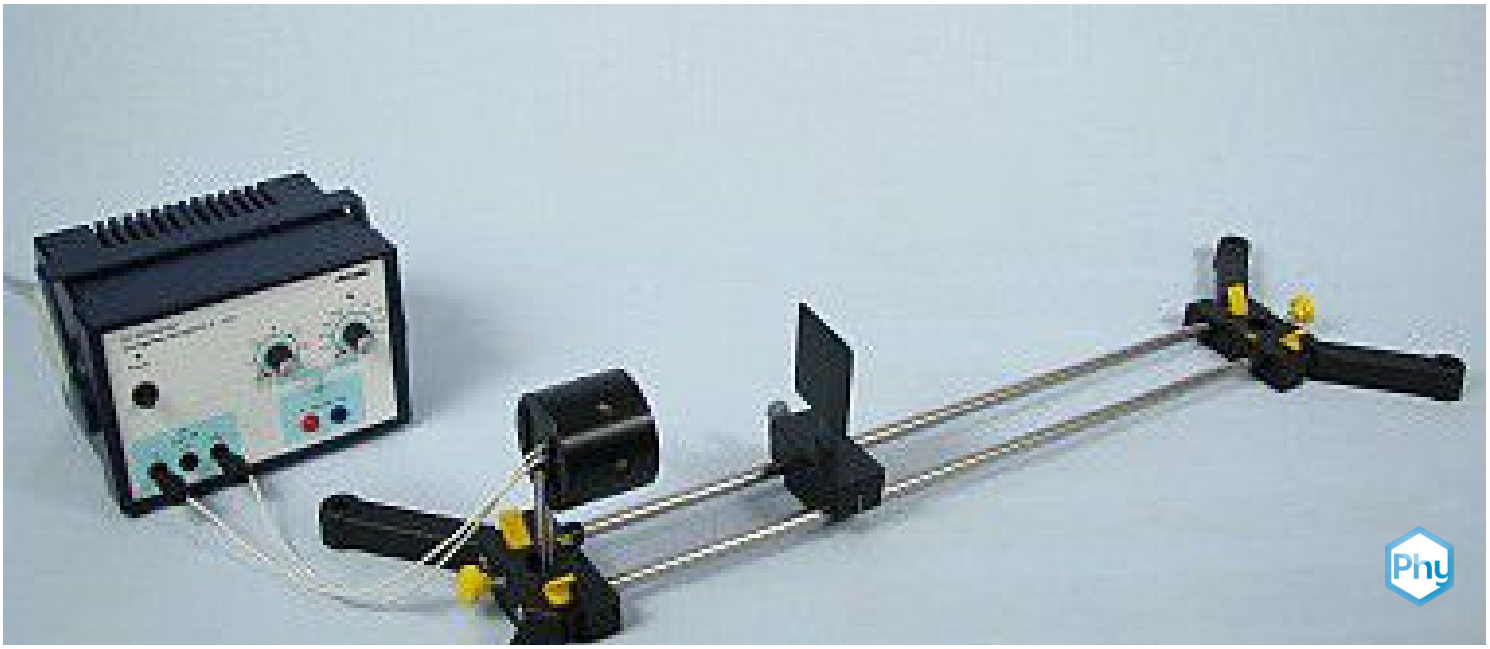
Influence of surface on the absorption of solar energy



Physics | Energy | Renewable energies: Sun

Difficulty level	Group size	Preparation time	Execution time
easy	1	10 minutes	10 minutes

This content can also be found online at:

http://localhost:1337/c/62e8112c7db41d0003cf9584

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

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Teacher information

Application

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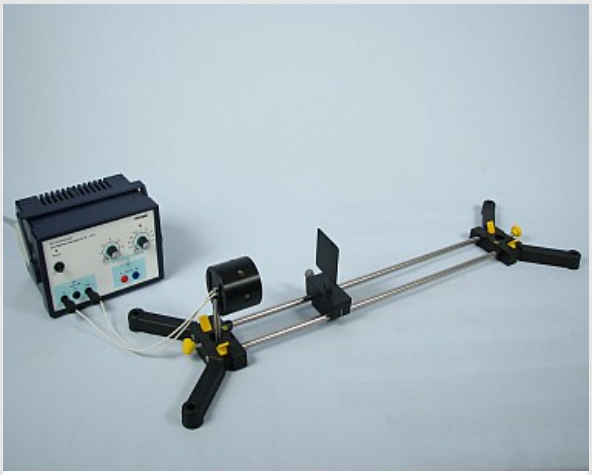

Experimental setup

In this experiment, the white tent in the desert is simulated by a white absorber plate that is illuminated by a halogen lamp for 5 minutes.

