

Objective Use Excel to:

- import data stored in .txt and .csv files using the Import Wizard;
- plot multiple curves on the same graph and paste graphs into Microsoft Word;
- apply curve fitting and display trendlines;
- work with semi-log and log-log graphs.

Instructions

- Answer each problem on a different worksheet in one workbook (one Excel file).
- Rename each worksheet with a one or two-word title that is descriptive of the problem.
- Save an electronic copy of your file for reference. Name the file: Last_name_Mod_4.xlsx, e.g., Hancock_Mod_4.xlsx.
- When you have completed all the problems in the module, upload the Excel file (workbook) and Word document to the Canvas web site for ENGR 124.

Formatting

- In the first column (**A**) of *Sheet1*, in the first three rows enter: (1) your **Name**, (2) the **Project (Problem) Title**, and (3) the **Date**.
- Start all work below **Row 4**.
- Make sure you format the worksheet and use text (titles, prompts, etc.) in the worksheet, so that someone else who opens the workbook can understand what you have done.

Problem 1 *Multiple sets of data on a single graph* [Gottfried, pg. 92] ,
Downloading, Importing Data

In this problem, you will download a set of data that models hypothetical chemical reactions “ $A \rightarrow B \rightarrow C$ ”. The concentrations of chemicals *A*, *B* and *C* (moles per liter) as a function of time are given.

- (a) Download the file **chem_conc.txt** from the course website (ah-engr.com/engr124), and save it to your flash drive or computer (the desktop). This file is a *text file* (.txt), with the data is separated by commas.

Text files are very efficient in storing large amounts of data...the formatting, etc., that Excel requires makes storing large amounts of data in

Excel files unwieldy. Sometimes files that store data have an extension of **.csv**, which stands for *comma separated values*. In Excel, there are options to save worksheets as both .txt and .csv formats. In Word, you can save .txt files (i.e., no formatting).

- (b) Select the **FILE Tab/OPEN** and navigate the menu system to find **chem_conc.txt**. Make sure you can open **Files of Type: All Files**. The Text Import Wizard will open.
- (c) In Step 1 of the Text Import Wizard (*Figure 4.1*), make sure you select **Delimited**.

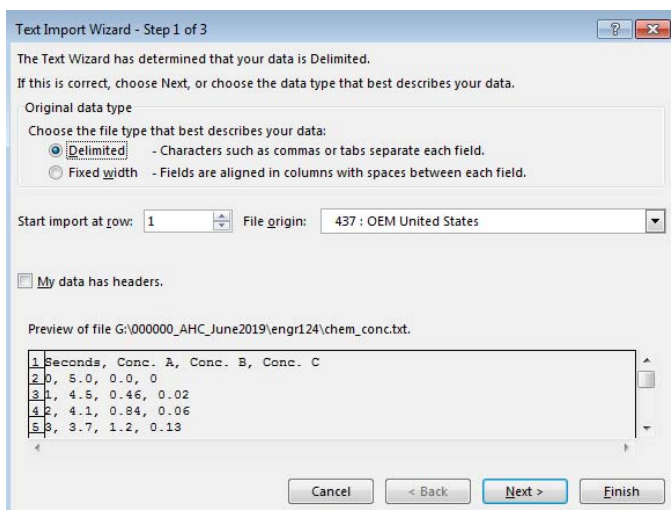


Figure 4.1: Import Wizard, Step 1 of 3.

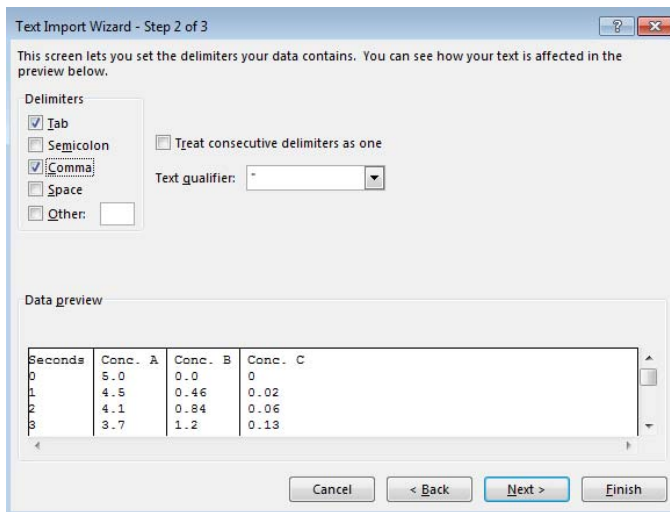


Figure 4.2: Import Wizard, Step 2 of 3.

