




## MacroLab Lesson 4

### Percentages: Student Guide

You are going to be using Sphero to learn about percentages. The Sphero uses percentages in two places: speed and color. You will be using these Sphero macro commands:

-  Roll – Makes the Sphero roll at a given speed and heading.
-  RGB – Changes the color of the Sphero.
-  Delay – Sets an amount of time the ball waits to execute the next command

First you have to connect the Sphero to the iPad (Part 1), then aim your Sphero in the correct direction (Part 2). Next you will perform an experiment and challenge for speed (parts 3 and 4), and an experiment and challenge for color (parts 5 and 6).

### What is Percentage?

The word “percent” comes from the Latin “per centum”, meaning “by 100”. When we say 50% (50 percent), which means 50 out of 100, which can be expressed as a decimal or a fraction:

$$50\% = \frac{50}{100} = 0.50 = \frac{1}{2}$$

When you see a percentage, to figure out what decimal or fraction it is, you just need to divide it by 100. And remember, to divide by 100, all you need to do is to move the decimal point by two digits.

### How Does Sphero Use Percentages?

For Sphero, the speed is expressed as the percentage of the fastest speed it can roll. So 100% speed means that fastest it can go, and 50% speed means half that speed.

For colors, Sphero has three colored lights: red, green, and blue. 100% red means it lights up the red light as much as it can and 50% means that it lights it up half as bright. The same is true for green and blue. But what’s cool is that you can mix different colors to create new colors, and percentages become important then.

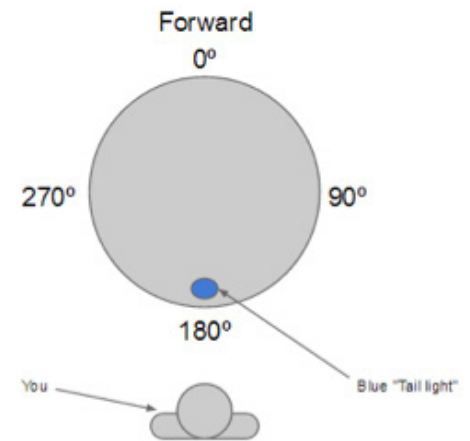
### Part 1: Connect the Sphero

First thing you need to do is to connect the iPad to Sphero. Here’s how:

1. Pick up Sphero from its charging station and tap it twice on the logo to wake it up. You may have to tap it hard. It will start flashing colors when it is awakened out of its “sleep” state.
2. On your device, make sure Bluetooth is enabled. From the home page, click on Settings at the bottom. Then choose Bluetooth.
3. You will be shown a list of Spheros. Connect to the appropriate Sphero by tapping it. You can tell which Sphero is which by the names, which relate to the colors the ball is flashing. For example, if it flashes purple, then yellow, then green, then that is ball PYG. Select the one you want. Once successfully connected, it will say “Connected”.

## Part 2: Aiming Sphero

Sphero has a direction built into it that it thinks of as "straight ahead". This is called the orientation. The first thing we want to do is to aim the Sphero so that the orientation is on the path we want it to go. Each Sphero has a blue light inside of it called the "taillight", which is always on the exact opposite side of the straight ahead direction. You are going to set the taillight so that it's pointing right at you when you look down the path you want Sphero to go. Then, when it goes straight ahead, it will be on that path.



Follow these steps to aim the Sphero:

1. Go to the home screen and open MacroLab.
2. Have one of you hold the Sphero and stand at the beginning of the path you will use for your experiments.
3. Now, you will aim the Sphero in that direction. Have a second member of the group use the iPad. In MacroLab, you will see a circle with two arrows at the bottom center of the screen. Tap on it and hold it.



4. A white circle will appear. Move your finger slightly to rotate the insides of the Sphero. You will see a blue light inside the ball. Move it around until the blue light is directly facing the person holding the Sphero. This is the "taillight", and shows the direction opposite where the Sphero will move when moving straight ahead.



Important: For these experiments, the Sphero will travel a long distance, so be sure to aim the Sphero as accurately as you can to keep it on track. You can also re-aim Sphero anytime!

