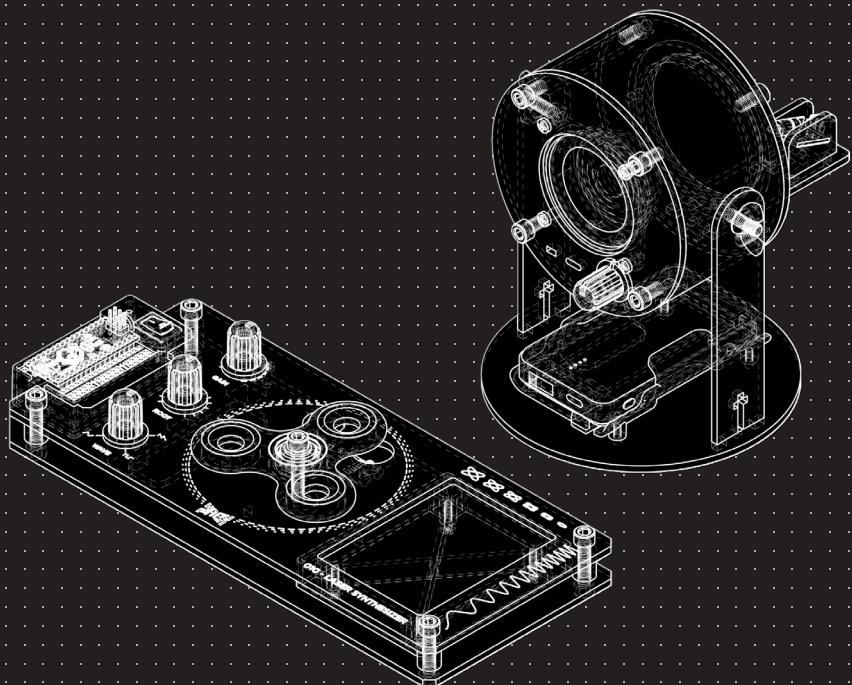


CRUNCH
LABS

PACK



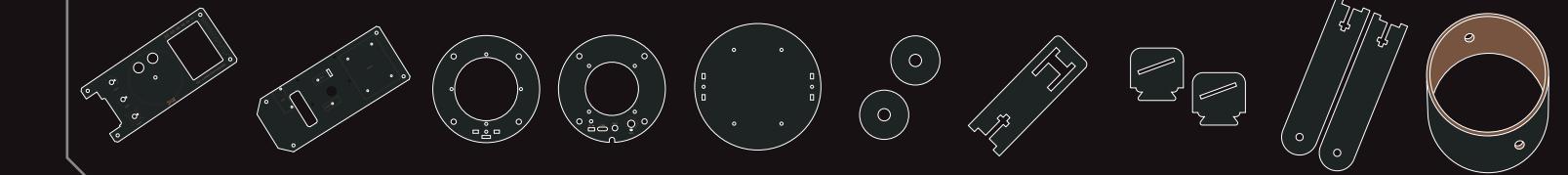
010 - LASER SYNTHESIZER

BUILD ALONG WITH MARK ROBER

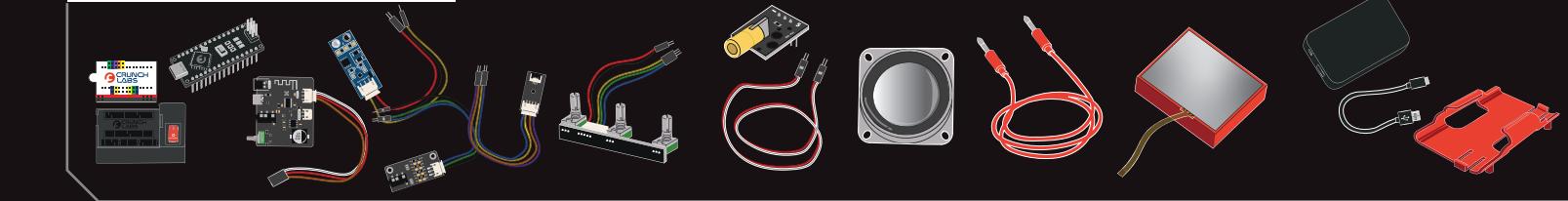


CRUNCHLABS.COM/SYNTH

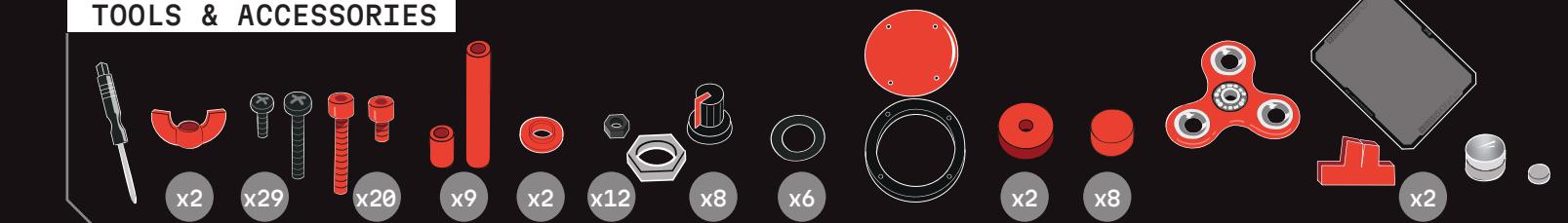
ROBOT CHASSIS



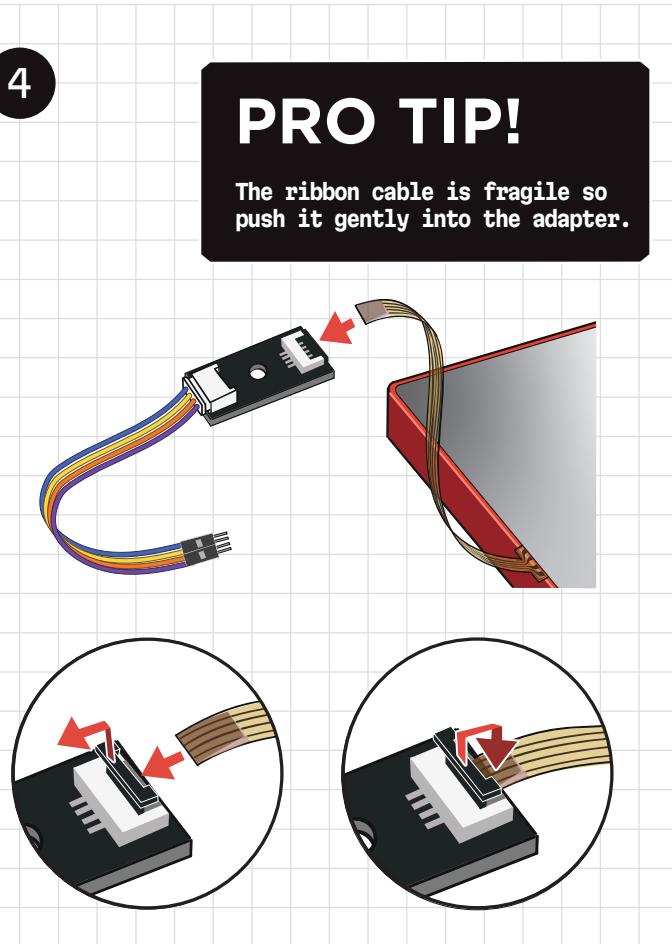
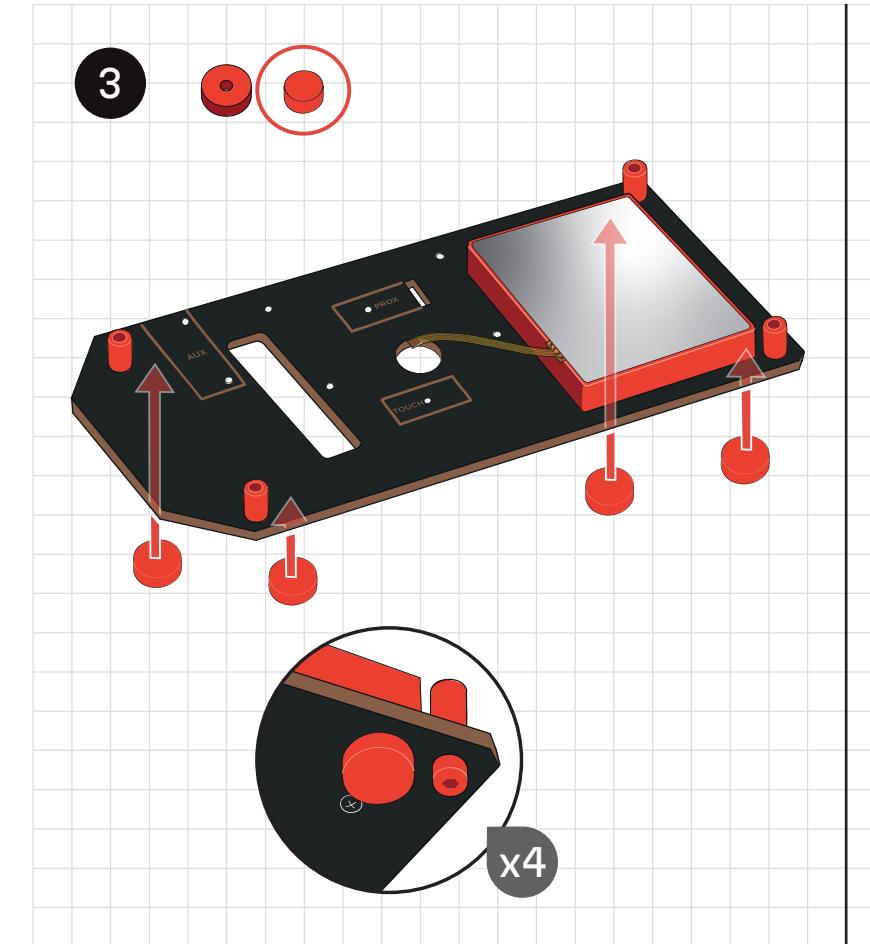
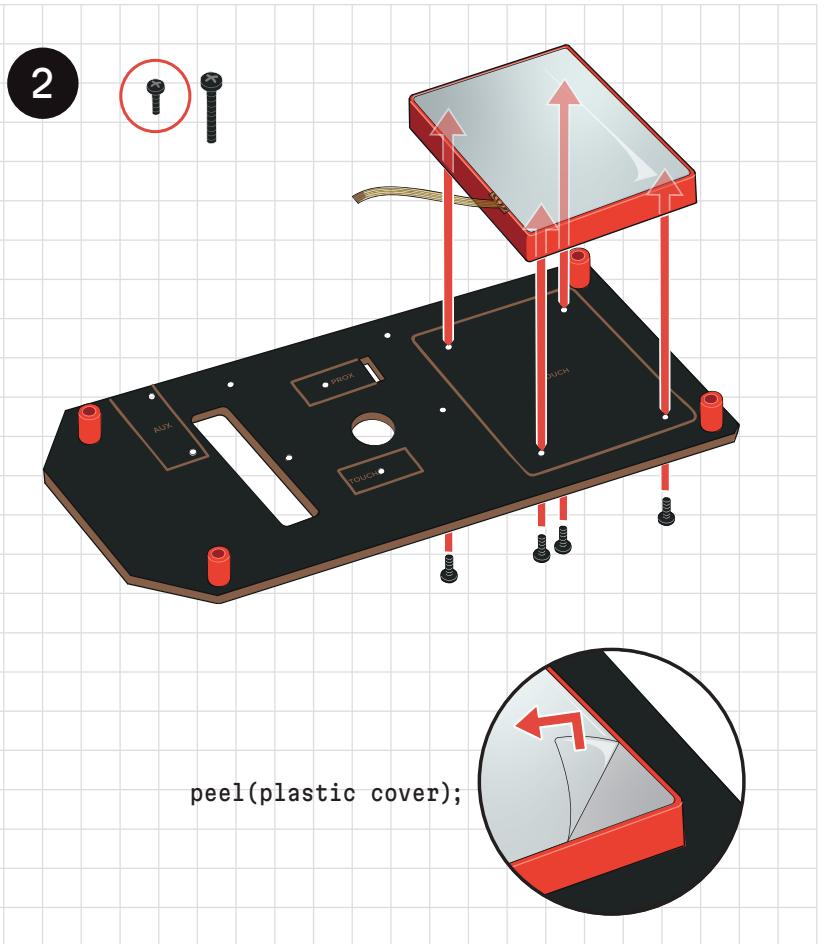
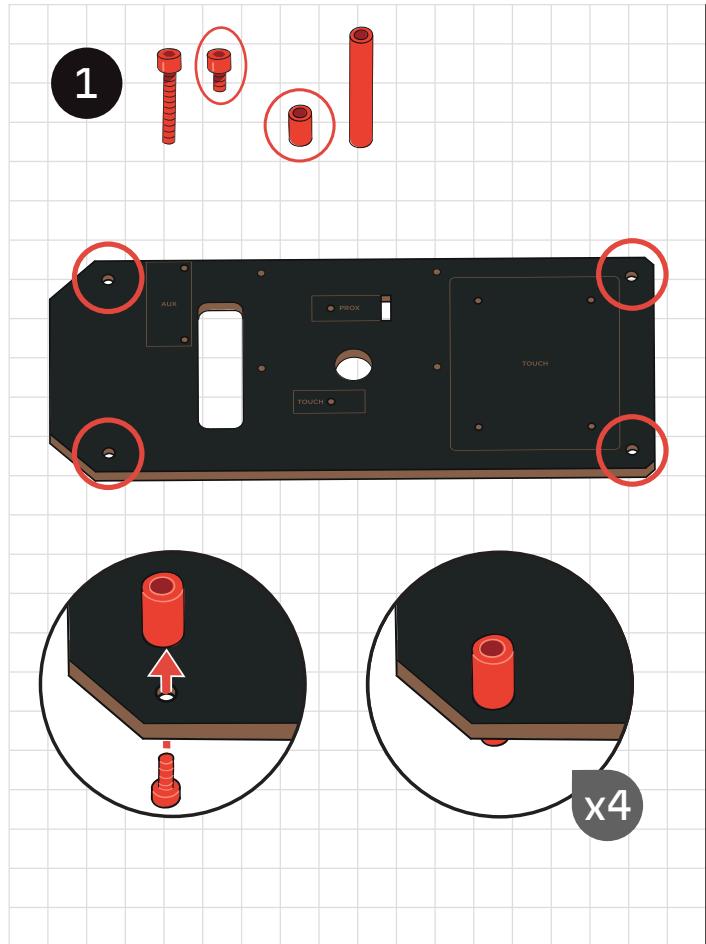
ELECTRONICS

