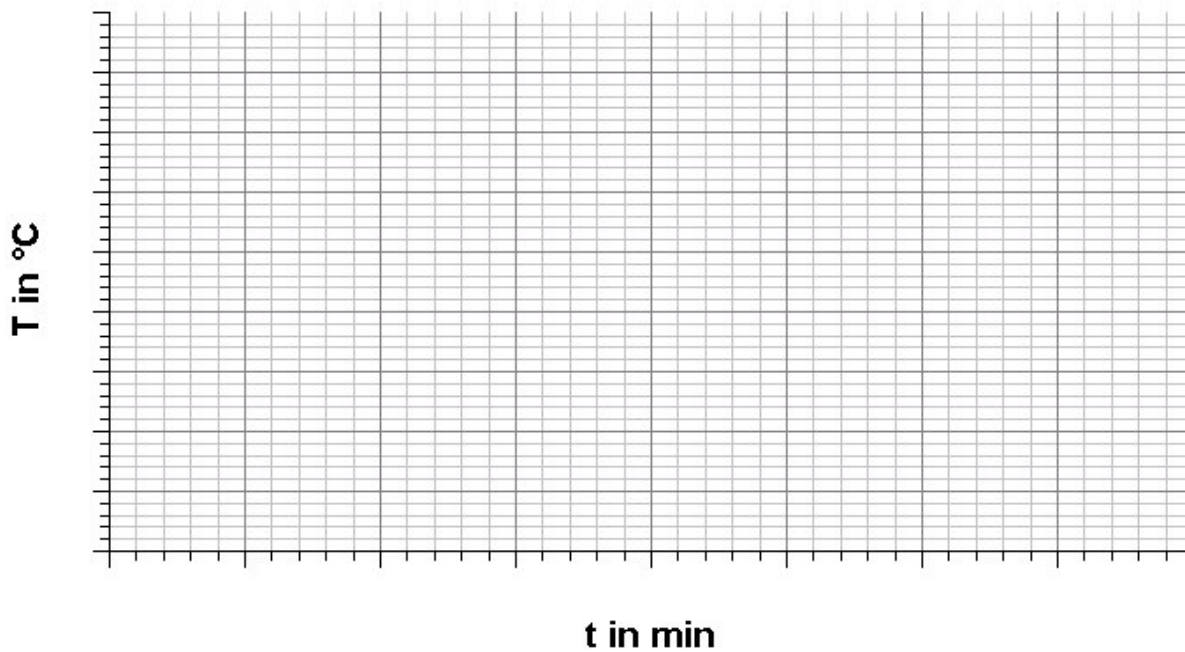


8. Variation of the flow speed

Procedure

3. Explain why the variation in flow speed has an effect on the heating of the collector circuit.
4. To integrate your findings from this experiment into real-life systems, name possible improvements for collector systems.

Diagram



Analysis

2.



8. Variation of the flow speed

Analysis

3.

4.

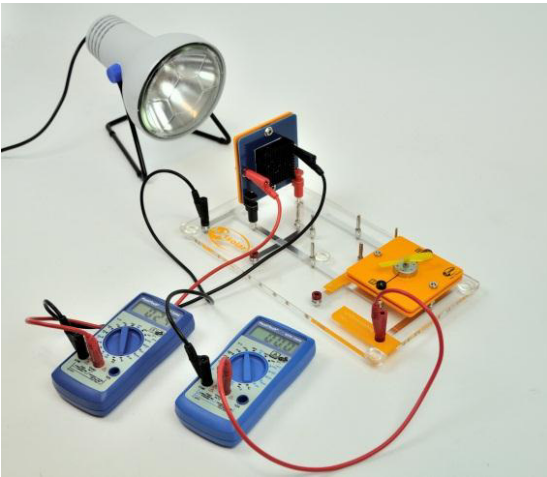


15. Quantitative determination of the electrical power

Task

Show quantitatively that, by heating one side of the Peltier element, a voltage is generated, which can be used to operate a small electrical consumer.

Setup



Equipment

- Basic module
- Peltier module
- 2x digital meter
- Cables
- Spotlight
- Motor module

Procedure

1. Place the Peltier module onto the basic module as shown.
2. Furthermore, connect both digital meters to the basic module and the Peltier module as depicted.

