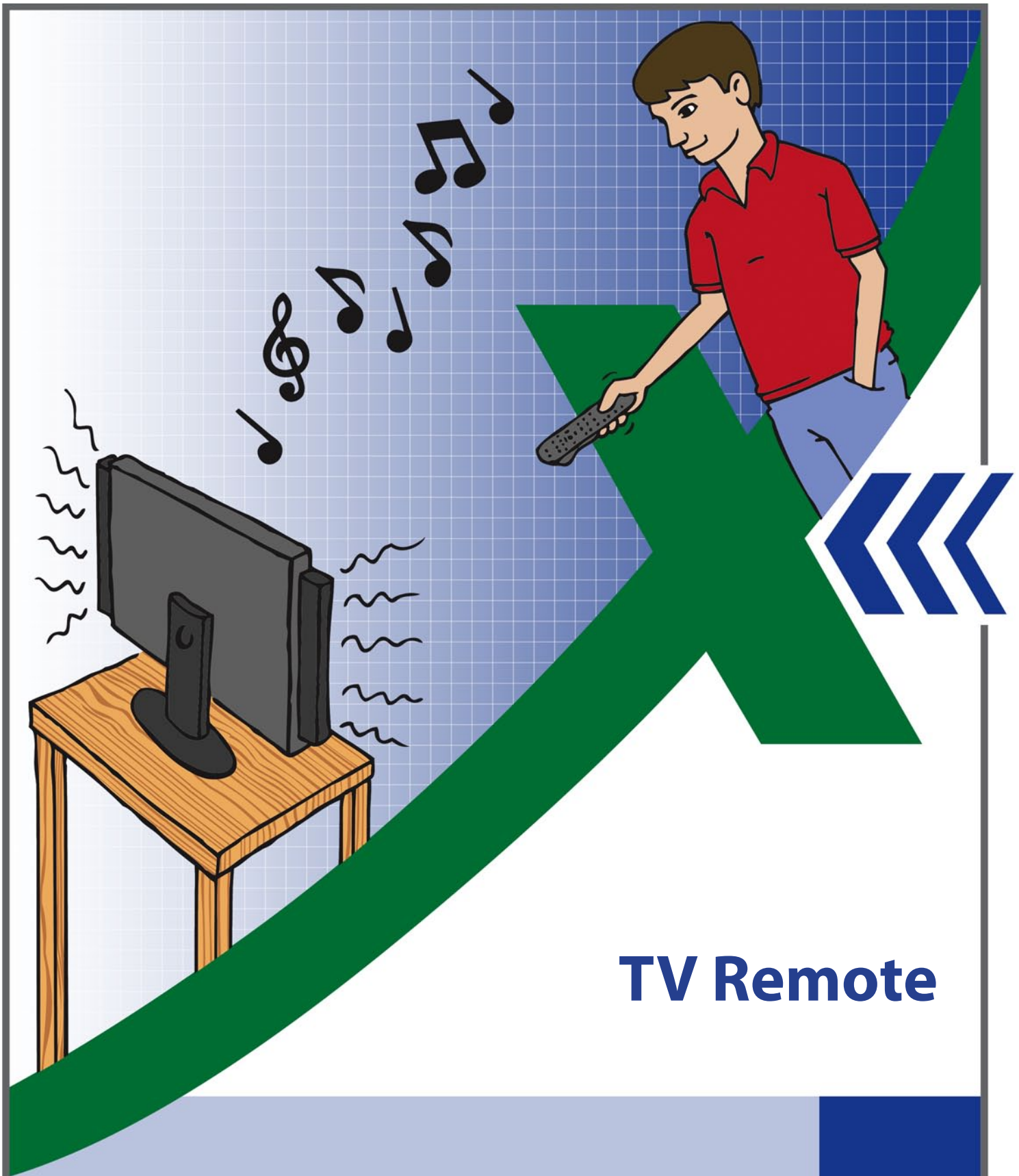
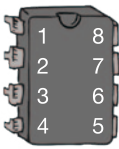
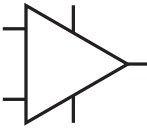
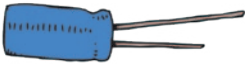
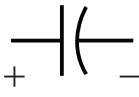
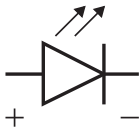
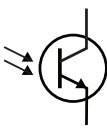
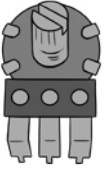
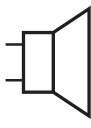
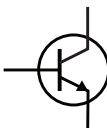




TV Remote

Electronic Component Guide



Component	Symbol	Notes
Amplifier chip 		The amplifier chip (labeled LM 386) has 8 legs, or pins. Each pin connects to a different part of the circuit. On top of the chip, there is a notch at one end. The pins are numbered counterclockwise around the chip, starting at the notch (see image). When handling the LM 386, avoid bending the pins.
Capacitor 		Capacitors store energy and stabilize voltage. The capacitors in this kit are polarized, meaning they have a positive (+) wire and a negative (-) wire. To tell them apart, the longer wire is positive (+) and the shorter wire is negative (-). Also, there is a black band running down the negative side of the capacitor.
LED 		A light emitting diode, or LED, converts electrical energy into light of a single color. Just like the capacitor, the longer wire is positive (+) and the shorter wire is negative (-).
Phototransistor 		A phototransistor converts light into electricity and looks like an LED. The wire closest to the flat side is positive (+).
Potentiometer 		The potentiometer, or variable resistor, has an adjustable dial and three pins. Rotating the dial changes the resistance between the center pin and the pins on the outside. The two outer pins are the same, so the direction doesn't matter.
Resistor 		A resistor resists the flow of electricity and converts electrical energy into heat. The colored bands refer to a special code used to indicate the resistance value.
Speaker 		The speaker converts electricity into sound. Be careful when handling the speaker because the wires break off easily.
Transistor 		The transistor is used, much like an amplifier, to increase a signal. It has a black body with a flat front and 3 pins coming out of the bottom. When building the circuit, the orientation of the transistor is very important.

