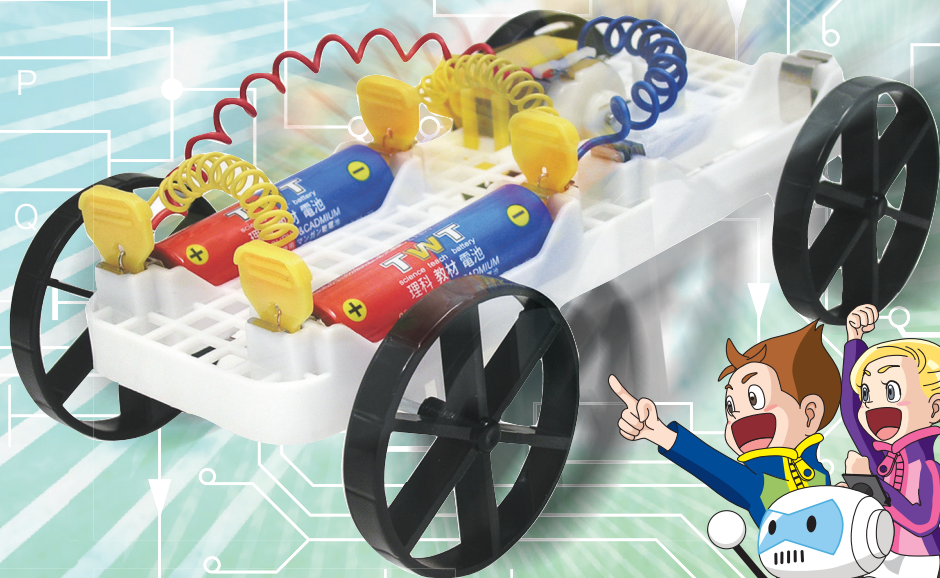




2-Way Car Circuit Kit

Study
Guide

AGE
8+

Artel

Learn about electric circuits by comparing the way series and parallel circuits work!



WARNING:

CHOKING HAZARD - Small parts.

Not for children under 3 yrs. Keep out of reach of small children to prevent accidental swallowing.

PUNCTURE HAZARD - Parts with sharp points.

Only for use by children aged 8 yrs and older.

To be used under the direct supervision of an adult.

Two cycles for turning a child into a science lover



Inquisitive learning approach nurtures the abilities of...

- ① Planning ... Look ahead by yourself
- ② Action ... Put the plan into practice
- ③ Analysis ... Self-examine the result of the action
- ④ Improvement ... Improve the results based on the analysis

Experiential learning approach nurtures the abilities of...

- ① Focusing ... Direct attention to what is fun
- ② Thinking ... Focus and think hard while experiencing
- ③ Accomplishment ... Sense of accomplishment by figuring out something after thinking
- ④ Aspiration ... Gain a strong desire for achievement after the accomplishment

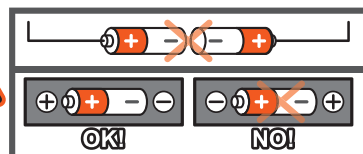
The inquisitive learning and experiential learning approaches of Artec's Science Series will turn children into great lovers of science!

WARNING

CHOKING HAZARD - Small parts.
Not for children under 3 yrs. Keep out of reach of small children to prevent accidental swallowing.
PUNCTURE HAZARD - Parts with sharp points.
Only for use by children aged 8 yrs and older.
To be used under the direct supervision of an adult.

Make sure to read these carefully before use. (Parents/guardians, read these instructions carefully.)

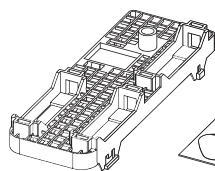
- Instructions for parents are included and must be observed.
- 2 x 1.5 V x AA/LR6 (not included)
- Read the instructions carefully and check the wiring. If wiring is incorrect, a short circuit may occur.
This could cause overheating or damage to the equipment.
- Take care to avoid the following situations, which may cause the battery leakage, overheating, or other damage.
 1. Short-circuiting of batteries
 2. Incorrectly attaching the connecting plugs
 3. Installing batteries with the polarity reversed
 4. Continuing operating while the motor is stalled
- The toy is not to be connected to more than the recommended number of power supplies
- Store this product away from high temperatures, humidity, and direct sunlight.