## Part 3: Speed

Now that we have Sphero going in the right direction, let's see what the different speed percentages do. Follow these steps for the first experiment:

1. Tap the + button at the bottom to create a new macro.



## Part 3: Speed (continued)

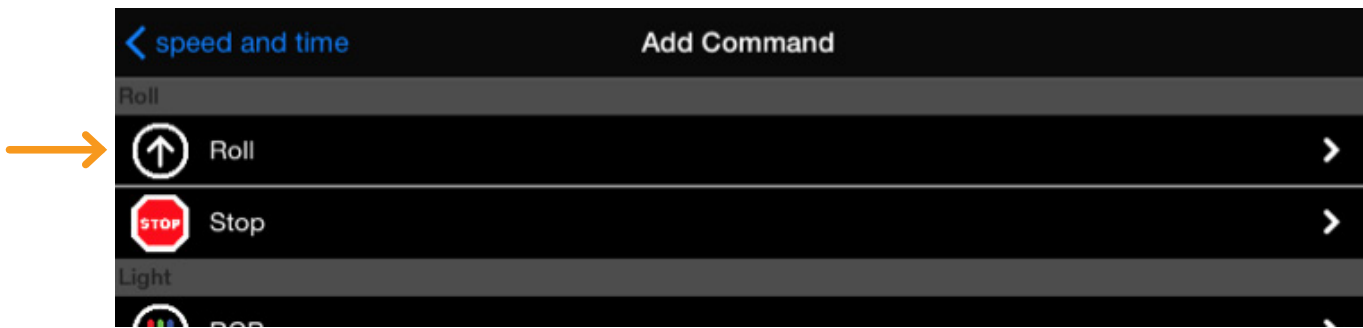
- Where it says Macro Name, call type percent. Click Create Macro.



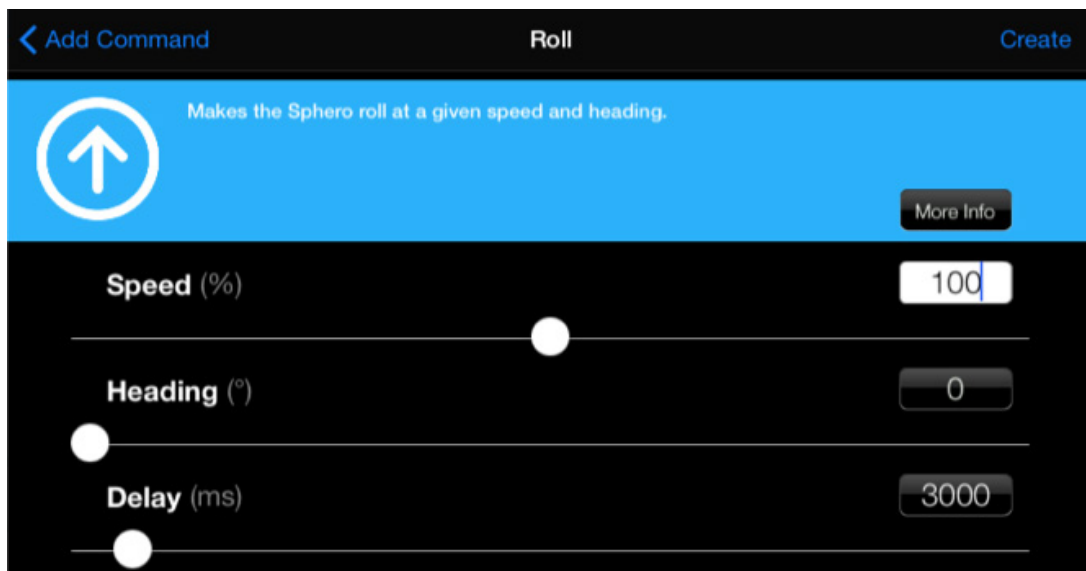
- Add a command by tapping the + button at the bottom right.



- Tap on Roll, the first command in the list.



- Change the Speed to 100 and the Delay to 3000. Leave the Heading at zero. Click the Create button up top.

