Pumping water using solar energy

Task and equipment

Information for teachers

Additional information

So-called hydro-electric power stations have large water reservoirs up high that store water prior to use. The water is pumped up to them from coal-burning power stations or nuclear power stations etc. using electric energy. Waste products such as CO_2 gas or radioactive material are hereby generated. This experiment shows that this could be a possible application for renewable energy.

Notes on the setup and procedure

Do not apply force to attach the solar cell holder to the solar battery as this would cause damage to the solar battery.
Ensure that there is no air in the pump otherwise the pump performance will drop significantly.
It is advisable to use distilled water. This avoids a possible jamming of the impeller and other problems associated with furring up.

Measures for improving the pump performance:
- Switch the voltage source on and off several times so that the water head air that has already been generated is pressed out by the water return.
- If necessary, incline the pump and then switch the voltage source on and off several times.
- Knock the pump lightly against the bottom of the dish.
- Turn the impeller in the pump should it have jammed, for example because of furring.
(The impeller is visible through the opening in the bottom of the pump.)

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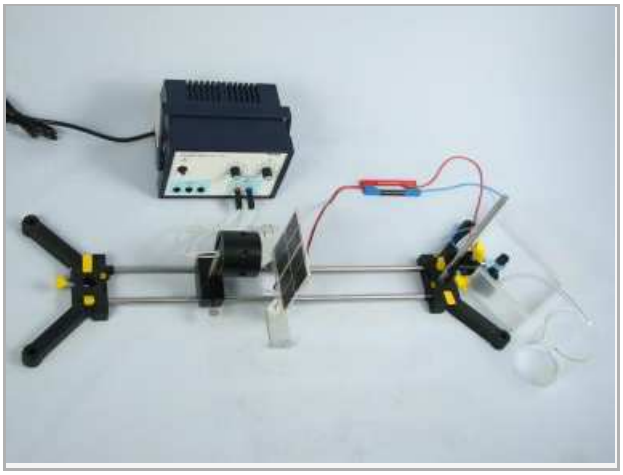
Task and equipment

Task

How high can water be pumped by light?

A pump that is driven by electric energy supplied by a solar battery is used in this experiment. The effect of the light intensity on the pump performance is to be examined.



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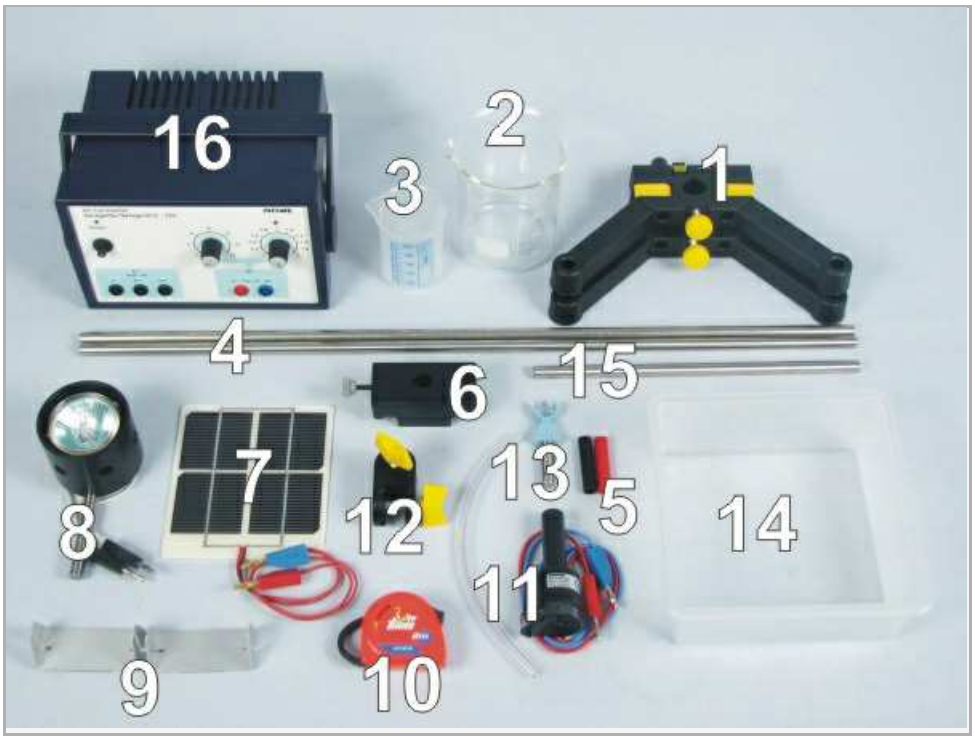
Equipment



