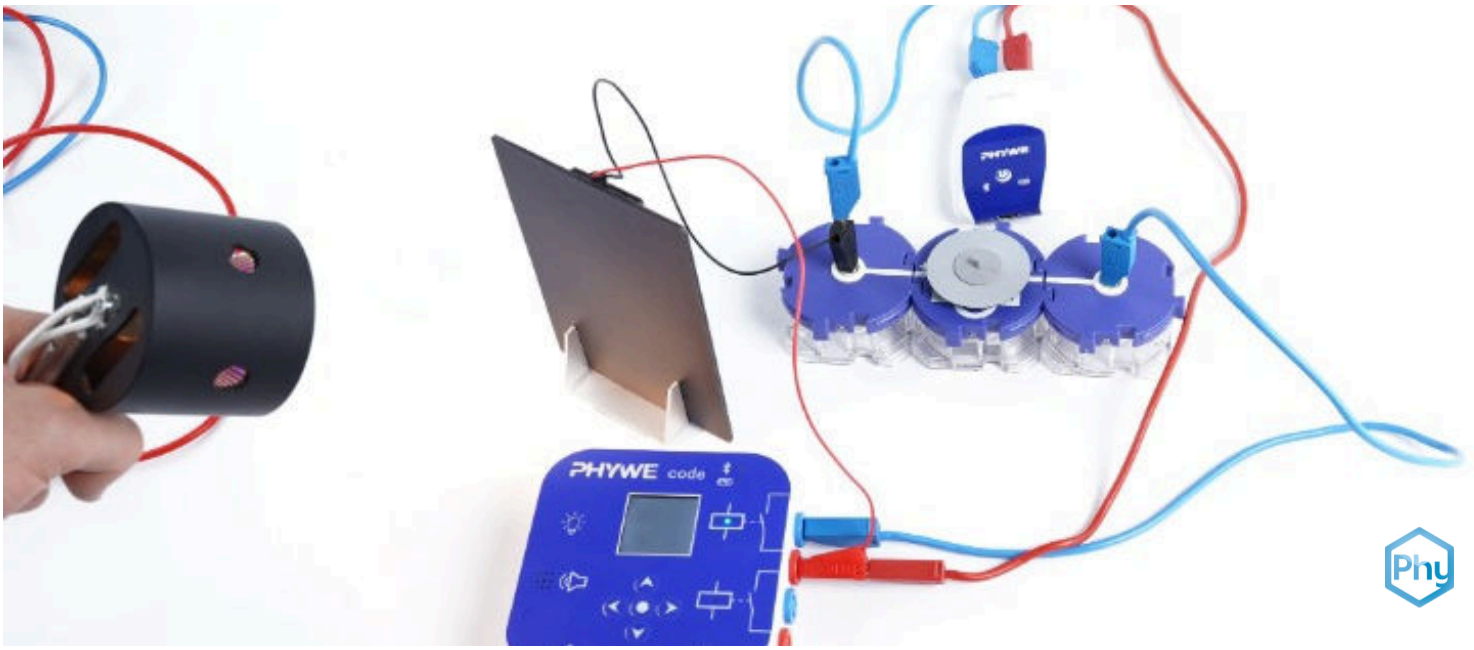
Converting light into motion with Cobra SMARTsense code



This student experiment investigates the conversion of solar energy into electrical energy. They will also be familiarised with simple programming of a device for voltage monitoring and switching relays.

Physics	Energy	Energy forms, conversion & conservation
Physics	Energy	Renewable energies: Sun