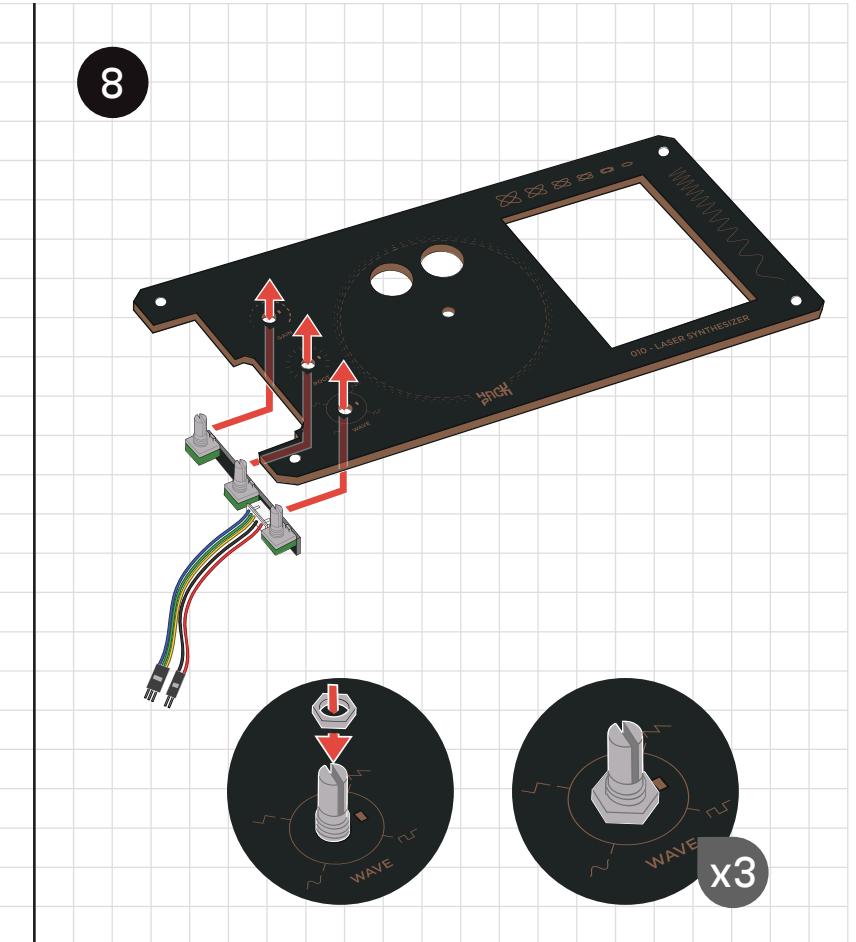
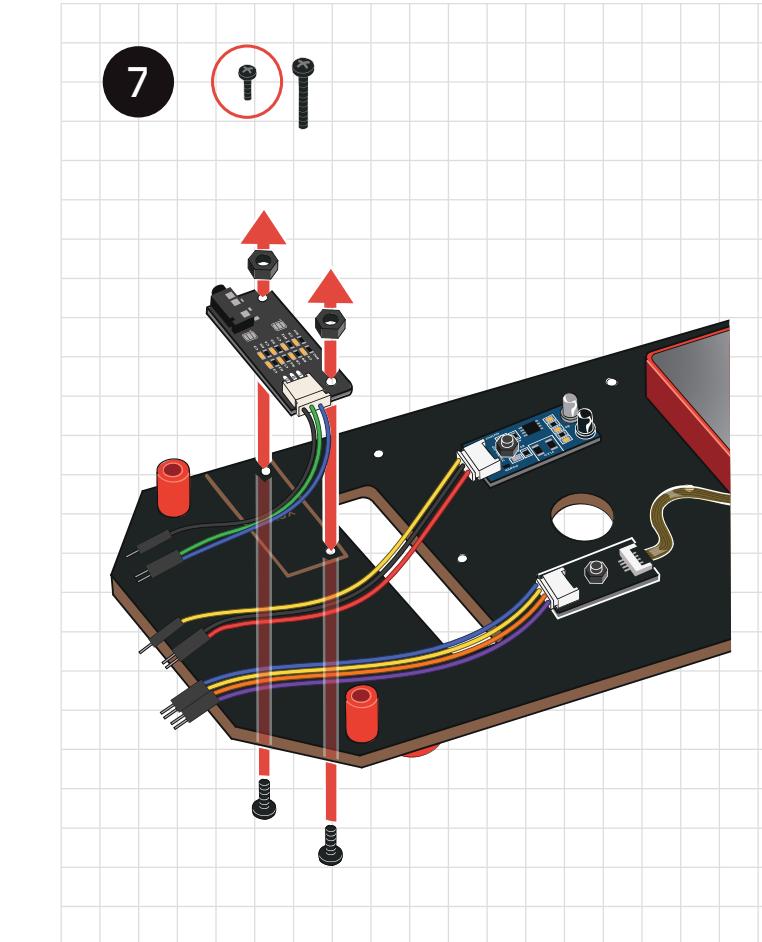
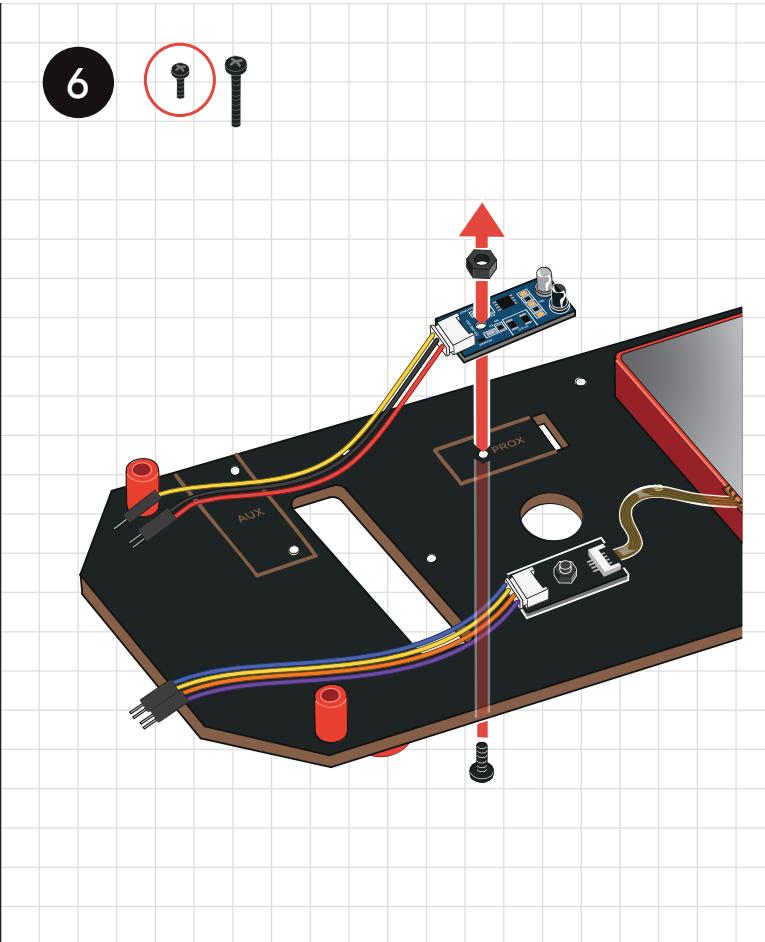
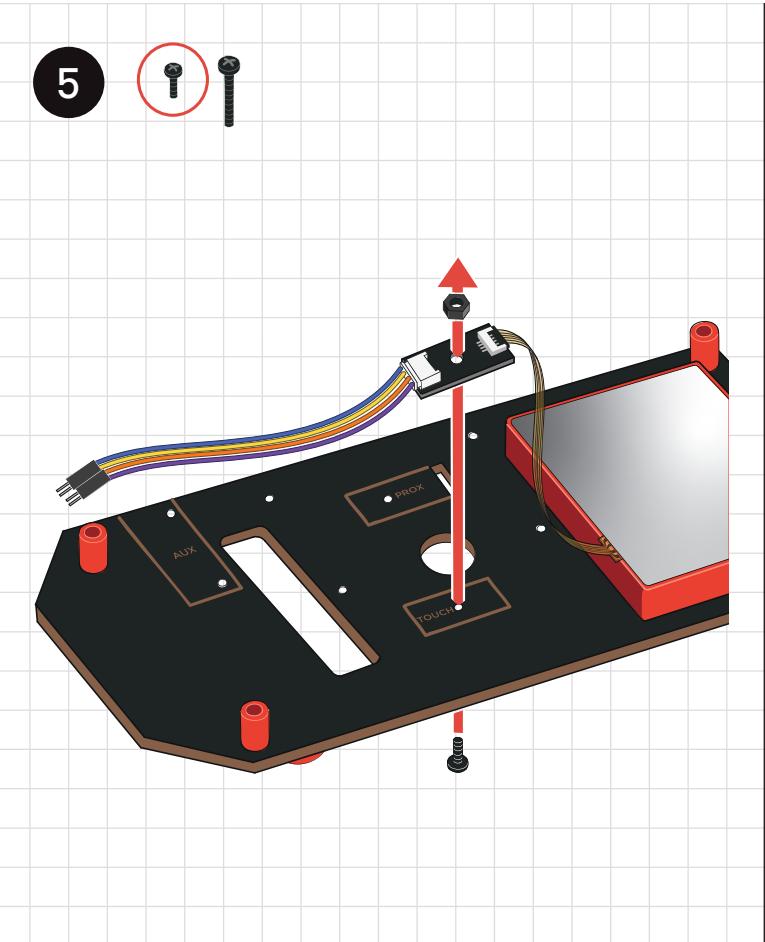


TOOLS & ACCESSORIES

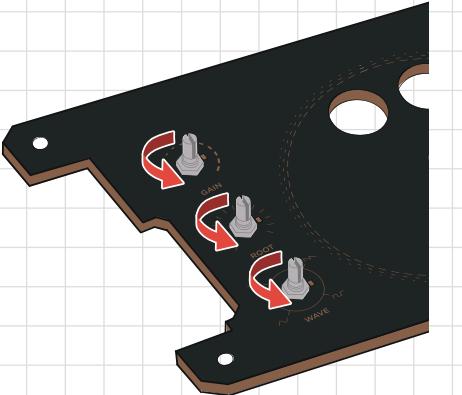


For missing and replacement parts, visit "My Account" at crunchlabs.com and we'll ship them to you for free.





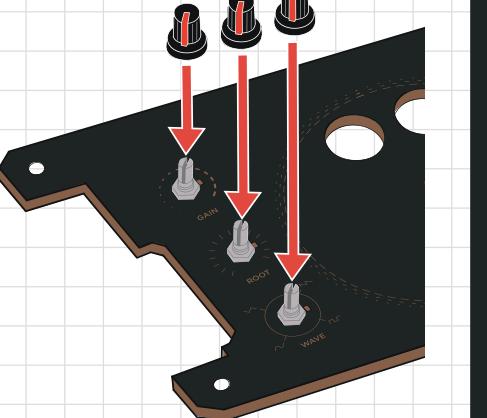
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**PRO TIP!**

Turn the bolt so the lines are facing the left.

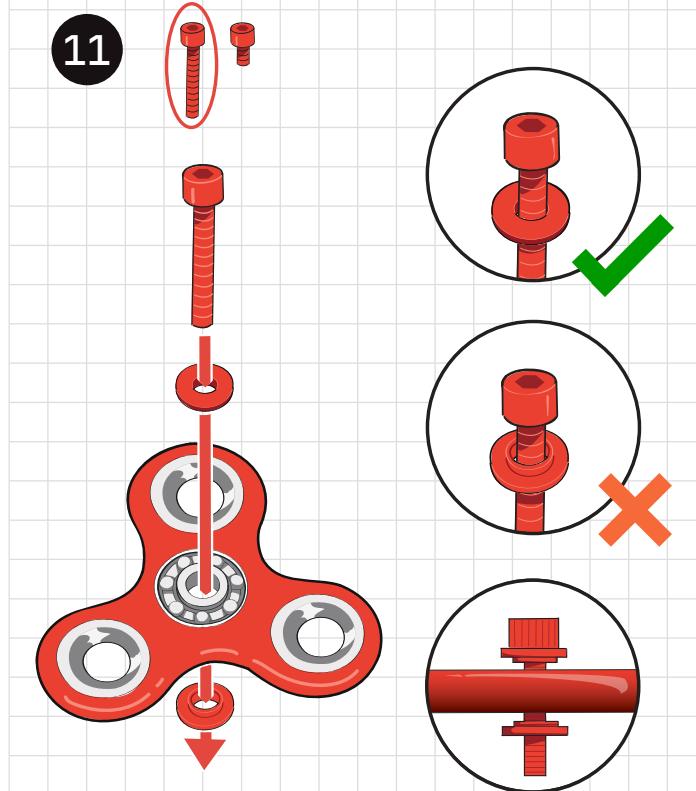


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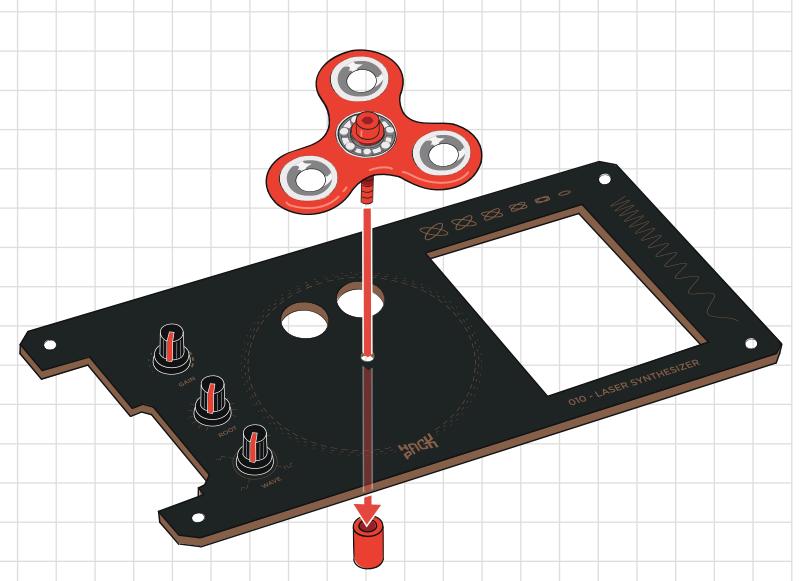
**PRO TIP!**

