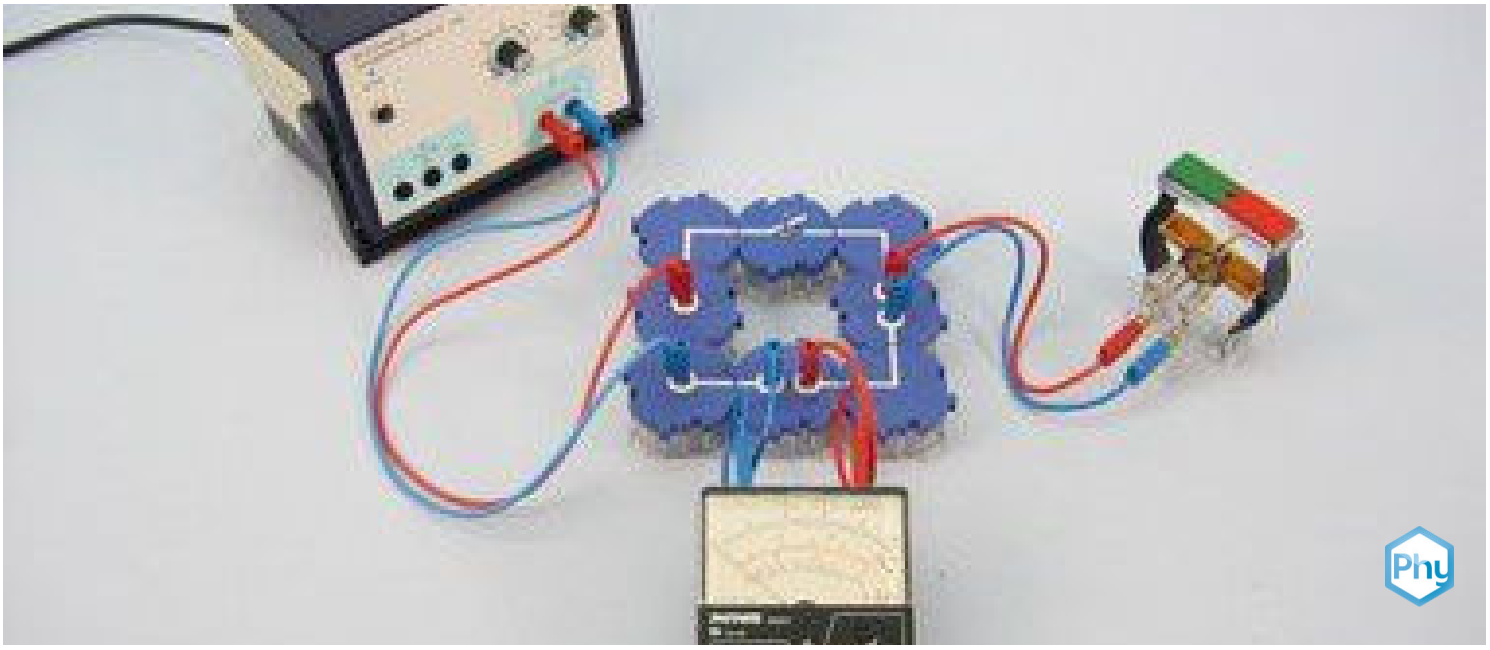
The permanent magnet DC motor



Physics	Electricity & Magnetism	Electric generator, motor, transformer

Difficulty level	Group size	Preparation time	Execution time
medium	2	10 minutes	10 minutes

This content can also be found online at:

http://localhost:1337/c/5f4fade237ffe20003f0fa98

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Teacher information

Application

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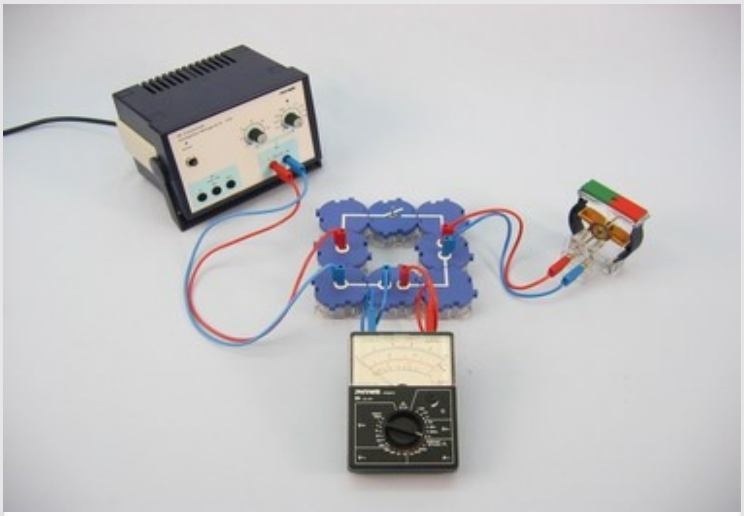

Experiment set-up

Electric motors are built into many electrical devices.

