
Experiment P-45 Radioactivity and Distance



Objectives

- To learn about radioactivity.
- To investigate the relationship between radiation and distance from the source.

Modules and Sensors

- PC + NeuLog application
- USB-200 module 
- NUL-247 Geiger counter logger sensor 

Equipment and Accessories

▪ Ruler
▪ Radioactive source
▪ Paper
▪ Pen

Introduction

Radioactivity is the spontaneous emission of radiation. This emission can occur from unstable atomic nuclei or as a consequence of a nuclear reaction. The most common types of radiation are alpha, beta and gamma.

Radioactive decay rates are stated in terms of their half-lives. A radioactive half-life is the time it takes for half of the atoms to emit radiation. The half-life of a given nuclear species is related to its radiation risk. The radioactivity of a sample can be measured by counting how many ionizing events occurred in a period of time or as rate (counts per second). This is done by a Geiger counter, which contains an inert gas filled tube that conducts electricity when a particle or photon of radiation makes the gas conductive by ionization.

There are many applications to the use of radioactivity. It is used to study living organisms, to diagnose diseases, to produce energy for heat and electric power, etc.

The fundamental principles of radiation protection are time, distance and shielding. One should try to decrease the amount of time spent in the radiation field. By increasing the distance from the radiation source, one decreases the radiation dose received. It is also important to use proper shielding, depending on the type of radiation source.

In this experiment we will use a Geiger counter logger sensor in order to investigate whether the relationship between radiation and distance from the source follows the inverse square law (the radiation is inversely proportional to the square of the distance).

Procedure

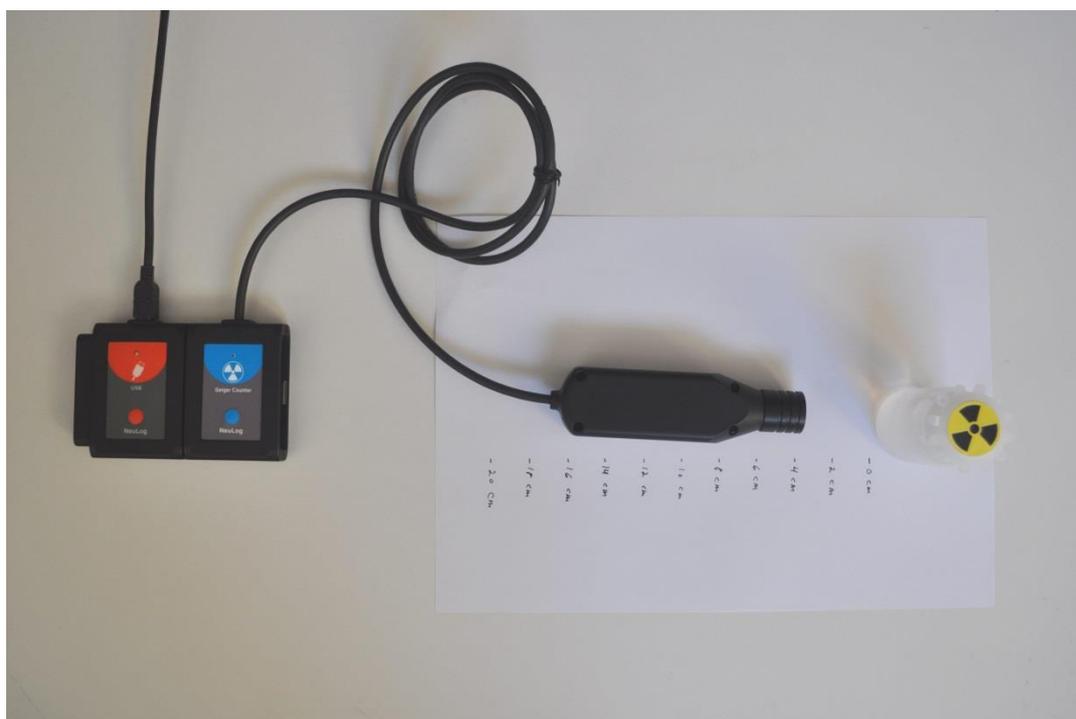
Experiment setup

Caution:

You will be working with a radioactive source provided by your teacher. It is important to follow her/his safety instructions.



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



2. Make 10 marks along a piece of paper, every two centimeters.
3. Put the radioactive source on the "0 cm" mark.
4. Put the Geiger counter sensor on the 4 cm mark.

Sensor setup

5. Connect the USB-200 module  to the PC.
6. Check that the Geiger counter logger sensor  is connected to the USB-200 module.