(d) In Step 2 of the WIZARD (Figure 4.2), the **delimiter** is the symbol that separates data...here the *comma*. The separator can be a tab, a space, or any other symbol. When you press **Finish**, the data from the text file will automatically be placed in a spreadsheet with the upper left cell of data at **A1** (Figure 4.3). You can move the data to give some space for title info, etc., by cutting-and-pasting the data, or inserting rows and columns.

	A	B	C	D
1	Seconds	Conc. A	Conc. B	Conc. C
2	0	5	0	0
3	1	4.5	0.46	0.02
4	2	4.1	0.84	0.06
5	3	3.7	1.2	0.13
6	4	3.4	1.4	0.22
7	5	3	1.6	0.33
8	6	2.7	1.8	0.45
9	7	2.5	1.9	0.58
10	8	2.3	2	0.72
11	9	2	2.1	0.87
12	10	1.8	2.2	1
13	12	1.5	2.2	1.3
14	14	1.2	2.2	1.6
15	16	1	2.1	1.9
16	18	0.83	2	2.2
17	20	0.68	1.85	2.5
18	25	0.41	1.5	3.1
19	30	0.25	1.2	3.5

Figure 4.3: Imported Data.

- (e) Plot all three sets of data as a function of time on the same graph. Show individual data points (**do not** include lines between data points). Display each data set in a different color and with a different symbol for the data points. Which kind of plot should you use – a LINE PLOT or an X-Y SCATTER PLOT?
- (f) In the spreadsheet, sum the concentrations at any given time; e.g., Conc. A + Conc. B + Conc C.
- (g) Open a Word Document. Type in some filler text (e.g., “The following graph plots concentration versus time”).
- (h) In Excel, select the plot and copy it by either selecting HOME/COPY, or using the keyboard shortcut **[CTRL]+[C]**, or RIGHT CLICKING and selecting COPY.
- (i) Go back to the Word document and insert the cursor. Select HOME Tab/PASTE, use **[CTRL]+[C]**, or RIGHT CLICK/PASTE.
- (j) You should have inserted the plot as an object in Word. You can center the plot, and then type text under it as the figure title.
- (k) Submit the Word document with the Excel document.

Problem 2 *Curve-Fitting* [Gottfried] *and Importing Data*

An environmental engineer obtains a bacteria culture from a municipal water sample and allowed the bacteria to grow in a petri dish.

- (a) Download the file **bacteria.txt** from the course website, and save it to your flash drive or computer.
- (b) **OPEN** the text file (the data is separated by commas).
- (c) Plot concentration vs. time. Label the graph correctly including units.
- (d) *Curve-fitting* is done in order to create models of real-world data. Not all data points fall on the *curve-fit*. In Excel, a curve-fit is called a **trendline** (*Figure 3*). The curve can be linear or non-linear.

SELECT the plot. Under **CHART TOOLS/Add Chart Element/Trendline**

Alternatively, **RIGHT-CLICK** on the data and **SELECT Add Trendline**.

SELECT the *exponential* trendline, *i.e.*,

$C_A = ae^{bt}$. Display the equation on the chart.

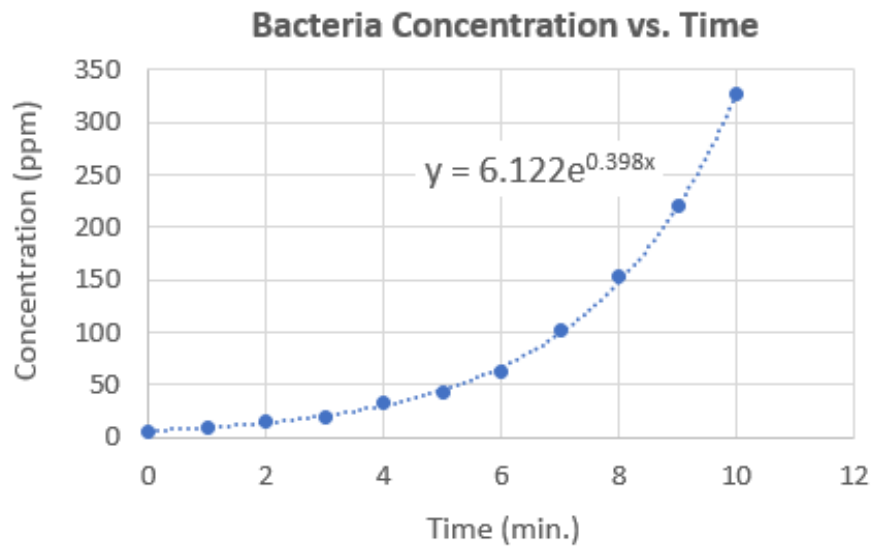


Figure 4: Concentration vs. Time

Problem 3 *Semi-Log Plot* [Gottfried]

