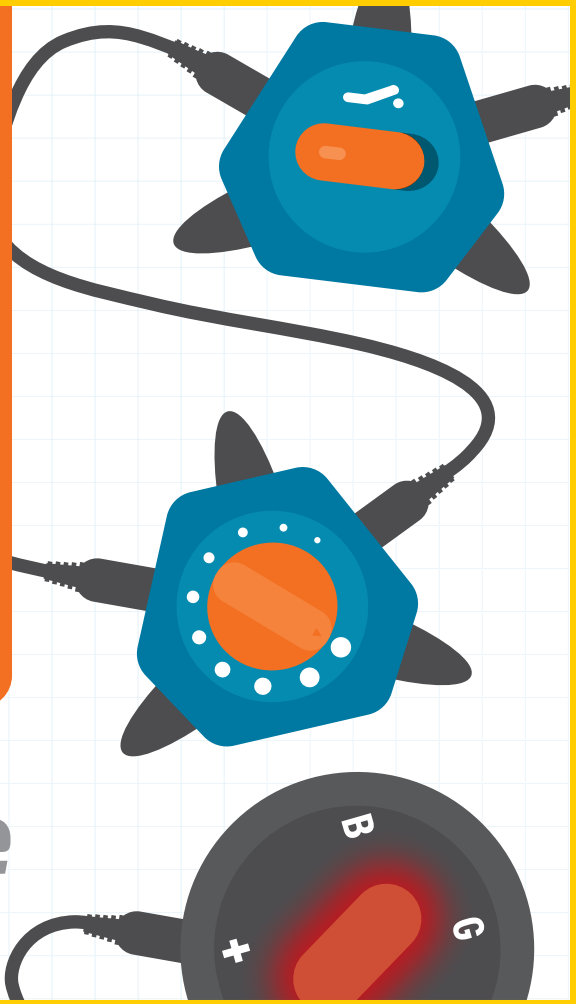
NATIONAL GEOGRAPHIC

EPIC CIRCUITS

SCIENCE KIT

60+ Projects Guide



ADULT SUPERVISION RECOMMENDED

PLEASE READ ALL INSTRUCTIONS before use of this product. Retain this instruction manual since it contains important information, address, and phone numbers for future reference.

Caution: changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

WARNING

! WARNING: To prevent serious eye or face injuries: 1) Read instructions before assembling or using. 2) Do not aim at your eyes or face. 3) Do not aim at persons or animals.

Requires 3 x AAA 1.5V alkaline batteries (not included).
Batteries are small objects. Replacement of batteries must be done by adults. Follow the polarity (+/-) diagram in the battery compartment. Promptly remove dead batteries from the item. Dispose of used batteries properly. Remove batteries for prolonged storage. Only batteries of the same or equivalent type as recommended are to be used.

- DO NOT incinerate used batteries.
- DO NOT dispose of batteries in fire, as batteries may explode or leak.
- DO NOT mix old and new batteries or types of batteries (i.e. alkaline/standard/rechargeable).
- Rechargeable batteries are only to be changed under adult supervision.
  Replaceable rechargeable batteries are to be removed from the product before being charged.
- DO NOT recharge non-rechargeable batteries.
- DO NOT short-circuit the supply terminals.

Requires 3 x AAA 1.5V alkaline batteries (not included).
Batteries or battery packs must be recycled or disposed of properly.
When this product has reached the end of its useful life, it should not be disposed of with other household waste. The Waste Electrical and Electronic Equipment Regulations require it to be separately collected so that it can be treated using the best available recovery and recycling techniques. This will minimize the impact on the environment and human health from soil and water contamination by any hazardous substances, decrease the resources required to make new products and avoid using up landfill space. Please do your part by keeping this product out of the municipal waste stream! The "wheelie bin" symbol means that it should be collected as "waste electrical and electronic equipment". You can return an old product to your retailer when you buy a similar new one. For other options, please contact your local council.

This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) This device must accept any interference received, including interference that may cause undesired operation.

NOTE: This equipment has been tested and found to comply with the limits for Class B digital devices pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference to radio communications. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction, may cause harmful interference to radio communication. However, there is no guarantee that interference will not occur in a particular installation. If this toy does cause interference to radio or television reception (you can check this by turning the toy off and on while listening for the interference), one or more of the following measures may be useful:

- Reorient or relocate the receiving antenna.
- Increase the separation between the toy and the radio or the TV.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced TV-radio technician for help.

CAN ICES-003(B)/NMB-003(B)

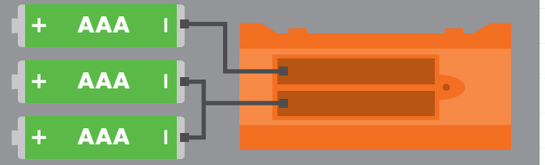
PARTS GUIDE

POWER BLOCK

This is your electrical power source.

HOW TO INSTALL BATTERIES IN THE POWER BLOCK

Use a small Phillips-head screwdriver to remove the battery cover. Connect three AAA alkaline batteries to the terminals, paying attention to the correct polarity. Replace cover.



RGB LIGHT

A light-up module that displays multiple colors of light. RGB is an acronym for Red, Green, and Blue.

TOGGLE SWITCH

Opens and closes the circuit.

BUTTON SWITCH

Opens and closes the circuit. Must be pressed to allow electricity to flow.

DIAL SWITCH

Opens and closes the circuit and allows the user to adjust the amount of electricity available.

MULTIFUNCTION MODULE

Two-in-one module that sucks air in through the hole on the side and blows air out through the hole on the top.

VACUUM FILTER

Affix this filter to the multifunction module intake to keep debris from entering the housing.

VACUUM TUBE CONNECTOR

Affix this connector to the vacuum filter to allow vacuum hose attachment.

FUNNEL

Directs exhaust air out of the multifunction module.

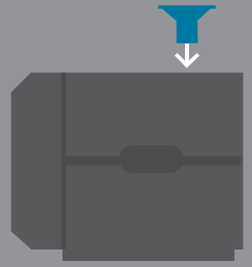
VACUUM TUBE

Connects to the vacuum tube connector.

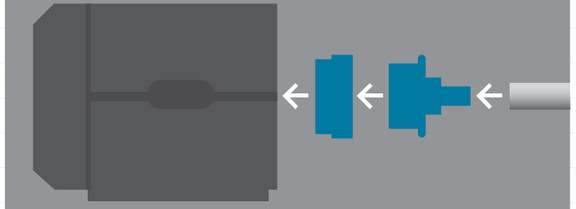
HOW TO USE THE MULTIFUNCTION MODULE

Note: *For some projects, you'll want only the funnel installed to maximize airflow. Please read the instructions for each project carefully.*

BLOW AIR
Insert the funnel into the port on top of the module.



CREATE A VACUUM Insert the vacuum filter. Insert the vacuum tube connector into the installed filter. Connect the vacuum tube to the tube connector.



SPINNER MODULE

Module with a motor inside that spins when connected to a closed circuit. Powers the fan and copter attachments.

FAN

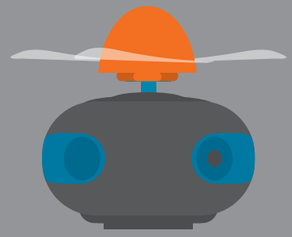
Attaches to the spinner module and rotates in place.

COPTER

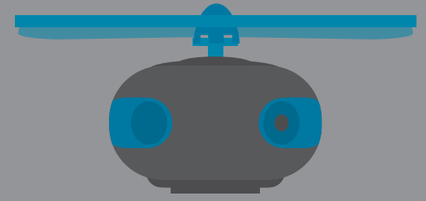
Rests on the spinner module and flies up into the air.

HOW TO USE THE SPINNER MODULE

The spinner module is the base for the fan and copter attachments.



*Fan **CONNECTS** for fixed spinning*



*Copter **DOES NOT CONNECT** to allow flight*

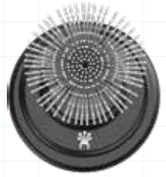
PASSTHROUGH

A three-way port that carries electrical current through without modifying it.

LIGHT MODULE

The light source for the fiber optic bundle and image projector. Only activates when the bundle or projector are attached.

FIBER OPTIC BUNDLE



Fiber optic light cables. Illuminates when attached to the light module.

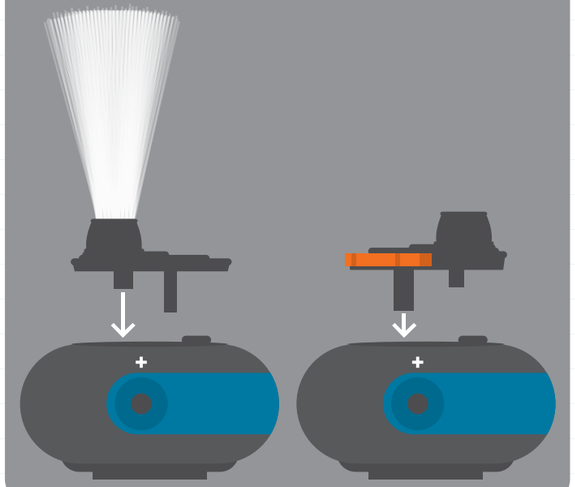
IMAGE PROJECTOR

A projector with a built-in wheel that displays 8 images.

HOW TO USE THE LIGHT MODULE

Overhead view of light module with slots noted in orange.

The light module activates once the fiber optic bundle or image projector is installed. To install, align the piece over the slots in the module, as shown in the image below. Press the piece into place.



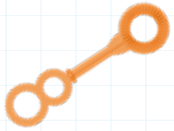
WIRE

Transfers electrical current between switches and modules.

T-WIRE

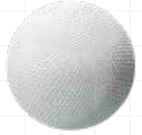
Transfers electrical current between switches and modules.

BUBBLE WAND

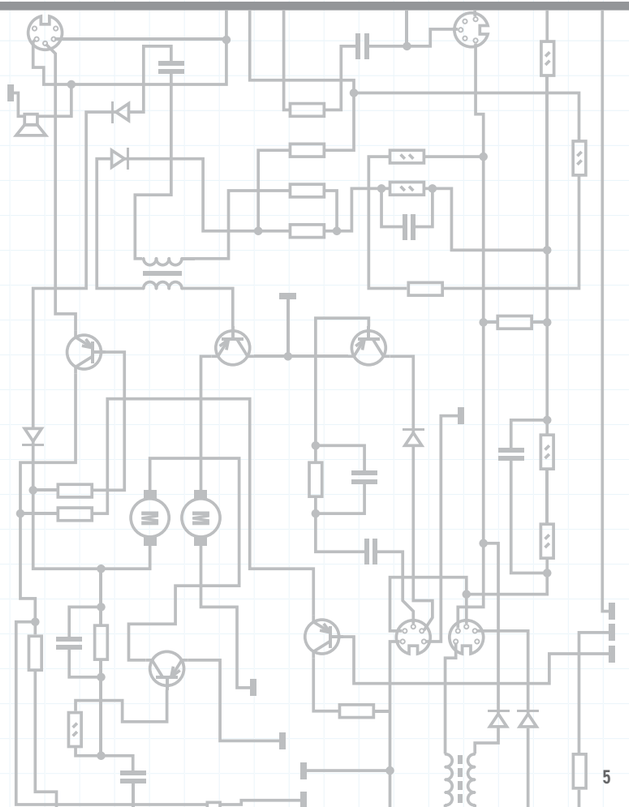


Dip into soap solution and hold directly above the multifunction module to blow bubbles.

FOAM BALL



An accessory for the multifunction module.



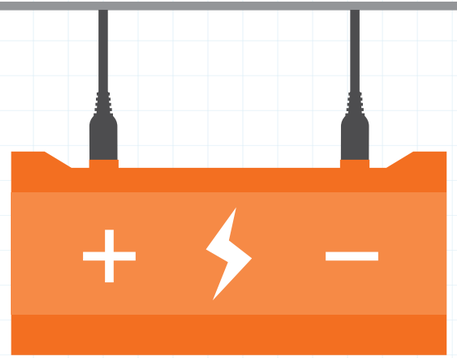
BEFORE YOU BEGIN

Watch this short video and get started faster!

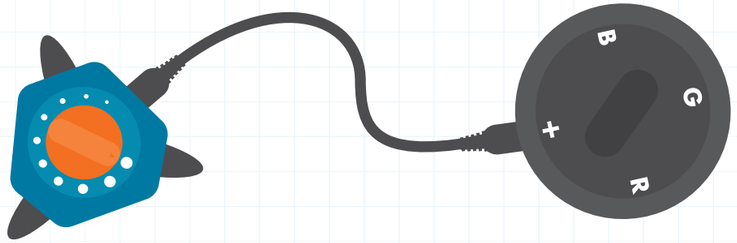
www.thinkbluemarble.com/circuit60

There is no on/off switch. Once batteries are installed, you simply need to plug wires into the positive and negative ports to start to build your circuits.

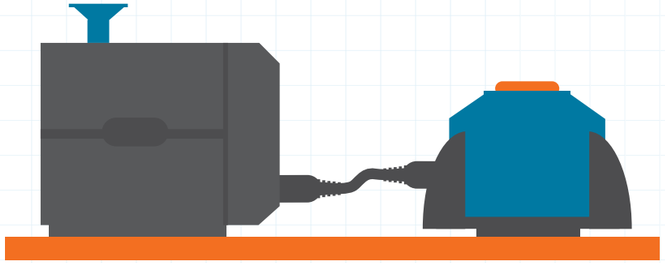
If you find that an experiment is not working right, try using fresh batteries.



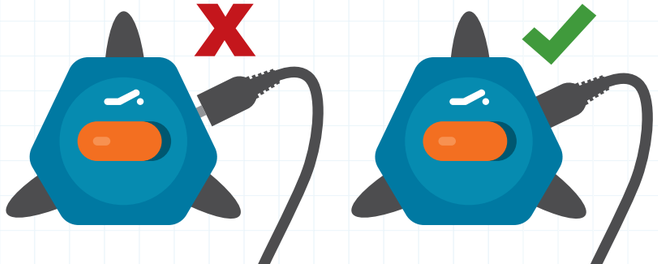
The modules and switches have two to four ports. These ports are where you'll plug in the wires which make it possible to transfer electricity through the circuit.



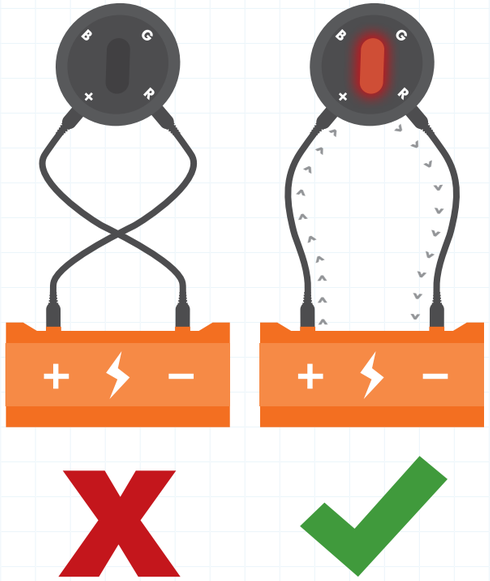
Always build your circuits on a flat, stable surface.



Make sure that the wires are fully inserted into the ports of the switches and modules. A loose connection can lead to problems completing a circuit.

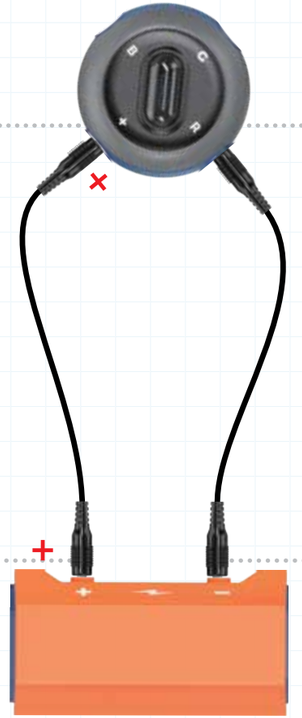


Follow the diagram for each project carefully and be sure to follow the positive and negative signs as indicated.