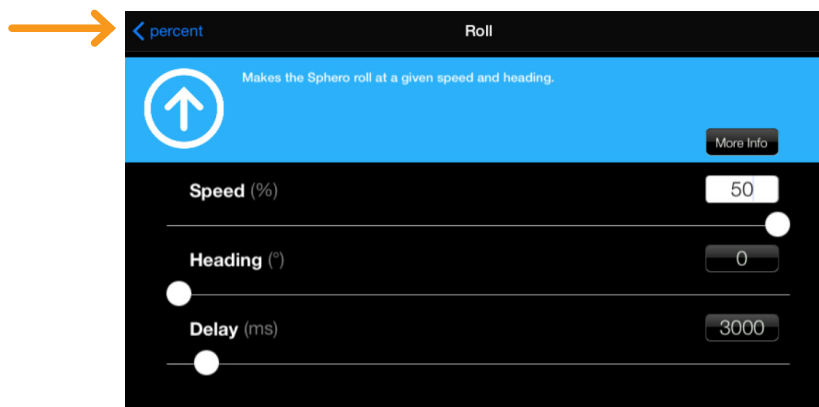


- Your program now moves Sphero at 100% speed for 3000 milliseconds, which is 3 seconds. You will see a Roll command.
- Tap the Play button. Make sure your Sphero can roll freely for the entire three seconds. You may have to adjust the direction like you did in Part 1 (Setup) to get it on right path.

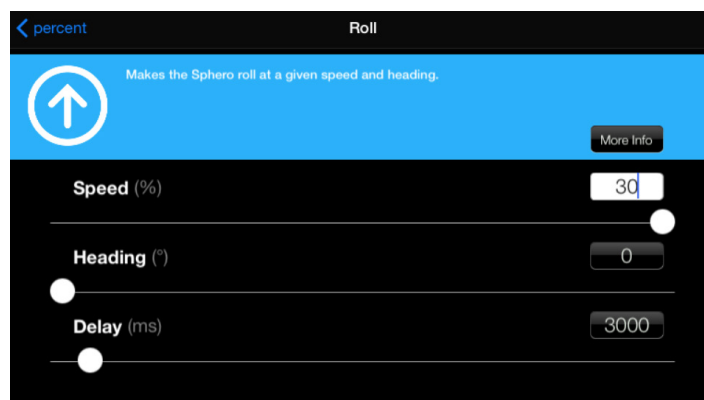


Now, let's do the experiment! Follow these steps:

1. Put a small piece of masking tape on the floor. Place Sphero on top.
2. Have one member of the team hold the iPad, and the rest of the team evenly spaced along the path the Sphero will roll. Have the person with the iPad tap the Play button to start Sphero. Everyone else should be looking for when Sphero stops rolling. At this high speed, once it stops rolling, it will continue to slide, but you want to make sure you know where it stopped rolling.
3. Place a small piece of masking tape where Sphero stopped rolling.
4. With your tape measure, measure how far it traveled. Write the answer on your worksheet.
5. Let's calculate the actual speed of Sphero. The speed is the distance traveled divided by the time it took the travel it. So, divide the distance by 3 seconds, and write that in your worksheet.
6. Now, let's do it again for 50% speed. Tap on the Roll line and change the speed to 50%. Tap percent when you are done.



7. Put Sphero back on the starting piece of tape and tap Play on the device. Once again, put a piece of tape where Sphero stops rolling. Measure the distance between the starting and ending pieces of tape and write it on your worksheet.
8. Do this one more time with a speed of 30%. Measure the distance and write it on your worksheet. Divide the distance by 3 seconds to get the speed, and write that on your worksheet, too.



9. Now, for our final calculations. Divide the 50% speed by the 100% speed. Turn this number into a percentage. You should have a number somewhere near 50. Divide the 30% speed by the 100% speed, and turn this into a percentage. You should get a number close to 30.

Why is it not exactly 50 and 30? It turns out that the speed calculation is not exact because Sphero takes a little time to get up to speed. The faster the speed, the more time it takes to go from zero to its final speed.