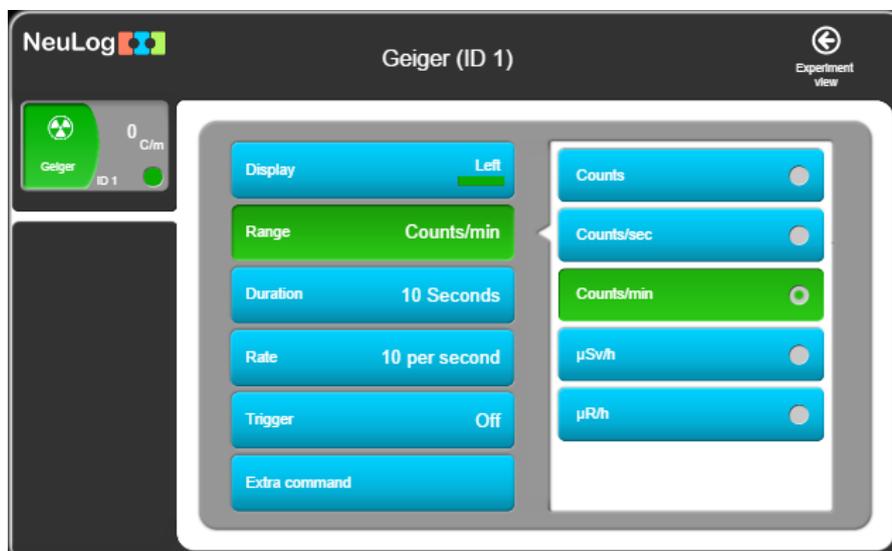
Note:

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

7. Run the NeuLog application and check that the Geiger counter sensor is identified.

Settings

- Click on the **Sensor's Module** box.
- Select the Counts/min button to change the sensor's mode.



- This experiment is done in single step mode so the experiment duration and sample rate will not be set.

Testing and measurements

Note:

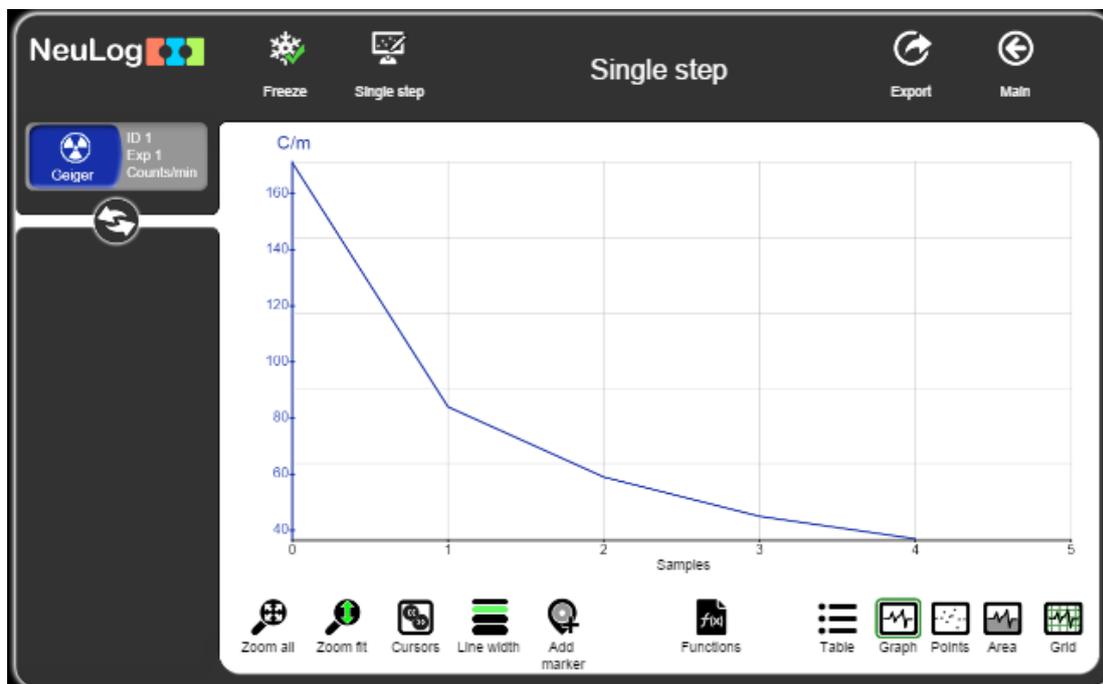
You will need to wait for the reading to stabilize at each distance, this will take about a minute.

