Solar energy

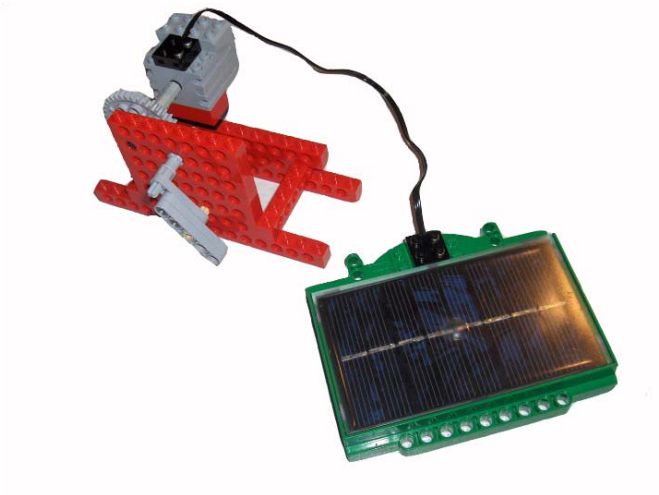
Teacher's document

Introductory experiment for the teacher

The purpose is to explain in a simple way how a solar panel works and then demonstrate it with the help of a small LEGO construction. Finally the students need to conduct an experiment themselves.

Experiment

construction for introductory experiment

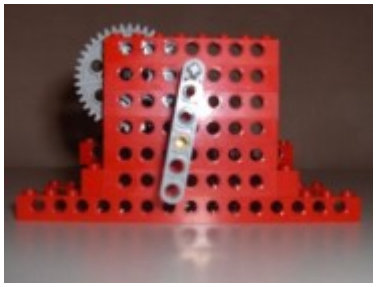
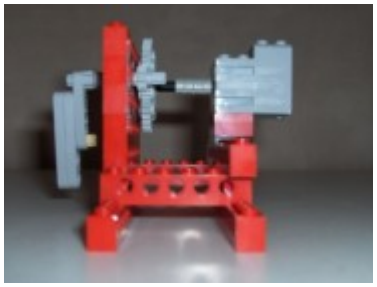
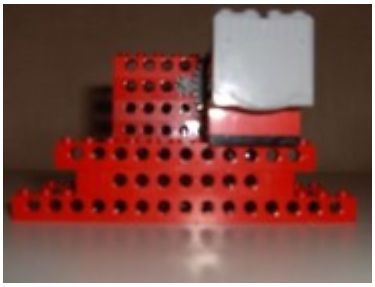


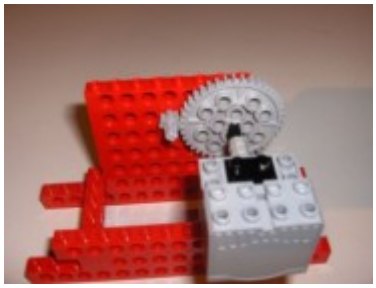
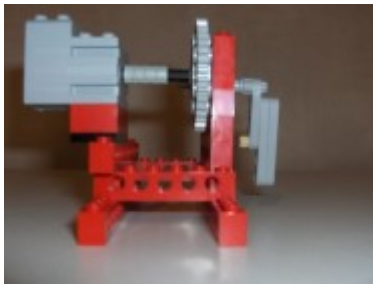
What you need

- LEGO box (9684 version 46)
- 60 W light bulb (frosted)
- 100 W light bulb (clear)

Task

With this experiment you demonstrate the influence of light intensity on the power production of a solar panel. Use the set-up shown underneath.


As you can see, you use an accelerating gear transmission. This will allow you to notice the speed of the rotating grey arm more easily Conduct the experiment with the light bulb at different distances from the solar panel and with different light bulbs (clear and frosted).

Students' experiment

What you need

- LEGO box (9684 version 46)
- 60 W light bulb (clear)
- 60 W light bulb (frosted)
- 100 W light bulb (frosted)

Results

light source **5 cm** above the solar cell			
power	60W (clear)	60W (frosted light bulb)	100W (frosted light bulb)
distance (cm)	*35*	*35*	*35*
time (s)	*3,85*	*4,56*	*3,62*
speed (cm/s)	*9,09*	*7,68*	*9,67*
light source **6 cm** above the solar cell			
power	60W (clear)	60W (frosted light bulb)	100W (frosted light bulb)
distance (cm)	*35*	*35*	*35*
time (s)	*4,10*	*4,62*	*3,90*
speed (cm/s)	*8,54*	*7,58*	*8,97*

light source **7 cm** above the solar cell			
power	60W (clear)	60W (frosted light bulb)	100W (frosted light bulb)
distance (cm)	*35*	*35*	*35*
time (s)	*4,65*	*8,50*	*4,06*
speed (cm/s)	*7,53*	*4,12*	*8,62*
light source **8 cm** above the solar cell			
power	60W (clear)	60W (frosted light bulb)	100W (frosted light bulb)
distance (cm)	*35*	*35*	*35*
time (s)	*5,20*	*13,0*	*4,20*
speed (cm/s)	*6,73*	*2,69*	*8,33*
light source **9 cm** above the solar cell			
power	60W (clear)	60W (frosted light bulb)	100W (frosted light bulb)
distance (cm)	*35*		*35*
time (s)	*6,95*		*4,43*
speed (cm/s)	*5,04*		*7,90*
light source **10 cm** above the solar cell			
power	60W (clear)	60W (frosted light bulb)	100W (frosted light bulb)
distance (cm)			*35*
time (s)			*4,83*
speed (cm/s)			*7,25*

