Version 2.0

power house

Thames & Kosmos

Experiment Manual

SCIENCE EDUCATION SET

WARNING — This set contains chemicals and parts that may be harmful if misused. Read cautions on individual containers and in the manual carefully. Not to be used by children except under adult supervision.

Kit Contents

The Power House experiment kit contains the following parts:

	Description	*Qty.*	*Item No.*
1	Power House polystyrene parts:		708662
	a) Base, roof sections, inserts		
	b) Wall (pointed) with house door		
	c) Wall (pointed) with window		
	d) Wall with solarium		
	e) Wall with window		
2	Solar cell	1	708678
3	Solar motor	1	709143
4	Contact Clips	4	708664
5	Thermometer	1	232105
6	Black bottle		
	(Solar collector)	1	263160
7	Lid	1	709131
8	Large dowel	1	263118
9	LED	1	000145
10	Solarium cover	1	708665
11	Long wooden sticks	2	020042
12	Black paper sheet	1	702303
13	Propeller	1	263143
14	Sandpaper	1	700881
15	Plastic pot	3	705804
16	Disk	1	708666
17	Short wooden sticks	8	705296
18	Die-cut sheet	1	708663
19	Cut-out sheet	1	709170
20	Connecting wire, black	1	263140
21	Connecting wire, red	1	263139
22	Small dowel	1	709140
23	Straight drinking straw	1	707597
24	Bendable drinking straw	1	529118
25	Fastening clips	3	020039

Additional Items Needed

You will also need various household items for some of your experiments. These items are highlighted in *italics* in the individual experiments. Before beginning an experiment, carefully read through the list of all the things you will need, and make sure to get anything that might be missing.

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Light and heat from the sun

Heating water is nice enough. But the sun's light can be used to do other things as well. First, though, you have to learn a little about the behavior of light.

EXP. 52 A star made of light

A candle's flame illuminates, which is to say it emits light. What happens to the light it sends out?

An adult should be present for this experiment!

You will need

"Light path" die-cut piece, tealight candle, matches, white paper, tape

Experiment

1. Remove the "light path" piece from the die-cut sheet. Bend it together into a circle and secure it with some tape.
2. Place the circle on a sheet of white paper in a darkened room. Set a tealight candle in the center and light it. What do you see?

Explanation

A ray of light streams through each one of the slits. It runs perfectly straight. So light spreads out equally in all directions. As the rays of light get farther from their source, they diverge farther and farther from each other.

EXP. 53 Do the sun's rays also diverge?

Strange: Objects in sunlight cast sharp shadows. How can that be, if rays of light move apart from one another as soon as they leave their source?

You will need

"Light path" die-cut piece, roof piece, *white paper, lamp*

Experiment

1. Remove the tape and pull the strip apart again. Tape it to the roof of your experimental house and observe the patterns that the sun makes as it shines through it.
2. Unlike the candle in the previous experiment, the sun is very far away from the "comb." Use a desk lamp or flashlight to experiment with the way that the distance between the light source and the "comb" can affect the shadows.

Explanation

Rather than diverging, the rays of the sun run parallel — that is, they always keep the same distance from one another. That is due to the unbelievably huge distance of the sun from Earth. That becomes clear in the second pat of the experiment: The greater the distance between the "comb" and the light source, the less the rays diverge.

Appearances are deceiving: The sun's rays only seem to diverge. In reality, they run parallel.

EXP. 54 Why it gets cold in winter

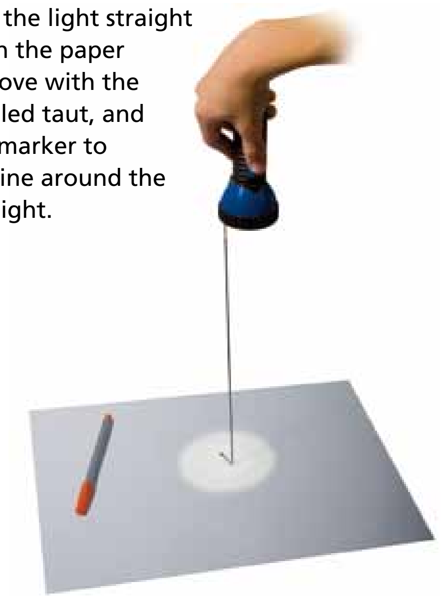
If you want to save energy with your Power House and, more importantly, in an actual building, the outside temperature will have an important role to play. In the winter, you will need a lot more heat than in summer, because it is cold. But why is it cold, actually?

