Experiment P-11
How Incandescent Light Bulbs Work?

Physics

Objectives

- To learn how incandescent light bulbs work.
- To measure the time it takes for a light bulb to turn on from the moment current flows.
- To investigate the effect of heating the filament on the current.

Modules and Sensors

- PC + NeuLog application
- USB-200 module
- NUL-202 Current logger sensor
- NUL-204 Light logger sensor

Equipment and Accessories

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

- The items above (Except for 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.

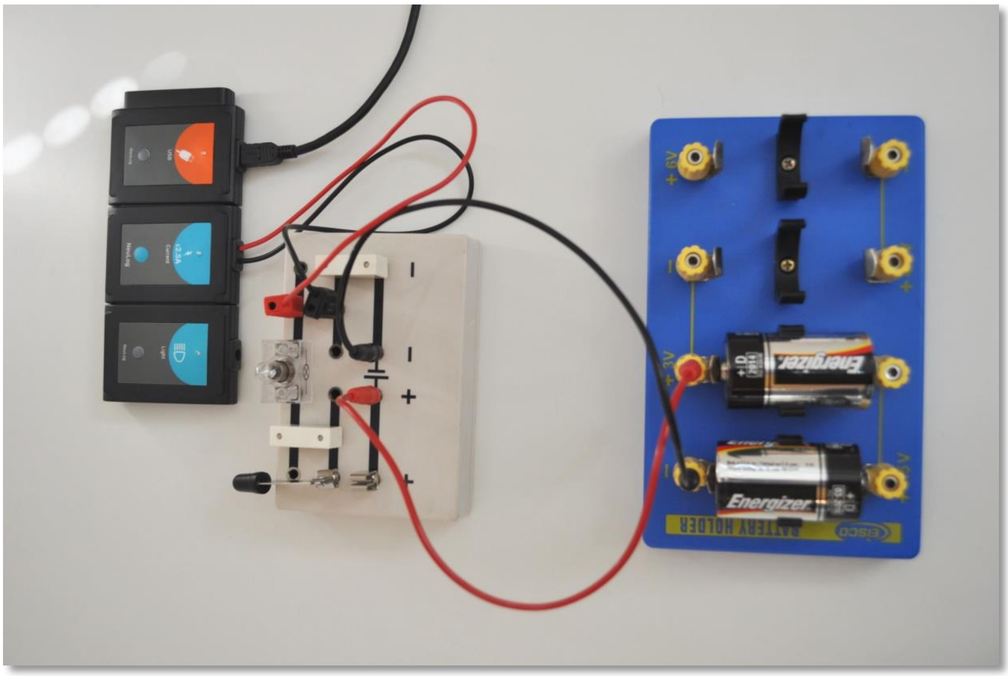
Incandescent bulbs are simple but not very efficient. Most of the electricity flowing through the filament generates heat while a small percentage actually produces light. That is why switching to fluorescent and LED lighting is so popular.

In this activity we will measure how long it takes the light bulb to finally irradiate light, from the moment current (electrons) begins to flow through the circuit.

Procedure

Experiment setup

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



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

3. Connect the red cable of the current sensor to the socket next to the mounted bulb holder.

4. Connect the black cable of the current sensor on the next board line.

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 current and the light sensors are connected to the USB-200 module in a chain.

Note:

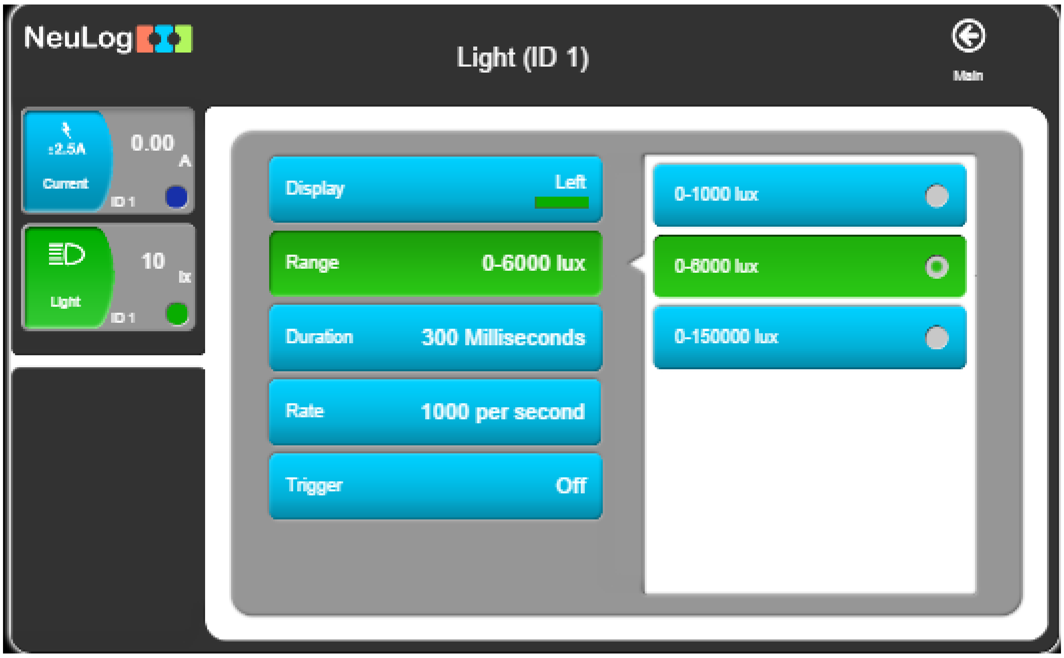
The following application functions are explained in short. It is recommended to practice the NeuLog application functions (as described in the user manual) beforehand.