2-Way Car Circuit Kit

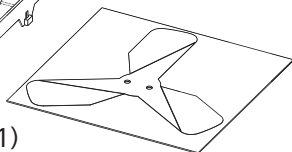


Contents:

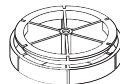
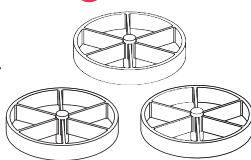


1 Car Body (1)

2 Propeller (1)



3 Wheels (3)



4 Wheel with attached pulley



5 Connector plug (6)



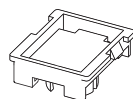
6 Propeller clasp (1)



8 Motor holder (1)



7 Pulley (1)

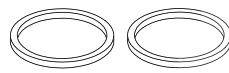


9 Motor platform (1)

10 Support brace (1)



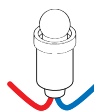
11 Coated wire (1)



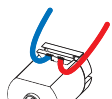
12 Rubber band (2)



13 Battery clips (6)



14 Miniature bulb with socket (1)

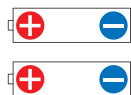


15 Motor (1)

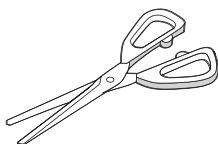


16 Axle (2)

What you need:

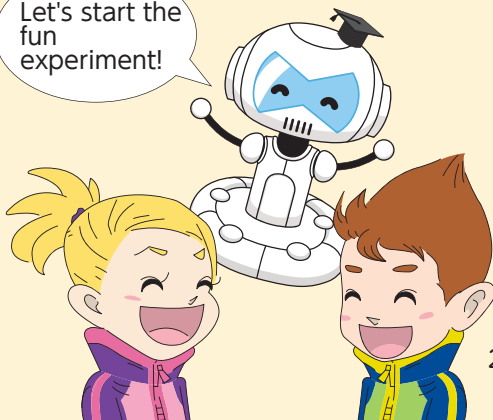


2 size AA
batteries



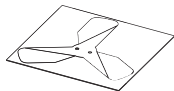
Scissors

Let's start the
fun
experiment!



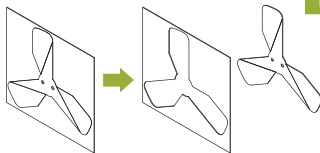
Assemble the propeller

What you will use:



2 Propeller(1)

Instructions:



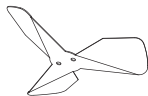
Remove the propeller from the cardboard.



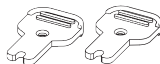
Bend each of the three wings back slightly.

Attach the motor

What you will use:



The propeller



5 Connector plug(2)



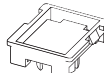
6 Propeller clasp(1)



7 Pulley(1)



8 Motor holder(1)



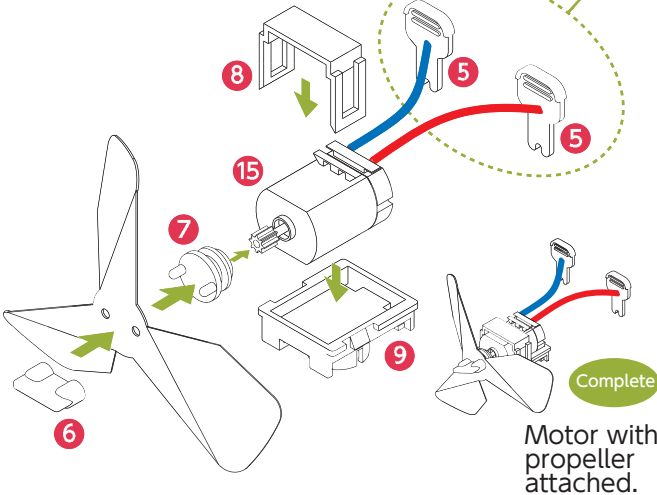
9 Motor platform(1)



15 Motor(1)

Instructions:

Refer to page 6 for how to attach the connector plug (5)

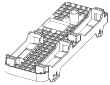


Assemble the parts as shown.

