littleBits

PROJECT LESSONS

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BASE KIT

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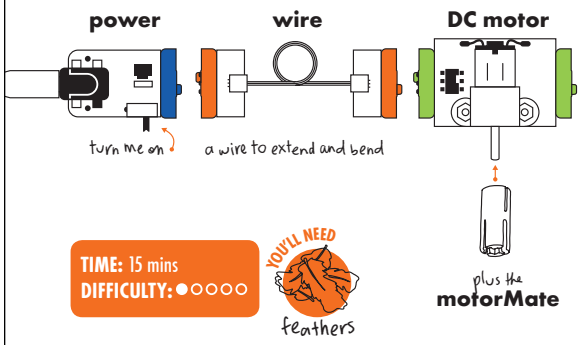
BASE KIT, DELUXE KIT How can electronics help spread laughs?

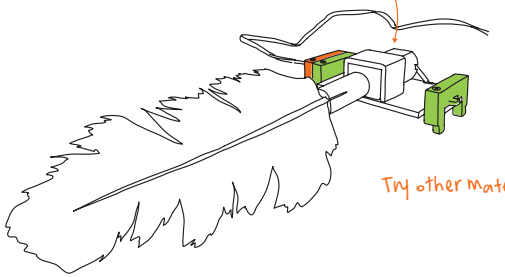
TICKLE MACHINE

1 Start with this circuit



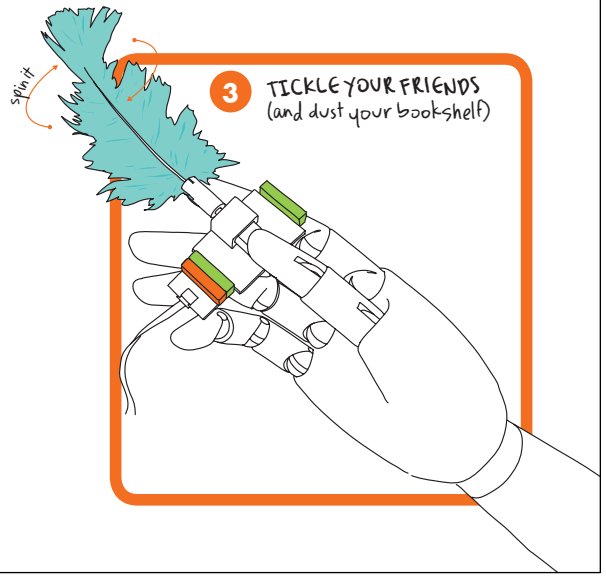
TIME: 15 mins
DIFFICULTY: ●○○○○

2 Attach feathers to the motorMate



Try other materials too!

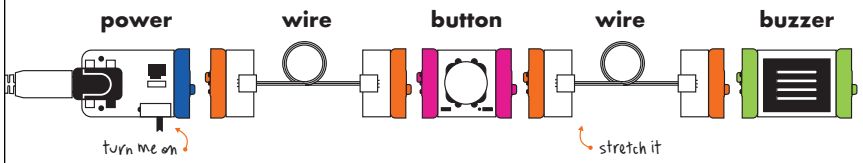
3 TICKLE YOUR FRIENDS (and dust your bookshelf)



BASE KIT, DELUXE KIT Want to trick a friend? We'll show you how!

PRANK HANDSHAKE

1 Start with this circuit



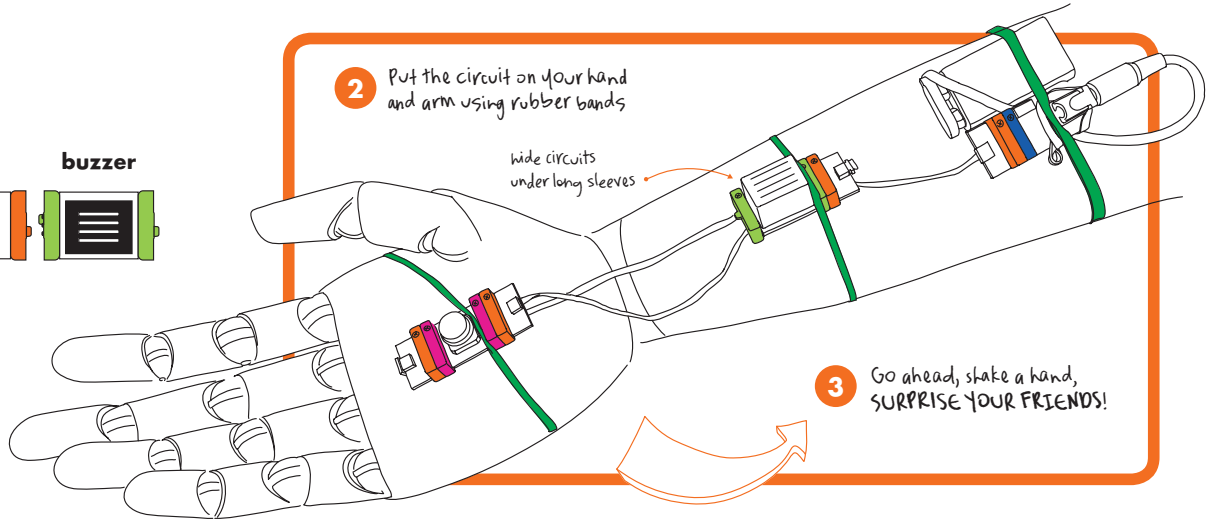
TIME: 15 mins
DIFFICULTY: ●○○○○

YOU'LL NEED

rubber bands

How else can you surprise your friends using modules?

2 Put the circuit on your hand and arm using rubber bands



3 Go ahead, shake a hand, SURPRISE YOUR FRIENDS!

BASE KIT How can you create a light that only turns on at night?

THE NIGHT RIDER

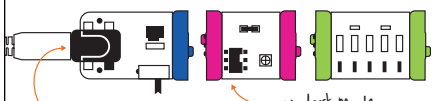
TIME: 30 mins
DIFFICULTY: ●●○○○

YOU'LL NEED

box cutter, rubber bands, plastic cup, bike

STAY SAFE! Always use with an adult.

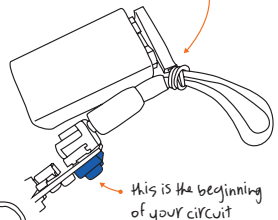
1 Start with this circuit



don't forget to connect your battery to the power module

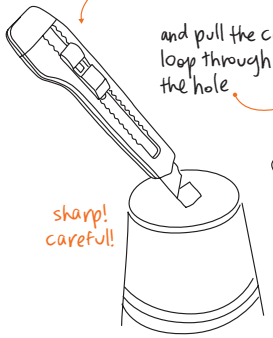
on dark mode, adjust sensitivity

2 Rubber band battery cable in a loop



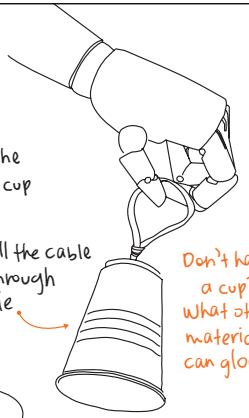
this is the beginning of your circuit (the power module)

3 Cut a hole in the bottom of the cup



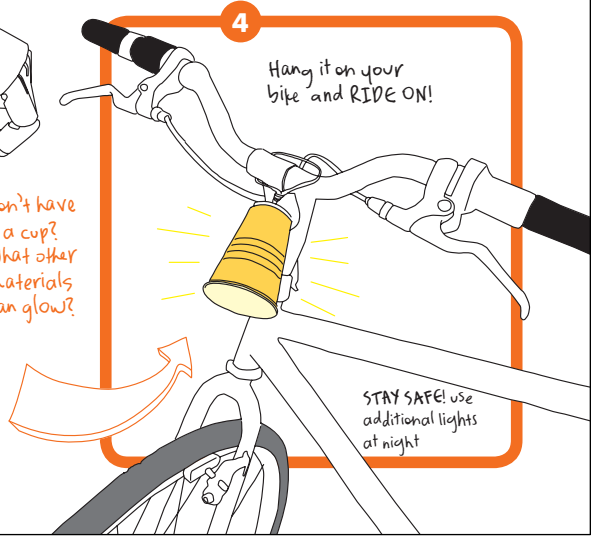
sharp! careful!

and pull the cable loop through the hole



Don't have a cup? What other materials can glow?

4 Hang it on your bike and RIDE ON!

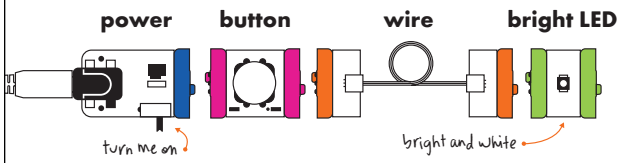


STAY SAFE! use additional lights at night

BASE KIT Illuminate your way with household materials.

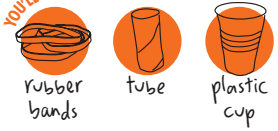
FLASHLIGHT

1 Start with this circuit

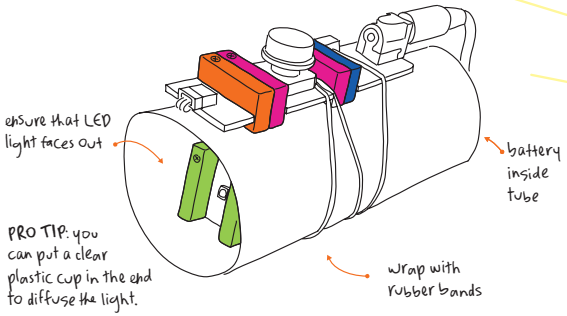


TIME: 30 mins
DIFFICULTY: ●●○○○

YOU'LL NEED



2 Put circuit in tube



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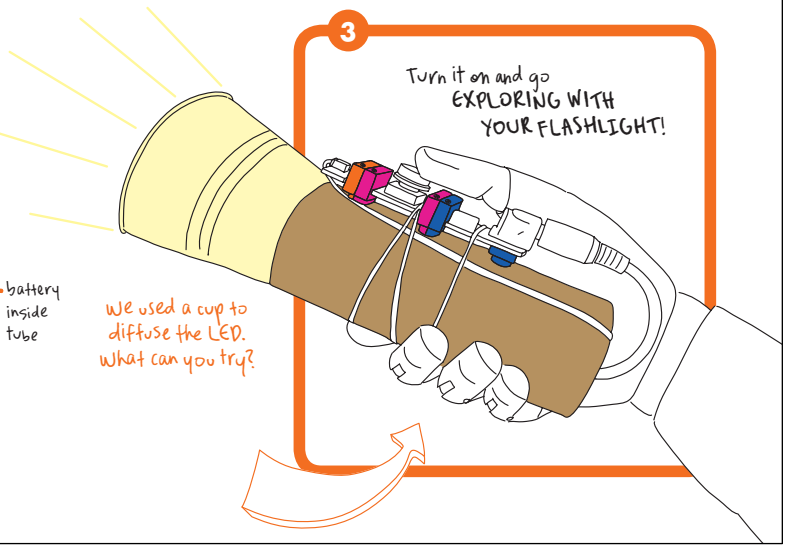


BASE KIT, DELUXE KIT How can you build a device to draw

ART BOT

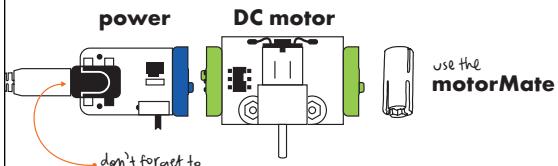
TIME: 30 mins
DIFFICULTY: ●●○○○

YOU'LL NEED

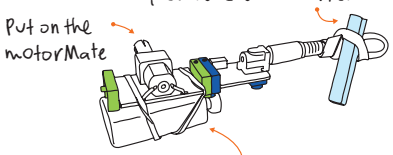
marker, charcoal, rubber bands, LEGO™ axle, wheel

any kind of marking device is fine

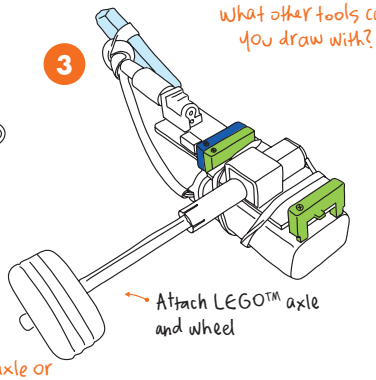
1 Start with this circuit



2 Rubber band together battery cable and insert your charcoal or marker

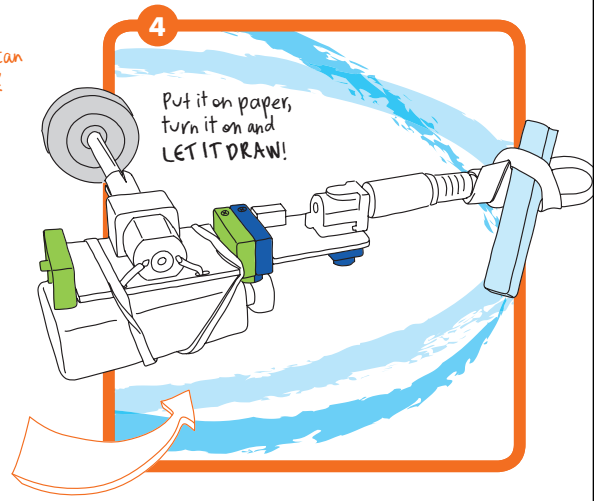


3 What other tools can you draw with?



Don't have an axle or wheel? Make one!

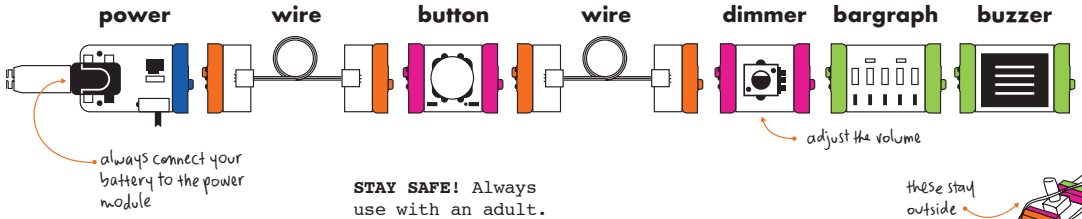
4 Put it on paper, turn it on and LET IT DRAW!



BASE KIT Deck out your bedroom door.

DOORBELL

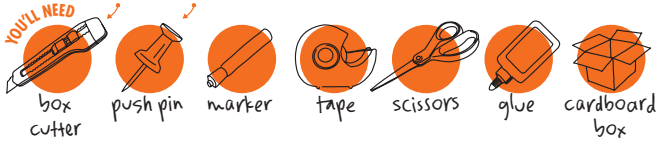
1 Start with this circuit



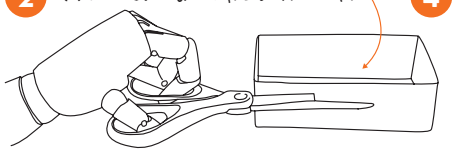
TIME: 60 mins
DIFFICULTY: ●●●○○

YOU'LL NEED

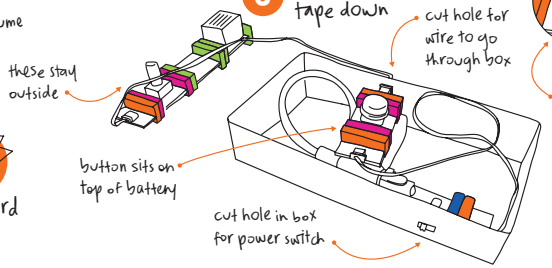
STAY SAFE! Always use with an adult.



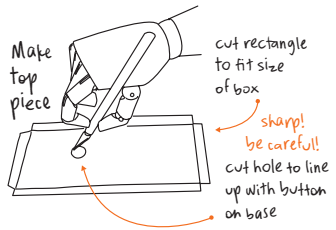
2 Find a box and cut the bottom off



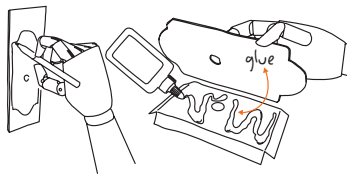
3 Place modules in box and tape down



4 Make top piece



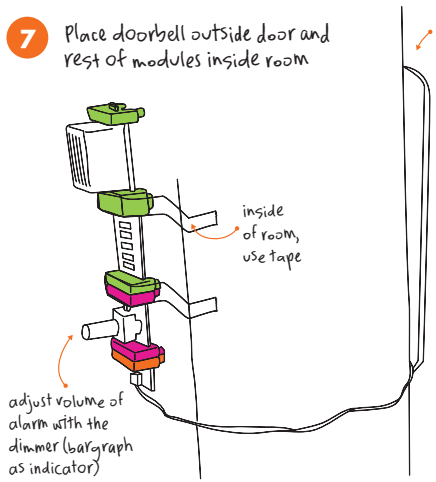
5 Cut out decorative doorbell shape and glue to top piece

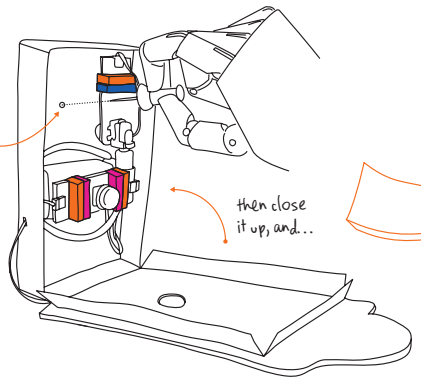


PRO TIP: you can disconnect the connector to feed through small holes. Don't forget to reconnect it!

6

7 Place doorbell outside door and rest of modules inside room





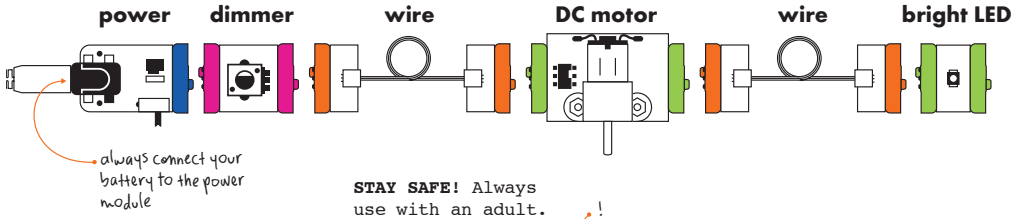
8

BASE KIT Make your own spinning windmill.

LIL' BREEZY

TIME: 90 mins
DIFFICULTY: ●●●○○

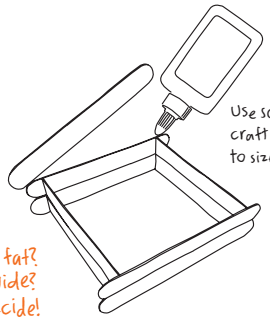
1 Start with this circuit



STAY SAFE! Always use with an adult.

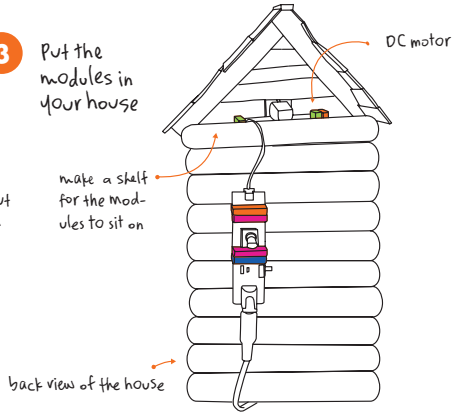
YOU'LL NEED

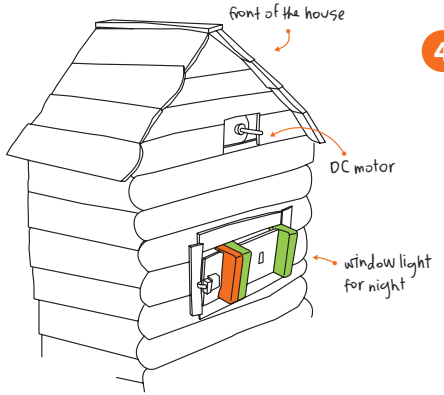
2 Make a house out of craft sticks



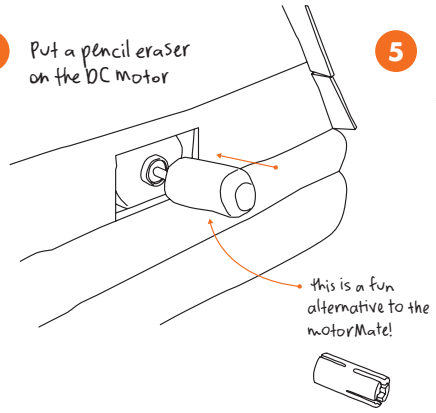
short? fat? tall? wide? you decide!

3 Put the modules in your house

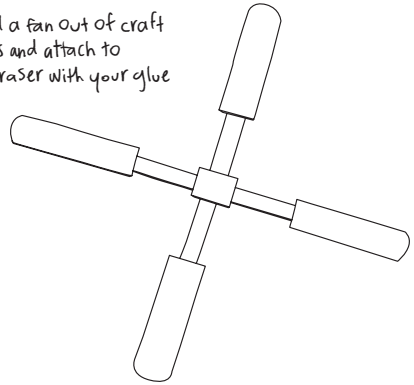




4 Put a pencil eraser on the DC motor



5 Build a fan out of craft sticks and attach to the eraser with your glue



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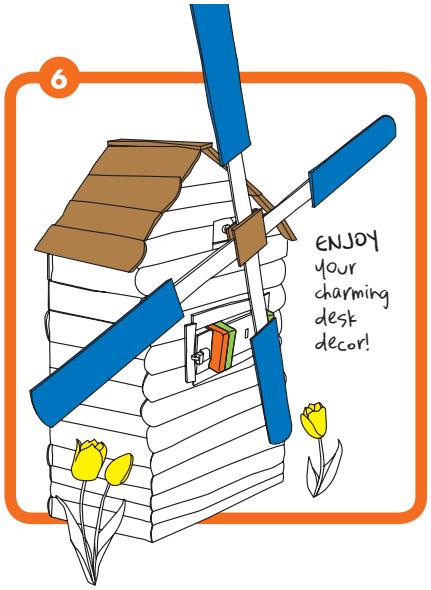
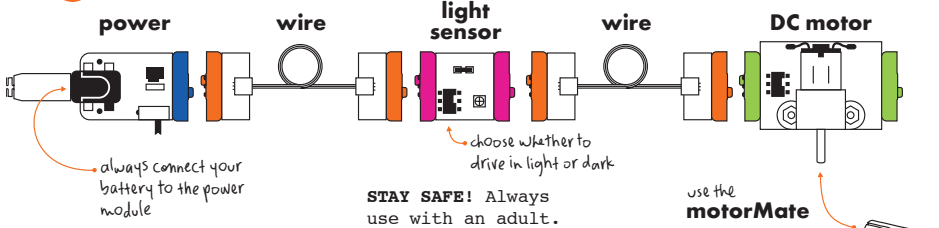


BASE KIT Learn how to make a light-controlled vehicle.

THREE WHEELER

See this tutorial with video extras at **littleBits.cc/base**

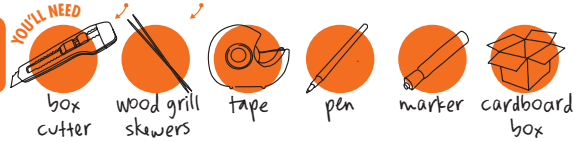
1 Start with this circuit



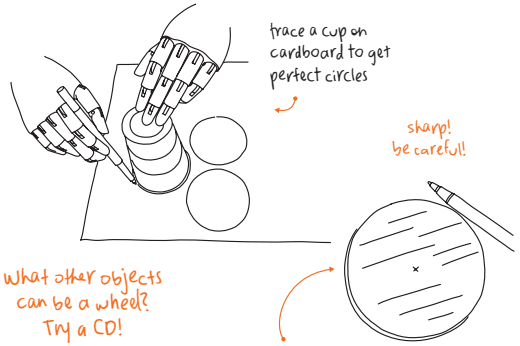
TIME: 90 mins
DIFFICULTY: ●●●●○

STAY SAFE! Always use with an adult.

