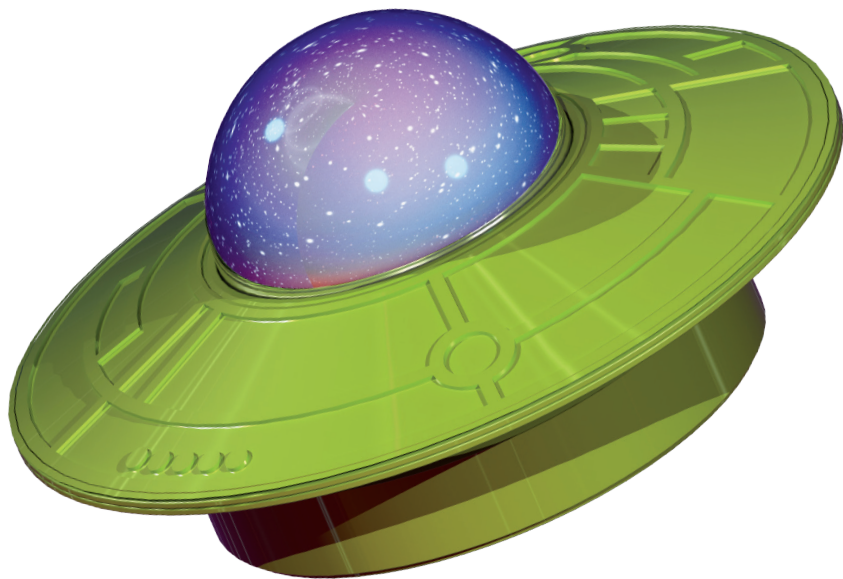


**GEEK  
& CO.  
SCIENCE!**



PROJECT KIT **Ages  
8+**

# MuSiCaL UFO



**THAMES & KOSMOS**



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## Safety information

**WARNING.**

Not suitable for children under 3 years. Choking hazard — small parts may be swallowed or inhaled.

Keep the packaging and instructions as they contain important information.

## Advice for parents and supervising adults

Before starting the experiments, read through the manual together with your child and discuss the safety notes. Check to make sure that the musical UFO has been properly assembled before each use, and help your child with the experiments.

Have fun with the experiments!

## Notes on experimenting with batteries



**Warning.** Only for use by children aged 8 years and older. Instructions for parents or other supervising adults are included and have to be observed. Keep the packaging and instructions as they contain important information.

The wires are not to be inserted into socket-outlets. Never perform experiments using household current! The high voltage can be extremely dangerous or fatal!

Two AAA batteries (1.5-volt/LR03) are required, which could not be included in the kit due to their limited shelf life.

Different types of batteries or new and used batteries are not to be mixed.

Do not mix old and new batteries.

Do not mix alkaline, standard (carbon-zinc), or rechargeable (nickel-cadmium) batteries.

Always insert batteries in the right

polarity orientation, pressing them gently into the battery compartment.

Non-rechargeable batteries are not to be recharged. They could explode!

Rechargeable batteries are only to be charged under adult supervision.

Rechargeable batteries are to be removed from the toy before being charged.

Exhausted batteries are to be removed from the toy.

The supply terminals are not to be short-circuited. A short circuit can cause the wires to overheat and the batteries to explode.

Dispose of used batteries in accordance with environmental provisions.

Be sure not to bring batteries into contact with coins, keys, or other metal objects.

Avoid deforming the batteries.

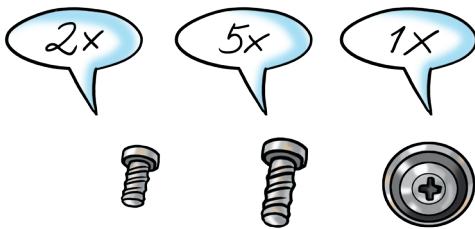
Have an adult check the Musical UFO before you use it so you can be sure it was assembled properly!

## Notes on disposal of electrical components



None of the electrical or electronic components in this kit should be disposed of in the regular household trash when you have finished using them. Instead, they must be delivered to a collection location for the recycling of electrical and electronic devices. The symbol on the product, instructions for use, or packaging will indicate this. The materials are reusable in accordance with their designation. By reusing or recycling used devices, you are making an important contribution to the protection of the environment. Please consult your local authorities for the appropriate disposal location.