1 2 BUILD AN ELECTRICAL CIRCUIT

PARTS NEEDED Power block • Wires x 2 • RGB light



PROJECT 1

Connect the positive side of the power block to the positive side of the RGB light.

Complete the circuit by connecting the wire to the R port of the RGB light and to the negative port of the power block.

DID YOU KNOW?

RGB is a short way of saying the colors the light can make:

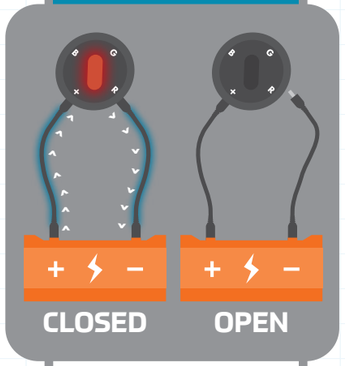
R = Red
G = Green
B = Blue

See page 12 for what happens when these three special colors mix!

In Project 1 we made a **closed circuit**, *or a complete path for electricity to go from the positive pole of the power block and return to the negative pole.*

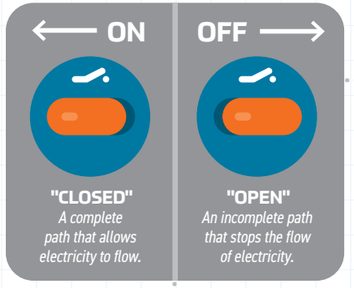
PROJECT 2

Disconnect one of the wires to make an open circuit. This is an incomplete path of electricity, and the RGB loses power.



3 USE THE TOGGLE SWITCH TO TURN THE LIGHT ON AND OFF

PARTS NEEDED Power block • Wires x 3 • RGB light • Toggle switch



"CLOSED"
A complete path that allows electricity to flow.

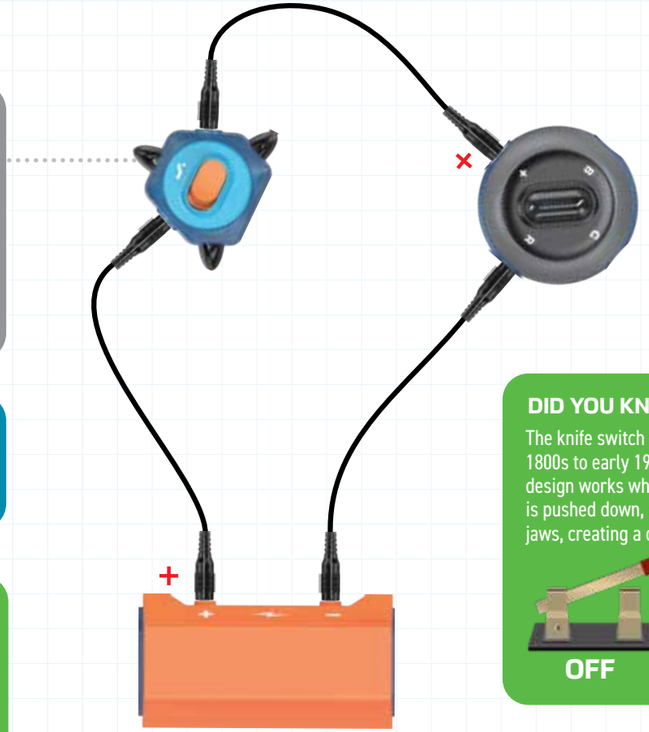
"OPEN"
An incomplete path that stops the flow of electricity.

PROJECT 3

Connect the toggle switch to the circuit in Project 1. Use the switch to power the RGB light on and off.

CIRCUIT SCIENCE

The light switch on your wall is an example of a toggle switch opening and closing an electrical circuit.



DID YOU KNOW?

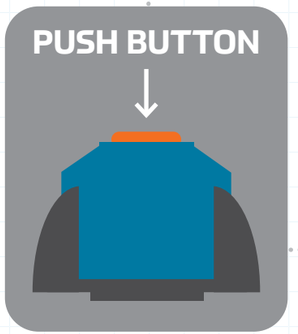
The knife switch was common in the late 1800s to early 1900s. This simple switch design works when the hinged metal "blade" is pushed down, connecting with the switch's jaws, creating a closed circuit.

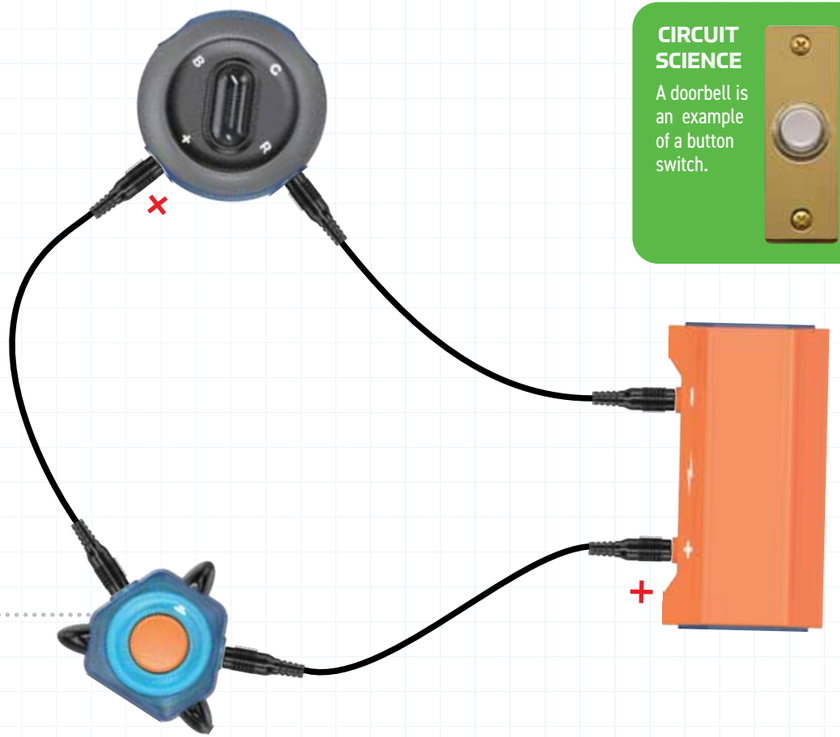
4 PUSH FOR POWER

PARTS NEEDED Power block • Wires x 3 • RGB light • Button switch

PROJECT 4

Press and hold the button to allow electricity to flow freely. Release the button and the connection is broken, meaning the current cannot pass through.



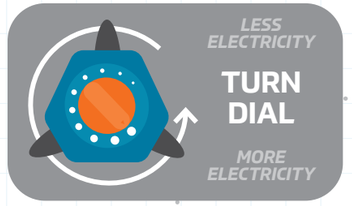


CIRCUIT SCIENCE

A doorbell is an example of a button switch.

5 6 7 CONTROL THE RGB LIGHT

PARTS NEEDED Power block • Wires x 3 • RGB light • Dial switch



PROJECT 5

Turn the dial to adjust the amount of electricity that flows through the circuit.

What happens to the RGB light?

PROJECT 6

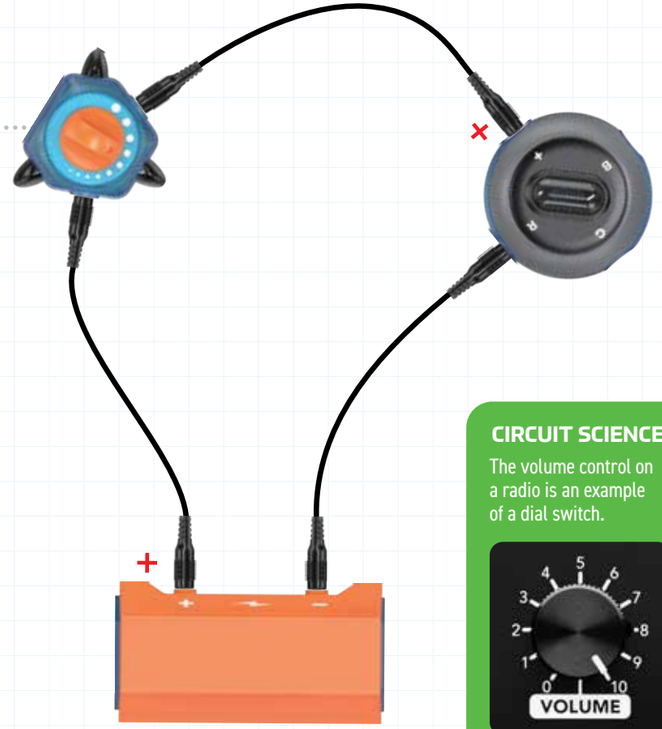
Disconnect the wire from the "R" port and connect it to the "G" port.

What happens to the RGB light?

PROJECT 7

Disconnect the wire from the "G" port and connect it to the "B" port.

What happens to the RGB light?



CIRCUIT SCIENCE

The volume control on a radio is an example of a dial switch.

8 9 10 COMBINE COLORS WITH THE T-WIRE

PARTS NEEDED Power block • Wires x 2 • T-wire • RGB light • Dial switch

PROJECT 8

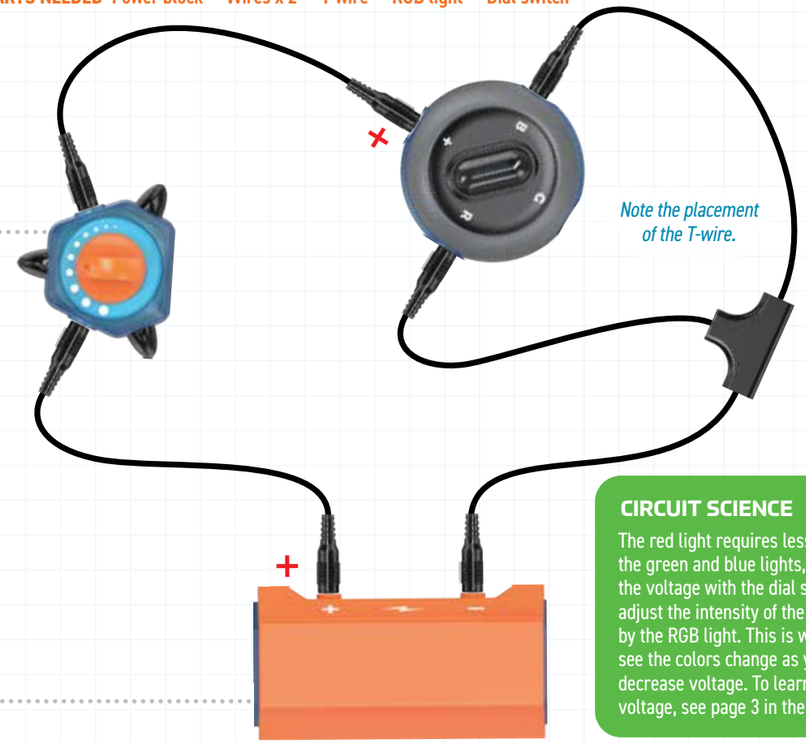
Plug the T-wire into the R and B ports of the RGB light. Turn the dial and watch the colors change!

PROJECT 9

Plug the T-wire into the B and G ports of the RGB light. Turn the dial and watch the colors change!

PROJECT 10

Plug the T-wire into the G and R ports of the RGB light. Turn the dial and watch the colors change!



Note the placement of the T-wire.

CIRCUIT SCIENCE

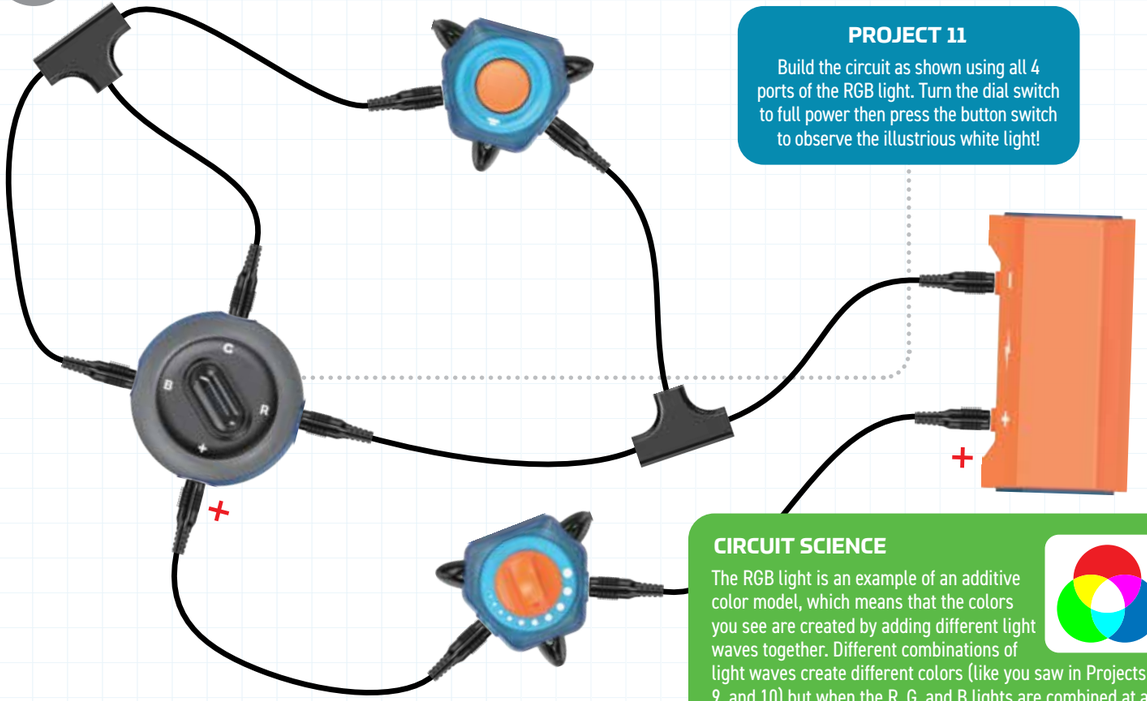
The red light requires less voltage than the green and blue lights, so as you adjust the voltage with the dial switch, you adjust the intensity of the colors displayed by the RGB light. This is why you can see the colors change as you increase or decrease voltage. To learn more about voltage, see page 3 in the learning guide.

11 MAKE THE RGB LIGHT TURN WHITE

PARTS NEEDED Power block • Wires x 2 • T-wires x 2 • RGB light • Dial switch • Button switch

PROJECT 11

Build the circuit as shown using all 4 ports of the RGB light. Turn the dial switch to full power then press the button switch to observe the illustrious white light!



CIRCUIT SCIENCE

The RGB light is an example of an additive color model, which means that the colors you see are created by adding different light waves together. Different combinations of light waves create different colors (like you saw in Projects 8, 9, and 10) but when the R, G, and B lights are combined at an equal, maximum intensity they make white.

12 13 14 SPIN, SPIN, SPIN THE FAN!

PARTS NEEDED Power block • Wires x 3 • Spinner module • Fan • Toggle switch • Dial switch • Button switch

PROJECT 12

See page 3 for how to assemble the spinner module and fan.

Use the toggle switch to "close" or turn on the circuit and provide the electricity needed to spin the fan.

PROJECT 13

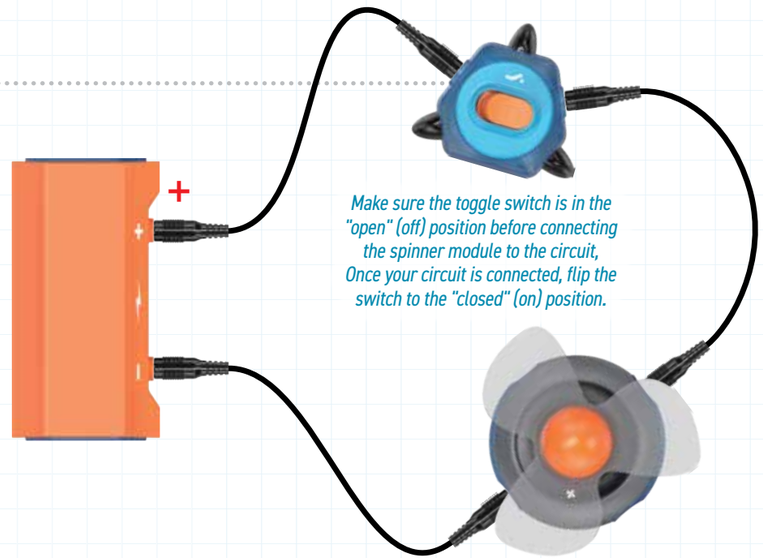
Replace the toggle switch with the dial switch. Turn the dial to experiment with fan rotation speed.