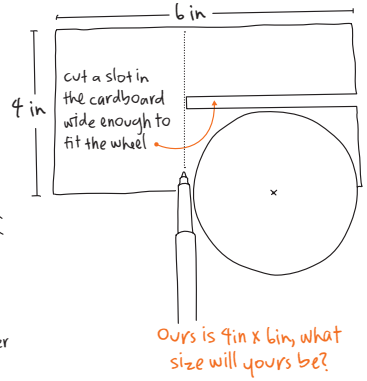
YOU'LL NEED



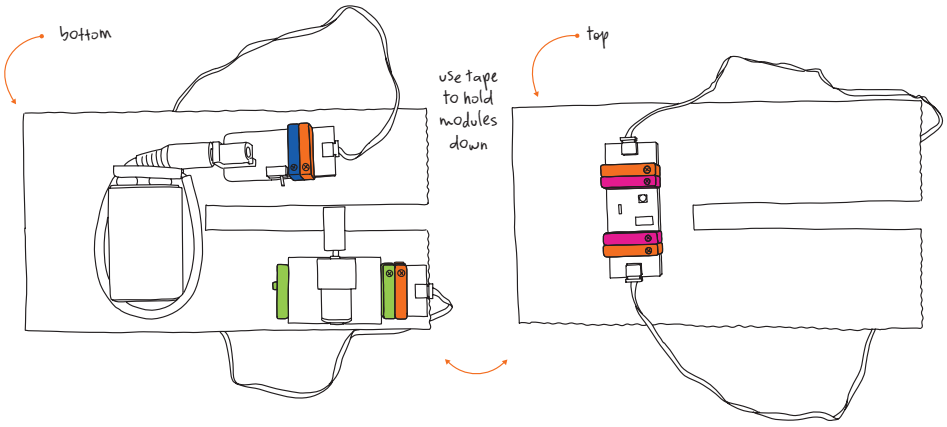
2 Make 3 wheels



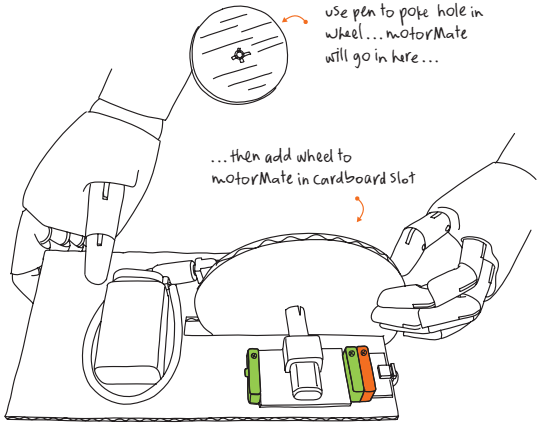
3 Make the base out of cardboard



4 Put modules on cardboard base



5 Add wheel to motorMate



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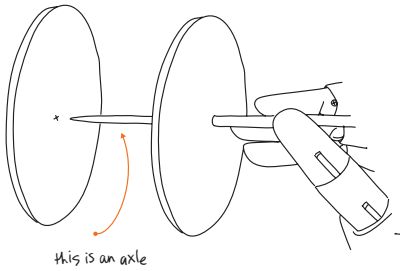
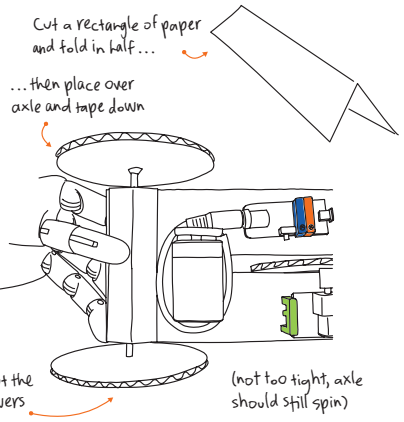
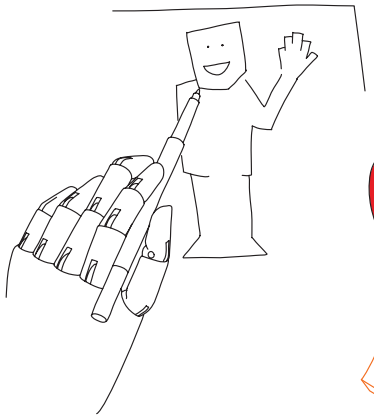
6 Poke skewer through two remaining wheels and glue them in place, these will be the back two wheels



7 Attach back wheels



8 Draw yourself and cut the figure out



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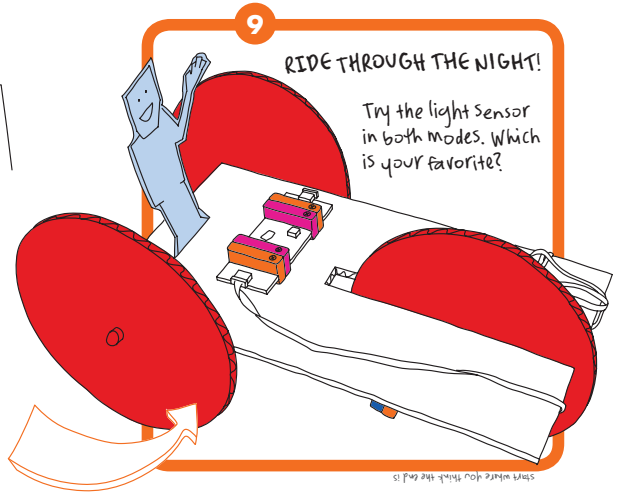

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PREMIUM KIT

Cooling Campfire
Hypnotizing Wheel
Auto Greeter
Truck Crane
Funny Face
Drawer Alarm
Box Monster
Bristole Bot
Bubble Flute
Playful Pet

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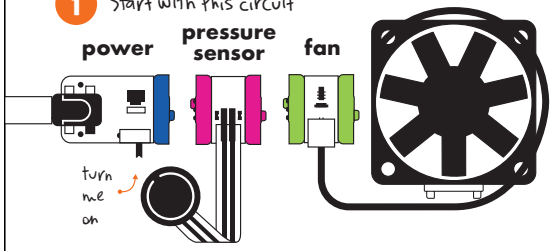
PREMIUM KIT Cool down and camp out.

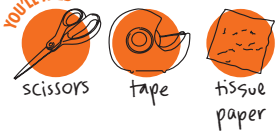
COOLING CAMPFIRE

1 Start with this circuit



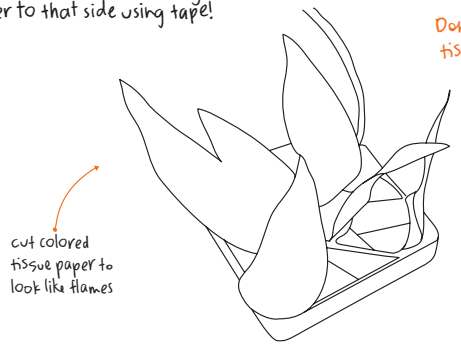
TIME: 30 mins
DIFFICULTY: ●●○○○

YOU'LL NEED



2 Feel which end air is coming out from, and attach tissue paper to that side using tape!

Don't have any? Try tissues or feathers



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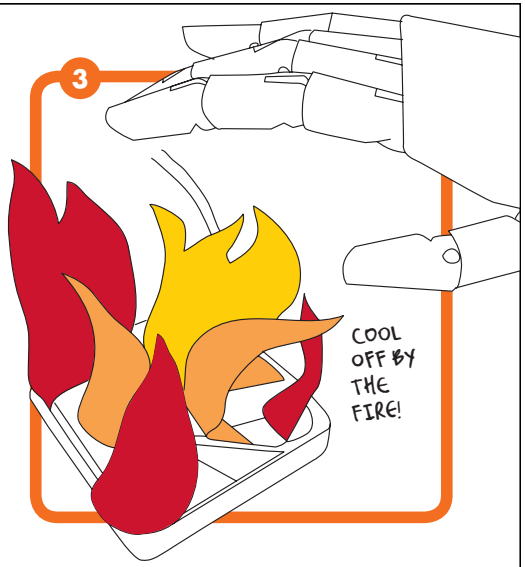
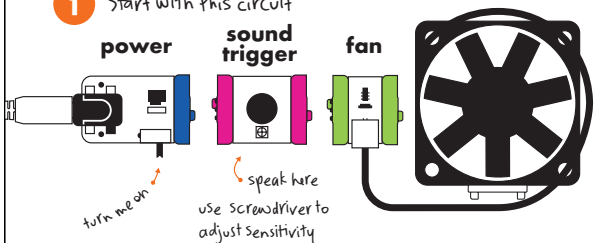


PREMIUM KIT Create a simple machine to hypnotize your friends!

HYPNOTIZING WHEEL

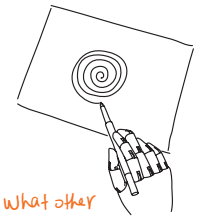
1 Start with this circuit



TIME: 15 mins
DIFFICULTY: ●○○○○

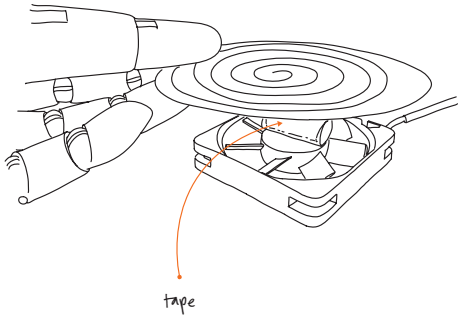
YOU'LL NEED

2 Draw a hypno circle on paper and then cut it out

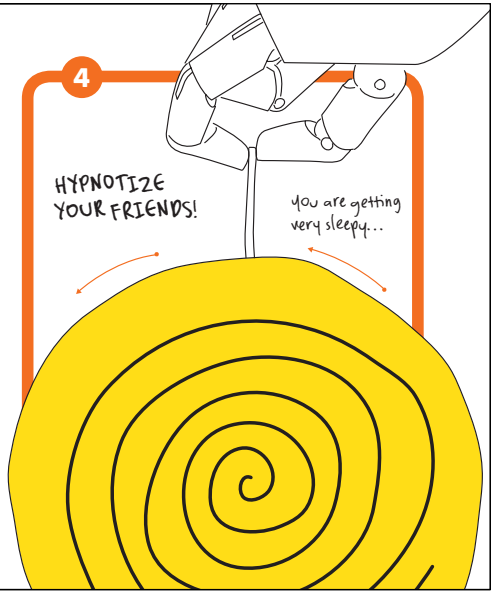


What other patterns do you find mesmerizing?

3 Attach paper wheel to fan with tape (on the fan piece that spins)



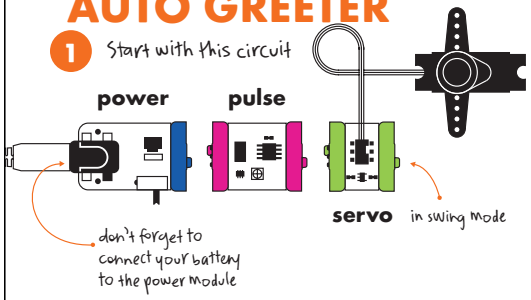
4



PREMIUM KIT, DELUXE KIT How can you use a servo to imitate a human wave?

AUTO GREETER

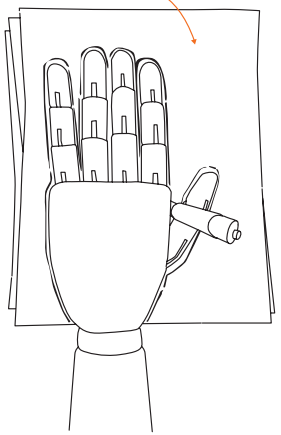
1 Start with this circuit



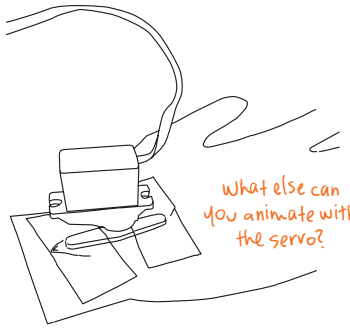
TIME: 15 mins
DIFFICULTY: ●○○○○

YOU'LL NEED

2 Trace hand on paper and cut it out



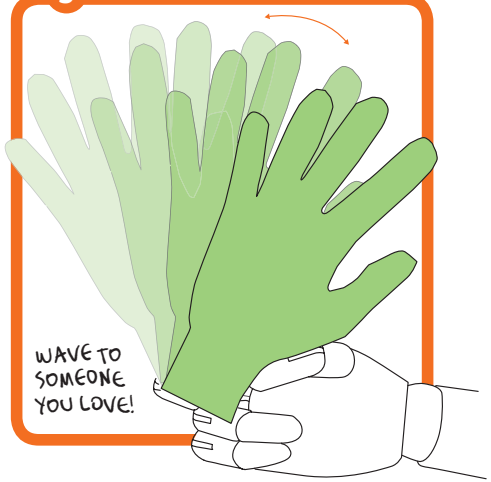
3 Tape paper hand to servo



4 Use screwdriver to adjust pulse if you want to wave faster or slower

What else can you animate with the servo?

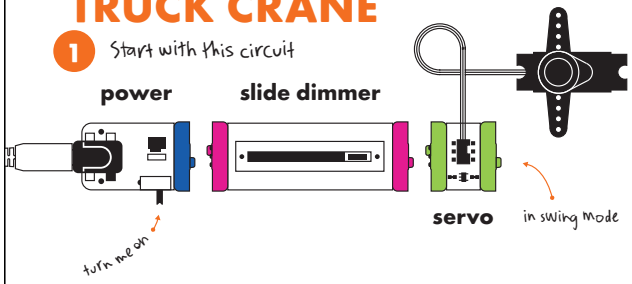
5



PREMIUM KIT, DELUXE KIT How can you use a servo to pick things up?

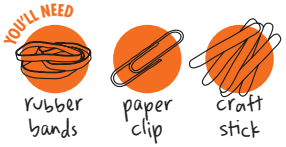
TRUCK CRANE

1 Start with this circuit

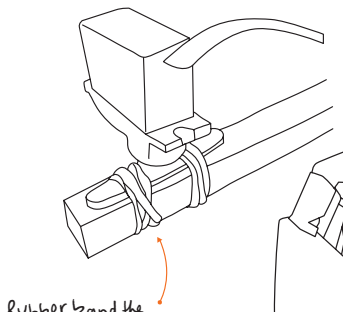


TIME: 30 mins
DIFFICULTY: ●●○○○

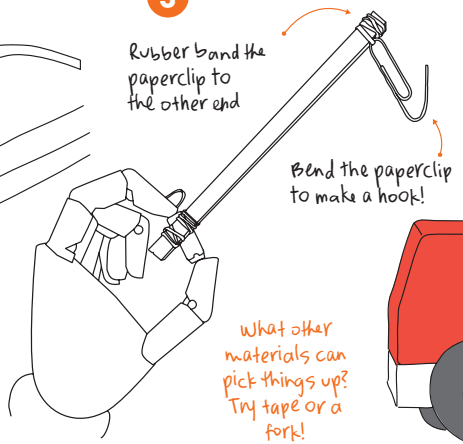
YOU'LL NEED



2



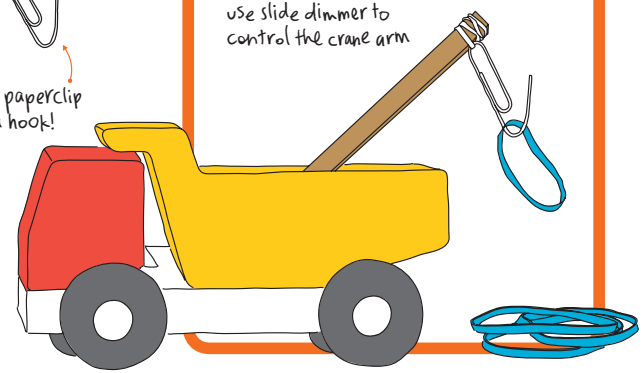
3



4

PICK THINGS UP!

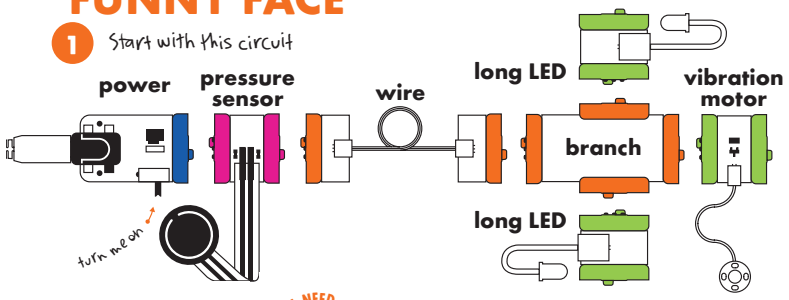
use slide dimmer to control the crane arm



PREMIUM KIT Make someone smile with this silly project.

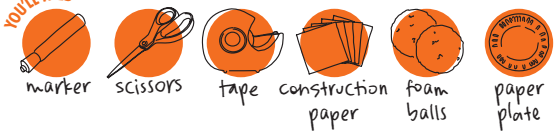
FUNNY FACE

1 Start with this circuit

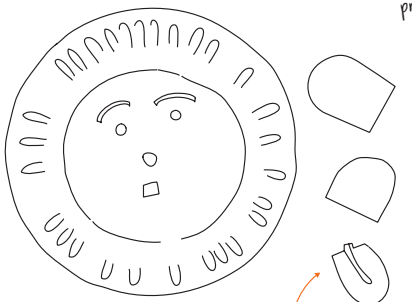


TIME: 30 mins
DIFFICULTY: ●●○○○

YOU'LL NEED

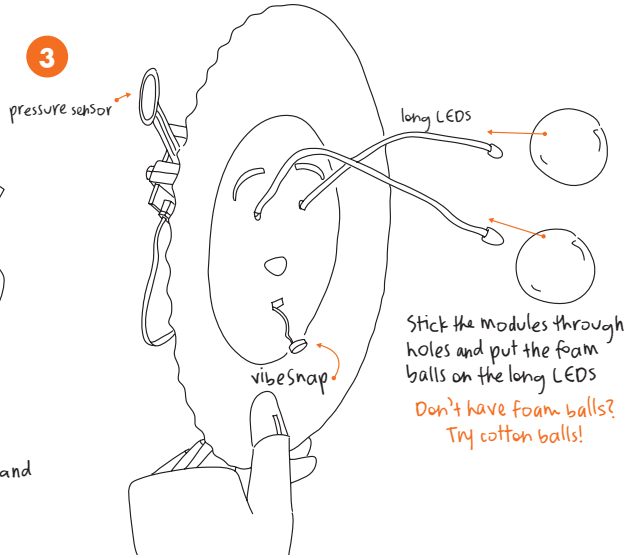


2 Draw a face on the plate and cut out holes for eyes and mouth

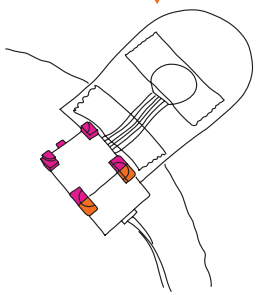


Draw ears and tongue on paper and then cut them out

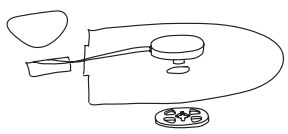
3



4 Tape ear to pressure sensor on the back of the plate

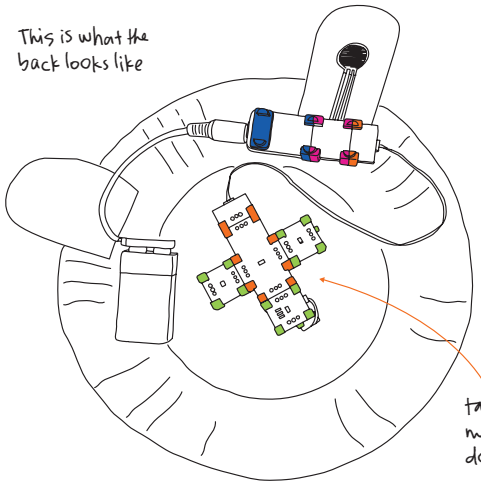


See this tutorial with video extras at **littleBits.cc/premium**



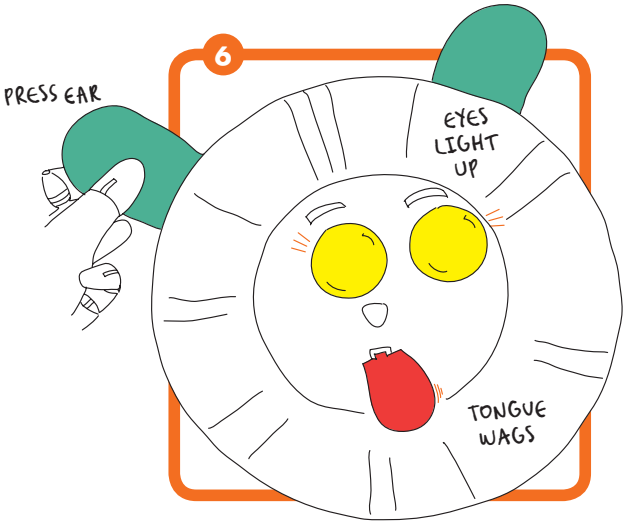
use vibeSnap to attach the tongue

5 This is what the back looks like



tape modules down

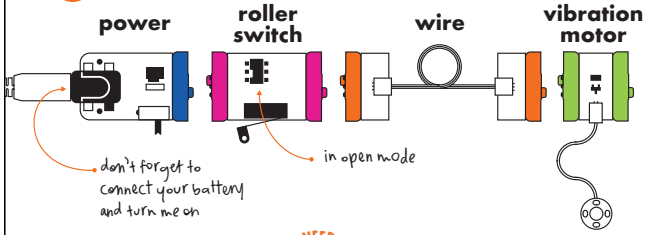
6



PREMIUM KIT How can you design a system to prevent someone from going through your things?

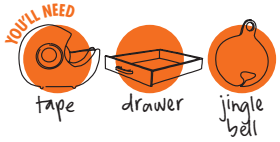
DRAWER ALARM

1 Start with this circuit



TIME: 30 mins
DIFFICULTY: ●●○○○

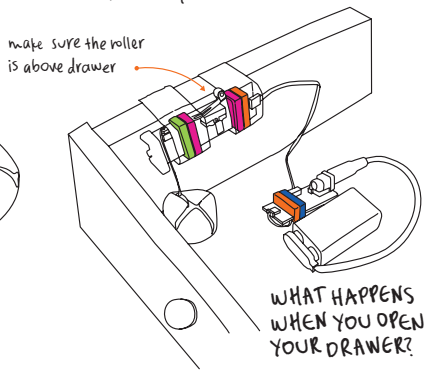
YOU'LL NEED



2 Insert the vibration motor into the jingle bell

What other material would make a loud noise?

