Radioactivity iLab Analysis Guide

For OpenOffice

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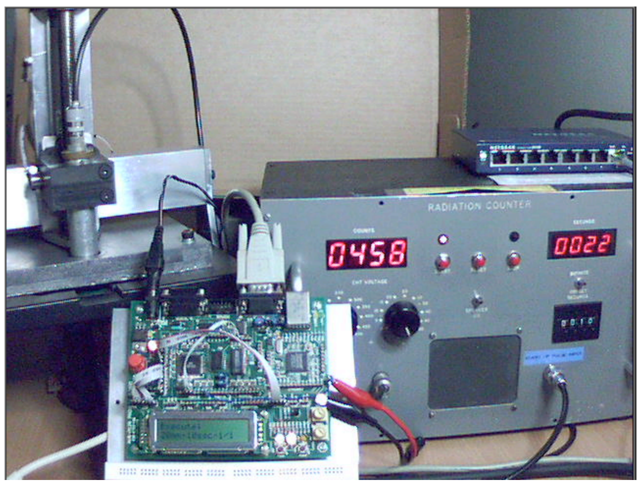


You are now in the **Analyze** step of the Radioactivity iLab. In this step, you will analyze the experimental results that you gathered in the lab. This means that you will find patterns and trends in the data to figure out how radiation changes as a function of distance.

Follow the steps on the next page to analyze your results from the Radioactivity iLab.

Radioactivity iLab Analysis Guide

For OpenOffice

Part I: Export & Save Results

1. Click on the **Export Results for Analysis** button in the Analyze step in the iLab.
2. You will see a pop-up window, prompting you to save your results under the name **results.csv.**
3. Click **Save** to save your results to your computer.
4. If you have Open Office already downloaded on your computer, open your results file in Open Office. If you do not have Open Office, follow the directions below:
   a. Go to http://www.OpenOffice.org, and click on **I want to download OpenOffice.org → Download now!**
   b. A file with the extension ".dmg" will download to your computer.
   c. Double click on this file and follow the directions to have the Open Office Application on your computer.
   d. Locate your results.csv file on your computer.
   e. Double click on the file to open it in Open Office.
      i. If the file doesn't automatically open in Open Office, go back to the file location on your computer. Right click (or Control + click) on the file and select **Open With → OpenOffice.org.app**.

Part II: Graph All Experimental Trials

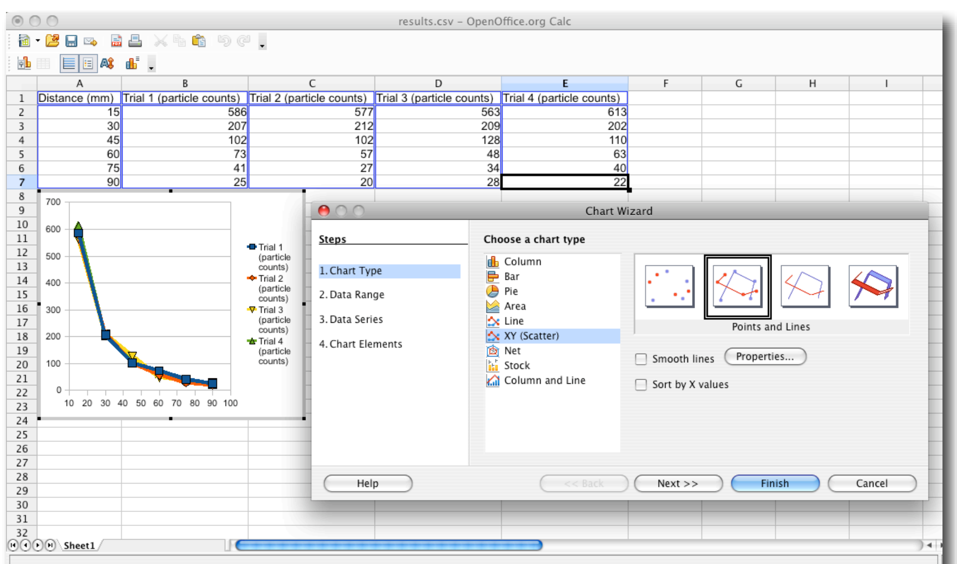
To see how radiation changes as a function of distance, you can first graph **each trial** of data you collected. You can see how each trial compares to one another, and whether your data is generally consistent across trials. Follow the steps below to graph your results from the Radioactivity iLab.

