SUNdidactics
SolarEnergyDidactics
SolarEducation
SolarEngineering

innovative Solarsysteme für Schule und Ausbildung
innovative solar- systems for school, college, technical education

- Solardidaktik
- Solarzellen
- Solarmodule
- Photovoltaik- Experimentiergeräte
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- solar toys

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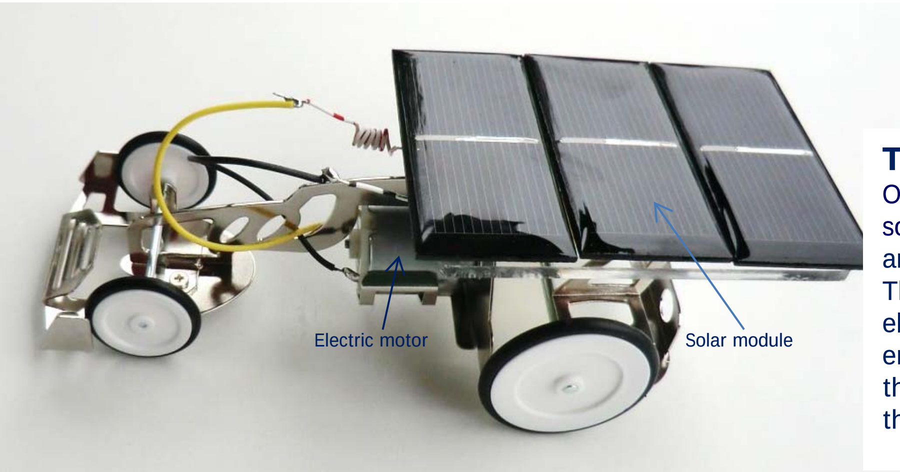
Experiments with the SUSE solar vehicle 5

Powerful solar vehicle with solar module 1.8 V / 450 mA

Learning station **A20**



The solar vehicle 5

On the surface the 3-solar-cell solar module with U_{oc} = 1.8 V and I_{sc} = 450 mA can be seen. The solar module feeds the electric motor with electric energy, which is gained through the transformation of the light's radiation energy.

Necessary devices and measurement instrumentation:
1 SUSE solar vehicle 5, 1 folding rule 2 m, 1 stopp watch (or stopp watch app on mobile phone), 1 digital multimeter with 2 connective wires red (+) and black (-), 2 alligator clips, 1 halogen spot light 35 W (SUSE 5.16), 1 power supply 12 V, 2 connective wires, 1 pencil

With bright sunshine or even with slight clouding you can conduct the experiments outside in the natural sunlight, with heavy clouding or bad weather we experiment inside.

A Experiments outside with bright sunshine

Find a sunny spot with a smooth, flat driving surface. Place the solar vehicle on the ground, it should drive forwards with high speed.

A1 Measuring the velocity

On the smooth driving surface, mark a measured distance of exactly 2 m with the folding rule. Place the car on the ground at the starting point and simultaneously start the stopp watch. At the end of the 2 m distance stop the time measurement. Now you can calculate the speed, use the calculator in your mobile phone:

$$\text{Velocity } v = \frac{\text{Distance}}{\text{Time}} = \frac{2\text{m}}{\text{Measured time s}} = \frac{2\text{m}}{\ldots\ldots\ldots} = v = \ldots\ldots\ldots\ldots \text{m/s}$$

You get the velocity in the unit of m/s; because we are used to km/h, we multiply the value with 3.6 and get v in km/h:

My measured velocity in m/s:..................................

My measured velocity in km/h:..................................

For professionals and future scientists: If a velocity is given in the unit of m/s, this value has to be multiplied with 3.6 to get it in units of km/h. Explain this conversion here and deduce the number 3.6:

If slight clouds move in front of the sun, the car drives more slowly, test this with a new measurement here:

A2 Measuring the electric voltage of the solar module

In the solar module 3 solar cells are connected in series, the module voltage is therefor 3 times as high as the voltage of one single solar cell. Plug 2 wires into the multimeter, one black wire into the negative socket, one red wire into the V socket. Set the multimeter to the measurement range 20 V DC with the rotary control. Connect the wires with 2 alligator clips to the soldered connections between module wires and motor wires, red to yellow and black to black.