The temperature difference before and after irradiation is compared with that of a black absorber plate.

The result is that the white panel absorbs less solar energy and thus heats up less.

This result is to be transferred by the students to practical examples, such as the white tent of the Bedouin and the black skin of the polar bear.

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Other teacher information (1/3)

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Prior knowledge

Students should be proficient in the use of a power supply unit.

Principle

In this experiment, the absorption behaviour of surfaces is observed and the observed differences are traced back to their physical basis.

Other teacher information (2/3)

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Learning objective

The students learn how the absorption behaviour of solar energy depends on the surface.

Tasks

This experiment investigates how black and white absorber plates behave when irradiated with a halogen lamp.

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Other teacher information (3/3)

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Notes on set-up and procedure

The measured initial temperatures of the absorber plates differ depending on the ambient temperature.

Different results in the temperature increase can be caused by reading inaccuracies on the thermometer or by different orientations of the absorber plate.

Safety instructions

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

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Student information

Motivation

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A sleeping polar bear

A well-known everyday wisdom says that you should not wear black clothes in the hot summer.

Based on the same physical conditions, polar bears have black skin under their fur and Bedouins prefer to live in white tents.

These circumstances are explained by the absorption behaviour of different surfaces.

In this experiment, a special focus is placed on the colour of a surface and its effect on absorptivity.

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Tasks

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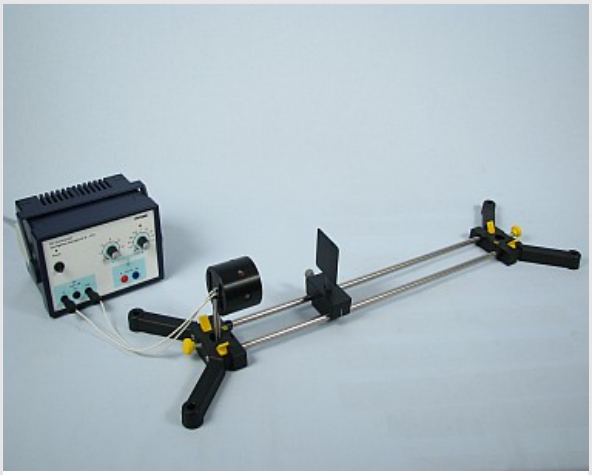

The experimental setup

This experiment investigates how black and white absorber plates behave when irradiated with a halogen lamp.

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Equipment

Position	Material	Item No.	Quantity
1	Halogen lamp with reflector, 12V / 20W	05780-00	1
2	Mount for halogen lamp with reflector	05781-00	1
3	Solar collector for student experiments	05760-00	1
4	Support base, variable	02001-00	1
5	Slide mount for optical bench	09822-00	1
6	Measuring tape, l = 2 m	09936-00	1
7	Support rod, l = 600 mm, d = 10 mm, split in 2 rods with screw threads	02035-00	2
8	Digital stopwatch, 24 h, 1/100 s and 1 s	24025-00	1
9	Lab thermometer,-10..+110 °C	38056-00	1
10	PHYWE Power supply, 230 V, DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1

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Set-up (1/2)

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1. First screw the two-part stand rods together to form two long rods (Fig. 1).

Assemble the stand bench from the variable stand foot and the two rods (Fig. 2 and Fig. 3).

Figure 1

Figure 2

Figure 3

Set-up (2/2)

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3. Clamp the lamp in the left part of the stand base and connect it to the power supply unit (12 V~) (Fig. 4).
The power supply unit is switched off.

4. Put the black absorber plate on the stem (Fig. 5). Attach the stem with plate in the tab and place it on the stand bench (Fig. 6).

