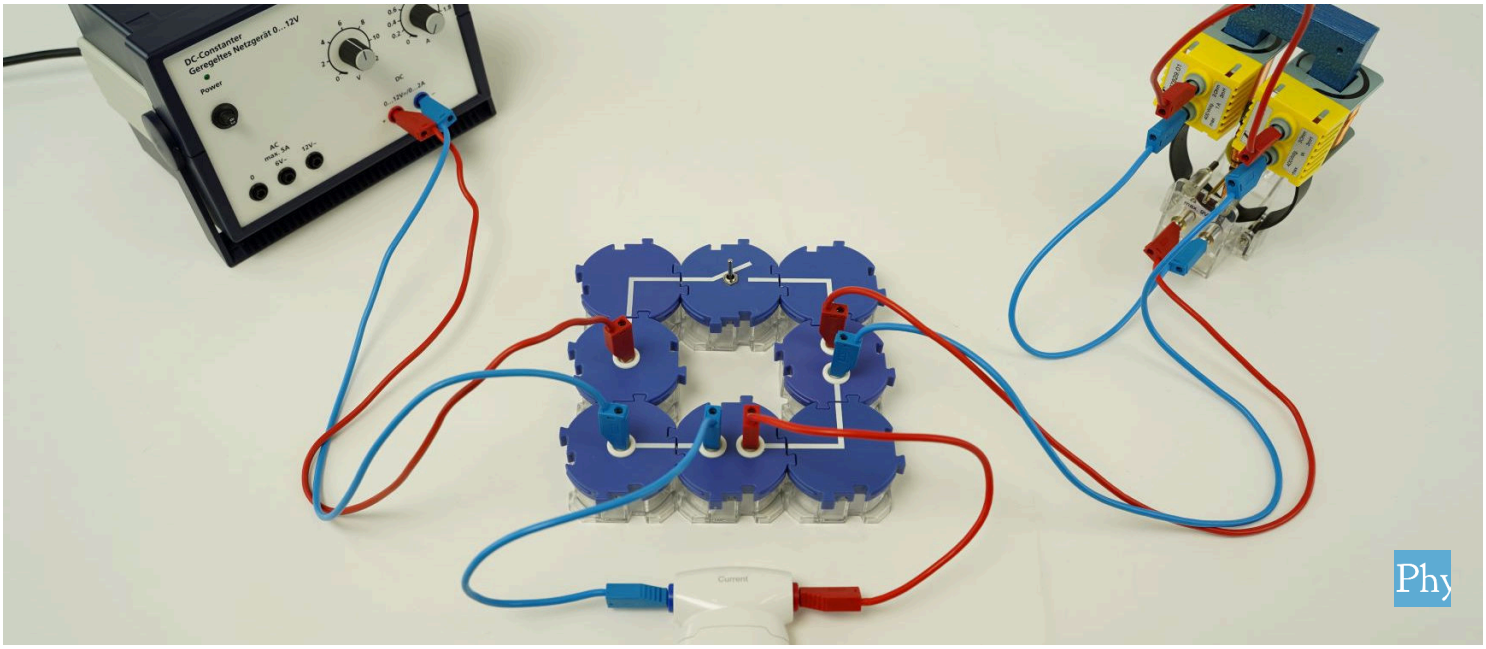
The main shutter motor with Cobra SMARTsense



Physics | Electricity & Magnetism | Electric generator, motor, transformer

Difficulty level	Group size	Preparation time	Execution time
easy	2	10 minutes	20 minutes

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Teacher information

Application

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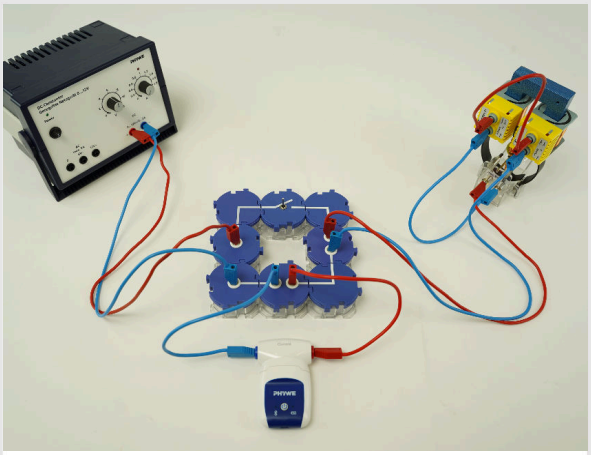