Activity 1: Sound from a Speaker



Name: _____

Date: _____

Materials List

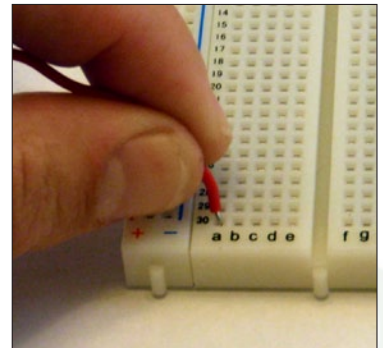
- Speaker
- Wire with headphone plug
- Breadboard
- Music player with headphone output

Procedure

1. Try to make music play using just the music player, wire with headphone plug, and speaker.

Note: Be careful with the wires on the speaker. They break off easily.

2. Breadboards are used by electrical engineers to build and test circuits. Wires of a component can be inserted into the holes to connect them to the circuit. Insert a wire as shown to the right
3. Now try to connect the music player to the speaker using the breadboard.
Note: Not all of the holes in the breadboard are electrically connected.
4. Once you figure this out, try different connections until you are confident which sections of the breadboard are connected and which are not.



Exploration Questions

1. How is the breadboard similar to a piece of wire?
2. What did you notice about sound when the larger speaker was connected?

Activity 2: Amplifying Sound



Name: _____

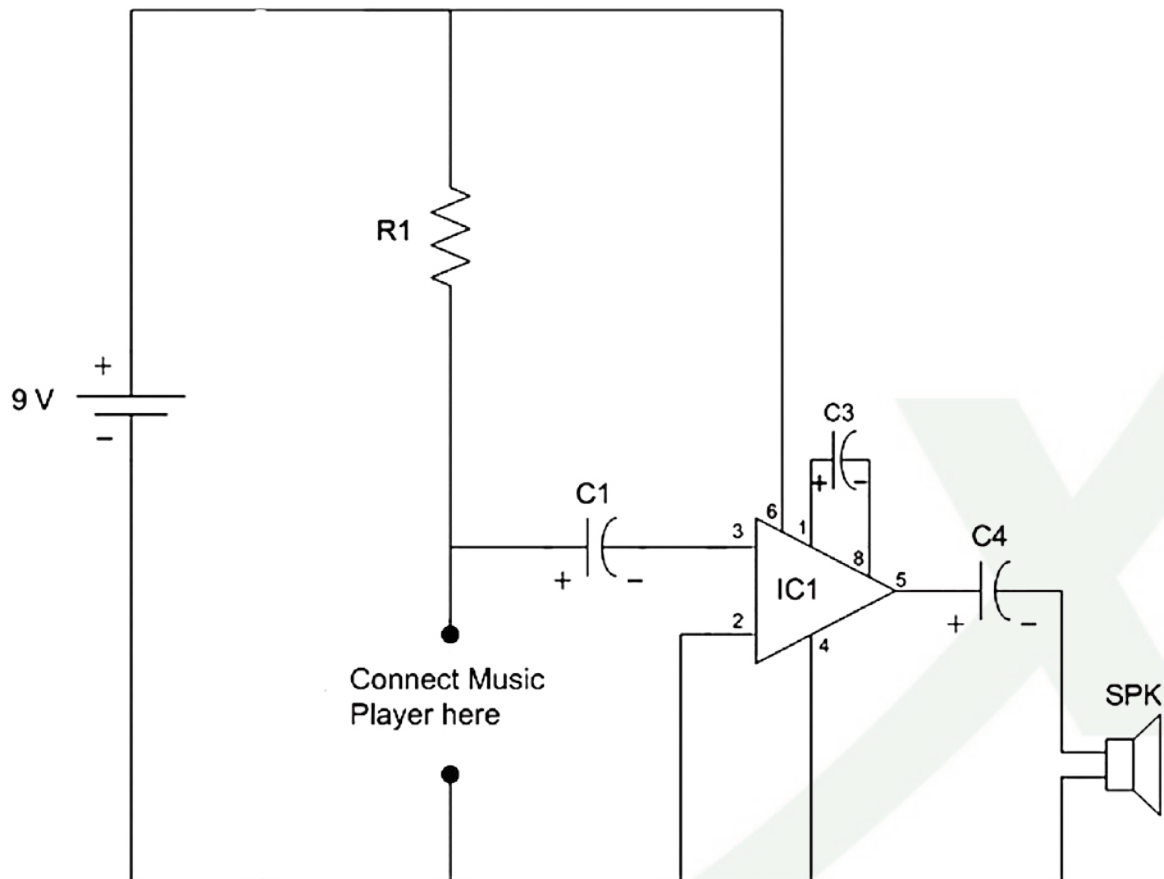
Date: _____

Materials List

- 3 Capacitors (10 μ F electrolytic)
- Amplifier chip (LM 386 electrolytic)
- Resistor (red, yellow, orange - 24k Ω)
- Speaker
- Battery snap
- Battery (9 V)
- Jumper wires (2")
- Wire with headphone
- Music player with headphone output
- Breadboard