Difficulty level	Group size	Preparation time	Execution time
-	-	-	-

This content can also be found online at:

https://www.curriculab.de/c/685d2ffdd0b4740002bf1f17

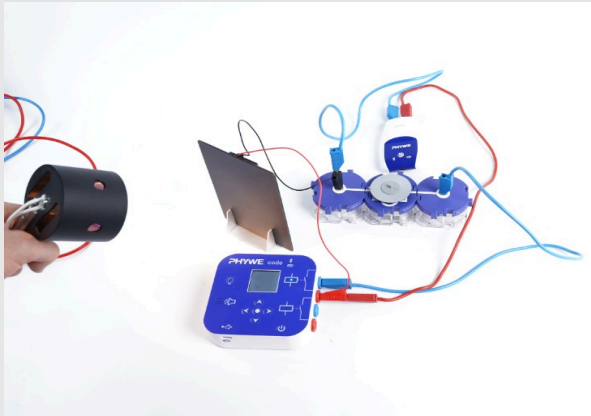
PHYWE
Robert-Bosch-Breite 10
37079 Göttingen
Tel.: 0551 604 - 0
Fax: 0551 604 - 107
info@phywe.de
www.phywe.de

PHYWE

Teacher information

Application

PHYWE



Experimental setup

Solar energy can be converted into electrical energy with the help of a solar cell.

This is a very important form of energy both in the household and in industry, as it can easily be converted into other forms of energy, such as heat, light or mechanical energy (movement).

PHYWE

Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de

Other teacher information (1/3)

PHYWE

Prior

The students should have experience in using a student power supply unit and it is recommended that they have some previous experience with the measureAPP. The students should also be familiar with the different forms in which energy can be present.

Principle

The solar cell plays an important role in the utilisation of alternative energy sources, as it converts the sun's radiant energy directly into electrical energy. The electrical energy generated is demonstrated very clearly in this experiment using a small motor. The relationship between illuminance and electrical power/speed of the motor is demonstrated by changing the voltage on the power supply unit. An incandescent lamp is sufficient as the radiation source.

Other teacher information (2/3)

PHYWE

Learning

This student experiment investigates the conversion of solar energy into electrical energy. They will also be familiarised with simple programming of a device for voltage monitoring and switching relays.

Tasks

In the experiment, a small electric motor is operated with a solar cell. The students illuminate a solar cell and observe the motor connected to it.

PHYWE

Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de

Other teacher information (3/3)

PHYWE

Notes on structure and implementation

Do not use force to attach the solar cell holders to the solar battery, as this will damage the solar battery.

In addition: The threshold voltages set here were determined empirically. If the lighting conditions or the condition of the solar cell or halogen lamp change drastically, new threshold values may need to be selected.

Safety instructions

PHYWE

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

Furthermore, caution is advised with these sources of danger:

- The light bulb and its holder heat up during operation. You should therefore not touch them once they have been switched on.
- The cables to which the lamp is connected have exposed ends that are live.

  These should not be touched and should not be brought into contact with conductive materials under normal conditions.

PHYWE

Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de

PHYWE

Student information

Motivation

PHYWE

Solar cells on the roof of the SolarWorld GT experimental vehicle

Science is constantly endeavouring to convert existing energy so that it can be used by humans.

Even today, the conversion of light into electricity is part of everyday life.

If this principle can be efficiently extended to kinetic energy, we could be travelling with solar-powered vehicles in the near future and dispense with the use of limited and environmentally harmful fossil fuels.

The Solarworld GT at Bochum University of Applied Sciences serves as an application example here.

PHYWE

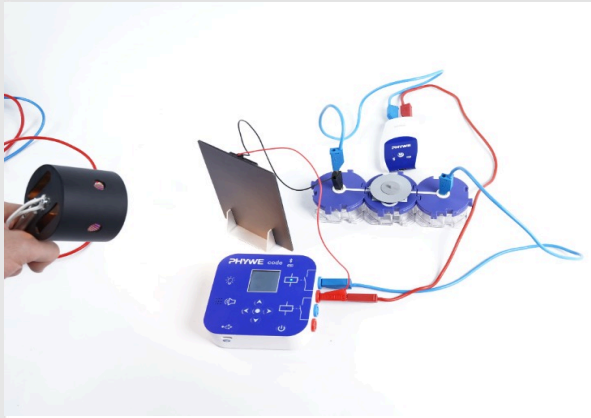
Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de

Tasks

PHYWE



Experimental setup

1. Supply an electric motor with electrical energy using a solar battery.
2. Install overvoltage protection with the Cobra SMARTsense Code and Cobra SMARTsense Voltage according to the instructions.
3. Illuminate the solar cell and investigate how the light intensity (brightness) affects the motor frequency.

