

## How bright is that light?

This describes some ideas for experiments to investigate what we mean by the brightness of light and how we measure it. We will be using a picoboard and a very simple scratch project to let us focus on the sensorboard response from the light sensor.

**Ingredients:** Torch, box with a hinged lid (shoe boxes are ideal), and for the most advanced variation, a light meter ideally giving a reading in lumens (you can download one as an app for your phone, but it will be less reliable than a standard light meter).

### Step 1

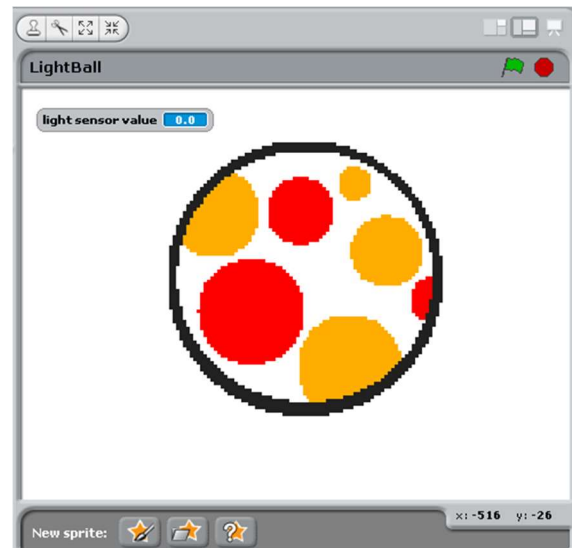
Put the picoboard into the box, ideally feeding the cable into a hole in the side so that the picoboard lies flat. Then plug it into your computer and start up Scratch.



**Safety:** Please note that you use these resources at your own risk. Correct use of some components requires care.

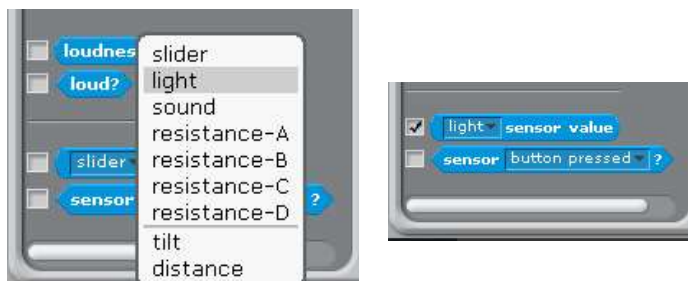
## Step 2

Choose a Sprite (we have chosen a ball) and create the simple program as shown below.



## Step 3

In order to view only the light sensor value as in the screen, select 'light' from the menu for the 'sensor value' block and click on the tick box.



## Step 4

Try opening and closing the lid slowly: you should see the ball shrink when the lid goes down (because it gets darker inside the box) and grow as the lid is opens (because it gets brighter).

But what's really happening?

### The science behind it:

Light carries energy. When it hits the back of our eye, this energy passes on information about the surroundings to our brains. The brighter the light, the more energy, and the more information it can carry: we see things poorly in a dim room, and better in a brightly lit one. If the light is bright enough, it can even damage our eyes, which is why you should never look directly at a very bright light source such as the sun



But just how do we measure how bright the light is? We can use a scientific measure: actually measure how much energy is arriving at a sensor per second, and this is called the luminance. Brightness is measured in lumens, which give a direct measure of the energy: shining two identical torches on the same spot gives twice as many lumens as a single torch.

### How does that apply here?

The idea here is to investigate what the picoboard tells us about this.

The light sensor in the picoboard works in a rather complicated way. It is made out of a combination of materials whose ability to conduct electricity depends on how well illuminated it is. This is then translated into a number between 0 (completely in the dark) to 100 (as bright as a well-lit room, or any brighter than that), which is sent to the computer as the `light_sensor` value.

The radius of the ball is proportional to this value, which is also shown in the corner. Let's take a look at what this number actually tells us.

**Now we can use our program to investigate the following:**

- Inside the code there is a 'magic number': the value 4. What is this for? Experiment with other values, and see why 4 was chosen.
- Play about with the lid, and see how the level of brightness inside the box is displayed by scratch.
- Try shining a torch at the light sensor. Does the response depend on the angle at which the torch is shone? What about the distance of the torch from the sensor?
- Try holding the torch at varying distances from the board. How does the sensor value depend on the distance? Does it make a difference if you try this in a room which is well-lit compared to one where the torch is the only source of illumination?
- Compare the reading on the light sensor with the reading from a light meter: plot a graph with the light sensor reading on the x axis and the light meter reading on the y axis. What is the relationship?

