

Note: These instructions will assume you purchased the parts from Jameco Electronics listed in the materials section, and can assemble your circuit exactly as shown in Figure 5. If you have other parts (for example, a different breadboard, or a servo motor with different colored wires), you might not be able to follow these directions exactly. Someone familiar with electronics might be able to help you with your circuit. However, the package of jumper wires you have might have all sorts of different lengths and colors. The colors do *not* make any difference to the circuit, so you can choose to use colors that make sense to you. For example, using a red wire for positive battery connections and black ones for negative will help you remember which is which. You can also choose wires just for their lengths (keeping them shorter for convenience).

1. Look at your breadboard. Hold it so that the valley in the middle goes up and down. On each side of the valley there are a series of rows that have five holes each (or more, depending on the breadboard you have). Each of the holes in each one of the rows is connected together, so putting wires in that row is like twisting them all together. You can learn more about breadboards and how they work by looking at the Science Buddies reference [How to Use a Breadboard](#).
2. Start with the 555 timer chip. Look at the top of the chip (pins pointing away from you). Do you see the small indentation at one end, or a small dot in one corner?
 - a. If your chip has the indentation, hold it so that the indentation is up. The upper left corner is called **pin 1**. Counting down the left side will be pins 1, 2, 3, and 4. Go back up the right side, starting with the lower right corner. The pins on that side (counting from the bottom) are 5, 6, 7, and 8. Pin 1 is opposite 8, 2 is opposite 7, 3 is opposite 6, and 4 is opposite 5. Knowing which pin is which is critical to making your circuit work.
 - b. If your chip has a single embossed dot instead of an indentation, that dot is pin 1. Proceed with the pin numbering as is explained in step 2.a.
3. Plug the chip into the breadboard so the pins straddle the gap in the middle, with pins 1 and 8 in row 10, and pins 4 and 5 in row 13. If it does not immediately plug into the board, *gently* squeeze the pins closer and try again.
4. Connect your battery pack to the breadboard's buses (the long strips marked by the red and blue lines), but do not put the batteries in the battery pack yet. Connect the red wire to the power bus (red line) and the black wire to the ground bus (blue line).
5. Use a jumper wire to connect pin 1 of the 555 chip (row 10, left side) to the ground bus.
6. The capacitor (marked as C1 Figure 2) is a 0.022 μ F capacitor, which may be marked as '223'. Connect one lead of the capacitor (C1) to pin 1 of the 555 chip (row 10), and the other lead in a hole for pin 2 of the chip (row 11, left side). It does not matter which lead goes in which hole.
7. Now you will connect the servo motor. If you purchased the servo from Jameco Electronics, the wires should be brown, red, and orange. Brown is the ground wire, red is the power wire, and the remaining orange wire is the signal that controls the servo. Note that other servo motors may have black (ground), red (power), and white (signal) wires instead.
 - a. Use a male-male jumper wire to connect brown lead of the servo to the ground bus.
 - b. Connect the orange lead of the servo to pin 3 of the chip (row 12, left side).
 - c. Connect the red lead to the power bus.
8. Connect chip pin 4 (row 13, left side) to the power bus.

9. With resistors, it does not matter which end is which. R2 in this circuit is a 2.2k Ω (ohm) resistor marked with three stripes, red-red-red. Connect one side of R2 to chip pin 5 (row 13, right side) and connect the other end to an empty, unused row (row 25 in Figure 5).
 - o Tip: The next two steps will be installing the photoresistor light sensors. In your project, you may want to position the two sensors away from the breadboard, perhaps in a stand where you will place your sculpture. The [Variations](#) section of the project describes how you can put them on wires instead of directly into the breadboard. You may want to put them directly on the breadboard at first, while you test your circuit, then move them later.
10. R3 is one of the photoresistors that you are using as a light sensor. Insert one side of R3 into the new row where you just connected R2 (row 25 in Figure 5) and the other side into the ground bus.
11. R4 is the other photoresistor light sensor. Insert one side of R4 into the new row where you connected R2 and R3 (row 25 in Figure 5), and the other side of R4 into the power bus.
12. R1 is a 3.3M Ω resistor, marked with orange-orange-green stripes. Use R1 to connect chip pins 6 and 7 (rows 11 and 12, right side).
13. D1 is a diode. Diodes work as valves to prevent electricity from flowing back and forth, so it *does* matter which way you use it. Find the end of D1 that has the black or gray band. Connect that end of D1 to chip pin 6 (row 12, right side).
14. Connect the other end of D1 to chip pin 7 (row 11, right side).
15. R5 is a 110k Ω resistor, marked as brown-brown-yellow. Note: 110k Ω is an unusual size. If you purchased a resistor kit, you might have a 100k Ω resistor (brown-black-yellow) or a 120k Ω resistor (brown-red-yellow), and can use that instead. Connect one end of R5 to chip pin 7 (row 11, right side) and the other end to the power bus.
16. Use a jumper wire to connect chip pin 8 (row 10, right side) to power bus.
17. Use a jumper wire to connect chip pin 2 (row 11, left side) to chip pin 6 (row 12, right side).
18. That is it for wiring! Take a few minutes to check and double-check your work and make sure that your version looks like the one in Figure 5. A single misplaced wire can prevent the entire circuit from working, so be careful!
19. Check to see if any of the wires or resistor/capacitor leads are touching each other. If you find any, bend them a bit to keep them separate.
20. Once you think you have everything right, go ahead and put the batteries in the battery holder. The servo motor should rotate to a position and stay reasonably steady.
21. With a bright light above you, use your finger to cast a shadow on the two photoresistors one at a time. As your shadow covers one of the sensors the motor will turn. Cast the shadow over the other one and it turns the other way. If your circuit is working, congratulations; it is time to do the art part of this project. If the circuit is not working, do not worry; the Troubleshooting section will help you find your problem and fix it.