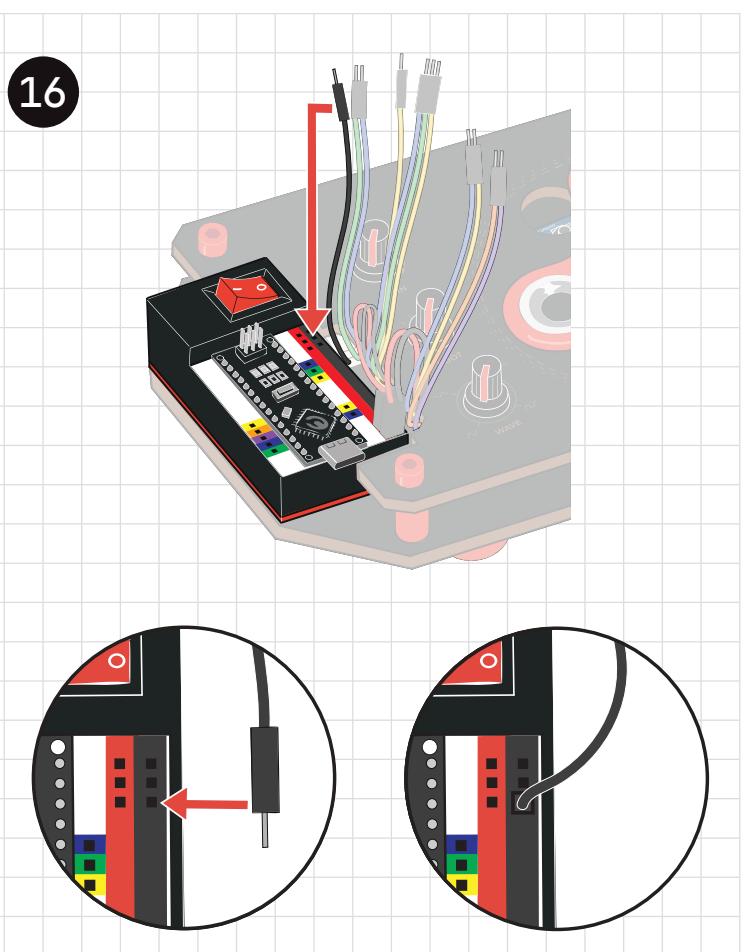
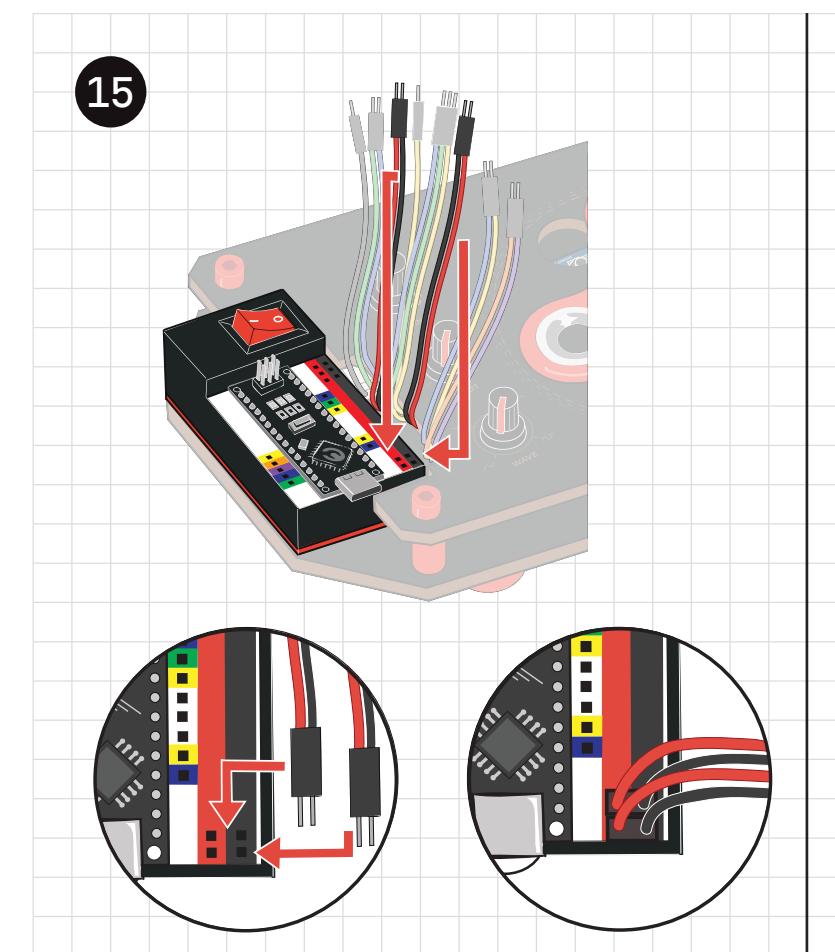
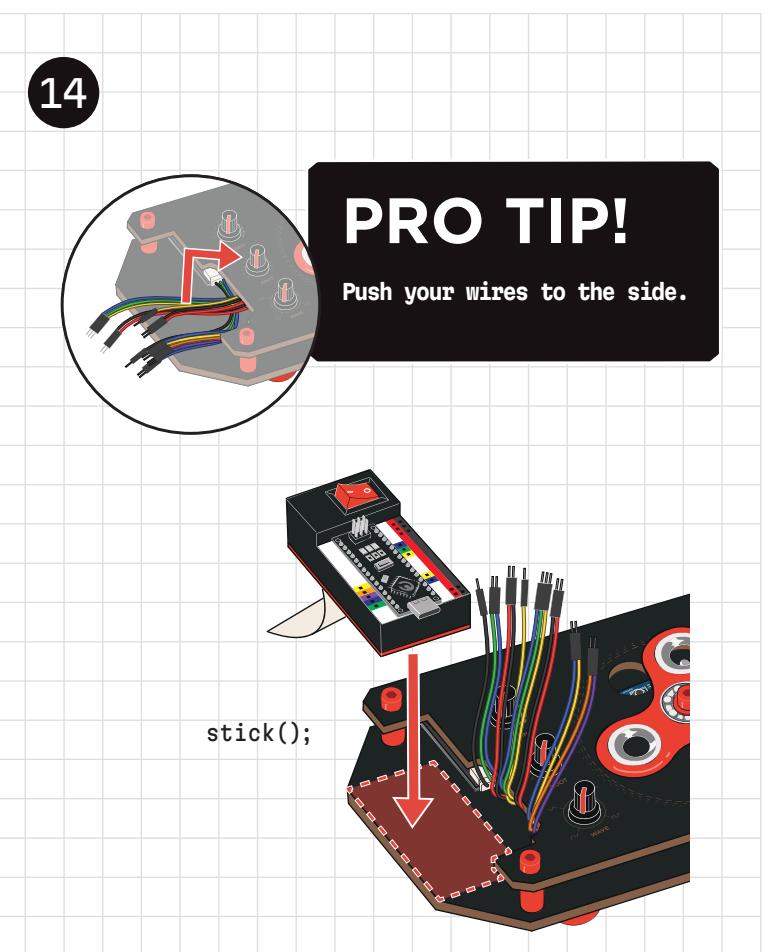
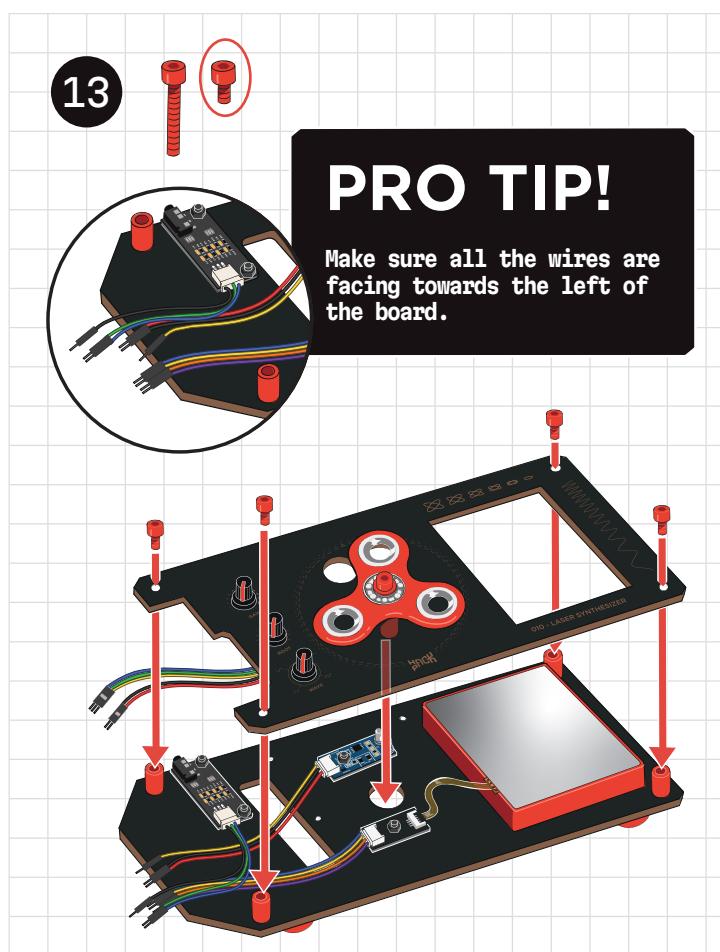
Make sure the knobs are facing left side.

11

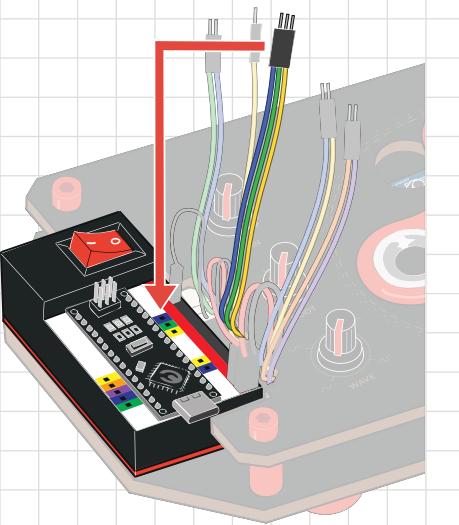


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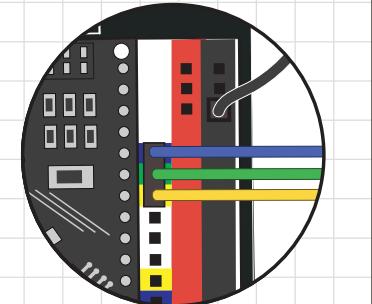
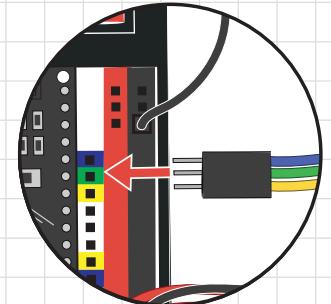
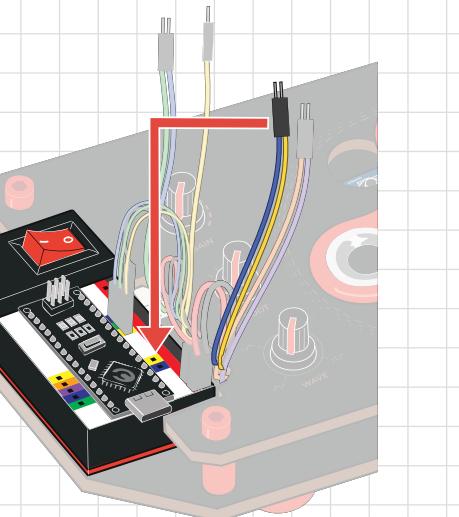