5. Insert the thermometer into the measuring socket of the plate, move the tab until the distance between the lamp and the plate is 12 cm and align the plate parallel to the tab (Fig. 7).

Figure 4

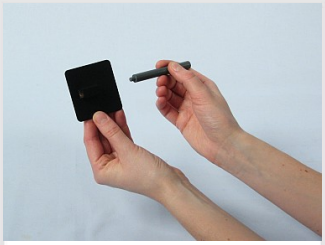

Figure 5

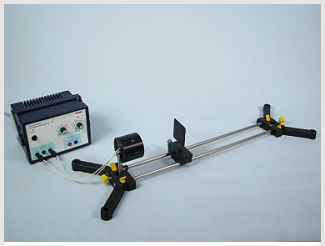

Figure 6

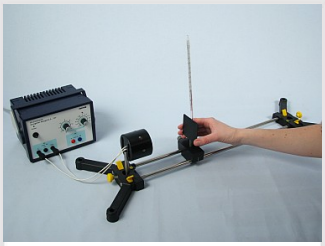

Figure 7

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Procedure

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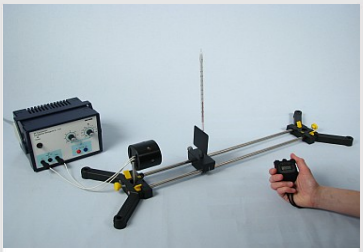

Figure 8

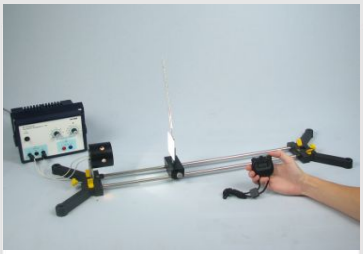

Figure 9

1. Observe the temperature before starting the measurement and wait until it stops changing.
2. Measure the initial angular temperature ϑ_{1black} of the black plate. Enter this under Result in the report.
3. Switch on the lamp (the power supply unit) and start the stopwatch at the same time (Fig. 8).
4. After 5 minutes, switch off the power supply and measure the final temperature of the plate. ϑ_{2black} and note them down.
5. Repeat the experiment with the white plate (Fig. 9).
6. Note the initial temperature ϑ_{1white} and the final temperature ϑ_{2white}.

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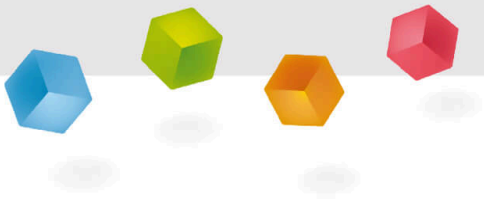

Report

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Robert-Bosch-Breite 10
37079 Göttingen

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

info@phywe.de
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Task 1

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Drag the words into the correct gaps

Light waves come in different _____ depending on their energy level. The higher the _____, the smaller the wavelength. When a _____ of light is reflected into our eye, our brain interprets the wavelengths as different _____.

Whereby _____ is the combination of all colours and _____ is the absence of any colour.

colours | energy | black | white | wavelengths | beam

Check

Task 2

PHYWE

Decide whether or which bracketed word does not belong there.

White materials (reflect / absorb) all wavelengths and the energy they carry is accordingly (not) absorbed.

This causes white materials to heat up (slower / faster).

Black materials (reflect / absorb) all wavelengths and appear black precisely because no light falls from them into our eye. Due to the (reduced / additional) energy absorption, they heat up significantly (more / weaker).

Check

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Task 3

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Find all true statements about light

- [ ] During absorption, the energy of the light is converted into kinetic energy.
- [ ] The more wavelengths a material reflects, the faster it heats up due to light irradiation.
- [ ] When light is reflected, the angle of incidence is exactly the same as the angle of reflection.
- [ ] During absorption, the energy of the light is absorbed by the electrons of the material.

Check

Slide	Score / Total
Slide 15: What is a colour?	0/6
Slide 16: Reflection and absorption	0/6
Slide 17: Light	0/3

Total 0 / 15

Solutions Repeat

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