Universität Basel

Swiss Nanoscience Institute

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EINE INITIATIVE DER UNIVERSITÄT BASEL UND DES KANTONS AARGAU

Electric motors

Electric motors work by combining the principles of electricity and magnetism. Any moving electric charge — in other words, every (electric) current — generates a magnetic field (e.g., an electromagnet). Every changing magnetic field exerts a force on electric charges. Here, we make use of the latter phenomenon to build two simple electric motors. It's hard to imagine everyday life without electric motors, which are found in everything from electric toothbrushes to blenders, washing machines, roller blinds and garage doors, as well as countless other devices and pieces of machinery.

Simple electric motor 1 — homopolar motor

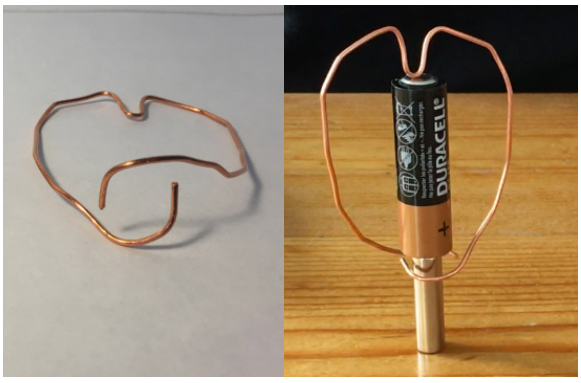
What you'll need:

- 1-2 strong magnets, depending on size (ideally with a similar diameter to the battery)
- Copper wire with a thickness of approx. 1 mm
- Pliers
- Battery (AA or AAA)

The wire short-circuits the battery, causing both it and the wire to become hot. It is therefore important NEVER to leave the electric motor unattended. Before building the motor, please check whether your battery permits short-circuiting. For example, some batteries say "Do not short circuit" and could catch fire.

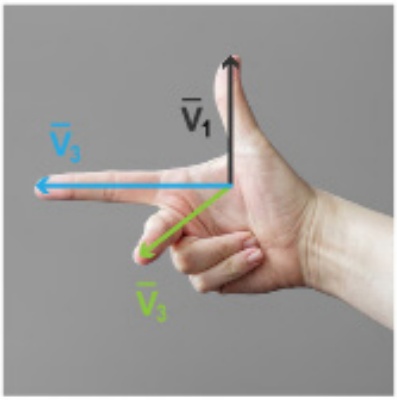
Instructions:

1. Place the magnet(s) on the positive pole of the battery.
2. Bend the copper wire into a symmetrical circle or heart shape. The important thing is to have a U-shaped bulge in the middle of the wire.
3. Now place the "U" on the negative pole of the battery. The two loose parts of the copper wire should not touch one another, but they should be in contact with the magnet(s).
4. It takes a bit of patience to balance the wire on the battery.



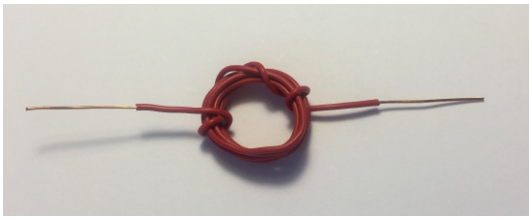
What happens?

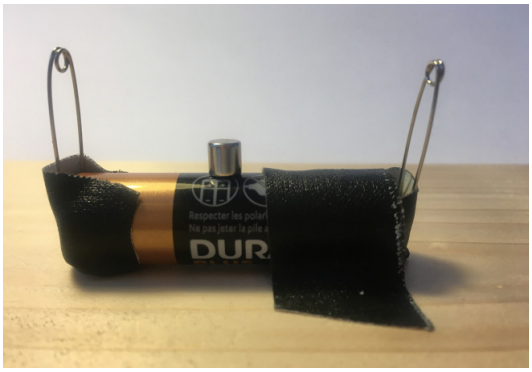
The wire short-circuits the battery, causing strong currents to flow from the + pole of the battery, through the wire and the magnets, and into the - pole of the battery. As the electrons pass through this circuit, they are exposed to the strong magnetic field of the magnet. When electrically charged particles, such as electrons, travel through a magnetic field, they experience a force known as the Lorentz force, the direction of which can be determined using the "right-hand rule" (see diagram — the arrows are at right angles to one another). v_1 = direction of current, v_2 = magnetic flux density, v_3 = Lorentz force.