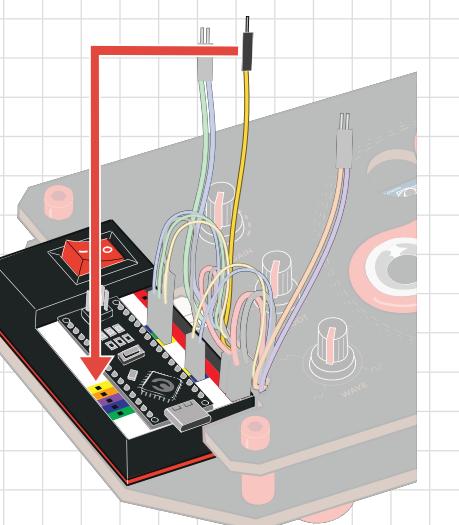
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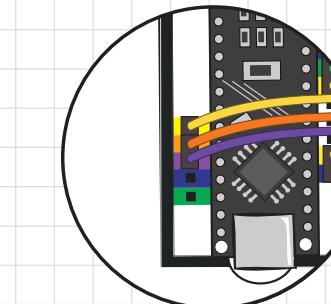
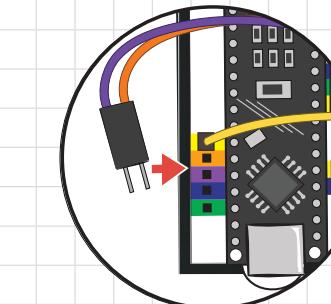
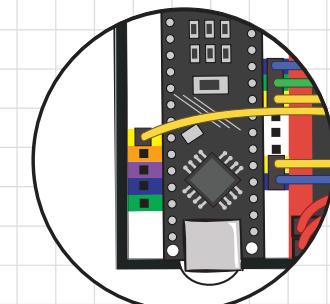
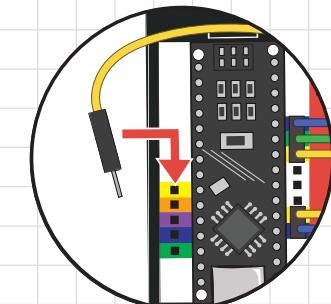
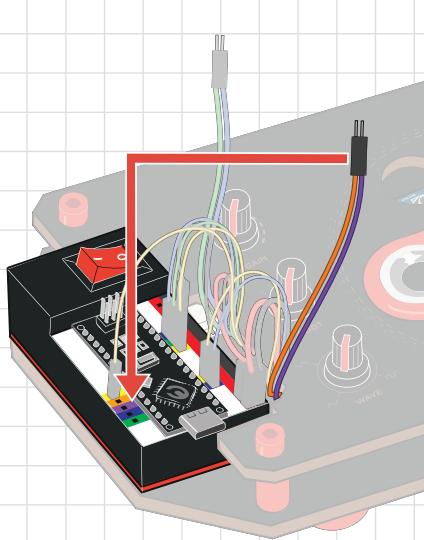
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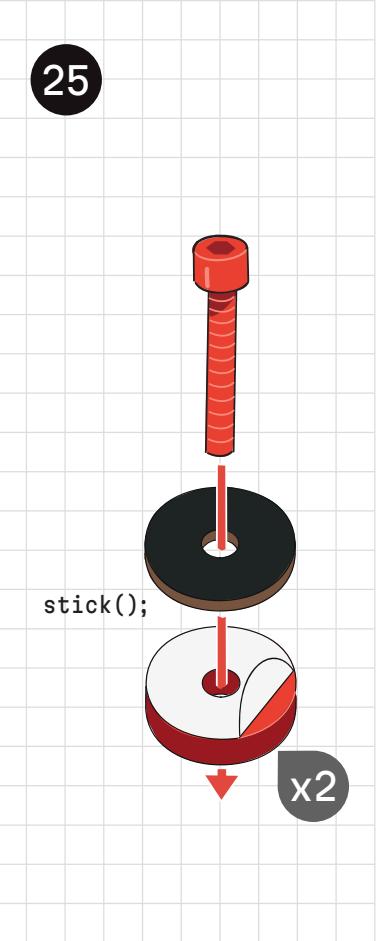
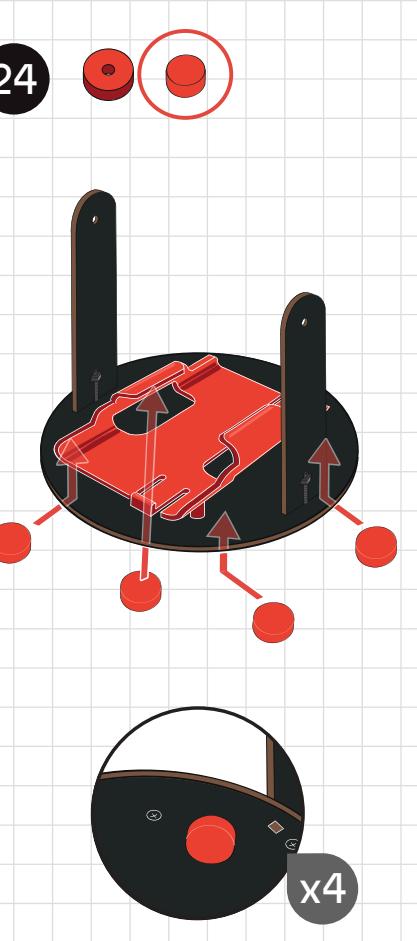
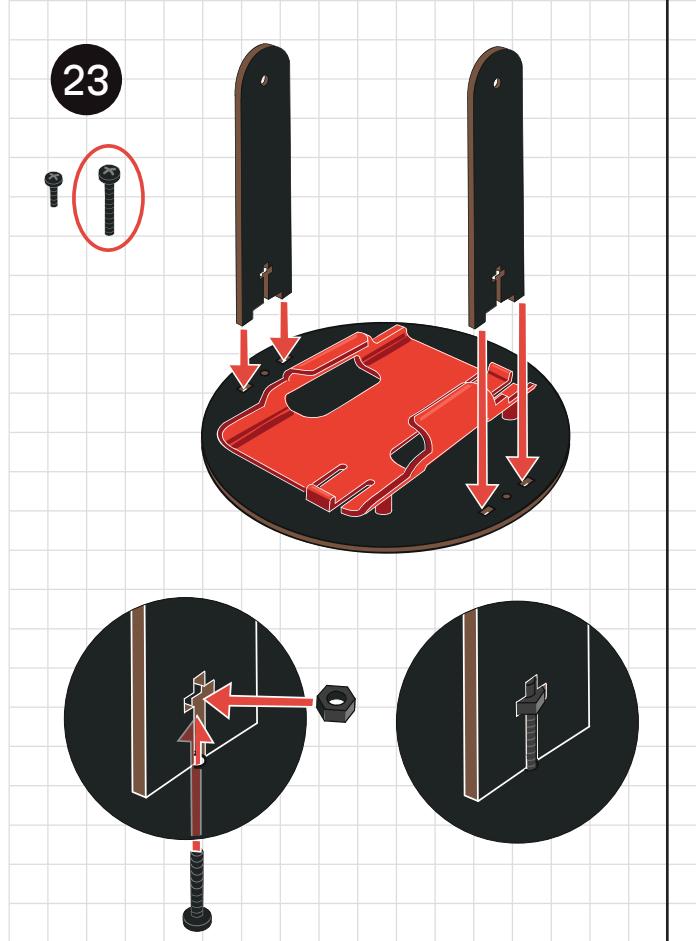
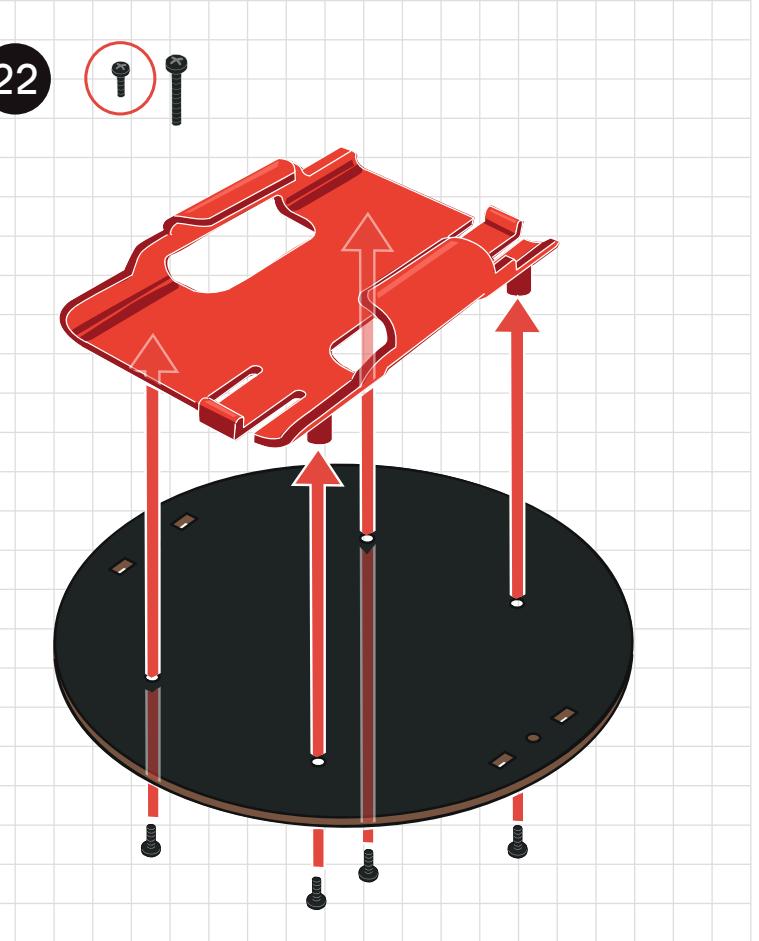
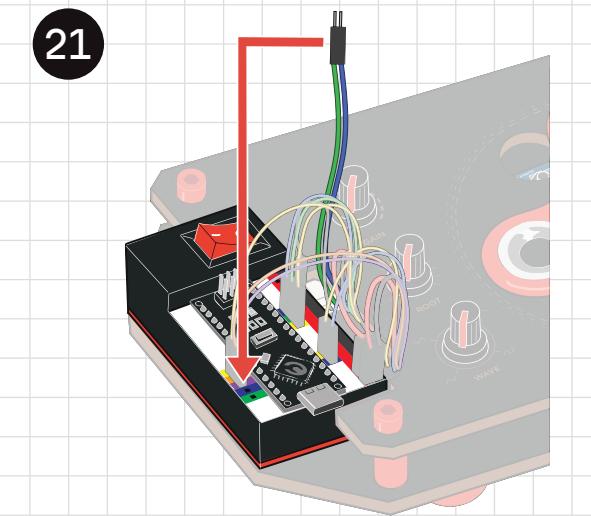


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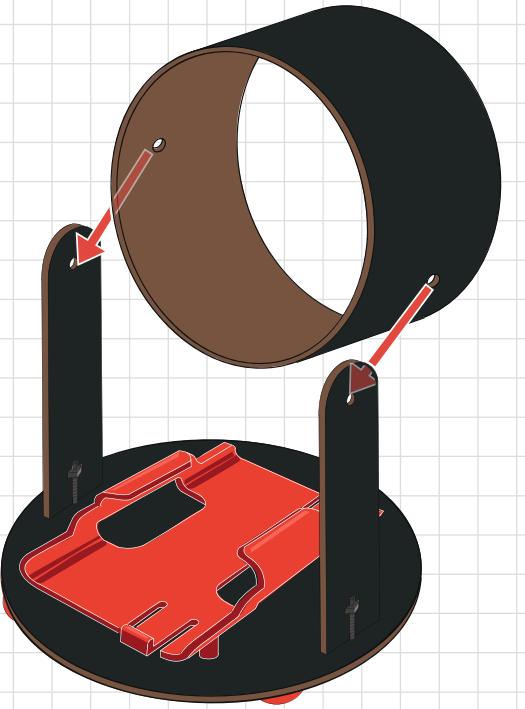


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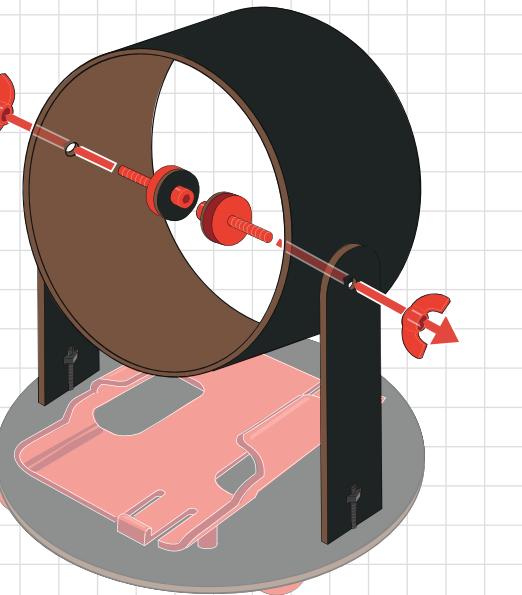




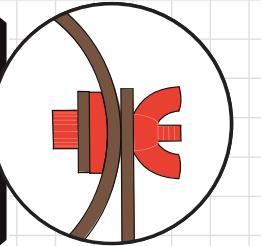
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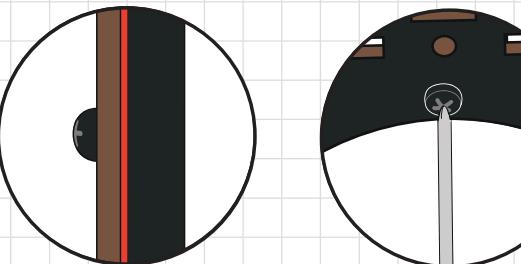
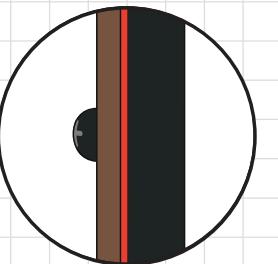
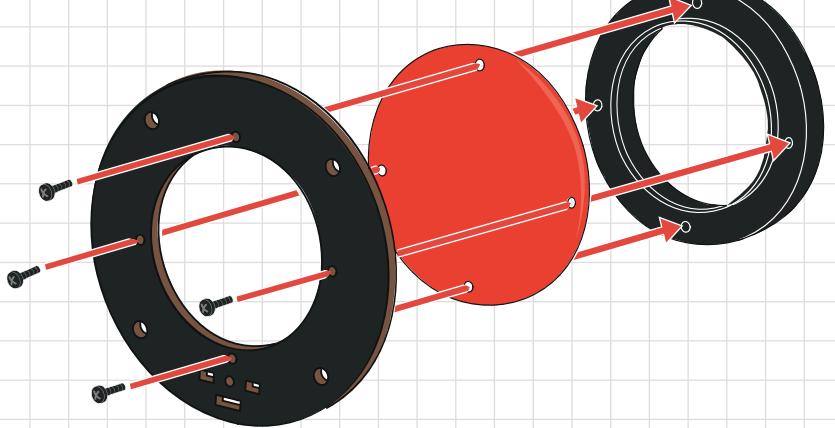
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**PRO TIP!**

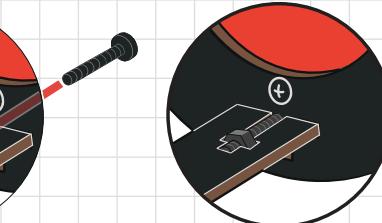
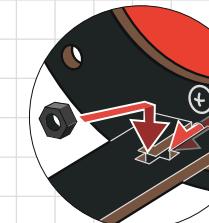
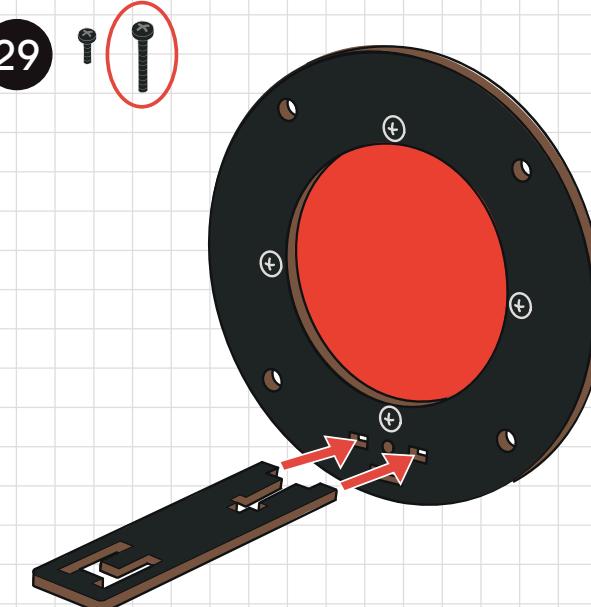
Tighten the bolts so the speaker cylinder can still move.