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 0-6000 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 300 milliseconds
Sampling rate to 1000 per second
Trigger level 0.02 A (rise)

Testing and measurements

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

    In this experiment, this command does not start the measurement. Since the process is very fast, the measurement is programmed to begin when the sensor detects current (0.02 A) flowing through the circuit.

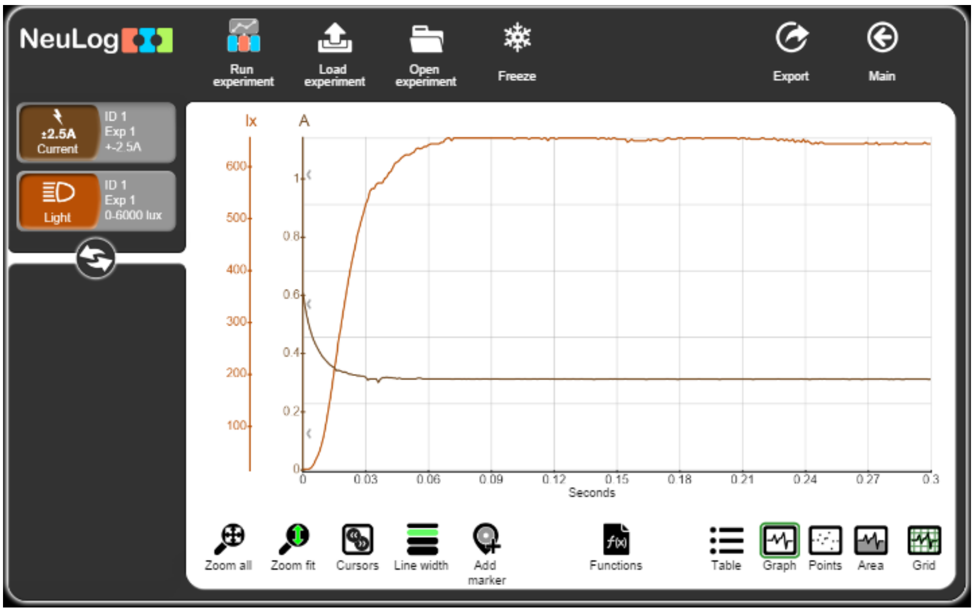
20. Place the light sensor in front of the light bulb.

