Heating water with a parabolic trough with ADM3

Heating water with a parabolic trough

Physics | Energy | Renewable energies: Sun

Difficulty level	Group size	Preparation time	Execution time
medium	-	10 minutes	20 minutes

This content can also be found online at:

http://localhost:1337/c/64a65e24108e10000205af74

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General information

Application

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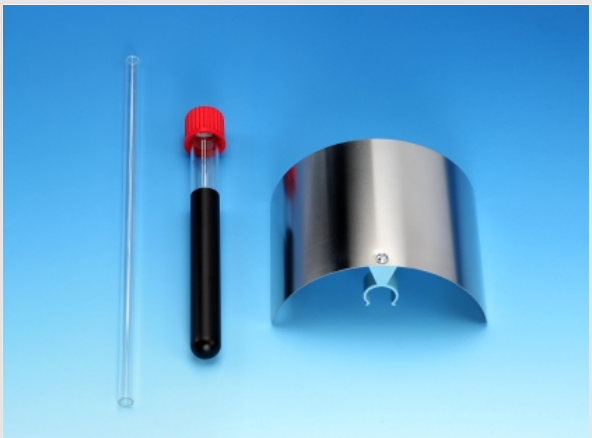

Parabolic trough unit

Heating water with a parabolic trough

Concave mirrors, which collect solar radiation at the focal point and generate great heat, e.g. for cooking, have always been used by humans.

The mirror used in this experiment, in the form of a parabolic (or semi-circular) trough, has a focal line instead of a focal point.

It is an example of the mirrors used in large parabolic trough power plants. Here, there is a pipe with a liquid in the focal line. This is heated to boiling point and can generate electricity via turbines.

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Other information (1/2)

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Prior knowledge

The basic concepts of thermodynamics should be known for this experiment.

Principle

Parabolic mirrors concentrate the light of the sun in a focal point. Parabolic troughs, on the other hand, have a focal line in which tubes, for example, are heated very effectively.

In the experiment, a black test tube filled with water is illuminated with a reflector lamp and the influence of the parabolic trough is investigated in various experimental set-ups.

Other information (2/2)

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Learning

The pupils recognise that water heats up in a parabolic trough due to the absorption of light.

In addition, the heating of the water in the test tube without the parabolic trough and outside the focal line is measured.

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Safety instructions

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The general instructions for safe experimentation in science lessons apply to this experiment.

Be careful, the concentration of the light makes the test tube very hot!

For H and P phrases, please refer to the safety data sheet of the respective chemical.

Theory

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- Parabolic troughs collect the sunlight and concentrate it on a focal line.
- There is an absorber tube on the focal line.
- In this tube, the medium can be heated to a very high temperature.
- The steam obtained from the process can be used to generate electricity.

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Equipment

Position	Material	Item No.	Quantity
1	PHYWE Demo Physics board with stand	02150-00	1
2	PHYWE Demo Multimeter ADM 3: current, voltage, resistance, temperature	13840-00	1
3	Immersion probe NiCr-Ni, steel, -50...400 °C	13615-03	1
4	Clamping holder with 2 clamping possibilit, 0-13 mm,fixing magnet	02151-08	2
5	Scale for demonstration board	02153-00	1
6	Clamp on holder	02164-00	1
7	Concentrated solar power unit, 180 mm	02168-00	1
8	clamp, d = 16 mm, with mounting rod	05764-00	2
9	Connector, angled, module DB	09401-02	3
10	Beaker, Borosilicate, low-form, 400 ml	46055-00	1
11	Syringe 20ml, Luer, 100 pcs	02591-10	1
12	Support rod, stainless steel, 750 mm	02033-00	1
13	Ceramic lamp socket E27, with reflector, switch and security plug	06751-01	1
14	Filament lamp, 220V/120W, with reflector	06759-93	1
15	G-clamp	02014-01	2

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Setup and procedure

Setup (1/3)

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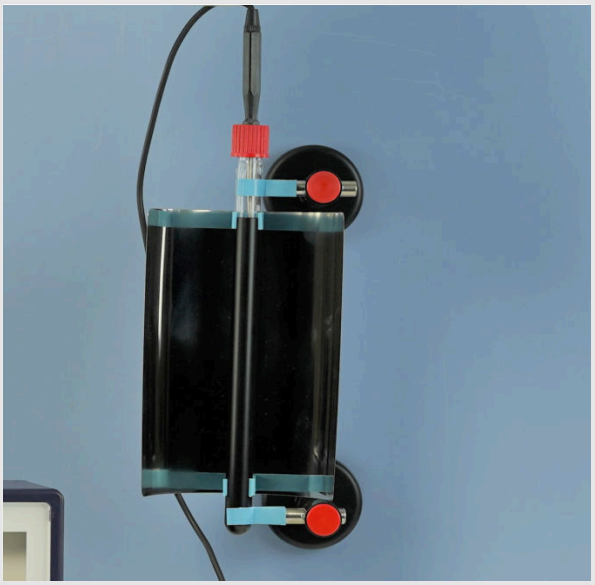

- Place two magnetic clamps on the board.
- Measure the distance between the clamps to approx. 21 cm so that the test tube and the parabolic mirror can be clamped in place.
- Fill the test tube with cold water. The water surface should be visible about 1 mm above the black painted part.
- Put on the screw cap with 8 mm seal.