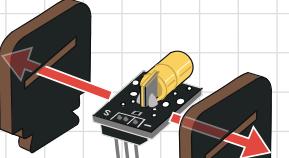
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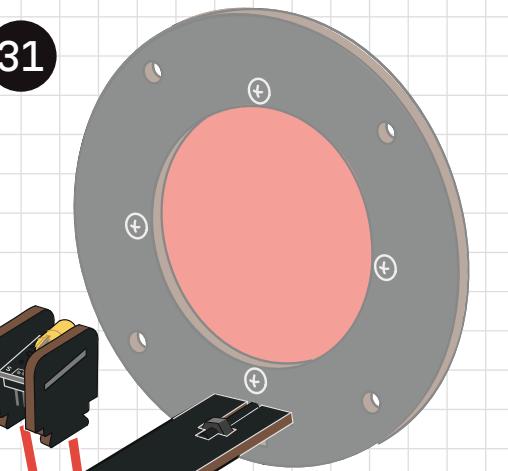
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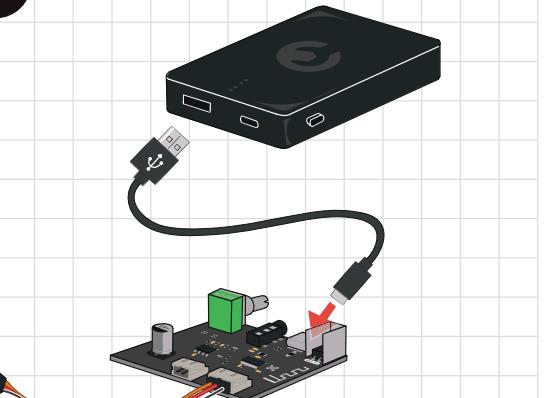
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31



32

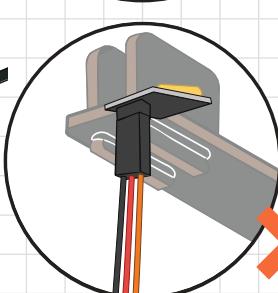
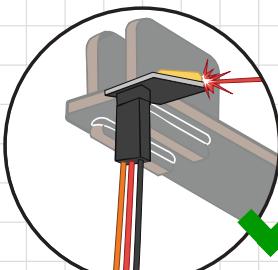
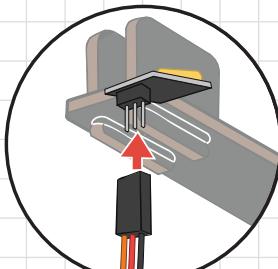
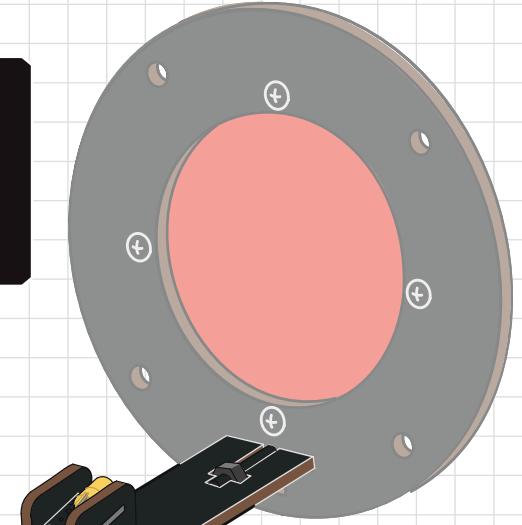
**PRO TIP!**

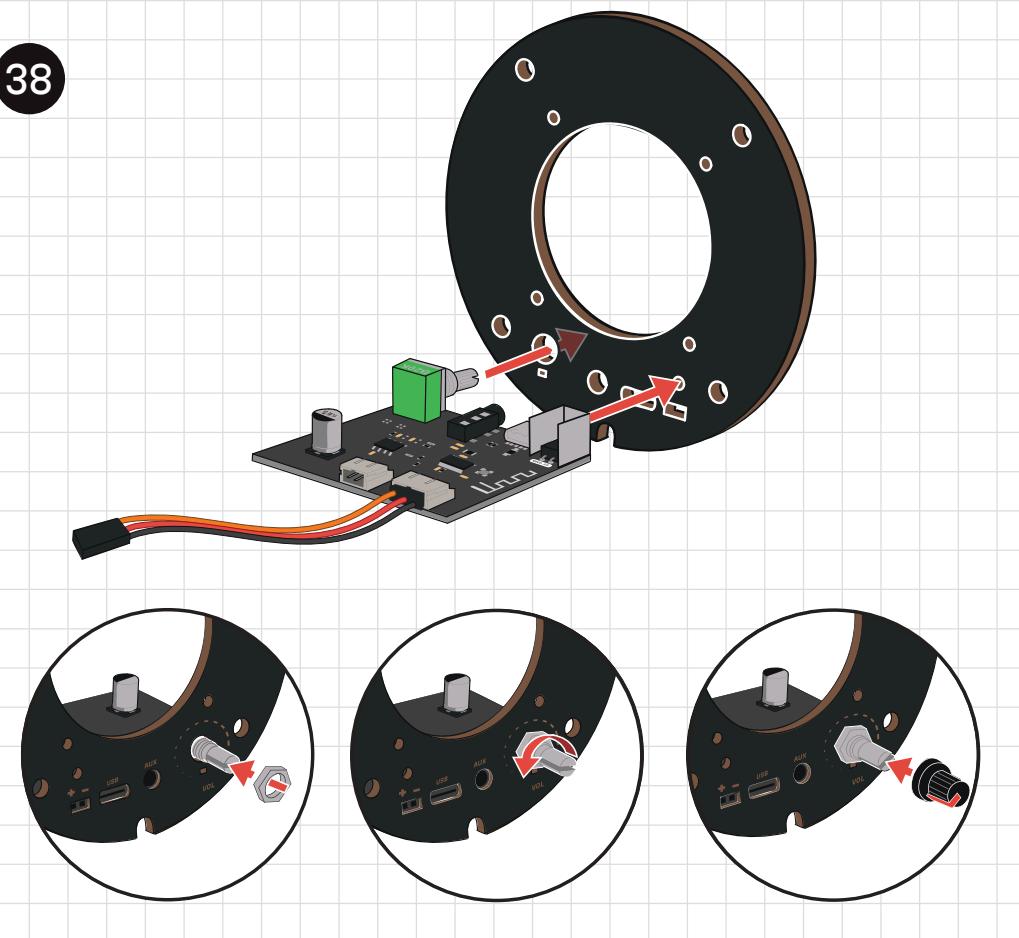
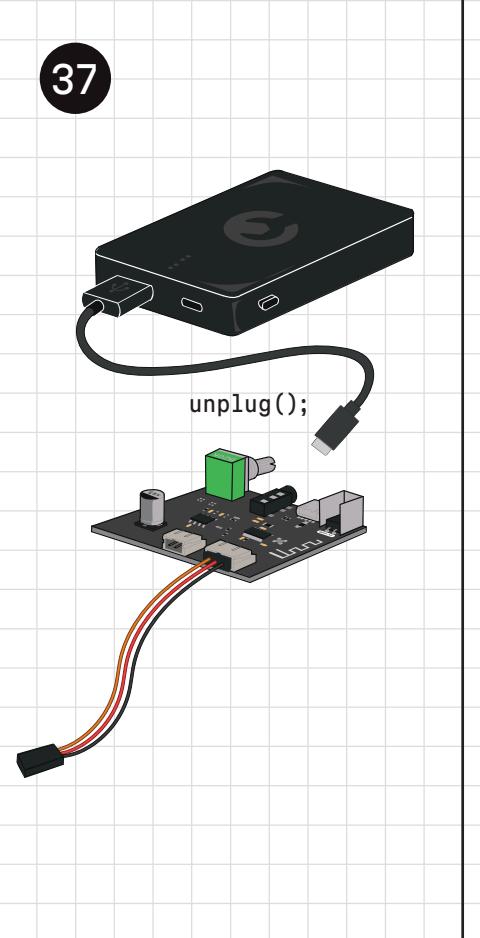
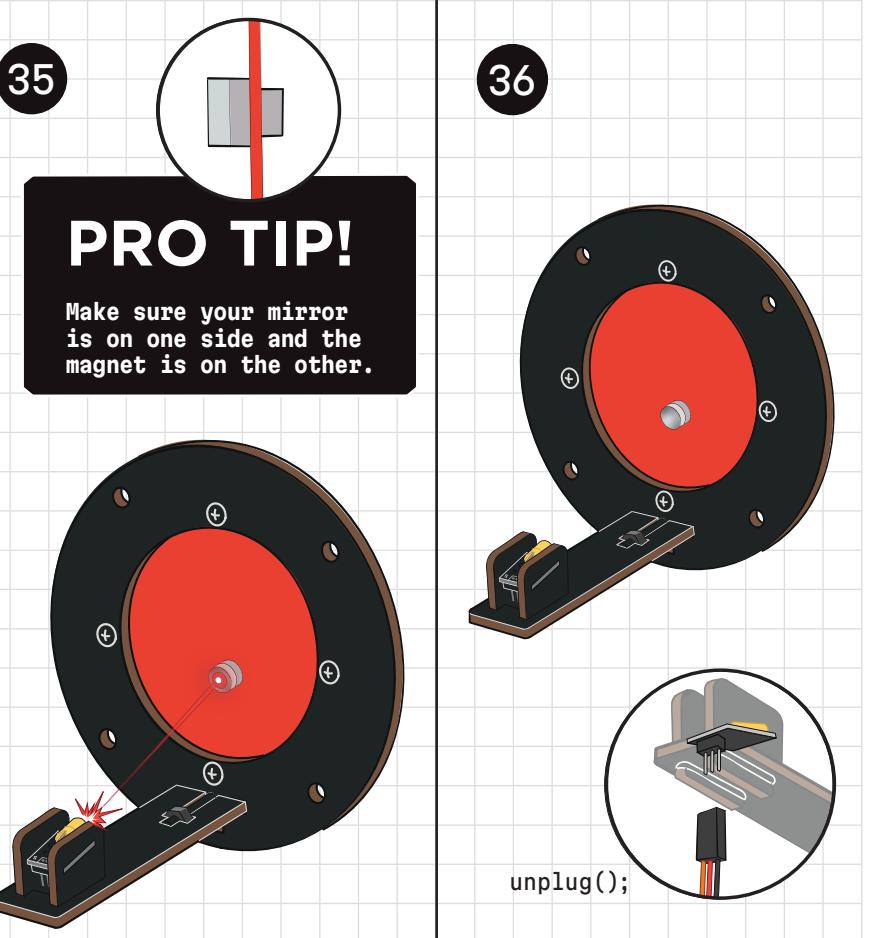
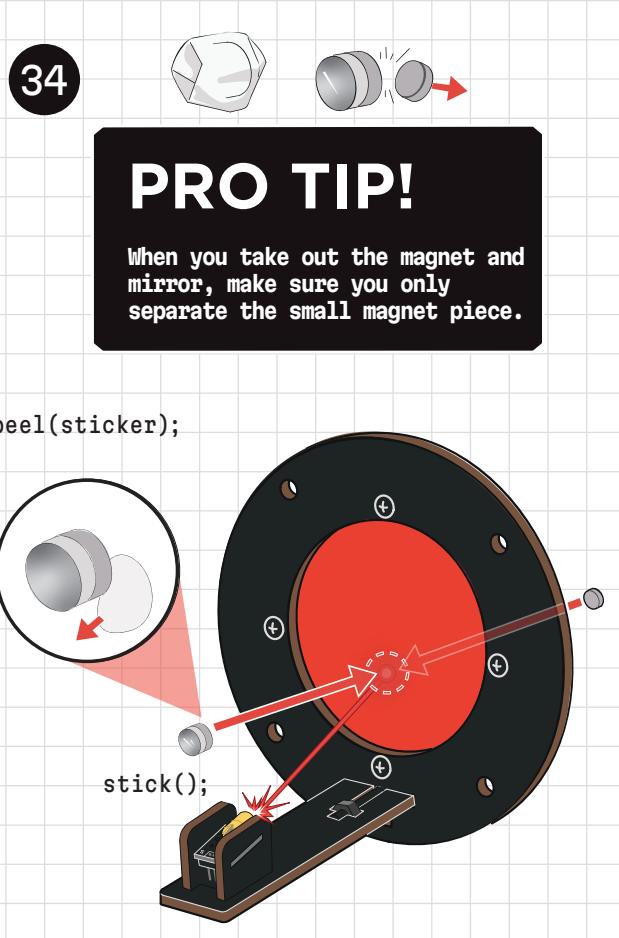
When you plug your board in, the light will blink.