You will need

Flashlight, yarn or string, tape, scissors, graph paper, colored marker

Experiment

1. Cut off a piece of yarn about 30 cm in length. Tape one end to the center of a sheet of graph paper, and tie the other end to the flashlight.
2. Shine the light straight down on the paper from above with the yarn pulled taut, and use the marker to draw a line around the spot of light.

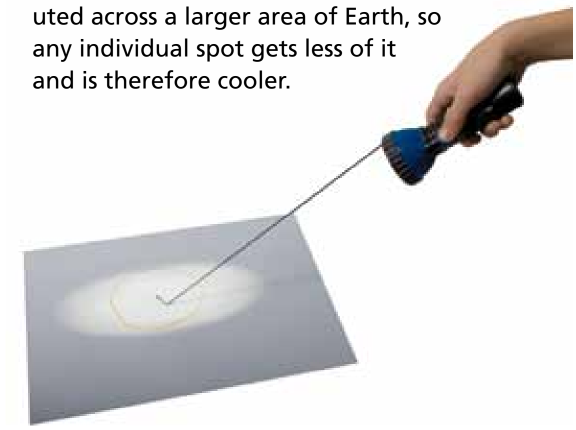


3. Now shine the light at an angle from the side from the same distance, and mark the bright spot again.
4. Count the squares inside the two outlined areas and compare.

Explanation

When you shine the light at a slant, the bright spot is much larger, but also less bright. That is due to the fact that the quantity of light from the flashlight now has to be distributed across a much larger surface area. Any single individual square, then, gets less light.

It's similar with sunshine. In the winter, when the sun stands closer to the horizon than in winter, its light and warmth are distributed across a larger area of Earth, so any individual spot gets less of it and is therefore cooler.



EXP. 55 Light rays take a detour

Normally, as Experiment 52 showed, light rays will stubbornly run straight ahead and won't turn any corners. There are a few tricks, though…

You will need

Solarium annex cover, *aluminum foil, white paper*

Experiment

1. Look at the transparent annex cover at a slant. It is reflective. So you will see things, for example, that are behind you and to the side.
2. If you hold the paper and cover sheet in the sun as shown in the illustration, you can create a bright spot on the paper or on a shaded wall.
3. Bend the edges of the sheet slightly toward the sun. How do the shape and size of the spot change?
4. Now bend the edges of the sheet away from the sun. What effect does that have on the spot?
5. Place smooth aluminum foil behind the sheet, with the shiny side toward the sheet, and repeat the experiments. Now the spot is somewhat brighter.

Explanation

Smooth surfaces reflect light rays — in other words, they change the direction of movement of the rays. That fact lets you use the sheet to look around corners, for example, or to direct the sunlight onto a shaded wall. It works even better with the shiny aluminum foil, which reflects more light — the cover, after all, lets most of the light through. Mirrors work best of all. With a smooth sheet, incoming parallel light rays keep traveling in parallel manner after being reflected, just in a different direction. But if you bend the sheet, you also change the manner in which the rays of light are reflected back. As shown in the illustration, you can use this technique to concentrate the rays on one spot or to pull them apart.

EXP. 56 Diffuse lighting

A good mirror is pretty expensive. Why not try it with a piece of paper?

You will need

Black paper, *white paper*

Experiment

1. Hold the white sheet of paper in the full sun a few centimeters away from a shaded wall. The wall close to the paper will appear brighter, but only slightly so. You won't see a clearly bright spot.
2. Repeat the experiment with the black paper. Now the wall doesn't look any brighter at all.

Explanation

The black paper swallows up almost all the light and therefore doesn't light up the wall at all. The white paper, on the other hand, reflects back almost all the light that hits it — which is why it looks bright white to us. But it scatters the light: The originally parallel rays are steered in all directions by the rough paper surface.

EXP. 57 Can heat be reflected?

If the aluminum foil redirects the sun's light, can it do that with heat as well?