Assemble the car body

Instructions:

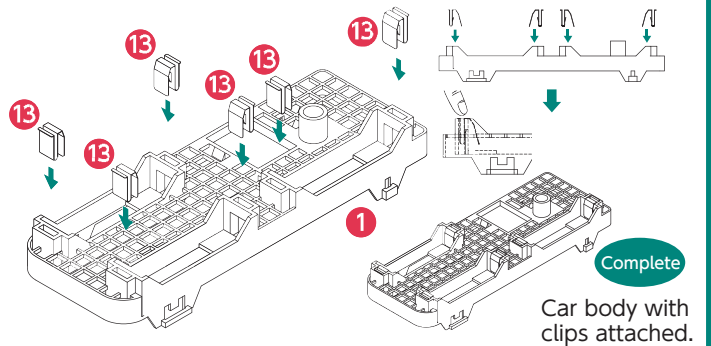
What you need:



1 Car body (1)



13 Battery clips (6)

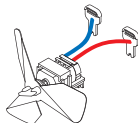


Attach the clips to the car body.

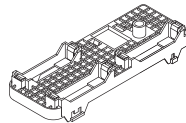
Make sure you push the battery clips firmly into place.

Attaching the propeller

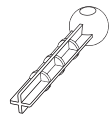
What you need



Motor with propeller attached.

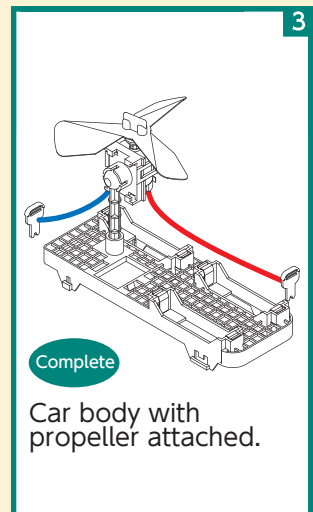
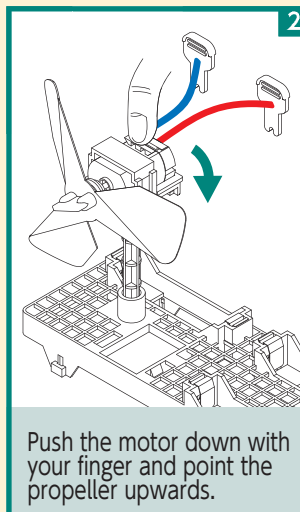
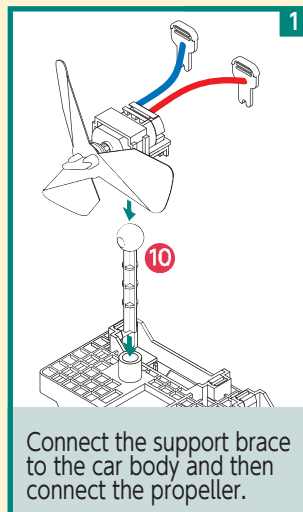


Car body with clips attached.



10 Support brace (1)

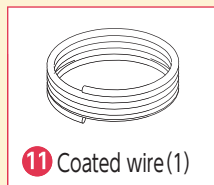
Instructions:



Preparation for the experiment!

Strip both ends
of the coated
wire

What you need:



11 Coated wire (1)



scissors (1)

Instructions:

1

18 cm

Cut an 18 cm length of coated wire.
You can use the ruler on this page to measure the length.

2

Tip:
How to remove the plastic coating

Pinch it between your nails

Pull it off

4 cm 10 cm 4 cm

Strip off about 4 cm of the plastic coating from each end.
Use your nails to pinch the plastic and it should peel off easily.