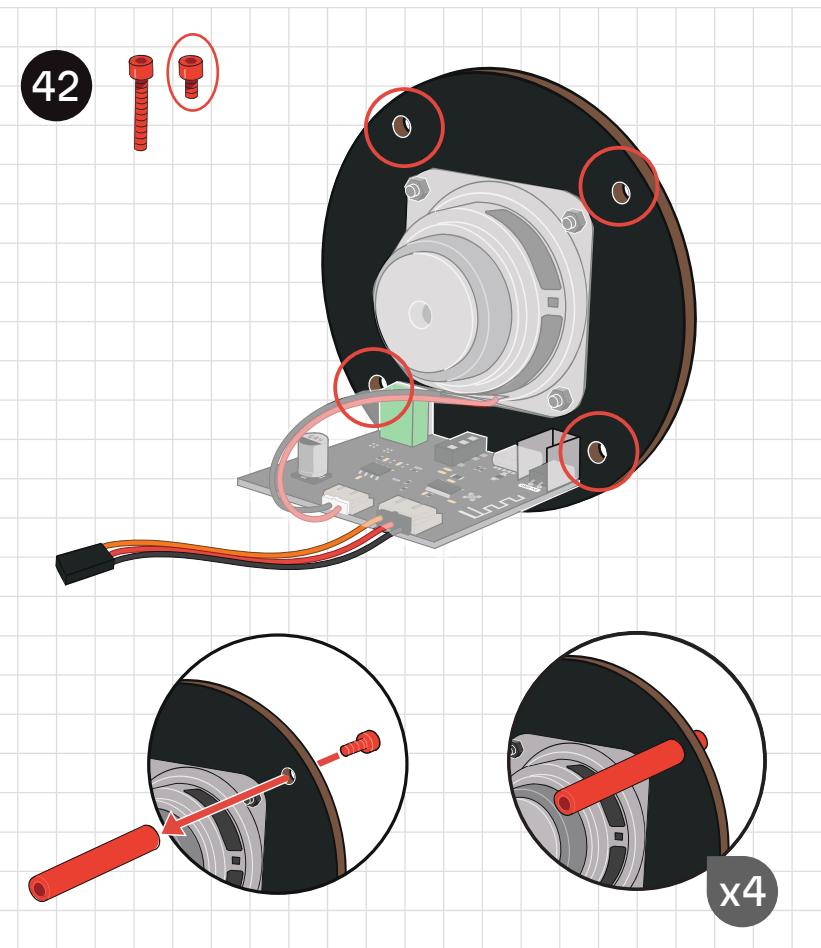
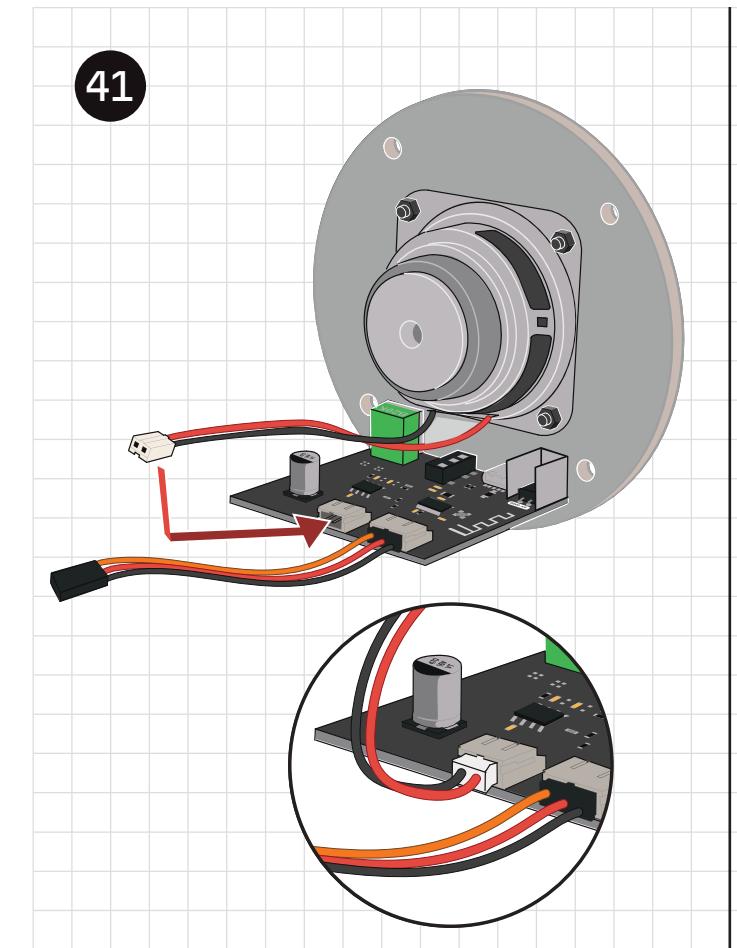
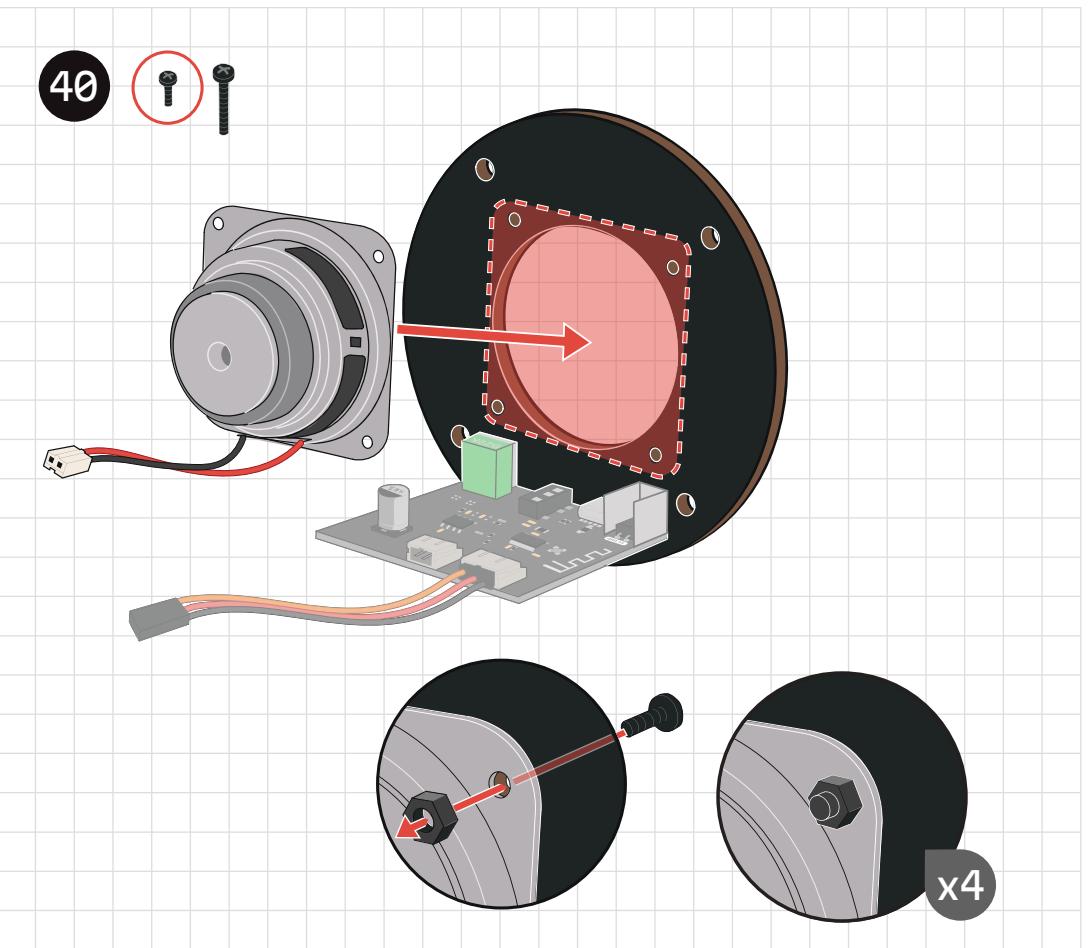
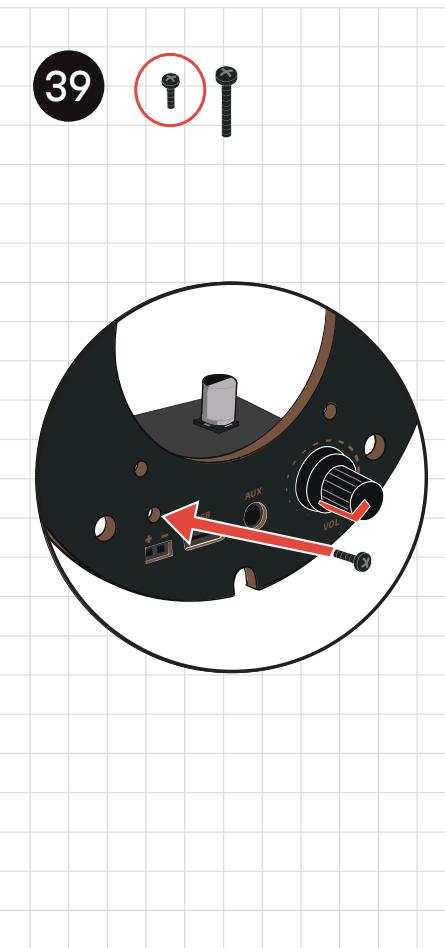
33

**CAUTION!**

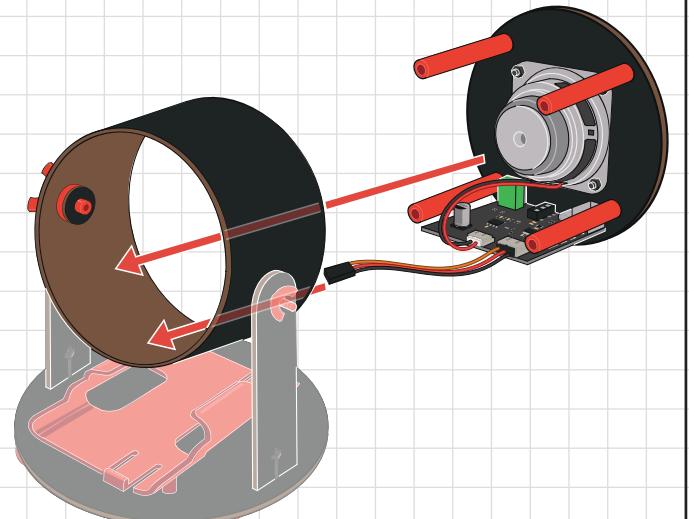
DO NOT point the laser at your eyes!