Position No.	Material	Order No.	Quantity
1	Support base, variable	02001-00	1
2	Glass beaker DURAN®, short, 400 ml	36014-00	1
3	Beaker, low form, plastic, 100 ml	36011-01	1
4	Support rod, stainless steel, l = 600 mm, d = 10 mm	02037-00	2
5	Double sockets,1 pair,red a.black	07264-00	2
6	Slide mount for optical bench	09822-00	1
7	Solar battery, 4 cells, with cable and connectors	06752-20	1
8	Halogen lamp with reflector, 12V / 20W	05780-00	1
8	Mount for halogen lamp with reflector	05781-00	1
9	Holder for solar cell 2.5 x5 cm, with plugs	06752-12	2
10	Measuring tape, l = 2 m	09936-00	1
11	Water pump/ water turbine/ generator	05753-00	1
12	Boss head	02043-00	1
13	clamp, d = 16 mm, with mounting rod	05764-00	1
14	Dish, plastic, 150x150x65 mm	33928-00	1
15	Support rod, stainless steel, l = 250 mm, d = 10 mm	02031-00	1
16	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

Construct the rail support from the variable support base and the two rods (Figs.1 and 2).

Fig. 1

Fig. 2

Fix the short rod vertically on the one side and mount the halogen lamp on the slide mount that is to be placed on the rail support (Fig. 3).

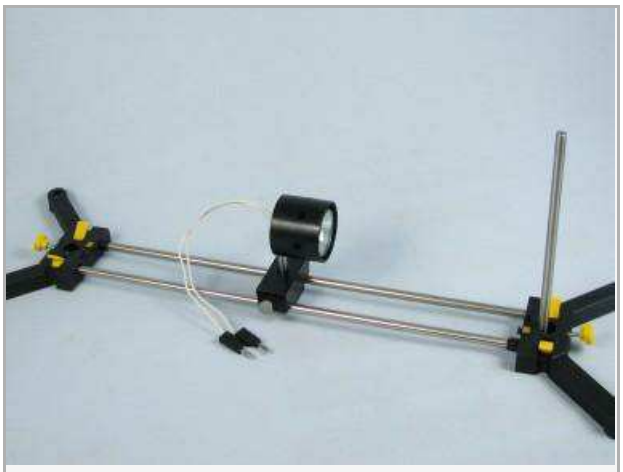


Fig. 3

Connect the halogen lamp to the direct voltage socket of the power supply (Fig. 4).
The power supply is in the switched-off state.

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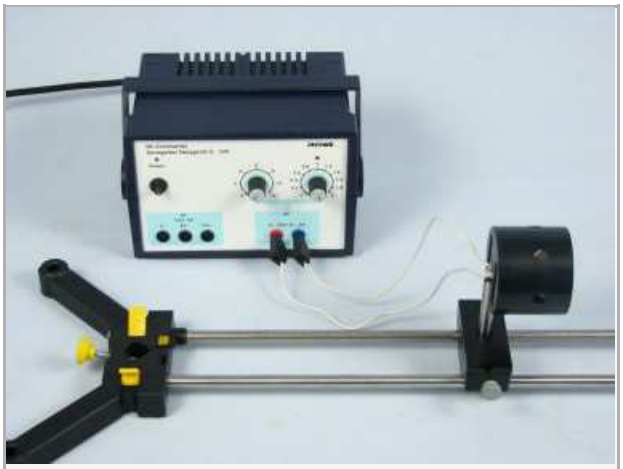

Fig. 4

Use the boss head to fit the clamp on the short rod (Fig. 5).

Fig. 5

Position the plastic dish so that one corner is under the clamp. Fix the tubing to the pump and press the pump in the clamp. Adjust the pump to be at a distance of about 2 mm from the bottom of the dish (Fig. 6).