Procedure

Part A: Building the Amplifier

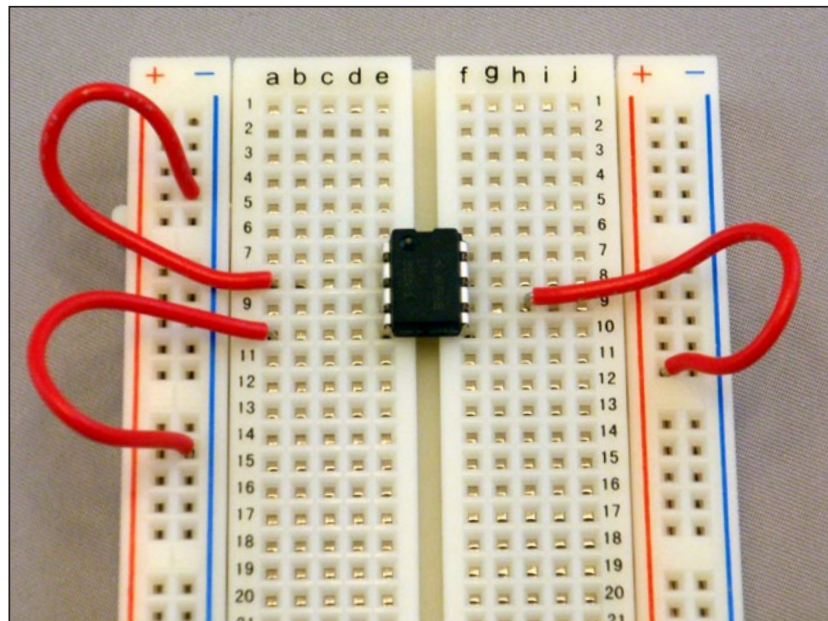


Amplifier Schematic Diagram

Activity 2: Amplifying Sound



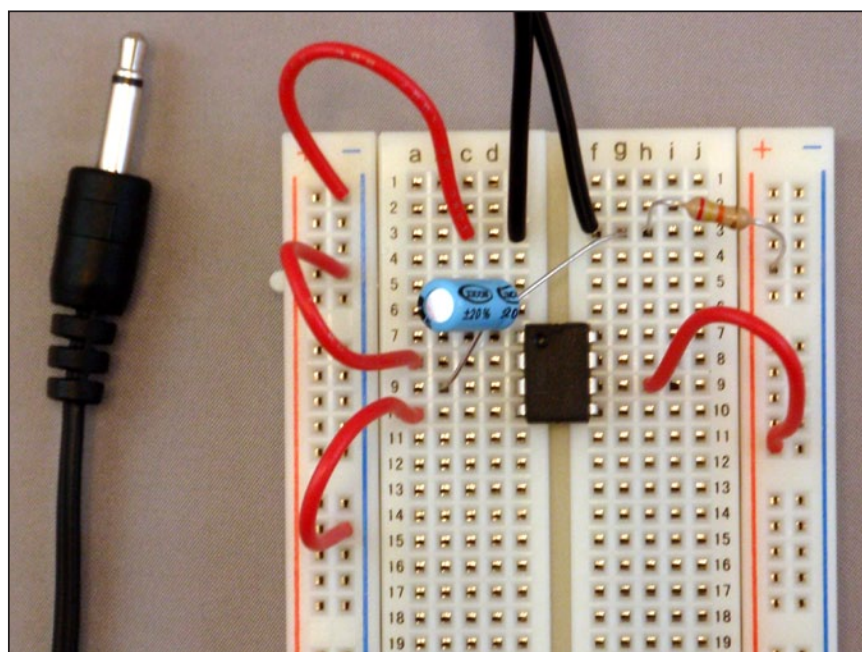
Step	Component	Location	Why did I just do that?
1	Amplifier chip	Place chip across middle of breadboard as shown. Notch should face the top of the board. Bottom pins should be in row 10.	The chip needs to split the middle of the board so that each of the 8 pins is connected to a separate row.
2	2" Jumper	Connect A8 anywhere on left blue power rail.	This connects pin 2 of the chip to negative, providing power to the amplifier.
3	2" Jumper	Connect A10 anywhere on left blue power rail.	This connects pin 4 of the chip to negative, providing power to the amplifier.
4	2" Jumper	Connect H9 anywhere on right red power rail.	This connects pin 6 of the chip to positive, providing power to the amplifier.



Activity 2: Amplifying Sound



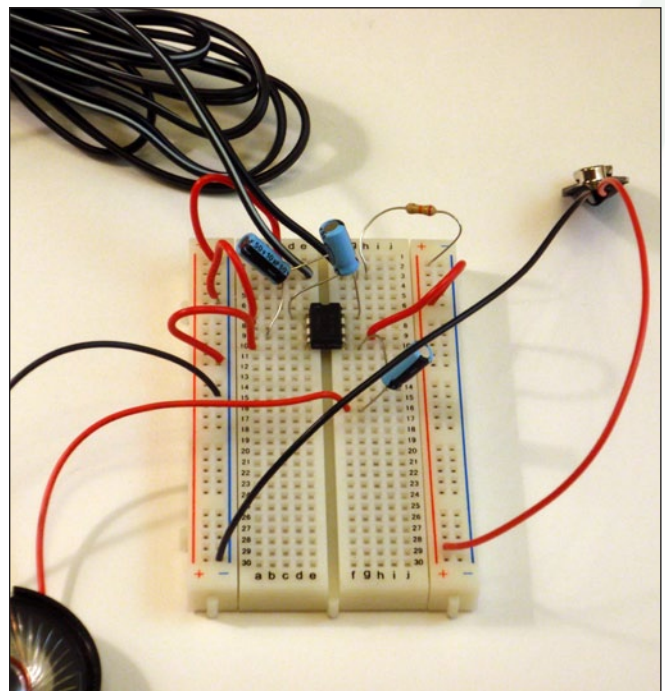
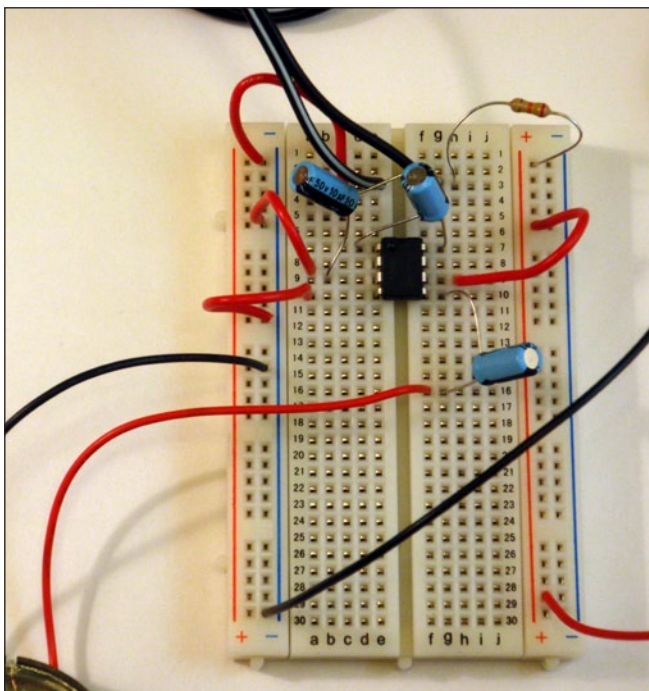
Step	Component	Location	Why did I just do that?
5	Wire with headphone output	Connect these two wires to E3 and F3 .	This is how the music player connects to the amplifying circuit. The sound signal enters through its wire.
6	2" Jumper	Connect C3 anywhere on left blue power rail.	These connect the signal to the positive and negative power supply rails.
7	Resistor (R1)	Connect H3 anywhere on the right red power rail.	
8	Capacitor (C1)	Insert long wire of capacitor into G3 and short wire of capacitor into B9 .	The shorter, negative wire on the side of the capacitor with the stripe connects to pin 3 of the amplifier chip. The capacitor connects the music player to the amplifier chip.



