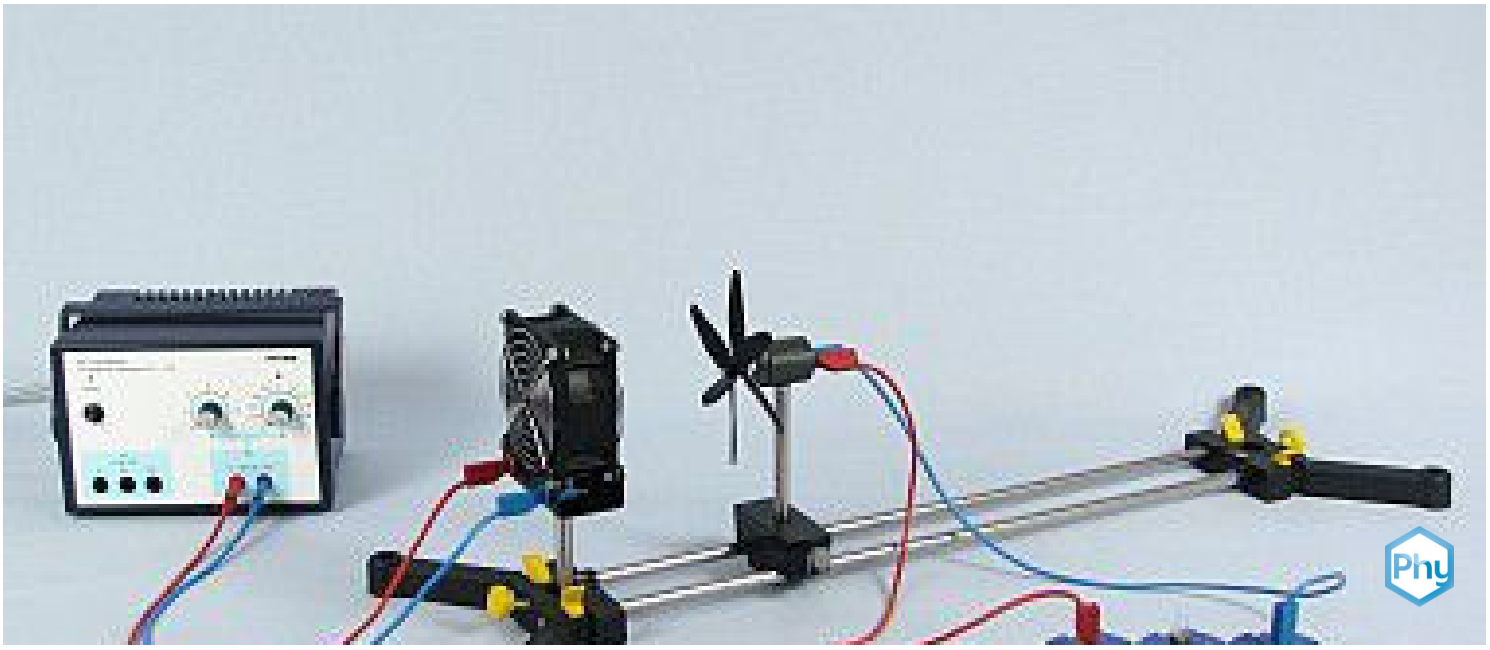
Electrical energy from wind energy



Physics > Energy > Energy forms, conversion & conservation

Physics > Energy > Renewable energies: Wind

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

This content can also be found online at:

http://localhost:1337/c/6167d9222d1cf30003518ad3

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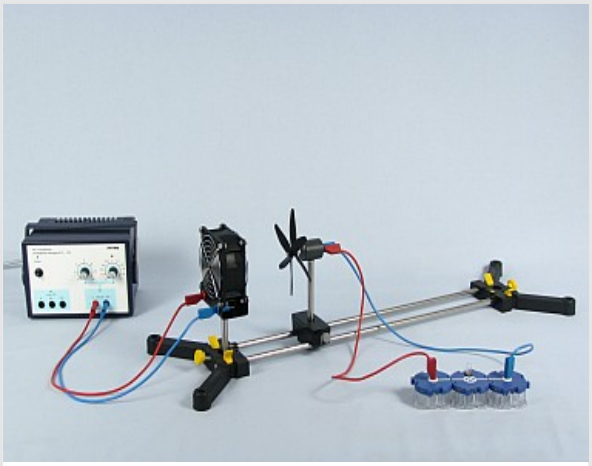
General information

