Experiment P-54
Resistance of a Light Bulb

Physics

Objectives

- To learn how incandescent light bulbs work.
- To investigate the effect of heating the bulb's filament on the resistance.

Modules and Sensors

- PC + NeuLog application
- USB-200 module
- NUL-204 Light logger sensor
- NUL-249 Resistance logger sensor

Equipment and Accessories

▪ Circuit board	1
▪ 6 V cell holder	1
▪ Knife switch	1
▪ Bridge	1
▪ Mounted bulb holder	1
▪ 6 V bulb	1
▪ Black 4 mm connector cable	1
▪ Red 4 mm connector cable	1
▪ Black crocodile clip and 4 mm connector cable	1
▪ Red crocodile clip and 4 mm connector cable	1
▪ 1.5 V battery (type D)	2

- The items above (except the batteries) are included in the NeuLog Electricity kit, ELE-KIT.

Introduction

The incandescent light bulb produces light by heating a metal filament wire to a high temperature until it glows. The filament is protected from air by a glass bulb evacuated or filled with inert gas that doesn't allow the filament to burn.

Incandescent bulbs are simple but not very efficient. Most of the electricity flowing through the filament generates heat while a small percentage actually produces light. That is why switching to fluorescent and LED lighting is so popular.

The resistivity and conductivity are inversely related. Good conductors have low resistivity, while poor conductors (insulators) have high resistivity.

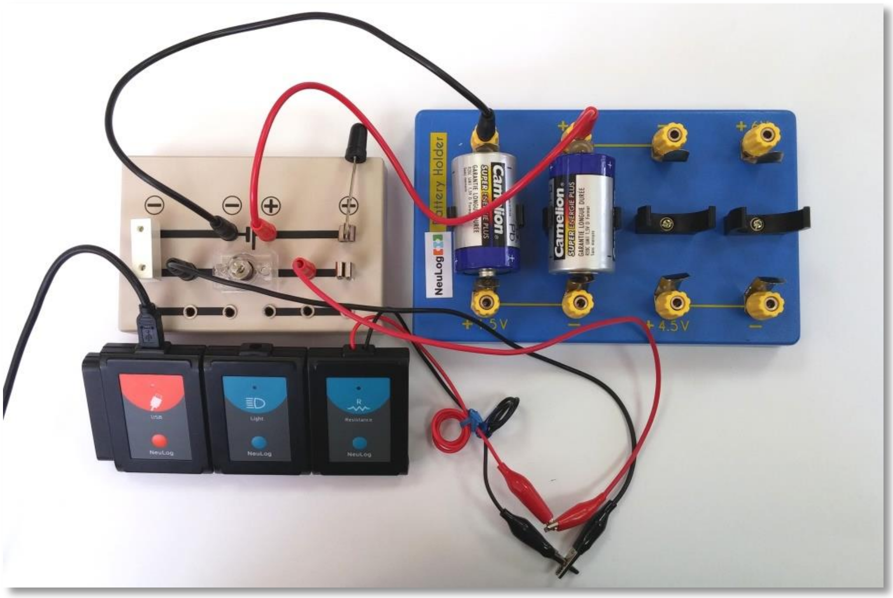
Resistance depends on temperature; it usually increases as the temperature increases. Since heat is generated by the light bulb we would expect its resistance to rise while turned on.

In this activity, we will turn the light bulb on and off, while measuring the light intensity and resistance. The resistance cannot be measured while the bulb is on (shows maximum resistance) but we will still be able to see resistance values a few seconds after it is turned off.

Procedure

Experiment setup

1. Set up the experiment as shown in the picture below.



2. Connect the bridge, the knife switch, and the mounted bulb holder with the bulb as shown in the picture.

3. Take a red connector cable and connect the 4 mm connector next to one side of the bulb and the crocodile clip side to the red cable of the resistance sensor.