Activity 2: Amplifying Sound



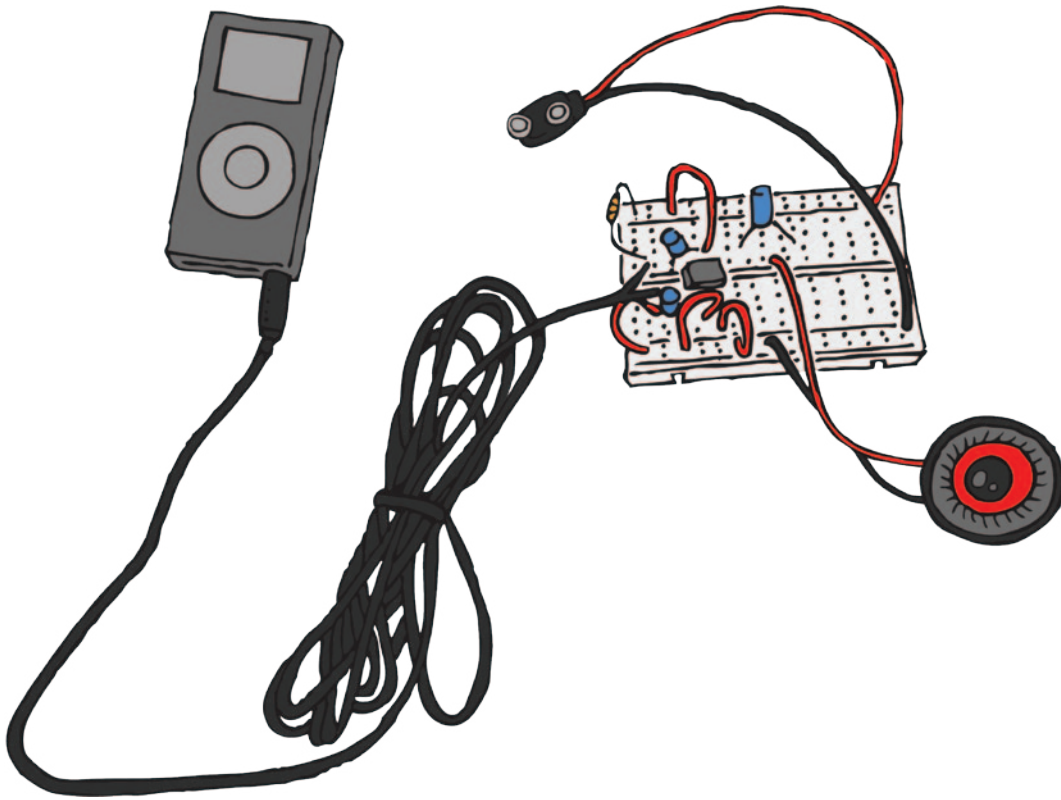
Step	Component	Location	Why did I just do that?
9	Capacitor (C3)	Insert long wire of capacitor into D7 and short wire of capacitor into G7 . Be sure that the wires do not touch other components on the board.	The longer, positive wire connects to pin 1 of the amplifier chip. The shorter, negative wire on the side of the capacitor with the stripe connects to pin 8 of the amplifier chip.
10	Capacitor (C4)	Insert long wire of capacitor into G10 and short wire of capacitor into G16 .	This connects the speaker to pin 5 of the amplifier chip.
11	Speaker	Connect red speaker wire to F16 and black speaker wire to left blue power rail.	The speaker changes the electrical signal into sound.
12	Battery snap	Connect red battery snap wire to right red power rail and black battery snap wire to left blue power rail.	This connects the battery to the power circuit.
13	Battery	Ask your instructor for a 9V battery to connect and test circuit.	The 9V battery provides power to the amplifier chip, which increases the volume of the sound.



Activity 2: Amplifying Sound



Part B: Testing



1. Plug the headphone jack into music player in and turn it on.
2. Connect a 9V battery to the battery snap. You should hear sound and it should be louder than in the last activity when the music player was connected directly to the speaker.

If your circuit does not work, immediately disconnect one of the battery snap wires from the breadboard. A wiring error has probably occurred and you don't want to drain the battery!

3. If you do not hear any sound from the speaker, you will need to troubleshoot your circuit. Troubleshooting is the process of figuring out why a circuit does not work.
 - a. The most common problem is a wiring error. Check to make sure that every wire and component lead is going into the correct hole.
 - b. The second most common error is a polarity mistake. Check the direction of each capacitor to make sure the short (negative) wire is in the correct hole.
4. When you've finished testing, disconnect your battery from the breadboard and remove the battery snap. This will maximize the life of your battery. Your instructor may collect the batteries.

Activity 2: Amplifying Sound



Exploration Questions

1. How does the amplifier circuit work?
2. How can you determine the polarity of a capacitor (which wire is negative and which is positive)?
3. What does troubleshooting mean?