3 Tape the circuit to the inside of your drawer

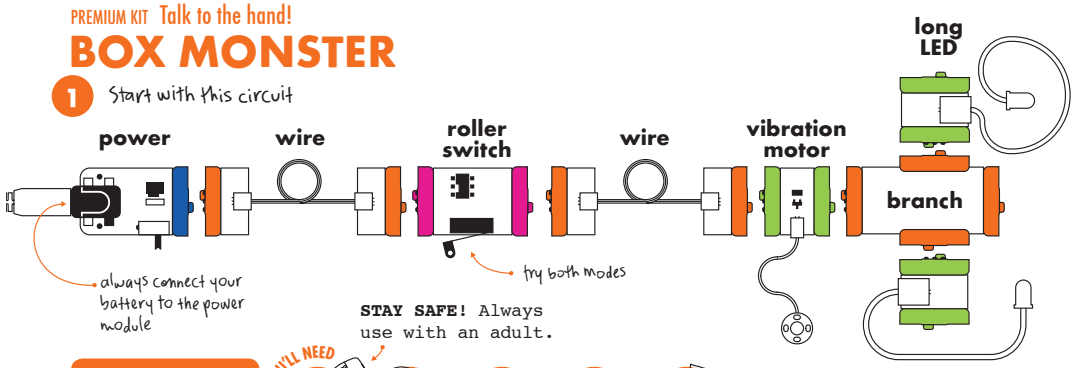


4 PROTECT YOUR THINGS!

PREMIUM KIT Talk to the hand!

BOX MONSTER

1 Start with this circuit

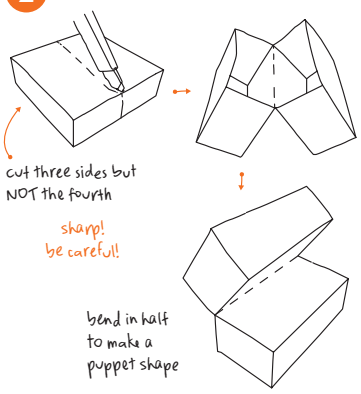


STAY SAFE! Always use with an adult.

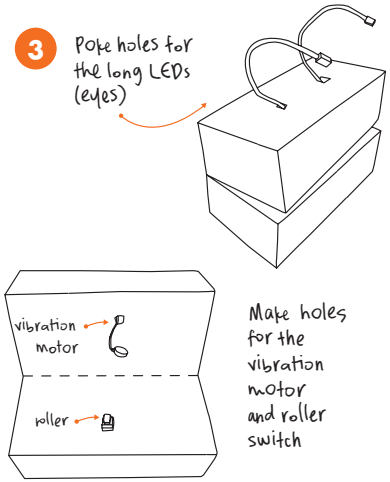
TIME: 60 mins
DIFFICULTY: ●●●○○

YOU'LL NEED

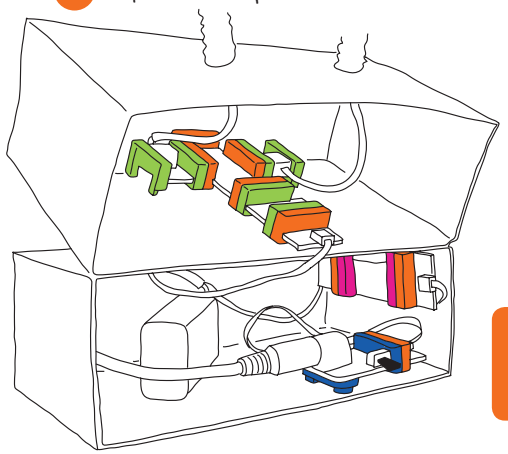
2 Find a box and cut it in half



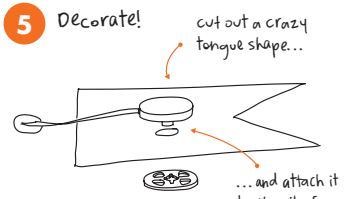
3 Poke holes for the long LEDs (eyes)



4 Tape modules in place inside the box

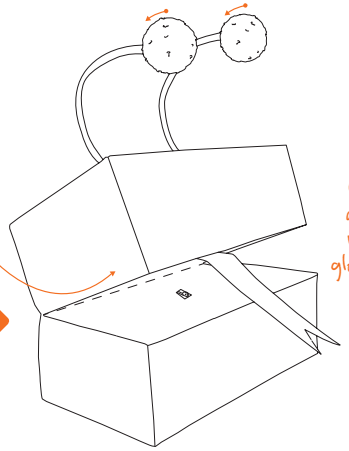


5 Decorate!



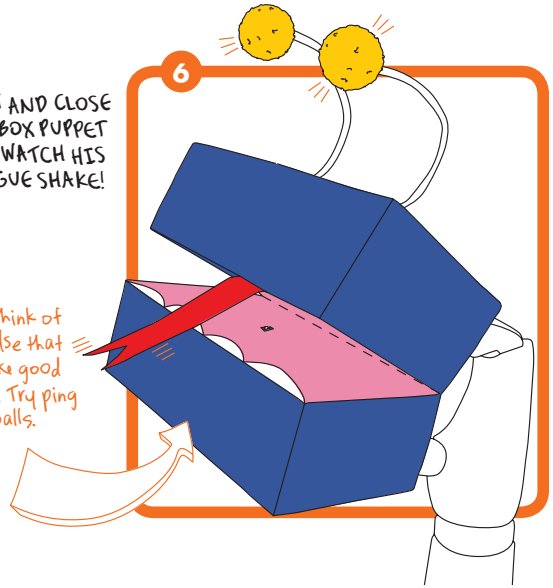
use markers, paint, glitter, colored paper and anything else you can think of to make your monster uniquely yours!

Got some cool colors or decorating techniques? We want to see your Box Monster! Upload it here **littleBits.cc/upload**



6 OPEN AND CLOSE THE BOX PUPPET AND WATCH HIS TONGUE SHAKE!

Can you think of anything else that would make good glowy eyes? Try ping pong balls.



PREMIUM KIT How can you make a robot from a toothbrush?

BRISTLE BOT

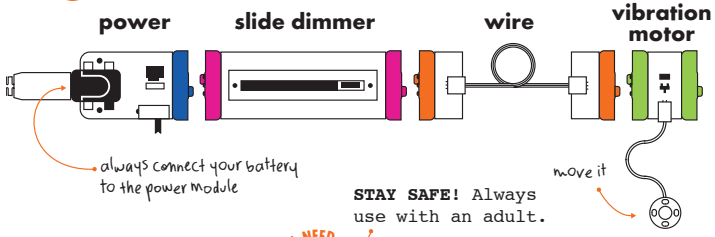
TIME: 60 mins
DIFFICULTY: ●●●○○

YOU'LL NEED

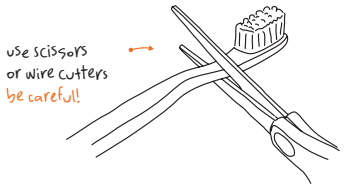
box cutter, marker, tape, glue, scissors, rubber bands, fuzzy balls, cardboard, tooth-brush, pipe cleaners

STAY SAFE! Always use with an adult.

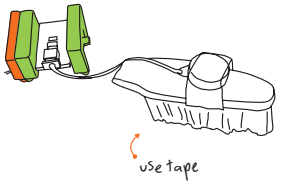
1 Start with this circuit



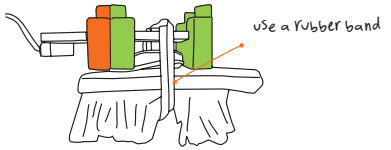
2 Have an adult cut the head off a toothbrush



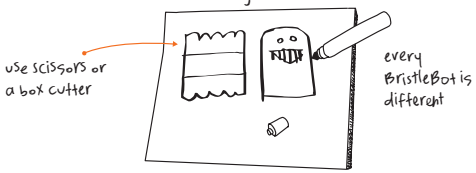
3 Attach the vibration motor to the back side of the bristles



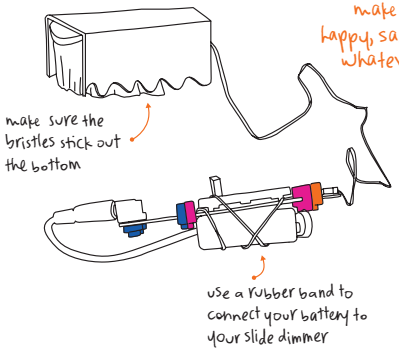
4 Now, attach the bristles to the actual vibration module



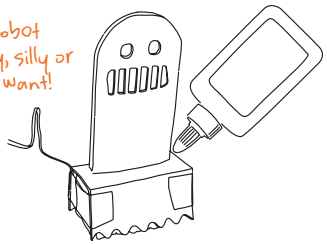
5 Draw and cut out your BristleBot design



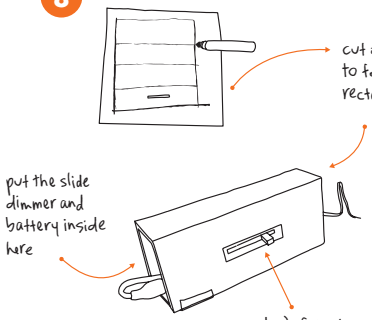
6 Wrap the cardboard base around the bristles and glue or tape in place



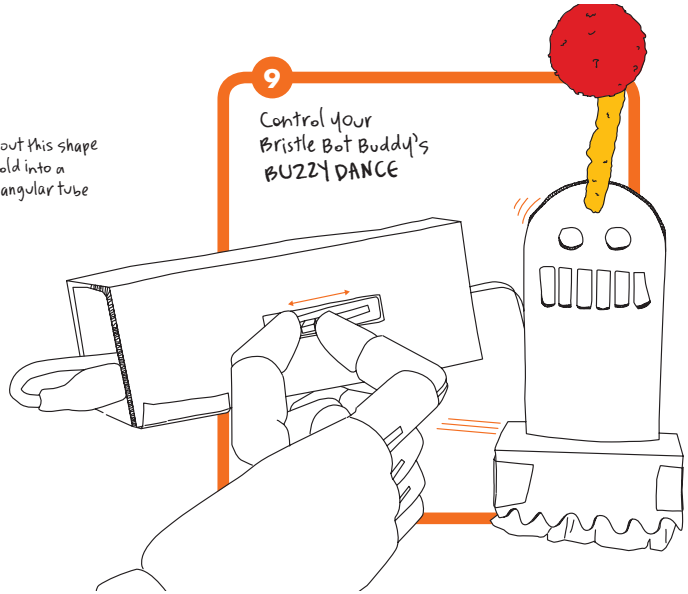
7 Glue the body to the base



8 Make a control box



9 Control your Bristle Bot Buddy's BUZZY DANCE



PREMIUM KIT Create bubbles with the sound of your voice.

BUBBLE FLUTE

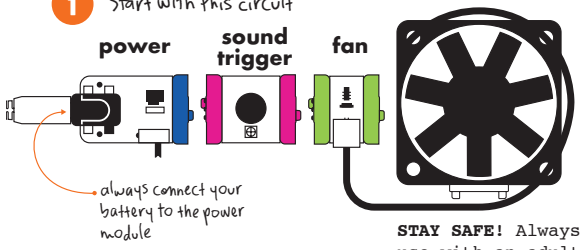
TIME: 60 mins
DIFFICULTY: ●●●○○

YOU'LL NEED

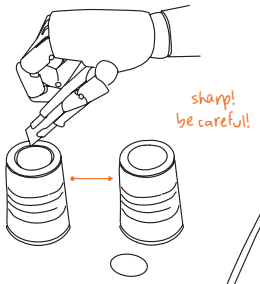
box cutter, duct tape, rubber bands, bubble solution, plastic cup, ruler

STAY SAFE! Always use with an adult.

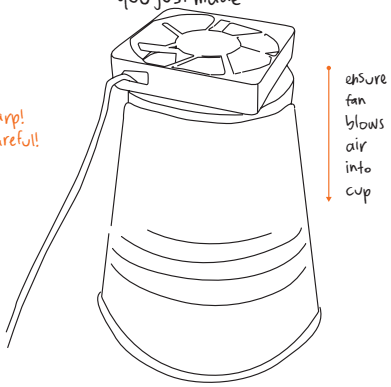
1 Start with this circuit



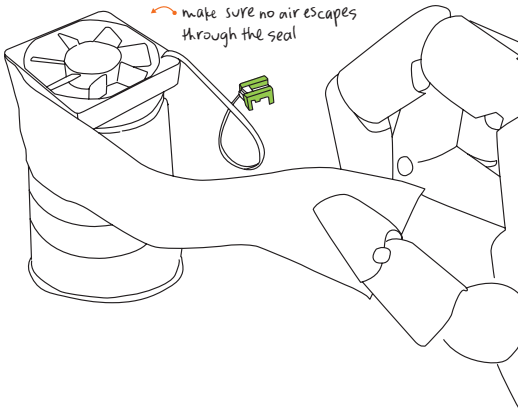
2 Cut a hole in the bottom of the cup



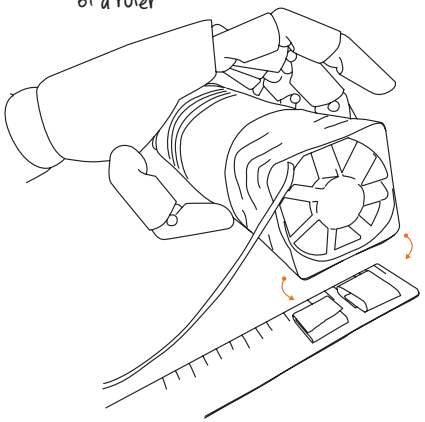
3 Place fan on the hole you just made



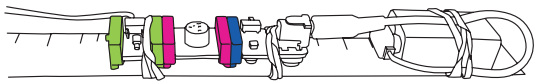
4 Tape in place



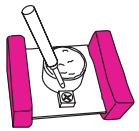
5 Tape to the end of a ruler



6 Connect modules to other end of the ruler with rubber bands



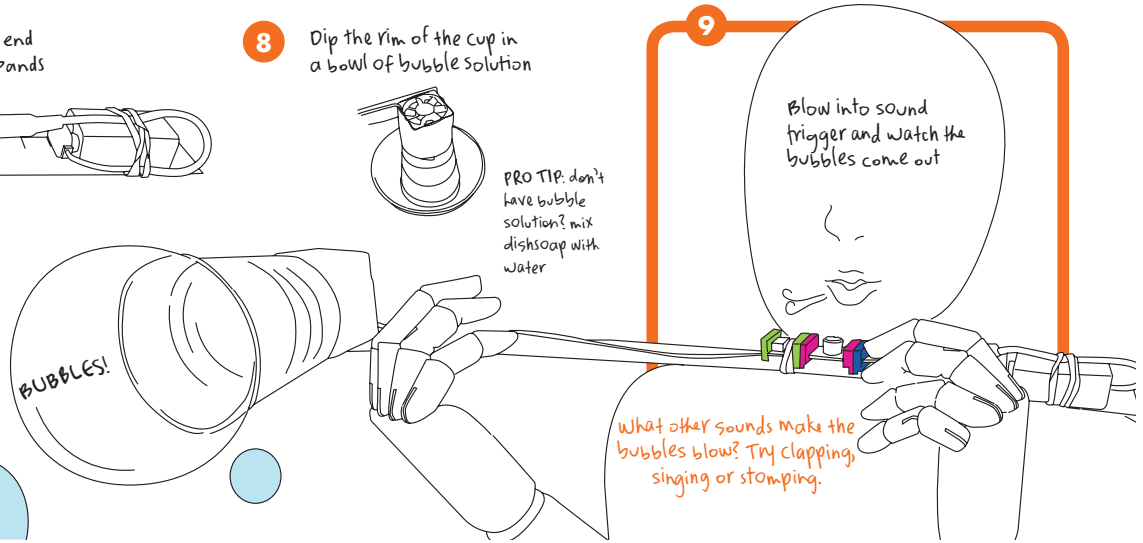
7 Use the screwdriver to adjust the sensitivity of the sound trigger to your liking



8 Dip the rim of the cup in a bowl of bubble solution

PRO TIP: don't have bubble solution? mix dishsoap with water

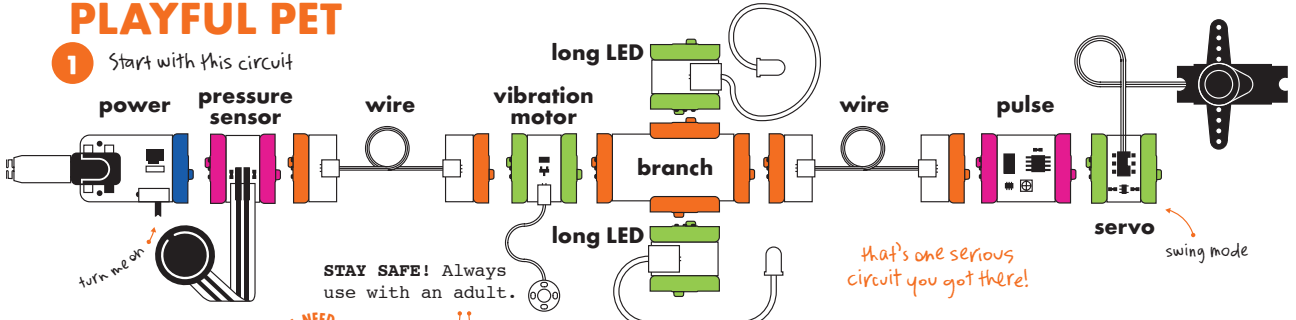
9



PREMIUM KIT How can you use modules to create your own interactive friend?

PLAYFUL PET

1 Start with this circuit

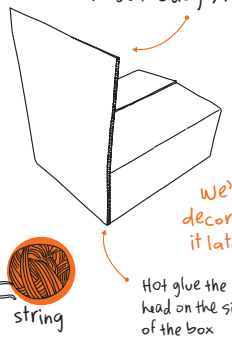


TIME: 2.5 hrs
DIFFICULTY: ●●●●○

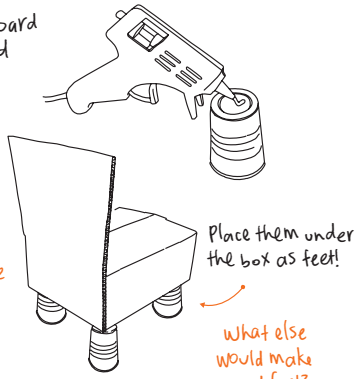
YOU'LL NEED

2 Find a box to be the dog's body

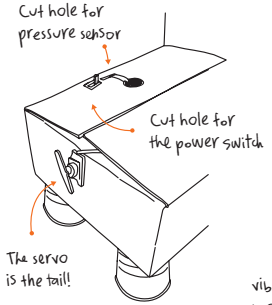
3 Cut piece of cardboard to be the dog's head



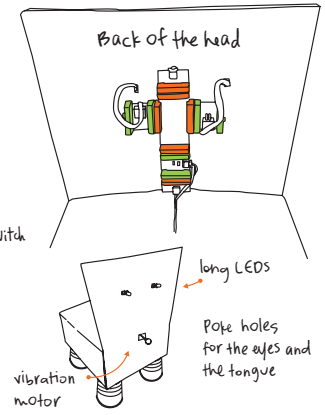
4 Put hot glue on the top of 4 cups



5 Insert modules into the dog's body

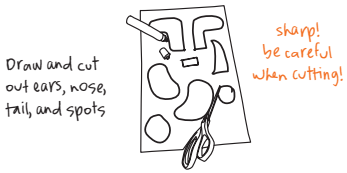


The behind

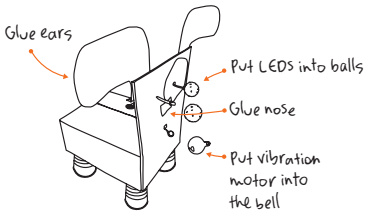


Front of the head

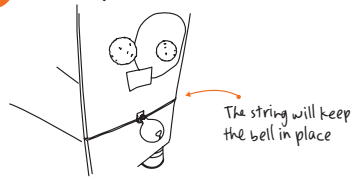
6 Decorate your dog!



7 Add foam balls and bell

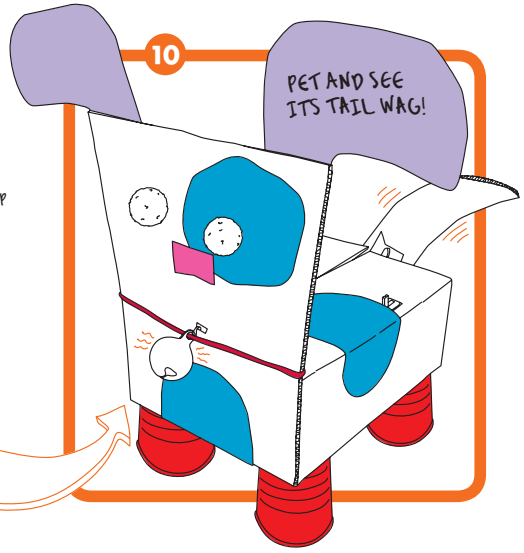


8 Tie string with bell around neck



9 Add spot of paper over pressure sensor and add tail

10



littleBits

DELUXE KIT

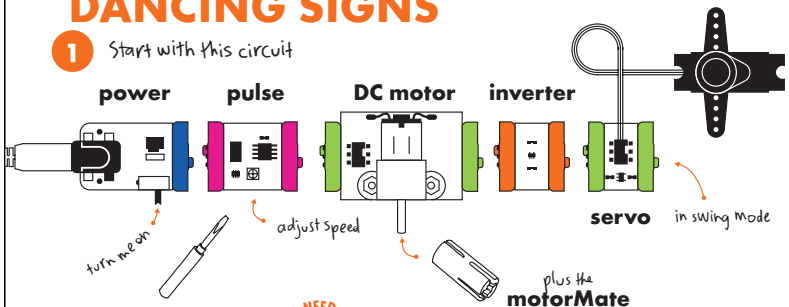
Tickle Machine
Prank Hand
Auto Greeter
Truck Crane
Art Bot
Dancing Signs
Glowing Handlebars
Birthday Candle
Stomping Shoes
Surprise Party
Flickering Lantern
Cat Nap
Unihorn Helmet
Honking Tricycle
Robot

littleBits.cc/projects

DELUXE KIT How can you use the inverter to activate two different and opposite motions?

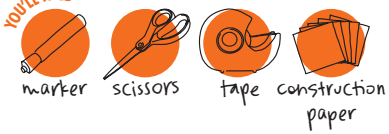
DANCING SIGNS

1 Start with this circuit



TIME: 30 mins
DIFFICULTY: ●●○○○

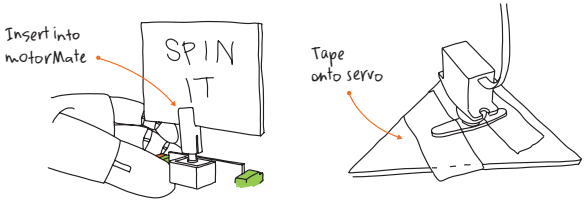
YOU'LL NEED



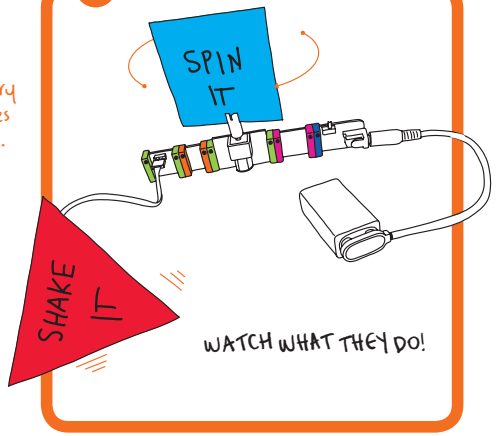
2 Make 2 signs out of paper

Get creative! Try different shapes or characters.

3 Attach the signs to the modules



4



DELUXE KIT How can you brighten up your bike for night rides?