A **semi-log plot** is a plot where one axis is a **logarithmic scale** and the other axis is an **arithmetic scale**.

An **arithmetic (linear) scale** is the scale we generally use when plotting data – the values are evenly spaced (0, 1, 2, 3, 4, 5....).

In a **logarithmic scale**, the *orders of magnitude* (factors of 10) are evenly spaced ($10^1, 10^2, 10^3, 10^4...$). The distance from 1 to 10 is the same as the distance from 10 to 100. Likewise, the distance from 1 to 10 is the same as the distance from 2 to 20, 3 to 30, 20 to 200, 300 to 3000, etc. (Figure 5). A log scale is linear: $\log(1) = 0, \log(10) = 1, \log(100) = 2, \log(1000) = 3$.

In general, when we say **log**, we mean logarithm of base 10... e.g.:

$$a = \log 10^a$$

The Excel command to take the base 10 logarithm of cell A5 is:

$$=LOG(A5)$$

or:

$$=LOG10(A5)$$

The scale of a log axis can be confusing at first since the minor ticks get closer together towards the right of each decade. As a good rule-of-thumb, 20 is about 1/3 of the way from 10 to 100; 30 is about half-way, and 50 is about 2/3 of the way (Figure 5). Likewise, 200 is 1/3 of the way from 100 to 1000, etc.

The log-scale allows you to plot the log of a number without actually doing the calculations. For example:

- $\log(1) = 0.0$ (leftmost gridline in Fig. 5)
- $\log(2) = 0.301$ (~1/3 from 1 to 10)
- $\log(3) = 0.477$ (~1/2 from 1 to 10)
- $\log(5) = 0.699$ (~2/3 from 1 to 10)
- $\log(10) = 1.0$ (first major gridline)
- $\log(20) = 1.301$ (~1/3 from 10 to 100)
- $\log(30) = 1.477$ (~1/2 from 10 to 100)
- $\log(50) = 1.699$ (~2/3 from 10 to 100)
- $\log(100) = 2.0$ (second major gridline)
- $\log(200) = 2.301$

A semi-log plot is useful in *plotting data that spans several orders of magnitude*; the data is essentially compressed ... the physical distance on the axis from 1 to 5 is the same physical distance as from 1000 to 5000, from 1 to 5 million, etc.

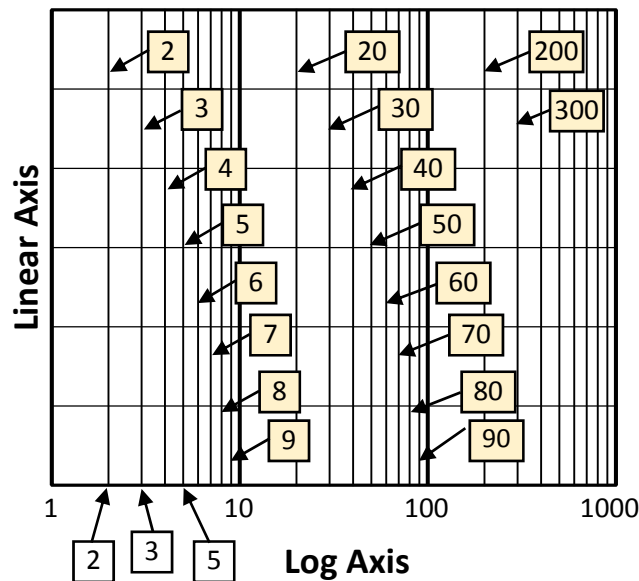


Figure 5: Semi-log set of axes.

Semi-log plots are also very useful when plotting an *exponential equation*, because an exponential equation appears as a straight line on a semi-log plot. For example, consider the exponential equation:

$$y = Be^{mx}$$

Taking the log of each side:

$$\log y = \log B + mx$$

The last equation looks like a straight line with slope m . The **ordinate axis** (the y -axis) is actually $\log(y)$ and the **abscissa axis** (x -axis) is an arithmetic (linear) scale x .

