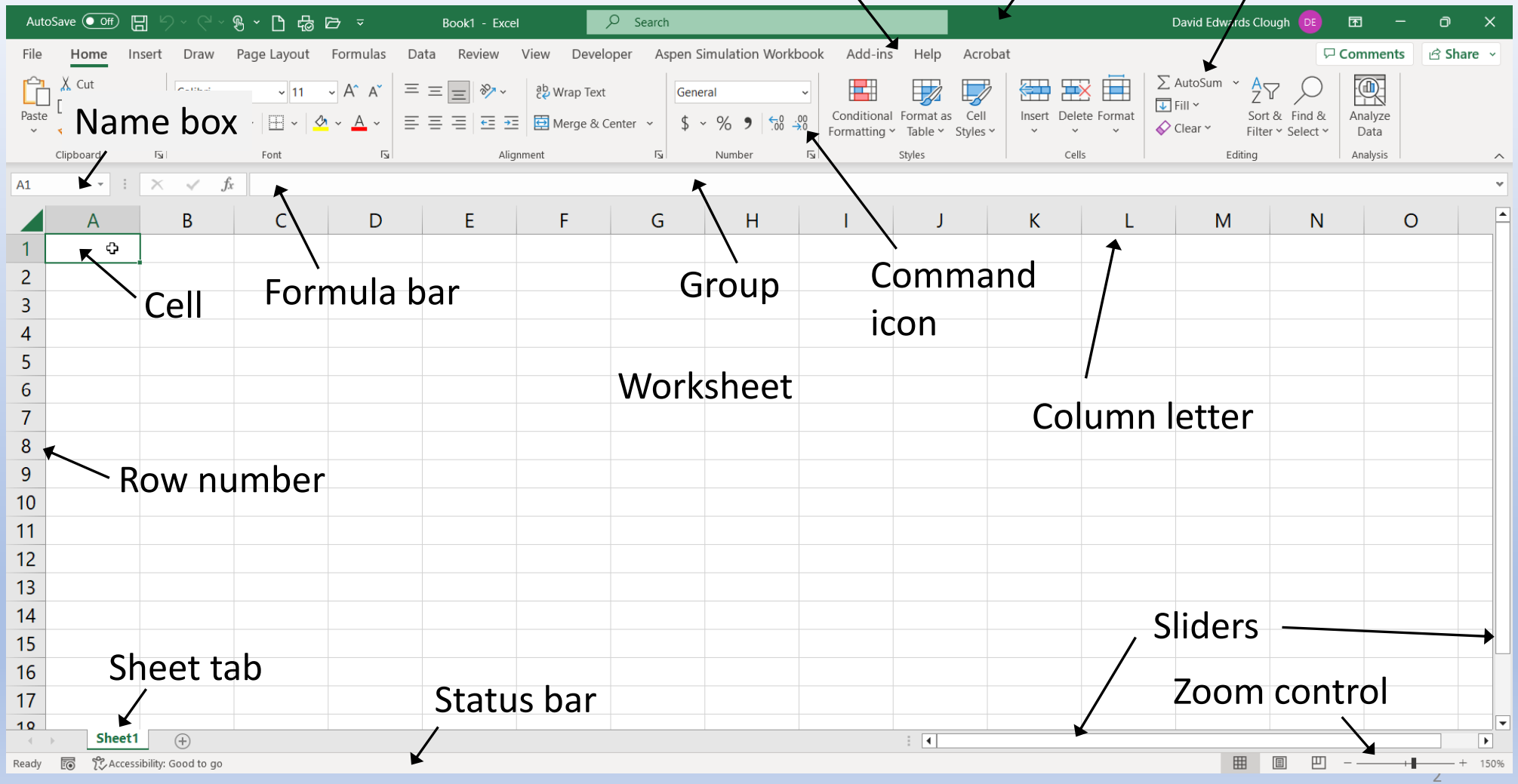
Excel Bootcamps 1, 2, 3 and 4

- 1: Getting up to speed with Excel
- 2: Introducing VBA
- 3: Learning to use Excel to solve typical problem scenarios
- 4: Detailed modeling of packed-bed and plug-flow reactors