Test setup

Electric motors are used to convert electrical energy into mechanical energy, which can then be used to perform mechanical work. Main shunt motors are made up of stator or field coils and armature or rotor coils, which are connected in series. Because they are connected in series, the amperage grows equally in the coils when a load is applied, so they can produce a large amount of torque. They can put out high power, but comparatively do not run very smoothly.

They are used in many household appliances such as vacuum cleaners, kitchen machines or drills. In the past they were used in electric locomotives and today they are still used in trams.

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Other teacher information (1/3)

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Previous

The students should be able to construct and understand a simple electric circuit. They should be generally familiar with the functioning of an electric motor and the terms rotor, stator, commutator and armature.

Principle

A main or series motor is an electric motor in which the coils of the stator and rotor are connected in series. When supplied with AC voltage, both the exciter field and the armature current thus change direction after each half-wave, so that the resulting torque continues to act in the same direction even when the direction of the current is reversed.

Other teacher information (2/3)

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Learning

With the help of this experiment, students will learn about the characteristics of a main shunt motor, also called a series motor.

Tasks

First, the effect of polarity on the direction of rotation of the motor is investigated, and it is recognized that the direction of rotation of the armature changes when the polarity is reversed. Then the effect of the operating voltage on the speed of the armature and the load on the motor is investigated. Here it is to be recorded that the speed of rotation increases with voltage and the current increases with load. Lastly, one of the coils is removed from the circuit and it is observed that the motor merely aligns itself.

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Other teacher information (3/3)

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Additional information

If electric motors are to have higher power, they are built with electromagnets instead of permanent magnets, because these can generate stronger magnetic fields in particular.

In a main shunt motor, the armature coil and field coils are connected in series.

Electric motors that can be operated with both direct and alternating current are called universal or universal-current motors. Their coil cores are generally laminated.

The experiments are designed to produce only qualitative or semi-quantitative results.

An essential prerequisite for the functioning of the motors is the correct connection of the two field coils (wound in the same direction) of the stator. Otherwise, the magnetic fields generated by the current-carrying coils will cancel each other out.

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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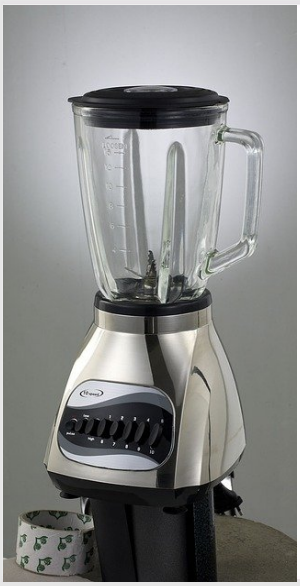

Electric motors are used to convert electrical energy into mechanical energy, which can then be used to perform mechanical work.

In this experiment, the main shunt motor is investigated. These motors are used in many household appliances such as vacuum cleaners, kitchen machines or drills. They used to be installed in electric locomotives and are still used in trams today.

With the help of this experiment you will learn which properties such a main circuit motor has.

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Tasks

Test setup

What are the characteristics of main shunt motors?

Build a model of an electric motor in which the permanent magnet is replaced by an electromagnet. Investigate the properties of the motor when the coils of the stator and the rotor are connected in series.