GLOWING HANDLEBARS

TIME: 30 mins
DIFFICULTY: ●●○○○

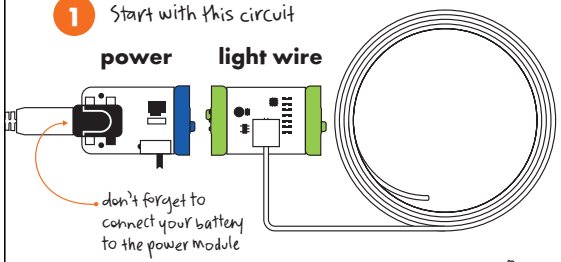
YOU'LL NEED


rubber bands

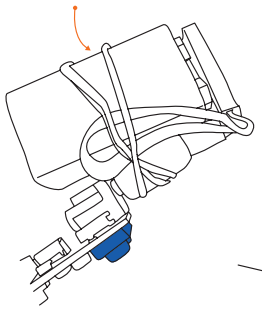

string


bike

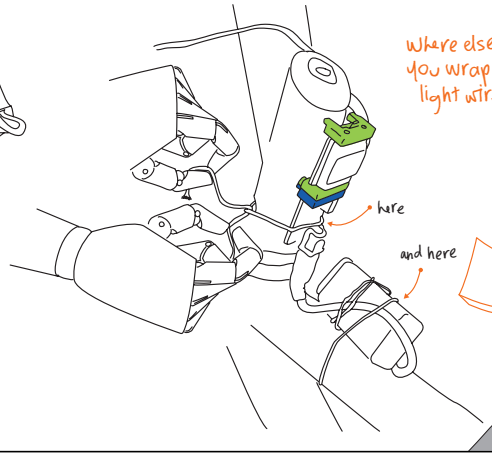
1 Start with this circuit



2 Rubber band battery cable around the battery

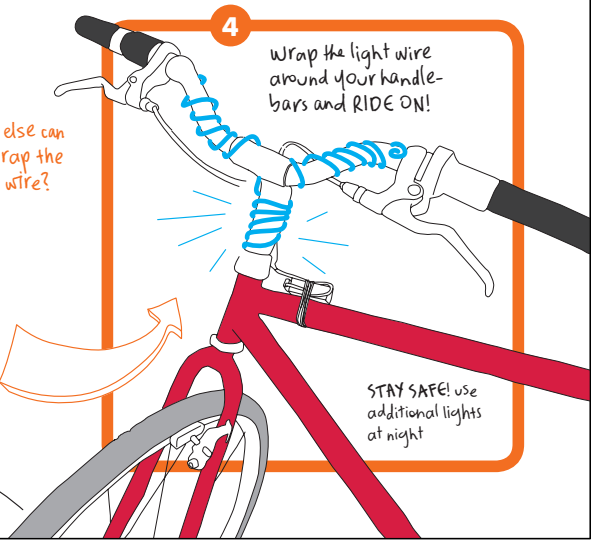


3 Tie the battery and circuit to your front handlebar post with string



Where else can you wrap the light wire?

4 Wrap the light wire around your handlebars and RIDE ON!

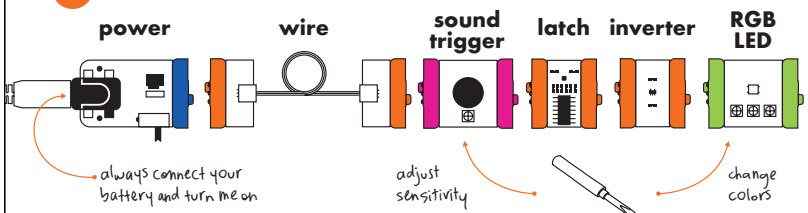


STAY SAFE! use additional lights at night

DELUXE KIT Create an electronic alternative to the classic birthday candle.

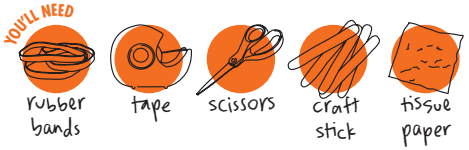
BIRTHDAY CANDLE

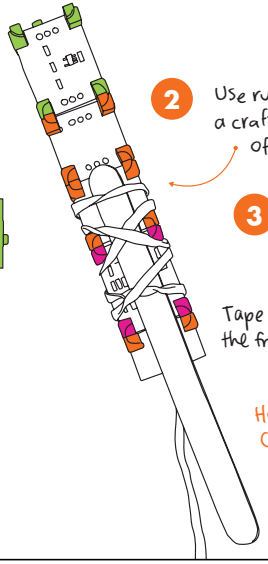
1 Start with this circuit



TIME: 30 mins
DIFFICULTY: ●●○○○

YOU'LL NEED



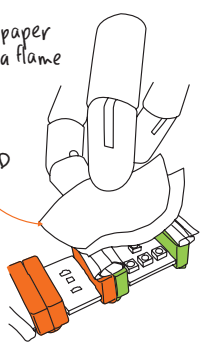


2 Use rubber bands to connect a craft stick to the back of the modules

3 Cut out tissue paper in the shape of a flame

Tape the flame to the front of the RGB LED

How old are you? Create a custom candle shape.



4

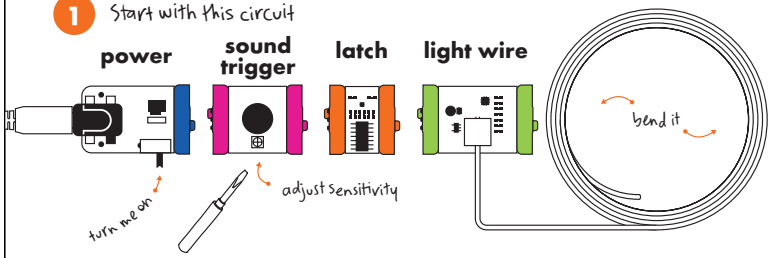
Place the craft stick in a cake...

Blow on the flame to turn it on and off!

DELUXE KIT Going to a dance party? Create a fun accessory!

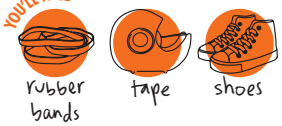
STOMPING SHOES

1 Start with this circuit

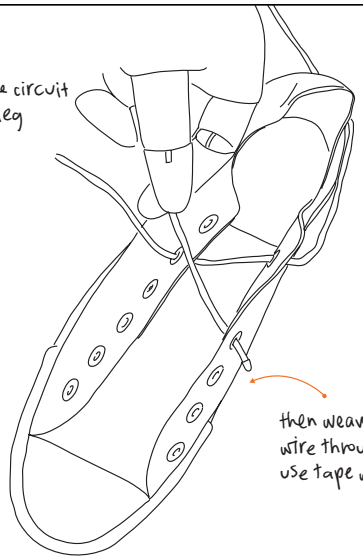


TIME: 60 mins
DIFFICULTY: ●●○○○

YOU'LL NEED



2 Rubber band the circuit to your lower leg



What other clothing can you attach the light wire to?

then weave the light wire through the holes, use tape when needed

3

DELUXE KIT Throwing a surprise party? Use the timeout!

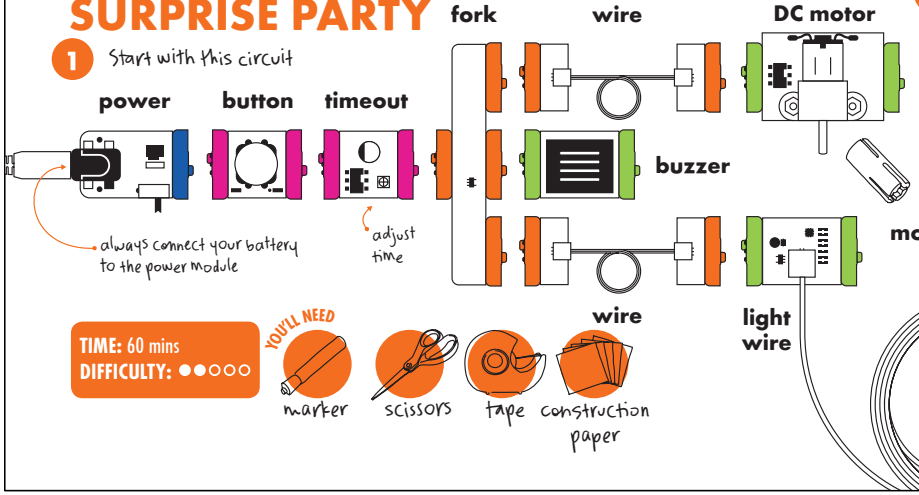
SURPRISE PARTY

TIME: 60 mins
DIFFICULTY: ●●○○○

YOU'LL NEED

marker, scissors, tape, construction paper

1 Start with this circuit



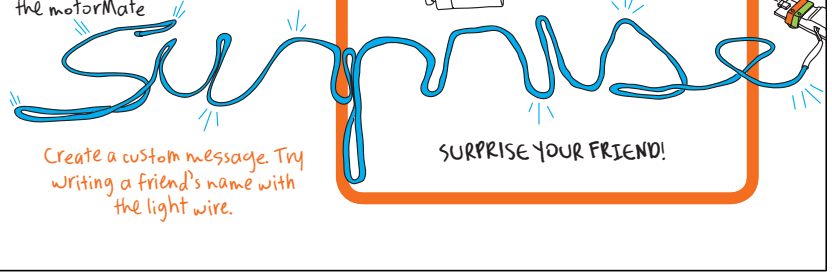
2 Decorate and cut out a sign

plus the **motorMate**

Put sign in the motorMate

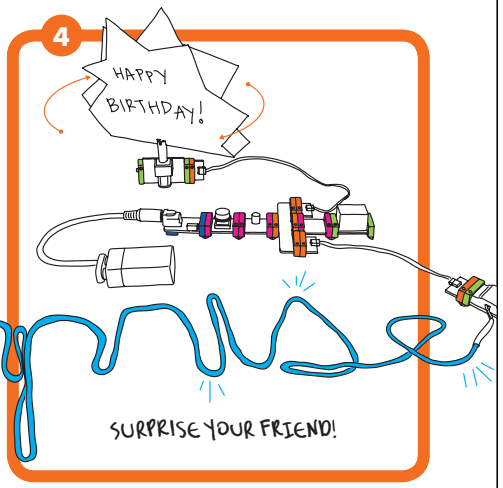
3 Bend light wire into the shape of the message

use tape to keep the shape



Create a custom message. Try writing a friend's name with the light wire.

4



DELUXE KIT How can you use modules to imitate a flame?

FLICKERING LANTERN

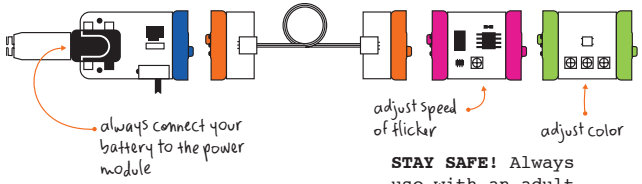
TIME: 60 mins
DIFFICULTY: ●●●○○

YOU'LL NEED

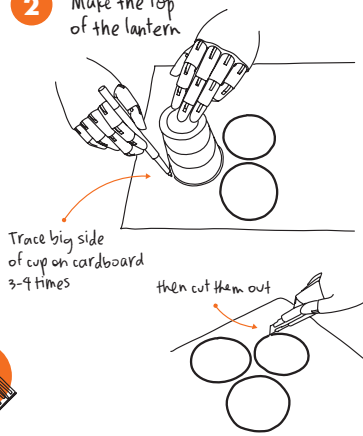
box cutter, glue, cardboard, plastic cup, marker, pipe cleaners

STAY SAFE! Always use with an adult.

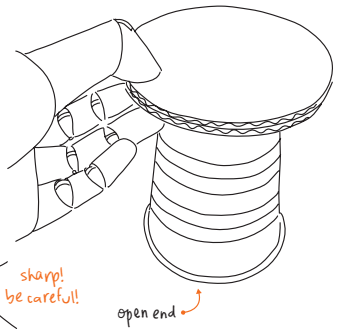
1 Start with this circuit



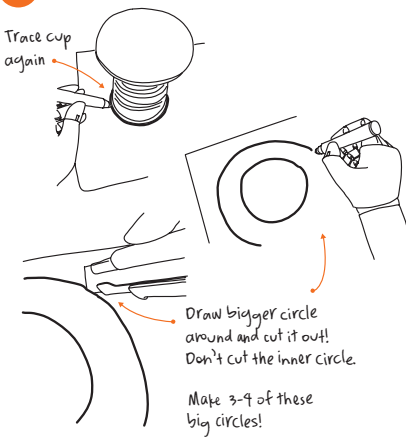
2 Make the top of the lantern



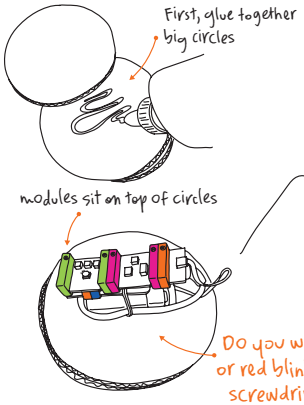
3 Glue circles on top of cup



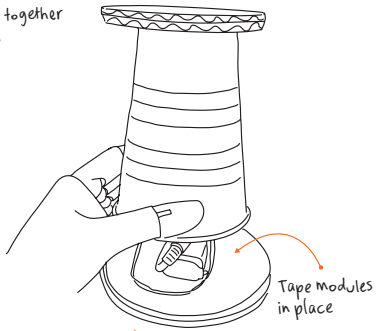
4 Make bottom of lantern



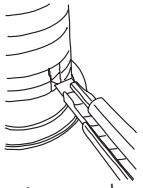
5 Put modules in lantern



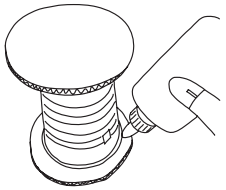
6 Put top of lantern on cardboard base



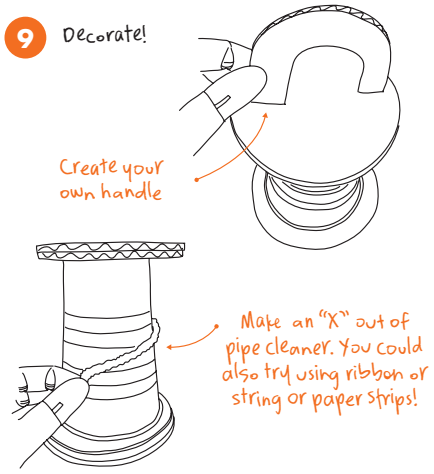
7 Cut hole to reach the power switch



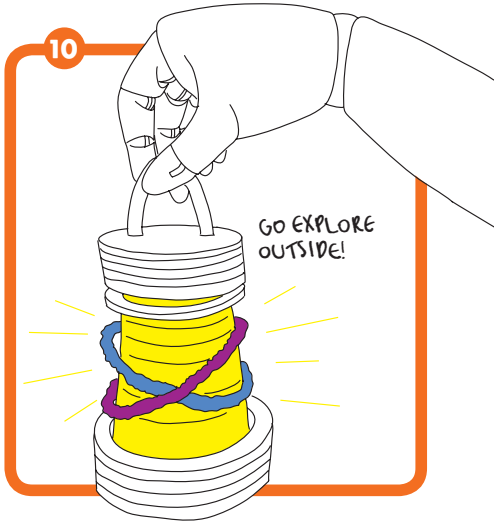
8 Glue or tape cup to base



9 Decorate!



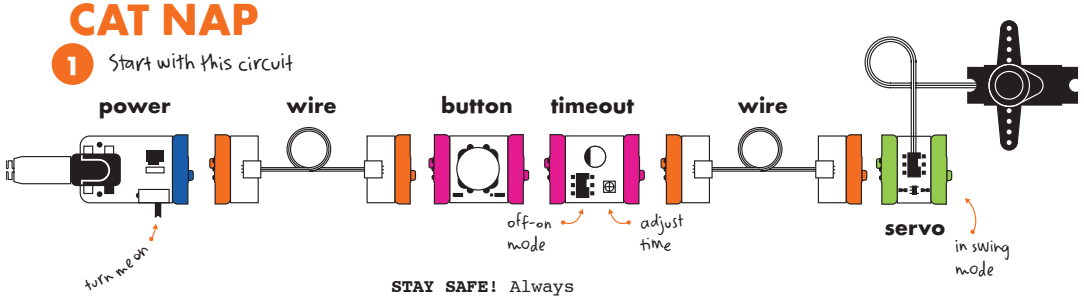
10



DELUXE KIT How can you use modules to create an alarm without sound?

CAT NAP

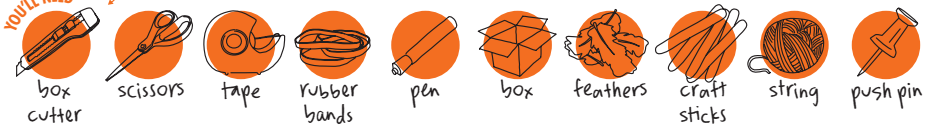
1 Start with this circuit



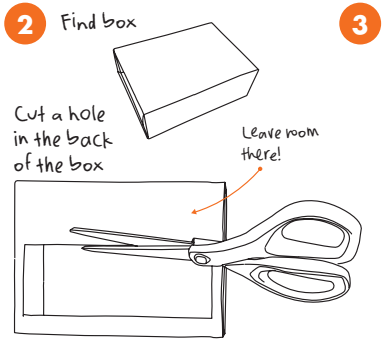
STAY SAFE! Always use with an adult.

TIME: 60 mins
DIFFICULTY: ●●●○○

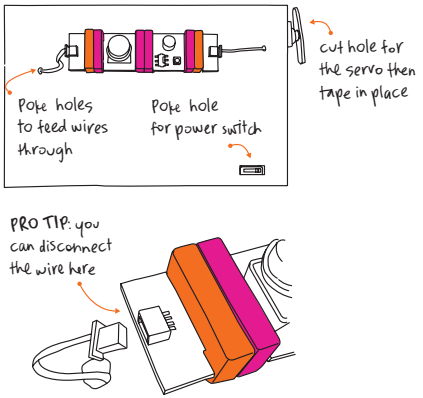
YOU'LL NEED



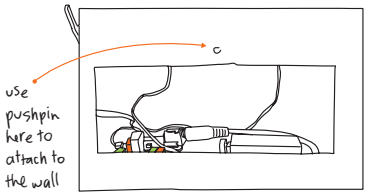
2 Find box



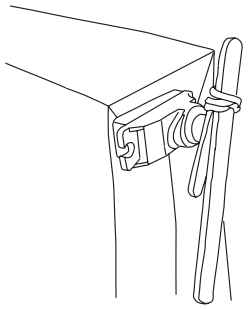
3 Place these modules on the front of the box



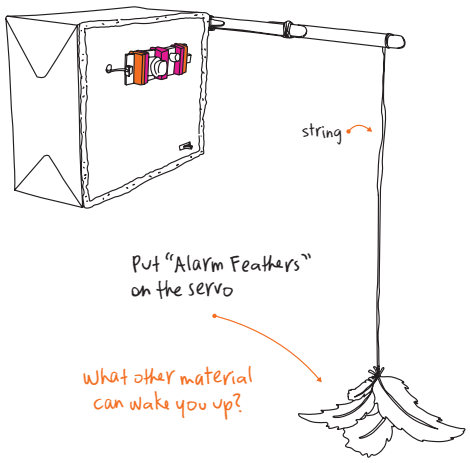
4 Place the other modules inside the back of the box



5 Rubber band the servo to the craft stick



6



7

DELUXE KIT Invent a magical accessory for nighttime bike riding.

UNIHORN HELMET

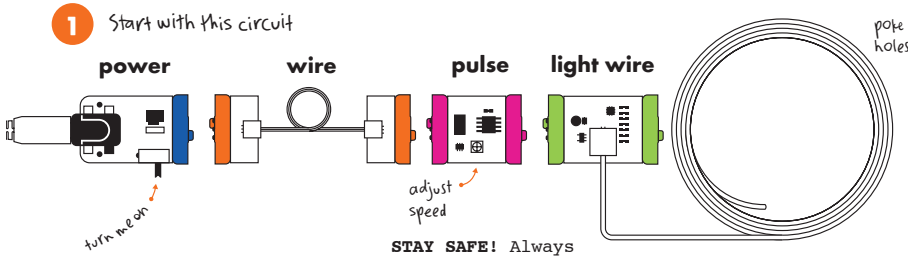
TIME: 2.5 hrs
DIFFICULTY: ●●●●○

YOU'LL NEED

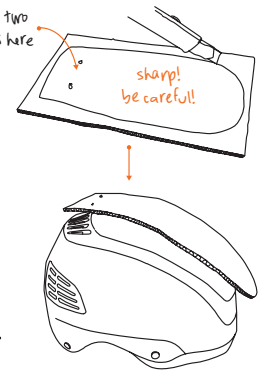
box cutter, tape, bike helmet, cardboard, colored paper, tissue paper, pipe cleaners

STAY SAFE! Always use with an adult.

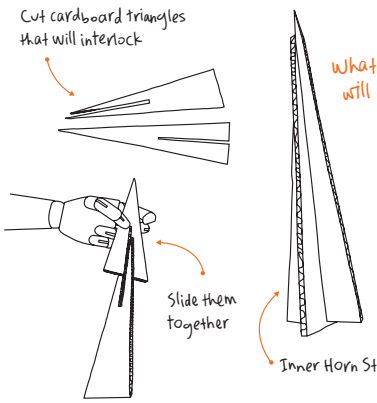
1 Start with this circuit



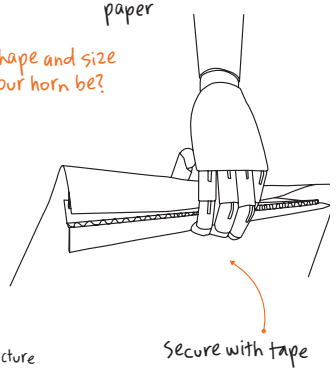
2 Measure and cut a piece of cardboard to fit along the top of your helmet



3 Make the inner horn structure

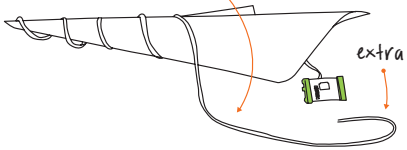


4 Roll the inner horn structure in colored paper

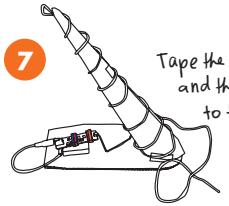


5 Feed light wire up through the base of the horn and out through the top

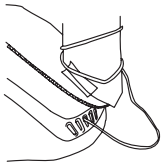
6 Wrap the light wire down and around the horn, leave some extra at the end



7 Tape the base of the horn and the rest of the modules to the cardboard

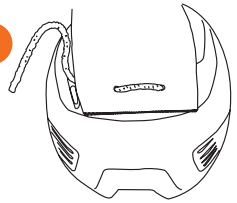


8 Use the excess light wire to secure the cardboard to the helmet at the front

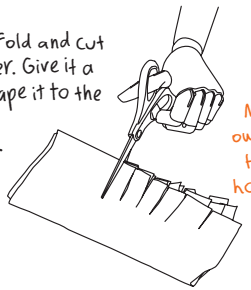


Tie down the cardboard base with the light wire

9 Tie the back of the cardboard down with a pipe cleaner

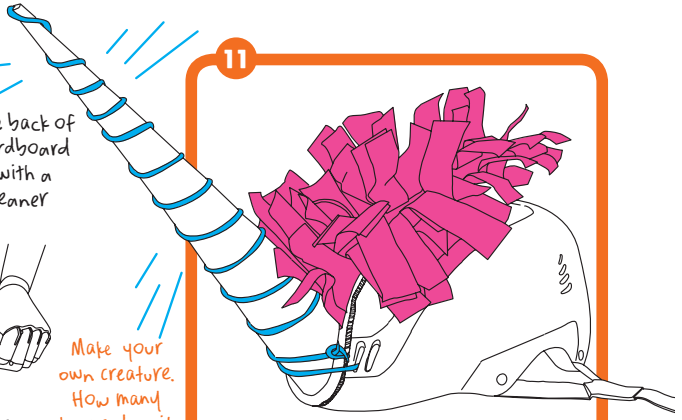


10 Add hair! Fold and cut tissue paper. Give it a fluff and tape it to the top of the cardboard.



Make your own creature. How many horns does it have?