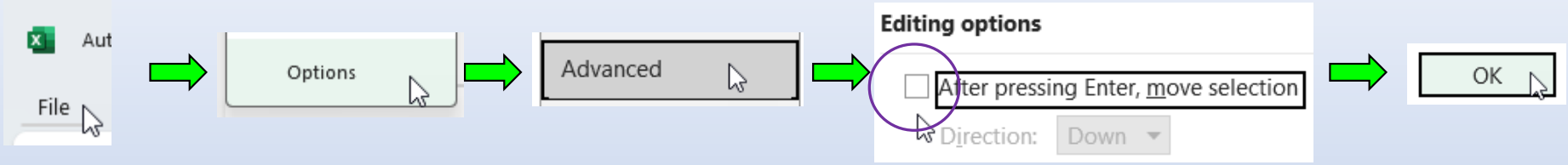
Bootcamp 1 Outline

Layout of the Excel Main Window

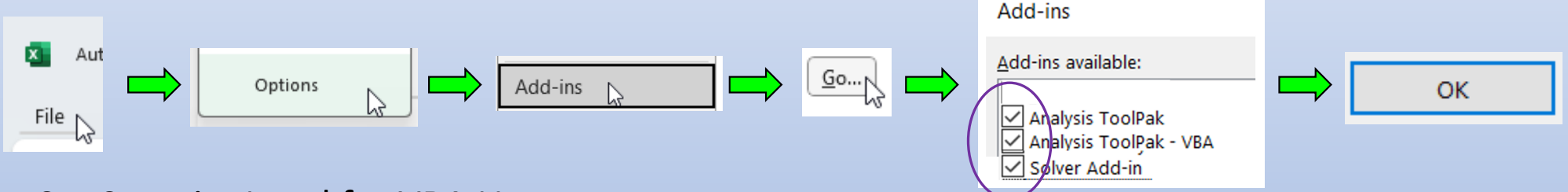


Preferred Settings

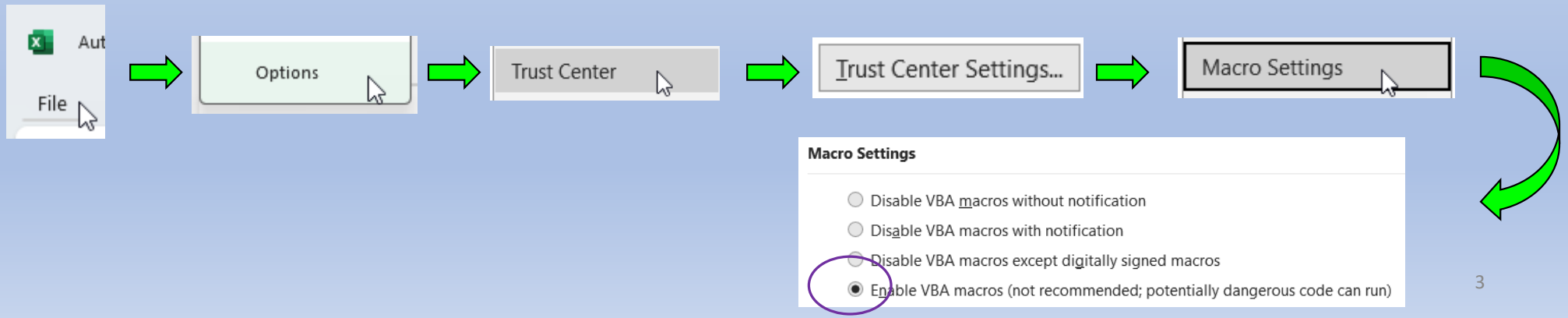
No Move After Enter



Enable Solver and Data Analysis

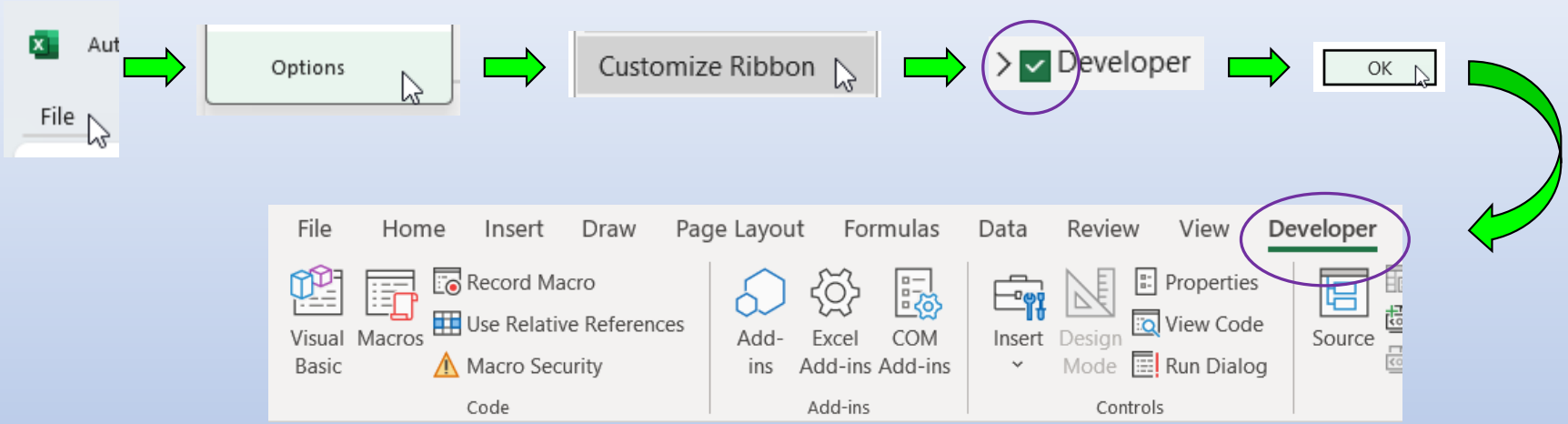


Set Security Level for VBA Use



Preferred Settings

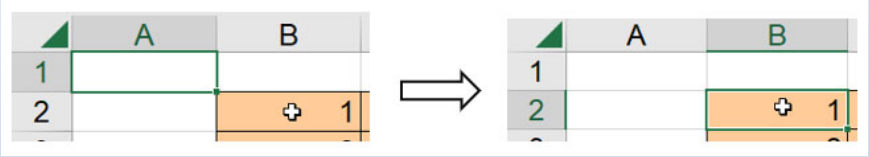
Enable the Developer Tab on the Ribbon



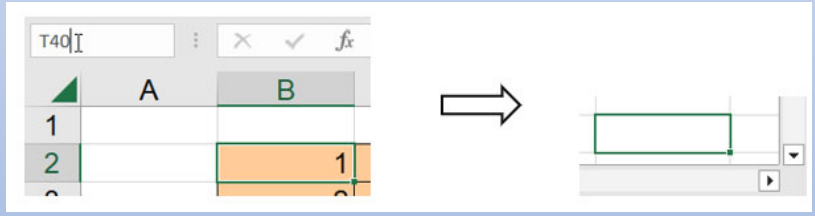
Efficient Spreadsheet Manipulations

SelectionPractice.xlsx

Moving the ActiveCell



Click on the new cell or use the ↓ → keys

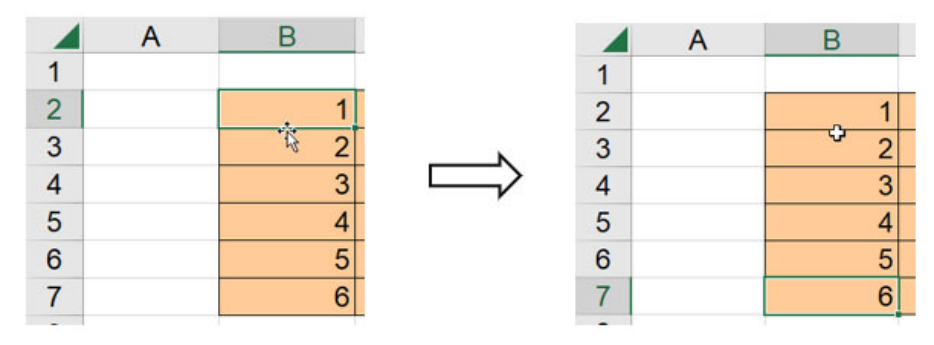


Enter the cell address in the Name Box
(can also use F5 GoTo)

	A	B	C	D	E
1					
2		1	0.243		
3		2	0.755		
4		3	0.047		
5		4	0.745		
6		5	0.254		
7		6	0.864		
8					
9					
10		39.93	39.71	40.06	40.29
11		40.28	40.40	39.50	39.95
12		40.25	39.75	39.84	39.61
13		39.58	39.78	39.82	39.51