PHYWE

Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de

Equipment

Position	Equipment	Item no.	Quantity
1	Cobra SMARTsense Code - Output device for switching relays	12953-00	1
2	Cobra SMARTsense Current - Sensor for measuring electrical ± 1 A (Bluetooth + USB)	12902-01	1
3	Solar battery 4 cells 10.5 x 17 cm, with plugs, 2 V, 838 mA	06752-22	1
4	Line module, connection module, SB	05601-10	2
5	Halogen lamp with reflector, 12 V / 20 W	05780-00	1
6	Holder for halogen lamp with reflector	05781-00	1
7	PHYWE power supply unit, RiSU 2023 DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1
8	Motor 5V, SB	05660-00	1
9	Connecting cable, 32 A, 25 cm, blue Experiment cable, 4 mm plug	07360-04	3
10	Connecting cable, 32 A, 25 cm, red Experiment cable, 4 mm plug	07360-01	2

PHYWE
Robert-Bosch-Breite 10
37079 Göttingen
Tel.: 0551 604 - 0
Fax: 0551 604 - 107
info@phywe.de
www.phywe.de

Setup (1/5)

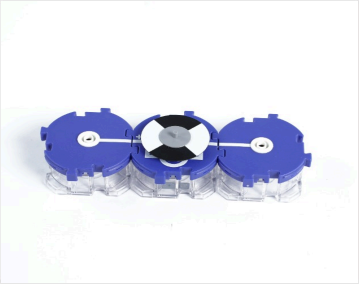
PHYWE

Cobra SMARTsense Code

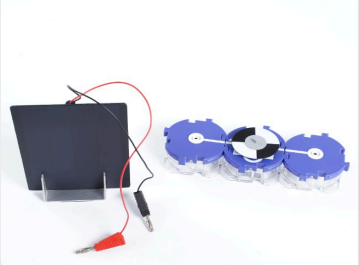
In this experiment, you will use the Cobra SMARTsense code. This is a control unit that can output specific signals. Possible signal forms are, for example: Illumination of an LED, display indication or sound. In this experiment, we use the relay control of the Cobra SMARTsense Code. In this case, a relay is nothing more than a switch. It can be used to open and close circuits in a targeted manner.

Setup (2/5)

PHYWE



Plug the cable components together as shown in the picture.



Place the solar cell on the solar cell holder.

PHYWE

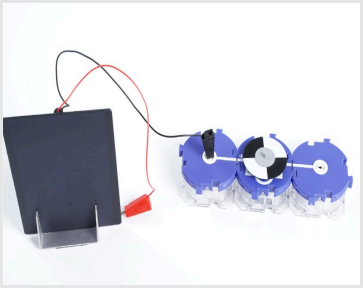
Robert-Bosch-Breite 10
37079 Göttingen

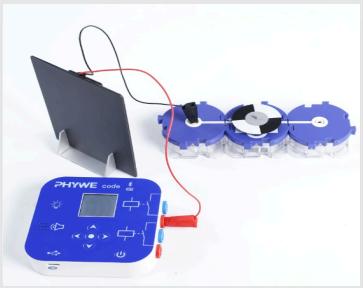
Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de

Setup (3/5)

PHYWE



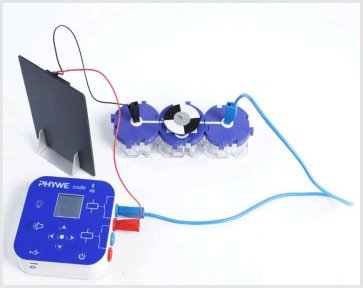


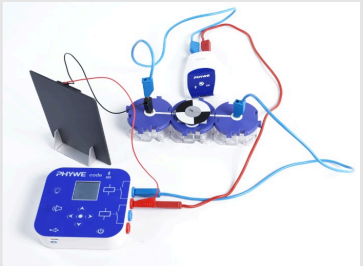
Connect one end of the solar cell directly to a connection module.