4. Take a black connector cable and connect the 4 mm connector next to the other side of the bulb and the crocodile clipe side to the black cable of the resistance sensor.

5. Connect a red 4 mm connector cable to the "+" side of the battery sign ⊣⊢.

6. Connect a black 4 mm black cable to the "-" side of the battery sign ⊣⊢.

7. Place two 1.5 V (type D) batteries in the 6 V cell holder (the "+" side of the battery should be on the "+" side of the cell holder).

8. Connect the other end of the red 4 mm connector cable to the socket next to the "+ 3 V" writing at the 6 V cell holder.

9. Connect the other end of the black 4 mm connector cable to the socket next to the "-" writing.

10. Leave the knife switch opened.

11. If possible, dim the light in the room.

Sensor setup

12. Connect the USB-200 module to the PC.

13. Check that the light and resistance sensors are connected to the USB-200 module in a chain.

Note:

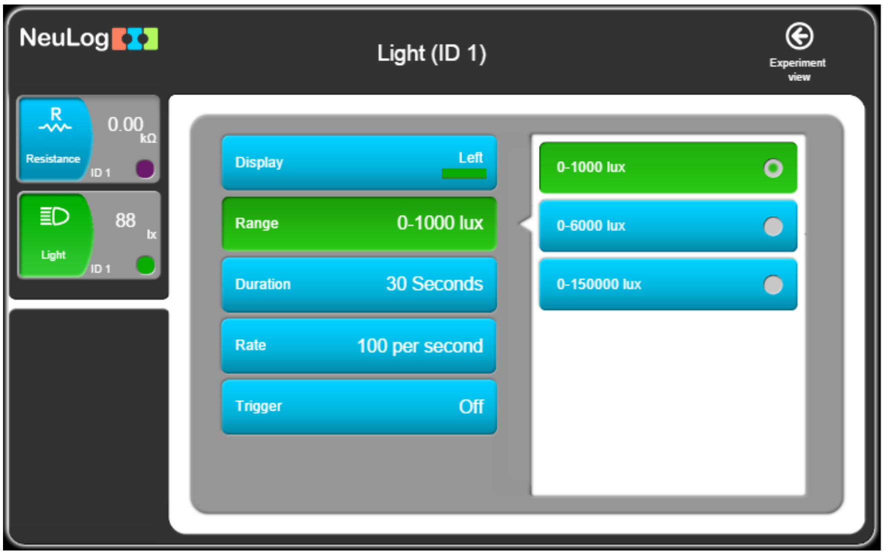
The following application functions are explained in short. It is recommended to practice the NeuLog application functions (as described in the user manual) beforehand.

14. Run the NeuLog application and check that the sensors are identified.

Settings

15. Click on the light **sensor's module** box.

16. Select the 0-1000 lux button to change the sensor's mode.



17. Click on the  icon to go back to the graph.

18. Click on the **Run Experiment** icon  and set the:

    Experiment duration to 30 seconds
    Sampling rate to 100 per second

Testing and measurements

19. Click on the **Record** icon .

20. Place the light sensor in front of the light bulb.

21. Pull down the knife switch to close the circuit.

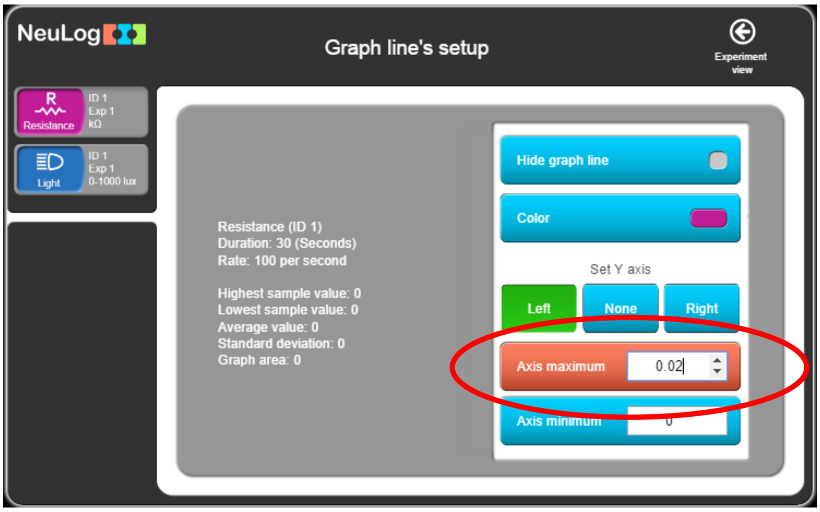
22. After about two seconds, pull the knife switch up.