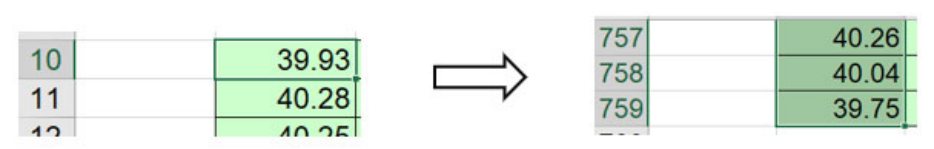
Efficient Spreadsheet Manipulations

Jumps within filled cell ranges



Double-click boundary of the ActiveCell or
Ctrl-↓

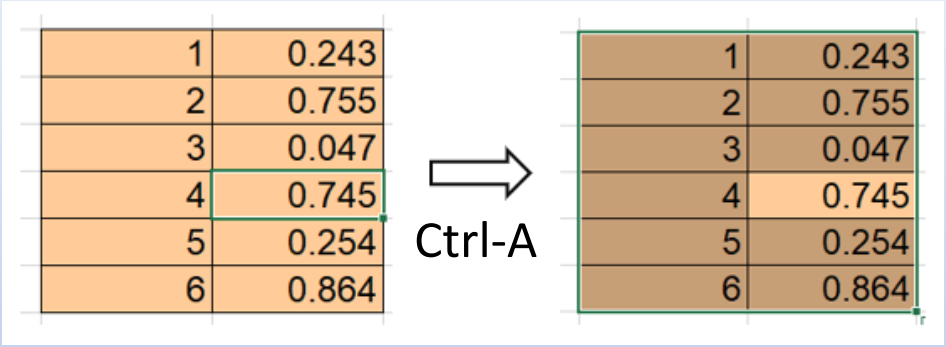
Selections within filled cell ranges



Adjoin the Shift key
to the above

Efficient Spreadsheet Manipulations

Selecting blocks of cells



1	0.243
2	0.755
3	0.047
4	0.745
5	0.254
6	0.864

Ctrl-A

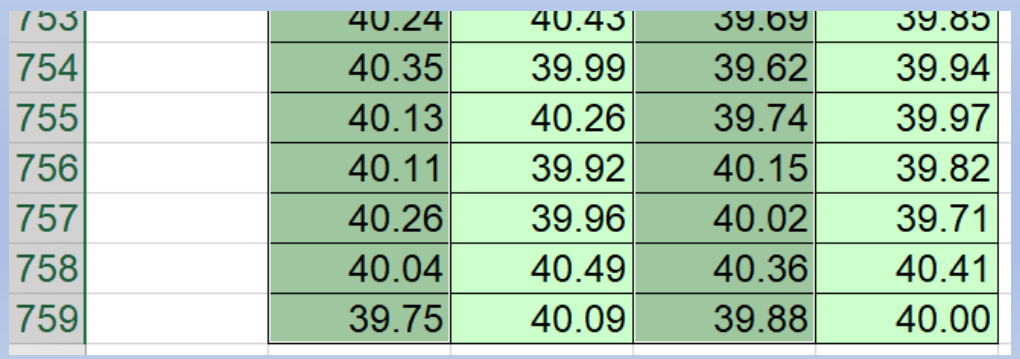
1	0.243
2	0.755
3	0.047
4	0.745
5	0.254
6	0.864

or
Ctrl-*

1	0.243
2	0.755
3	0.047
4	0.745
5	0.254
6	0.864

Moves the ActiveCell to the origin

Selecting discontiguous blocks of cells

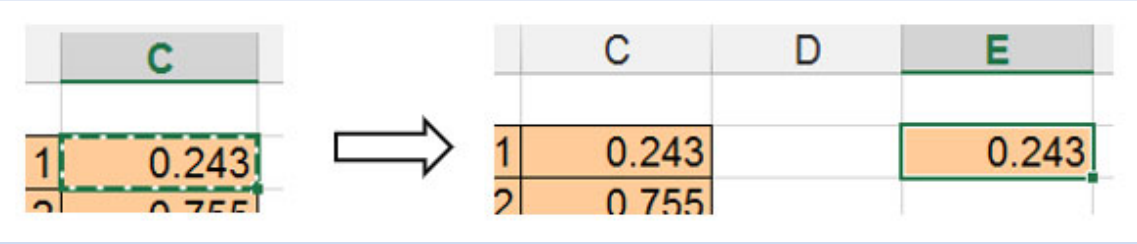


753		40.24	40.43	39.69	39.85
754		40.35	39.99	39.62	39.94
755		40.13	40.26	39.74	39.97
756		40.11	39.92	40.15	39.82
757		40.26	39.96	40.02	39.71
758		40.04	40.49	40.36	40.41
759		39.75	40.09	39.88	40.00

Select B10, Ctrl-Shift-↓
Tab, Back-Tab, Ctrl-click on D10
Ctrl-Shift-↓

Efficient Spreadsheet Manipulations

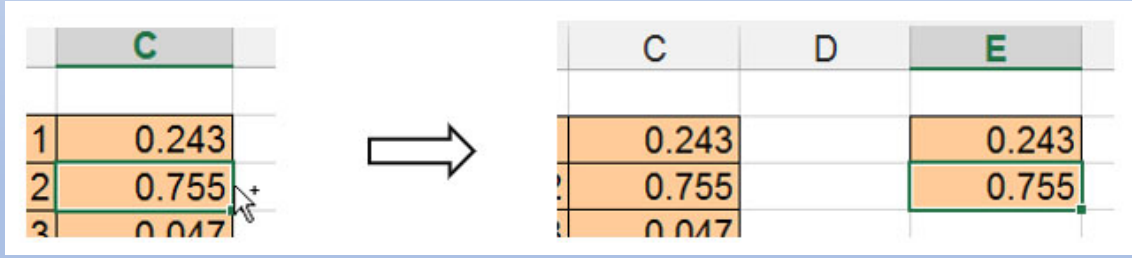
Copying cells



Ctrl-C
Select destination cell
Enter

Use Paste (Ctrl-V) for multiple copies

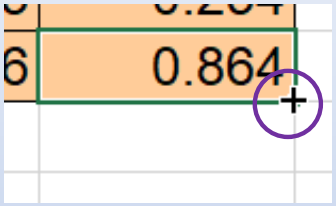
Drag copy



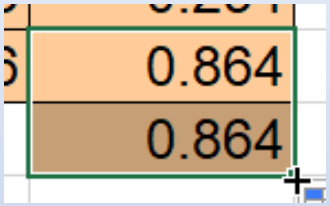
Hold down Ctrl
Drag to new location
Release Ctrl