11

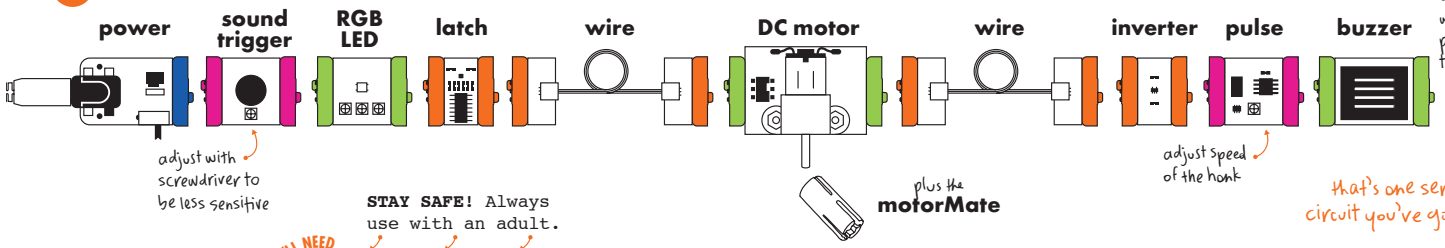


RIDE OFF INTO THE SUNSET!

DELUXE KIT Build an intelligent vehicle with multiple functions.

HONKING TRICYCLE

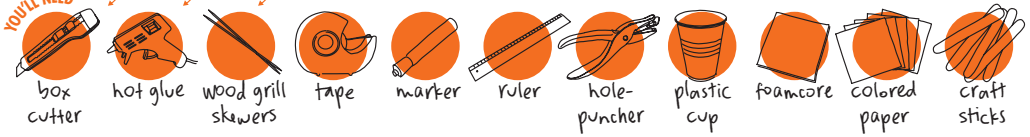
1 Start with this circuit



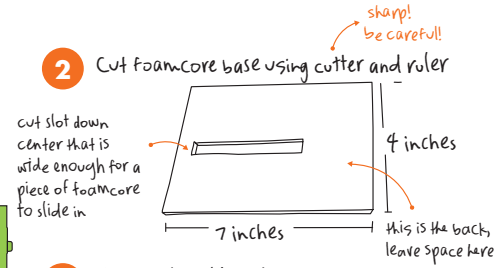
STAY SAFE! Always use with an adult.

TIME: 2 hrs
DIFFICULTY: ●●●●○

YOU'LL NEED

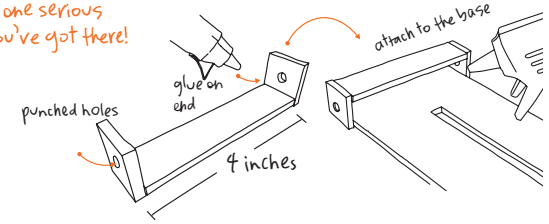


2 Cut foamcore base using cutter and ruler

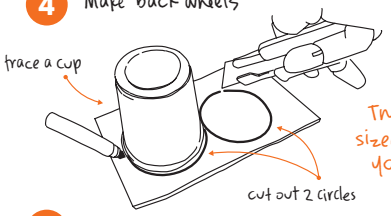


3 Make axle holder with foamcore and glue to the back of the base

that's one serious circuit you've got there!

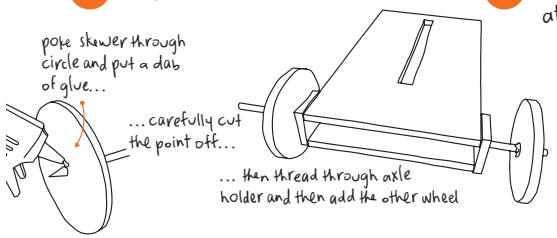


4 Make back wheels

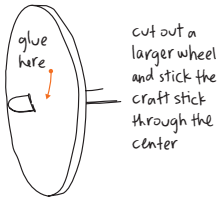


Try different sized circles for your wheels

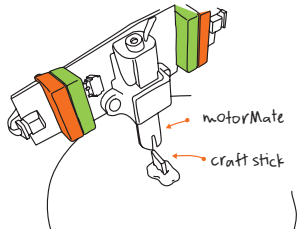
5 Make the back axle



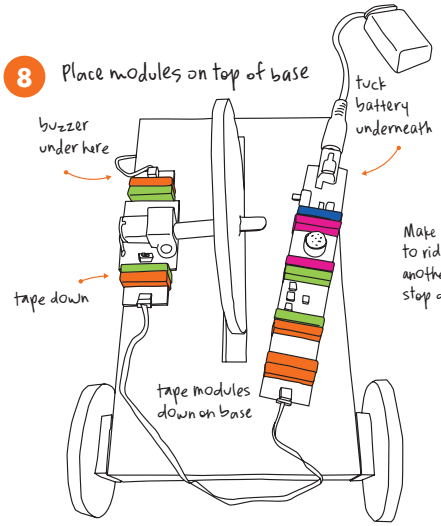
6 Make and mount the front wheel



7 Cut off end of craft stick, then attach wheel to motorMate

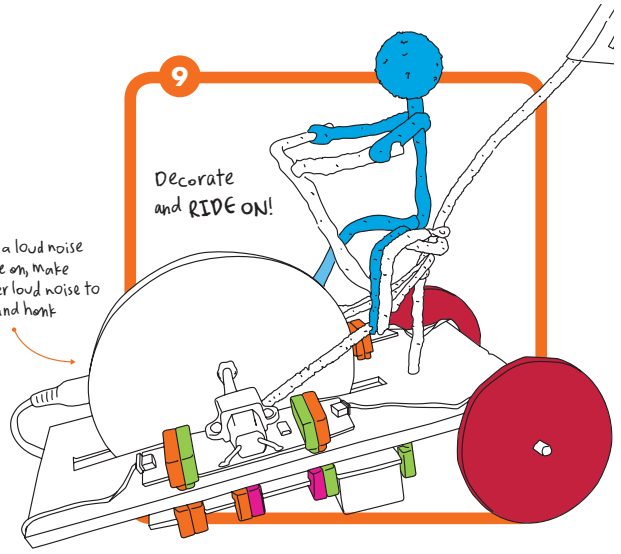


8 Place modules on top of base



9 Decorate and RIDE ON!

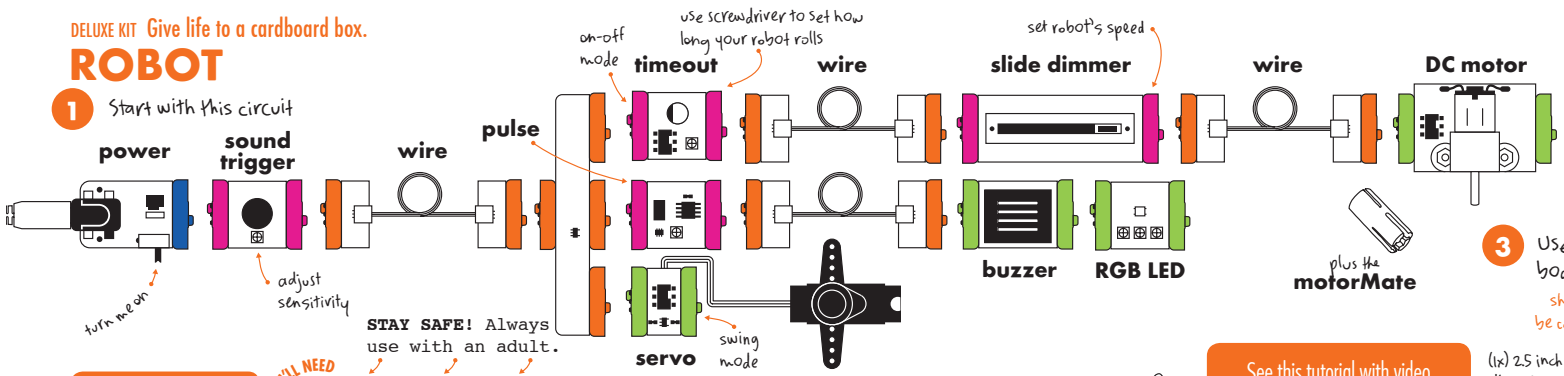
Make a loud noise to ride on, make another loud noise to stop and honk



DELUXE KIT Give life to a cardboard box.

ROBOT

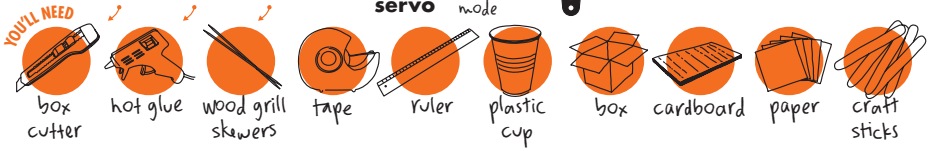
1 Start with this circuit



STAY SAFE! Always use with an adult.

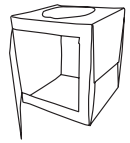
TIME: 2 hrs
DIFFICULTY: ●●●●○

YOU'LL NEED



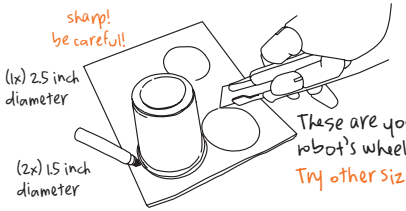
See this tutorial with video extras at **littleBits.cc/deluxe**

2 Cut a flap in the back of a box.

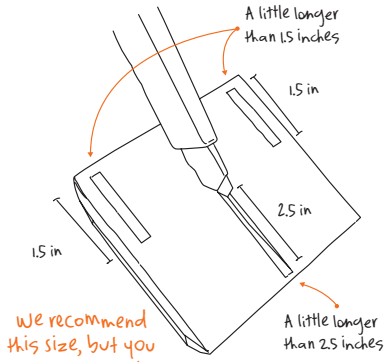


We used a tissue box. What do you have at home?

3 Use a small cup to trace 3 circles on cardboard. Mark the center and cut them out.

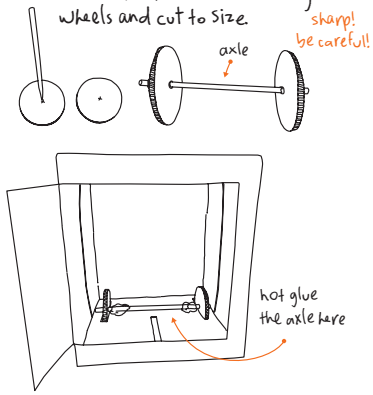


4 Cut slots for cardboard wheels in base of the box

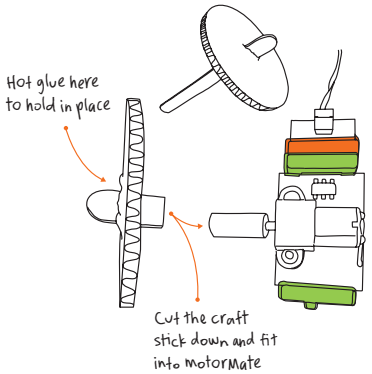


We recommend this size, but you can try others!

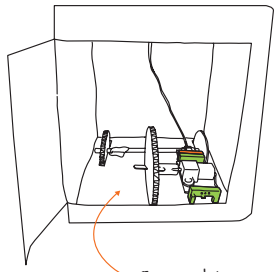
5 Poke holes in center of smaller wheels. Stick the skewer through wheels and cut to size.



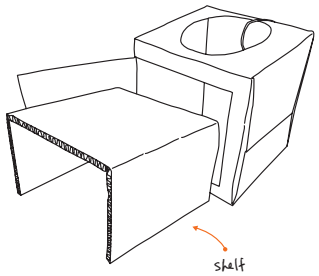
6 Stick a craft stick through the center of the 2.5 inch cardboard wheel



7 Place motor with motorMate and wheel in the center slot of the box base



8 Place a cardboard shelf inside box.

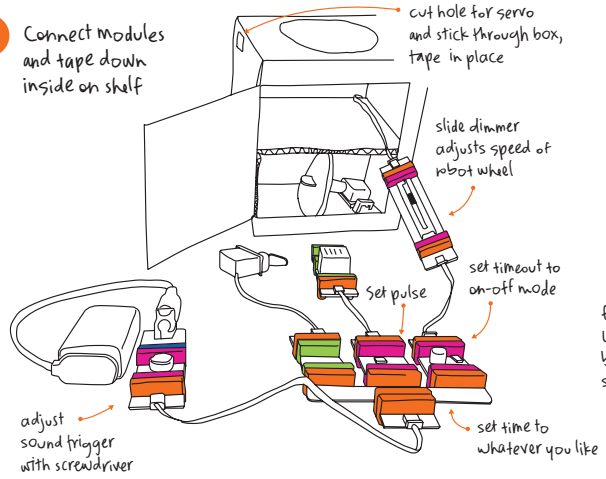


You can bend a piece of cardboard to make the shelf!

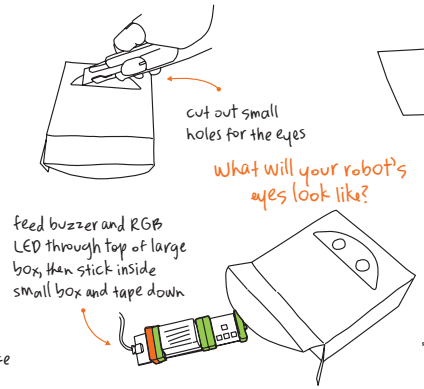
continued on next page

continued from previous page

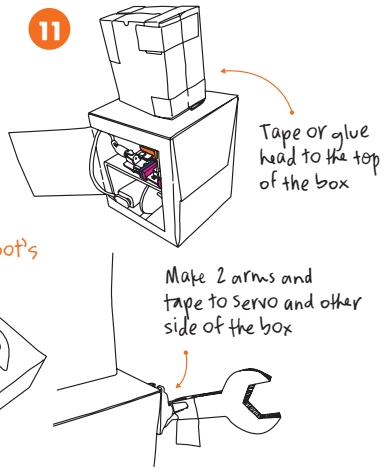
9 Connect modules and tape down inside on shelf



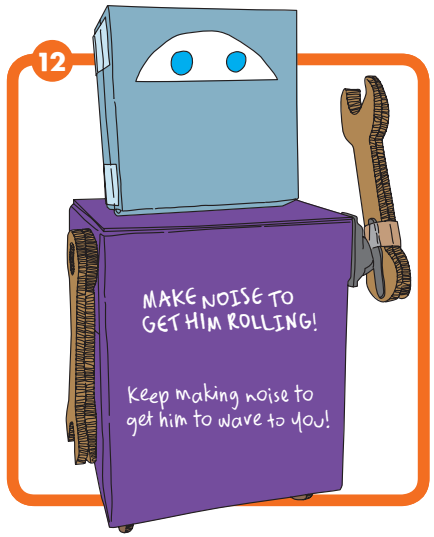
10 Use a smaller box to make the robot head



11



12



littleBits

SPACE KIT

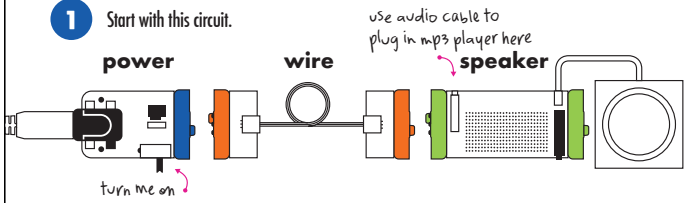
Wave Generator
Energy Meter
Make a Spectrum
Measuring the Atmosphere
Data Communication
Satellite Dish
Star Chart
Satellite Orbit
Grappler
Mars Rover

littleBits.cc/projects

SPACE KIT An introduction to speakers and mechanical waves.

WAVE GENERATOR

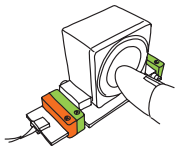
1 Start with this circuit.



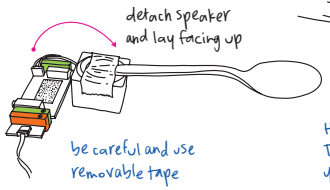
TIME: 15 mins
DIFFICULTY: ●●○○○

YOU'LL NEED

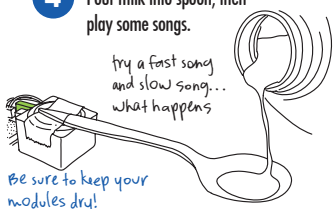
2 Play song on mp3 player and gently touch speaker cone.



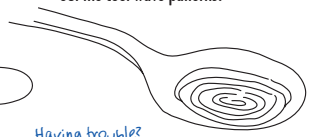
3 Attach spoon to speaker with tape.



4 Pour milk into spoon, then play some songs.



5 Turn up your volume and check out the cool wave patterns!



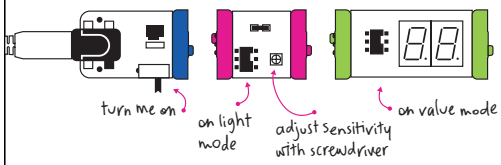
Describe how different music causes different reactions in the liquid.

WHY'D IT DO THAT?
refer back to What is Energy on p.10

SPACE KIT Discover sources of light energy around you.

ENERGY METER

1 Start with this circuit.



TIME: 15 mins
DIFFICULTY: ●○○○○

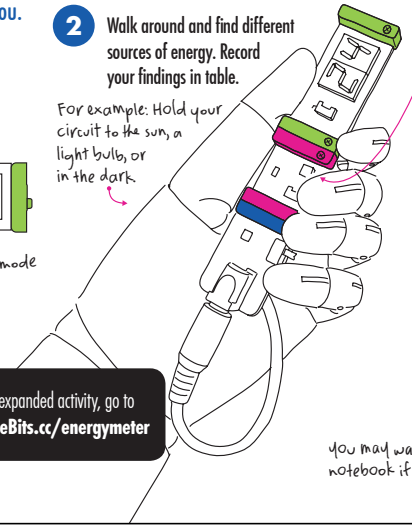
YOU'LL NEED

pen

For expanded activity, go to **littleBits.cc/energymeter**

2 Walk around and find different sources of energy. Record your findings in table.

For example: Hold your circuit to the sun, a light bulb, or in the dark



if you are having trouble seeing the numbers change, adjust sensitivity with screwdriver

3 Move the sensor closer or farther from the energy source. Record your observations in table.

4 Can you see any energy coming from a TV remote control? What happens if you point it at the energy meter and press a button?

(hint: most remotes have IR LEDs)

you may want to start your own scientific notebook if you find you need more room

What sources of energy can you find?

1. 3.
2. 4.

Describe what happens when you move the sensor closer to or farther from the energy source.

What happens if you point a household remote at the light sensor?

WHY'D IT DO THAT?
refer back to Electromagnetic Energy on p.11

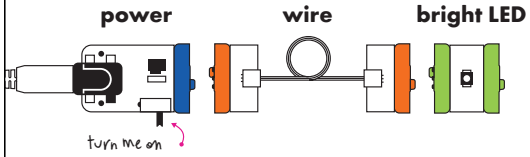
Digital cameras create images by measuring light energy. This is similar to how NASA satellite images are created by measuring energy reflecting off the Earth's surface.

NASA images by Reto Stöckli, based on data from NASA and NOAA

SPACE KIT Explore light waves you can see.

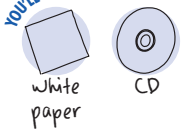
MAKE A SPECTRUM

1 Make this circuit.



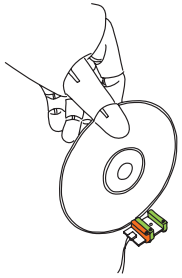
TIME: 15 mins
DIFFICULTY: ●○○○○

YOU'LL NEED



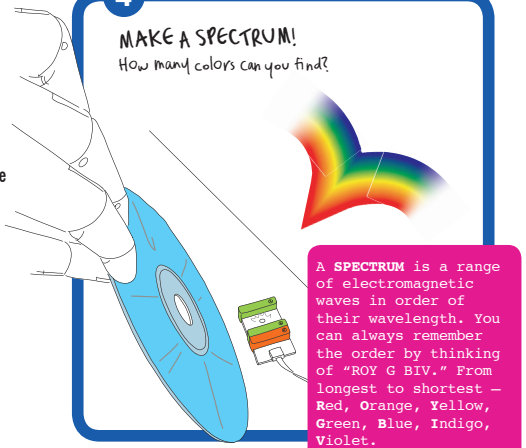
2 Find a dark place and set the reflective side of the CD opposite a white wall or piece of paper.

3 Place a bright LED in between the CD and the wall (or paper).



4 MAKE A SPECTRUM!

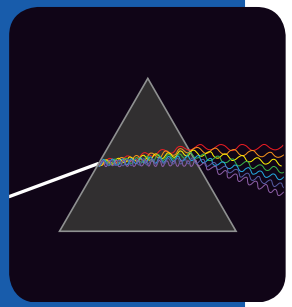
How many colors can you find?



A **SPECTRUM** is a range of electromagnetic waves in order of their wavelength. You can always remember the order by thinking of "ROY G BIV." From longest to shortest — **R**ed, **O**range, **Y**ellow, **G**reen, **B**lue, **I**ndigo, **V**iolet.

As white light bends, each color in the spectrum bends at a slightly different angle because their wavelengths are different sizes. Shorter wavelengths will bend more and longer wavelengths will bend less.

Why does a CD behave like a prism? They both act as "diffraction grating." The grooves on a CD diffract light into several beams like you saw in this experiment!

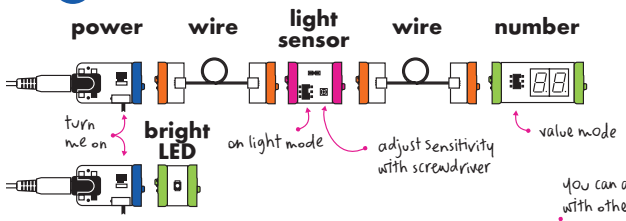


WHY'D IT DO THAT?
refer back to Electromagnetic Energy on p.11

SPACE KIT Learn how satellites detect particles in the atmosphere.

MEASURING THE ATMOSPHERE

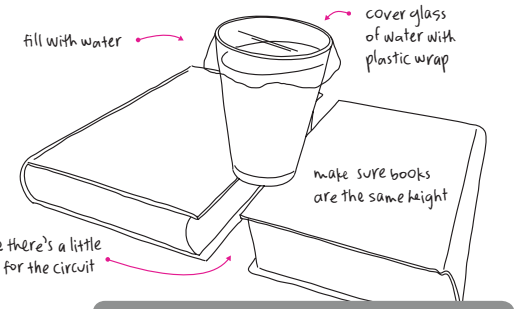
1 Make these two circuits.



TIME: 30 mins
DIFFICULTY: ●●○○○

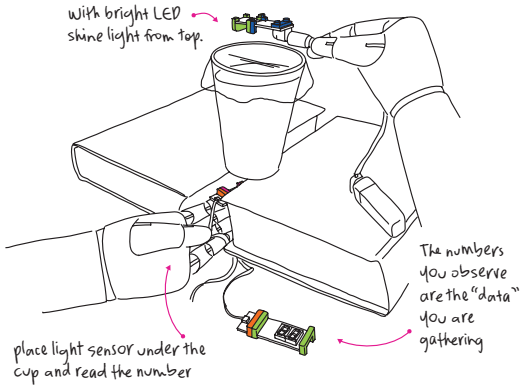
YOU'LL NEED

2 Place glass of water over the space between two books.

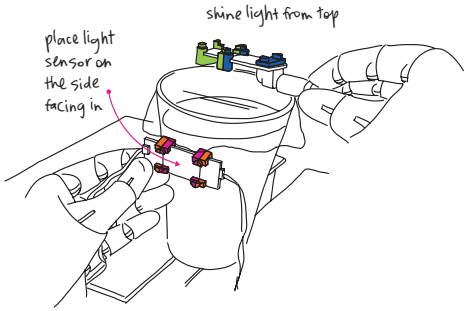


This project is similar to how satellite instruments measure the atmosphere. Since aerosols and gases scatter light differently, NASA instruments can determine the composition of the atmosphere by measuring how light is scattered.