23. Wait a few seconds and repeat this process, pulling the knife switch down and after about two seconds pulling it back up.

24. Repeat this process again after a few seconds.

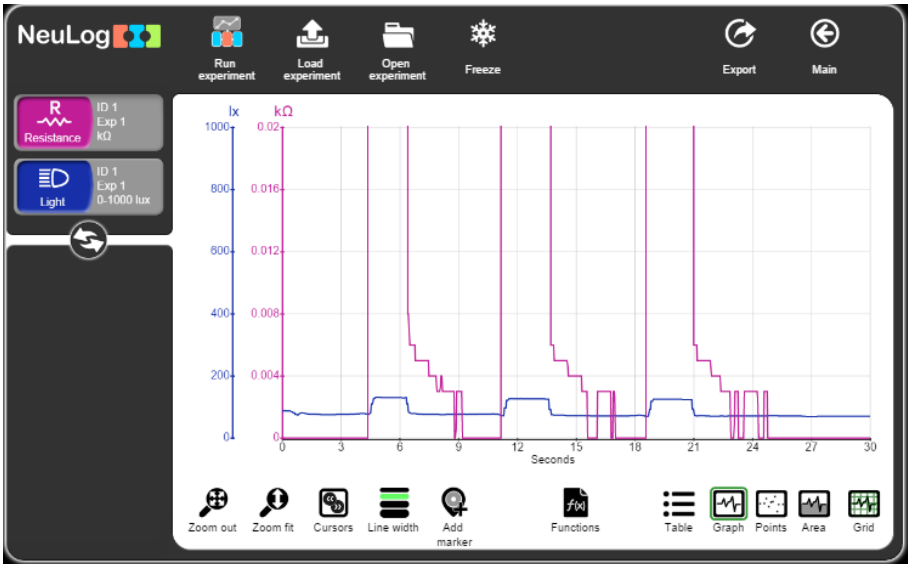
25. At the end of the measurement, make sure that the knife switch is up (to prolong the life of the bulb and the batteries).

26. Click on resistance experiment module box on the top left side of the screen and change the **Axis maximum** to 0.02 kΩ.



27. Press Enter and click on the icon to go back to the graph.

28. Your graph should be similar to the following:



29. If the light measurement is saturated (it reaches the maximum sensitivity of the sensor) you can put the sensor at a greater distance from the bulb and repeat the measurement or you can change the sensors range.

30. Click on the **Export** Icon  and then on the **Save value table (.CSV)** button to save your graph.

31. Click on the  icon to go back to the graph.

32. We can see that when the knife switch is up, the resistance of the light bulb is zero. When the light bulb is turned on by the knife switch, the current runs through the resistance sensor and it shows 200 kΩ. When the current runs through the resistance sensor we cannot address the results because the sensor is not meant for this purpose. When the light bulb is turned of by the knife switch, we can see about 0.006 kΩ (=6 Ω) of resistance, in the example experiment, which declines until it reaches zero.

Summary questions

1. Why is the resistance of the light bulb zero before it is turned on?

2. Why is the resistance value greater than zero after the bulb is turned off?

3. How does a fluorescent light bulb work and why is it considered to be more efficient than an incandescent light bulb?