3

4 cm 10 cm 4 cm

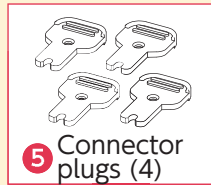
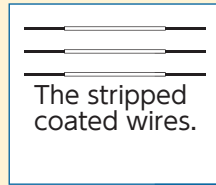
Complete

Stripped coated wire

Create two more like this.

Attach the connector plugs

What you need:



Instructions:

Tip:
How to wrap the coated wires

Wrap the coated wire securely around the plug.

Put the coated wire through the hole and wrap it around the plug. Then, wind the end back on itself as shown. Wrap it tightly so that the coated wire cannot come loose.

2

Complete Cord A

Make Cord A (with two connector plugs attached). Attach a connector plug to both sides of the coated wire.

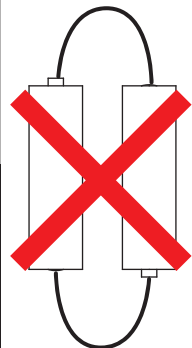
3

Complete Cord B

Make Cord B (with one connector plug attached). Connect one end of the coated wire to the connector plug.

Danger!!

Do not connect the battery directly to the coated wire.



It will become very hot!!

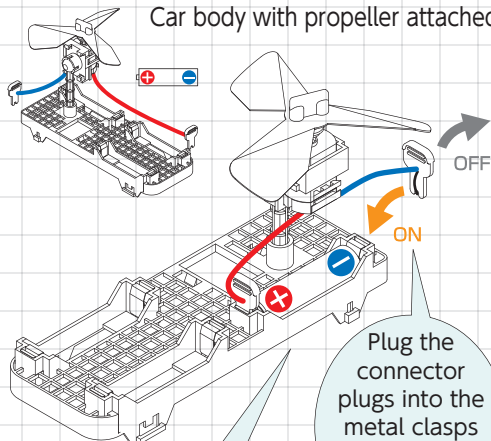
Warning!!

Let's rotate the propeller!

Experiment and observe!



What you need: 1 size AA battery
Car body with propeller attached.



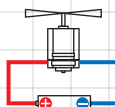
Turn on the battery power and the propeller will begin to spin.

Plug the connector plugs into the metal clasps and let the electricity flow!

⚠ Keep the propeller away from your face and hands while it is spinning.

Which way is the propeller spinning?

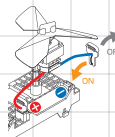
Observe its movement and check the correct answer.



☐ Spinning clockwise

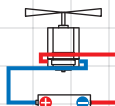


☐ Spinning counterclockwise



What happens when you switch the placement of the plugs?

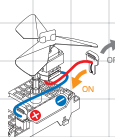
Observe carefully and check the correct answer.



☐ Spinning clockwise



☐ Spinning counterclockwise

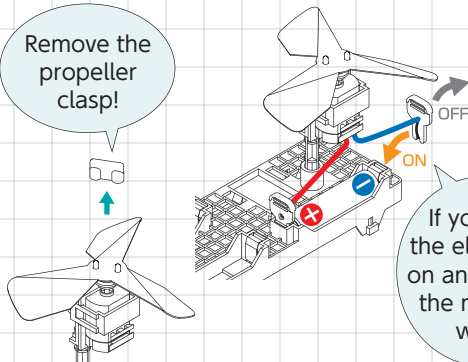


Release the propeller and let it fly!

Experiment and observe!

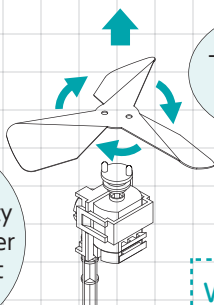


Remove the propeller clasp!



If you turn the electricity on and power the motor it will...

The propeller flies up!



Watch it from the side.

★ Adjust the angle of the propeller wings if it does not take off properly.

⚠ Point the propeller away from your face and other people.

★ Double check to make sure you inserted the batteries in the correct polarity.

★ Double check to make sure you wired the battery holders in the correct polarity.