Activity 3: IR Music Receiver



Name: _____

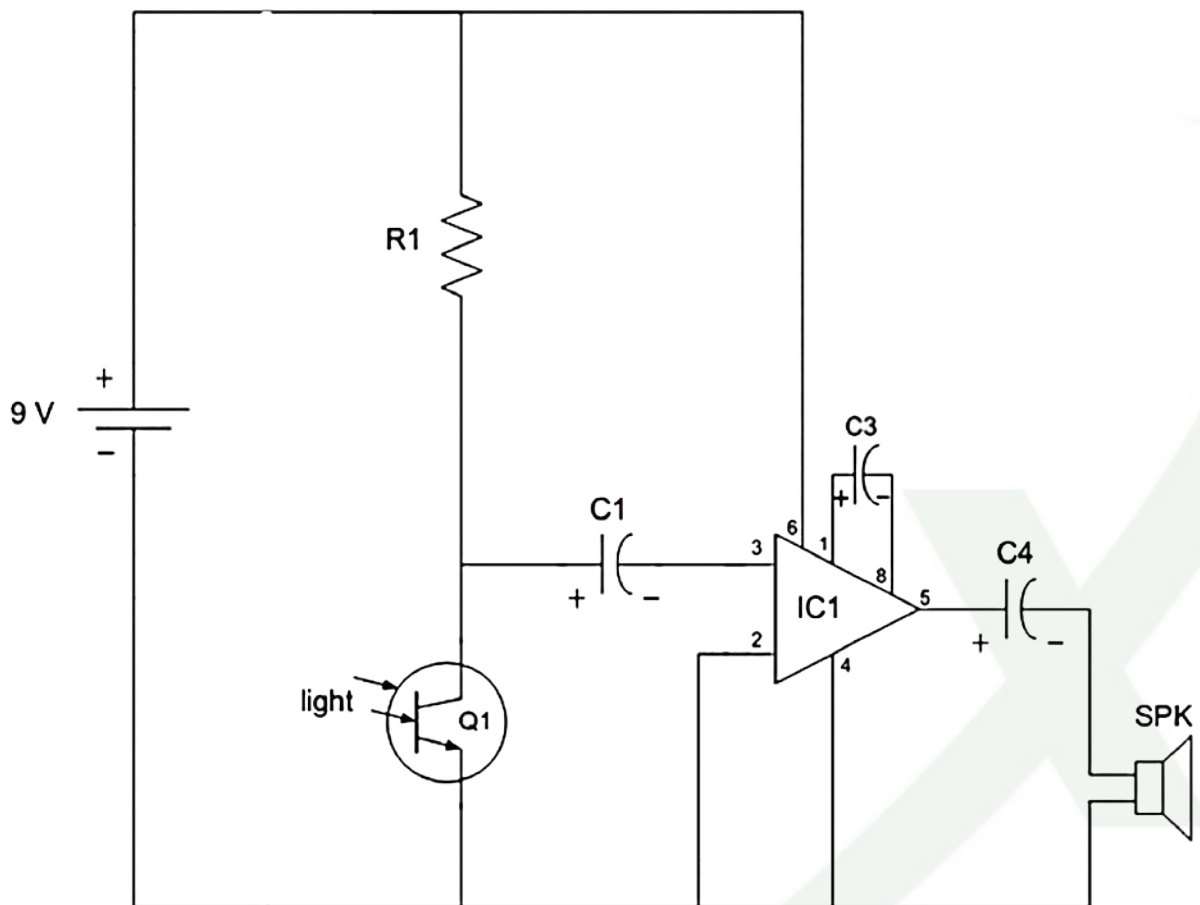
Date: _____

Materials List

- Amplifier circuit (from Activity 2)
- Phototransistor
- Music player with headphone output
- Jumper wires (2")
- Battery (9 V)
- Tape Measure
- TV remote(s)

Procedure

Part A: Converting the Amplifier to a Music Receiver

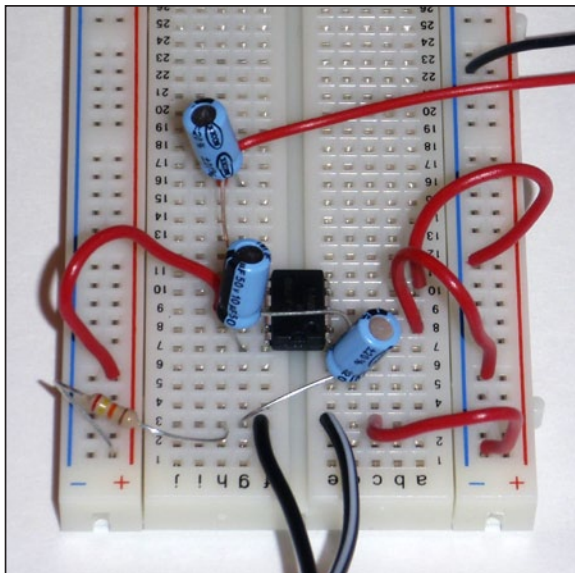


Music Receiver Schematic Diagram

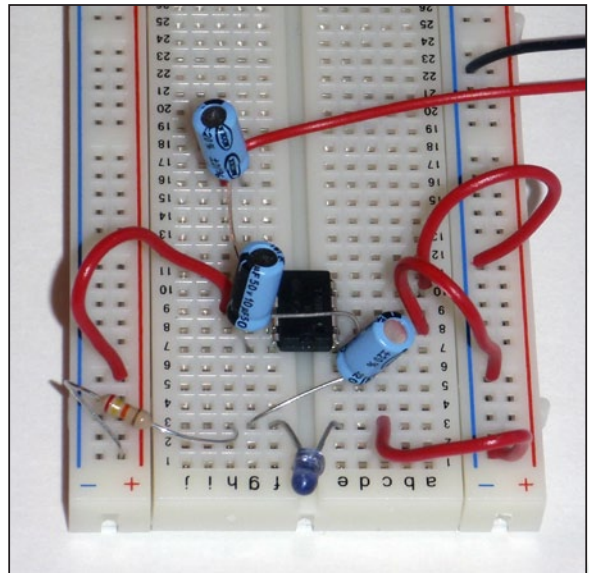
Activity 3: IR Music Receiver



Step	Component	Location	Why did I just do that?
1	Wire with headphone output	Remove these two wires from E3 and F3 . (See picture, below left)	This is where the electrical sound signal entered the circuit.
2	Phototransistor	Connect the phototransistor to E3 and F3 with wire coming out of the flat side in F3. (See picture, below right)	Now the light signal is received by the phototransistor and converted into an electrical signal.