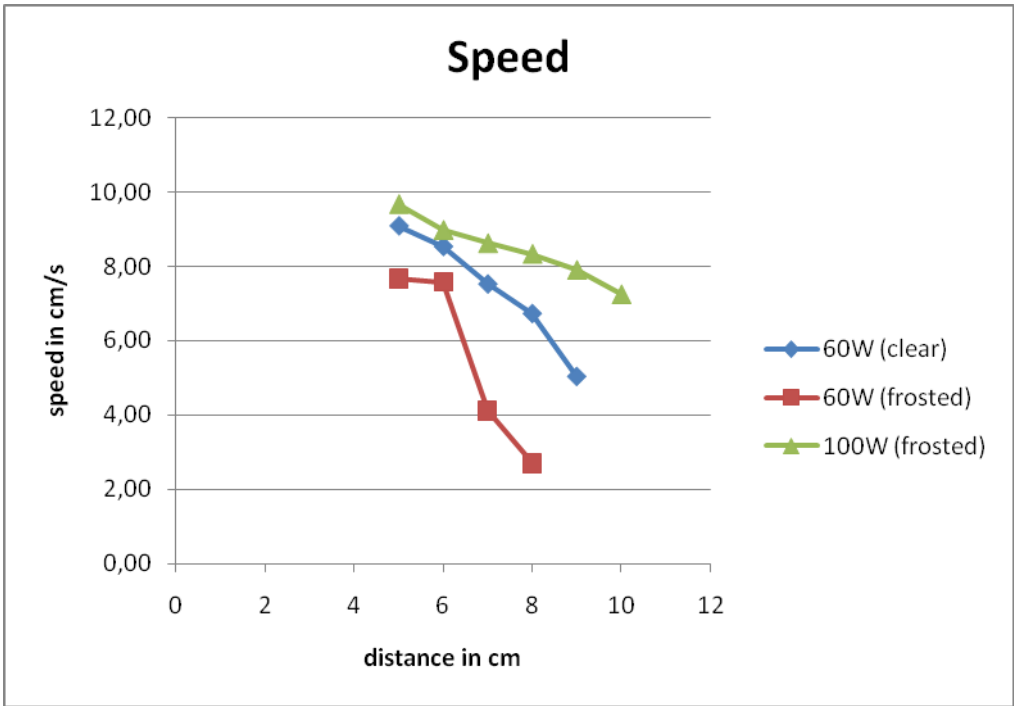
If there's a distance of 10cm between the clear light bulb of 60W and the solar panel you can't do the test because there's not enough intensity of light. If you use the frosted light bulb of 60W the motor won't start anymore from a distance of 9cm onwards.

The more powerful the bulb, the higher the speed.
The further you hold the bulb from the solar panel, the lower the speed.

Can you describe what this means for everyday use of solar panels?

When using solar panels, the light intensity of the sun is very important. The higher the light intensity, the more electric current / voltage you will be able to produce with a solar panel.

In winter we are further away from the sun. As a result solar panels will have a lower efficiency.
On a sunny summer day at noon, when the sun is at its brightest, the solar panels' efficiency will be at their highest.



Solar energy

Student's document

Experiment for the pupils

How does a solar panel work?

A solar panel is a panel which is directed to the sun and that transforms light intensity into electricity. A solar panel consists of photovoltaic cells. "Photos" means "light" and with voltaic we refer to voltage. So Photovoltaic cells produce a current from light.

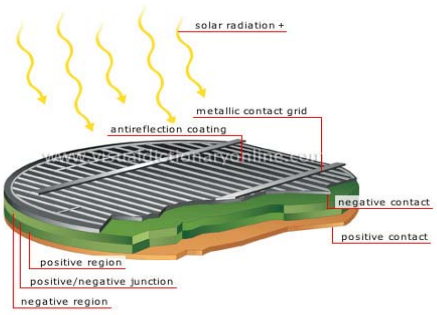
Where have you ever seen solar panels before? Give 2 examples.

- ……

- ……

The first application of photovoltaic solar energy was with the artificial satellite Vanguard I in 1958. This satellite was used to orbit the earth in order to collect data about the shape of the earth.

A solar cell consists of a thin layer of semiconducting silicon which only conducts electricity when there is solar radiation. Silicon is produced from sand, which you can find in abundance all over our planet. Chemical processes create a positive bottom and negative top layer in the silicon . This causes a voltage difference (of about 0,7V) similar to the plus and minus pole of a battery.