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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	Cobra SMARTsense - Voltage, ± 30 V (Bluetooth + USB)	12901-01	1
3	Cobra SMARTsense - Current, ± 1 A (Bluetooth + USB)	12902-01	1
4	Angled connector module, SB	05601-02	3
5	Interrupted connector module with sockets, SB	05601-04	2
6	Junction module, SB	05601-10	2
7	On-off switch module, SB	05602-01	1
8	Coil, 400 turns	07829-01	2
9	Iron core, U-shaped, laminated	07832-00	1
10	Motor model for student experiments	07850-10	1
11	Connecting cord, 32 A, 250 mm, red	07360-01	2
12	Connecting cord, 32 A, 250 mm, blue	07360-04	2
13	Connecting cord, 32 A, 500 mm, red	07361-01	3
14	Connecting cord, 32 A, 500 mm, blue	07361-04	3
15	measureAPP - the free measurement software for all devices and operating systems	14581-61	1

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Set-up (1/3)

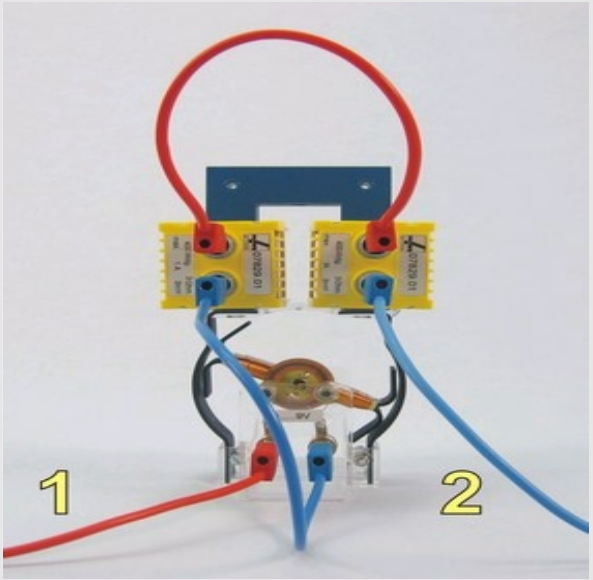
To measure the current, the Cobra SMARTsense and the measureAPP are required. The app can be downloaded free of charge from the App Store - see below for QR codes. Check whether Bluetooth is activated on your device (tablet, smartphone).

measureAPP for Android operating systems

measureAPP for iOS operating systems

measureAPP for Tablets / PCs with Windows 10

Set-up (2/3)



- Build the model of the engine according to the illustration.
- To do this, slide two coils onto the U-core and place it upside down on the motor model.
- Connect the coils and the windings of the armature (rotor) in series as shown in the figure.

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Set-up (3/3)

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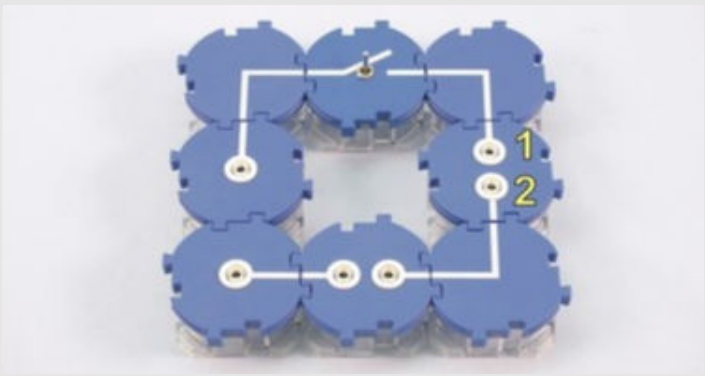
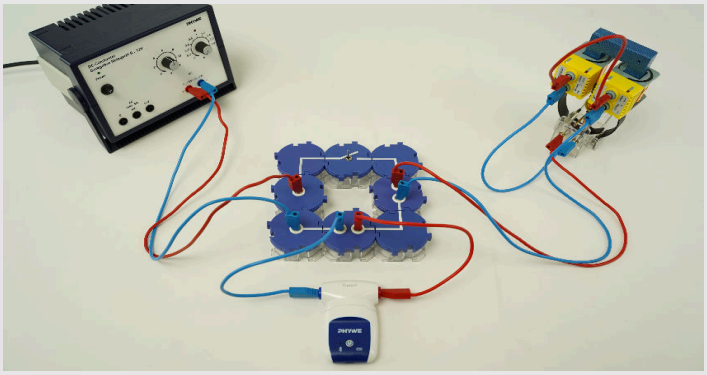
- Build the circuit according to the illustrations. The switch is open at first.
- Set the armature at an angle and connect the current sensor in series.