Efficient Spreadsheet Manipulations

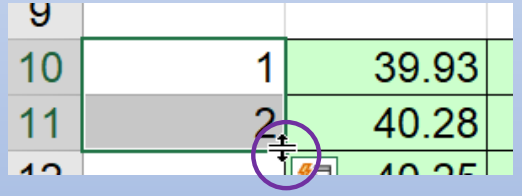
Copying cells using the Fill Handle

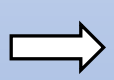


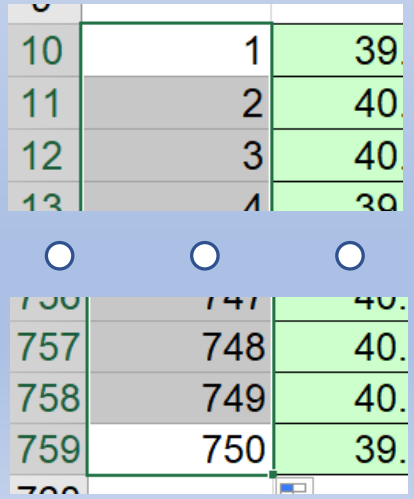
Drag down



Extending a pattern adjacent to a filled column using the Fill Handle



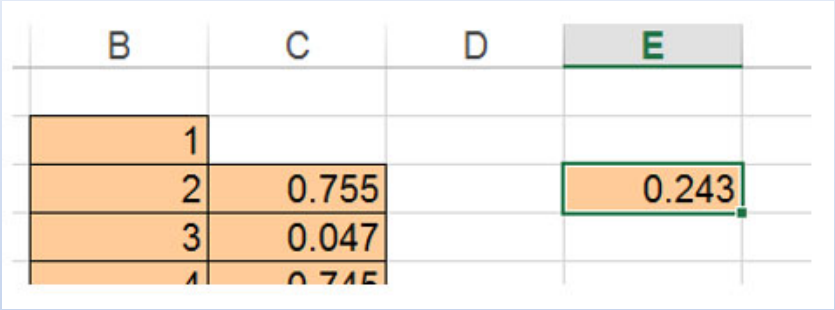




Select 2 cells
Double click

Efficient Spreadsheet Manipulations

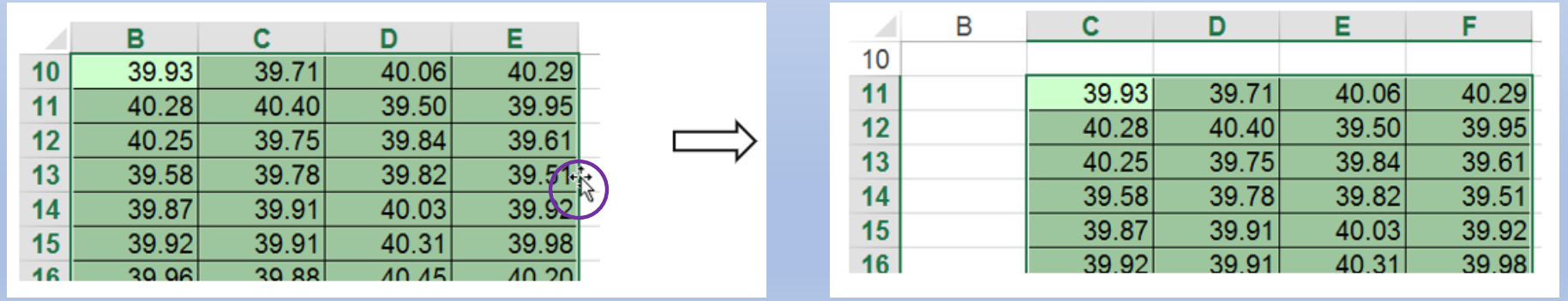
Moving cells



	B	C	D	E
1				
2		0.755		0.243
3		0.047		

Ctrl-X, Select destination, Enter
or
Drag cell with mouse

Drag block of cells one column to the right



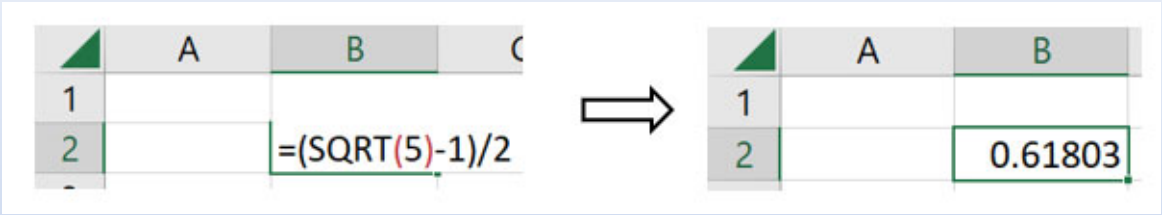
	B	C	D	E
10	39.93	39.71	40.06	40.29
11	40.28	40.40	39.50	39.95
12	40.25	39.75	39.84	39.61
13	39.58	39.78	39.82	39.51
14	39.87	39.91	40.03	39.92
15	39.92	39.91	40.31	39.98
16	39.96	39.88	40.45	40.20

	B	C	D	E	F
10					
11		39.93	39.71	40.06	40.29
12		40.28	40.40	39.50	39.95
13		40.25	39.75	39.84	39.61
14		39.58	39.78	39.82	39.51
15		39.87	39.91	40.03	39.92
16		39.92	39.91	40.31	39.98

Formulas, Cell Addresses, and Range Names

Calculator formulas

$$\frac{\sqrt{5}-1}{2}$$



- evaluate any functions, like SQRT above
- evaluate parentheses groupings
- negation or unary minus (–) (this is not subtraction)
- exponentiation (^) left to right
- multiplication (*) and division (/) left to right
- addition (+) and subtraction (–) left to right

Formulas, Cell Addresses, and Range Names

Calculator formulas

$$\frac{12}{\left(1+e^{-1}\right)\cdot 7^{1.5}}$$

=12/(1+EXP(-1))/7^1.5

or

=12/((1+EXP(-1))*7^1.5)