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Fig. 6

Mount the solar battery vertically on the rail support and lead the cable below a support rod.
Push the two solar cell holders underneath the solar battery, one from each side (Fig. 7).

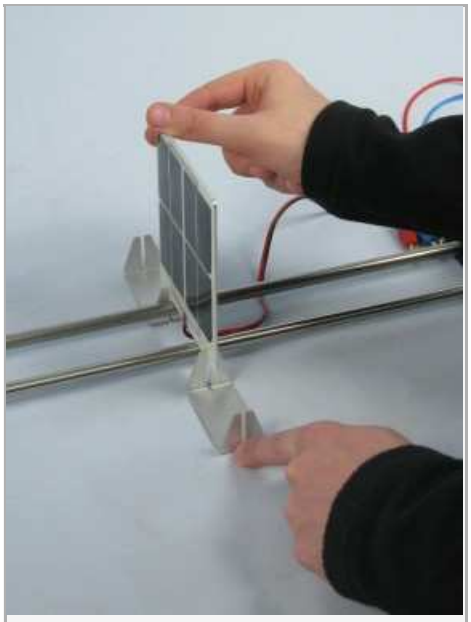

Fig. 7

Push the halogen lamp plus slide mount so that it is at a distance of 5 cm from the solar battery (Fig. 8).

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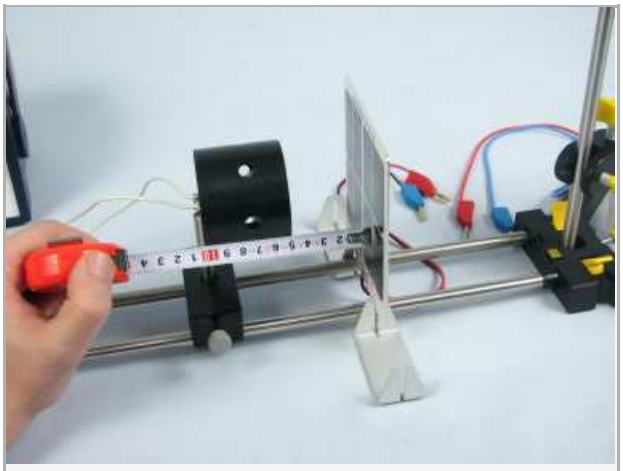

Fig. 8

Plug the blue plugs of the solar battery and the pump to a double socket and do the same with the two red plugs (Fig. 9).

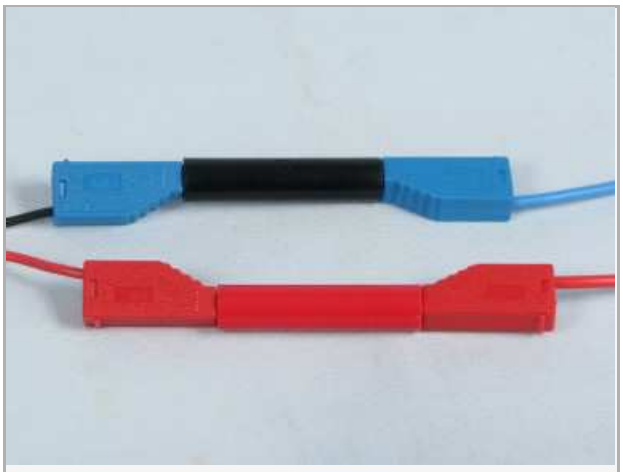

Fig. 9

Fill so much water in the plastic dish that the pump dips about 2 cm into it. Position the large beaker under the free end of the tubing from the pump (Fig. 10).