Before

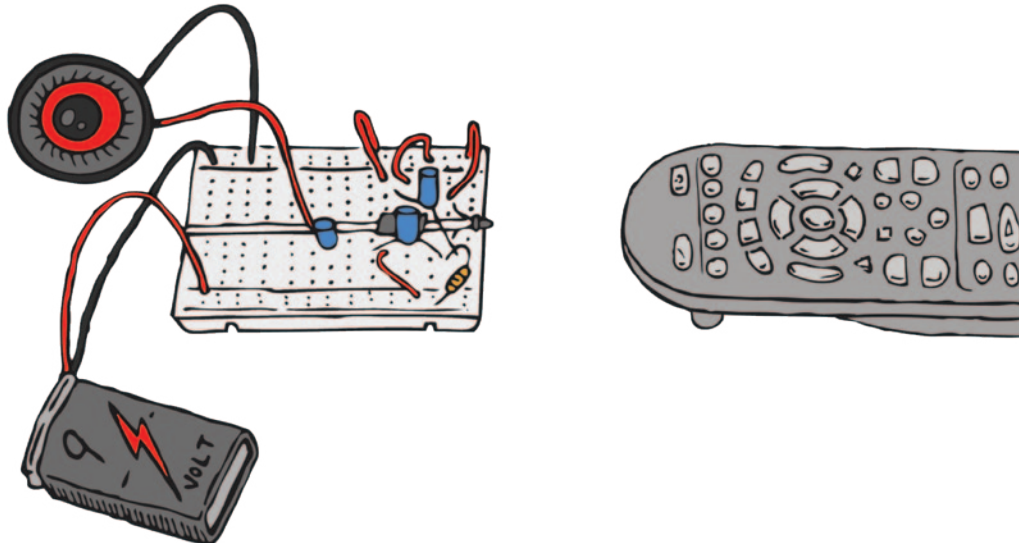


After

Part B: Testing

1. Connect a 9V battery to the battery snap.
2. Take turns firing the TV remote at the phototransistor from different distances and angles.
3. Use the tape measure to determine the farthest distance the TV remote can be fired and still trigger a sound in the receiver.
4. What happens if you put something (like a piece of paper) between the remote and phototransistor? With Discuss your observations and what you think causes the system to respond the way it does.
5. Compare your results with other teams. Are your results different? Why?
6. When you've finished testing, disconnect your battery from the breadboard and remove the battery snap. This will maximize the life of your battery. Your instructor may collect the batteries.

Activity 3: IR Music Receiver



Exploration Questions

1. What is the purpose of the phototransistor in the circuit?
2. What is the farthest distance the remote can be fired and still trigger a sound in the receiver? What could you change in the receiver circuit to increase this distance?
3. Why do you think engineers use infrared light for remote controls?

Activity 4: IR Music Transmitter



Name: _____

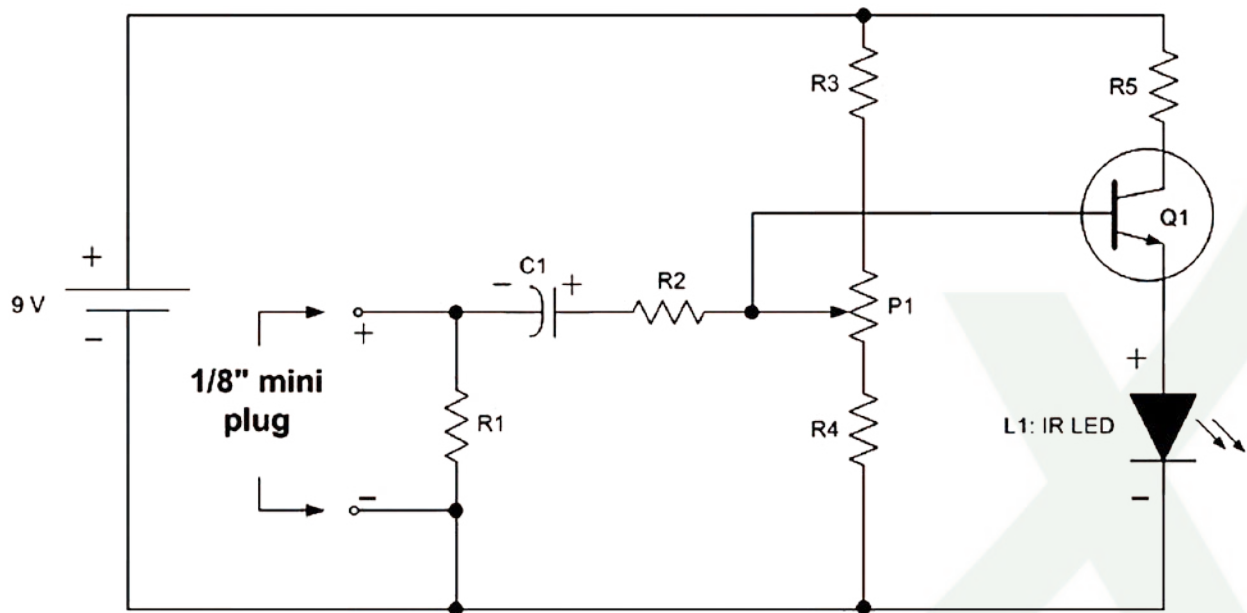
Date: _____

Materials List

- Music Receiver circuit (from Activity 3)
- 5 Resistors (brown, black, black, 100 Ω)
- Infrared LED
- Red LED
- Transistor
- Potentiometer (50 k Ω)
- Capacitor (10 μ F)
- Wire with headphone plug
- Jumper wires (2")
- Battery (9 V)
- Breadboard
- Music player with headphone output
- TV remote(s)

Procedure

Part A: Building the Music Transmitter

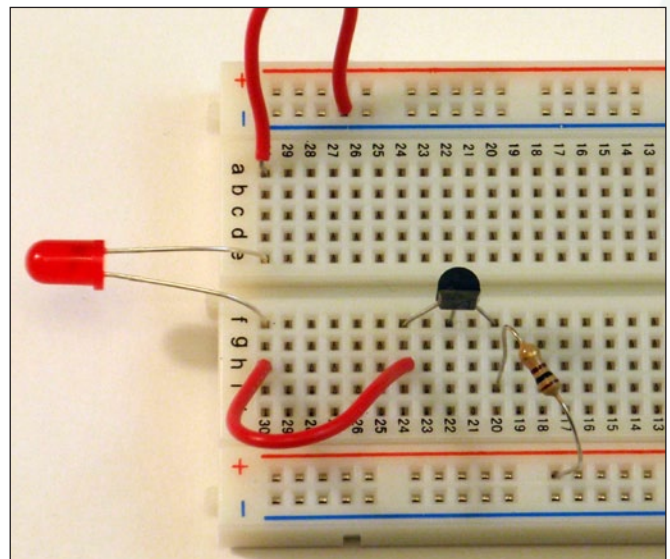
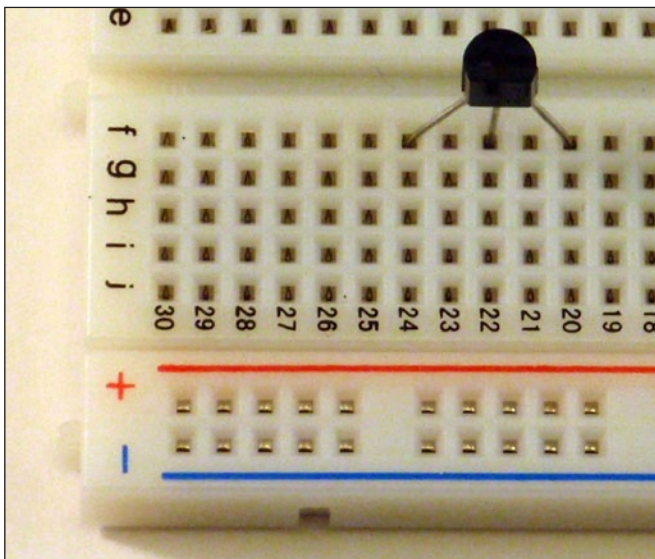