⇨ 0.47368

Watch out for these

=-3^2 ⇨ 9

or

=-(3^2) ⇨ -9

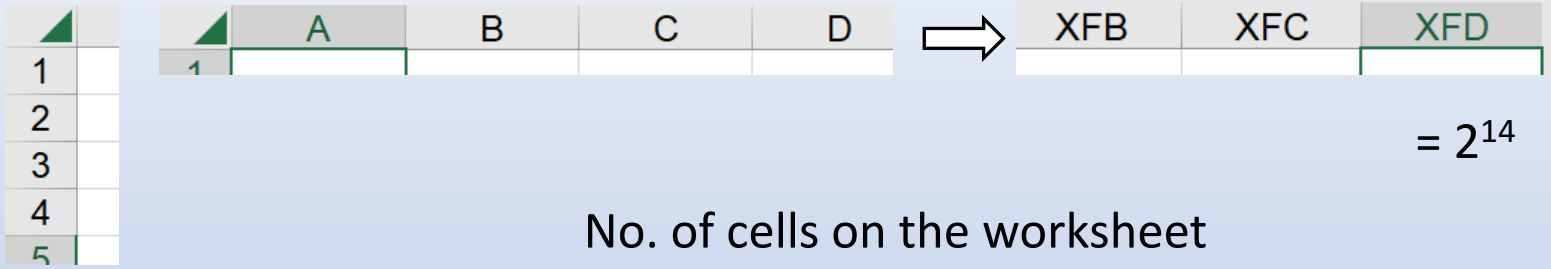
=3^2^1.6 ⇨ 33.63

or

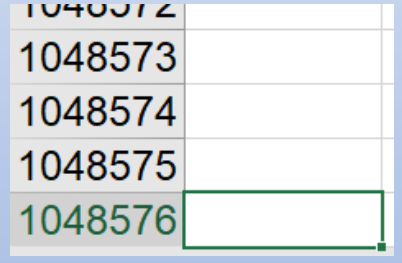
=3^(2^1.6) ⇨ 27.95

Formulas, Cell Addresses, and Range Names

Cell Addresses

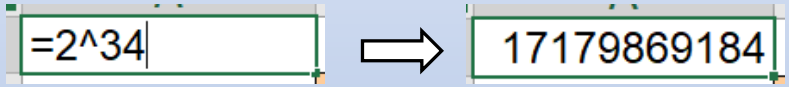


$= 2^{14}$



$= 2^{20}$

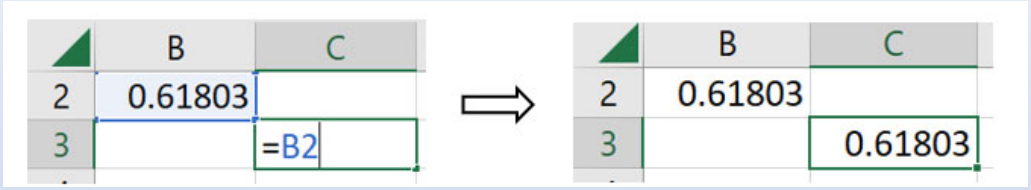
No. of cells on the worksheet



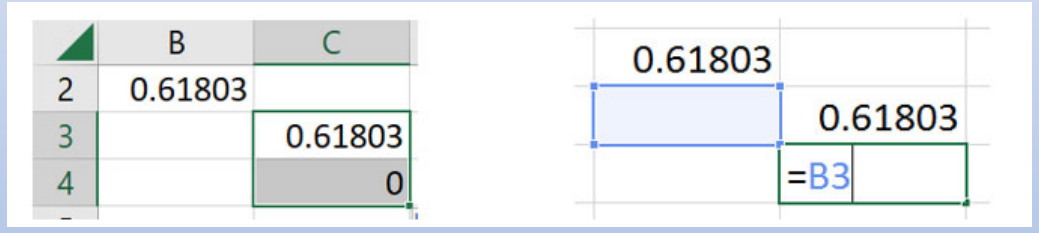
Number stored in 8 bytes (64 bits).
Capacity of worksheet = 128 Gb

Formulas, Cell Addresses, and Range Names

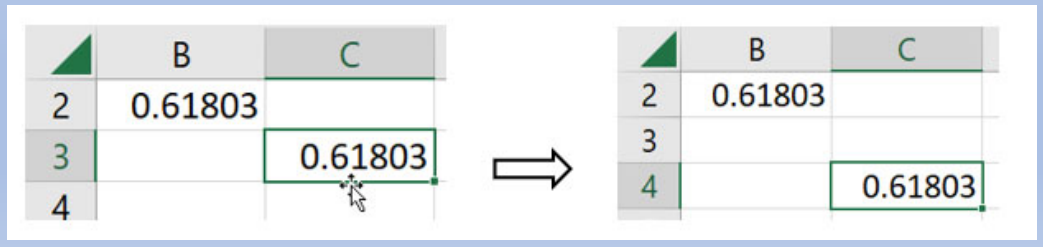
Cell Addresses



Pointer formula



Drag-copy the formula down
Relative reference moves with copy

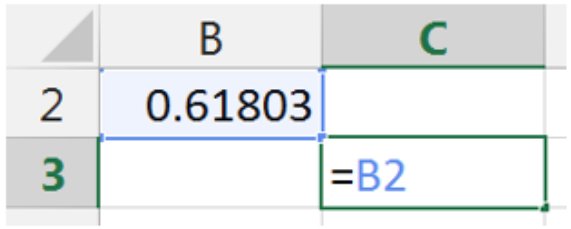


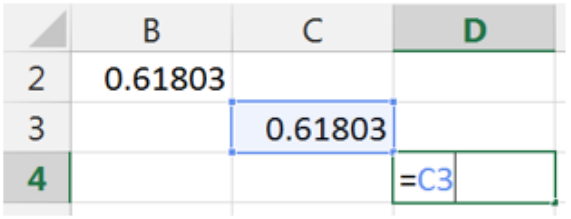
Drag-move the formula down
Cell reference is retained