Attach the wheels and set the propeller spinning!

Experiment and observe!

What you need

3 Wheels (3) 4 Wheel with attached pulley (1)

16 Axles (2) 6 Propeller clasp (1)

Put the axles through the car body and attach the wheels.

Don't forget the propeller clasp. Tilt the propeller.

Turn it on and let it run!

⚠ Be careful not to poke your hand with the axle stick.

⚠ Keep the propeller away from your hands and face while it is spinning.

Which way is the car moving?

Observe it carefully and check the answer.

☐ Forward

☐ Backward

What do you think will happen if we reverse the plugs?

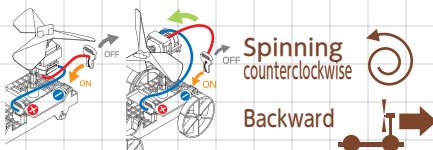
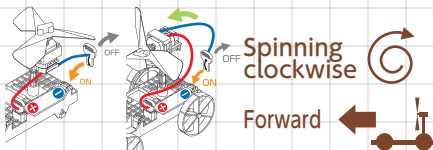
Observe it carefully and check the answer.

☐ Forward

☐ Backward

The flow of electric current

Think about it!



The way the plugs are connected will change the way the propeller spins and the way the car moves. Electricity has a current and connecting the plug the opposite way reverses the electric current, which causes the motor to spin in the opposite direction. Electricity flows from the + terminal to the - terminal.

★Double check to make sure you inserted the batteries in the correct polarity.

★Double check to make sure you wired the battery holders in the correct polarity.

Attach the miniature bulb!

Experiment and observe!



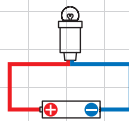
What you need:

- 14 Miniature bulb with socket (1)



Tighten the bulb in the socket if it is loose!

Unplug the plugs from the motor before attaching the bulb.



Connect it to a single battery.

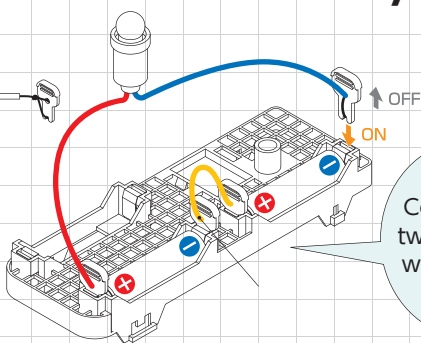
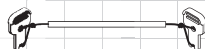
Add another battery.

Experiment and observe!

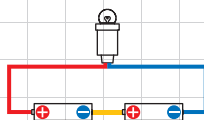


What you need:

- 24 Cord A.



Connect the two batteries with Cord A.



Connected to two batteries.
A series circuit

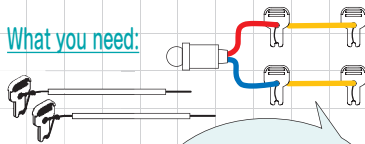
Change the way the batteries are aligned!

Experiment and observe!

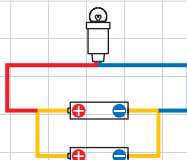
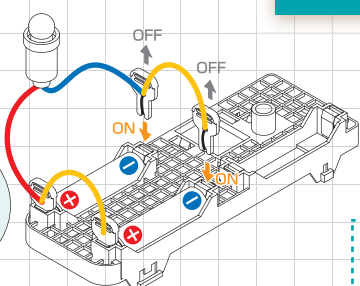


What you need:

- 25 Cord B



Connect Cord B to the plug of the miniature bulb.



Connected to two batteries.
A parallel circuit

★ Insert all four connector plugs into the sockets.

★ Double check to make sure you inserted the batteries in the correct polarity.

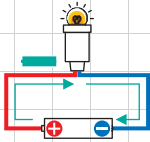
★ Double check to make sure you wired the battery holders in the correct polarity.

Series and parallel circuits

Think about it!



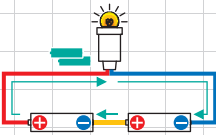
◆ When the miniature bulb is powered by a single battery.