How slow can you make the fan spin?

PROJECT 14

Replace the dial switch with the button switch.

Press and hold the button. Then, quickly press and release the button. How does the fan rotation or speed change?



Make sure the toggle switch is in the "open" (off) position before connecting the spinner module to the circuit, Once your circuit is connected, flip the switch to the "closed" (on) position.

15 CREATE FAN ART

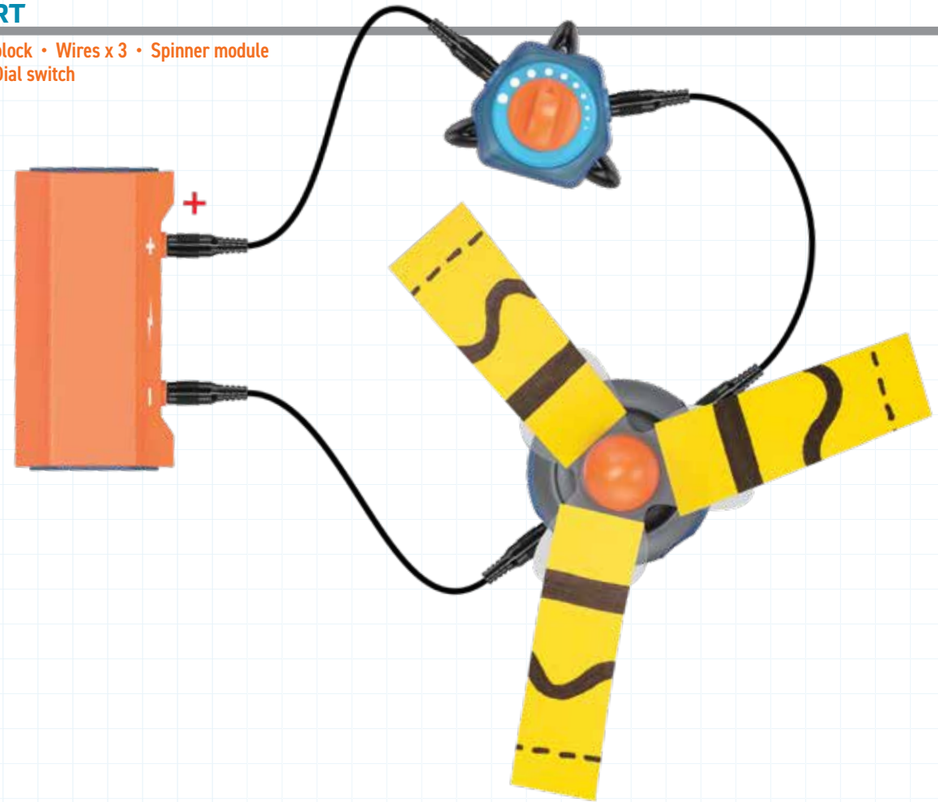
PARTS NEEDED Power block • Wires x 3 • Spinner module Fan • Dial switch

PROJECT 15

This project requires a sticky note and black marker from home.

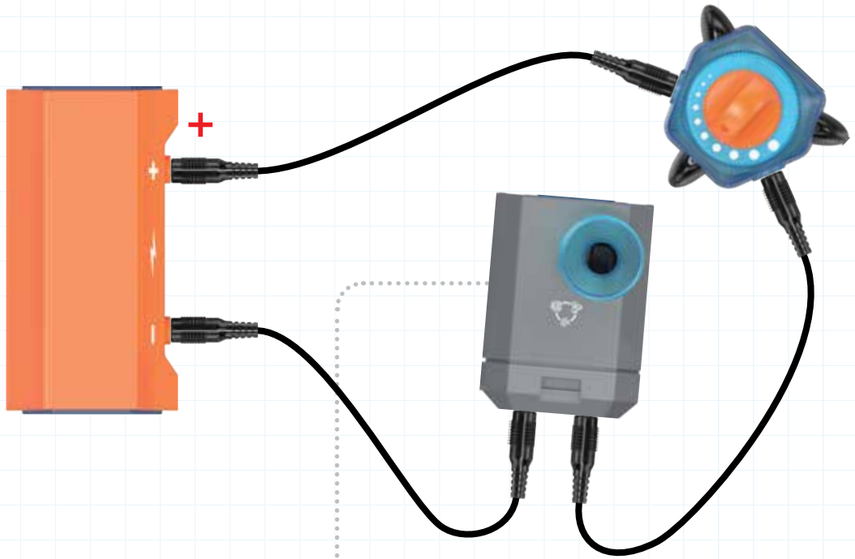
Draw various lines across the width of a sticky note with a black marker. Cut into three pieces vertically. Attach the sticky pieces to the blades of the fan. Use the dial switch to spin the papers around.

What do you see? Do some of the lines disappear? Does drawing different types of lines effect what you see when it spins? Does changing the speed change anything?



16 17 REGULATE AIR SPEED + FLOAT A BALL

PARTS NEEDED Power block • Wires x 3 • Multifunction module • Funnel • Dial switch

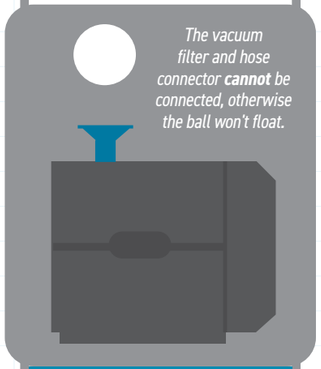


PROJECT 16

See page 2 for how to make the multifunction module blow air.

By turning the dial switch, you can adjust the electrical current flowing into the module and thus increase or decrease the strength of air taken in and blown out.

PART NEEDED Foam ball



*The vacuum filter and hose connector **cannot** be connected, otherwise the ball won't float.*

PROJECT 17

Use the circuit from Project 16 along with the ball from the kit.

Turn the dial switch to the second to last dot.

Hold the ball 4 inches (10 cm) above the funnel and release it.

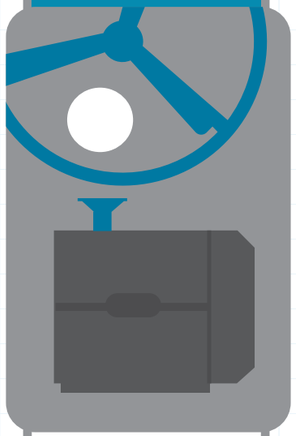
Adjust the airflow with the dial switch to help the ball stay afloat.

18 19 20 21 DEFY AIRFLOW + CATCH A BALL + BLOW BUBBLES!

PART NEEDED Copter

PROJECT 18

Float the ball with the same circuit used in Project 17. Hold the copter vertically and try to pass the floating ball through one of the spaces between the blades of the copter without letting the ball drop.

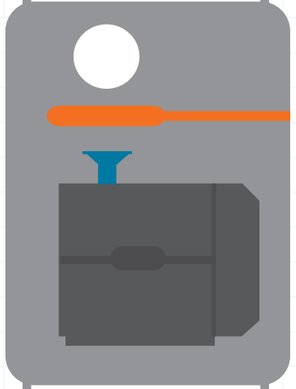


PART NEEDED Bubble wand

PROJECT 19

Float the ball with the same circuit used in Project 17 and carefully try to land the ball on the bubble wand.

After you've landed the ball on the wand, position the wand above the funnel and slowly lower it until the ball starts to float again.

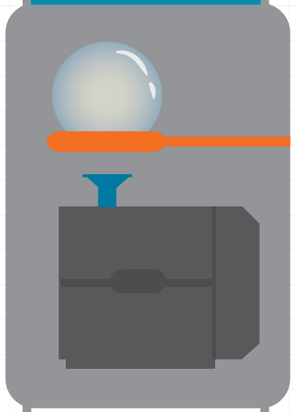


PROJECT 20

This project requires bubble solution from home.

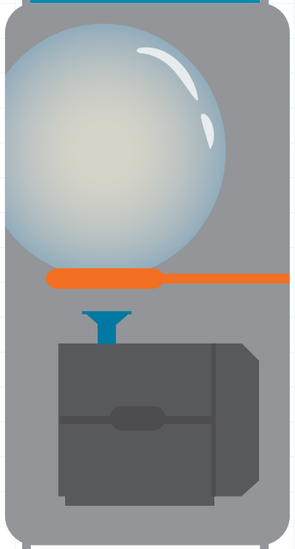
Use the circuit from Project 19. Adjust the dial to regulate the airflow speed.

Dip the bubble wand in bubble solution then place it right above the funnel to make bubbles.



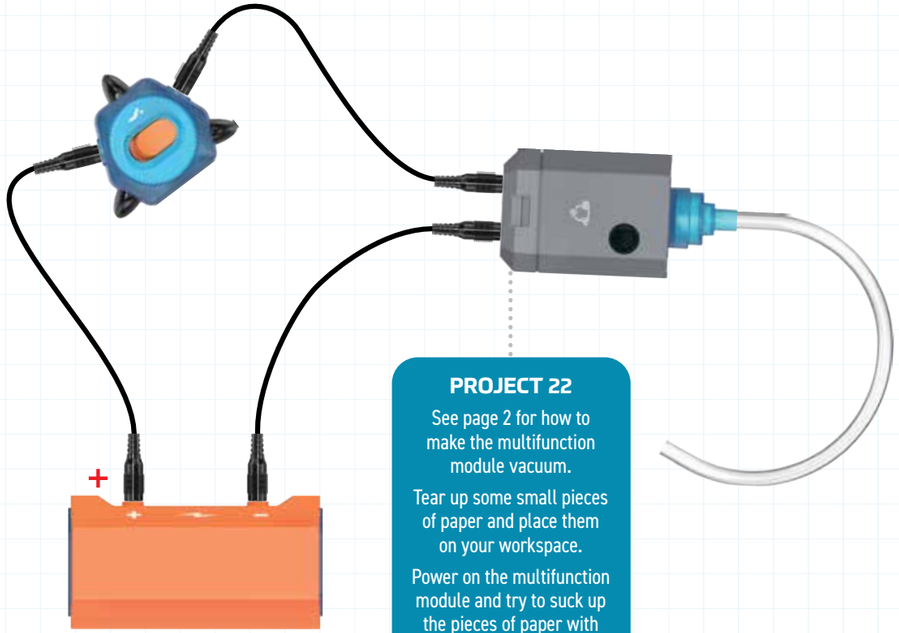
PROJECT 21

Use the circuit from Project 19. Turn the dial switch down to reduce the airflow speed and see how big you can make a single bubble.



22 23 CREATE A VACUUM CLEANER + ADJUST THE VACUUM'S POWER

PARTS NEEDED Power block • Wires x 3 • Toggle switch • Multifunction module • Funnel
Vacuum filter • Vacuum tube connector • Vacuum tube



PROJECT 22

See page 2 for how to make the multifunction module vacuum.

Tear up some small pieces of paper and place them on your workspace.

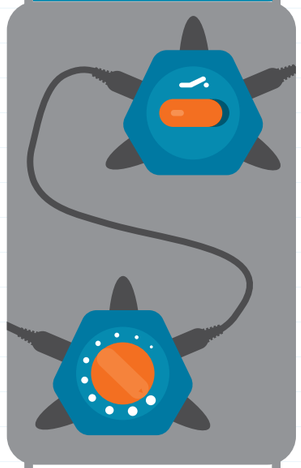
Power on the multifunction module and try to suck up the pieces of paper with the vacuum tube.

PARTS NEEDED
Dial switch • Wire

PROJECT 23

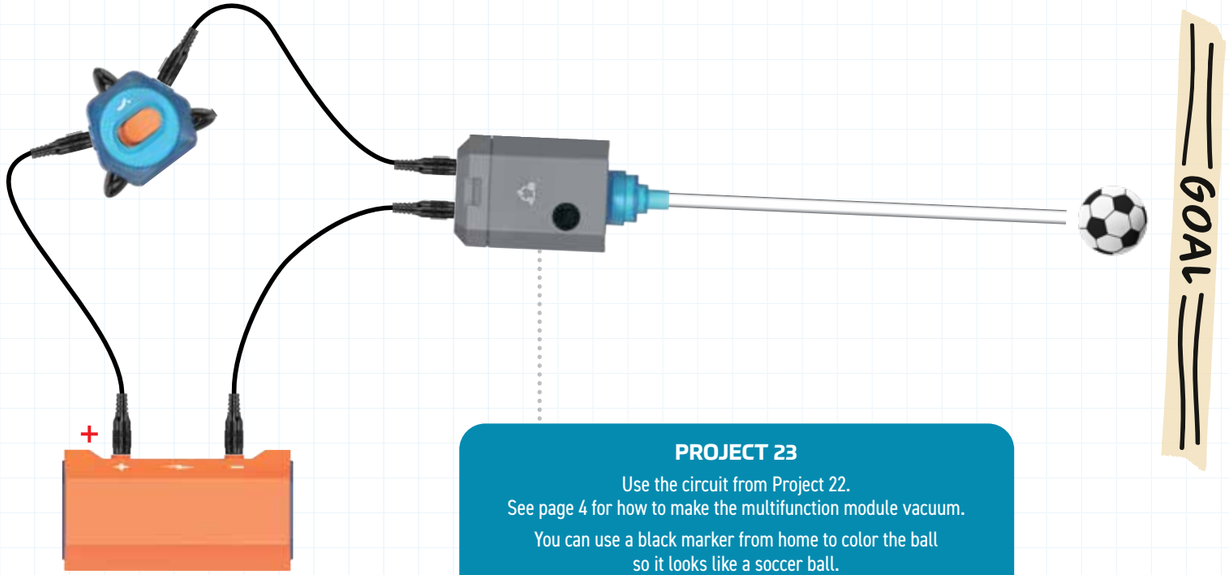
Add the dial switch to the circuit built in Project 22 and power on the vacuum.

What happens to the vacuum's power when you adjust the dial?



24 SCORE A GOAL

PARTS NEEDED Power block • Wires x 3 • Toggle switch • Multifunction module • Funnel
Vacuum filter • Vacuum tube connector • Vacuum tube • Foam ball



PROJECT 23

Use the circuit from Project 22.
See page 4 for how to make the multifunction module vacuum.

You can use a black marker from home to color the ball so it looks like a soccer ball.

Create a "goal" with a piece of tape from home. Use the suction power of the vacuum to pull the soccer ball across the goal line.

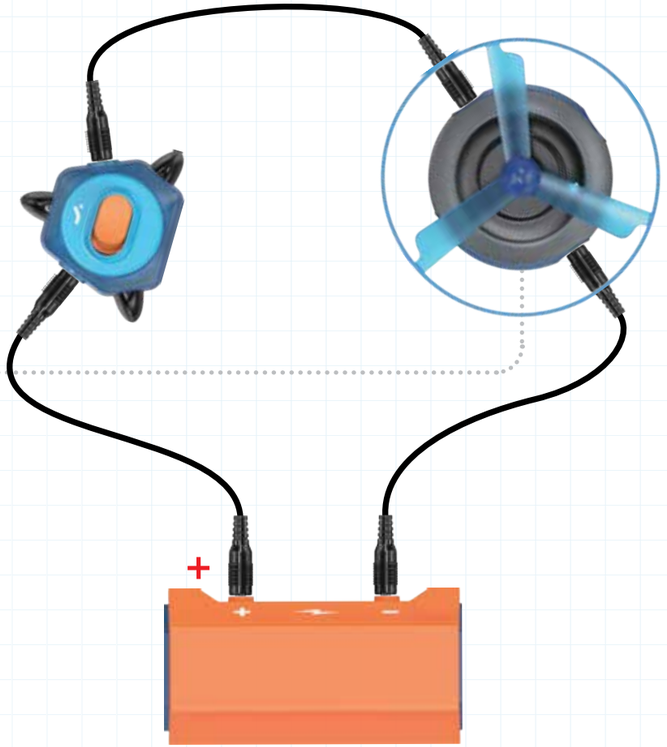
25 LAUNCH A COPTER

PARTS NEEDED Power block • Wires x 3 • Toggle switch
Spinner module • Copter

PROJECT 25

See page 3 for how to assemble the spinner module and copter.