Formulas, Cell Addresses, and Range Names

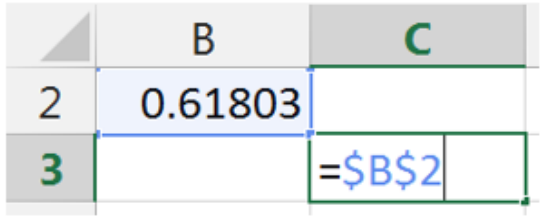
Relative and Absolute Cell Addresses

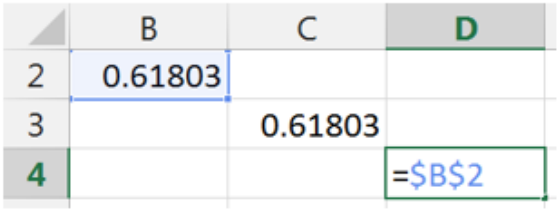
Relative copy





Absolute copy



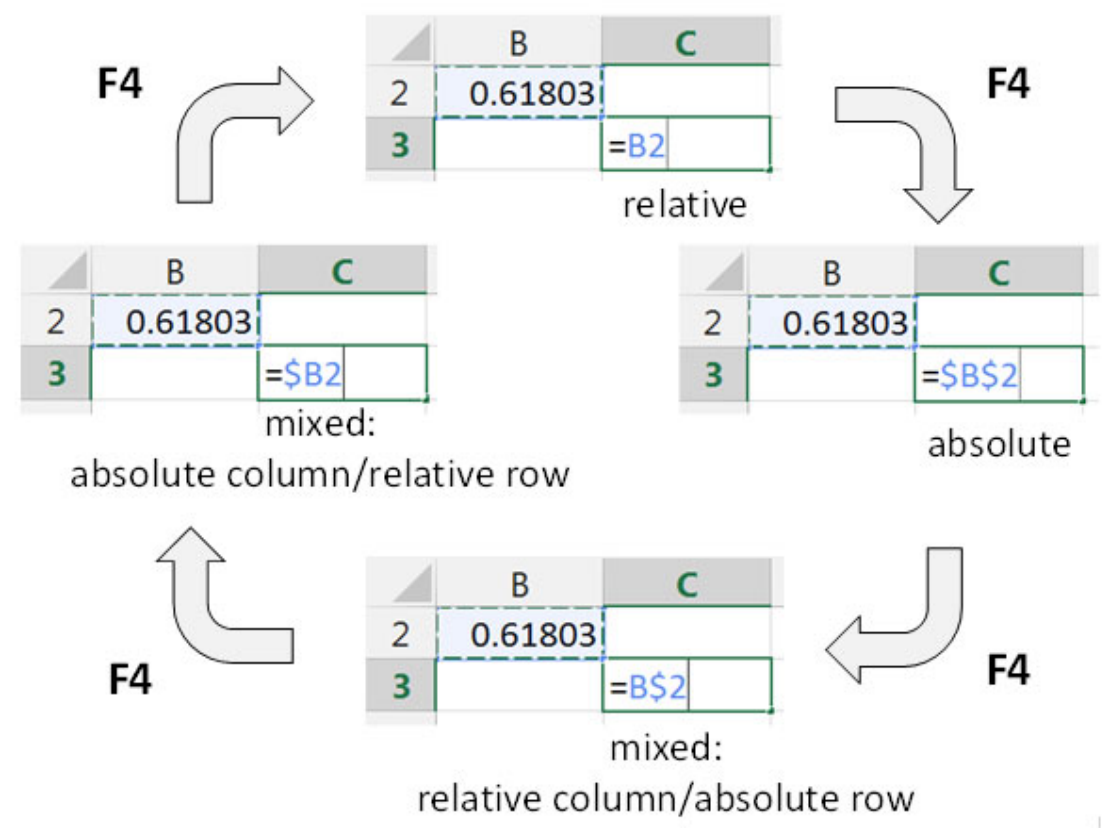


Copy from
B2 to C3

Formulas, Cell Addresses, and Range Names

Relative, Mixed, and Absolute Cell Addresses

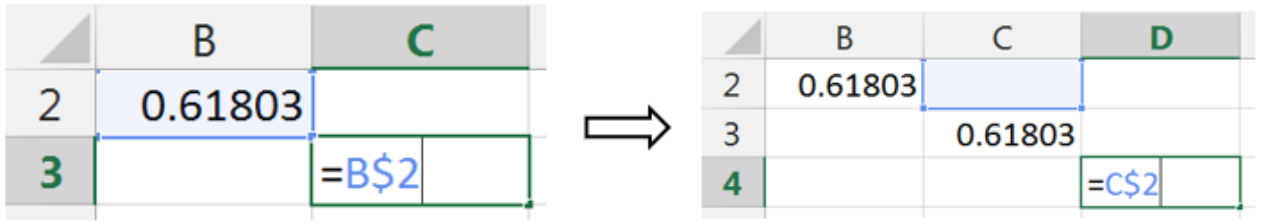
Using the F4 Key



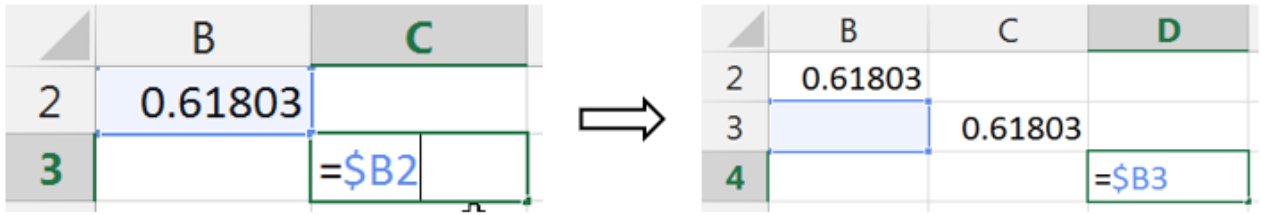
Formulas, Cell Addresses, and Range Names

Relative, Mixed, and Absolute Cell Addresses

Relative column/absolute row copy



Absolute column/relative row copy



Formulas, Cell Addresses, and Range Names

Mixed Cell Addresses Example

	A	B	C	D	E	F	G	H	I
1			Relative Roughness						
2	Reynolds Number		0.0001	0.0005	0.001	0.005	0.01	0.02	0.05
3		4000							
4		10000							
5		20000							
6		50000							
7		100000							
8		200000							
9		500000							
10		1000000							

$$f_M = \frac{1}{\left\{-1.8 \cdot log_{10}\left[\left(\frac{\varepsilon/D}{3.7}\right)^{1.1} + \frac{6.9}{Re}\right]\right\}^2}$$

Haaland equation for friction factor in pipe flow

	A	B	C	D	E	F	G
1			Relative Roughness				
2			0.0001	0.0005	0.001	0.005	0
3	mber	4000	=1/(-1.8*LOG10((C$2/3.7)^1.1+6.9/$B3))^2				
4		10000					

	A	B	C	D	E	F	G	H	I
1			Relative Roughness						
2	Reynolds Number		0.0001	0.0005	0.001	0.005	0.01	0.02	0.05
3		4000	0.0405	0.0408	0.0413	0.0451	0.0497	0.0580	0.0789
4		10000	0.0310	0.0316	0.0323	0.0378	0.0436	0.0532	0.0754
5		20000	0.0259	0.0267	0.0278	0.0347	0.0413	0.0514	0.0742
6		50000	0.0210	0.0224	0.0239	0.0326	0.0397	0.0504	0.0735
7		100000	0.0183	0.0202	0.0222	0.0318	0.0392	0.0500	0.0732
8		200000	0.0163	0.0189	0.0212	0.0314	0.0389	0.0498	0.0731
9		500000	0.0144	0.0178	0.0205	0.0312	0.0388	0.0497	0.0731
10		1000000	0.0135	0.0175	0.0203	0.0311	0.0387	0.0497	0.0730

HaalandMoodyStarter.xlsx

Formulas, Cell Addresses, and Range Names

Creating Cell Names

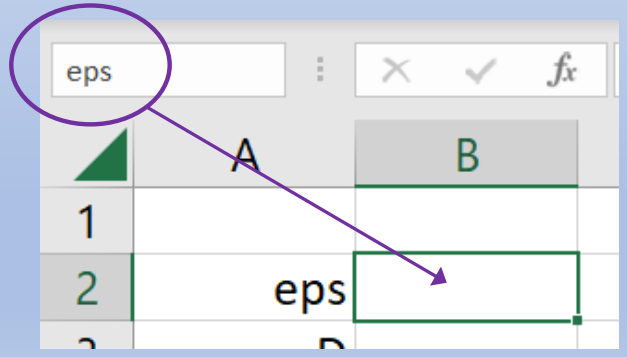
	A	B
1		
2	eps	
3	D	
4	Re	
5		
6	fM	

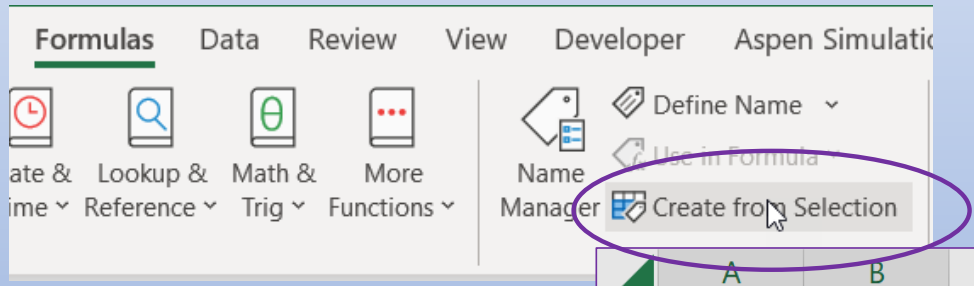
- names cannot be cell addresses,
  TMP1 cannot be a name
- R and C cannot be names
- R and C followed by any numeral cannot be names