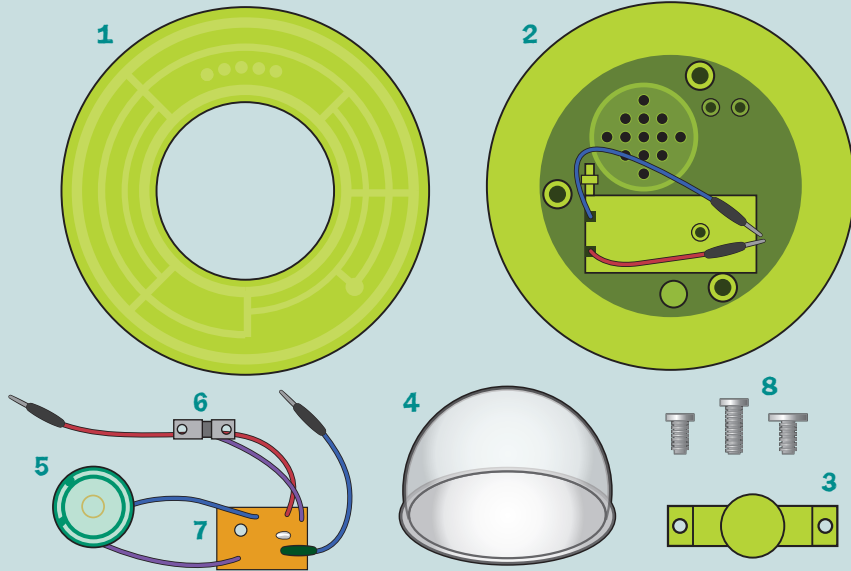
## Note regarding the eight screws



The kit has a total of eight screws for assembling the UFO: two small ones, five medium ones, and one screw with a broad head. Be sure to use the screws in their correct places. The assembly instructions tell you which screw is used where.

**NOTE!** *The additionally required items are highlighted in italic script in the individual experiments. Before starting the experiments, carefully read through everything that will be required and make sure to have all the materials ready.*

# KIT CONTENTS



- 1 | Cover
- 2 | Saucer
- 3 | Speaker cover
- 4 | Dome

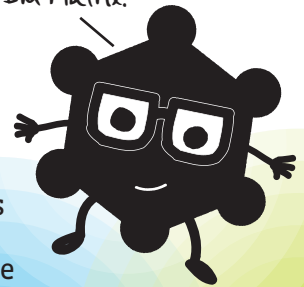
- 5 | Speaker
- 6 | On-off switch
- 7 | Circuit board
- 8 | Screws (8)

**YOU WILL ALSO NEED:** *Two AAA batteries (1.5-volt, type AAA/LR03), small Phillips head (cross-head) screwdriver*

## Greetings, Earthlings!

Everyone knows what an alien flying saucer is, and everyone has their own idea about what one should look like — despite the fact that nobody has actually ever seen one. Still, the idea of visitors from other another planet inspires our fantasies. And who knows? Maybe one day we really will have a close encounter of the “third kind.” Until then, you can use this experiment kit to build your own UFO and send musical messages into outer space. These instructions will show you how to do it. So let’s get going!

Hi! I'm Matrix!



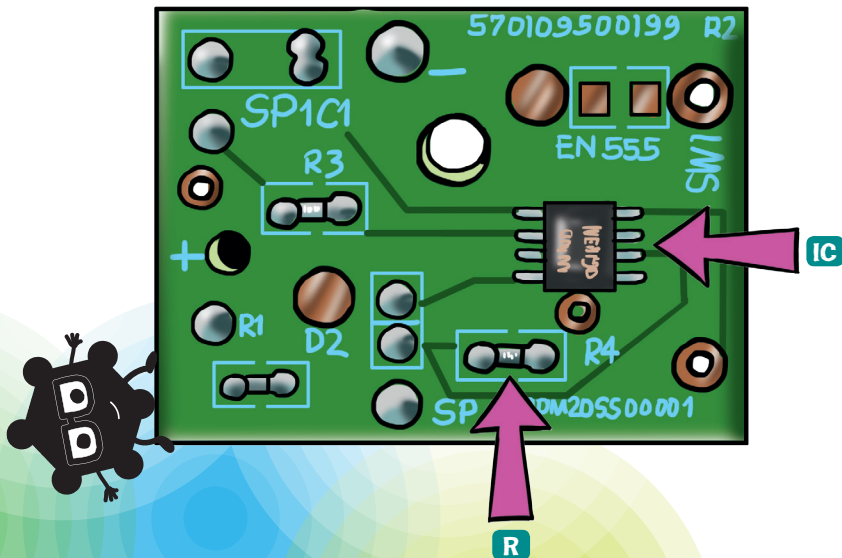
# OVERVIEW OF THE UFO'S ELECTRONICS

On the top side of the circuit board, you will find the **light sensor D** and the **capacitor C**. On the bottom, you will see the **integrated circuit IC** and **resistors R**.