## Part 4: Speed Challenge

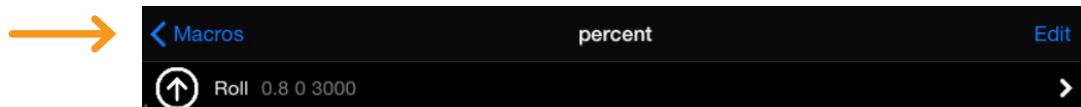
For the challenge, let's work backwards and see if we can figure out what speed percentage we need to get Sphero to stop rolling where we want to. Follow these steps:

1. Put a piece of tape somewhere between your starting piece of tape and your ending piece of tape for the 100% speed. Make it closer to the end than the beginning.
2. Measure the distance from the starting tape to the new tape you put down. Write that number in your worksheet.
3. If Sphero only has 3 seconds, how fast does it need to go to stop rolling at that point? Speed is distance divided by time, so divide the distance you measured by 3 seconds. Write the answer in your worksheet.
4. What percentage of the 100% speed is this? See if you can figure it out and write it in your worksheet.
5. Change the Roll step of the macro to roll at that speed and try it out. Watch the spot near the masking tape. Did Sphero stop rolling close to that point? Remember, it won't be exact because of the time it takes for Sphero to get up to speed.

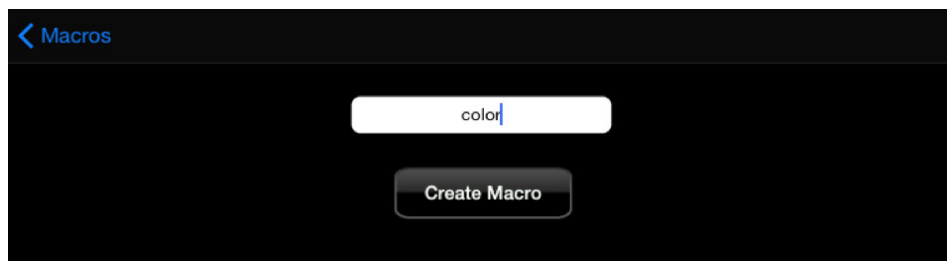
## Part 5: Color

Let's switch now from movement to color, and you'll learn how to make Sphero light up with different colors. Every color that you see can be made up of a mixture of the colors red, green, and blue. Sphero lets you set the percentage of red, green, and blue that you use in this mixture. Follow these steps to play around with color percentages:

1. First, create a new macro for colors. Tap Macros on top to get to the list of macros. Then tap the + button at the bottom to create a new macro.



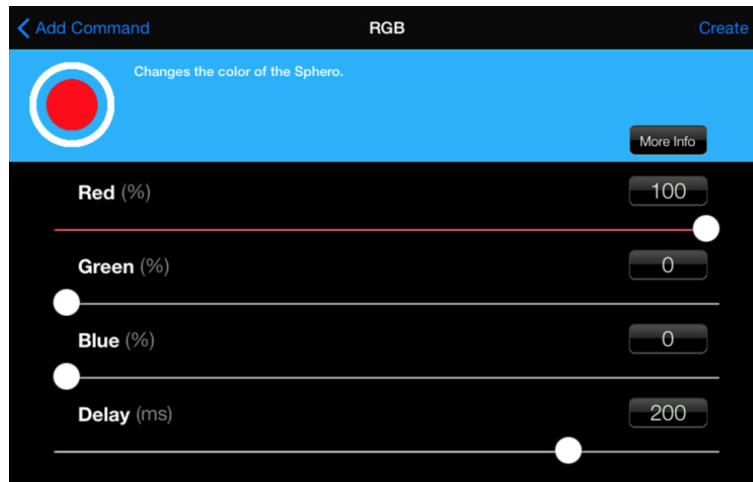
2. Name the macro color. Tap Create Macro.



3. Tap the Add (+) button at the bottom of the screen. Tap on RGB (which stands for "Red, Green, Blue"), the third command in the list.



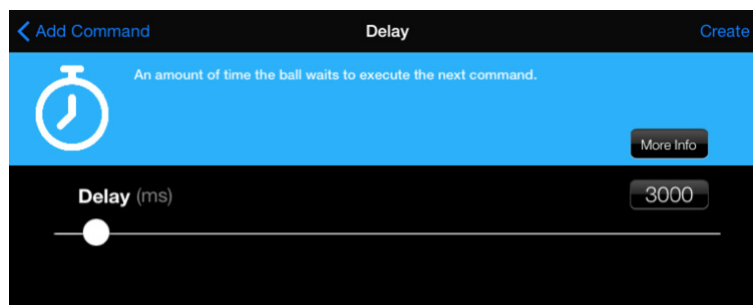
4. Drag the slider for Red to the right for 100% in order to make a red color. Slide the Green and Blue sliders to the left for 0%. Leave the Delay at 200. Click Create.