Flip the toggle switch to provide electrical current to the spinner module and launch the copter!



CIRCUIT SCIENCE

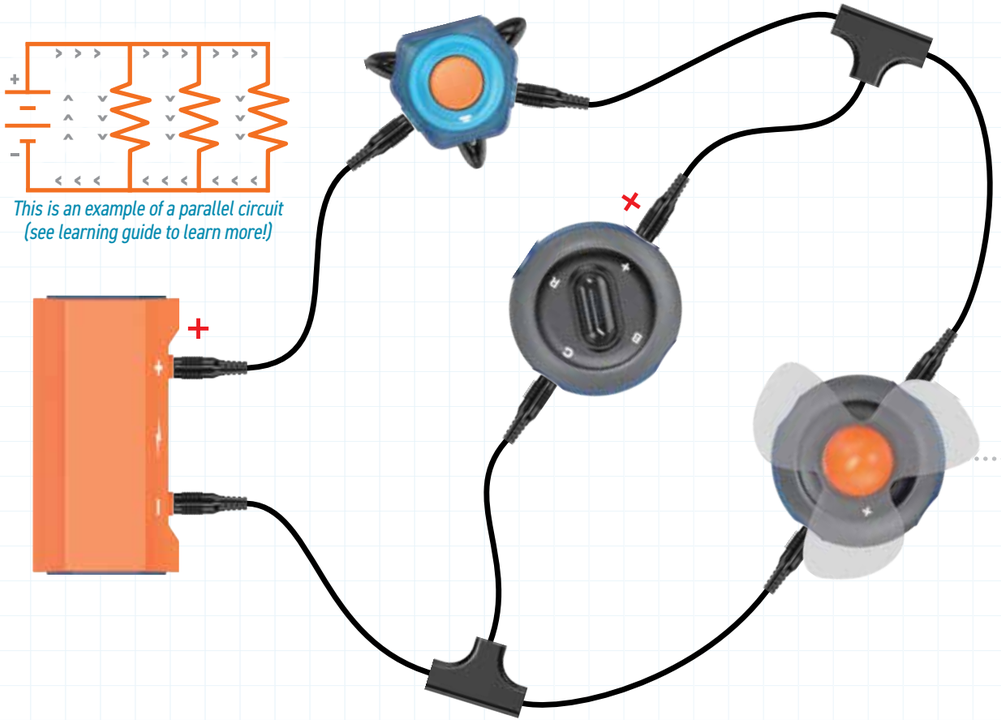
Up to this point you've been building ***series circuits***. In a series circuit, the electricity flows from one section to the next and its rate of flow is determined by the amount of resistance offered by the component with the most resistance.

Next, you'll build a ***parallel circuit***. In a parallel circuit, the electricity can flow along different pathways, and it will seek out the path with the least resistance.

26 CREATE A COLORFUL SPINNING PARALLEL CIRCUIT

PARTS NEEDED Power block • Wire • T-wires x 2 • Button switch • RGB light • Spinner module • Fan

This is an example of a parallel circuit (see learning guide to learn more!)



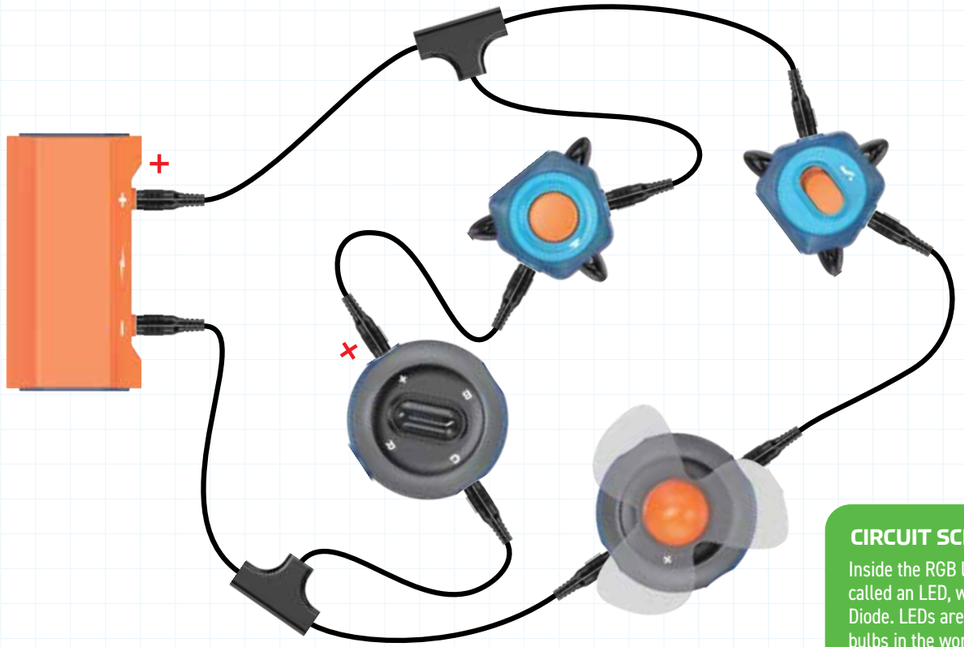
PROJECT 26

See page 3 for how to assemble the spinner module and fan.

If you disconnect the spinner module, will the RGB light still light up? How about if you disconnect the RGB light?

27 ALTERNATE BETWEEN A SERIES CIRCUIT AND A PARALLEL CIRCUIT

PARTS NEEDED Power block • Wires x 2 • T-wires x 2 • Toggle switch • Button switch • RGB light • Spinner module • Fan



PROJECT 27

See page 3 for how to assemble the spinner module and fan.

When the toggle switch is in the "on" position and you press the button switch, you create a parallel circuit that powers both the RGB light and spinner module.

When the toggle switch is in the "off" position and you press the button switch, you create a series circuit that powers the RGB light.

CIRCUIT SCIENCE

Inside the RGB light, there's a special part called an LED, which stands for Light Emitting Diode. LEDs are the most energy efficient light bulbs in the world. They're environmentally friendly and can stay shining for over 20 years!

28 CREATE AN "AND" LOGIC GATE

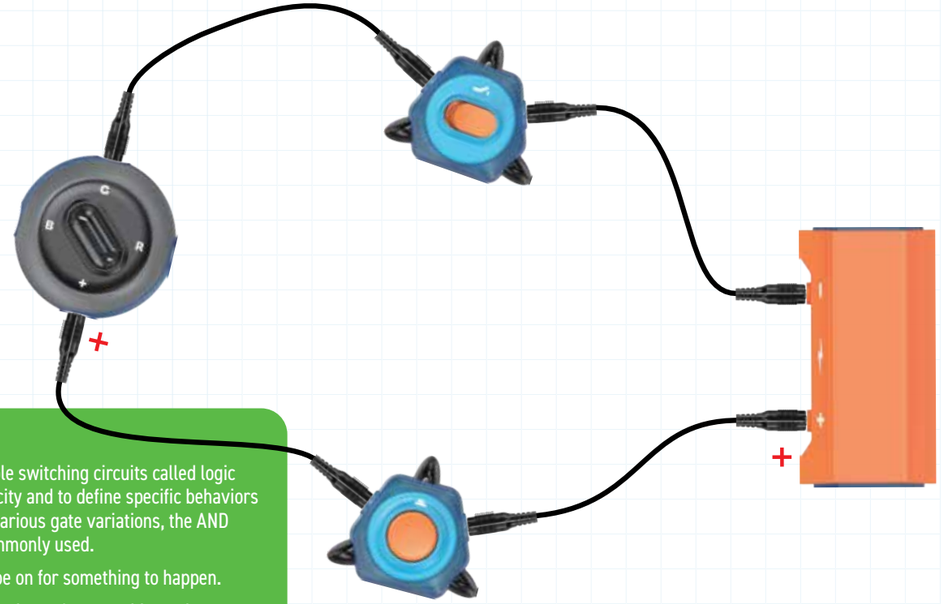
PARTS NEEDED Power block • Wires x 4 • RGB light • Button switch • Toggle switch

PROJECT 28

Turn on the toggle switch. What happens to the RGB light?

Turn off the toggle but press the button switch. What happens to the RGB light?

Press the button and turn the toggle switch on at the same time. What happens to the RGB light?



CIRCUIT SCIENCE

Engineers and designers use simple switching circuits called logic gates to control the flow of electricity and to define specific behaviors in electronic devices. Among the various gate variations, the AND gate and OR gate are the most commonly used.

AND Gate = All switches need to be on for something to happen.

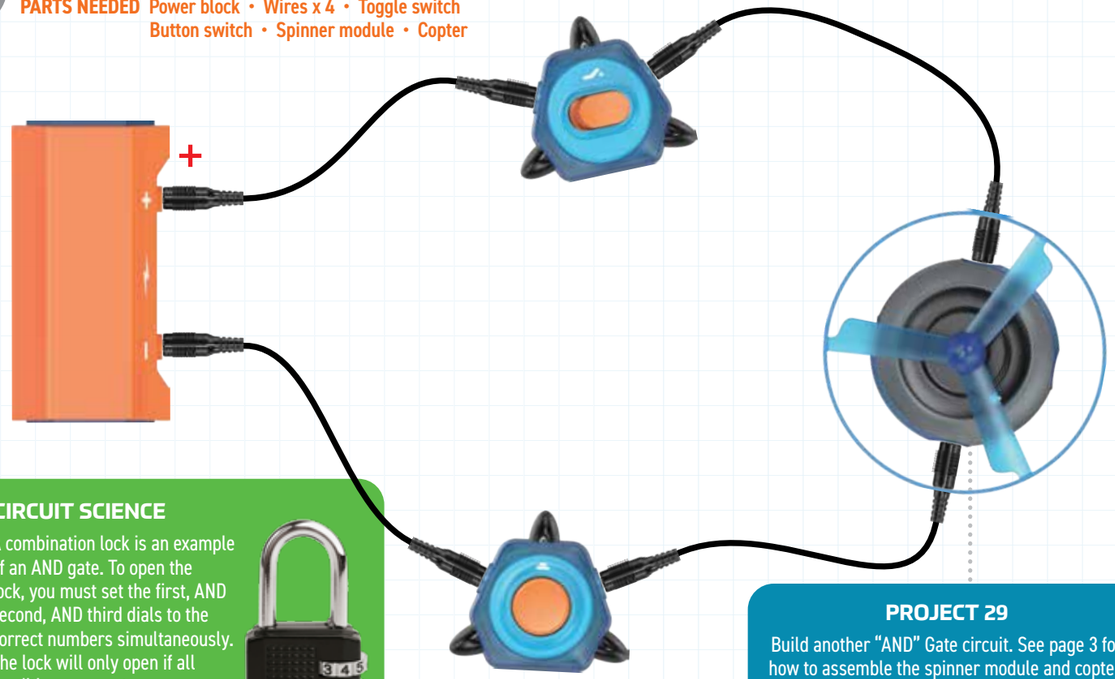
OR Gate = Only one switch needs to be on for something to happen.

In this project, both the button switch AND the toggle switch need to be on for electricity to flow through and illuminate the RGB light.

See page 25 to build a circuit with an "OR" gate.

29 BUILD A TWO-SWITCH COPTER LAUNCH

PARTS NEEDED Power block • Wires x 4 • Toggle switch
Button switch • Spinner module • Copter



CIRCUIT SCIENCE

A combination lock is an example of an AND gate. To open the lock, you must set the first, AND second, AND third dials to the correct numbers simultaneously. The lock will only open if all conditions are met.

See page 25 to build a circuit with an "OR" gate.

PROJECT 29

Build another "AND" Gate circuit. See page 3 for how to assemble the spinner module and copter.

Press and hold the button and turn on the toggle switch to close the circuit and launch the copter.

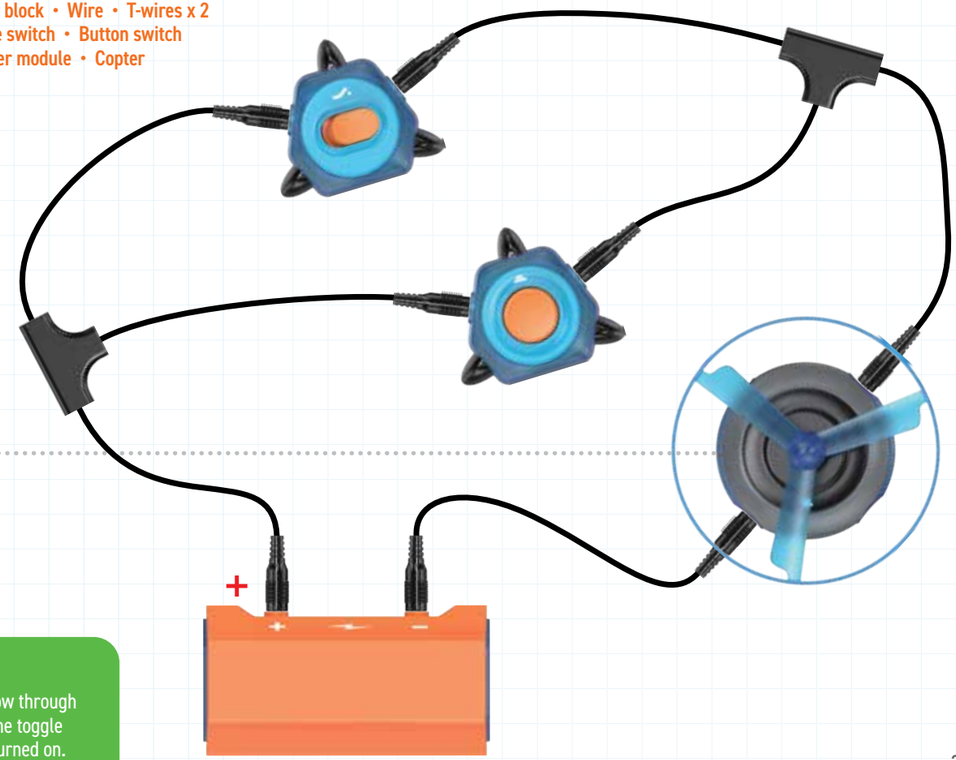
30 CREATE AN "OR" LOGIC GATE

PARTS NEEDED Power block • Wire • T-wires x 2
Toggle switch • Button switch
Spinner module • Copter

PROJECT 30

See page 3 for how to assemble the spinner module and copter.

Turn on the toggle switch. Did the copter launch? Turn off the toggle switch, then press and hold the button. What happens to the copter?



CIRCUIT SCIENCE

In this project, electricity will flow through and launch the copter if either the toggle switch OR the button switch is turned on.