The light sensor registers how much light is hitting your UFO. More light makes the pitch higher, less light makes it lower. A capacitor is able to save current (from the battery) and then release it again. So it's like a battery. The light sensor is what tells the capacitor how quickly it has to do that. The charging and discharging of the capacitor is controlled by the integrated circuit (IC), which works as a kind of timer here.

If you want to use the UFO in a very dark area, you will hear a sort of very fast clicking sound. That's the timer's control signal, rendered audible by the speaker. In bright surroundings, the clicking sound is so fast that it sounds like a continuous tone.

The small resistors (R) ensure that there isn't too much or too little current flowing in any one location.



# PART 1

# TIME FOR SOME UFO SIGHTINGS

Before assembly, take a careful look at all the components. You will have to be careful with the wires. They are soldered to the proper locations at their ends. If you bend or twist them too much, the wires might come loose at those locations. If that happens, they can no longer conduct current and the circuit will no longer work.

## How to assemble your Musical UFO

### You will need:

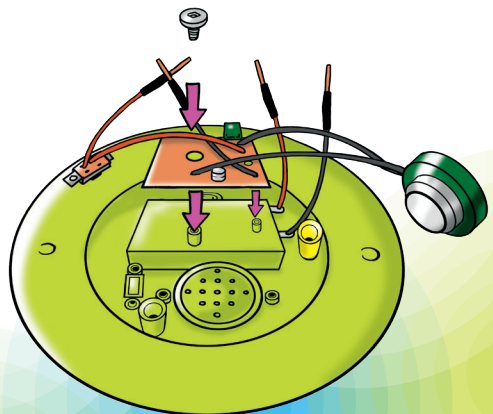
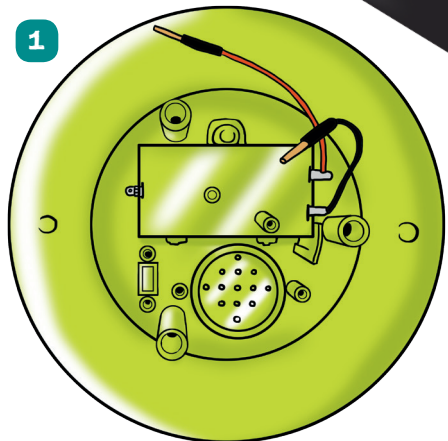
All of the components in this kit, two AAA batteries (1.5-volt, type LR03), small Phillips head (cross-head) screwdriver

### Here's how:

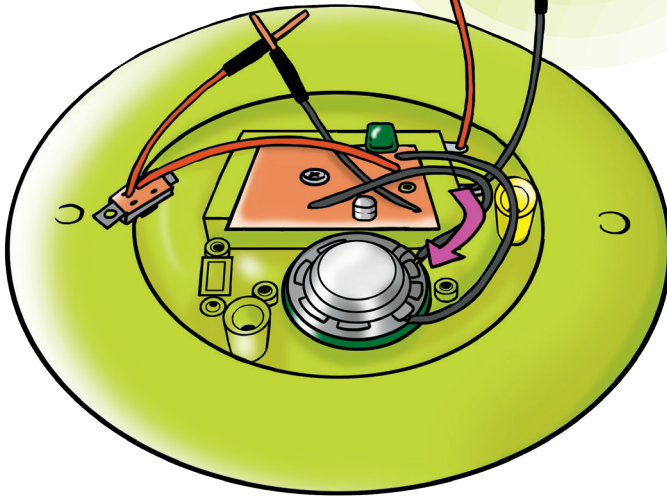
- 1 First, you will need the bottom half of the Musical UFO with the battery compartment and the circuit board with the soldered-on speaker and switch.

Mount the circuit board, with the light sensor to the top, on the narrower tube located on the battery compartment.