3 Orient your circuits above and below the glass. Measure the amount of energy passing through the bottom of the glass. Record your data.



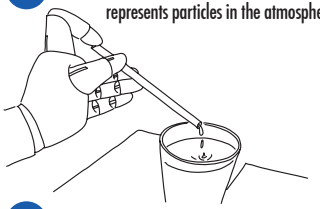
4 Measure the amount of energy coming through the side of the glass. Record your data in table.



5 What do you think will happen to the number if you add a drop of milk to the water? Record your hypothesis. Now conduct an experiment to find out if you were right.

Scientists use what they know to make a guess about what may happen. This is called a "hypothesis."

6 Add 1 drop of milk and stir. The milk represents particles in the atmosphere.



Why not try some other liquids as well? Orange Juice? Soda?

7 Continue adding milk and record your observations. Repeat steps 3 and 4 and record your data.

Hypothesis:

.....

Data Table

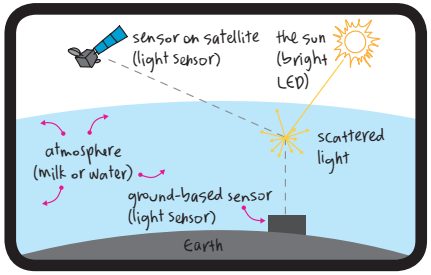
	Bottom	Side
Water		
1 drop milk		
2 drops milk		
3 drops milk		
4 drops milk		

Was your hypothesis correct?

.....

Measuring from bottom: With water, the reading will be high because light is traveling downward. With milk, the reading will be lower because light is scattered.

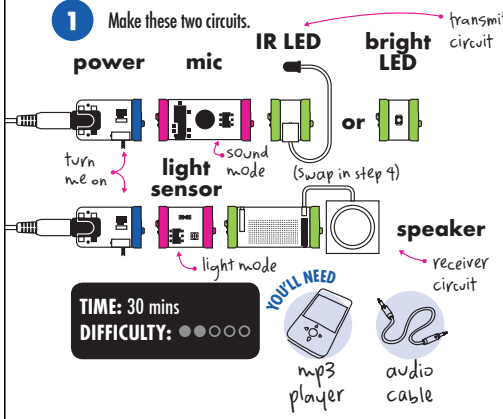
Measuring from side: With water, the reading will be low because light is traveling downward. With milk, the reading will be higher because the light is scattered.



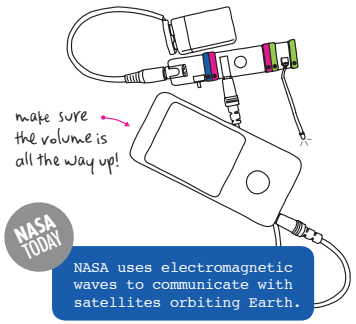
SPACE KIT Learn how to wirelessly transmit music using a digital signal.

DATA COMMUNICATION

1 Make these two circuits.



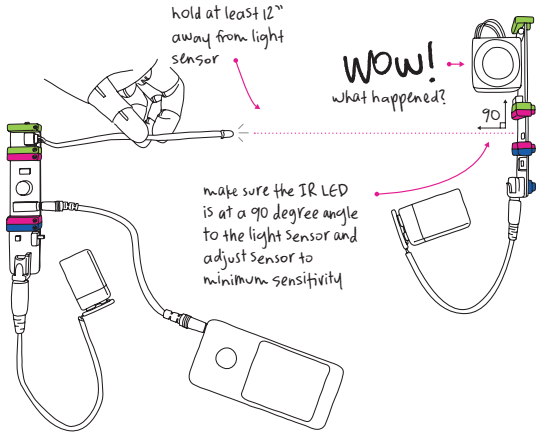
2 Plug audio cable into microphone module and an mp3 player and play your favorite song.



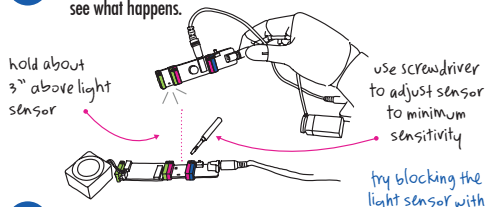
NASA TODAY

NASA uses electromagnetic waves to communicate with satellites orbiting Earth.

3 Place both circuits on a flat surface, like below.



4 Now swap out the IR LED for the bright LED and see what happens.



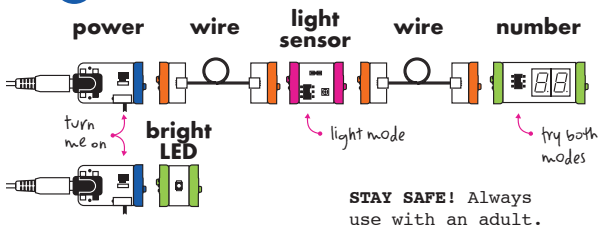
5 Put different materials between the light source and sensor. What happens?

How does it work?
Your digitized music is converted into a series of light wave pulses. The pulses are decoded by the light sensor and converted into sound waves by the speaker.

SPACE KIT Learn the science behind satellites and make your own parabolic reflector.

SATELLITE DISH

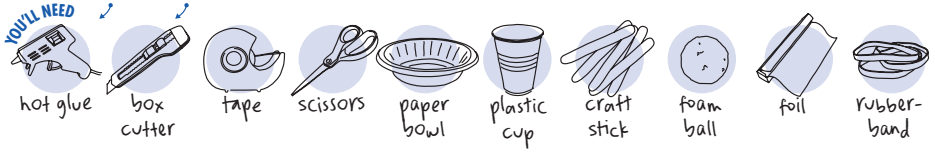
1 Make these two circuits.



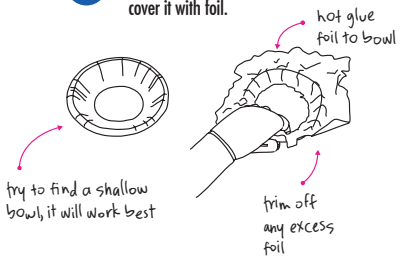
TIME: 60 mins
DIFFICULTY: ●●●○○

STAY SAFE! Always use with an adult.

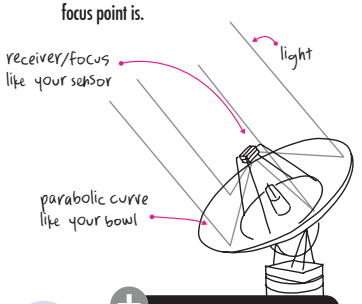
YOU'LL NEED



2 Find a paper or plastic bowl and cover it with foil.

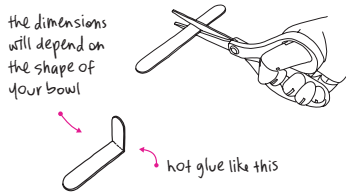


3 To optimize the amount of light that is reflected into your sensor, you'll need to calculate where the focus point is.

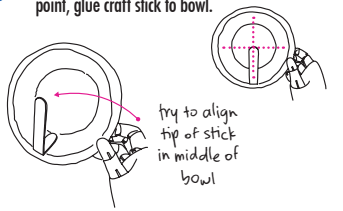


To learn how to calculate the focus distance, go here: **littleBits.cc/satellitedish**

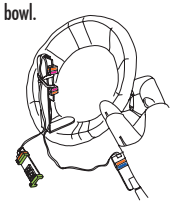
4 Use craft stick to make a sensor arm.



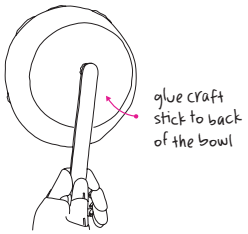
5 Once you have found the ideal focus point, glue craft stick to bowl.



6 Rubberband light sensor to tip of arm. It should face into bowl.

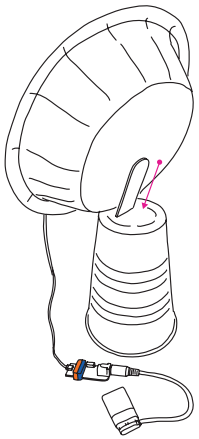


7 Create a mounting stick.

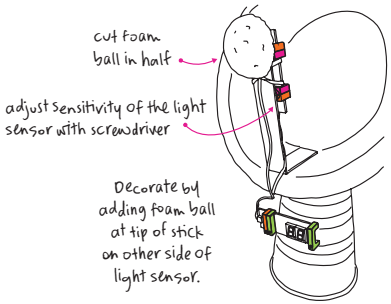


8 Cut slit in bottom of cup.

9 Stick satellite dish into cup through the slit.

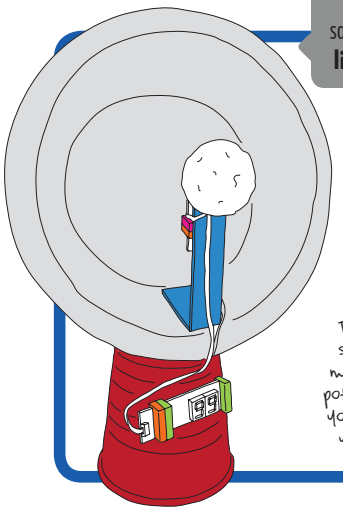


10 Use tape and place number module on front of cup.



11 Shine bright LED into your dish... what happens to the number reading?

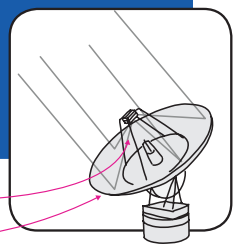
Show us what satellite dish you made! **littleBits.cc/upload**



Try different shapes like a mixing bowl or pot lid and see if you can improve your design!

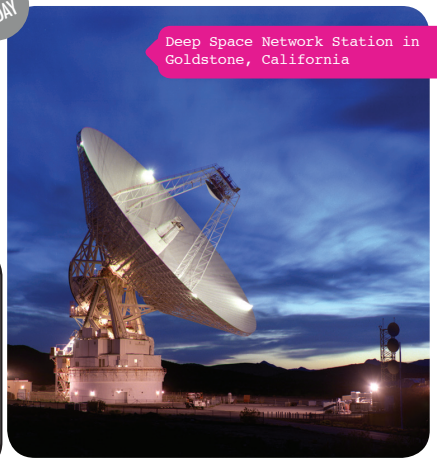
continued on next page

Unique curved surfaces, such as parabolas, have a point called the **FOCUS**, where all of the energy entering the shape is 'reflected' from the parabolic curve and intersects at the focus. In your satellite dish model, the light sensor is your focus that receives energy from the bright LED and measures it in the number module.



this focus is collecting data just like your light sensor, and this is just like the bowl in your model

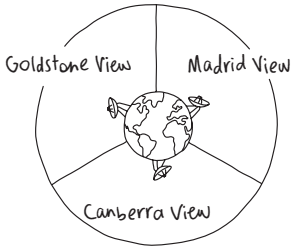
NASA TODAY



Deep Space Network Station in Goldstone, California

THE DEEP SPACE NETWORK (DSN) is a worldwide network of antennas developed by NASA to communicate with robotic spacecraft exploring our solar system and beyond. Sensors on board this spacecraft gather and transmit data about distant planets, moons, asteroids, comets, stars, and galaxies.

Receiving data from this spacecraft is very challenging because of the extreme distances between the spacecraft and Earth. Signals must travel millions or even billions of kilometers between Earth and a spacecraft in deep space. The spacecraft's communications equipment — designed to be small and lightweight — transmits at very low power, typically about the same as a refrigerator light bulb. Receiving antennas on Earth must have large collectors (antenna dishes) with precisely shaped surfaces and they must accurately point towards the spacecraft.

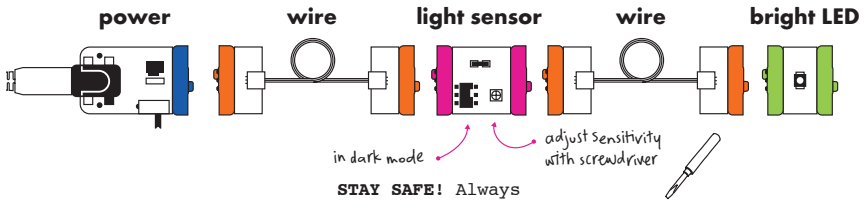


The DSN has three ground stations located approximately 120 degrees apart on Earth (120 + 120 + 120 = 360). This is to ensure that as the Earth rotates, at least one station is able to capture and transmit signals to any deep space mission without any gaps in coverage.

SPACE KIT Learn about astronomy and project the night sky in your room.

STAR CHART

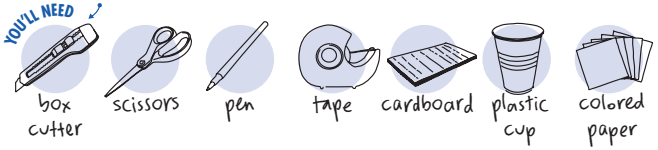
1 Start with this circuit.



STAY SAFE! Always use with an adult.

TIME: 60 min
DIFFICULTY: ●●●○○

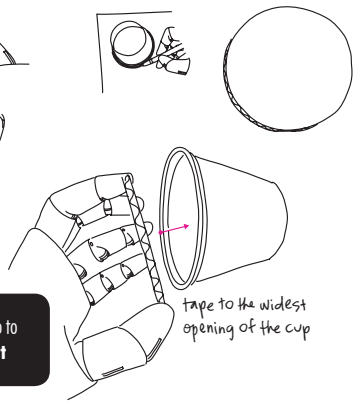
YOU'LL NEED



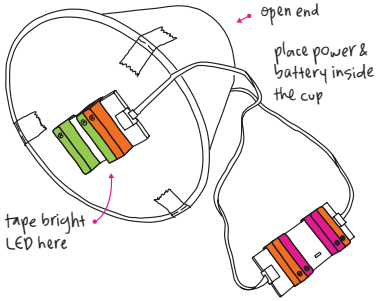
For expanded activity, go to **littleBits.cc/starchart**

2 Cut the bottom off of a plastic cup.

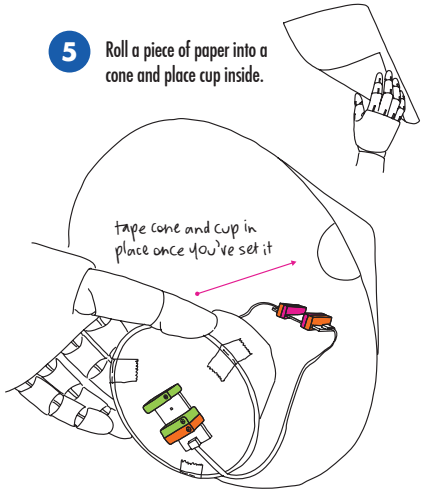
3 Trace wide end of the cup on a piece of cardboard and cut it out.



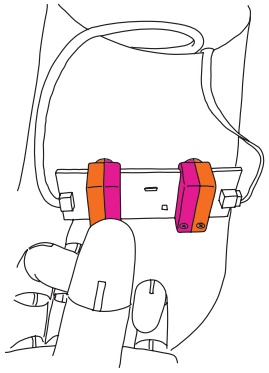
4 Tape bright LED on top of cardboard circle.



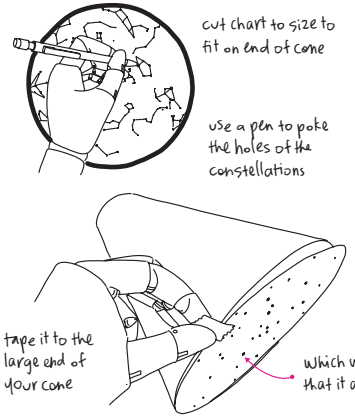
5 Roll a piece of paper into a cone and place cup inside.



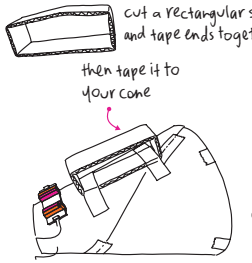
6 Tape light sensor on the outside of the cone.



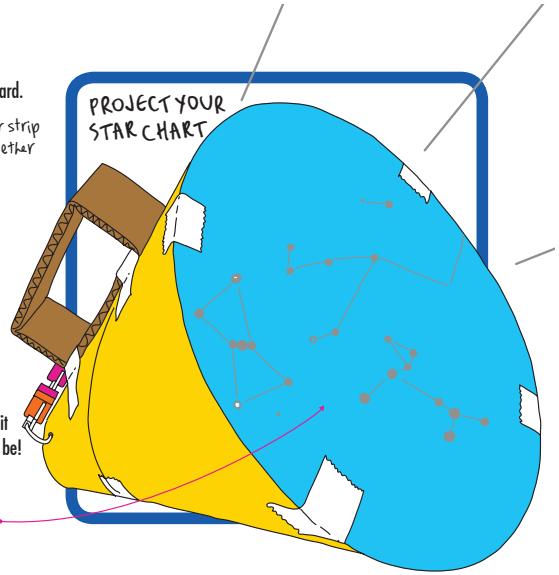
7 Print out a star chart. You can download one at littleBits.cc/starchart



8 Create a handle out of cardboard.



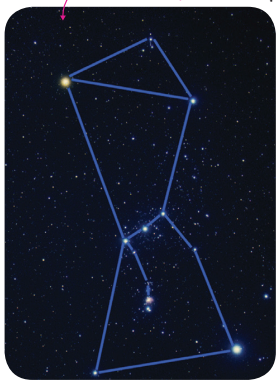
9 Turn off the lights, the darker it gets the brighter the stars will be!



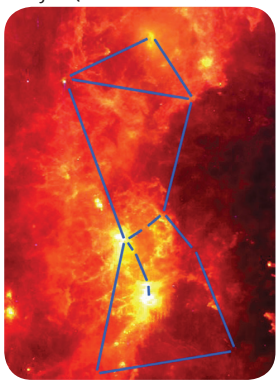
continued on next page

NASA instruments measure energy in the night sky across the electromagnetic spectrum. By looking at the sky in wavelengths beyond the visible spectrum, scientists can see a more complete picture. This helps them study questions like 'how was the universe formed' and 'how is it changing.'

The constellation Orion.
These images show features that cannot be seen in visible light but appear brightly in infrared



Visible light image: Akira Fujii



Infrared image: Infrared Astronomical Satellite

Orion is one of the most widely recognized of all the 89 constellations in the sky. It is also one of the oldest known to humans. The Ancient Egyptians called it Osiris as long ago as 2000 BC!

The brilliant stars that make up this rectangular star pattern seem to be close-by because they are so bright, but in fact they are very far away. Astronomers measure distances using a unit called the light year, which equals about 5.9 trillion miles (9.5 trillion km), or 63,240 times the distance from Earth to the Sun!

TRY THESE CALCULATIONS!
The bright star in Orion called **Betelgeuse** is located 650 light years from Earth. What is this distance in miles or kilometers?

Betelgeuse is expected to blow up as a supernova sometime in the next million years. Suppose this happened in the year 3000 AD. In what year would someone on Earth see this explosion? Go online to find the answers, littleBits.cc/starChart

SPACE KIT Learn about how satellites take photos of the Earth.

SATELLITE ORBIT

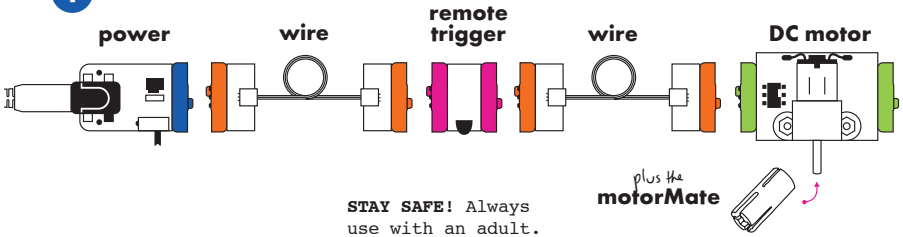
TIME: 90 min
DIFFICULTY: ●●●○○

STAY SAFE! Always use with an adult.

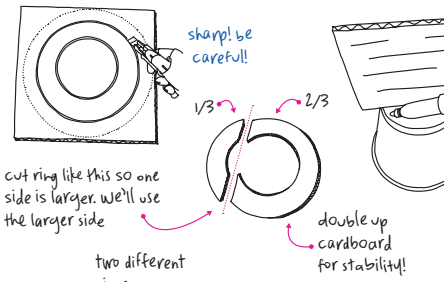
YOU'LL NEED

hot glue, box cutter, bbq skewers, marker, plastic cup, cardboard, foam ball (large), weight, plates, tape, pipe cleaner, remote

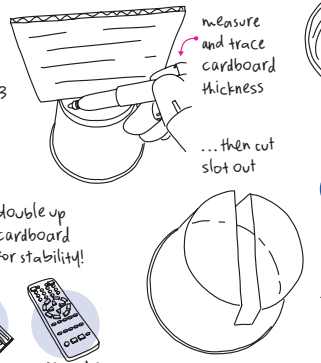
1 Make this circuit.



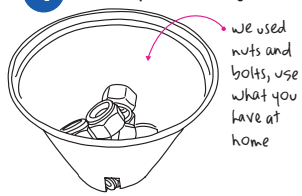
2 Make a ring. Trace a large plate and then a small plate on a piece of cardboard and cut them out.



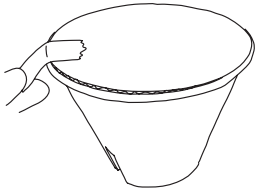
3 Cut a slot in a plastic cup.



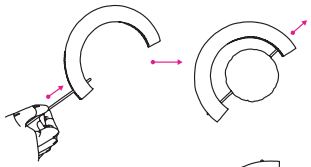
4 Fill the cup with some weight.



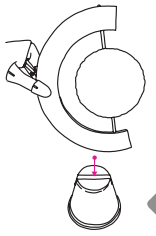
5 Cover cup with circular piece of cardboard and tape it down.



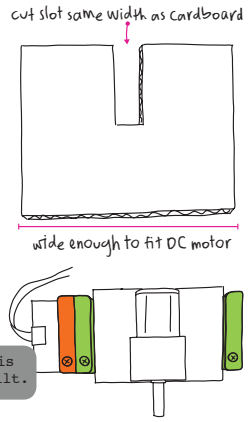
6 Stick skewer through the cardboard curve and the center of the foam ball.