31 BUILD A TRAFFIC LIGHT

PARTS NEEDED Power block • Wires x 3 • T-wire • RGB light • Toggle switch • Button switch

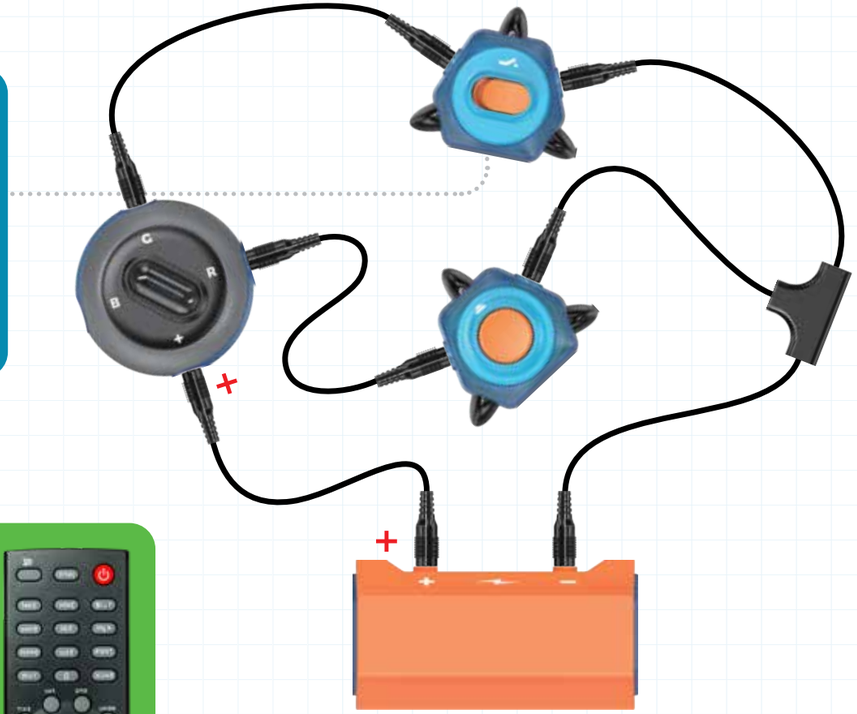
PROJECT 31

Build another "OR" gate circuit.

Turn on the toggle switch. What happens to the RGB light?

Turn off the toggle switch then press and hold the button switch. What happens to the RGB light?

Turn on the toggle switch and hold down the button switch at the same time. What happens to the RGB light?

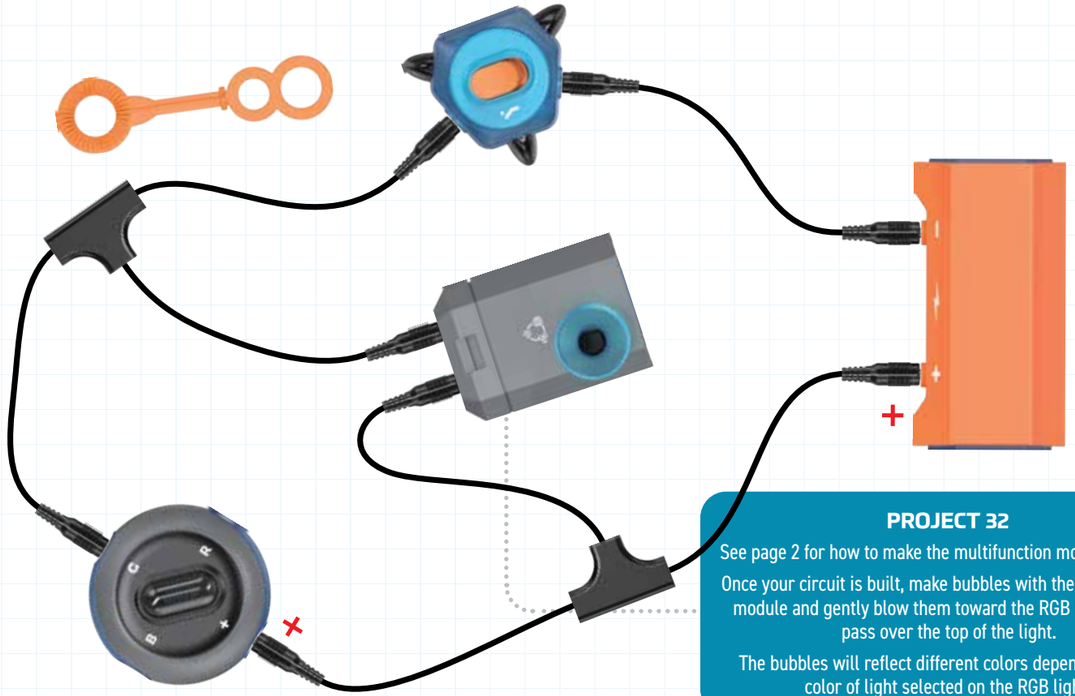


CIRCUIT SCIENCE

The "Power" button on a TV remote is an example of an OR gate. The TV turns on if you press the remote "Power" button OR the physical button on the TV itself. It works if at least one of these conditions is true.

32 BUILD A COLORFUL BUBBLE MACHINE

PARTS NEEDED Power block • Wire • T-wires x 2 • RGB light • Toggle switch • Bubble wand • Multifunction module • Funnel



PROJECT 32

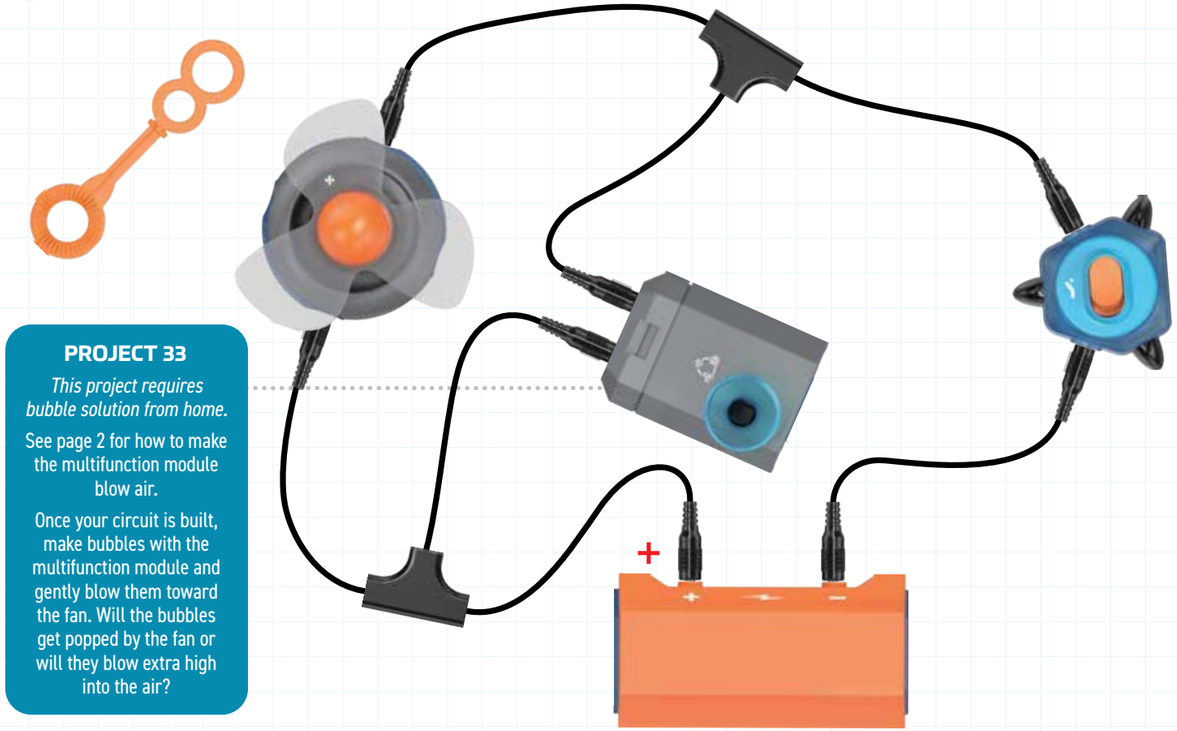
See page 2 for how to make the multifunction module blow air.

Once your circuit is built, make bubbles with the multifunction module and gently blow them toward the RGB light so they pass over the top of the light.

The bubbles will reflect different colors depending on the color of light selected on the RGB light.

33 BUILD A BUBBLE TURBINE

PARTS NEEDED Power block • Wire • T-wires x 2 • Toggle switch • Spinner module • Fan • Multifunction module • Funnel • Bubble wand



PROJECT 33

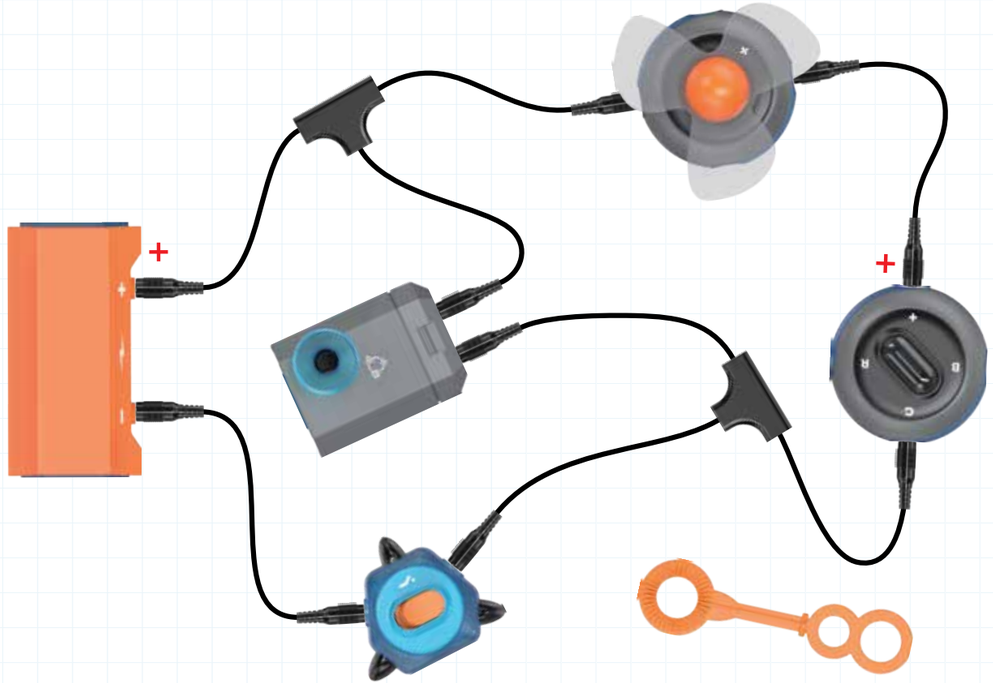
This project requires bubble solution from home.

See page 2 for how to make the multifunction module blow air.

Once your circuit is built, make bubbles with the multifunction module and gently blow them toward the fan. Will the bubbles get popped by the fan or will they blow extra high into the air?

34 BUILD THE ULTIMATE COLORFUL BUBBLE TURBINE

PARTS NEEDED Power block • Wires x 2 • T-wires x 2 • RGB light • Toggle switch
Spinner module • Fan • Multifunction module • Funnel • Bubble wand



PROJECT 34

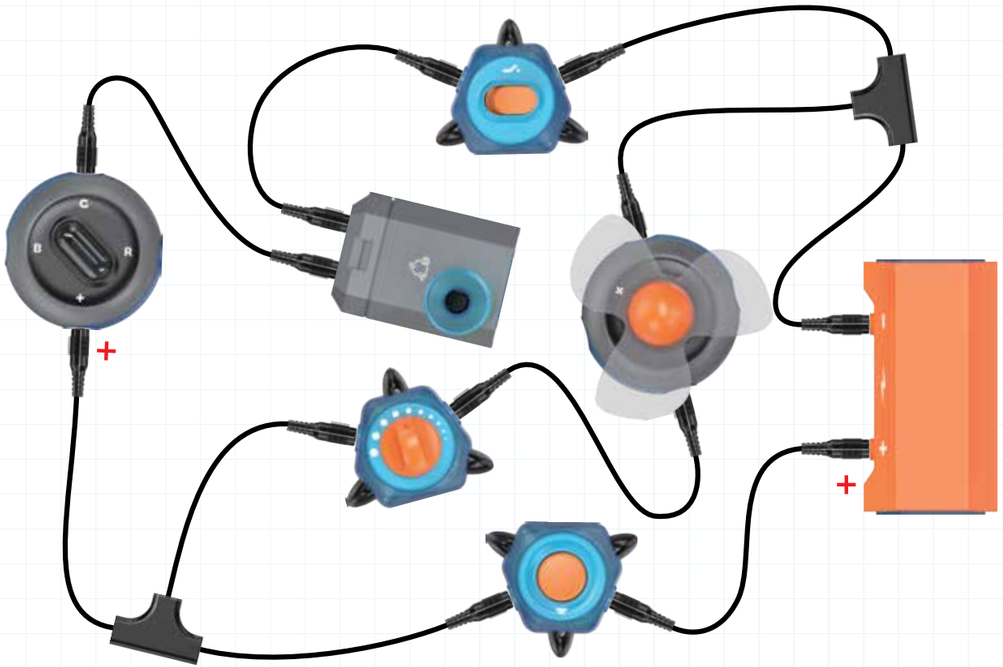
This project requires bubble solution from home.

See page 2 for how to make the multifunction module blow air. See page 3 for how to assemble the spinner module and fan.

Once your circuit is built, make bubbles with the multifunction module and gently blow them toward the fan. What colors do you think the bubbles will reflect when they float over the RGB light?

35 CREATE A CIRCUIT WITH MULTIPLE LOGIC GATES

PARTS NEEDED Power block • Wires x 4 • T-wires x 2 • RGB light • Toggle switch • Dial switch • Button switch Multifunction module • Funnel • Spinner module • Fan



PROJECT 35

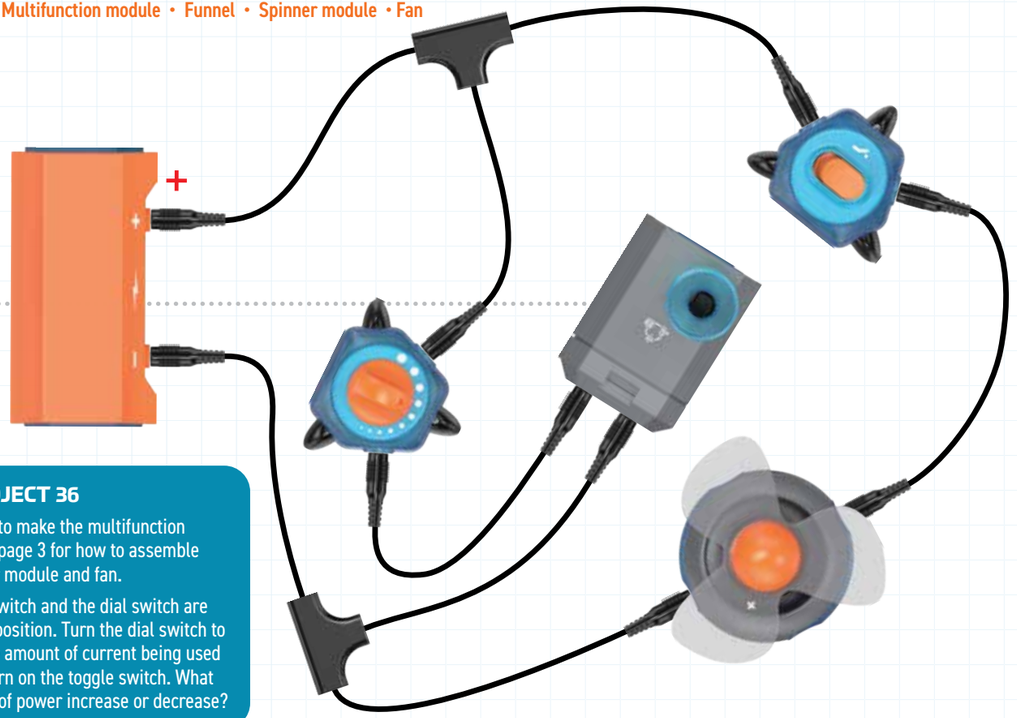
See page 2 for how to make the multifunction module blow air. See page 3 for how to assemble the spinner module and fan.

There is an AND logic gate (which uses the button switch) and two OR logic gates (the dial switch and the toggle switch).

Can you invent another configuration using these switches and modules?

36 INCREASE AND DECREASE ELECTRICAL CURRENT

PARTS NEEDED Power block • Wires x 2 • T-wires x 2 • Toggle switch • Dial switch Multifunction module • Funnel • Spinner module • Fan



PROJECT 36

See page 2 for how to make the multifunction module blow air. See page 3 for how to assemble the spinner module and fan.