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Setup (2/3)

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- Set up the experiment according to the illustration.
- Clamp the parabolic mirror to the test tube and place the test tube in the clamp with road so that the screw cap is on the upper holder.
- Adjust the parabolic trough parallel to the board (distance of both side edges from the board equal).
- Push the immersion probe into the test tube and then place the cable around the rod and sleeve so that the probe is held as vertically as possible in the test tube and does not hit a wall.

Setup (3/3)

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- Position the clamp on the upper edge of the board above the solar battery on the support and screw it down carefully.
- Attach the support rod with the lamp in it and align it with the solar battery.
- The distance between the centre of the solar battery and the front of the lamp should be approx. 35 cm.

Experiment setup

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Procedure (1/3)

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Experiment part 1: Test tube in the focal line

- Note the initial temperature in the chart in the evaluation.
- Switch on the lamp.
- Stop the measurement after 5 minutes.
- Also note the final temperature in the evaluation.
- Switch off the lamp.

Procedure (2/3)

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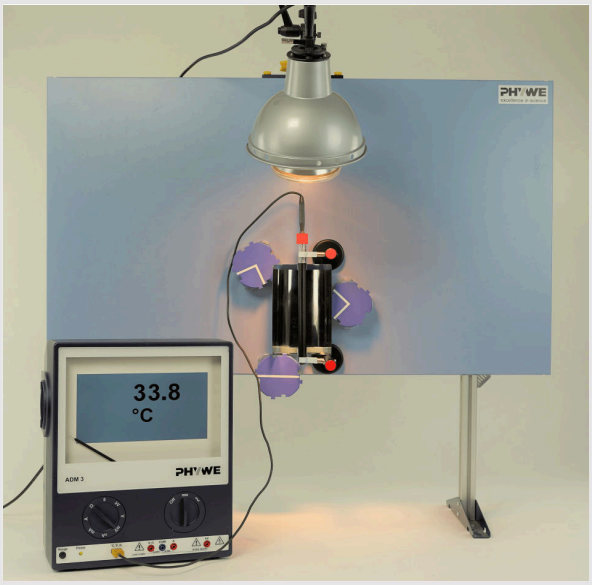

Experiment part 2 - Test tube outside the focal line

- Remove the test tube from the holders and remove the parabolic trough. Empty the test tube, place the glass under the
- Water tap cool down and dry off.
- Fill with new cold water and place the glass back in the holder.
- Parabolic trough with the help of 3 module DB vertical **behind** the test tube.
- Switch on the lamp and repeat the measurement.

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Procedure (3/3)

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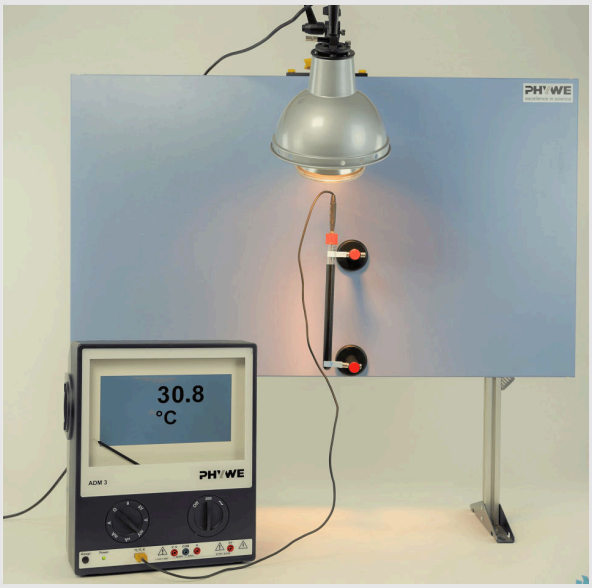

Experiment part 3: Set-up without parabolic trough

- Remove the parabolic trough, it is not needed for the last measurement.
- Cool and dry the test tube again, fill with cold water and place in the holders.
- Switch on the lamp and start the measurement again.
- Stop the measurement after 5 minutes and switch off the lamp.

Evaluation (1/2)

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Structure	Initial temperature in °C	Final temperature in °C	Temperature increase in °C
Test tube within the focal line			
Test tube outside the focal line			
Test tube without parabolic troug			

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Evaluation (2/2)

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Drag the words into the correct boxes!

The black test tube absorbs the incident light so that the water is _____. By using a mirror to _____ additional light onto the glass, much greater heating can be achieved. The test tube is directly in the _____ of the parabolic trough when it is clamped to the glass. Ideally, light from any part of the mirror will then be reflected onto the glass and _____ there. If the glass is outside the focal line, then only the light reflected from a part of the mirror falls on the glass, so it is absorbed _____.

- focal line
- less
- absorbed
- reflect
- heated

Check

Slide	Score / Total
Slide 16: Reflection and absorption	0/5

Total score 0 / 5

Show solutions | Repeat | Export text

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