11. Wait about a minute and click on the **Single step** icon  in order to measure the radiation 4 cm from the source.
12. Move the Geiger counter sensor to 6 cm from the source, wait about a minute and click again on the **Single step** icon .
13. Continue to move the Geiger counter sensor every two centimeters until it reaches 12 cm from the source.

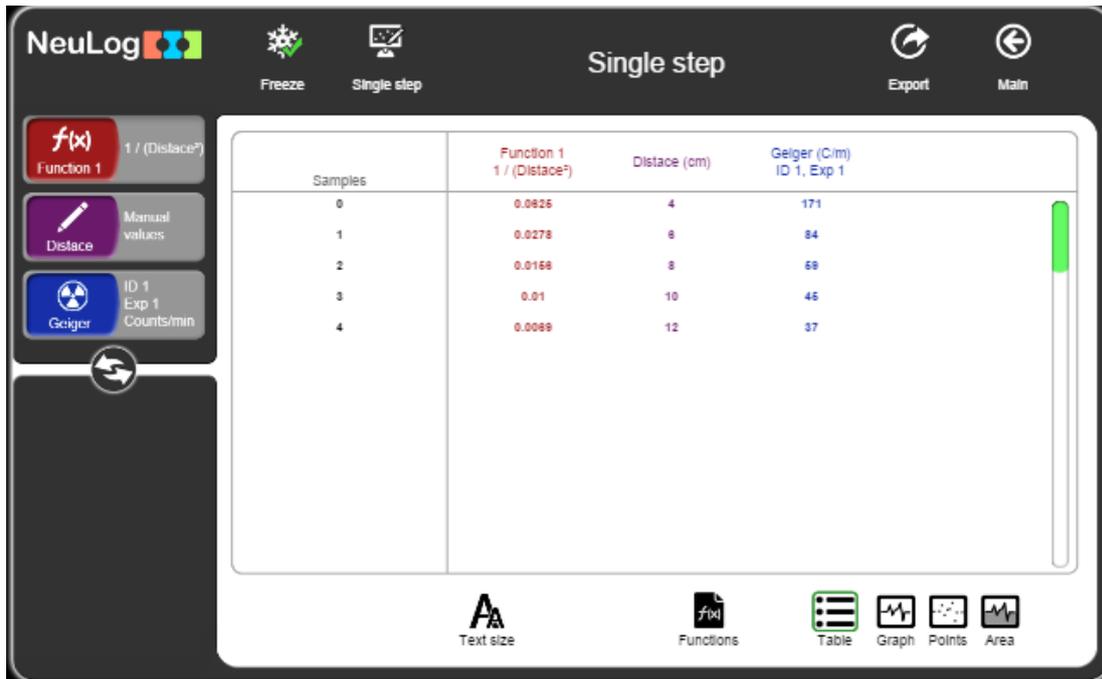
Note:

The distance from the source should depend on its radiation intensity. It might be necessary to change the distance values according to your specific source.