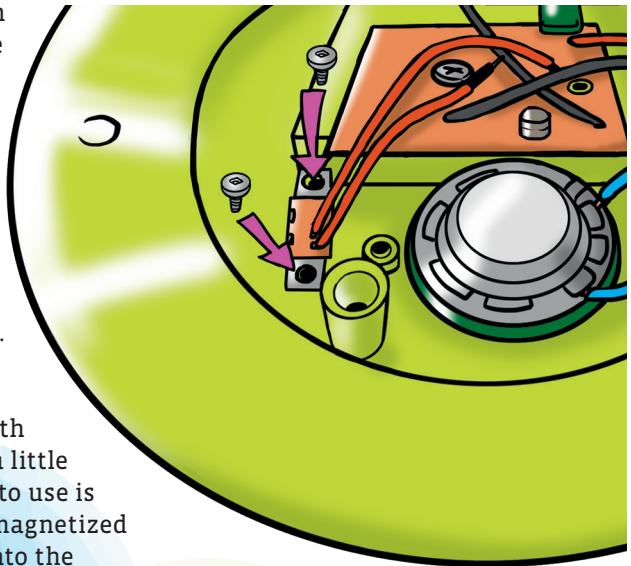
Screw the circuit board tightly onto the wider tube. Use the screw with the broad head.



- 2** Insert the speaker into the opening designed for it, but don't screw it on tightly yet.



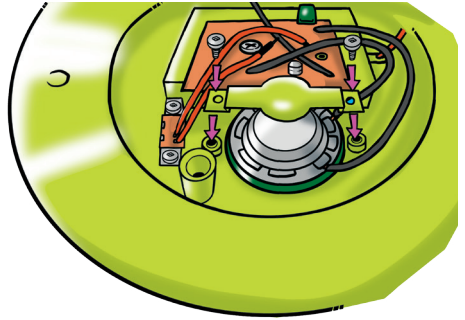
- 3** Now, insert the switch into its opening. Make sure it is facing the right direction when you insert it. In its initial state, the switch is turned to the "OFF" position. Check the bottom of the UFO to make sure it is inserted correctly.



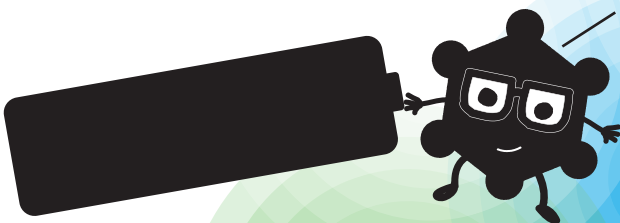
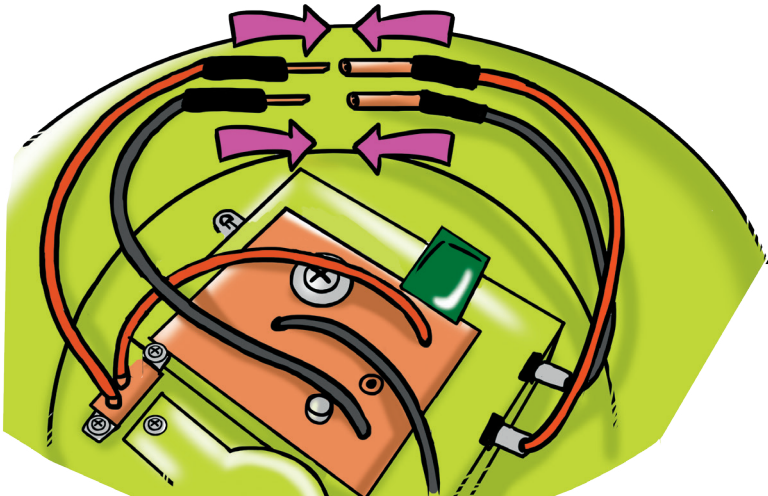
Now you have to fix the switch in place with the small screws. It's a little tricky. The best thing to use is a screwdriver with a magnetized tip, which will hold onto the screws.



4 Now it's time to fix the speaker in place as well. That's what the small green speaker cover is for. Lay it over the speaker in such a way that it sits firmly on the little tubes to the left and right of the speaker. Now you can secure the cover in place with two of the medium screws.

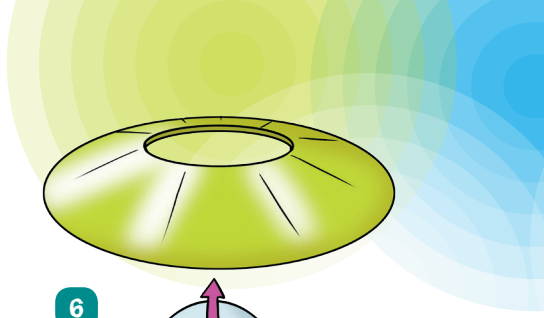


5 To connect the battery compartment to the other electronic components, all you have to do is insert the loose wire ends into one another. Pay attention to the colors: Red connects to red and black connects to black.