With a single battery and a miniature bulb, the miniature bulb is powered by one battery.



◆ When one miniature bulb is powered by two batteries:



When a miniature bulb is powered by two batteries (using a series circuit), it receives electricity from both batteries. It becomes twice as bright.

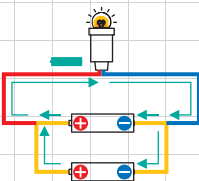


It is brighter.



The bulb stays on as if only one battery is used.

◆ When a miniature bulb is powered by two batteries in a parallel circuit.



When a miniature bulb is powered by two batteries (using a parallel circuit), it uses two batteries but receives only one battery's worth of electricity. But the batteries will power the bulb for twice as long.



The brightness is the same.



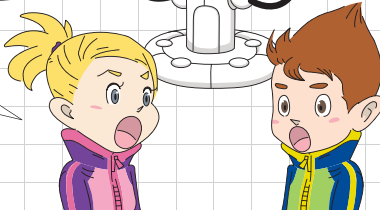
The bulb will stay on for twice as long.

Directly connecting two batteries together makes it brighter!

It's called a series circuit!

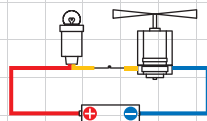
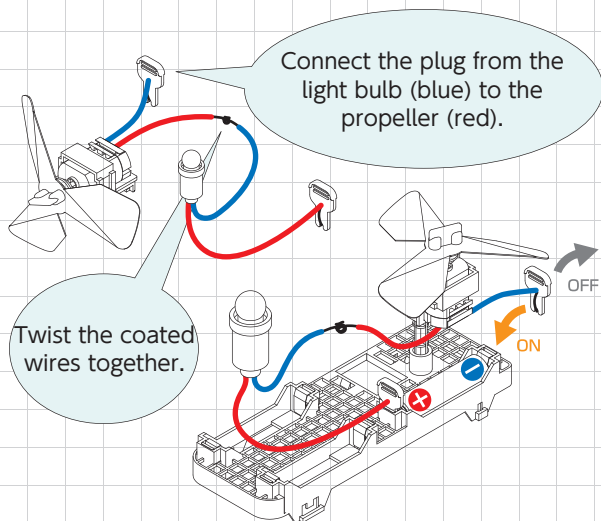
Connecting the same batteries in a different way makes a big difference!

Connecting the batteries in a parallel circuit doesn't make the bulb any brighter than when it was connected to one battery!



Connect the bulb and propeller in a **series circuit**.

Experiment and observe!



Does the bulb light up?

Does the propeller spin?

Observe the bulb and propeller carefully and check the answer.

☐ The bulb



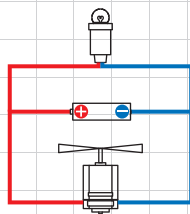
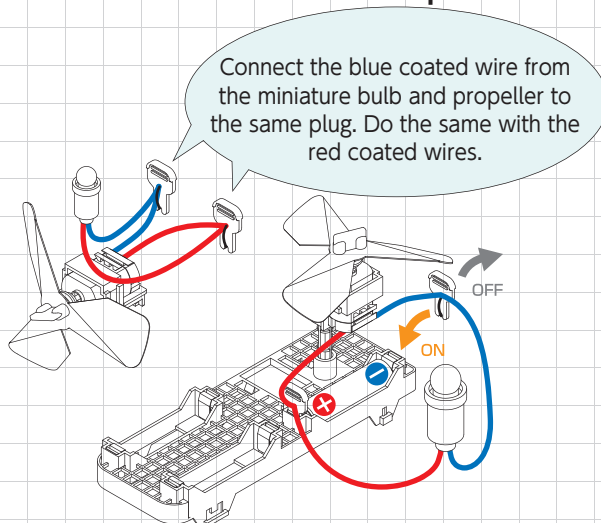
☐ The propeller



⚠ Keep the propeller away from your face and hands while it is spinning.