A separate solar cell is useless in itself because the produced voltage is very low. That's the reason why they link solar cells in a series or parallel circuit. In a series circuit we can add up the different voltages (volt), in a parallel circuit we add up the produced electric current (ampere). This is how we create a voltaic system which is called a solar panel

If you want to use the voltage of a solar panel in domestic appliances you need alternating current (AC), while the solar panel produces direct current (DC). That's the reason why we need an inverter to transform the direct current into alternating current.

Experiment with LEGO

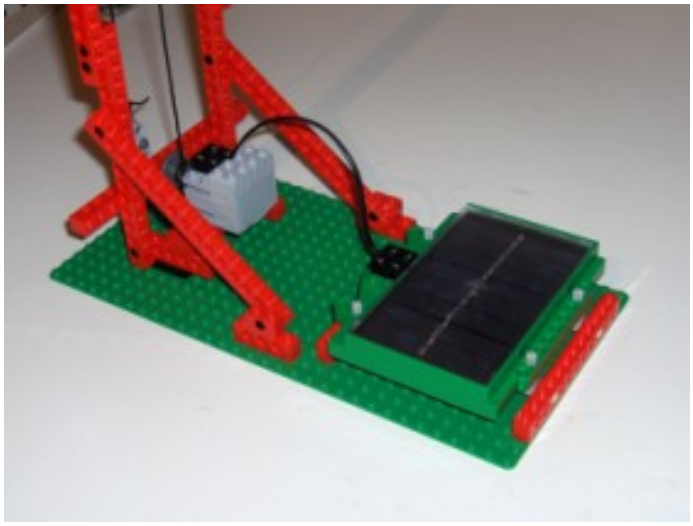
We don't need an inverter in the experiment because the LEGO motors work on direct current. The purpose of the experiment is to clearly demonstrate how a solar panel works. The measurement results will allow you to discover the most important factors that will help you to obtain the maximum efficiency from your solar panel .

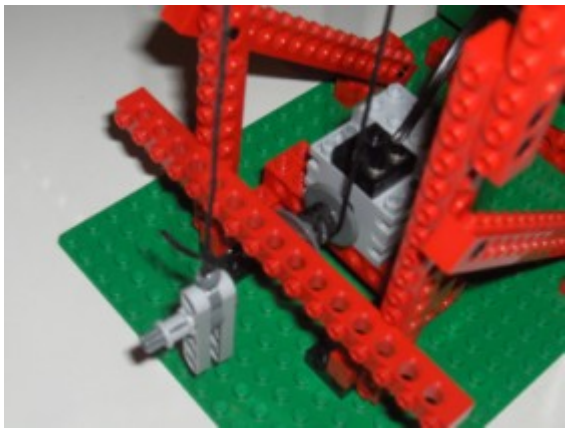
What you need

- LEGO box (9684 version 46)
- a stop watch
- a measuring tape
- 60 W light bulb (clear)
- 60 W light bulb (frosted)
- 100 W light bulb (frosted)

Description of the experiment

Build a construction like the one below. A solar panel powers a motor. The solar panel is lit by the artificial light from a light bulb, which is placed above the solar panel. The distance between the bulb and the solar panel will be changed in the course of the different measurements. Use different kinds of bulbs. When using 60W and 100W light bulbs, frosted and clear light bulbs, it will be easy to draw conclusions






When lit by the light bulb the solar panel produces energy that drives the motor. Take the time it takes to move an object over a set distance.

Determine this distance beforehand by selecting an easily noticeable start and stop mark.

The distance is …… cm.

Next measure the time it takes to lift an object over this distance. When you have the time and the distance it's easy to calculate the speed by using the formula: $s = \frac{d(cm)}{t(s)} \left[speed = \frac{dis\tan ce}{time} \right]$

Repeat this experiment with the different bulbs, and therefore different light intensities. Each time place the bulb right above the solar panel.
Also change the distance between the light bulb and the solar panel. Start at 5 cm and each time increase the distance by 1 cm.

light source ..... cm above the solar cell			
power	60W (clear)	60W (frosted light bulb)	100W (frosted light bulb)
distance (cm)			
time (s)			
speed (cm/s)			
light source ..... cm above the solar cell			
power	60W (clear)	60W (frosted light bulb)	100W (frosted light bulb)
distance (cm)			
time (s)			
speed (cm/s)			
light source ..... cm above the solar cell			
power	60W (clear)	60W (frosted light bulb)	100W (frosted light bulb)
distance (cm)			
time (s)			
speed (cm/s)			

Extra measurements at 8, 9, … cm can be performed when sufficient time.

<u>Conclusion</u>

The more powerful the light bulb, the ……. the speed will be.

The bigger the distance between the light bulb and the solar panel, the … ….. the speed will be.

Can you describe what this means for everyday use of solar panels?