Connect the other end to relay 1 (top) of the Cobra SMARTsense code.

Setup (4/5)

PHYWE





Now connect the other plug of the relay, which does not yet have a cable in it, to the other connection module.

Now connect the Cobra SMARTsense voltage sensor in parallel to the solar cell.

PHYWE

Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de

Setup (5/5)

PHYWE

To measure with the **Cobra SMARTsense sensors**, the **PHYWE measureAPP** is required. The app can be downloaded free of charge from the respective app store (QR codes below). Please check that **Bluetooth is enabled** on your device (smartphone, tablet, desktop PC) before starting the app.

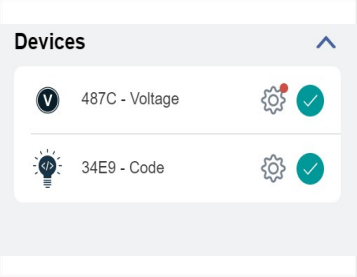
measureAPP for Android operating systems

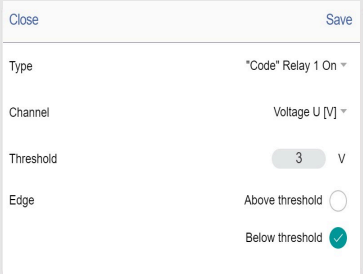
measureAPP for iOS operating systems

measureAPP for tablets / PCs with Windows

Realisation (1/4)

PHYWE



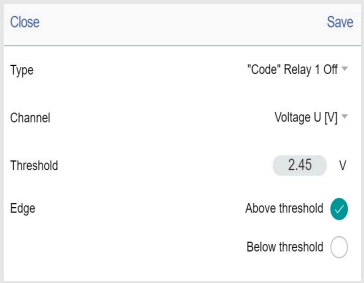


- Activate the Cobra SMARTsense Code and the Voltage Sensor by holding down the power button for a few seconds until the Bluetooth symbol lights up. Now open the measureAPP and connect the two devices by clicking on the white circle next to the sensor. A green tick will appear to confirm that the device is connected.
- Go to Trigger at the bottom left of the app, then to Select action and then select **"Code" Relay 1 On**. Then click on Save and another window will open.
- Set the voltage as the measuring channel $U[\mathrm{V}]$ as a threshold value $3\ \mathrm{V}$ with **Below threshold value** as the trigger and click on Save.

PHYWE
Robert-Bosch-Breite 10
37079 Göttingen
Tel.: 0551 604 - 0
Fax: 0551 604 - 107
info@phywe.de
www.phywe.de

Realisation (2/4)

PHYWE

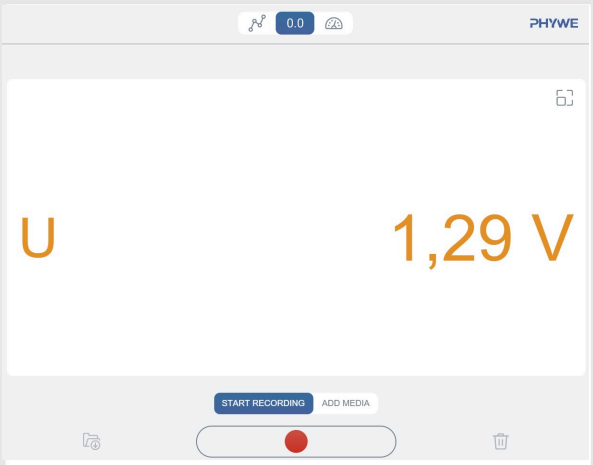


- Select the second trigger **Stop measurement (edge)**click on Save.
- Select the voltage measurement channel $U[\mathrm{V}]$ and place $2{,}45\ \mathrm{V}$ on the rising edge.
- You do the same with the action **"Code" Relay 1 Off**so choose $2{,}45\ \mathrm{V}$ and **Threshold value exceeded**.