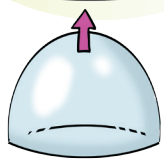
Woo-hoo! Get your batteries ready. Almost time to power this baby up!

**6** Your UFO is almost ready. All you still have to do is attach the top half. Insert the transparent dome into the upper housing.



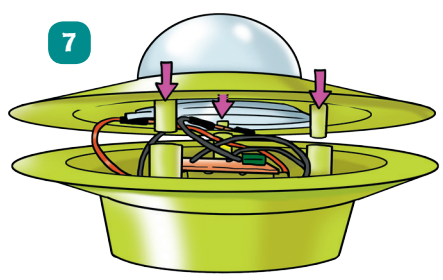
**7** Now, set this on the bottom portion so that all three connection tubes fit together. Be careful not to pinch any wires. Once you have fit everything together properly, there should be no visible gaps between the top and bottom halves.

**6**



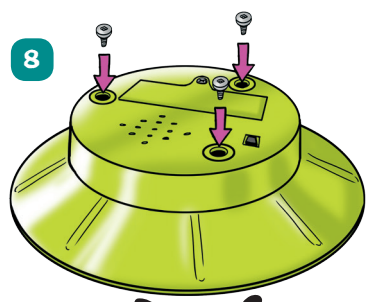
**8** Carefully turn the UFO over and secure the top and bottom halves together with the three remaining medium screws.

**7**

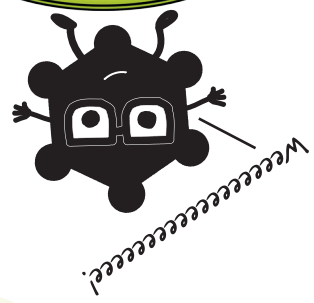


**9** Loosen the small screw on the bottom part to open the battery compartment. Insert two batteries into the compartment. Pay attention to the symbols on the batteries and in the compartment to be sure that you insert them in the right direction. Replace the lid on the battery compartment and secure it with the small screw.

**8**



**10** Now your UFO is ready to go. To turn it on, just slide the switch to the "ON" position. You can influence the tone of the UFO by moving your hand over the transparent dome. That way, more or less light will fall on the UFO's light sensor, which changes the tone.



## PART 2

# EXTRATERRESTRIAL SYMPHONIES

### Experiment 1: Lighting conditions

Test your UFO under various lighting conditions — for example, under direct or indirect sunlight, in the shade, or under different kinds of artificial light such as ordinary incandescent bulbs, energy-saving bulbs, LED lights, fluorescent lights or candlelight.

Where does the UFO work best?  
Where are you able to influence the tone the most?



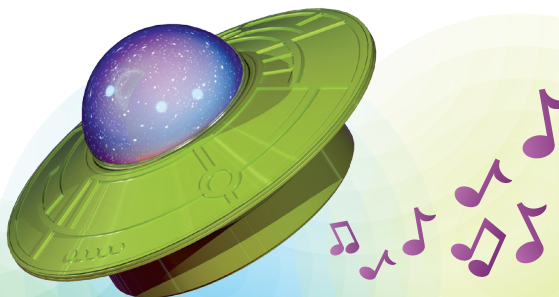
### Experiment 2: Roving light sensor

Switch on your Musical UFO and take it for a walk through your house. When you do that, the Musical UFO will act as a light sensor. You will be astonished how varied the lighting conditions can be in your home. The reason has to do with different kinds of lighting and the fact that some rooms have larger window areas.

Of course, it will also make a difference whether you are taking your walk in the middle of the day or in the evening, and whether it is cloudy or not.

### Experiment 3: Guess that song

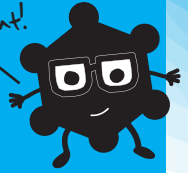
Try playing a song on your Musical UFO and get a friend to try to guess what song it is. It isn't very easy, and you will need a little practice. Start with the simplest song you can think of.



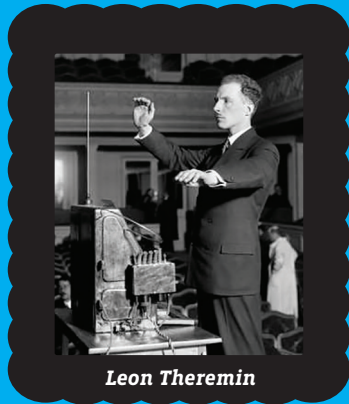
**GEEK  
OUT!**

# WHAT'S A THEREMIN?

My favorite  
instrument!