14. Click on the **Zoom fit** icon  and on the **Graph** icon .
15. Your graph should be similar to the following:

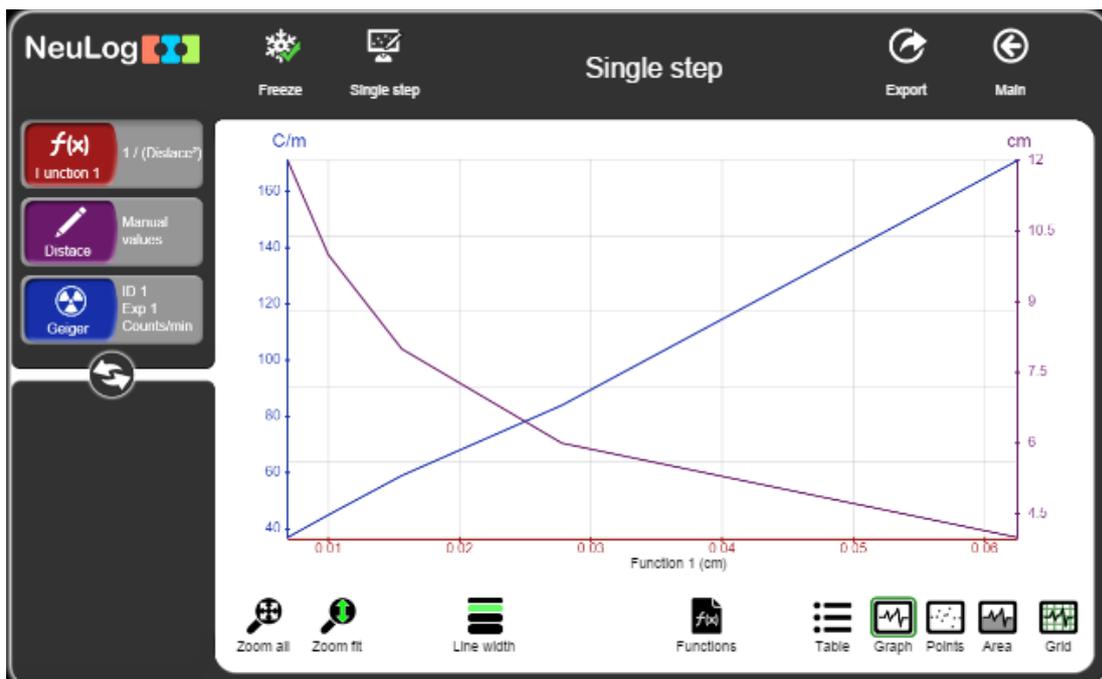


16. Save Click on the **Export** Icon  and then on the **Save value table (.CSV)** button to save your graph.
17. Click on the  icon to go back to the graph.
18. Click on the **Table** icon  and then on the **Manual values** icon .
19. Insert the word “Distance” to the column name section. Insert “cm” to the Units section. Click on the **Add** button.
20. Insert the relevant distances in the Distance (cm) column.
21. Click on the **Functions** icon , choose Distance as Parameter A.
22. Click on the **Functions** button and choose the function: $1/(A^2)$.



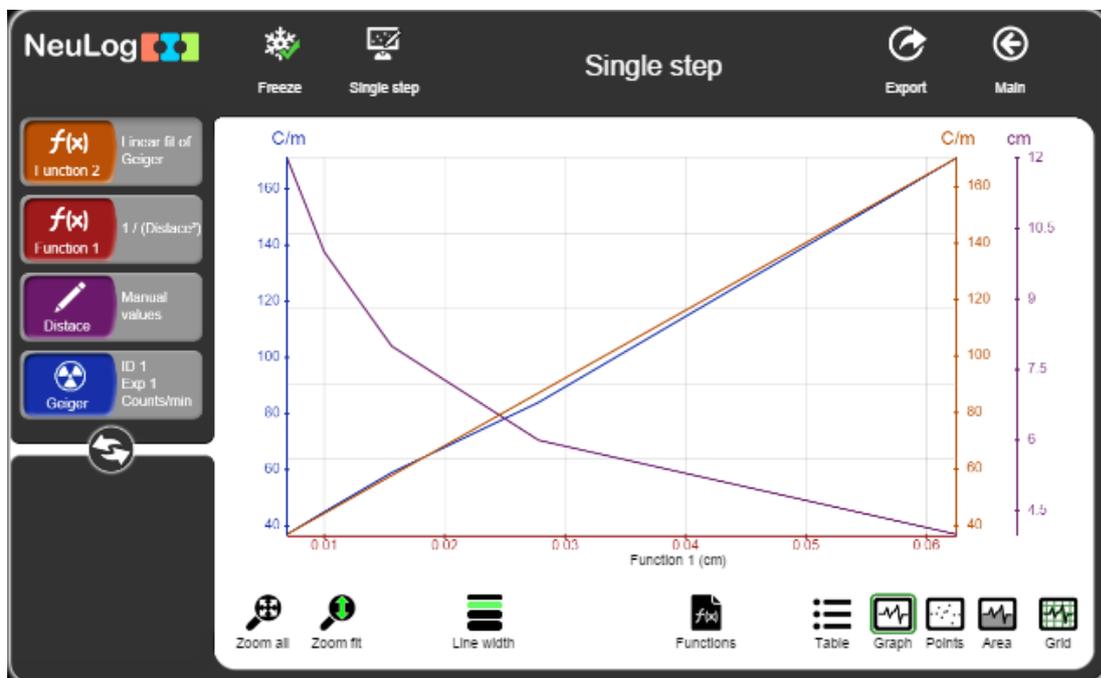
23. Click on the **Functions** icon  again.

24. Click on the **x axis** button and choose Function 1 as the x axis.



25. You should get a straight line. What does a straight line mean?

26. Click on the **Functions** icon  and click on choose Geiger as parameter A.
27. Click on the **Function** button and choose Linear fit of A.
28. Click on the **linear fit** module box in the left to see the equation.



Function 2
Linear fit of Geiger
 $2396.5041X+20.3419$

Challenge research

29. Measure the radioactivity far away from the source (across the room or in another room) or block the radiation (lead blocks gamma rays).

Summary questions

1. How many counts per minute did you get in the challenge experiment? Explain your result.
2. Explain the difference between alpha, beta and gamma radiation.
3. What other sources follow the inverse square law?