Connect the bulb and propeller in a **parallel circuit**

Experiment and observe!



Observe the result and check the answer.

☐ The bulb



☐ The propeller



⚠ Keep the propeller away from your face and hands while it is spinning.

★Double check to make sure you inserted the batteries in the correct polarity.

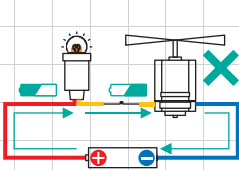
★Double check to make sure you wired the battery holders in the correct polarity.

Voltage and current

Think about it!



◆ When the miniature bulb and motor are connected to a single battery in a series circuit:



Only the miniature bulb works when the miniature bulb and motor are connected in series.

The electricity from the single battery is distributed as it travels and there isn't enough voltage to power the motor.



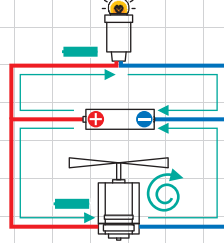
Bulb lights up.



Propeller does not rotate.



◆ When the miniature bulb and motor are connected to a single battery in a parallel circuit:



The miniature bulb and the propeller both function normally when connected in a parallel circuit.

Electricity from the battery is evenly distributed and both receive sufficient voltage.

However, it uses more electricity than the series circuit and will drain the battery faster.



Bulb lights up.



Propeller rotates.



The battery drains faster

"Voltage" is the force used to move the electricity.

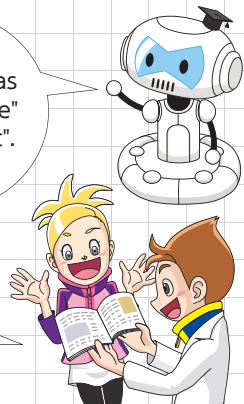
It pushes the electricity from the battery to the miniature bulb and the motor (propeller).

"Current" is the amount of electricity that flows.

The greater the current, the brighter the bulb will shine and the faster the motor will spin.

Electricity has both "voltage" and "current".

There's an explanation on the next page.



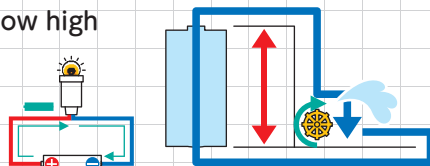
Let's learn more about it!

(Basic)



◆ When a single battery is used to power a single miniature bulb:

There is a limit to how high a single pump can pump water.

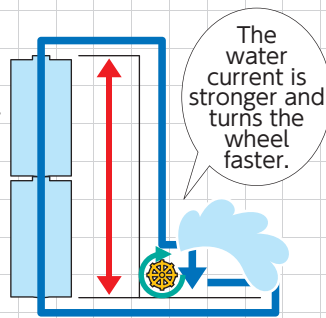
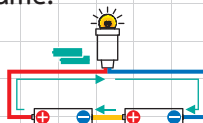


Batteries connected in a series circuit.

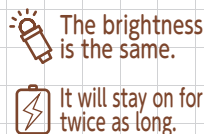


◆ When one miniature bulb is powered by two batteries in a series circuit:

Two pumps are stacked up and pump the water twice as high, which doubles the current and increases the force of the water that hits the water wheel. The amount of running water remains the same.

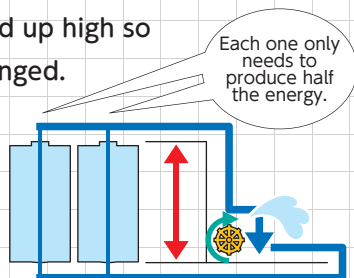
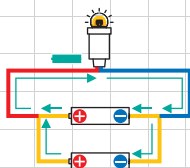


Batteries connected in a parallel circuit.



◆ When a miniature bulb is powered by two batteries in a parallel circuit.

When two pumps are lined up they last longer as they each provide only half the water needed. The water doesn't need to be pumped up high so the voltage remains unchanged.



"Voltage" is the force used to move the electricity and the "current" is the amount of electricity that flows. We'll use flowing water as an analogy.