Excel's LOGARITHM Functions:

- $=LOG(A5)$ $\log_{10}(A5) = \log(A5)$
- $=LOG(A5,2)$ $\log_2(A5)$
- $=LOG10(A5)$ $\log(A5)$
- $=LN(A5)$ $\ln(A5)$

Now for the PROBLEM:

Given: An RC circuit with capacitor initially charged to an initial voltage of V_o (**Figure 6**). When the switch is closed at $t=0$, the capacitor discharges as follows:

$$v(t) = V_o e^{-t/\tau}$$

where τ (“tau”) is called the *time constant* and is measured in seconds.

Req’d:

- (a) Create a spreadsheet that gives voltage as a function of time, $v(t)$, for $t = 0$ to 10 secs., with 1 second intervals (1, 2, 3, 4 ...). Use $V_o = 10$ V, and $\tau = 2$ seconds.
- (b) **Plot v vs. t using regular arithmetic (linear) scales on both axes;**
- (c) Modify the spreadsheet to have a column that calculates $\log_{10}(v)$. **Plot $\log_{10}(v)$ vs. t using arithmetic scales on both axes;**
- (d) **Plot v vs. t using a logarithmic scale for the ordinate (“y”) axis (Voltage Axis). This is a *semi-log* plot.**

Hint: SELECT the plot from Part (a), RIGHT CLICK/COPY and then RIGHT CLICK/PASTE to create a new graph from the same data. To make the “y-axis” a log axis, double click the “y-axis” and FORMAT AXIS and click LOGARITHMIC SCALE.

- (e) Compare the plots. **Plot (c)** (where you calculated the $\log_{10}(v)$ and plotted it on a normal *arithmetic scale*), should look the same as **Plot (d)** (which was plotted directly on a *log scale*). The only difference should be the scales.

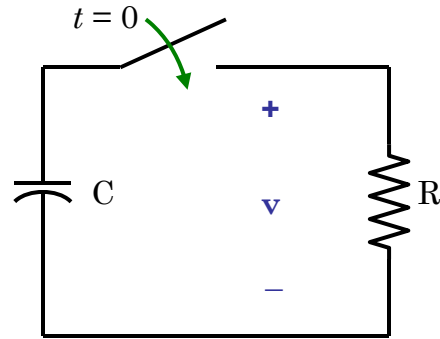


Figure 6 An RC circuit. Take the capacitor to be initially charged to $v(0) = V_o$. The switch is closed at time $t = 0$.

Problem 4 *Log-Log Plot* [Gottfried]

In a **log-log plot**, both the abscissa (x -) and ordinate (y -) axes have a *logarithmic scale*. A log-log plot is useful in plotting data that spans several orders of magnitude in both “ x ” and “ y ”.

It is also very useful when plotting a **power equation** ($y = Bx^m$), because a power equation appears as a straight line on a log-log plot. Start with:

$$y = Bx^m$$

Then, taking the log of each side:

$$\log y = \log B + m \log x$$

The last equation looks like a straight line with slope m :

$$Y = b + mX$$

where: $Y = \log y$; $b = \log B$; $X = \log x$

The **PROBLEM**:

Given: The surface area of a sphere is:

$$A(r) = 4\pi r^2$$

The volume of a sphere is:

$$V(r) = \frac{4\pi r^3}{3}$$

Req'd:

- Create a spreadsheet that gives area and volume as a function of radius r , for $r = 0$ to 10 units. ... *e.g.*, create three columns... one for *radius*, one for *area* and one for *volume*.
- Plot Area vs. Radius and Volume vs. Radius on one graph. Use regular arithmetic scales on both axes.
- Plot Area vs. Radius and Volume vs. Radius on one graph on a **log-log graph**.

Hint: just COPY and PASTE the Plot from **Part (b)**. **DO NOT calculate log10() values in your spreadsheet.** Just change both axes to *logarithmic scales*.

- For **Plot (c)**, determine the slope (rise over run) **in terms of orders of magnitude**. The slope should be 2 for the Area vs. Radius curve:

$$\log[A(r)] = \log[4\pi] + 2\log[r]$$

i.e.: $Y = \text{const} + 2X$

- What is the slope of the *Volume vs. Radius* curve? Use a text box to give the answer on the graph.