You will need

Thermometer, solarium annex cover, *aluminum foil, tape*

Experiment

1. Set the solarium cover on the table and lay a piece of aluminum foil on top of it, with the dull side toward the cover. Smooth out the foil and secure it to the cover with tape. Now the shiny side is nice and flat and can easily be used as a mirror.
2. Hold the thermometer in a shady location for a few minutes in order to measure the air temperature, and make a mental note of it.
3. Then use the aluminum foil to direct sunlight to the bulb of the thermometer — but don't let direct sunlight hit it. After a few minutes, take a reading of the temperature.

Explanation

Even reflected sunlight can increase the thermometer temperature quite a bit. Apparently, then, the heat of the sun is reflected too.

EXP. 58 Focused heat rays

In Experiment 55, you saw how to focus rays of light by using a certain shape of mirror. Maybe you can do that with heat rays too.

You will need

Thermometer, small concave mirror from the cutout sheet, *aluminum foil, scissors, glue*

Experiment

1. Cut out the small concave mirror from the cutout sheet and glue aluminum foil to its back, shiny side down. The foil should be as smooth as possible.
2. Pull the ends over one another to form a cone-shaped structure with the aluminum foil on the inside, and secure it with glue.

3. Hold the concave mirror in the sun and use your hand or a small piece of paper to determine where most of the reflected rays meet. That will be the brightest spot, and you will even be able to feel a little warmth with your hand.
4. Push the thermometer into the concave mirror from below so that as many reflected rays as possible hit the thermometer bulb, but as little direct sunlight as possible. As you do this, hold

the thermometer from the top by the small ring. Watch the temperature. Within a few minutes, it will start to rise.

Explanation

The aluminum foil concentrates the captured solar energy onto one small area, which therefore becomes hotter. Even though the concave mirror is small and doesn't have a particularly shiny surface, the effect is quite noticeable.

EXP. 59

The bigger, the hotter

The little mirror in the previous experiment managed to produce quite a noticeable increase in temperature. Will the effect be even more noticeable with a bigger and better mirror?

You will need

Thermometer, large concave mirror from the cutout sheet, *scissors, aluminum foil, glue*

Experiment

1. Cut out the large concave mirror from the sheet and glue aluminum foil to its back, shiny side out. The foil should be as smooth as possible. Glue the ends over one another as in the previous experiment.
2. Point the concentrated rays at the bulb of the thermometer, and watch the temperature. It will rise quickly and dramatically.

Be careful not to let the temperature rise above 100 degrees Celsius, or the thermometer could get damaged.

Explanation

With its large surface area, this mirror captures a lot more sunlight than the small one.

Be careful when experimenting with the concave mirror and the sun!
Never look directly into the sun, or you could suffer eye damage.
Always store the concave mirror with its foil side down, and never leave it unattended. Do not leave any ground lenses, such as magnifying lenses or eyeglasses, lying near it. It could cause a fire!

Energy Saving Tip

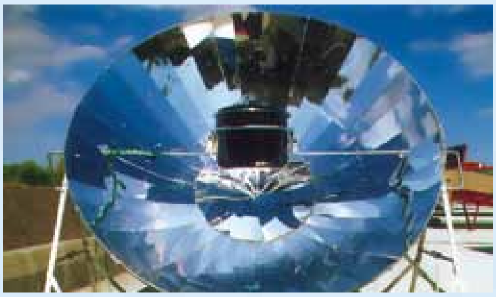
Don't let water run unnecessarily (while brushing your teeth, for example).

KEYWORD

Concave mirror

This is the name for a mirror that has an inward-curving surface rather than a flat one. Incoming parallel rays of light are not reflected back as a bundle of parallel rays, but are concentrated together in a tight spot. If the concave mirror forms a hemisphere, it creates a shape known as catacaustic, with the rays failing to meet exactly at one point. It is only with a so-called parabolic mirror that they do that, as shown in cross-section in the drawing. The larger the mirror, the more of the sun's rays it can capture and the hotter it will get at this "focal point."

In the Pyrenees Mountains in southern France, there is a giant solar oven with a concave mirror as tall as a house that is capable of generating temperatures of 3600 degrees Celsius. It has 63 secondary tracking mirrors that reflect the sun's light into the large concave mirror.



Instead of round mirrors, large solar power plants usually have parabolic mirrors in the shape of a channel or "trough." These mirrors have a focal line rather than a focal point, along which pipes carry a special liquid that is heated by the sun and that transports the heat to electricity generators.

Parabolic trough power plant in the California desert