Realisation (3/4)

PHYWE

- Then click on the 0.0 symbol at the top of the measureApp on the right-hand side, where you can see the coordinate system. You should now see the voltage values of the solar cell.
- Firstly, make sure that the voltage and current regulators on the power supply unit are set to 0. Then activate the power supply unit and turn the current regulator to $1{,}8\ \mathrm{A}$.



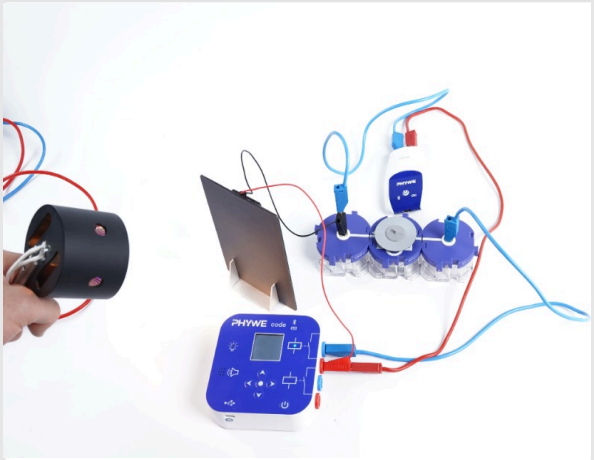
Voltage value given as a pure numerical value.

PHYWE
Robert-Bosch-Breite 10
37079 Göttingen
Tel.: 0551 604 - 0
Fax: 0551 604 - 107
info@phywe.de
www.phywe.de

Procedure (4/4)

PHYWE

- Now point the halogen lamp at the solar cell and slowly turn up the voltage until the motor has gone out again.
- Then turn the voltage back to 0 and deactivate the power supply unit.



Current test setup.

PHYWE

Report

PHYWE

Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

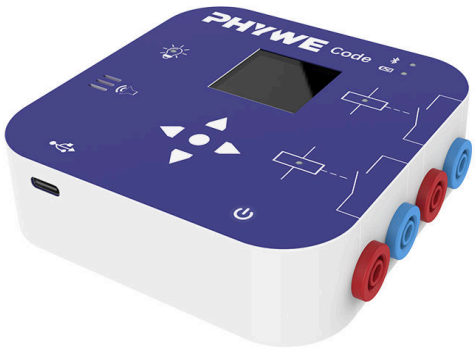
info@phywe.de
www.phywe.de

Task 1

PHYWE

What do we use the Cobra SMARTsense for?
Code in the experiment?

- To measure the current.
- To act as a switch.
- To measure the voltage.



Cobra SMARTsense code

Task 2

PHYWE

Which energy conversions take place in this experiment?

- ☐ Kinetic energy ⇒ Electrical energy
- ☐ Electrical energy ⇒ Kinetic energy
- ☐ Light energy ⇒ Electrical energy
- ☐ Kinetic energy ⇒ Light energy
- ☐ Electrical energy ⇒ Light energy

Check

PHYWE
Robert-Bosch-Breite 10
37079 Göttingen
Tel.: 0551 604 - 0
Fax: 0551 604 - 107
info@phywe.de
www.phywe.de

Task 3

PHYWE

Place the words in the correct gaps!

It can be observed here that the lamp also shines _____ at _____ voltage and the motor turns _____ at a _____ voltage and vice versa.
The _____ are not completely efficient.
Light and _____ are lost to the environment, especially through the halogen lamp.
One way to minimise the _____ is to use a larger _____.

energy conversions
brighter
heat
solar cell
energy loss
higher
lower
slower

Check

Slide	Score / Total
Slide 21: Intended use Sensors and actuators	0/2
Slide 22: Energy conversion	0/3
Slide 23: Energy loss	0/8

Total amount 0 / 13

Solutions Repeat

PHYWE
Robert-Bosch-Breite 10
37079 Göttingen
Tel.: 0551 604 - 0
Fax: 0551 604 - 107
info@phywe.de
www.phywe.de