Music Transmitter Schematic Diagram

Activity 4: IR Music Transmitter



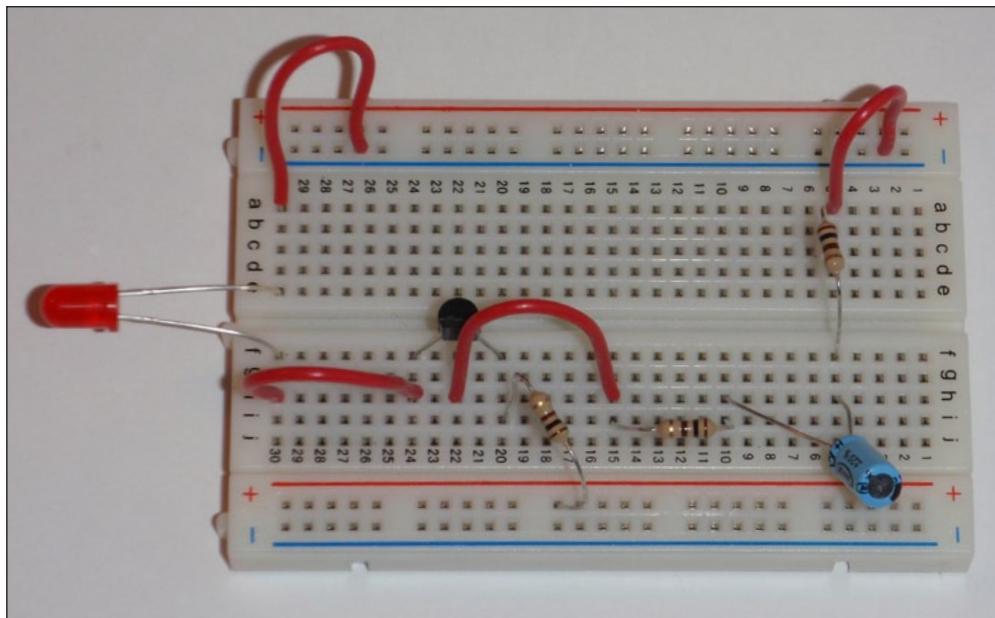
Step	Component	Location	Why did I just do that?
1	Transistor	With flat side of transistor facing you, insert left wire into F24 , middle lead into F22 and right wire into F20 .	The direction of the transistor is important, which is why the flat side is facing you. This will amplify the signal for the LED.
2	Resistor (brown, black, brown)	Connect resistor to I20 and bottom red power rail.	This connects the resistor between the right lead of the transistor and the bottom positive red power supply rail.
3	2" Jumper	Connect to H24 and to H30 .	This will connect to the LED.
4	Red LED	Connect longer wire (+) to F30 and shorter wire (-) to E30 .	This converts the electrical signal to a light signal.
5	2" Jumper	Connect to A30 and to top blue power rail.	This connects the LED to the negative.



Activity 4: IR Music Transmitter



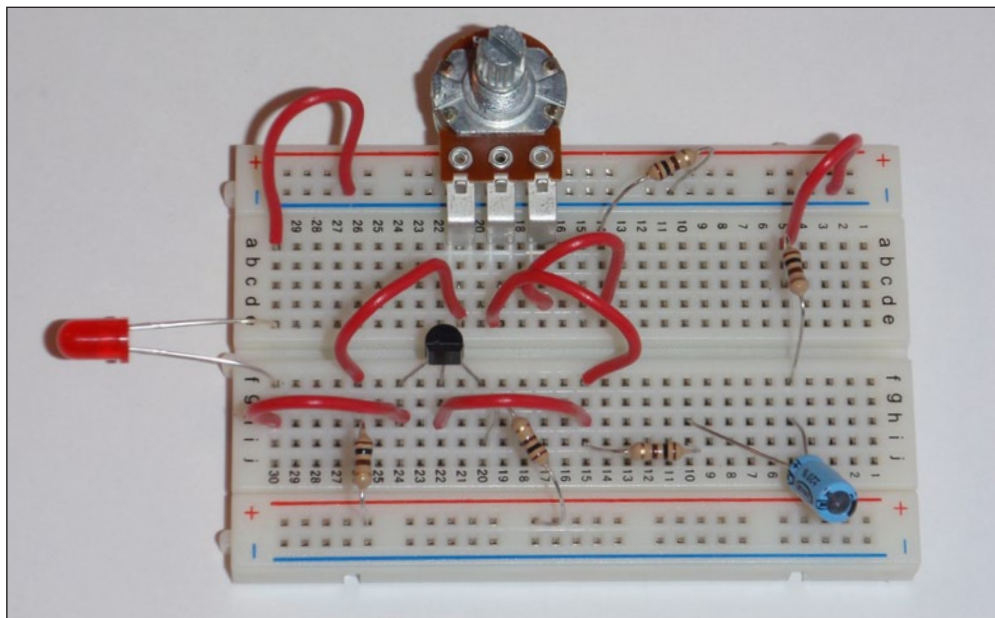
Step	Component	Location	Why did I just do that?
6	2" Jumper	Connect to H22 and to H15 .	These components connect the signal to the middle pin of the transistor and to the negative blue power rail.
7	2" Jumper	Connect to A5 and to top blue power rail.	
8	Resistor (brown, black, brown)	Connect to I15 and to I10 .	
9	Capacitor	Connect short negative lead to H5 and long positive lead to H10 .	
10	Resistor (brown, black, brown)	Connect to F5 and to C5 .	