The Musical UFO is based on an invention known as the **theremin**. That's a musical instrument that, like the UFO, can be played without actually touching it with your hands. Instead of responding to light, though, the theremin reacts to the electrical capacitance inside every human body. This influences the theremin's electromagnetic field, which then produces sounds.



*Leon Theremin*

The theremin gets its name from its Russian inventor, **Leon Theremin**. His invention was the inspiration for other electronic instruments such as the **synthesizer**, without which today's electronic music would be inconceivable. A theremin that responds to light is also known as a **photo-theremin**.

For decades, theremins have been used in science fiction and horror movie soundtracks. This is why their unique sound is associated with the eerie sounds of UFOs and monsters. Today, theremins are used by many rock, electronic, and concert musicians.



*Theremins  
have been  
custom built  
in many  
shapes and  
sizes*



# HOW DO THE UFO'S ELECTRONICS WORK?

To really understand how the Musical UFO works, you need to understand how four important electronic components work: the **phototransistor** (which is a type of **transistor**), the **integrated circuit**, the **speaker**, and the **capacitor**.

## THE TRANSISTOR

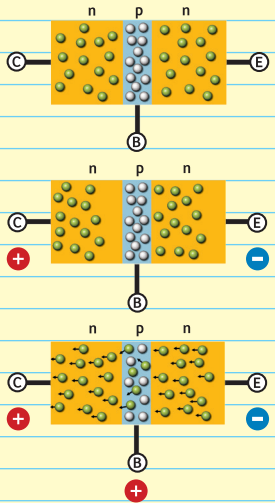
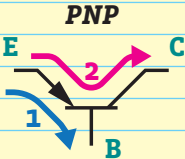
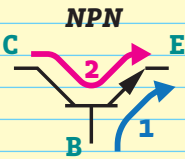
A transistor is a semiconductive device, meaning that it conducts different amounts of electrical current under different conditions. A transistor has three terminals. Differing current on one terminal changes the amount of current that can flow through the other two terminals.

There are many different types of transistors, but to understand how they work, let's explore two of them: NPN and PNP transistors.

In an NPN transistor, when a current **1** flows into the base terminal **B**, it allows current **2** to move through the other two terminals, from the collector **C** to the emitter **E**. If there is no current at the base, no current will flow through the collector to the emitter.

In a PNP transistor, when a current **1** flows out of the base terminal, it allows current **2** to move from the emitter to the collector.

An NPN transistor is a sandwich of "p" material between two layers of "n" material. A PNP is the opposite: "n" material sandwiched between two layers of "p" material. The "n" zone contains mobile electrons (shown here in green), while the "p" zone contains empty spaces, or holes. Between the zones, there are thin boundaries that normally block the current flow, since the electrons are attaching themselves to the holes there. When electrons either flow into or out of the base, they allow electrons to cross the boundaries, opening up the flow of current.

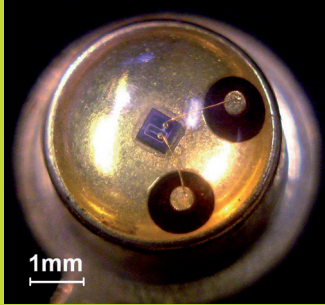


## THE PHOTOTRANSISTOR

The **phototransistor** is a transistor that responds to light. In any transistor, light knocks loose electrons in the p-n boundary region and the region becomes electrically conductive.

A phototransistor works by taking advantage of that phenomenon. In that component, the boundary region is positioned behind a transparent window and is turned as much as possible toward the oncoming light. It is connected to the base of a transistor whose collector and emitter terminals are pointed outward. This amplifies the effect about a hundred times.

If light hits the boundary region, a modest current enters the base of the transistor and opens its current-emitter line. That reduces its resistance. If the phototransistor is installed in a circuit, current is now able to flow. The phototransistor in the Musical UFO controls the amount of current flowing in the circuit, and thus controls the sound produced by the speaker.



*The light-sensitive transistor is the little square in the middle.*

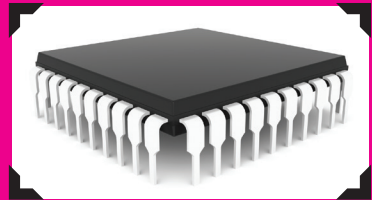
## THE INTEGRATED CIRCUIT

The “brains” of your Musical UFO is an integrated circuit. It consists of a tiny plate of silicon containing dozens of components. This kind of integrated circuit (“IC” for short) can be found inside many electronic devices today.