The electric motor is one of the most common methods of converting electrical energy into mechanical energy: whether in electric cars, electric toothbrushes, vacuum cleaners or many more. It is hard to imagine our lives today without the electric motor.

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Other teacher information (1/2)

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Prior knowledge

The students should know that a current-carrying conductor moves in an external magnetic field based on the Lorentz force. Ideally, the students should have acquired a previous knowledge of electromagnets, permanent magnets and the interactions between magnetic fields.

Scientific principle

The current flowing through the coil, which is located in a magnetic field in the electric motor, aligns itself. A commutator reverses the polarity of the coil, causing the coil to continue rotating and thus ultimately to change into a continuous rotary movement. In order for the commutator to pass over the point of polarity reversal, the motor must normally be "started up".

Other teacher information (2/2)

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Learning objective

With the help of the model of a permanent magnet DC motor, the students are to learn about the basic structure and function of an electric motor.

Tasks

The students connect the motor model to the DC current and observe how it works.

Note: The motor type under investigation cannot be operated with AC voltage.

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Safety instructions

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

Note: The test is not difficult to set up and conduct. But you should make sure that the voltage is only 6 V for a short time and not more. The current remains in the range of about 300 mA, but as a precautionary measure 3 A is recommended.

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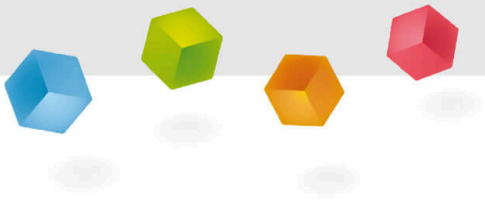

Student Information

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Motivation

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Electric car

Electric motors are built into many devices.

For example, an electric car is powered by an electric motor, but many household appliances such as vacuum cleaners or electric toothbrushes also use electric motors.

In this experiment, you will investigate the operation of an electric motor with permanent magnets and learn how electrical energy is converted into mechanical energy.

Tasks

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How does an electric motor work?

Place a permanent magnet on the model of an electric motor. Familiarize yourself with the structure and operation of a motor.

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Equipment

Position	Material	Item No.	Quantity
1	PHYWE Power supply, 230 V, DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1
2	Analog multimeter, 600V AC/DC, 10A AC/DC, 2 MΩ, overload protection	07021-11	1
3	Angled connector module, SB	05601-02	3
4	Interrupted connector module with sockets, SB	05601-04	2
5	Junction module, SB	05601-10	2
6	On-off switch module, SB	05602-01	1
7	magnet, l = 72mm, rodshaped, colored poles	07823-00	1
8	Motor model for student experiments	07850-10	1
9	Connecting cord, 32 A, 250 mm, red	07360-01	2
10	Connecting cord, 32 A, 250 mm, blue	07360-04	2
11	Connecting cord, 32 A, 500 mm, red	07361-01	1
12	Connecting cord, 32 A, 500 mm, blue	07361-04	1

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Set-up

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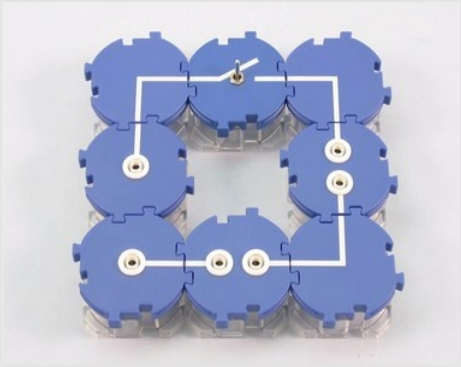
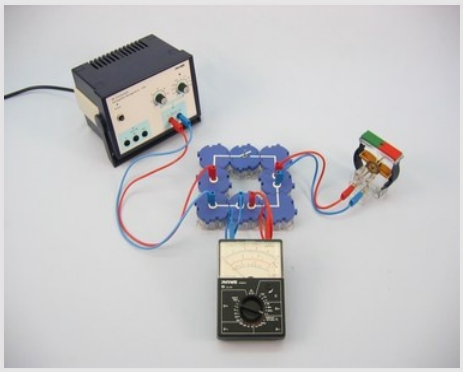
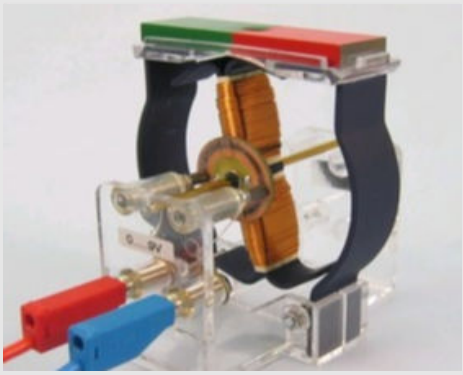
Set up the experiment according to the figures below. The switch is initially open.