1. In order to see how radiation changes over distance, graph your **distance (mm)** values along the x-axis by **radiation (particle counts)** on the y-axis.

   a. Highlight all of your data values by clicking on the box (called a "cell") in the upper left corner that says "Distance (mm)", and dragging your cursor to the bottom right corner of data.

   b. With your data highlighted, go to the file menu and click on **Insert → Chart…**

   c. Where the window says **Choose a chart type**, click on the graph type **XY (Scatter)**.



d. Click on the image that is second from the left, labeled "**Points and Lines.**" Then click **Next >>**. *<u>Do not click Finish!</u>

e. In the **Data Range** step, make sure that **Data series in columns** is selected (this should be the default). Then click **Next >>.**

f. You will be brought to the **Data Series** step. Click **Next >>** again to skip this step.

g. In the **Chart Elements** step, add a title for your graph. Include your name in the title.

h. Add labels for the x and y-axes. Include units for the axis labels.

i. Click **Finish.**

2. To make more changes to your graph, right click (or control + click) on any part of the graph and select from the available options.

You've now completed your first graph. Think about how the data from each of your trials compare to one another. Are they all exactly the same? If not, at which distances do they seem to differ the most? Then move this graph over to the side in your spreadsheet file, so that you can work on making a new graph.

<u>Part III: Graph Average Radiation and Find Best-Fit Function</u>

To see how radiation changes as a function of distance across all of your data, you can first graph the **average radiation** (measured in particle counts) for each distance value. This average particle count value tells you how many beta particles, on average, were released from strontium-90 and counted by the Geiger counter at a given distance.

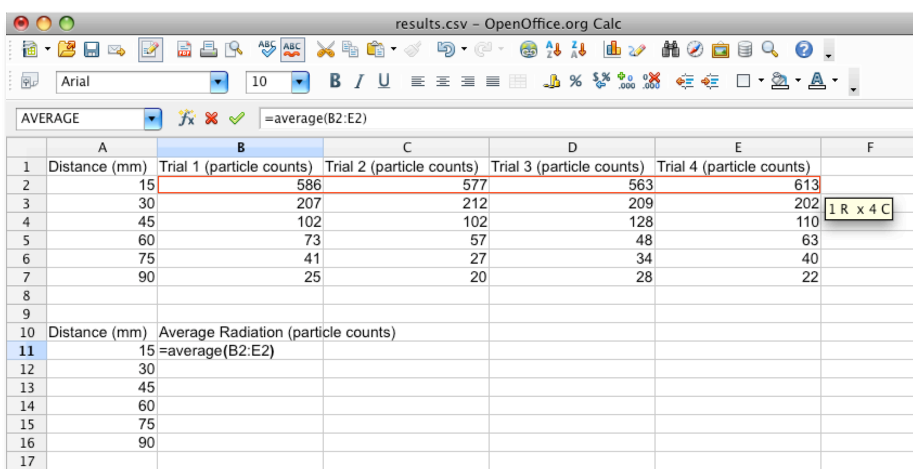
Then to see what kind of mathematical relationship exists between radiation and distance, you can find the **best-fit function**, which is a curve that most closely fits the trend between your data points.

1. Set up your spreadsheet for your new graph.

a. Highlight the distance values and the title **Distance (mm)**.

b. Go to file menu and choose **Edit → Copy**.

c. Click on an empty cell below where you would like the copied cells to be pasted. Then go to the file menu and choose **Edit → Paste**.



d. In the column next to where you've copied **Distance (mm)**, type **Average Radiation (particle counts)**.

2. Find the average particle count **for each distance** at which you measured radiation.

   a. In the cell to the right of your first distance value, type in a new cell: **=average(**

   b. Highlight (click and drag over) the cells you want to take the average of.

   c. Type **)** and hit Enter/Return.

> **Tip:**
> The function for finding an average in Excel is [=average(range)], where the "range" means the number of cells that should be averaged together.

3. Graph the average radiation (in units of particle counts) by distance.

   a. Highlight the distance and average radiation values, including their titles.

   b. Create a scatter graph as you did in Part II.

   c. Label the graph and axes with the appropriate titles and units.