Application



Experiment setup

Wind is the term used to describe air currents from an area of high air pressure to areas of low air pressure.

The energy carried by the wind can be used to perform mechanical work or to generate electricity.

As high and low pressure areas are a permanent and natural part of the climate, wind energy belongs to the renewable energies.

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Other teacher information (1/3)

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Previous knowledge

Students should be familiar with the basic concepts of energy conversion and entropy.

Scientific principle

In this experiment, an artificial air current is generated and it is observed how this can be used by a wind turbine to generate electric current.

Other teacher information (2/3)

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Learning objective

The students learn about the physical background of wind turbines.

Tasks

Wind of varying strength is generated by a fan in this experiment. A wind turbine consists of a rotor (several blades) and a generator.

Observe a light bulb connected to the wind turbine when the fan generates wind.

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Other teacher information (3/3)

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Notes on structure and implementation

The distance between the blower and the generator is only estimated. It should not be greater than 10 cm, otherwise the lamp will not light up well. The adjusting knob for the amperage must be turned all the way to the right so that a supply voltage of 12 V for the blower can be achieved.

Safety instructions

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

Care should be taken to ensure that students always stand behind the fan and do not reach into the space between the fan and the wind turbine when voltage is applied and the wind turbine is turning.

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Student Information

Motivation

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Video format not supported.

A wind farm

Wind turbines in wind farms use the air currents (also known as wind) created when high and low pressure areas are balanced to generate electricity.

Since the atmospheric pressure will theoretically never be balanced by natural processes, the use of kinetic wind energy is one of the sustainable renewable forms of energy.

These play an essential role in guaranteeing the energy supply for mankind as soon as the fuel reserves are exhausted.

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Tasks

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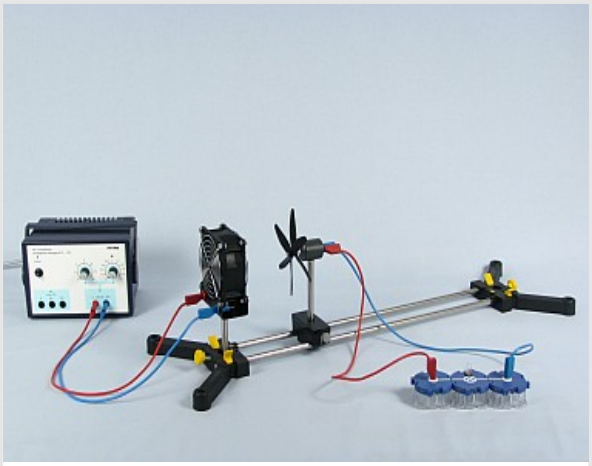

The experimental setup

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Equipment

Position	Material	Item No.	Quantity
1	Support base, variable	02001-00	1
2	Support rod, stainless steel, l = 600 mm, d = 10 mm	02037-00	2
3	Junction module, SB	05601-10	2
4	Socket module for incandescent lamp E10, SB	05604-00	1
5	Rotor, 2 pieces	05752-01	1
6	Generator with metrical thread axis and nut	05751-01	1
7	Blower, 12V	05750-00	1
8	Slide mount for optical bench	09822-00	1
9	Connecting cord, 32 A, 500 mm, red	07361-01	2
10	Connecting cord, 32 A, 500 mm, blue	07361-04	2
11	PHYWE Power supply, 230 V, DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1
12	Lamp 4 V/0,04 A,E 10 socket	06154-00	1

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Set-up (1/3)

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1. Assemble the tripod bench from the variable tripod base and the two rods (Fig. 1 and 2).