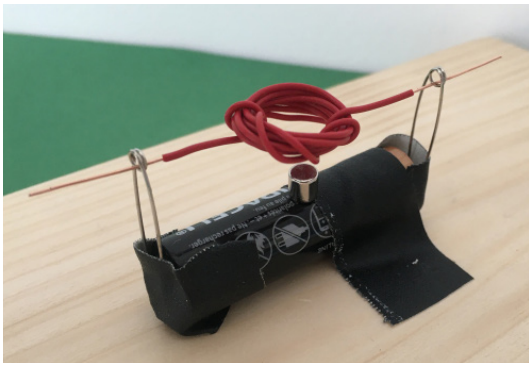


Source: www.supermagnete.ch

Simple electric motor 2 — direct current motor







What you'll need:

- Battery (AA or AAA)
- Long piece of insulated copper wire, 15 cm and 30 cm
- 2 safety pins of the same size
- Base (e.g., a small wooden board)
- Small, strong magnet
- Electrical tape

Variation: The safety pins can also be substituted with paper clips or other wire, provided there is a small hole through which the wire can be threaded.

Caution: You have to be careful with super magnets because they are very strong and can cause crushing injuries. Please also note the warnings on page 1.

Instructions:

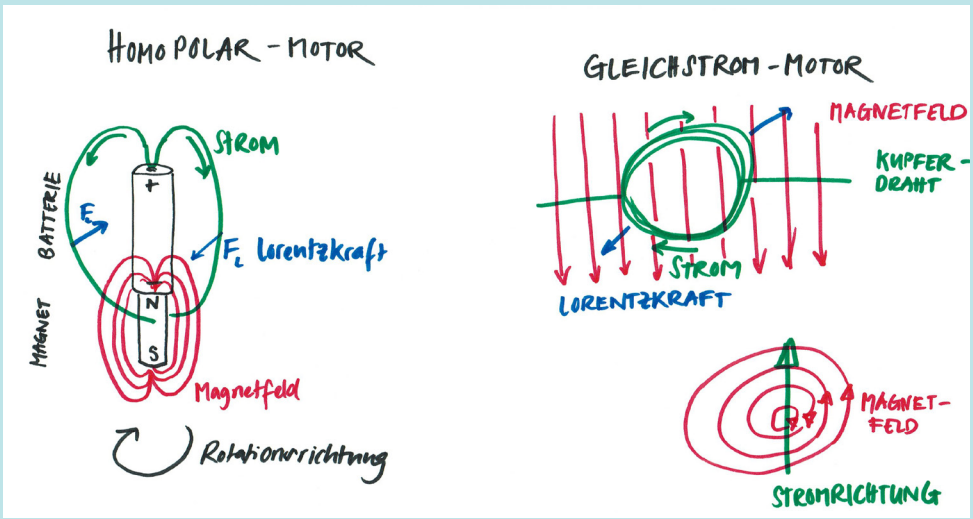
1. First, we need to make a coil: Wrap the copper wire around the battery in tight loops, take the coiled wire off, and pass the ends through the coil on both sides to secure it.
2. Remove the insulation on the ends of the wire to allow electrical contact.
3. Use the electrical tape to attach the two safety pins to the two poles of the battery so that the two "eyes" are pointing up. Ensure that the two safety pins are in contact with the poles.
4. Fix your battery to the base and place the magnet on the middle of the battery.
5. Insert the bare ends of the wire into the two eyes of the safety pins.

What happens?

The coil of wire starts to move and rotate around its own axis.

Want to know more?

Different principles come together in electric motors. Electricity: Moving charges, such as electrons, generate a magnetic field (see figure, bottom right). Magnetism: Like poles repel; unlike poles attract. This results in an interaction between the magnetic field of the permanent magnet and that of the moving charges.



Source: www.experimentis.de