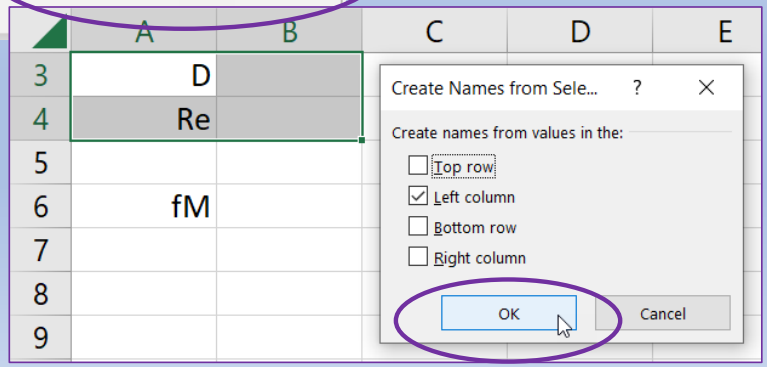
Or transfer adjacent labels

	A	B
3	D	
4	Re	

Enter name in the Name Box







Formulas, Cell Addresses, and Range Names

Using Cell Names in Formulas

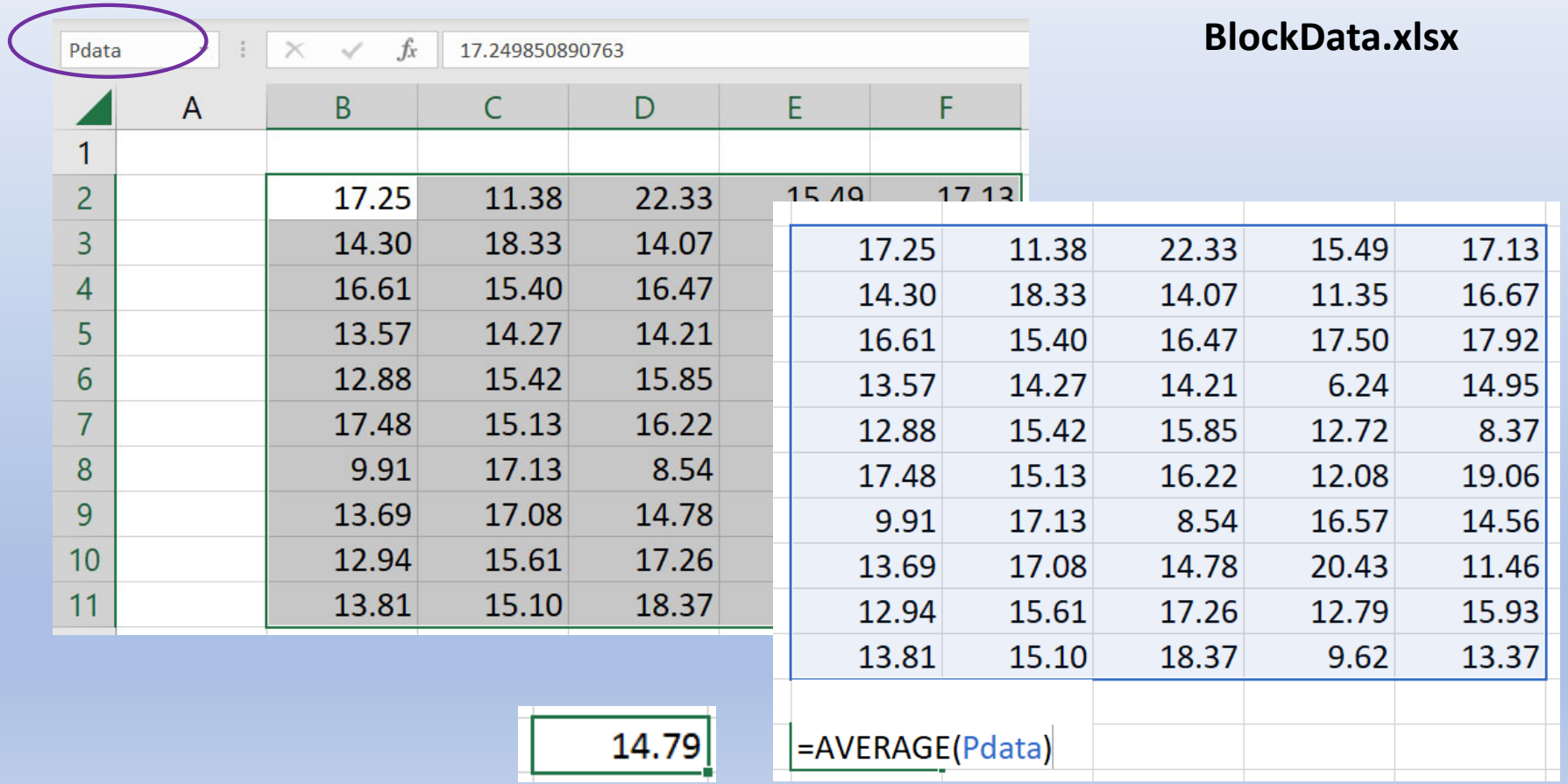
	A	B	
2	eps	4.50E-05	m
3	D	0.0525	m
4	Re	10000	

fM =1/(-1.8*LOG10((eps/D/3.7)^1.1+6.9/Re))^2

	A	B	
2	eps	4.50E-05	m
3	D	0.0525	m
4	Re	10000	
5			
6	fM	0.0323	

Formulas, Cell Addresses, and Range Names

Using Range Names in Formulas



BlockData.xlsx

Formulas, Cell Addresses, and Range Names

The **IF** Function and Logical Expressions

Syntax: =IF(logical expression,true option,false option)

Example: Square a value and retain the sign in the result

	B	C	D
2	-3	=IF(B2<0,-(B2^2),B2^2)	

	B	C
2	-3	-9
3	3	9
4	0	0

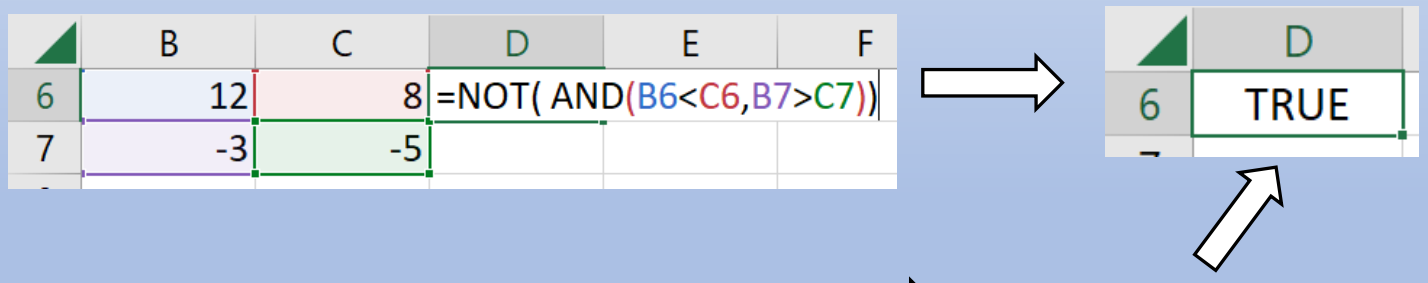
Logical expression here is relational

Relational Operators and Logical Functions

Relational Operators	
=	equal to
<>	not equal to
>	greater than
<	less than
>=	greater than or equal to
<=	less than or equal to

Logical Functions	
NOT	logical negation
AND	logical and
OR	logical or
XOR	exclusive or