Advice: The digital meter at the Peltier module is used to measure the temperature. Voltage and current are measured with the second digital meter.

3. Place the spotlight 15 cm away from the Peltier element and start the measurement.
4. Observe the development of temperature, voltage and current and write your data into the table.

Data

Time in minutes	Current in mA	Voltage in mV	Power in mW	Temperature Peltier element in °C



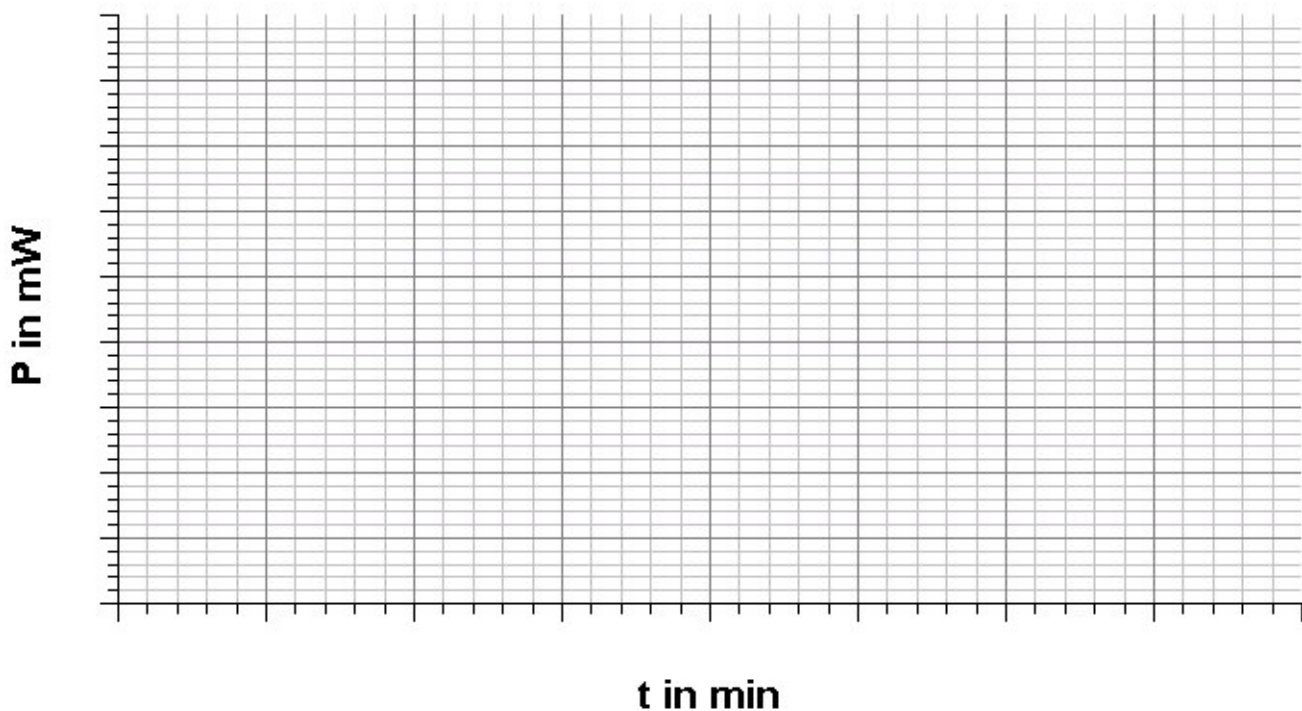
15. Quantitative determination of the electrical power

Data

Analysis

1. Calculate the power for each data row and write the result into the respective column.
2. Enter your results in the depicted diagram.
3. Estimate the permanent power of the thermoelectric generator by using the measurement data and calculate the power conversion efficiency of the measurement setup.
4. Name a few possible applications where the thermoelectric generator can be used even though its power conversion efficiency is low.

Diagram





15. Quantitative determination of the electrical power

Analysis

3.

4.

leXsolar GmbH
Strehleener Straße 12-14
01069 Dresden / Germany

Telefon: +49 (0) 351 - 47 96 56 0
Fax: +49 (0) 351 - 47 96 56 - 111
E-Mail: info@lexsolar.de
Web: www.lexsolar.de