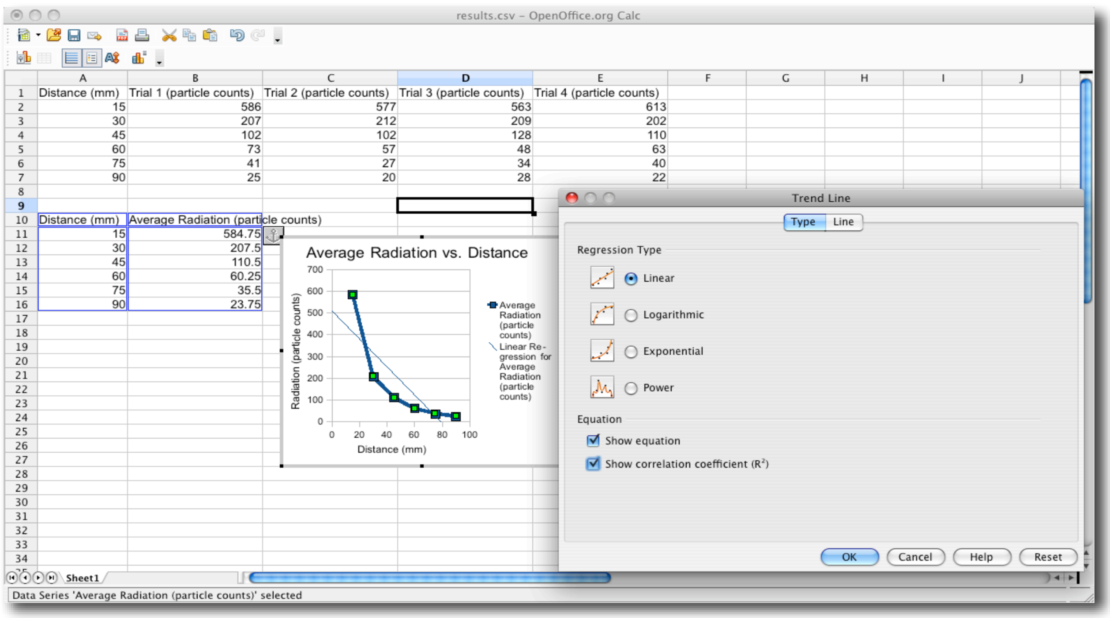
4. Find the best-fit function for the data you just graphed.

> A best-fit function is a curve that most closely resembles the relationship between your data points. It will help you find out more information about **how** radiation changes over distance.
>
> The degree of fit between the best-fit function and your data can be determined by an R^2 value. R^2 is known as the coefficient of determination, which gives information about the goodness of fit of a model. R^2 values can range from 0 to 1, where 0 means no fit, and 1 means a perfect fit. Therefore, the closer an R^2 value is to 1, the better the fit is between the best-fit function and your actual data. For example, a best-fit function with an R^2 value of 0.95 is a better fit than a function with an R^2 value of 0.75.
>
> Open Office calls the best-fit function a trend line. Open Office allows you to try out different types of trend lines to fit your graphed data. You will choose a type of function, and Open Office will automatically find the parameters (such as the slope and y-intercept of a line) that best fit the data. When working with experimental data, the best-fitting parameters will very rarely be whole integers. Your job is to find out which type of trend line fits best to your data, in order to understand the mathematical relationship between radiation and distance.

a. Double click on your graph, and right click (or control + click) on one of the data points in your graph.

b. Select **Insert Trend Line**.

c. Check the boxes at the bottom of the window that appears, that say **Show equation** and **Show correlation coefficient (R^2)**.



To find out whether the relationship between radiation and distance is linear or non-linear, you will graph both the Linear and Power fit functions. Then ask yourself – *Which function best fits my data? How do I know? Which function has the higher R^2 value?*

A **linear** fit will find the linear function (y=mx + b) that comes closest to fitting the data. Linear functions will be best for data that changes at a constant rate.

A **power** fit will find the power function ($y=ax^b$) that comes closest to fitting the data. Power functions will be best for data that change at an increasing or decreasing rate.

d. In the same **Trend Line** window, click on the top choice labeled **Linear.** A linear trend line, an equation (y=mx + b), and an R^2 value should appear.

   i. If the equation and R^2 value are hidden in the other text of the graph, click on the equations and drag them to more open space on the right in the graph.

> Open Office does not allow you to graph two trend lines at once. So, you will need to delete the linear trend line in order to create a second trend line.

e. **Type the equation and R^2 value for the linear trend line into blank cells next to your graph**.

f. Right click (or control + click) on the trend line and select **Delete Trendline**.

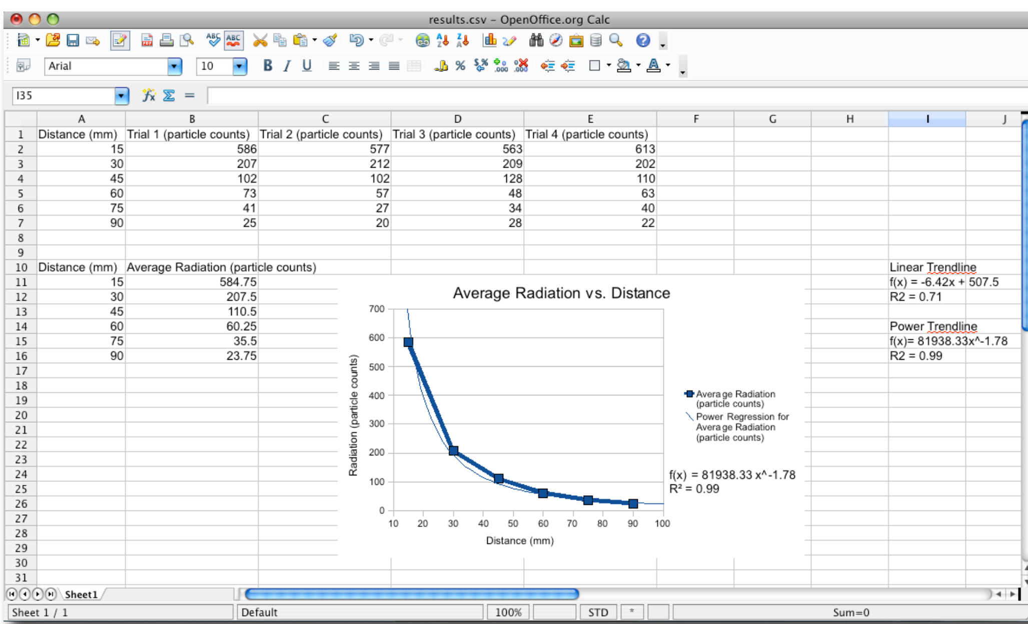
g. Double click on your graph, and right click (or control + click) on one of the data points in your graph.