Think about it!



Voltage is the height from which water is dropped, current is the amount of running water, a battery is the pump that draws water, the miniature bulb and motor will be the water wheels that are powered by water.

The miniature bulb and propeller are connected in a **series circuit**.



Bulb lights up but is dim.

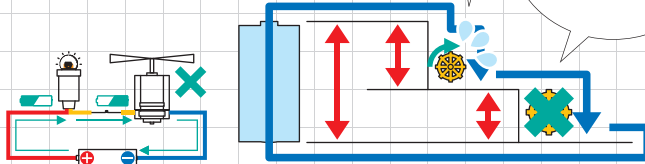


Propeller does not rotate.



◆ When the miniature bulb and motor are connected to a single battery in a series circuit.

The two water wheels must run on the same current and since the current grows weaker with each wheel it powers, the bulb becomes dim and the motor doesn't spin properly.



The miniature bulb and propeller are connected in a **parallel circuit**.



Bulb lights up.



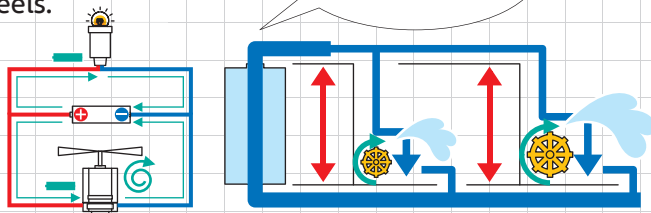
Propeller rotates.



The battery gets drained faster.

◆ A miniature bulb and motor powered by a single battery in a parallel circuit.

Each wheel receives one battery's worth of electrical current so the miniature bulb shines and the motor rotates normally. The battery will run out quicker, as water has to be pumped out twice as fast to power the two wheels.



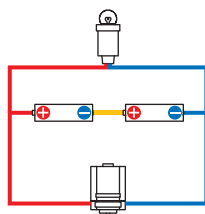
Let's make a motor car!

Let's make it!

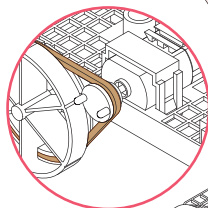
Attach the pulley directly to the motor!

Place the motor on the car body and fasten it with the motor clasp.

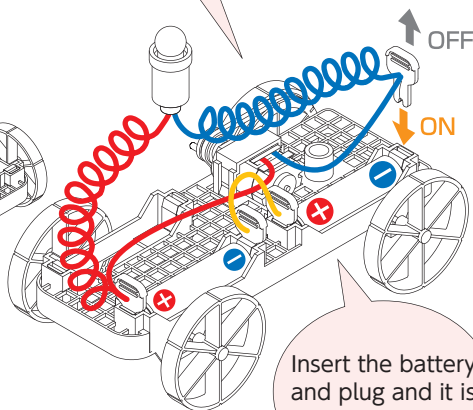
Wrap the cords that are connected to the miniature bulb around a pencil or stick to give them a coiled shape.



Wiring diagram



Use a rubber band to connect the motor pulley and the wheel with an attached pulley, as shown.

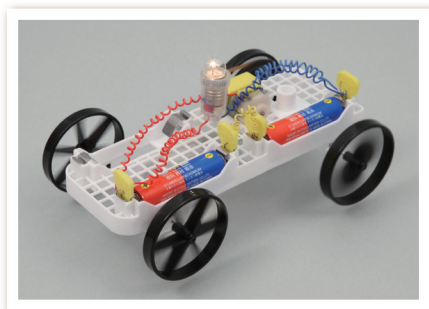


Insert the battery and plug and it is ready to run!

How did your car turn out?

Cool!

Change the number of batteries and switch around the wiring to see if it affects the car's performance.



★ Check the placement of the rubber band and the wiring if the car doesn't run properly.

⚠ Please play with car in a safe, automobile-free area.

★Double check to make sure you inserted the batteries in the correct polarity.

★Double check to make sure you wired the battery holders in the correct polarity.