Now lift the car, align the solar module with the sun and measure the electric voltage V:

Measurement results:

Bright sunshine: V = …………………………V, Voltage of one solar cell:………….. V

Clouding or in the shadows: V = …………V, Voltage of one solar cell:………….. V

Inside a building: V = …………………………V, Voltage of one solar cell:………….. V

What do you notice with the measurements? Note here:

A3 Measuring the short-circuit current I_{sc} (maximum current) **of the solar module:**

Plug 2 wires into the multimeter, a black one into the negative socket, a red one into the 10 A socket. Set the multimeter to the measurement range of 10 A DC with the rotary control. Connect the wires with 2 alligator clips to the soldered connections between the module wires and the motor wires, red to yellow and black to black. With a series connection the same current flows through all 3 solar cells.

Now lift the car, align the solar module with the sun and measure the short-circuit current I_{sc}:

Measurement results:

Bright sunshine: I_{sc} = …………………………A

Clouding or in the shadows: I_{sc} = …………A

Inside a building: I_{sc} = …………………………A

What do you notice with the measurements? Note here:

A4 Determination of the electric power of the solar module:

If you multiply the voltage V and the short-circuit current I_{sc}, you (approximately) get the electric power in W (Watts), calculate for the bright sunshine:

$P = V*I_{sc}$ = ………………….*……………………..=…………………..W

B Experiments inside with halogen spot light 35 W or halogen spot light 120 W

For the vehicle to operate, you have to illuminate it with light of a halogen lamp. Plug 2 wires into the halogen lamp SUSE 5.6 and connect them to the 12 V power supply. Plug the power supply into the wall socket and switch it on. If you illuminate the car, you obviously have to follow with the lamp in the range of the cable length, the distance between lamp and car should be approx. 20 cm.

B1 Measuring the velocity

On the smooth ground mark a measurement distance of exactly 2 m with the folding rule. Place the car on the ground at the starting point and simultaneously start the stop watch. Follow the car with the halogen lamp! At the end of the 2 m distance stop the time measurement. Now you can calculate the velocity, use the calculator of your mobile phone:

$$\text{Velocity } v = \frac{\text{Distance}}{\text{Time}} = \frac{2\text{m}}{\text{Measured time s}} = \frac{2\text{m}}{\ldots\ldots\ldots\ldots} = v = \ldots\ldots\ldots\ldots\text{m/s}$$

You get the velocity in the unit of m/s; because we are used to km/h, we multiply the value with 3.6 and get v in km/h:

My measured velocity in m/s:…………………………….

My measured velocity in km/h:……………………………..

If you withdraw the lamp from the solar module (to approx. 30 cm), the car drives more slowly, test this with a new measurement here:

B2 Measuring the electric voltage of the solar module

In the solar module 3 solar cells are connected in series, the module voltage is therefor 3 times as high as the voltage of one single solar cell. Plug 2 wires into the multimeter, one black wire into the negative socket, one red wire into the V socket. Set the multimeter to the measurement range 20 V DC with the rotary control. Connect the wires with 2 alligator clips to the soldered connections between module wires and motor wires, red to yellow and black to black.
Now lift the car, illuminate the solar module with the lamp and measure the electric voltage V:

Measurement results:

Distance lamp - Solar module 20 cm: V = …………….V, Voltage of <u>one</u> solar cell:…………………V

Distance lamp - Solar module 30 cm: V = …………….V, Voltage of <u>one</u> solar cell:…………………V

Inside a building without illumination: V = ………V, Voltage of <u>one</u> solar cell:…………………V

What do you notice with the measurements? Note here:

B3 Measuring the short-circuit current I_{sc} (maximum current) of the solar module:
Plug 2 wires into the multimeter, a black one into the negative socket, a red one into the 10 A socket. Set the multimeter to the measurement range of 10 A DC with the rotary control. Connect the wires with 2 alligator clips to the soldered connections between the module wires and the motor wires, red to yellow and black to black. With a series connection the same current flows through all 3 solar cells.
Lift the car, align the halogen lamp to the solar module in a distance of 20 cm and measure the short-circuit current I_{sc}:

Measurement results:

Lamp in a distance of 20 cm: I_{sc} = ...A

Lamp in a distance of 30 cm: I_{sc} = ...A

Inside a building, without illumination: I_{sc} = ...A

What do you notice with the measurements? Note here:

B4 Determination of the electric power of the solar module:
If you multiply the voltage V and the short-circuit current I_{sc}, you (approximately) get the electric power in W (Watts), calculate for the illumination in a distance of 20 cm:

$P = V*I_{sc}$ = ...*..........................=......................W

C Energy conversion processes

In this solar vehicle a multi-level energy conversion takes place, write your ideas into the boxes:

Light

↓

Solar cell

↓

Electric motor

↓

Gear and wheels