Model of a parabolic trough field

Task and equipment

Information for teachers

Additional information

Water in an insulated black pipe is heated by the sun in a parabolic trough power station. The parabolic trough bundles the incident rays of light to obtain a higher efficiency.
The heat evaporates water in the pipe. The steam so produced is used to drive a turbine and so a generator.

Condensate on the inner surface of the test tube clearly demonstrates the evaporation of water here.

Notes on the setup and procedure

The increase in temperature (thermal expansion) and the condensation to water can be even more clearly seen when the sun is used for heating instead of the 20 watt student’s lamp. Condensation is then not only to be seen in the test tube, but also in the rise tube.

A 150 watt reflector lamp can be used in place of the sun.

Care must be taken that the test tube is not positioned too near to the lamp, as the illumination of the parabolic trough would then be very inhomogeneous. The given distances of 10 cm from the 20 watt student’s lamp and 30 cm from the 150 watt reflector lamp are therefore to be observed.

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Task

The parabolic trough power station

In this experiment, a model of a parabolic trough power station is to be constructed and used to help explain the basic principle involved.

Student's Sheet

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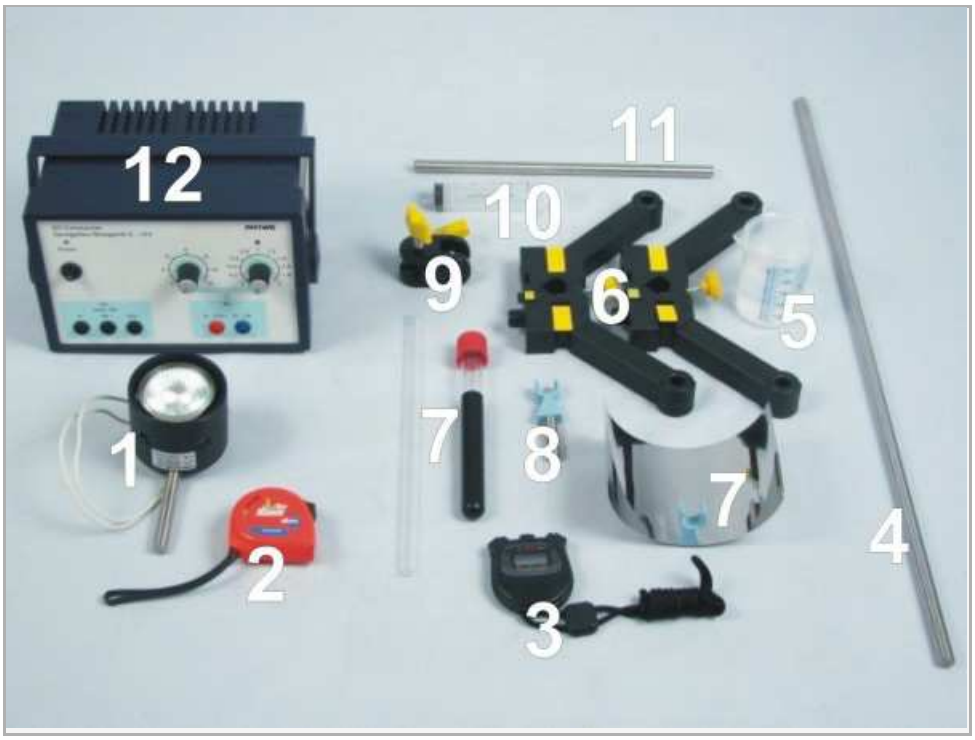
Equipment