5. Now let's add a three second delay so that you can see the color for three seconds. Tap the + button to add a new step.
6. Tap the Delay button.



7. Set the Delay value at 3000 milliseconds (3 seconds). Click Create.



8. Set Sphero on a table. Tap Play and Sphero will turn red for 3 seconds.

That's the color we get with 100% red. Let's modify the color and make it 50% red. What do you expect it to look like?

1. Tap RGB and change the red value to 50%. Leave the others at zero.
2. Tap percent to get back to the macro list. Tap Play.

That's the color we get with 100% red. Let's modify the color and make it 50% red. What do you expect it to look like?

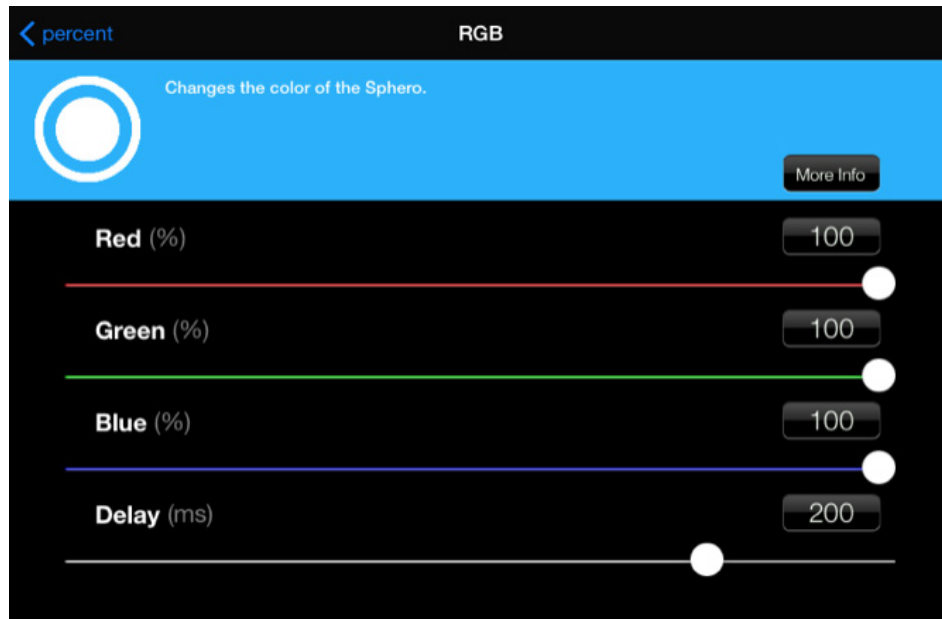
Now, let's make the color yellow. When you mix red and green paint, you get brown. But when you mix red and green light, you get yellow. Here's how:

1. Tap RGB and change the red and green values to 100%. Leave blue at zero.
2. Tap percent to get back to the macro list. Tap Play.

Let's say you wanted to make orange. Orange is like yellow, but it's got more of the red color in it. Try reducing the green to 50%, but leaving the red at 100% and the blue at 0%. Did that get orange?

## Part 6: Color Challenge

For the challenge, let's try to make two new colors: gray and purple. To make gray, let's start by making white. White is the color you get when you have 100% red, 100% green, and 100% blue.



Try it out. Sphero won't be exactly white, but it will be pretty close.

What happens when you have 0% red, 0% green, and 0% blue? Try it.

As you might expect, Sphero puts out no light at all. No light at all is considered black.

You know how to make white and black, so how about gray? Gray is about halfway between white and black, so what is your guess? Once you figure out the percentage values for red, green, and blue, write them in your workbook.

Finally, once you have gray, try making purple. By now you have noticed the little circle at the top left when you are choosing your colors. You can use this to get to the color you want, even though it won't exactly match what's shown on Sphero. Play around with the sliders and see if you can get purple.

Fill in your color percentage values for purple on your worksheet.