Make sure the toggle switch and the dial switch are both in the "open" or off position. Turn the dial switch to full power and notice the amount of current being used by the modules. Now turn on the toggle switch. What changed—did the amount of power increase or decrease?

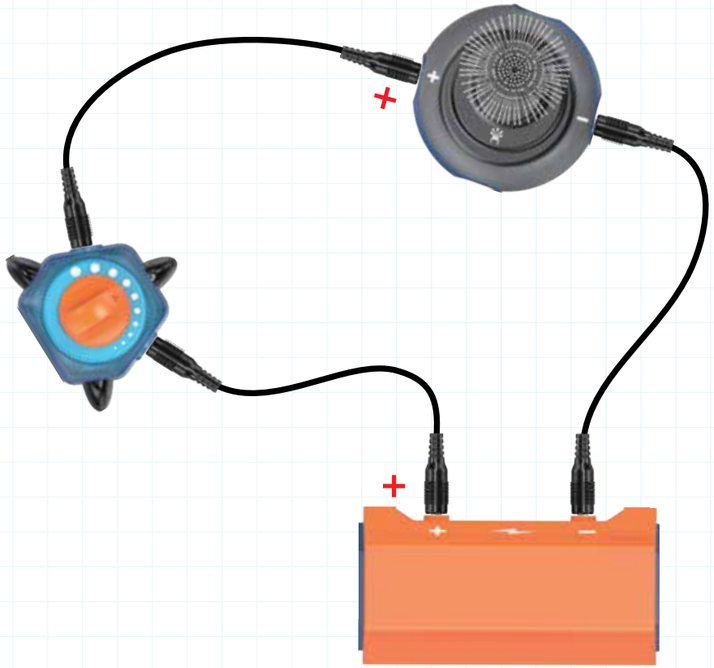
37 POWER ON A FIBER OPTIC LIGHT

PARTS NEEDED Power block • Wires x 3 • Dial switch • Light module • Fiber optic bundle

PROJECT 37

See page 4 for how to assemble the light module and fiber optic bundle.

Turn the dial to increase the current and watch as the fiber optic light show begins!



38 39 LIGHT UP THE FIBER OPTIC BUNDLE WITH A THREE SWITCH LOGIC GATE

PARTS NEEDED Power block • Wires x 2 • T-wires x 2 • Toggle switch • Dial switch • Button switch Light module • Fiber optic bundle

PROJECT 38

See page 4 for how to assemble the light module and fiber optic bundle.

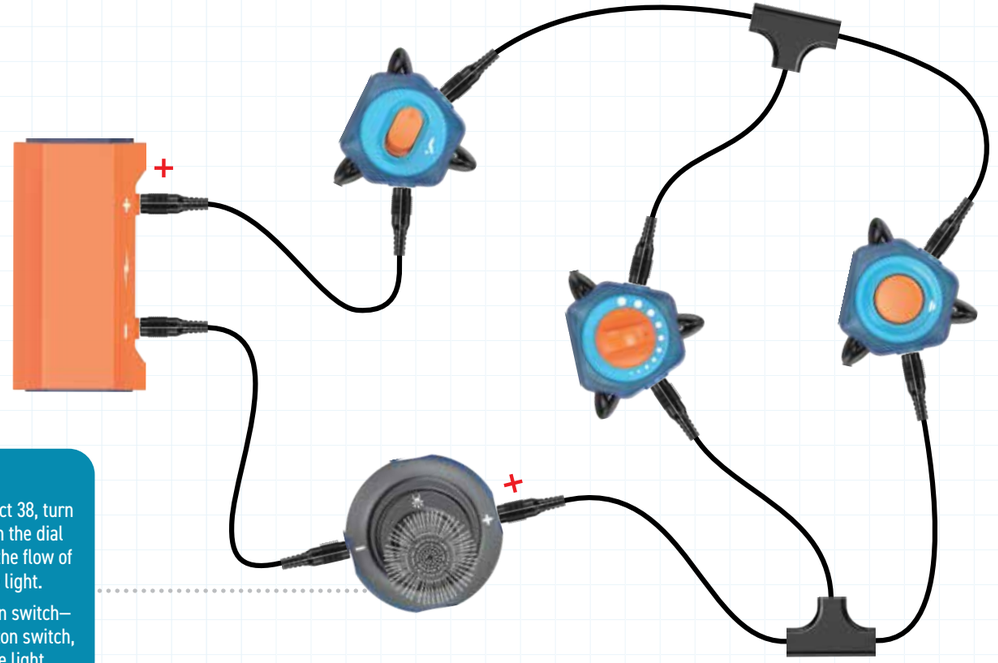
Flip the toggle switch to the "closed" or on position and turn the dial switch to full power to illuminate the light.

Current flows through the dial switch, allowing you to control the brightness of the light.

PROJECT 39

Using the circuit built in Project 38, turn the toggle switch on and turn the dial switch all the way off to stop the flow of current from reaching the light.

Now press and hold the button switch—current flows through the button switch, allowing power to reach the light.



40 BUILD A PURPLE SPINNING CIRCUIT WITH THE PASSTHROUGH

PARTS NEEDED Power block • Wires x 4 • T-wires x 2 • RGB light • Dial switch • Button switch Spinner module • Fan • Passthrough

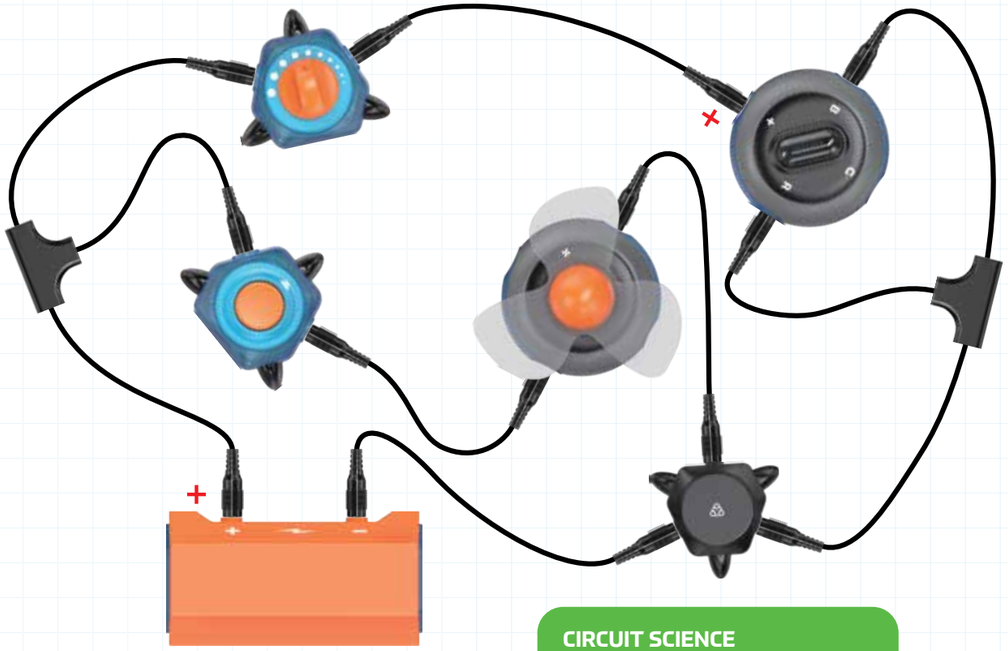
PROJECT 40

See page 3 for how to assemble the spinner module and fan.

Turn the dial to full power and press the button. What happens to the fan and RGB light?

Turn the dial off and press the button. What happens to the fan and RGB light?

Turn the dial on without pressing the button. What happens to the fan and RGB light



CIRCUIT SCIENCE

The passthrough is a 3-way port that allows current to flow through unmodified.

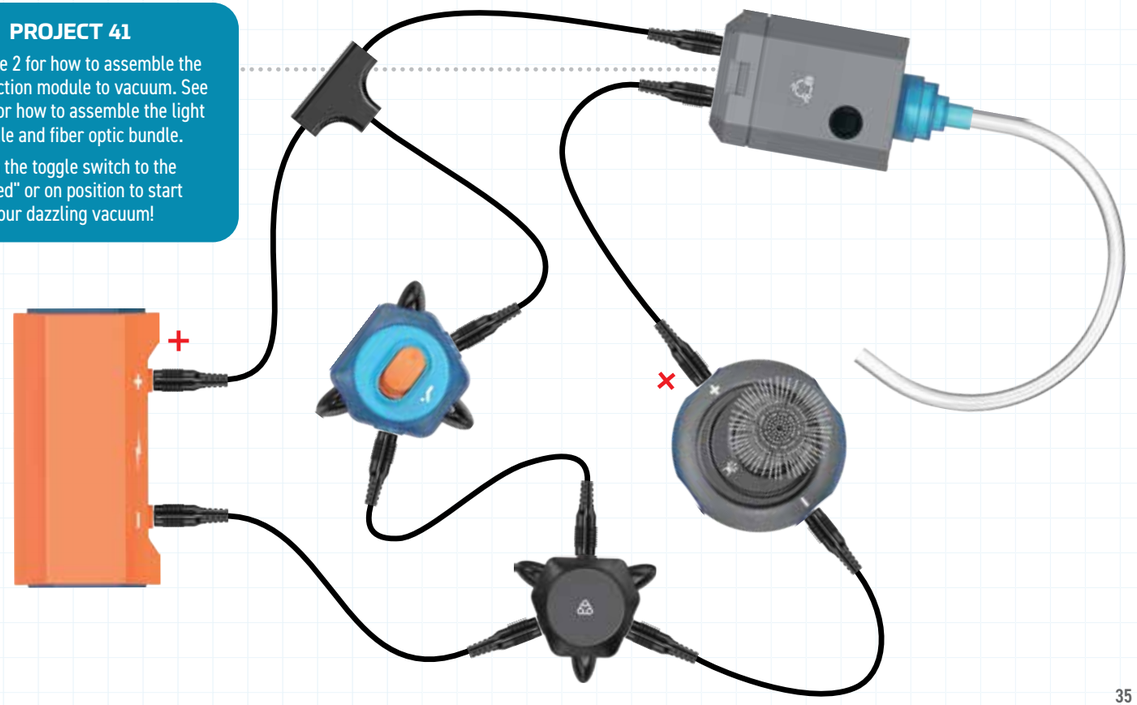
41 BUILD A DAZZLING VACUUM CLEANER

PARTS NEEDED Power block • Wires x 4 • T-wires • Toggle switch • Multifunction module • Funnel • Vacuum filter • Vacuum tube Light module • Fiber optic bundle • Passthrough

PROJECT 41

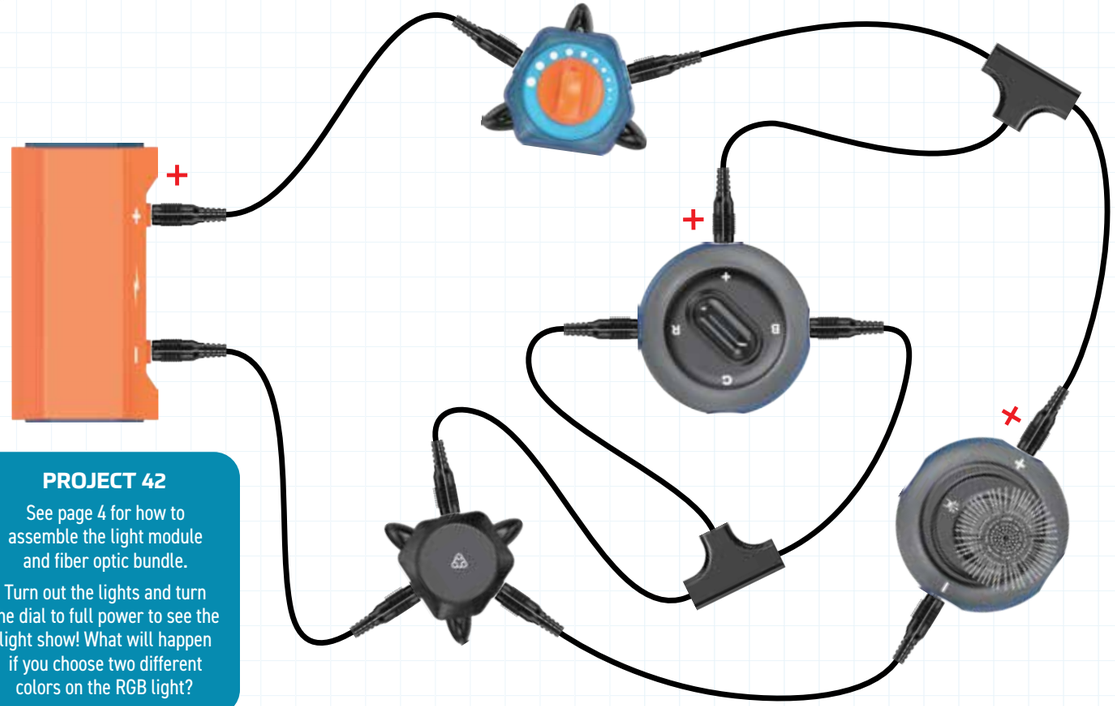
See page 2 for how to assemble the multifunction module to vacuum. See page 4 for how to assemble the light module and fiber optic bundle.

Turn the toggle switch to the "closed" or on position to start your dazzling vacuum!



42 BUILD A COLOR-CHANGING LIGHT SHOW

PARTS NEEDED Power block • Wires x 3 • T-wires x 2 • RGB light • Dial switch • Light module • Fiber optic bundle • Passthrough



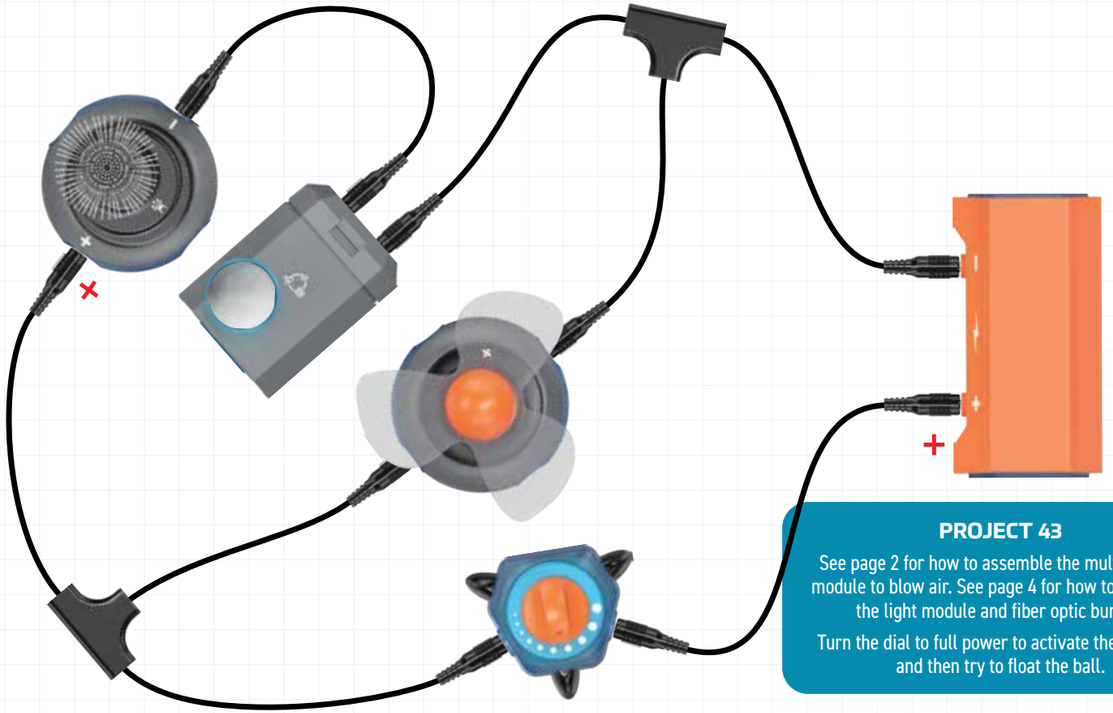
PROJECT 42

See page 4 for how to assemble the light module and fiber optic bundle.