Position No.	Material	Order No.	Quantity
1	Halogen lamp with reflector, 12V / 20W	05780-00	1
1	Mount for halogen lamp with reflector	05781-00	1
2	Measuring tape, l = 2 m	09936-00	1
3	Digital stop watch, 24 h, 1/100 s & 1 s	24025-00	1
4	Support rod, stainless steel, l = 600 mm, d = 10 mm	02037-00	1
5	Beaker, low form, plastic, 100 ml	36011-01	1
6	Support base, variable	02001-00	1
7	Concentrated solar power unit	05765-00	1
8	clamp, d = 16 mm, with mounting rod	05764-00	1
9	Boss head	02043-00	1
10	Syringe 20ml, Luer, 10 pcs	02591-03	(1)
11	Support rod, stainless steel, l = 250 mm, d = 10 mm	02031-00	1
12	PHYWE power supply DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1
Additional material			
	Water		

Set-up and procedure

Set-up

Set up the rail support with the variable support base and the two support rods, using the front opening of the left part of the support base and the back opening of the right part of it (Figs. 1 and 2).

Fig. 1

Fig. 2

Fix the lamp in the left part of the support base and connect it to the switched-off power supply (12 V~) (Fig. 3).

Fig. 3

Fit the short rod in the right part of the support base. Now fasten the boss head to the rod with one mounting screw pointing to the right and the other pointing down. Slide the clamp in the boss head. Adjust the position of the boss head on the rod so that the clamp is at the same height as the middle of the lamp (Figs. 4 and 5).

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Fig. 4

Fig. 5

Shift the right part of the support base so far that it is about 16 cm away from the left part of it (Fig. 6). The test tube that is to be used later will then be at a distance of about 10 cm from the lamp.

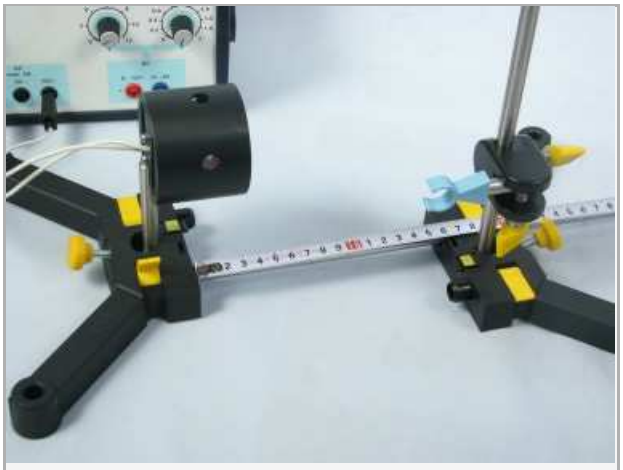

Fig. 6

Fill about 15 ml of water into the test tube until the water level is approx. 2 mm above the end of the blackened part (Fig. 7). Use of the syringe makes it easy to measure water in.

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Fig. 7

Screw the closing cap on the test tube (Fig. 8). Ease the rise tube through the cap and into the test tube until the water level in the rise tube reaches the upper edge of the cap (Fig. 9).

Fig. 8

Fig. 9

Fit the parabolic trough on the test tube. Make sure that each edge of the black part of the test tube protrudes the same distance out from the parabolic trough (Fig. 10).

Fig. 10

Fit the test tube with parabolic trough into the clamp on the boss head so that it is held horizontally. Check that the middle of the parabolic trough is now at the same height as the middle of the lamp and that the parabolic trough is optimally aligned to the lamp (Fig. 11).

Fig. 11

Procedure

Switch on the lamp (power supply) and simultaneously start the stop watch.
Observe how the water level rises in the rise tube over the 15 minute duration of the experiment and note your observations under Result - Observations 1 in the report. Also use the measuring tape to measure the rise of the water every 5 minutes and note each value in the appropriate cell.
Keep a watch on intermediate space between the black part of the test tube and the closing cap. Note what you observe under Result - Observations 2.

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Report: Model of a parabolic trough field

Result - Observations 1

Note your observations on the water level.

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Result - Observations 2

Note your observations on the intermidiate space.

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Evaluation - Question 1

How does the rise of water in the rise tube come about?

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Evaluation - Question 2

How can the formation of condensed water in the space between the lift tube and the test tube be explained?

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Evaluation - Supplementary problem 1

How can current be generated in a real parabolic trough power station?

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