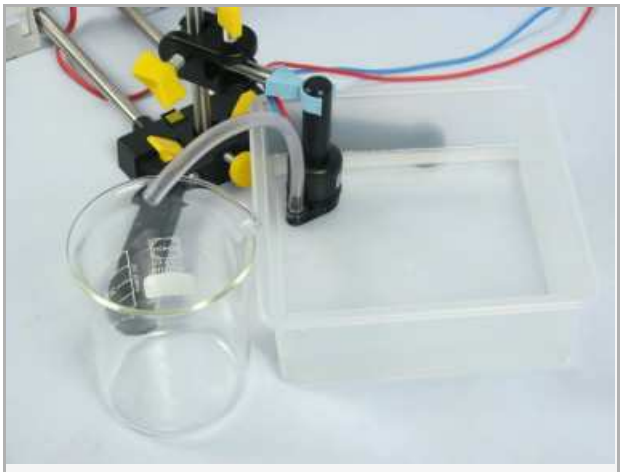

Fig. 10

The complete experimental set-up should now look as shown in Fig. 11.

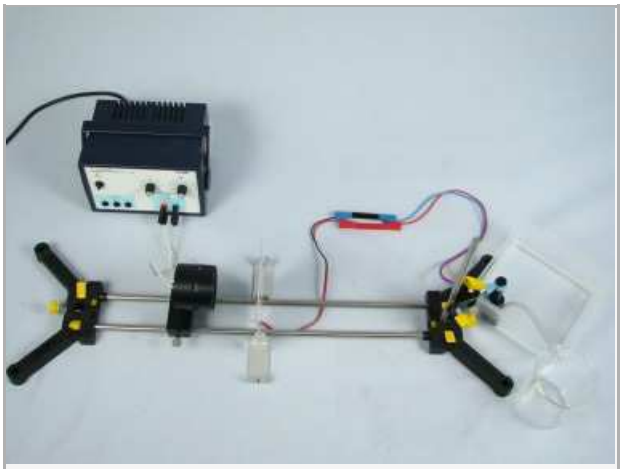

Fig. 11

Procedure

Make sure that the end of the tubing from the pump is over the large beaker.
Turn the two adjusting knobs for voltage and current fully clockwise and switch the power supply on (Fig. 12).
Note your observations in Result - Observations 1 in the report.

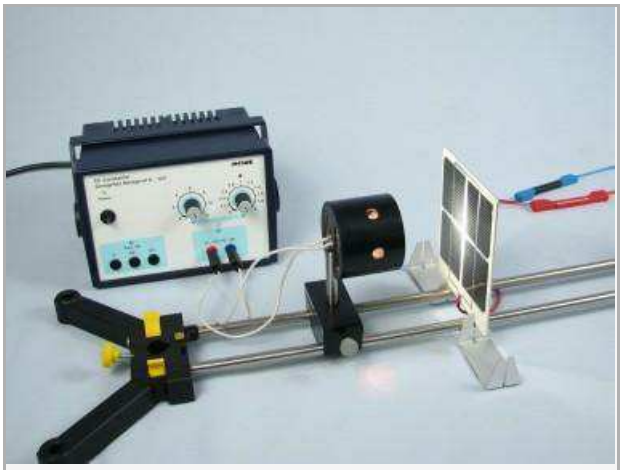

Fig. 12

Lightly push the tubing down towards the edge of the beaker and note what you observe under Result - Observations 2.

Very slowly reduce the voltage from 12 V until exactly the time that water stops flowing into the large beaker, even when you push the tubing down. Observe the behaviour of the halogen lamp Result - Observations 3.

Replace the large beaker by the small one and again push the tubing down as above.
Make sure again here that the end of the tubing is over the beaker.
Note what you observe under Result - Observations 4.

Should the pump not run properly, try the following helping measures:

- Knock the pump lightly against the bottom of the dish.
- Switch the power supply on and off several times.
- Turn the impeller from underside the pump.

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Report: Pumping water using solar energy

Result - Observations 1

What was to be observed when the power supply was switched off?

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Result - Observations 2

What can you observe when the tubing is pressed down?

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Result - Observations 3

How did the halogen lamp behave?

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Result - Observations 4

What happened at the small beaker?

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Evaluation - Question 1

Assume that water did not reach the open end of the tubing.

Is it sufficient to push the open end further down in the beaker to get water to flow into the beaker?

Give the reason for your answer in brief.

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Evaluation - Question 2

Why is a reduction in the voltage sufficient for the performance of the pump to be able transport water into the small beaker but not into the large beaker, although there is no change in the length of the tubing?

Consider the potential energy E = m g h.

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Evaluation - Question 3

How can this experimental set-up be used in practice?

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