Turn out the lights and turn the dial to full power to see the light show! What will happen if you choose two different colors on the RGB light?

43 BUILD A TRI-MODULE CIRCUIT

PARTS NEEDED Power block • Wires x 2 • T-wires x 2 • Dial switch • Multifunction module • Funnel • Foam ball Spinner module • Fan • Light module • Fiber optic bundle



PROJECT 43

See page 2 for how to assemble the multifunction module to blow air. See page 4 for how to assemble the light module and fiber optic bundle.

Turn the dial to full power to activate the modules and then try to float the ball.

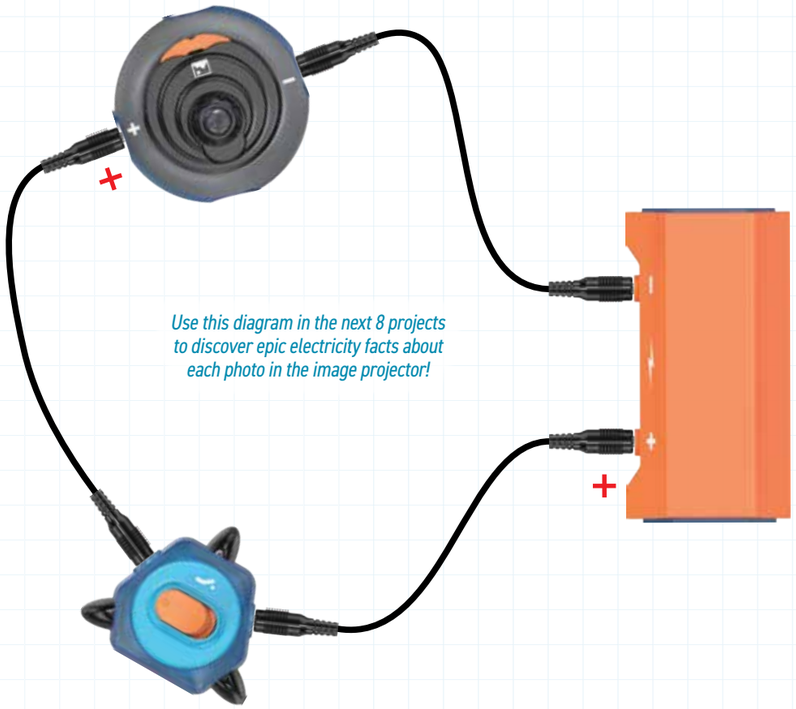
44 POWER UP THE PROJECTOR

PARTS NEEDED Power block • Wires x 3 • Toggle switch • Light module • Image projector

PROJECT 44

See page 4 for how to assemble the light module and image projector.

Make sure the room is dark then turn on the toggle switch to see the images projected!



Use this diagram in the next 8 projects to discover epic electricity facts about each photo in the image projector!

45 EPIC ELECTRICITY FACTS + FILL-IN-THE-BLANKS: LIGHTNING

Use the diagram on page 38 to project this image on your wall or ceiling!

LIGHTNING

There is constant movement inside a storm cloud, with hail and tiny ice particles rising and falling and bumping into one another in the process. Scientists believe these collisions contribute to the creation of lightning. As the particles hit one another, positive and negative electrical charges are created. Once these opposite charges grow strong enough then an electrical charge is released in the form of lightning. A bolt of lightning has up to 300 million volts. The current available in most homes, to compare, is 120 volts.

FILL IN THE BLANK

A bolt of lightning has up to

_____

million volts.

46 EPIC ELECTRICITY FACTS + FILL-IN-THE-BLANKS: AURORA BOREALIS

Use the diagram on page 38 to project this image on your wall or ceiling!

AURORA BOREALIS

Energized particles from solar flares or solar winds interacting with atoms in Earth's atmosphere create the dazzling colors of the Aurora Borealis. These beautiful light displays also create electromagnetic disruptions in the atmosphere, which in turn can damage power grids on Earth's surface, if strong enough.

FILL IN THE BLANK

_____

particles from solar flares or solar winds interacting with atoms in Earth's atmosphere create the Aurora Borealis.

47 EPIC ELECTRICITY FACTS + FILL-IN-THE-BLANKS: COMET

Use the diagram on page 38 to project this image on your wall or ceiling!

COMET

The dramatic tail of a comet is actually two tails; an ion tail and a dust tail. When a comet comes close to the sun, the heat vaporizes some of the material of the comet, creating a trail of particle dust (dust tail). The ultraviolet light of the sun, meanwhile, creates a trail of electrically charged ion particles (ion tail). The solar wind carries the ions out away from the sun, resulting in a long tail that typically glows blue.

FILL IN THE BLANK

The ion tail of a comet typically glows

_____ .

48 EPIC ELECTRICITY FACTS + FILL-IN-THE-BLANKS: SPACE SHUTTLE

Use the diagram on page 38 to project this image on your wall or ceiling!

SPACE SHUTTLE

Many of NASA's space shuttle orbiters used special hydrogen fuel cells to create electricity for the crew onboard. The typical orbiter had three fuel cells that would produce electricity by harnessing the electrical power created by the chemical reaction of hydrogen and oxygen. An additional benefit of this system is that the byproduct of the reaction is water, which the crew would drink.

FILL IN THE BLANK

The byproduct of the chemical reaction of hydrogen and oxygen _____ .

49 EPIC ELECTRICITY FACTS + FILL-IN-THE-BLANKS: ASTRONAUT

Use the diagram on page 38 to project this image on your wall or ceiling!

ASTRONAUT

Astronauts rely on electricity for many of the essential functions of their spacesuits. The large backpack they wear contains life support systems such as the oxygen needed to breathe and the regulators that keep the suit properly pressurized. Radio communicators, fans, and cooling systems are all powered by the electricity offered by this highly specialized and essential piece of equipment.

FILL IN THE BLANK

Astronauts rely on _____ for many of the essential functions of their spacesuits.

50 EPIC ELECTRICITY FACTS + FILL-IN-THE-BLANKS: MOON

Use the diagram on page 38 to project this image on your wall or ceiling!

MOON

The moon has an extremely thin atmosphere, called an *exosphere*, so its surface is subject to very harsh conditions. These conditions have led researchers to discover that the surface of the moon is negatively charged, owing largely to the constant stream of electrons and protons hitting the surface from solar winds. The fine silica dust granules on the moon react to the negative electrostatic charge by repelling one another. As a result, a layer of dust sits suspended about 1 meter (3.3 ft.) above the lunar surface which makes it very difficult for astronauts to safely land on and explore the moon.

FILL IN THE BLANK

Researchers have found that the surface of the moon is

_____

charged.

51 EPIC ELECTRICITY FACTS + FILL-IN-THE-BLANKS: SUN

Use the diagram on page 38 to project this image on your wall or ceiling!

SUN

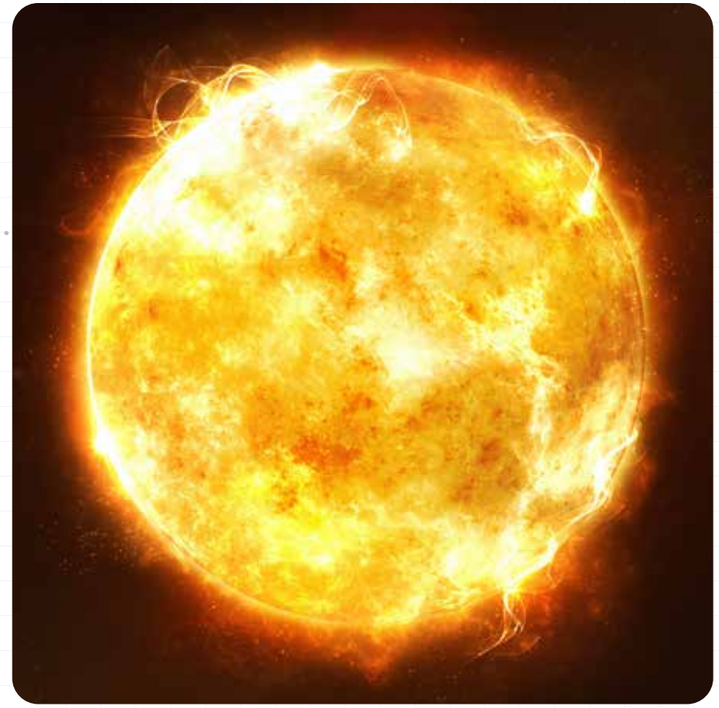
We can turn the energy from the sun into electricity using solar panels. These panels contain numerous photovoltaic cells comprised of semiconductors, often made from silicon, which absorb the sun's energy. This energy is transferred to negatively charged electrons in the semiconductors which flow through the metal contacts of the panel as direct current (DC) to an inverter in the home. This inverter converts the electricity to the alternating current (AC) used to power your toaster or television.

FILL IN THE BLANK

We use

_____

to turn energy from the sun into electricity.



52 EPIC ELECTRICITY FACTS + FILL-IN-THE-BLANKS: GALAXY

Use the diagram on page 38 to project this image on your wall or ceiling!

GALAXY

In addition to planets and stars, galaxies are also home to plasma, gases that have become so hot that the atoms have split into negatively charged electrons and positively charged ions. Scientists believe that up to 99.9% of the visible universe is plasma. The sun and other stars, for example, are made from gases in the plasma state.

FILL IN THE BLANK

Scientists believe that up to

_____

of the visible universe is plasma.

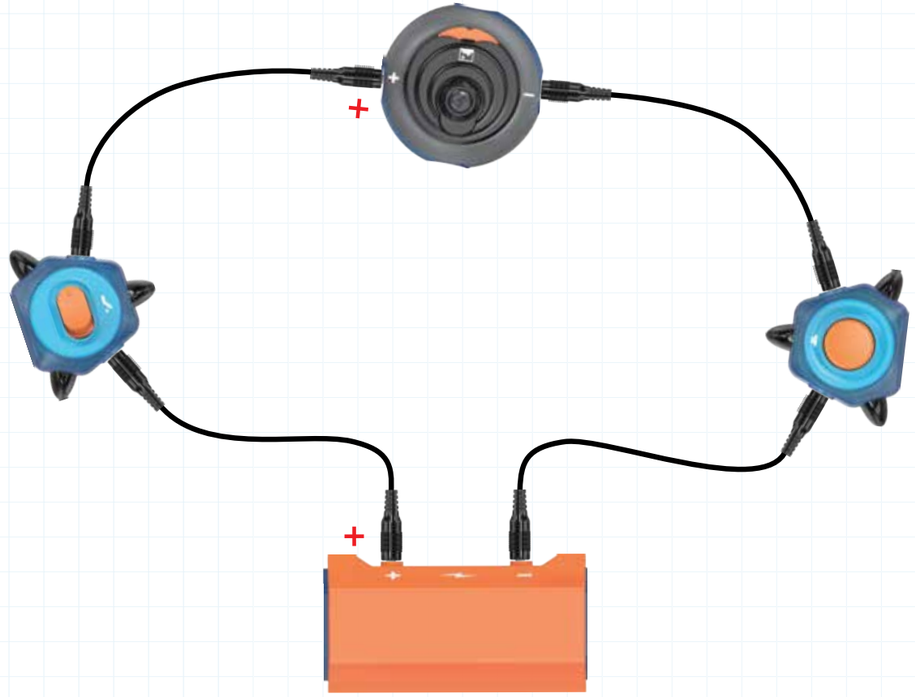
53 PLAY THE FLASH PROJECTOR GAME

PARTS NEEDED Power block • Wires x 4 • Toggle switch • Button switch • Light module • Image projector

PROJECT 35

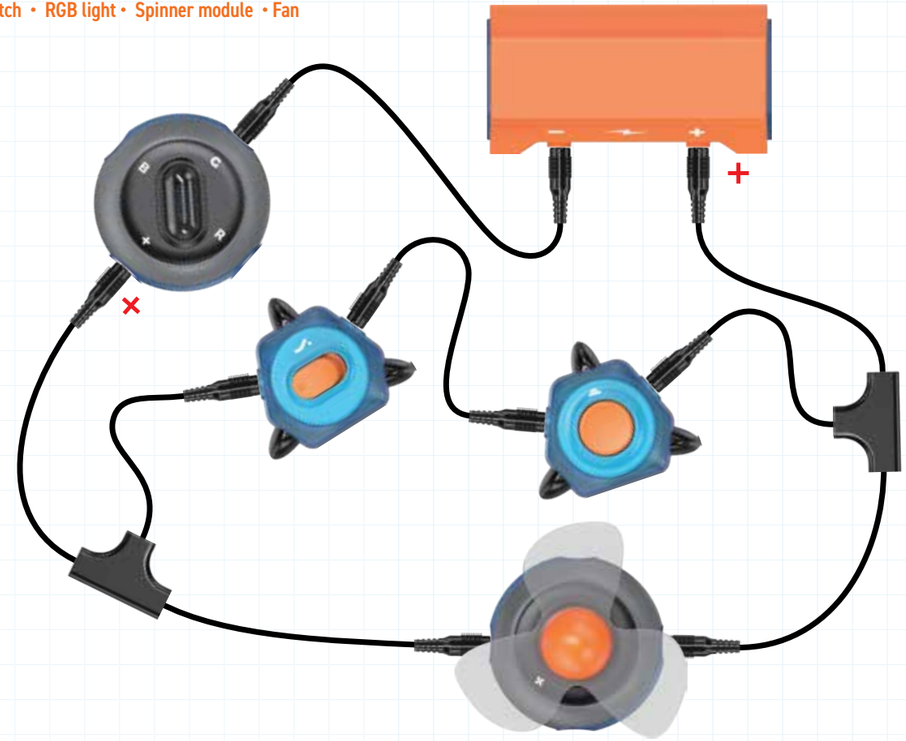
See page 4 for how to assemble the light module and image projector.

Grab a friend or family member and select one of the 8 images on the projector. Then, turn the toggle switch on and quickly press the button. See if your partner can call out what image was projected. Once they get it right, change to the next image and try again!



54 CREATE + FIX A FAULTY CIRCUIT

PARTS NEEDED Power block • Wires x 2 • T-wires x 2 • Toggle switch
Button switch • RGB light • Spinner module • Fan



PROJECT 36

See page 3 for how to assemble the spinner module and fan.

Observe what happens to the fan and the RGB lamp by switching the toggle on and off.

Now, press the button switch with the toggle switch on and with it off. Try to explain each phenomenon.

Can you revise the circuit so that both the motor and RGB lamp are on?

55 USE MORSE CODE TO SEND A MESSAGE

PARTS NEEDED Power block • Wires x 3 • RGB light • Button switch

PROJECT 35

Once you've built your circuit, imagine you have been left alone on an island and you are holding a lamp. Do you know how to ask for help from the vessels passing by when it is dark? You'll need to use Morse Code!

Morse Code is a way people transmit information as a series of on-off tones, lights, or clicks. A skilled listener or observer can translate the tones/lights/clicks into letters without needing special equipment.

So, if you're stranded on an island, you'd want to use the internationally recognized distress signal in Morse Code, which is "SOS".