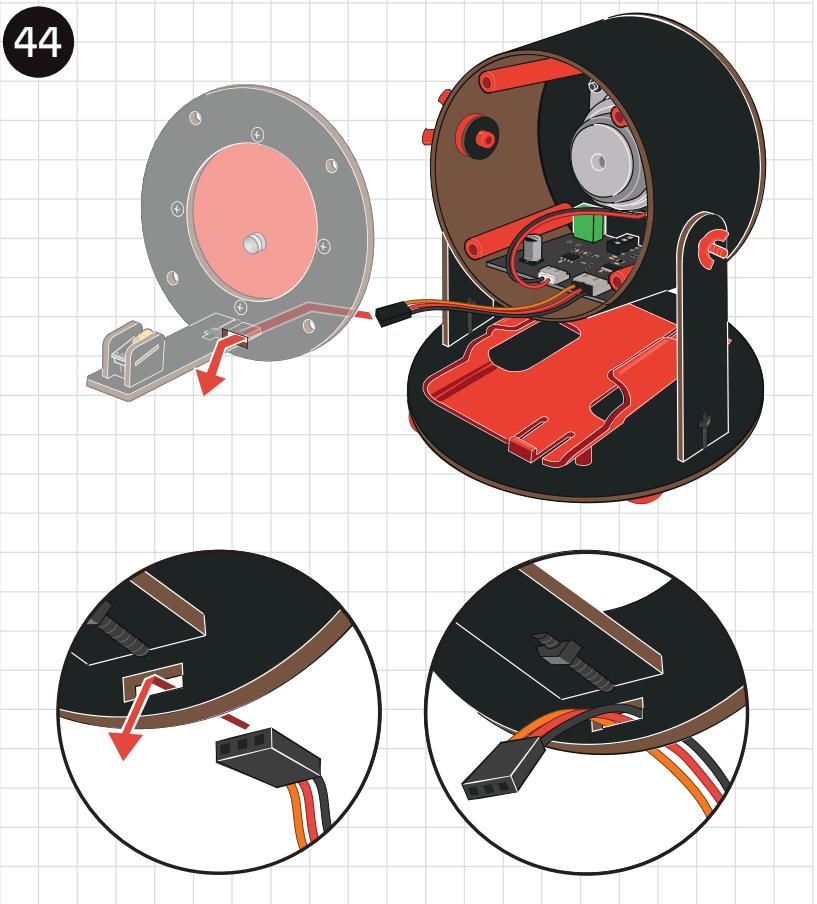




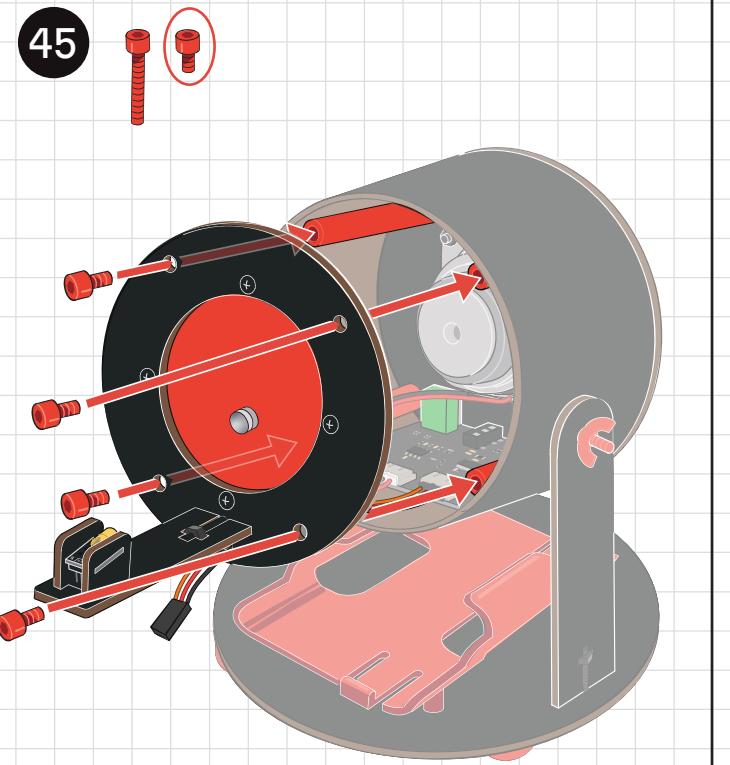
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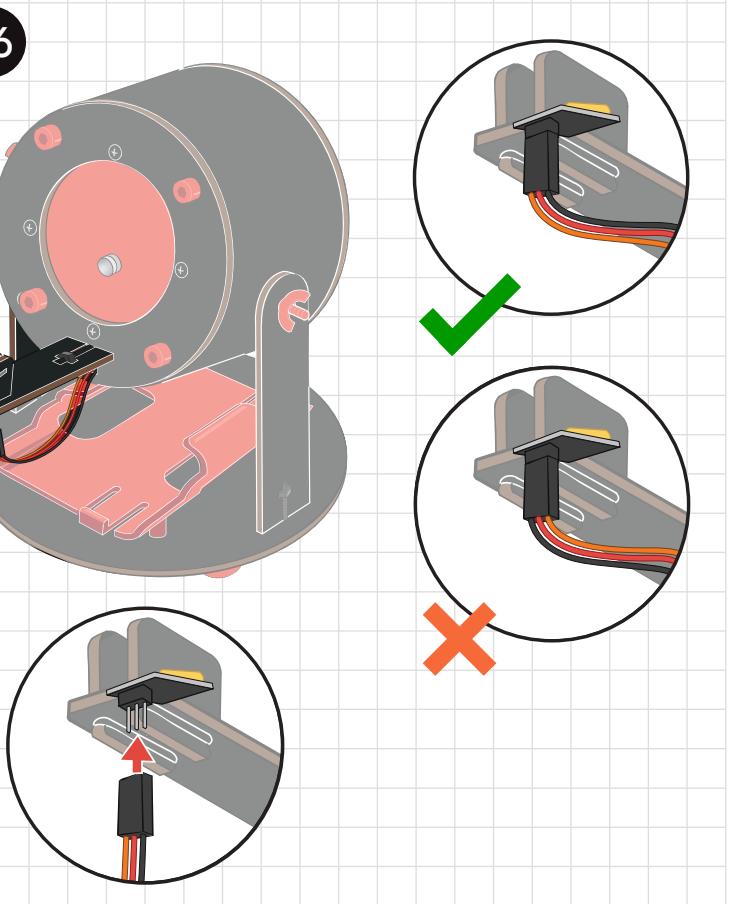
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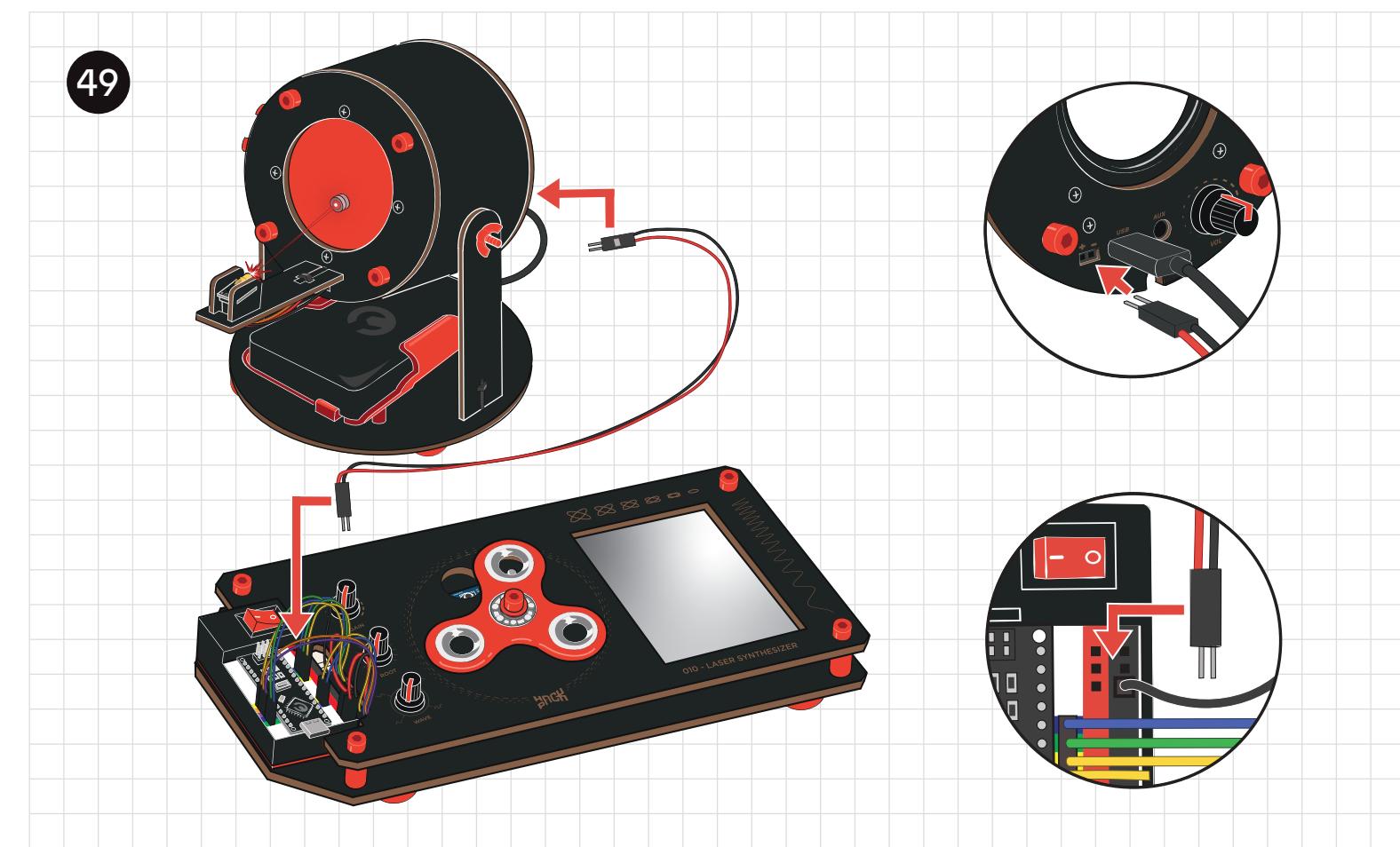
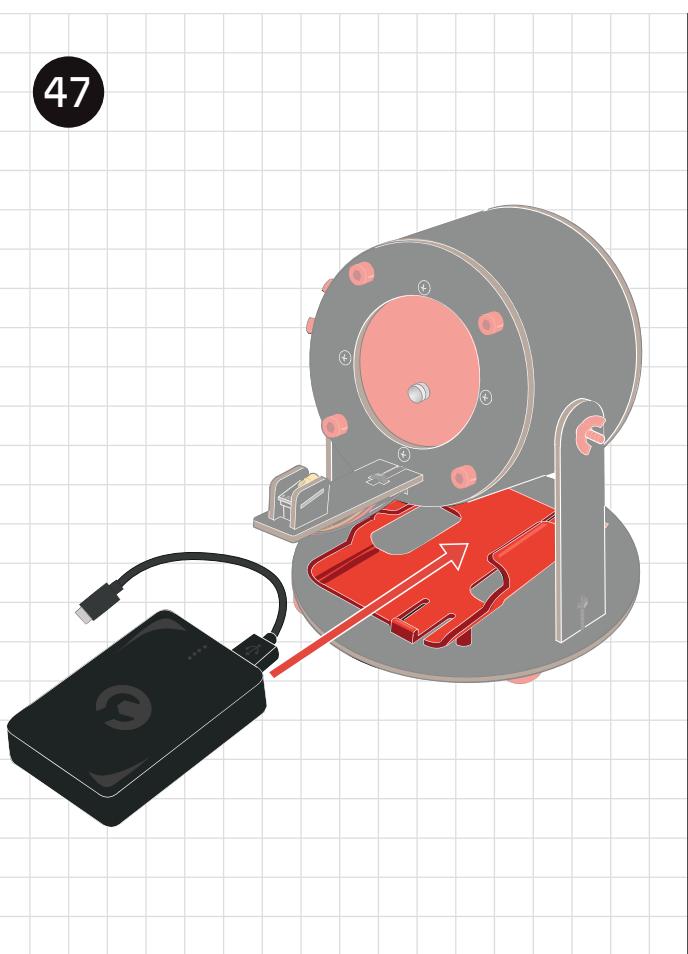


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46

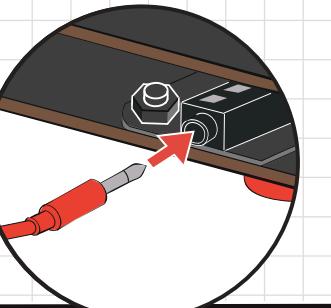
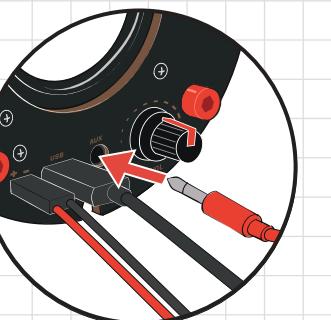




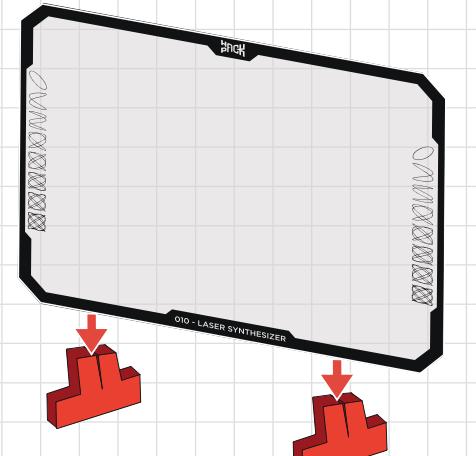
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**PRO TIP!**

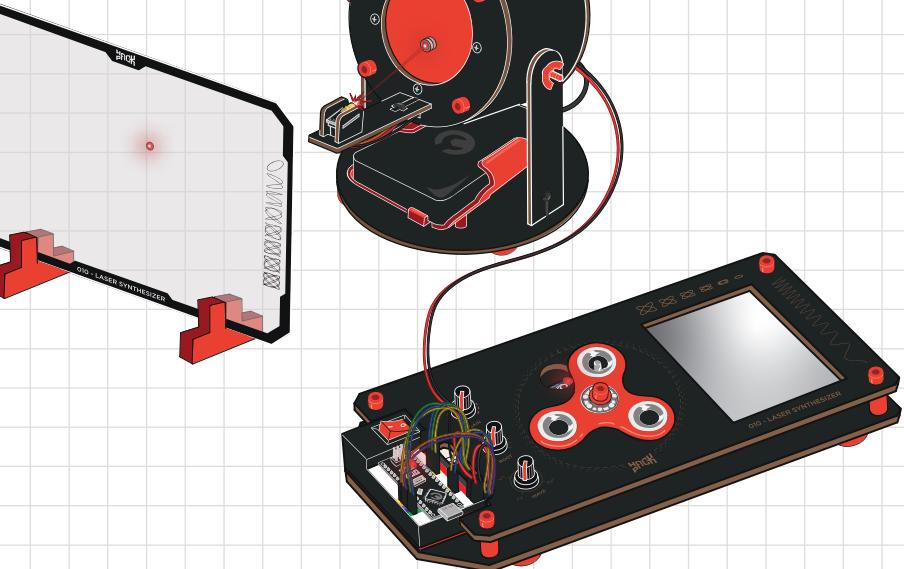
You should hear "AUX MODE" when you plug in the wire.



51



BUILT!



TOOLS YOU NEED



GAIN



ROOT



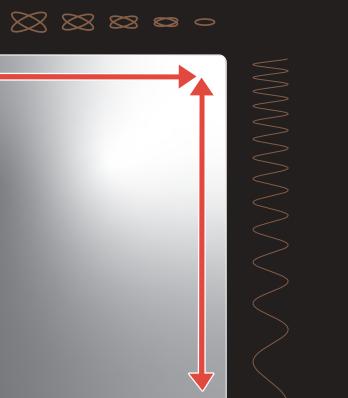
WAVE

GAIN is the value which scales the audio signal, so that you can control volume. At higher values the signal will start to clip causing a more crunchy, distorted sound.

ROOT sets the second note which is played when you touch the touch pad (the other is set by **TOUCH Y**) from a preset musical scale. This can also be changed in software to control other variables, or set the second note as an offset of the first.

WAVE changes which waveforms are used to generate the sounds. Each waveform has distinct qualities, so try all of them out and see which you like best. You can even combine waveforms in the software to craft your own sounds!

Having trouble? Watch the video at
crunchlabs.com/synth



O10 - LASER SYNTHESIZER

The **TOUCH PAD** uses electrical resistance to read the X and Y positions of your finger.

TOUCH X increases the volume of the root note as you move from right to left.

TOUCH Y increases the pitch of the main note as you move up.

SET UP

1



GAIN



ROOT



WAVE

Start by turning **GAIN** up half way.

2



O10 - LASER SYNTHESIZER

2



O10 - LASER SYNTHESIZER

3

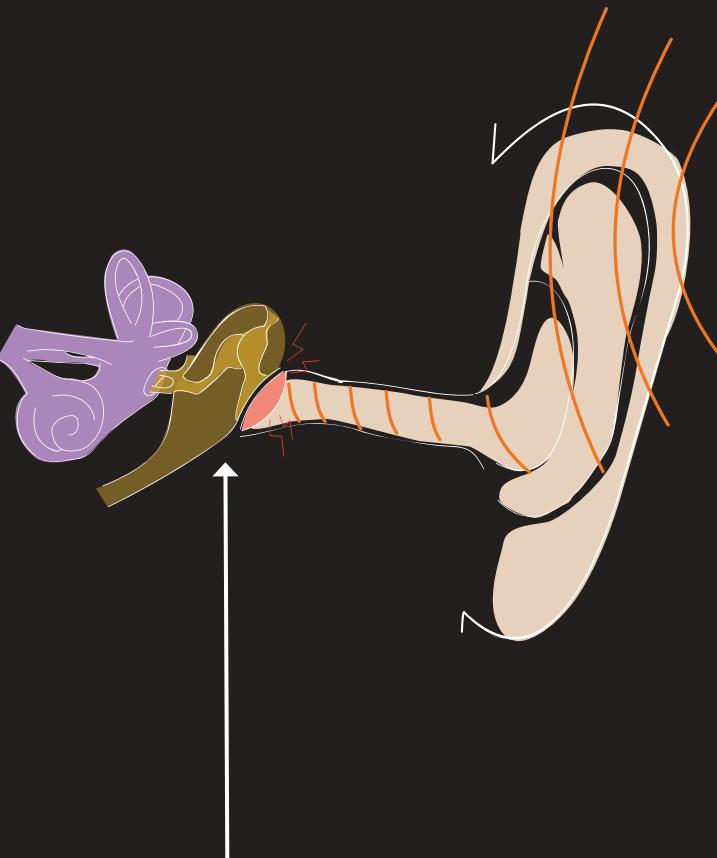


3

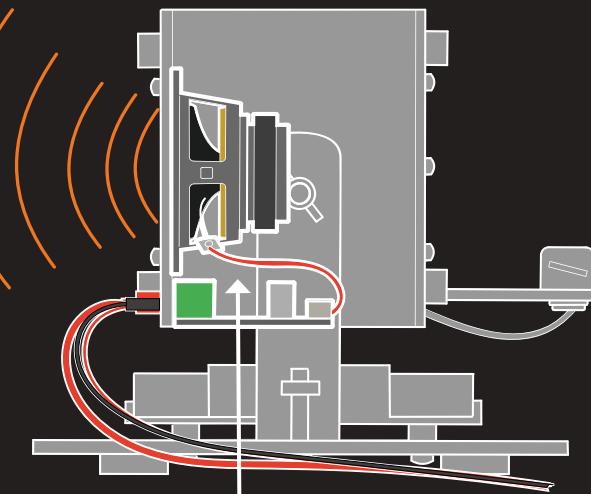
BACK

Create sounds with the touchpad by pressing a fingernail or the end of a screwdriver against it - the pad needs some pressure to read positions properly.