Shortly following the invention of the transistor, these components were still soldered individually into circuits. A transistor crystal is tiny, but the housing around it has to be a certain size in order to be handled easily. That’s how people got the idea of packing entire circuits into a single housing.

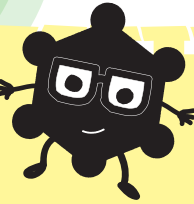
The next step led to ICs. These were made from a silicon chip, with transistors, resistors, and other components produced in numerous production steps applied to hundreds of ICs at one time. Their building blocks and connection wires are so tiny that you can only see them under a powerful microscope.

The IC in the Musical UFO responds to the current output from the phototransistor and the capacitor, and in turn changes its output to the speaker, which changes the pitch emitted by the speaker.



# GEEK OUT!

I love major beats, man.



## THE SPEAKER

There are many types of **speakers**. What all speakers have in common is that they convert fluctuations in current into sound vibrations.

Speakers can be built in many different ways. But all have a large, flexible membrane to set the greatest possible quantity of air into vibration.

Simple speakers use the **piezoelectric effect** for this: Certain materials become elastically deformed under the influence of current fluctuations, rising and falling in rhythm with the fluctuations and thereby creating sound vibrations in the air.

Better speakers, by contrast, have a movable suspended coil made of fine wire, with the coil positioned near a strong magnet and connected to the membrane. When current flows through the coil, the coil itself becomes magnetic. As this current fluctuates, the magnetism rapidly changes in strength and direction, so the coil is attracted one moment by the external magnet and repelled the next. It is these movements that are transferred through the membrane to the air. Ears interpret the vibrations in the air as sound.

## Light Pollution

Light pollution, also known as light smog, is a kind of environmental pollution. Because of the artificial light in our cities, it never really gets dark even at night. That in turn can have a negative impact on plants and animals, and it also means that we see far fewer stars in the city than we would in, say, the desert. You can use your Musical UFO to determine where the light pollution is especially high. The processed satellite image here shows the Earth's lights at night.

Peekaboo!



# THE SEARCH FOR REAL ALIENS

Are we alone? This is a question that has been on scientists', explorers' and many other people's minds for centuries. SETI, or the Search for Extraterrestrial Intelligence, is the name for all sorts of ideas and activities that involve the search for intelligent life on other planets.

The first question we should consider is: Are there planets that may be able to support life in the universe? You may find the answer a bit surprising. In just our galaxy alone, the Milky Way Galaxy, there are anywhere from 200 to 400 billion stars and 50 billion planets. In recent studies, it has been estimated that 50 million of these planets may be able to support life

or have environments similar to Earth.

One of the most common ways scientists look for possible life in space is by listening for and looking at electro-magnetic radiation. Electromagnetic radiation exists all around us, all the time. Anytime you watch TV, listen to the radio, or use your microwave, there are electromagnetic waves present. We can tell the difference between types of electro-magnetic radiation by comparing the distances between their wavelengths.

Scientists at the Search for Extraterrestrial Intelligence Institute use large radio telescopes to listen and see if there is

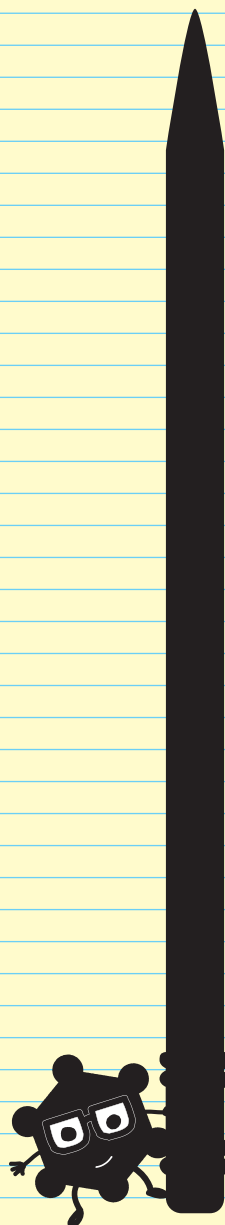
intelligent life somewhere in the universe that is trying to communicate using a type of technology that emits electromagnetic radiation. What would you do if we received a signal? Do you think we should respond?