7 Place the cardboard curve in the slot in the cup and tape in place.

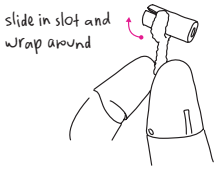


8 Make a cardboard shelf for the DC motor.

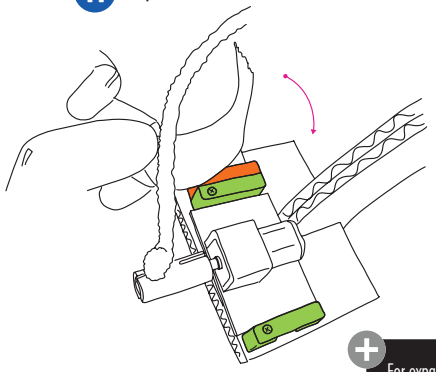


9 Then glue to center of cardboard curve.

10 Attach pipe cleaner to motorMate and put on the DC motor.

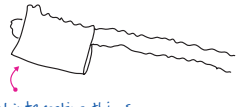


11 Tape the DC motor to the cardboard shelf.

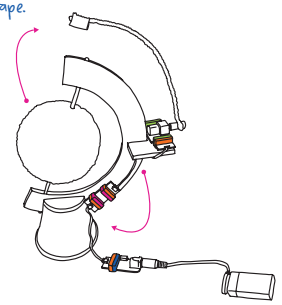


For expanded activity, go to **littleBits.cc/orbit**

12 Add satellite to end of pipe cleaner.



13 Decorate your model.



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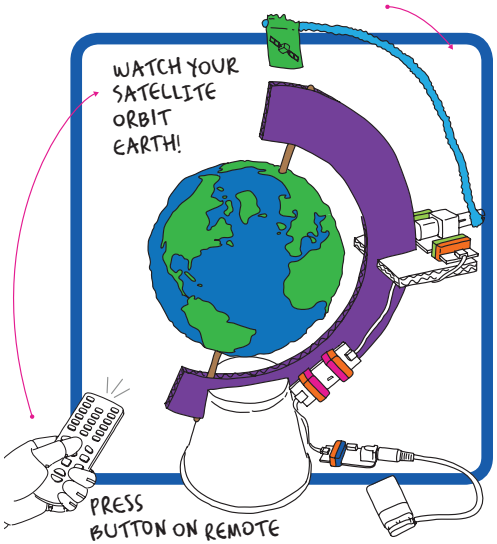
SATELLITE ORBIT

continued from previous page

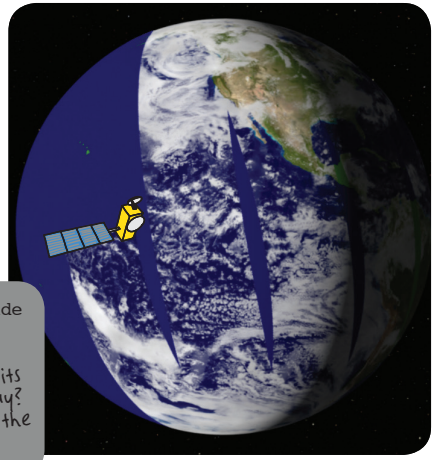


The AURA Satellite

NASA TODAY

Every day, NASA satellites (like AURA pictured to the left) collect global observations of the Earth. The image to the right shows the path of the Aqua satellite. Data is only collected when the satellite is on the sunlit side of the Earth because it measures reflected light from the Sun. With each orbit, the MODIS sensor onboard the satellite can observe a swath of data over 1400 miles (2253 km) wide and can image almost the entire Earth surface everyday.

A satellite at an altitude of 438 miles (705 km) orbits Earth once every 99 minutes. How many orbits does the satellite make in a day? How many times does it cross the equator in one day?

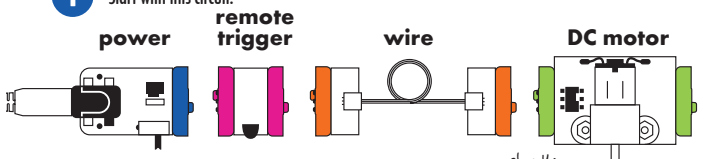


Images Courtesy NASA

SPACE KIT Learn NASA engineering by building this robotic space arm.

GRAPPLER

1 Start with this circuit.

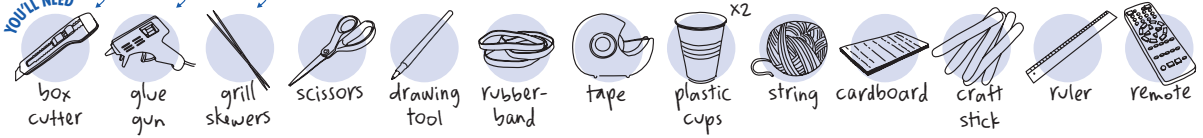


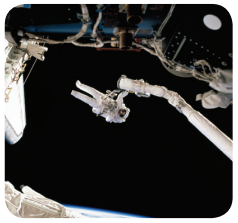
This is a hard project, try it with a parent!

TIME: 90 mins
DIFFICULTY: ●●●●●○

STAY SAFE! Always use with an adult.

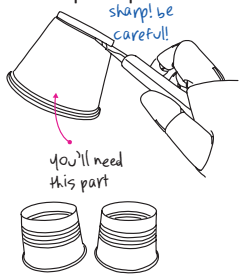
YOU'LL NEED



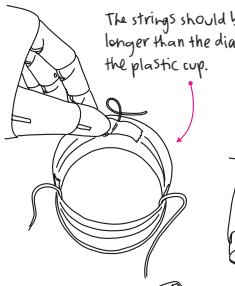


A **GRAPPLER** is on the end of the ISS Robot Arm and is used to grab onto objects in space – like astronauts!

2 Cut the bottom off of 2 plastic cups.



3 Cut three pieces of string the same length. Tape them to the inside of one cup.



4 Place the other cup over the cup with strings. Feed the strings up through the top of both cups. Tape them to the outside of the outer cup.

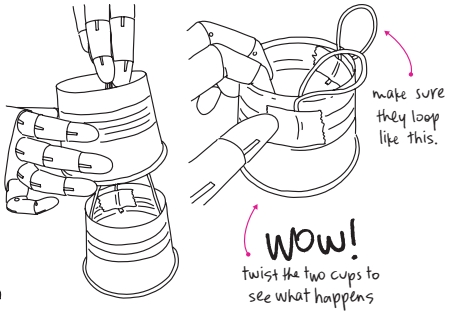
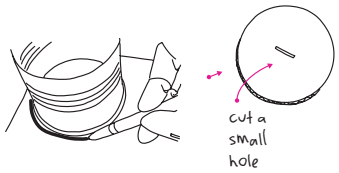
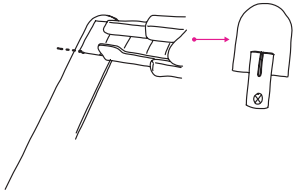


Image Courtesy NASA

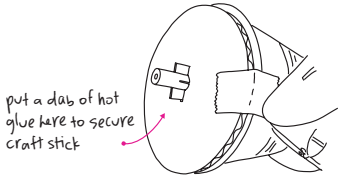
5 Trace wide end of cup on cardboard and cut out circle.



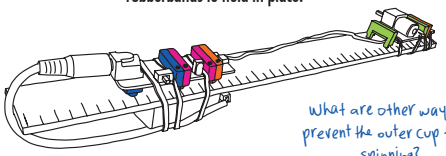
6 Cut the end off a craft stick and stick into motorMate.



7 Tape cardboard circle to inner cup and stick the craft stick in the hole.

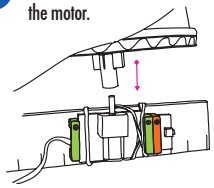


8 Put the circuit on a ruler and use rubberbands to hold in place.

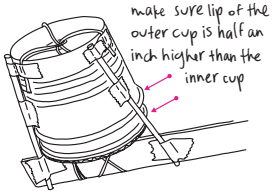


What are other ways to prevent the outer cup from spinning?

9 Place motorMate onto D-shaft of the motor.



10 Secure the outer cup to the ruler using wooden skewers and tape.



Use a household remote to control your grappler. This is similar to the arm that grabs onto moving vehicles in space!

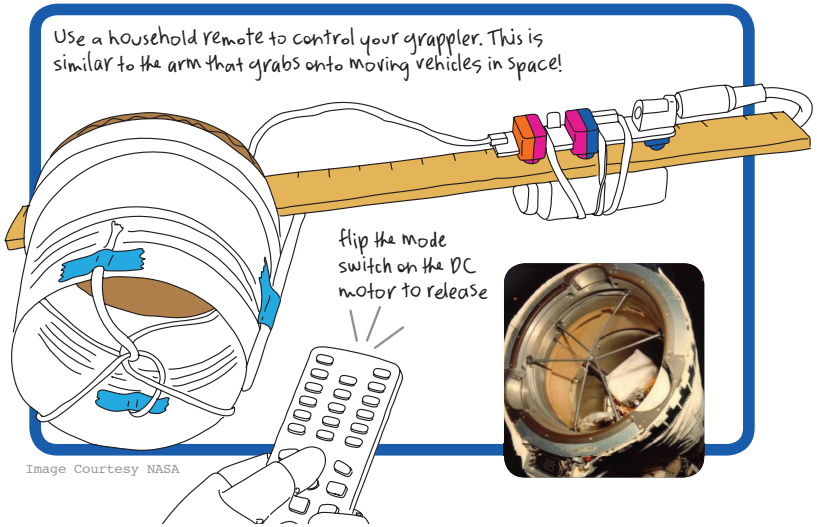


Image Courtesy NASA

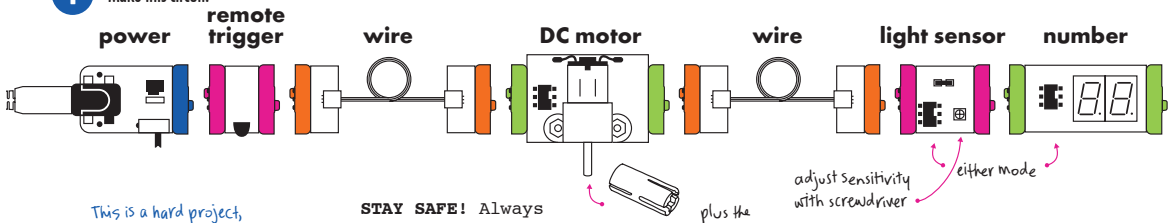
SPACE KIT Learn how NASA scientists are able to explore new worlds!

MARS ROVER

January 2004
Mars Exploration Rover "Opportunity" lands.

Image Courtesy NASA/ JPL-Caltech

1 Make this circuit.

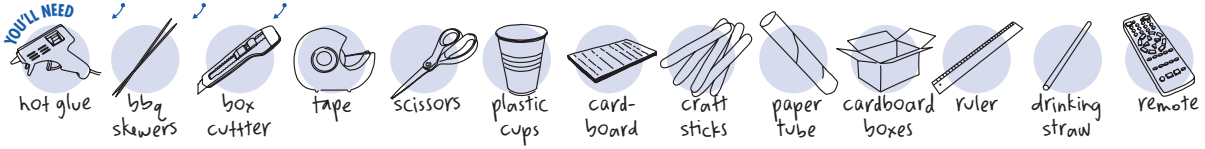


This is a hard project, try it with a parent!

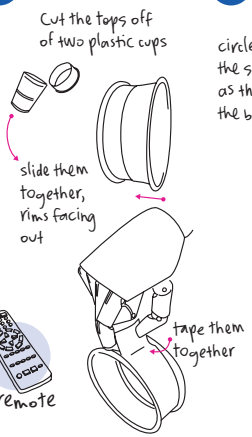
TIME: 2 hrs
DIFFICULTY: ●●●●●

STAY SAFE! Always use with an adult.

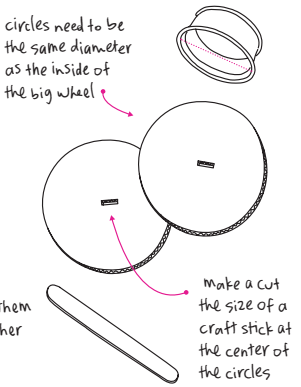
YOU'LL NEED



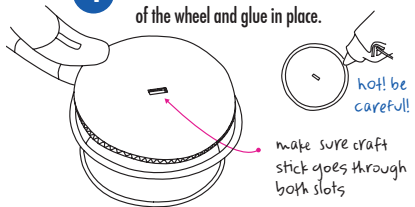
2 Make the big wheel.



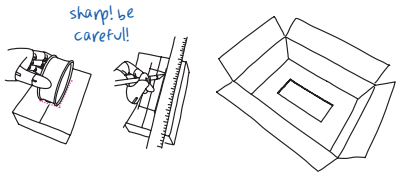
3 Make 2 cardboard circles for the inside of the big wheel.



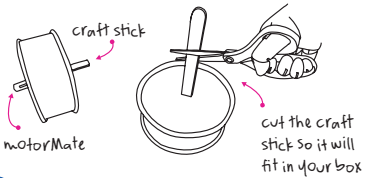
4 Place cardboard circles on both sides of the wheel and glue in place.



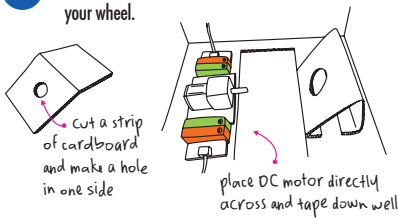
5 Cut a hole in the base of a box large enough to fit your wheel.



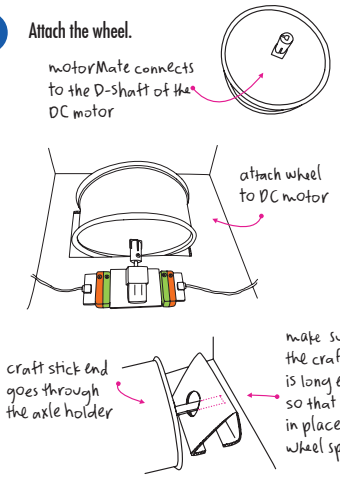
6 Put the craft stick through the slots and add the motorMate to one end of it.



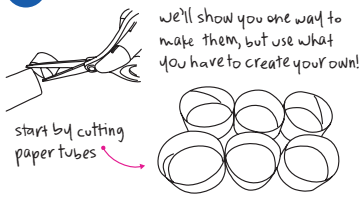
7 Make an axle holder for the craft stick on your wheel.



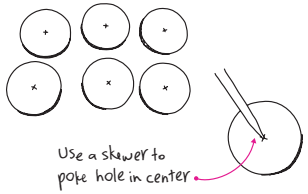
8 Attach the wheel.



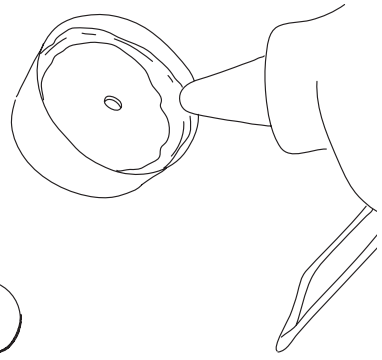
9 Make 6 wheels!



10 Cut six cardboard circles to fit inside the wheels.

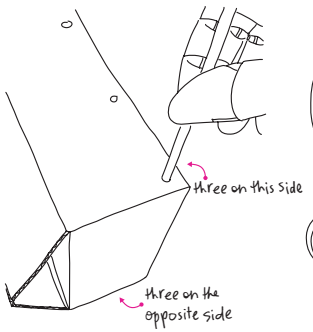


11 Place cardboard circle in paper tube and glue in place.

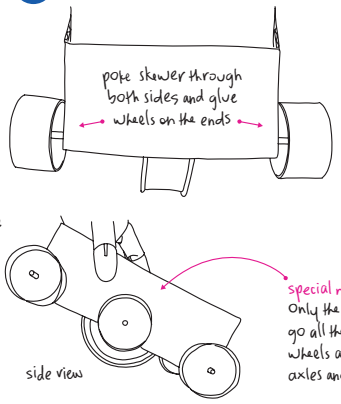


continued on next page

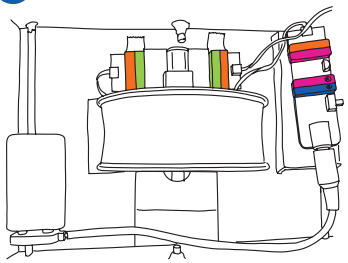
12 Make holes for axles.



13 Put the wheels on.



14 Arrange everything in the box.

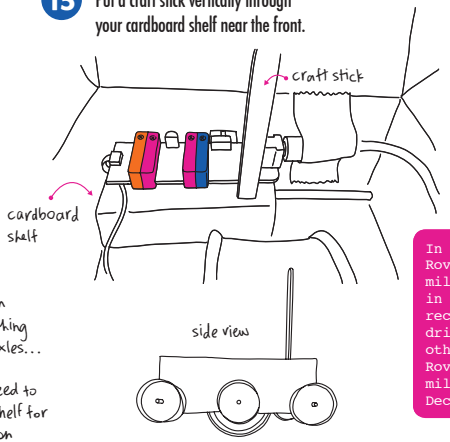


special note!
Only the first and last wheel axles go all the way through, the middle wheels are just glued in with short axles and don't spin

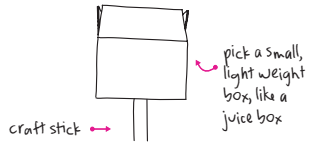
Tape everything down making sure that nothing interferes with the axles...

PRO TIP: you may need to build a cardboard shelf for your modules to sit on

15 Put a craft stick vertically through your cardboard shelf near the front.



16 Stick a small box on top of the craft stick and hot glue in place.



NASA TODAY

In **May 2013,** the Mars Exploration Rover "Opportunity" exceeded 22.22 miles (35.76 km) since its landing in January 2004. This breaks the record for the greatest distance driven by a NASA vehicle on a world other than Earth since the Lunar Roving Vehicle was driven 22.21 miles (35.74 km) on the moon, in December 1972.

17 Tape the light sensor and number modules to the front of the small box.

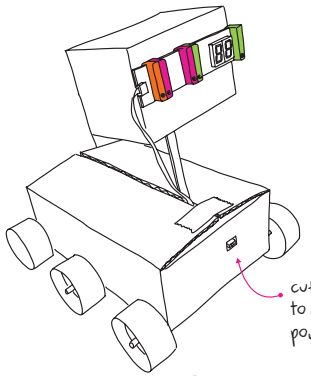
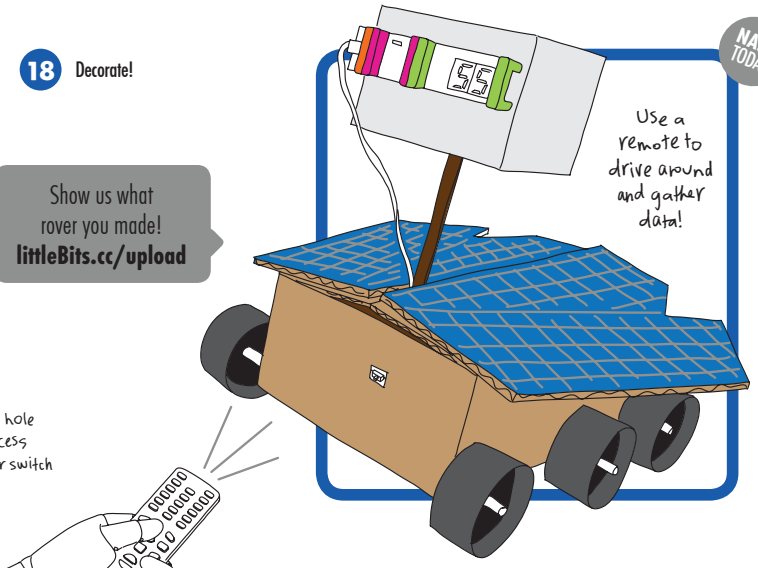


Image Courtesy NASA/JPL-Caltech

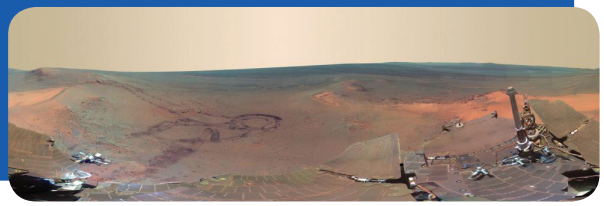
18 Decorate!

Show us what rover you made!
littleBits.cc/upload



NASA TODAY

NASA engineers send instructions to the rovers via radio communications. Depending on where the planets are in their orbits, a radio signal traveling at the speed of light will arrive on Mars between just over 3 minutes or as long as 20 minutes. Due to these time delays it is impossible to communicate with and control the rover in real time. To send instructions to rovers on Mars, NASA scientists must have a line-of-sight between Earth and Mars. Occasionally Earth and Mars are on opposite sides of the sun, called conjunction. During this time, the sun can disrupt or block radio communication between the two planets.



Martian landscape image taken by Opportunity

littleBits

SYNTH KIT

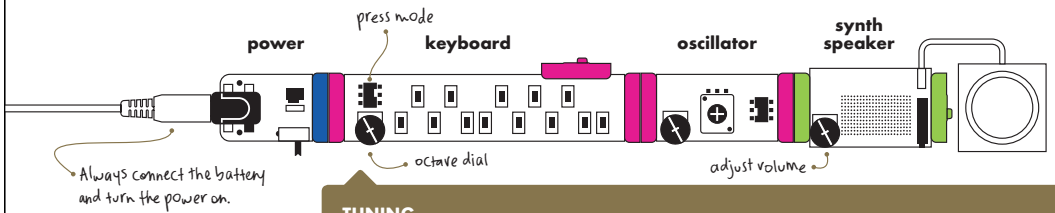
Tuning
Play a Song
Spooky Sounds
Percussion Party
Metal Music
Synth Band
Synthesizer with the Works

littleBits.cc/projects

SYNTH KIT Learn how to make your song's pitch perfect.

TUNING

1. Start with this circuit.



2. Pick one key and turn the "octave" dial clockwise and counterclockwise. Do you hear the difference? Listen to the range (how "high" and "low" the sound goes).

3. Turn the keyboard "octave" control to the middle of the range.

4. Turn "pitch" knob on oscillator to change the frequency.

5. Play all the notes on the bottom row of the keyboard consecutively from left to right. This is called a major scale in music. You may recognize it as do-re-mi-fa-so-la-ti-do.

6. Play do-re-mi again, does it sound "right" to you? Remember "pitch" is perceived differently for everyone! If the notes didn't sound quite right, try slowly adjusting the tune dial counterclockwise until it sounds "in tune."

TUNING

- Tuning is the relationship between the pitches in a musical instrument. Instruments need to be "tuned" and a synthesizer is no different. By tuning instruments, you can create "melodies" that are recognizable.
- The tuning dial on the oscillator module will alter the relationship between pitches. This will be important when using the keyboard and micro sequencer.

7. You've successfully tuned your oscillator, YOU'RE READY TO PLAY!

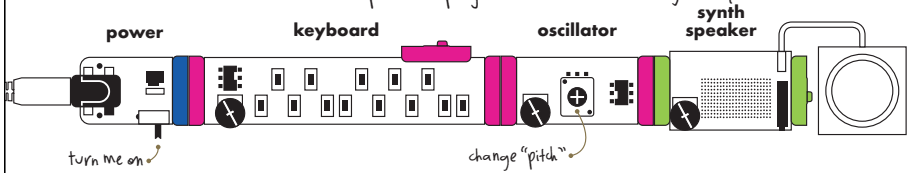
SYNTH KIT Serenade a friend!

PLAY A SONG

❶ Start with this circuit.

❷ Then, tune your oscillator (See previous project).

❸ Adjust "pitch" to match the range of your voice!



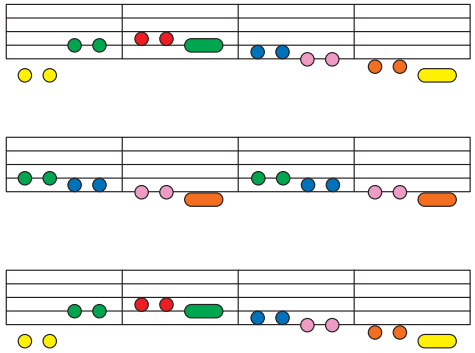
The bass sound in **Stevie Wonder's** 1973 song "Living for the City" features the use of a keyboard, oscillator, and envelope. Can you replicate that sound?

SYNTH HIST

❹ USE THIS COLOR CODED KEYBOARD AND THE NOTES TO THE RIGHT TO HELP YOU PLAY A SONG!

Go to **littleBits.cc/synth** to learn how to play more tunes!