Procedure (1/3)

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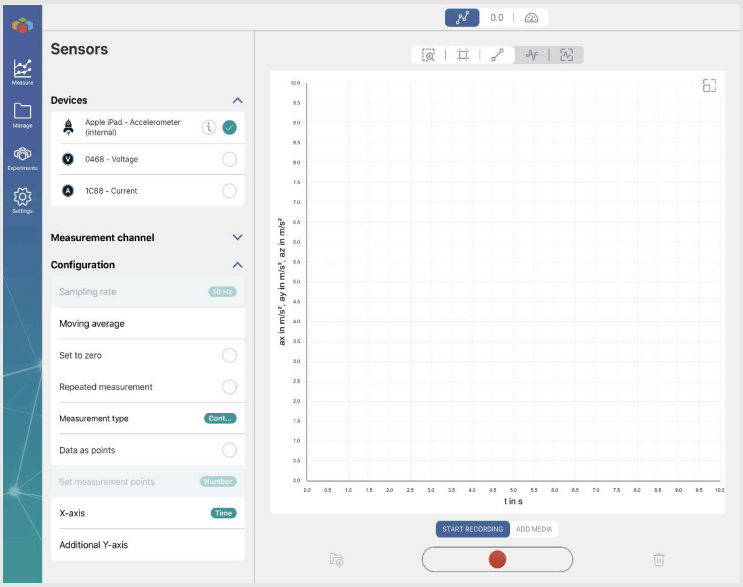

- Turn on the SMARTsense sensor by pressing and holding the power button and make sure the tablet can connect to Bluetooth devices.
- Open the PHYWE measure app and connect the sensor under "Measure" > "Sensor" and then select the sensor "Current" (top left).
- After each of the following measurements, the measurement can be saved. For further analysis, the measurement can be opened again at any time under "My measurements".

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Procedure (2/3)

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- Switch on the power supply and set it to 6 V. Close the switch and lightly push the armature if necessary. Observe the direction of rotation of the armature.
- Open the switch and pole the operating voltage of the motor by reversing the contacts 1 and 2 (see fig. setup).
- Close the switch, observe the direction of rotation of the armature and compare it with the previous direction of rotation.
- Open the switch, reverse the previous reversal, and this time reverse the connections on the armature.
- Close the switch again, observe the direction of rotation of the armature and compare it with the previous direction of rotation.

Procedure (3/3)

- Change the operating voltage between 4 V and 6 V. Observe the speed of the armature.
- Set the operating voltage to 6 V and load the motor. Brake the armature by finger pressure on the disc with the commutator. Observe the speed and the deflection of the ammeter.
- Open the switch, disconnect one of the two coils from the circuit by reconnecting a connecting wire.
- Set the voltage to $12\,V$~ and close the switch briefly. Observe the motor while doing this.
- Turn off the power supply.

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Report

Task 1

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How can the direction of rotation be changed in a main squirrel-cage motor?

- The direction of rotation cannot be changed.
- When reversing the polarity of the voltage source.
- When reversing the polarity of the coils on the armature.

Why can a main shunt motor be operated with direct current and with alternating current?

- Since a rectifier is always connected in front of the motor, which converts the alternating current into direct current.
- The main shunt motor can only be operated with direct current.
- Since the direction of rotation of the motor does not change when the polarity of the connections is reversed.

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Task 2

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When the operating voltage is increased, the speed also increases.

○ True ○ False

Check

How does the current change when the motor is loaded?

The current is not affected by the load.

The current increases when the motor is loaded.

The current drops when the motor is loaded.

Task 3

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Drag the words into the correct boxes!

The advantage of a main shunt motor is that it can be powered by both DC and _____. This is because the coils of the motor are all _____ and so _____ the polarity of the voltage source has no effect on the _____.
When the motor is loaded, the _____ increases, which in turn causes a high _____, making these motors suitable for use as heavy-duty drives on, for example, trams.
Not needed: _____ (adjective), _____ (noun).

torque
reversing
direction of rotation
parallel
connected in series
speed
current
AC

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Slide	Score/Total
Slide 18: Multiple tasks	0/2
Slide 19: Multiple tasks	0/2
Slide 20: Main shunt motor	0/8

Total 0/12

Solutions Repeat

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