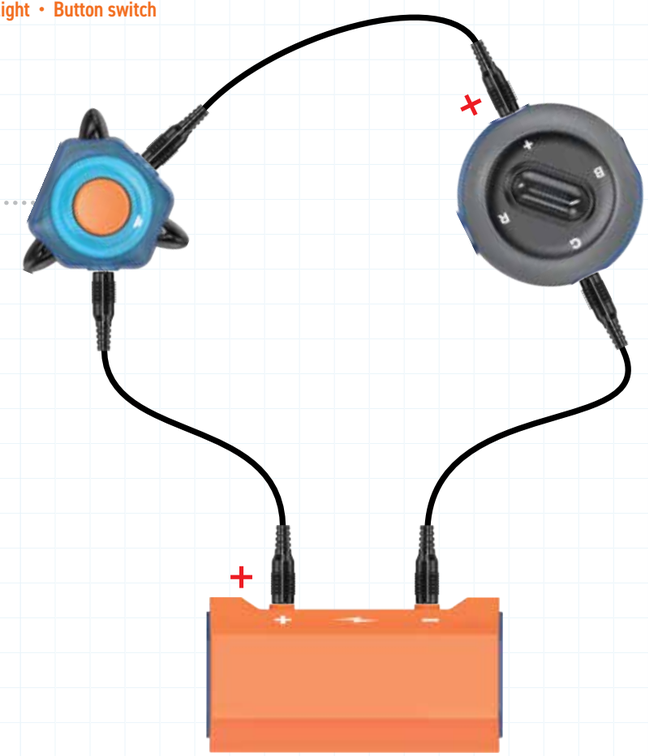
Turn off your room light and press the button switch with:

3 short presses

3 long presses

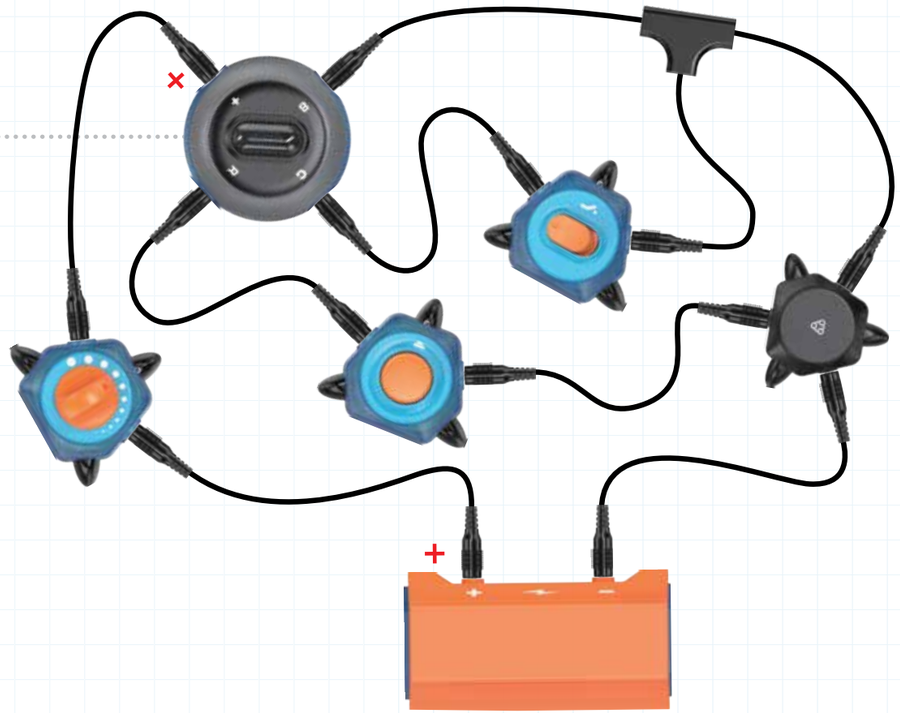
3 short presses

That is the signal for SOS. Be sure to only use SOS when you're truly in distress though!



56 BUILD A 3-SWITCH, COLOR-CHANGING CIRCUIT

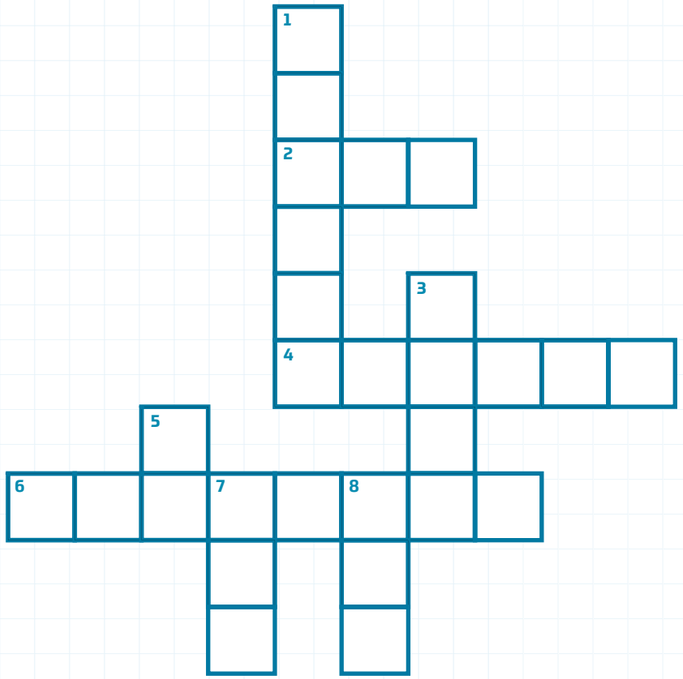
PARTS NEEDED Power block • Wires x 6 • T-wire • Passthrough • Toggle switch • Dial switch • Button switch • RGB light



PROJECT 36

Experiment with the switches. What light color displays when only the toggle switch is on? Does the color change if you press the button switch while the toggle switch is on? What happens if you turn the dial switch on? How many different colors can you make?

57 CROSSWORD PUZZLE



DOWN

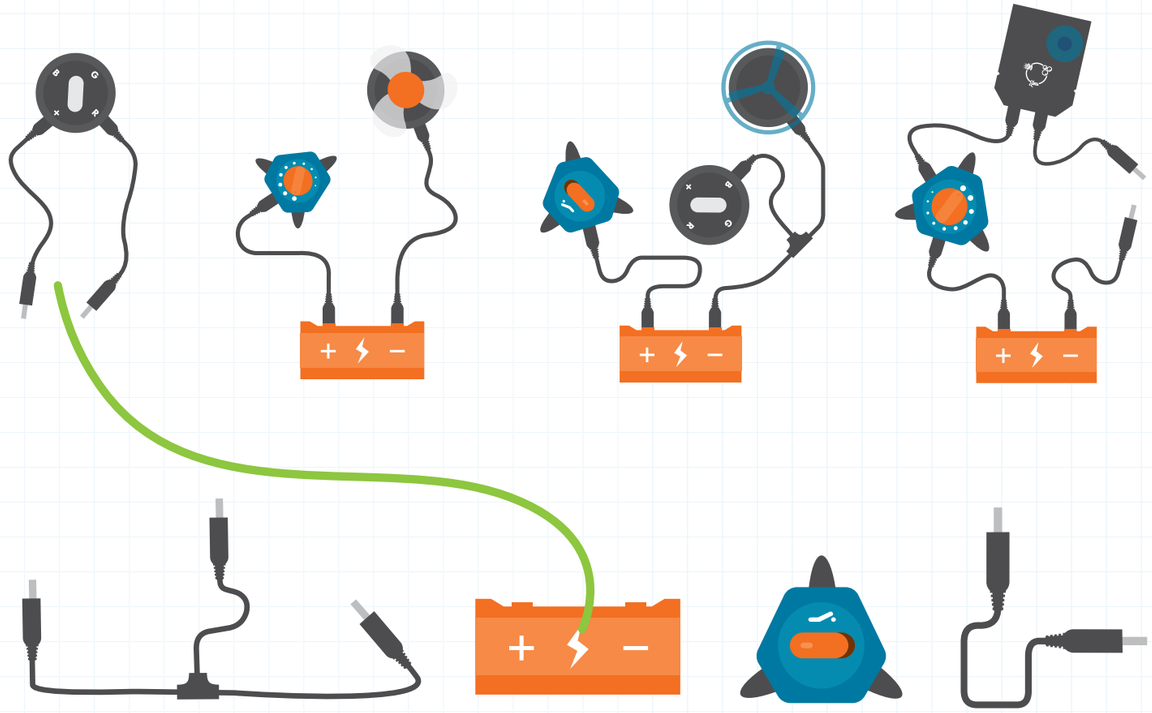
1. a type of circuit where electricity flows from one section to the next and the rate of flow is determined by the amount of resistance offered by the component with the most resistance.
3. transfers electrical current between switches and modules
5. a type of gate where only one switch needs to be on for something to happen
7. a type of gate where all switches need to be on for something to happen
8. an acronym for light emitting diode.

ACROSS

2. an acronym for red, green, and blue
4. opens and closes a circuit
6. a type of circuit where electricity can flow along different pathways, seeing out the path of least resistance.

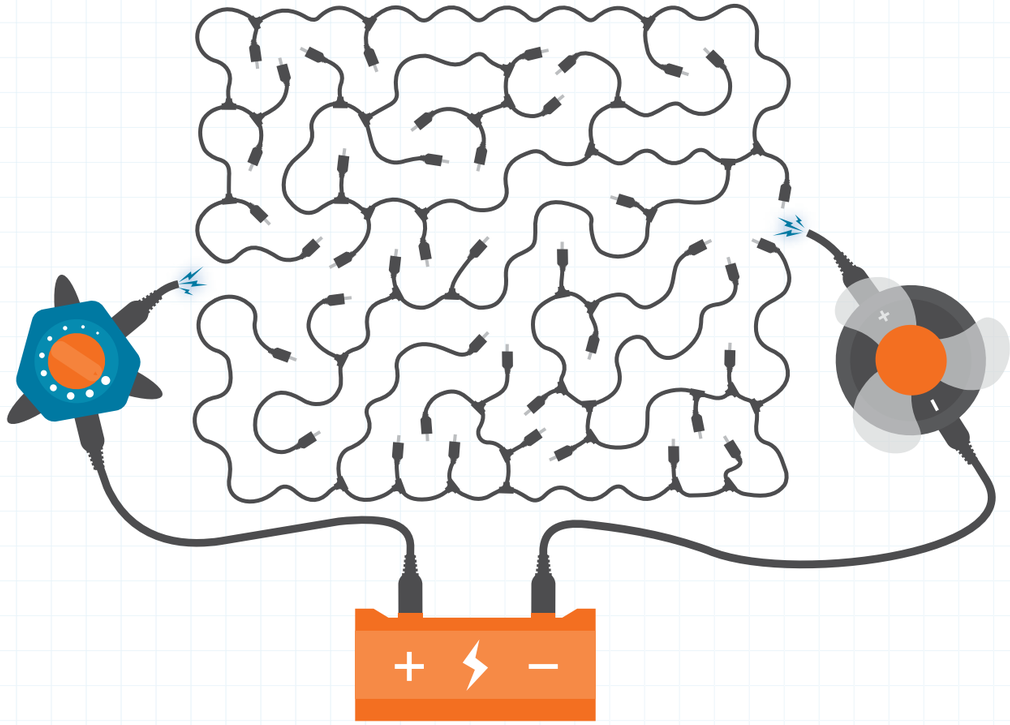
58 WHAT'S MISSING?

Match the circuit to its missing piece on the bottom row.



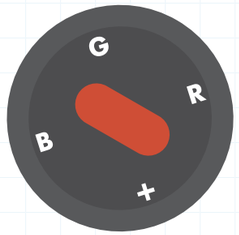
59 MAZE

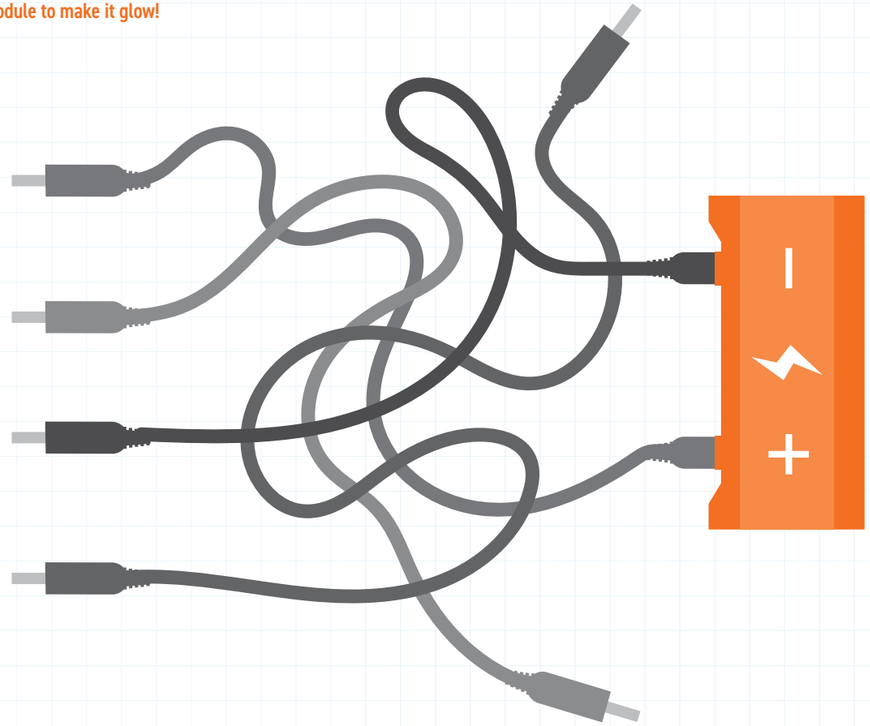
Find your way through the maze to complete the circuit!



60 UNTANGLE THE WIRES!

Trace the wires through the tangle to figure out which ones you need to plug into the RGB Module to make it glow!





61 WORD SEARCH

M L C D X M J Y S T O G G L E
M Y G O M U P I M F L Y T J M
S O C L G L O X O C U C W M O
P C U I E T W S D C R X I N I
F A D G D I E P U F S C R F G
O L L H M F R I L V F O E F H
A C U T W U B N E R U P N L E
A O E W T N L N R O A Z H U W
S P Q O D C O E E M C W J Z I
K T J V I T C R U A Q F I K R
P E F E A I K L V A C U U M E
V R K A L O P X H Z K Q R S O
T G R O N N I S W I T C H W E
I S A P Y Q U A A C T H Q Q T
C E R C W E B U T T O N R Z I

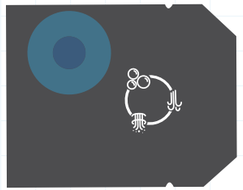
WORD BANK

multifunction
toggle
vacuum
T-wire
spinner
switch
copter
wire
button
module
power block
light
dial
fan

62 DESIGN YOUR OWN CIRCUIT

1. Write down an idea of what you want your circuit to do:

2. In the space below, use a pencil to draw wires between the parts to determine how the electricity will flow.
3. Build the circuit and test if your idea works!



ANSWERS

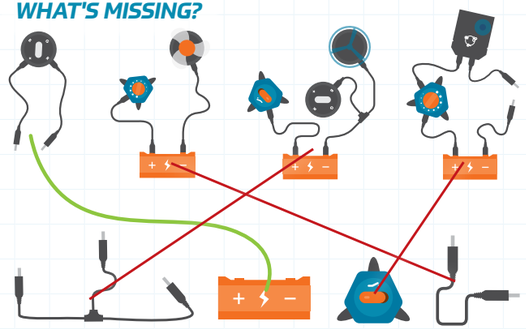
FILL-IN-THE-BLANK

45 - LIGHTNING: *300*
46 - AURORA BOREALIS: *ENERGIZED*
47 - COMET: *BLUE*
48 - SPACE SHUTTLE: *WATER*
49 - ASTRONAUT: *ELECTRICITY*
50 - MOON: *NEGATIVELY*
51 - SUN: *SOLAR PANELS*
52 - GALAXY: *99.9%*

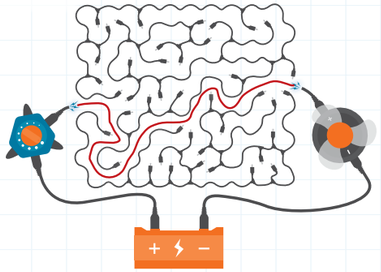
CROSSWORD

1. *SERIES*
2. *RGB*
3. *WIRE*
4. *SWITCH*
5. *OR*
6. *PARALLEL*
7. *AND*
8. *LED*

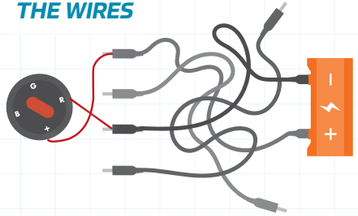
WHAT'S MISSING?



MAZE



UNTANGLE THE WIRES



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