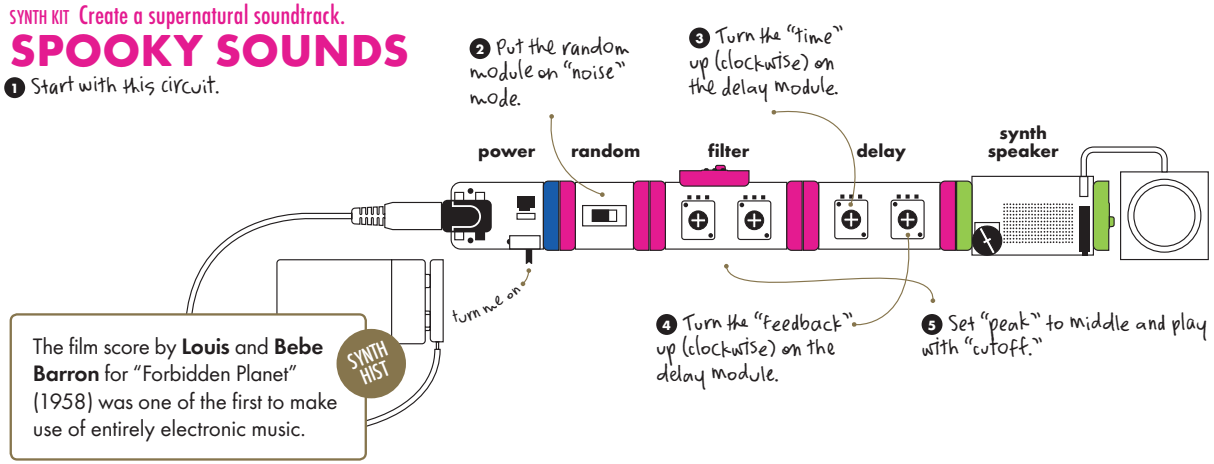
Do you recognize it?



SYNTH KIT Create a supernatural soundtrack.

SPOOKY SOUNDS

❶ Start with this circuit.



SYNTH HIST

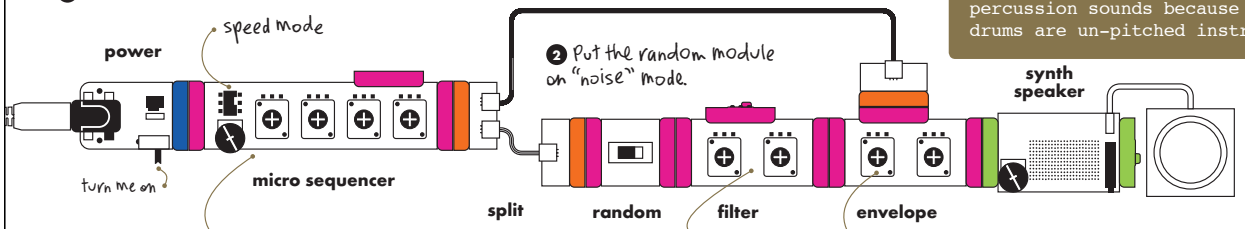
The film score by **Louis** and **Bebe Barron** for "Forbidden Planet" (1958) was one of the first to make use of entirely electronic music.

The "peak" knob has a large effect on what the "cutoff" knob does. It emphasizes certain frequencies and creates a "peak" at these frequencies. If the "peak" is turned all the way up, the emphasis can be strong enough to increase the loudness of the sound and in some cases create an oscillation.

SYNTH KIT Dance to the beat of your own drums.

PERCUSSION PARTY

❶ Start with this circuit.



❷ Put the random module on "noise" mode.

❸ Set your rhythm by adjusting knobs on the micro sequencer and adjust tempo with speed dial.

❹ Adjust the filter to affect the timbre.

❺ Turn the "attack" knob all the way down (counterclockwise). Turn the "decay" knob low, but slightly higher than the "attack."

NOISE

Noise is an un-pitched sound. It is often used as a way to create percussion sounds because most drums are un-pitched instruments.

BONUS

TRY MAKING A...

...horse galloping sound – Turn one of the knobs all the way down on the sequencer to make the sound effect for a horse galloping.

...woodblock sound – Turn the "peak" knob up (clockwise), turn the "cutoff" down (counterclockwise).

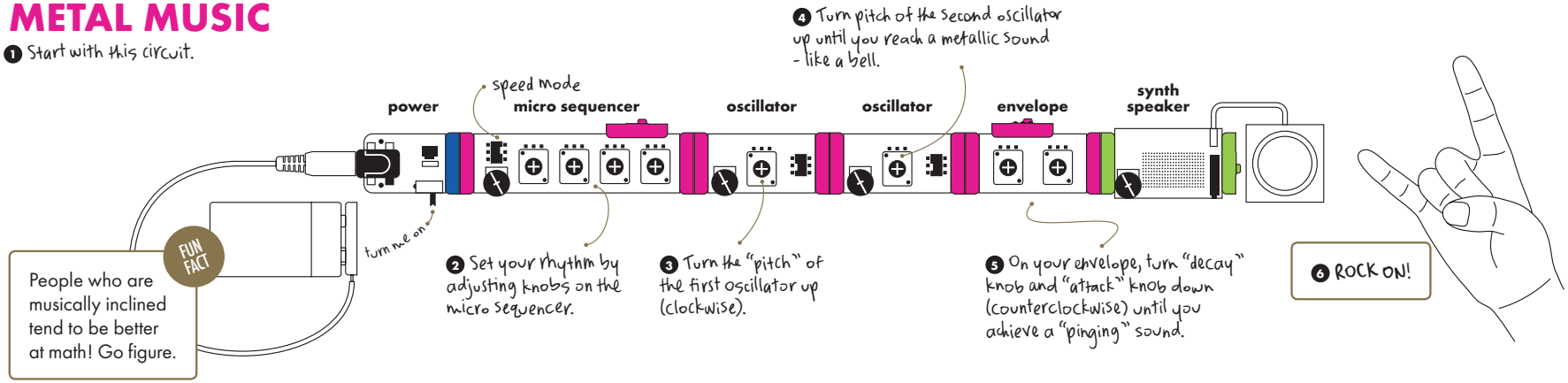
...water drop sound – Keep the "peak" up. Turn the "cutoff" to a mid-range (higher than the woodblock).

❻ WAIL on your synth drumset!

SYNTH KIT Recreate metallic sounds with the envelope.

METAL MUSIC

1. Start with this circuit.



4. Turn pitch of the second oscillator up until you reach a metallic sound - like a bell.

2. Set your rhythm by adjusting knobs on the micro sequencer.

3. Turn the "pitch" of the first oscillator up (clockwise).

5. On your envelope, turn "decay" knob and "attack" knob down (counterclockwise) until you achieve a "pinging" sound.

6. ROCK ON!

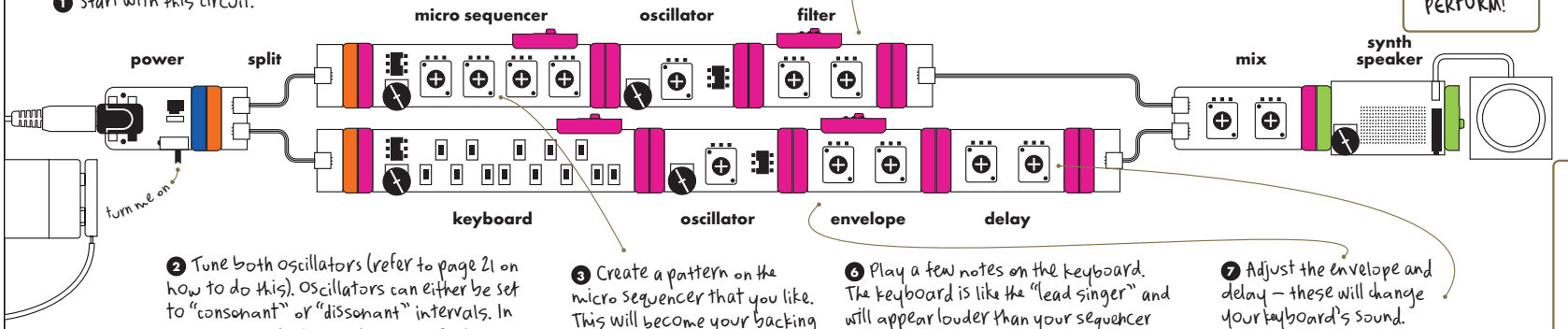
FUN FACT

People who are musically inclined tend to be better at math! Go figure.

SYNTH KIT Learn how to play a melody with accompaniment.

SYNTH BAND

1 Start with this circuit.



4 Adjust the filter until you reach the sound you like.

5 Set mix level 1 low and mix level 2 higher.

8 YOU'RE READY TO PERFORM!

2 Tune both oscillators (refer to page 21 on how to do this). Oscillators can either be set to "consonant" or "dissonant" intervals. In consonance, they are in harmony. In dissonance, they will sound inharmonious.

3 Create a pattern on the micro sequencer that you like. This will become your backing music.

6 Play a few notes on the keyboard. The keyboard is like the "lead singer" and will appear louder than your sequencer because nothing is filtering the sound.

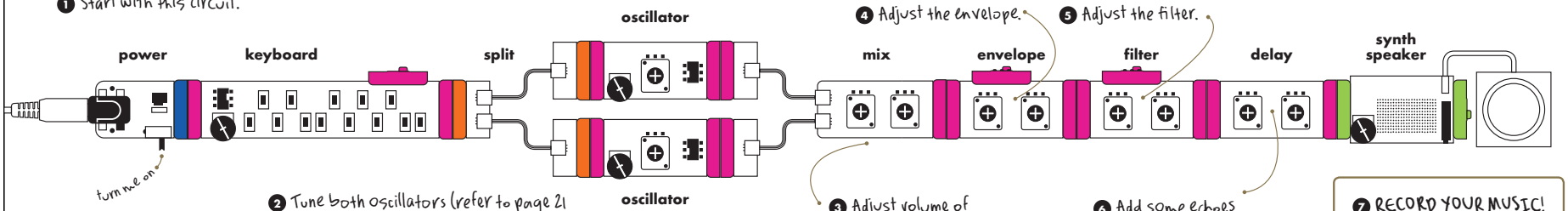
7 Adjust the envelope and delay – these will change your keyboard's sound.

PRO TIP

Use an audio cable to connect your speaker to your computer, headphones, or an amplifier!

SYNTH KIT Create one monster synth with all of these modules!

SYNTHESIZER WITH THE WORKS



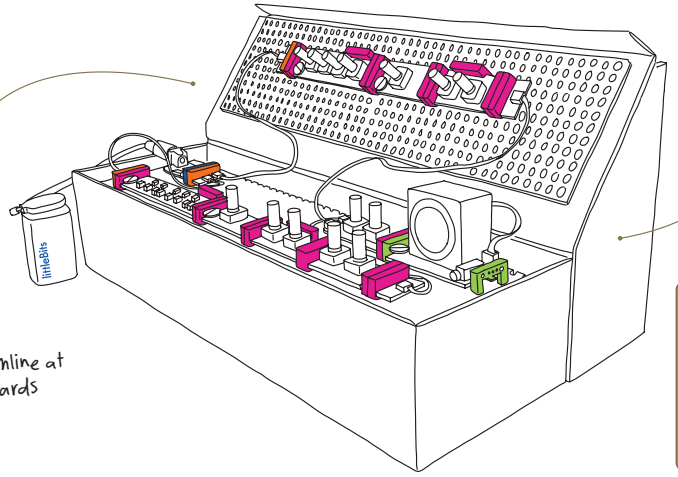
Record your music and share it with us! **littleBits.cc/upload**

SYNTH KIT Transform your box!

PERFORM LIKE A PRO

Visit **littleBits.cc/prosetup** for instructions on how to set up your modules so you can put on live performances anywhere and on the go!

TIME: 60 mins
DIFFICULTY: ●●○○○



Buy mounting boards online at littleBits.cc/mountingboards

Build a performance station!

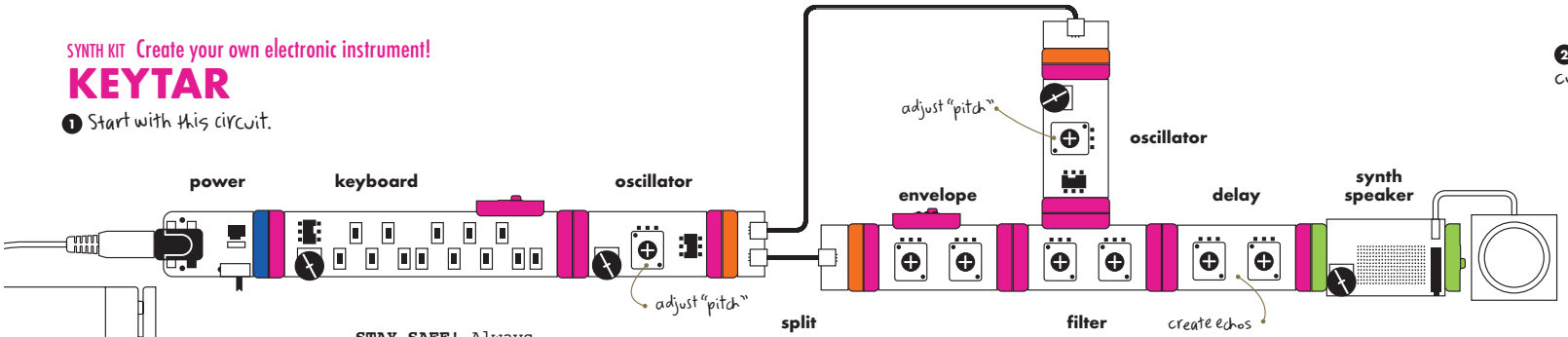
Power up your circuit and START PLAYING!

COOL! Just like the KORG MS-20.

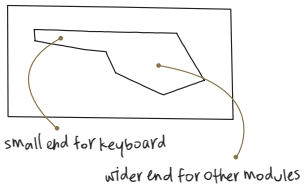
SYNTH KIT Create your own electronic instrument!

KEYTAR

1 Start with this circuit.



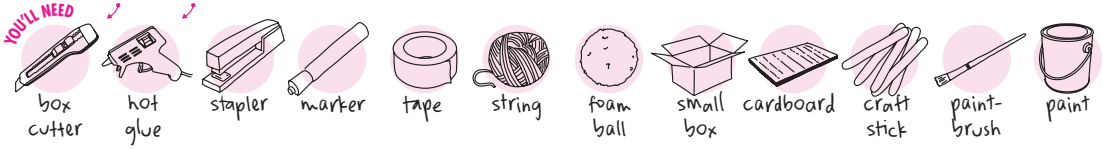
2 Draw a guitar-like shape and cut it out of cardboard.



TIME: 60 mins
DIFFICULTY: ●●○○○

STAY SAFE! Always use with an adult.

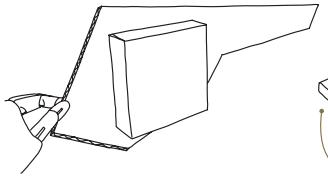
YOU'LL NEED



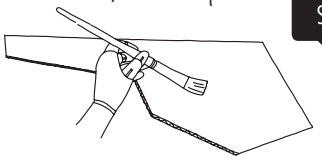
In the early '70s **Edgar Winter** was one of the first people to create a makeshift "keytar" by adding a shoulder strap to an electronic keyboard. Check out the popular song "Frankenstein."

SYNTH HIST

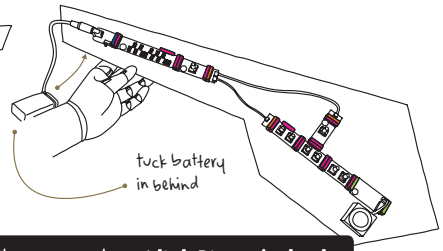
3 Tape or glue smaller box to the back of the wider end.



4 Decorate! Use paint, markers, whatever you have!



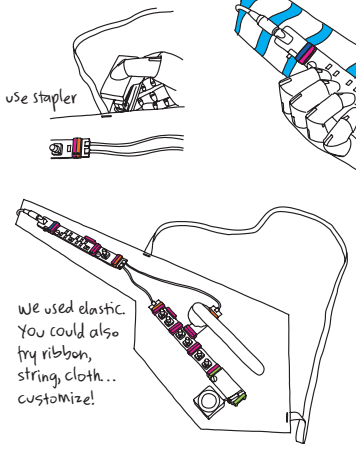
5 Add the circuit.

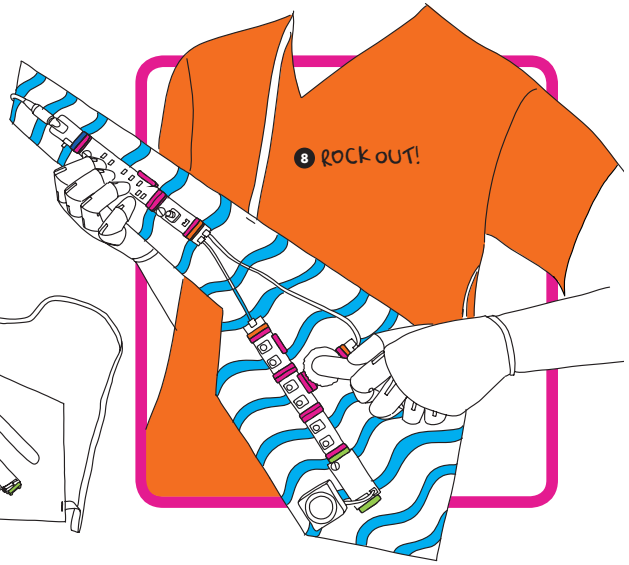


Show us your design! **littleBits.cc/upload**

6 Add a whammy bar!

7 Add a strap.

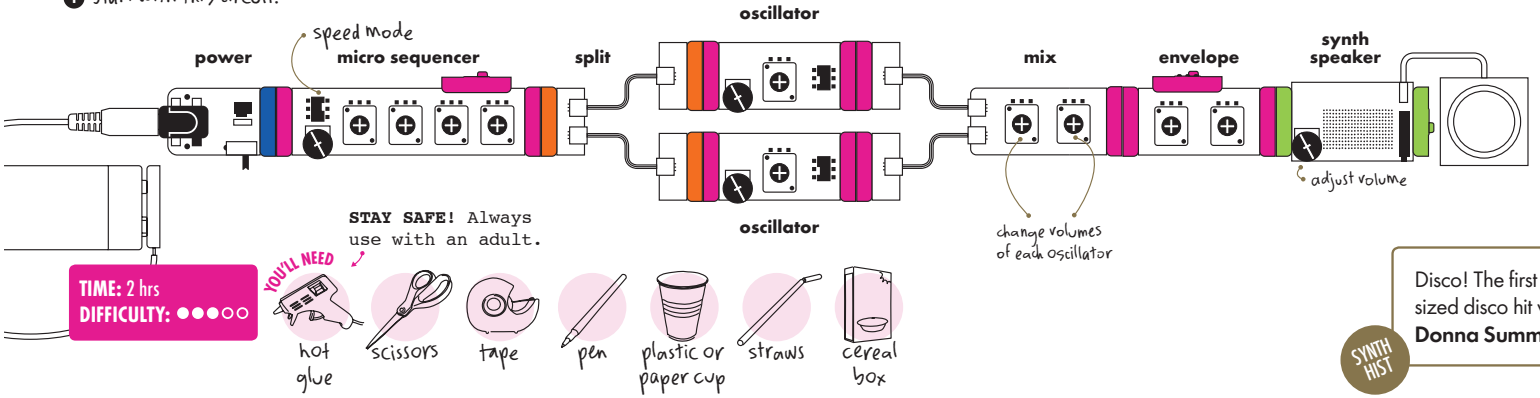




SYNTH KIT Play your Synth Kit like a DJ.

SYNTH SPIN TABLE

1 Start with this circuit.

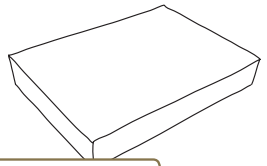


STAY SAFE! Always use with an adult.

TIME: 2 hrs
DIFFICULTY: ●●●○○

YOU'LL NEED

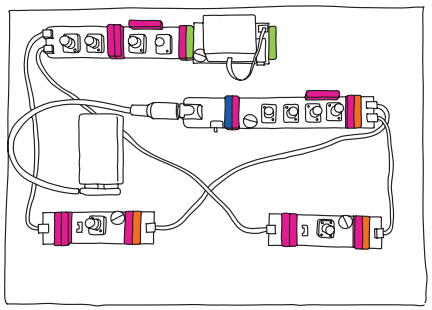
2 Lay cereal box flat.



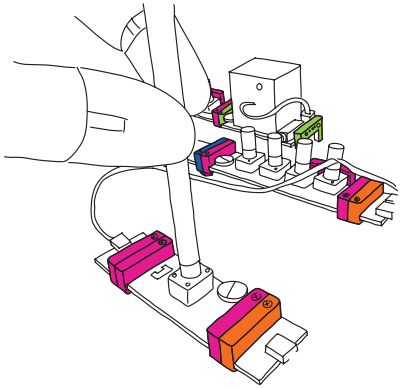
SYNTH HIST

Disco! The first notable fully synthesized disco hit was "I Feel Love" by **Donna Summer** in 1977.

3 Put the circuit on the box. Use tape to keep 'em in place.



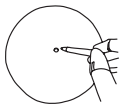
4 Attach one straw on each oscillator knob.



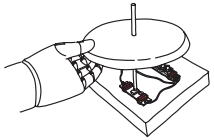
make first turntable

5 Get paper plate cut down to size.

6 Mark center of plate and poke hole.

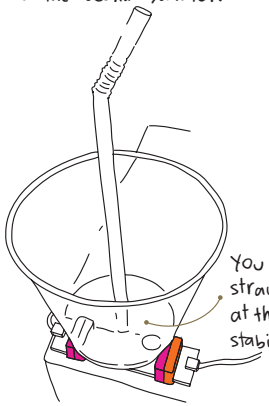


7 Slide plate onto straw.

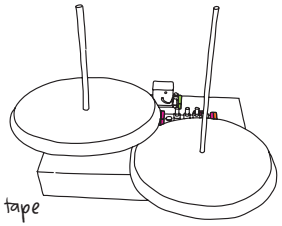


make second turntable

8 Poke a hole in the bottom of a cup and slide it on the straw of the second oscillator.



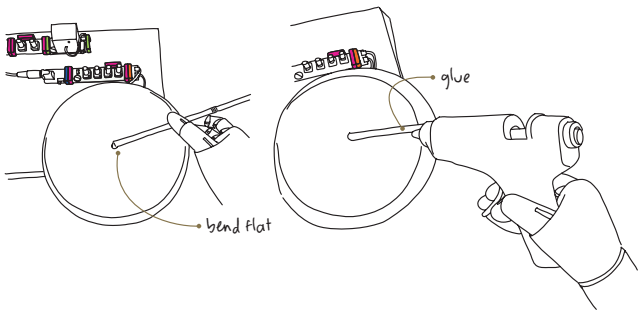
9 Repeat steps 5-7 and add another plate on top of the cup.



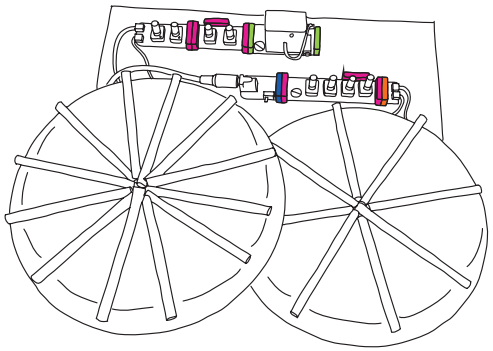
continued on next page

continued from previous page

❿ Glue straws to plates.



⓫ Decorate!



We used colored straws. What materials do you have at home?