Having trouble? Watch the video at
crunchlabs.com/synth

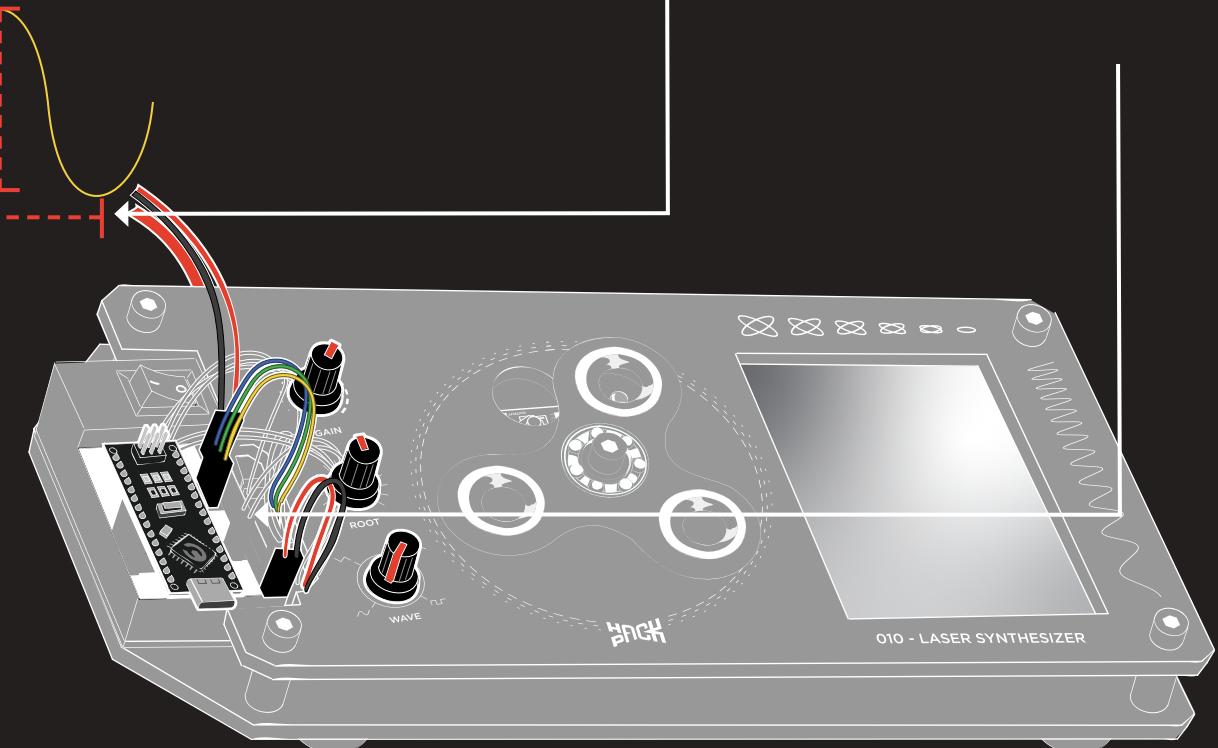


Your sense of hearing relies on air pressure hitting your eardrums which vibrate small bones in the ear to produce nerve signals that the brain interprets into sounds and music.



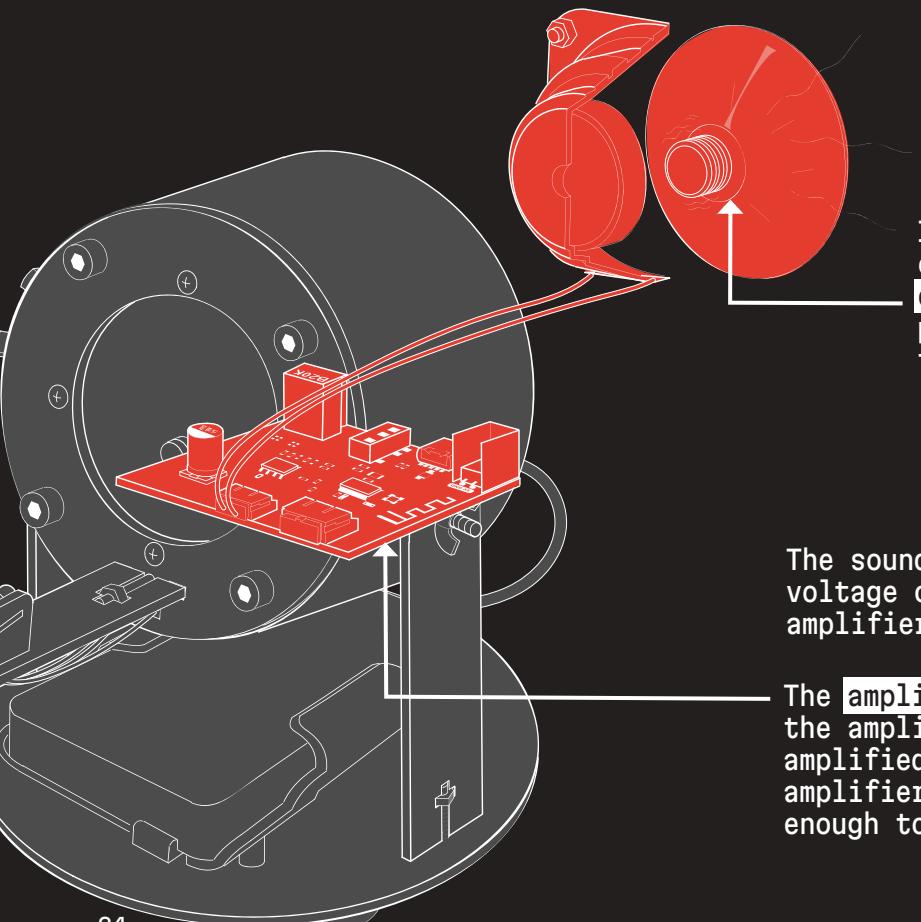
To create sounds with electronics, we need to create a sound signal and then convert that electrical signal into waves of air pressure.

All sounds are described in terms of **frequency**, which is how often waves hit your eardrum, and **amplitude**, which is the height or intensity of the wave. In music, higher frequency means higher pitch, while higher amplitude means higher volume.



First, the microcontroller takes readings from its sensors and uses those to change aspects of the sound signal like pitch, volume, and **waveform**, and synthesizes a signal using its internal oscillators – components specifically designed to generate waves.

FROM SIGNAL TO SOUND



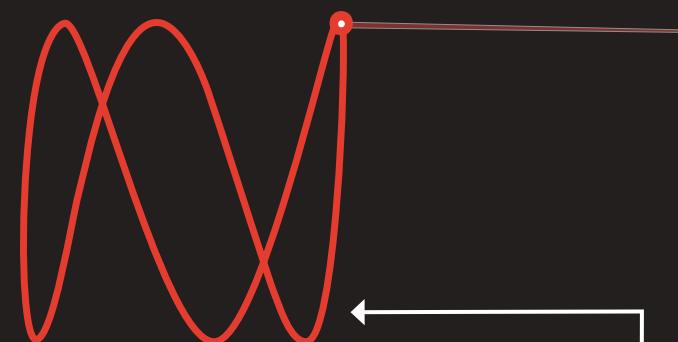
Inside the **speaker** is an **electromagnet** connected to a diaphragm. When the **electromagnet** is powered on, it pushes and pulls the diaphragm, creating waves of air as the diaphragm vibrates back and forth.

The sound signal is output by changing the voltage on a pair of pins connected to an amplifier and a speaker.

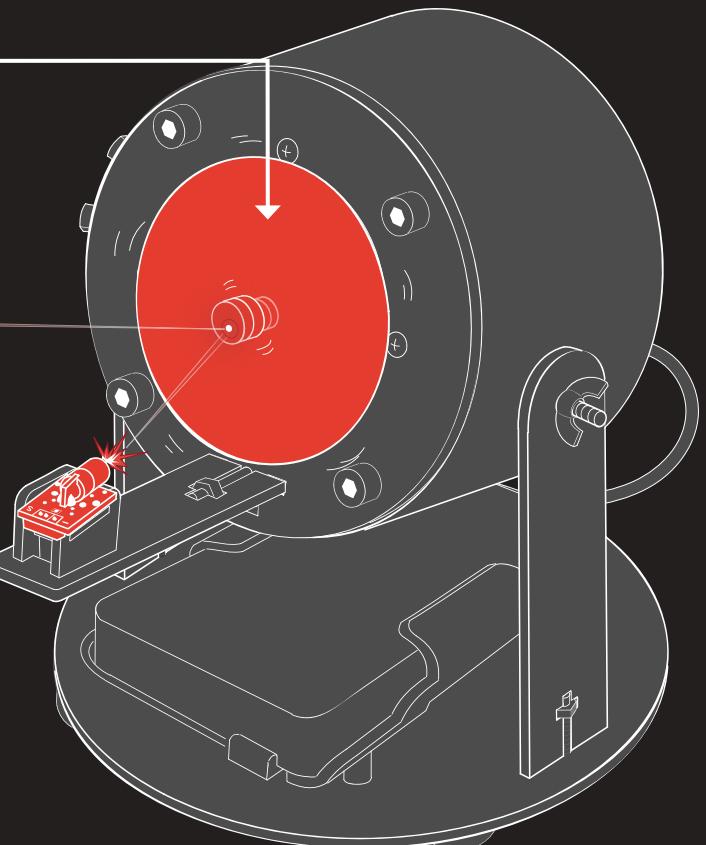
The **amplifier** boosts the sound signal, increasing the amplitude of the waves, and sends that amplified signal to the speaker. Without the amplifier, the sound signal would not be strong enough to move the electromagnet.

AUDIO VISUALIZATION

To visualize the sound, we shoot a laser at a mirror which is attached to a **silicone membrane** on the back of the speaker. When sound waves vibrate the membrane, the mirror wiggles around in a repeating pattern based on how the notes resonate with the membrane, reflecting a laser path which is distinct to the sound.



A single note produces one repeating path. If you add another note, the path becomes the combination of two individual circular paths, also called a **Lissajous curve**.



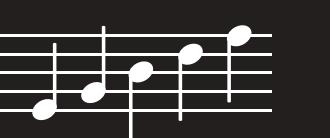


SOFTWARE



VARIABLE COMPOSITION

Try changing the musical scale in the IDE to get a different mood out of your synthesizer and experiment with different combinations of waveforms for brighter, sharper, or stranger sounds.



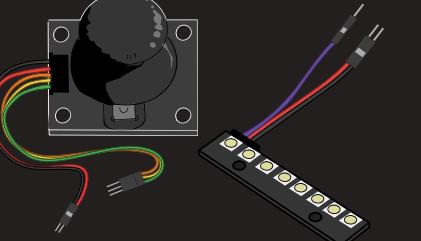
MODULAR SYNTHESIS

Visit the IDE to try different versions of the software which can build chords, generate sequences, and change the method of synthesis in a variety of different ways.



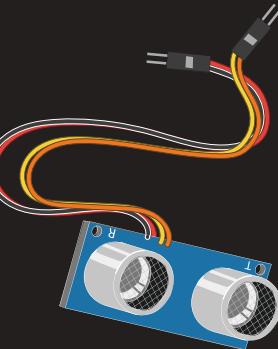
LASER THEREMIN

If you add the ultrasonic distance sensor from Balance Bot, you can play notes in the air above the interface!



SOUND AND COLOR

Add the LEDs or Joystick from Sand Garden to add more ways to visualize and control your sound.



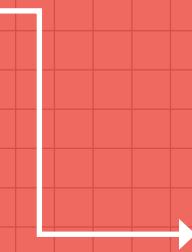
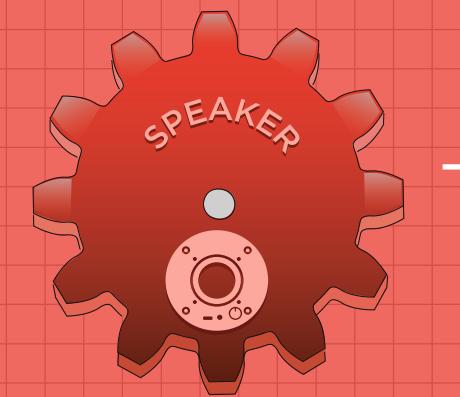
HARDWARE

SHOW OFF YOUR HACKS

Share your software mods and explore more ways to hack your Laser Synthesizer at crunchlabs.com



ADD THE LASER SYNTHESIZER GEAR BADGE TO YOUR HACKPACK DIPLOMA.



Warning: Improper assembly can short circuit batteries. Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications.

However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:



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

This product contains small magnets. Swallowed magnets can stick together across intestines causing serious infections and death. Seek immediate medical attention if magnets are swallowed or inhaled.

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation. FCC ID: 2BMCV-CL-HP-SYNTH