Radio telescope



What do you think a spacecraft from  
a far away galaxy would look like?  
Sketch your ideas here...



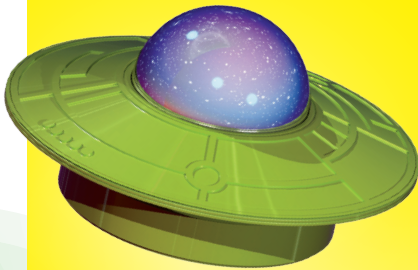


## THE CAPACITOR

A **capacitor** is a simple electronic component that stores up, holds, and releases electrical charge. At first glance, it isn't so easy to see how a capacitor stores electricity. These components are made of two very thin pieces of metal foil that are insulated from each other by a super-thin insulation layer (which, in the case of electrolytic capacitors, is created electrochemically).

When you connect a capacitor with a battery, a lot of electrons collect in one of the strips of foil while the battery sucks electrons out of the other. The result is that one of the foil sections acquires a negative charge while the other acquires a positive charge. These opposing charges attract each other and, in a manner of speaking, keep each other held firmly in place inside the capacitor — which is what accounts for its storage capacity. The higher the voltage you apply, the greater the charge the capacitor can absorb.

The capacitor in the Musical UFO responds to the output from the phototransistor and releases more or less of its current depending on the light level. The more current it releases, the faster the IC sends out signals to the speaker, and thus the higher the pitch emitted by the speaker. Pitch is directly related to **frequency**: the higher the frequency of a vibration, the higher the pitch. Frequency simply means the number of times something happens in a given period of time.



**Now that you understand how the Musical UFO works, practice playing it and compose your own song that is truly out of this world!**

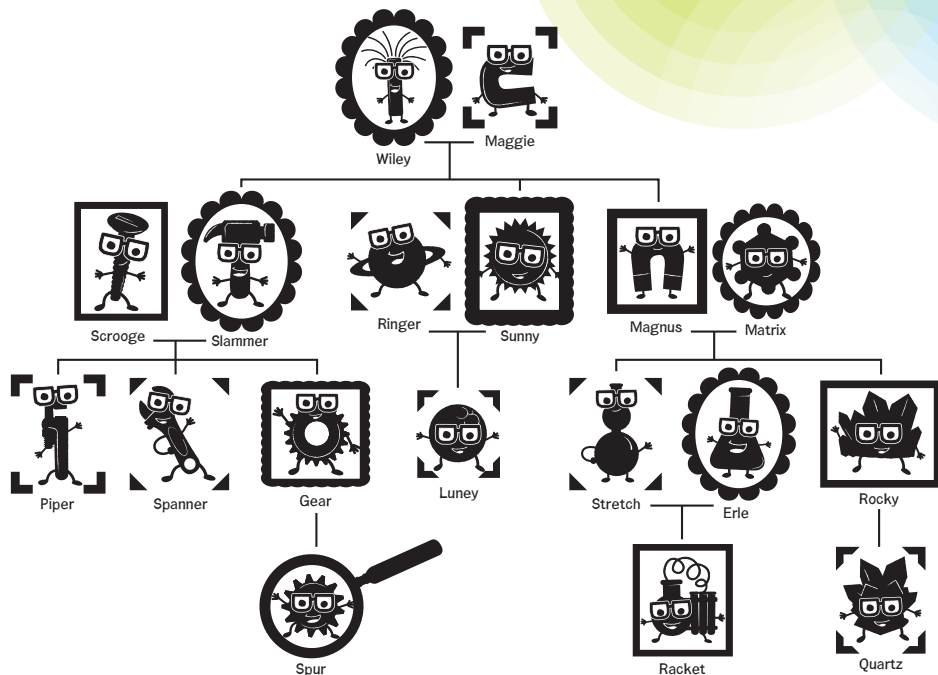




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# MEET THE GEEKERS!



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 Manual photos: chones p. 9 (fotolia.com); Elena Ryvkin (UFO rendering); Bengt Nyman CC BY 2.0 p. 10 bottom left (flickr); public domain p. 10 center left (wikipedia.org); Lenore Edman CC BY 2.0 p. 10 bottom right (flickr); Courtesy of NASA p. 13 bottom right; iStock p. 12 bottom right; Chris Amelung CC BY 2.0 p. 14 top (flickr); Franckh-Kosmos Verlags-GmbH & Co. KG: p. 12 top, p. 13 top, p. 16 top  
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