2.Clamp the blower into the left part of the stand base so that the side with the sockets faces away from the stand bench (Fig. 3).

Figure 1

Figure 2

Figure 3

Set-up (2/3)

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3. Place the two rotors one after the other on the axle of the generator (Fig. 4).

4.The six wings should then be evenly spaced (Fig. 5).

5.Attach the generator in the tab and place it on the tripod bench (Fig. 6).

Figure 4

Figure 5

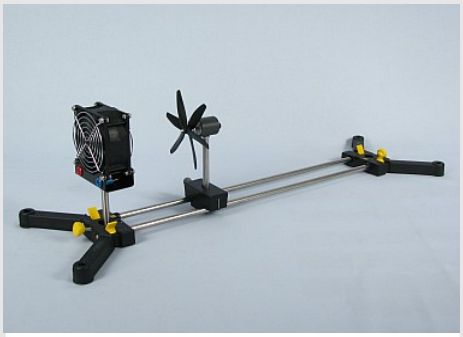

Figure 6

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Set-up (3/3)

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Figure 7

Figure 8

6. Screw the 4 V bulb into the bulb holder, connect it to terminal blocks and connect it to the generator as shown in Fig. 7.

7.Connect the blower to the DC output on the power supply (Fig. 8). The power supply unit is switched off.

Procedure (1/2)

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Figure 9

Figure 10

Experiment 1

1.Move the generator so that the distance between the front of the blower and the top of the generator is about 5 cm (Fig. 9).

2.Turn on the power supply and turn the current control knob all the way to the right.

Slowly turn the voltage control knob to the right (Fig. 10) while watching the bulb.

3.Describe your observation in your experimental protocol.

Attention: Always stand behind the fan when there is voltage and the wind turbine is turning. Never reach into the space between the fan and the wind turbine.

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Procedure (2/2)

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Experiment 2

1.Turn off the power supply and remove the windmill from the stand bench. Turn on the power supply again.

2.Hold your hand in front of the blower and turn the tension control knob to the right.

3.Describe your observation.

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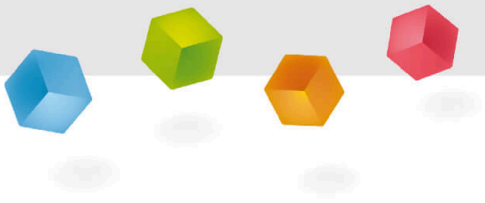

Report

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Task 1

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Which of these properties of the air affect the electrical power produced P?

- [ ] The air composition
- [ ] The average speed
- [ ] The density
- [ ] The humidity
- [ ] The temperature

Check

Task 2

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What is the equation that expresses the electrical power generated from wind energy P

$$P = \square \cdot \frac{1}{2} \cdot \square \cdot \square$$

$$\text{with } \dot{m} = \square \cdot \square \cdot \left(\square \right)^2$$

η	v
A	ρ
$\dot{m}$	m
h	ϑ

Check

η=effectiveness, v=Speed, A=support surface, $\rho = Luftdruck$, $\dot{m}$=mass flow, $m = Masse$, h=height, ϑ=temperature

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Task 3

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Drag the words into the correct gaps

Using the equation for electrical [ ]. P one recognizes that here a conversion of kinetic energy into electrical energy takes place. The [ ] ηwhich is between 0 and 1, describes how efficient the [ ] is and includes all processes (like [ ]) where energy is lost. Putting all the quantities together, we see that the most important factor is the [ ] of the air, since the power generated increases cubically with it.

- efficiency
- power
- velocity
- friction
- energy conversion

Check

Slide	Score / Total
Slide 17: Properties of the air	0/2
Slide 18: The electrical power	0/14
Slide 19: Conversion of energy	0/5
Total	**0 / 21**

Solutions Repeat

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