h. Select **Insert Trend Line**.

i. Check the boxes at the bottom of the window that appears, that say **Show equation** and **Show correlation coefficient (R^2)**.

j. In the same **Trend Line** window, click on the top choice labeled **Linear.** A linear trend line, an equation (y=mx + b), and an R^2 value should appear.

   i. If the equation and R^2 value are hidden in the other text of the graph, click on the equations and drag them to more open space on the right in the graph.



5. Save your file.
    a. Go to **File → Save As**.
    b. In the **Format:** window, choose **ODF Spreadsheet (.ods)**.
    c. Rename your document with the name of the lab, the experiment number, and your name, such as **Radioactivity iLab – Experiment 1 – Lance Armstrong.ods.**
    d. Click **Save**.

6. Print your spreadsheet document.
    a. Depending on where your data and graphs are in the spreadsheet, you may want to change your print settings so that all of your work is visible.
        i. You can click **File → Print** and select **Preview** to see how your file will print out.
            1. If a graph cuts across one or more pages, you may want to adjust your page setup.
        ii. Go to **Format Page** in the Page Preview window.
        iii. In **Orientation** in the middle left of the window, click on **Landscape → OK** to print our graph horizontally instead of vertically.
        iv. You can look at the preview again to see if this layout improved your printed area.
        v. You can also move graphs in your spreadsheet to make a better print-out by clicking on a graph, clicking in the white space of the graph, and dragging it to a different place in the spreadsheet.
    b. Go to **File → Print → OK.**

7. Return to the Radioactivity iLab website.
    a. If you have been gone for more than 20 minutes, you will see a message that tells you that your experiment has been saved, but you have been logged out.
    b. Click **OK** – this will bring you back to the Radioactivity iLab homepage.
    c. Click the orange button **Launch Lab**.
    d. Click on the yellow button **Launch Lab**, as you did before.

e. Before entering the lab, you will be asked if you want to resume your existing lab or start a new lab. **Click **Resume**.

   i. *This is very important – you must click **Resume** in order to access the journal responses you've entered for this lab.*

f. You will be brought back to the place where you left your lab – in the Analysis step.

g. Click **Next: Interpret.**

8. Answer the questions listed under the **Interpret** section in your Lab Journal.

9. Click **Download Lab and Exit** and download and print your lab report to bring to class.

You have now completed the Radioactivity iLab!

Activity Rubric

Total Possible Score: 30 points

Score	Reflection	Analysis
30	○ All answers are complete and clearly demonstrate reflection. ○ The research question is thoughtful and complete. ○ All experimental variables defined in the design phase (Distances, Measurement Time, and Number of Trials) are clearly justified.	○ Data is clearly labeled and organized. ○ All trials and average of trials are clearly graphed with the linear and power best-fit functions, equations and R^2 values for each fit functions, and labels for axes with correct units.
25	○ Some answers are complete and moderately demonstrate reflection. ○ The research question is somewhat thoughtful and complete. ○ Some experimental variables defined in the design phase (Distances, Measurement Time, and Number of Trials) are clearly justified.	○ Data is moderately labeled and organized. ○ Some data is graphed with best-fit functions, equations, R^2 values, and labels are somewhat clear.
20	○ Most answers are incomplete and demonstrate poor reflection. ○ The research question is incomplete and not thoughtful. ○ Most experimental variables defined in the design phase (Distances, Measurement Time, and Number of Trials) are poorly justified.	○ Data is poorly labeled and organized. ○ Data and best-fit functions are not properly graphed or labeled.
15	○ All answers are incomplete and demonstrate no reflection. ○ The research question is incomplete and not thoughtful. ○ None of the experimental variables defined in the design phase (Distances, Measurement Time, and Number of Trials) are justified.	○ Data and graphs are incomplete.