21. Close the circuit by pulling down the knife switch.

22. Immediately after the measurement ends, open the knife switch (to prolong the life of the bulb and the batteries).

23. Click on the **Zoom fit** icon.

24. Your graph should be similar to the following:



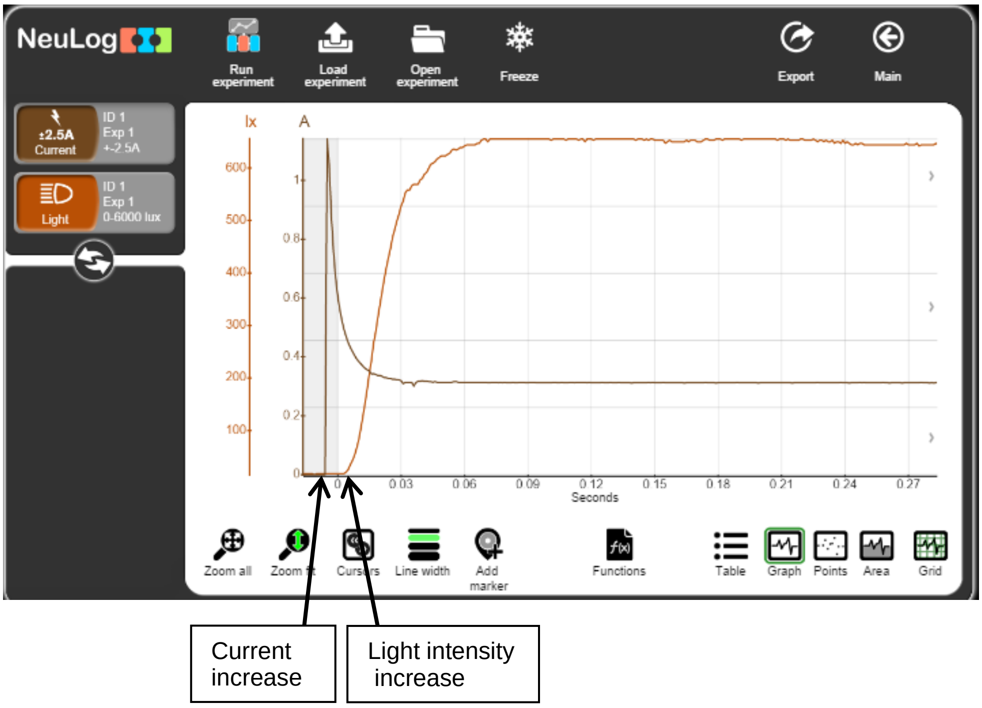
25. If the light measurement is saturated (it reaches the maximum sensitivity of the sensor) you can put the sensor at a greater distance from the bulb and repeat the measurement or you can change the sensors range.

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

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

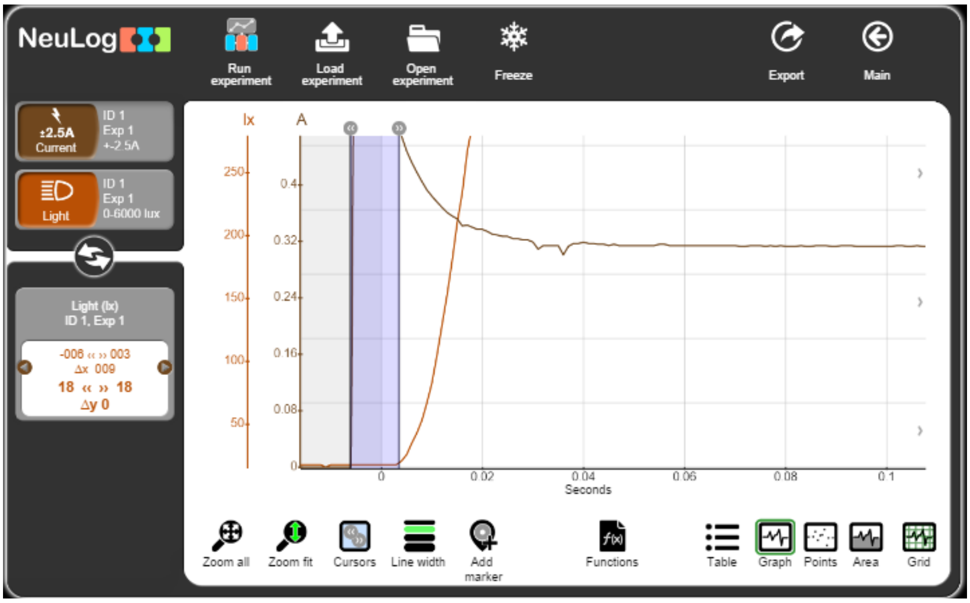
28. In order to see how the current initially goes up when the circuit is closed (before the trigger condition), move the graph to the right with your mouse. This allows you to see previous measurements taken before the trigger level was reached.

29. Your graph should be similar to the following:



30. In order to focus on the desired range (the range where the current and the light intensity change), use the mouse's scroll wheel.

31. Click on the **Cursors** icon  and select a part of the graph between the current increase and the light intensity increase.



32. Look at the ΔX value in the **selected area** table; this is the difference between the time the current started to increase and the time the light started to increase. After around 0.09 seconds (in the sample experiment), light intensity began to rise due to the heating of the filament. It takes some time until the filament reaches the temperature in which it starts to glow; therefore there is a small delay that our eyes cannot detect.

Summary questions

1. How long did it take the bulb to irradiate completely?

2. What would happen if you use alternating current instead of direct current?

3. Challenge question: Why does the electric current fall when it passes through the bulb?