Activity 4: IR Music Transmitter



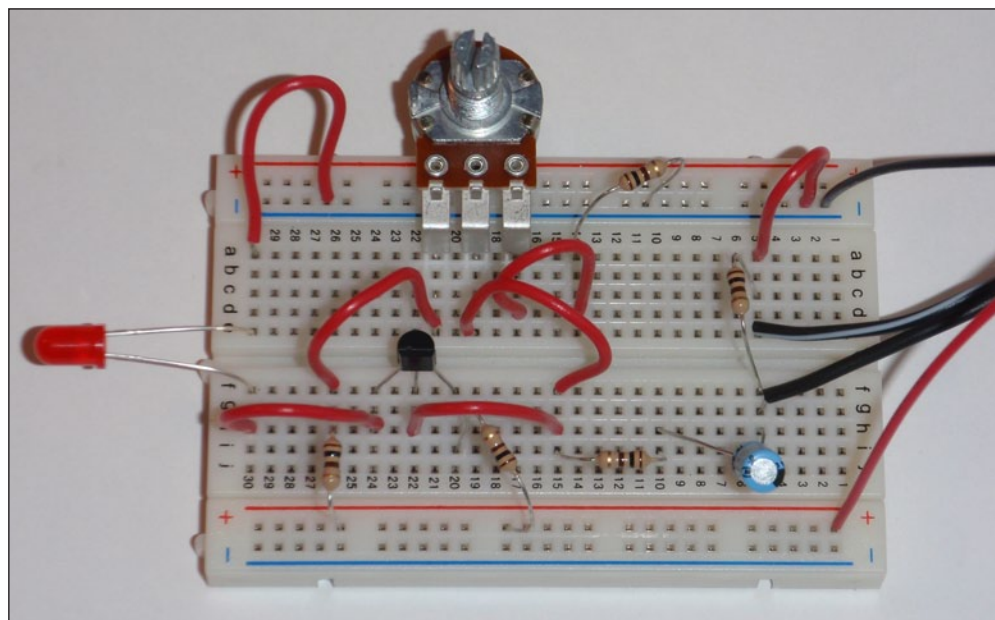
Step	Component	Location	Why did I just do that?
11	Potentiometer	Insert potentiometer's metal tabs into A21 , A19 , and A17 .	The potentiometer is a variable resistor and turning it varies the amplification of the transistor.
12	Resistor (brown, black, brown)	Connect resistor between J26 and bottom red power rail.	This connects the potentiometer to the red positive power rail.
13	2" Jumper	Connect to F26 and to E21 .	
14	2" Jumper	Connect to F15 and to E19 .	This connects the middle pin of the potentiometer to the middle pin of the transistor.
15	2" Jumper	Connect to D17 and to D14 .	This connects the potentiometer to the blue negative power rail.
16	Resistor (brown, black, brown)	Connect to A14 and to top blue power rail.	



Activity 4: IR Music Transmitter



Step	Component	Location	Why did I just do that?
17	Wire with headphone output	Connect these two wires to G5 and E5 .	This is how the music player is connected to the circuit. The sound signal enters through this wire.
18	Battery snap	Connect the red battery snap wire to right red power rail and the black battery snap wire to left blue power rail.	This connects the battery to power the circuit.
19	Battery	Ask your instructor for a 9V battery to connect and test the circuit.	The 9V battery provides power for the circuit. The transistor uses this to amplify the electrical signal to increase the brightness of the LED.



Activity 4: IR Music Transmitter

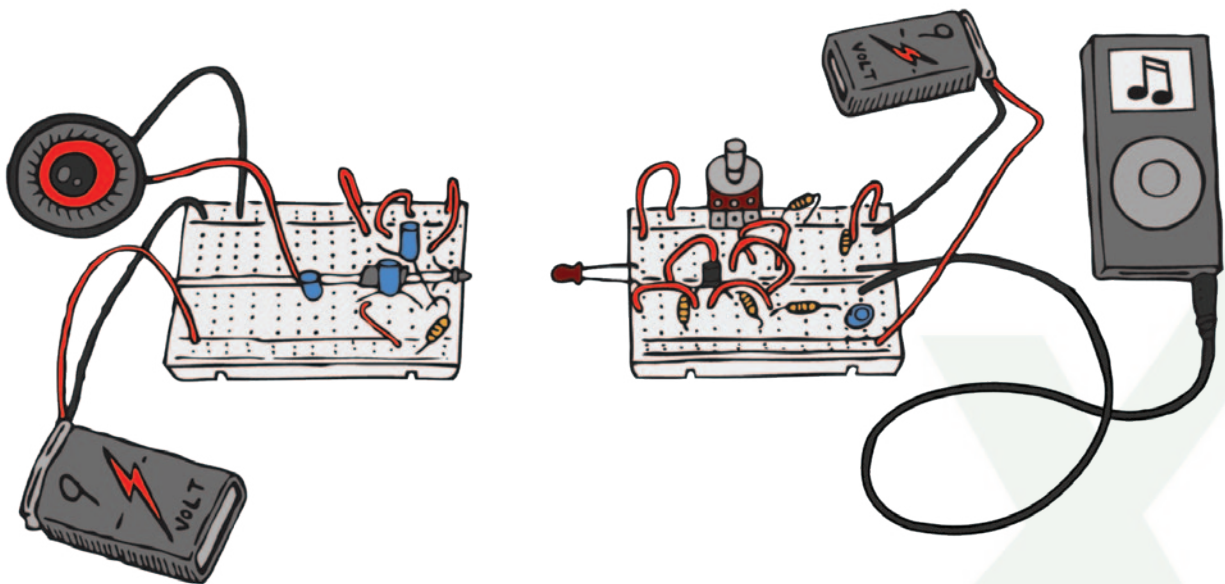


Part B: Testing

1. Connect a 9V battery to the battery snap.
2. Aim the red LED at the phototransistor of the music receiver (built in the last activity). Position the music transmitter so that the LED is about $\frac{1}{2}$ inch from the phototransistor.
3. Acquire a portable music player from your instructor or use one of your own. Listen to it through headphones and make sure it is producing loud and clear music or speech.
4. Plug the headphone jack into your music player and turn up the volume.
5. Rotate the stem of the potentiometer on your transmitter circuit. The red LED should be on and you should hear music coming out of the speaker in the receiver.

If your circuit does not work, immediately disconnect the battery of both the transmitter AND the receiver. A wiring error has occurred and you don't want to drain the batteries!

6. If you do not hear any sound from the speaker, troubleshoot your music transmitter-receiver system.
7. Now try using the clear infrared (IR) LED instead of the red LED.



Activity 4: IR Music Transmitter



Exploration Questions

1. What is the farthest distance the transmitter can be fired and still trigger a sound in the receiver? What could you change to increase this distance?
2. What is the disadvantage of using a lens on the transmitter?