Place a permanent magnet on the model of the motor.

Select a measuring range of about 3 A (direct current) for the measuring instrument.







Procedure (1/2)

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- Switch the power supply unit on and set it to about 5 V.
- Bring the rotor (armature) of the motor model into a vertical position and close the switch.
- Open the switch. Bring the rotor into a horizontal position and close the switch again. Observe the rotor and if necessary lightly bump it with your hand.
- Vary the operating voltage between about 4 V and 6 V while the engine is running. Pay attention to the speed of the motor. Pay attention to the direction of rotation of the rotor.
- Open the switch, turn the magnet around (change the position of the poles) and close the switch again.
- Again observe the direction of rotation of the rotor and compare it with the previous direction.

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Procedure (2/2)

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- Open the switch and exchange the connections of the motor.
- Close the switch, observe the direction of rotation after reversing the current direction in the rotor and compare it with the previous direction.
- Set the voltage to 6 V and brake the running motor by pressing the disc with the commutator (the disc pressing on the contact pins). Pay attention to the deflection of the ammeter.
- Set the power supply unit to 0 V and switch it off.

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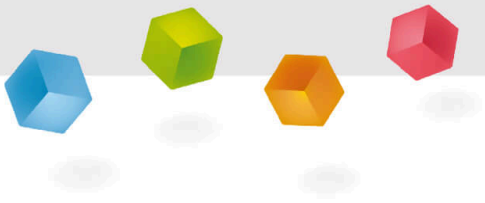

Report

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Task 1

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What happened when the motor was in horizontal position and the circuit was closed?

- [ ] The engine started by itself.
- [ ] The engine did not start by itself.
- [ ] With a light push, the engine started.

Check

Task 2

PHYWE

What happened when you increased the operating voltage on the engine

- [ ] The rotational frequency of the motor decreases with higher operating voltage.
- [ ] The motor slows down with higher operating voltage.
- [ ] The motor becomes faster at higher operating voltage.
- [ ] The rotational frequency of the motor increases with higher operating voltage.

Check

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Task 3

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What influences the direction of rotation of the motor?

- [ ] The polarity of the permanent magnet.
- [ ] The motor always rotates in one direction only.
- [ ] The current: From 1 A the motor rotates in the opposite direction.
- [ ] The polarity of the operating voltage

Check

Task 4

PHYWE

What happens when you slow down the engine?

- ○ The operating current of the morse is lower.
- ○ The operating current strength of the morse becomes higher.
- ○ The operating voltage becomes higher.
- ○ The operating voltage becomes lower.

Check

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Task 5

PHYWE

Paste the words into the correct gaps.

The motor runs because magnetic poles of the same name _____ each other and magnetic poles of different names _____ each other. If the direction of current in the rotor were not periodically _____, it could only perform a maximum of half a revolution.

reversed
repel
tract

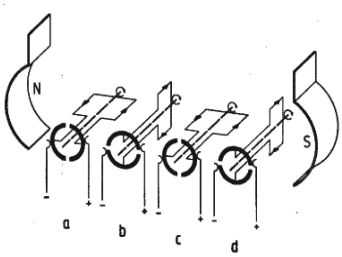
Check

Task 6

PHYWE

Paste the words into the correct gaps.

The commutator ensures that the current in the rotor coil is interrupted. This interruption occurs just before two _____ magnetic poles that have _____ each other face each other (position b and d in the figure). In addition, the _____ ensures that the current flows through the coil in _____ direction shortly afterwards and that two poles of the same name are now facing each other, repulsing each other.



attracted
reverse
unlike
commutator

Check

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Task 7

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The fixed part of the motor is called the stator. Why must it be made of iron?

- ○ Since currents flow in the electric motor, the stator must be made of iron.
- ○ Iron amplifies the magnetic field.
- ○ Iron is only used for stability.

Check

Task 8

PHYWE

If the motor is braked, this means a load. The motor must perform (additional) mechanical work, i.e. it must convert more electrical energy into mechanical energy than before. What does this mean for the electric current I?

- ○ Because of $W_{el} = U \cdot I \cdot t$ the current intensity must be I become larger than before because the voltage is constant.
- ○ The electric current I will decrease as the voltage increases.
- ○ The performance $W_{el} = U \cdot I \cdot t$ does not matter, because the engine still rotates under load. Therefore the current can also remain constant.

Check

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Slide	Score / Total
Slide 14: Motor - horizontal position	0/2
Slide 15: Operating voltage - rotational frequency	0/2
Slide 16: Direction of rotation	0/2
Slide 17: Load on the motor	0/1
Slide 18: Magnetic reversal of polarity	0/3
Slide 19: Commutator	0/4
Slide 20: Stator	0/1
Slide 21: Load on the motor	0/1

Total amount 0 / 16

Solutions Repeat

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