Example logical expression

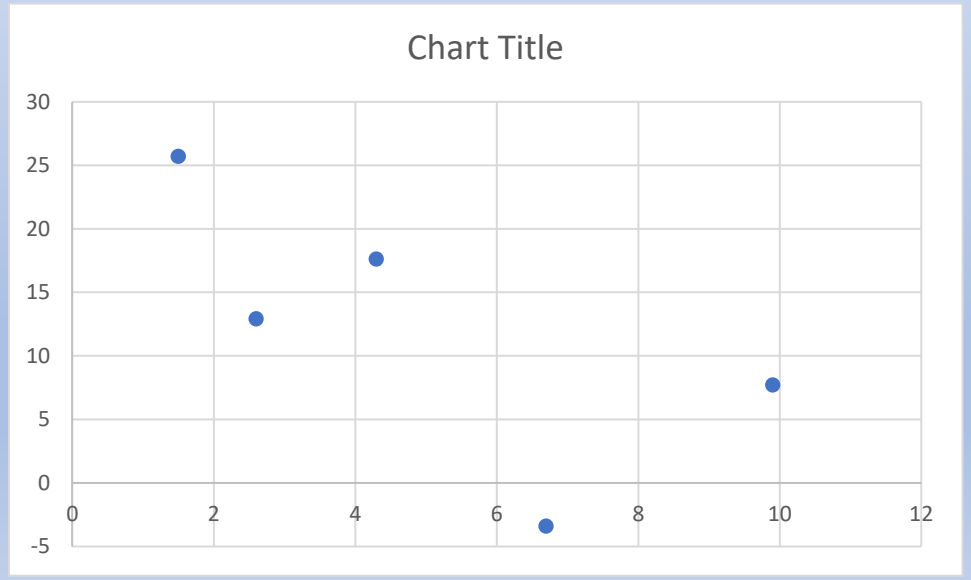


Creating Simple Plots

XY Charts

	B	C
2	x	y
3	1.5	25.7
4	2.6	12.9
5	4.3	17.6
6	6.7	-3.4
7	9.9	7.7

Create a scatter plot of y versus x



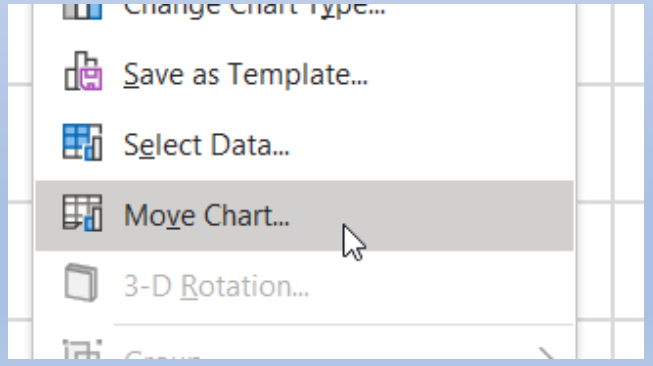
Creating Simple Plots

Customizing the scatter plot

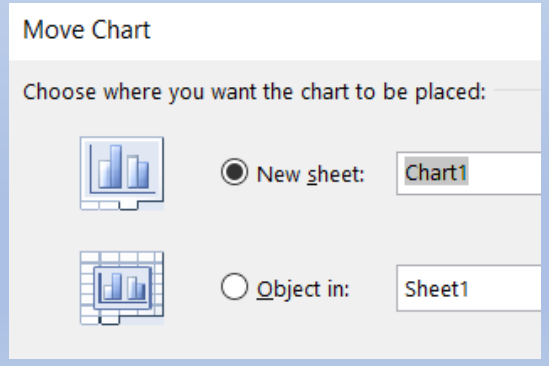
Typical steps:

- Move the plot to its own chart sheet
- Align and format the axes
- Adjust markers and lines
- Add axis titles and chart title

Move the plot to its own chart sheet



right-click the chart

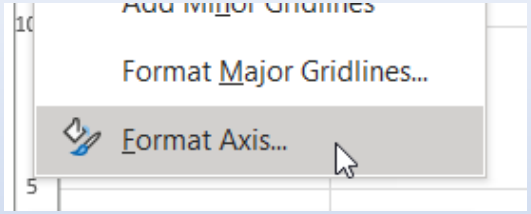


click OK

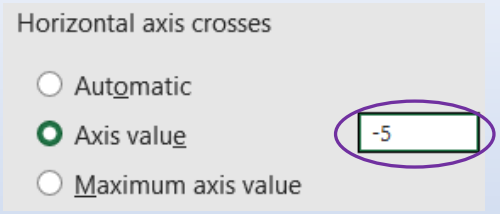
Formatting is best with the chart on its own sheet. Reasons to keep the chart on the worksheet include when multiple charts need to be visible and when it is advantageous to see plot responses to worksheet changes.

Creating Simple Plots

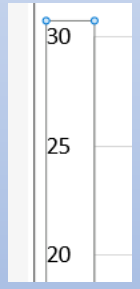
Align and format the axes



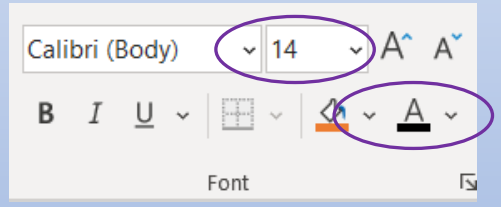
right-click vertical axis
select Format Axis...



lower where the
horizontal axis crosses



select each
axis

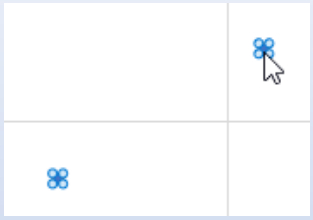


change font
size(14pt) and
color (black)

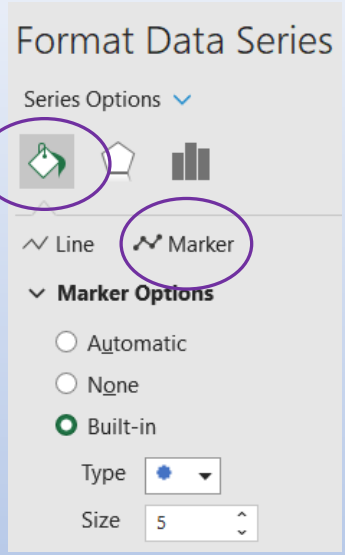
Note: Can change font style, if desired.

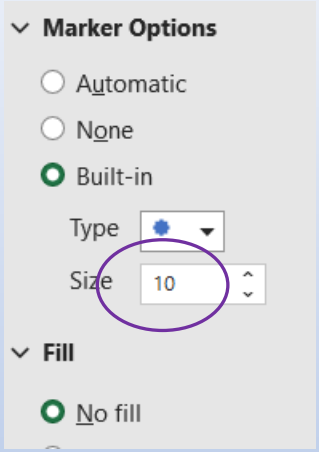
Creating Simple Plots

Adjust markers and lines

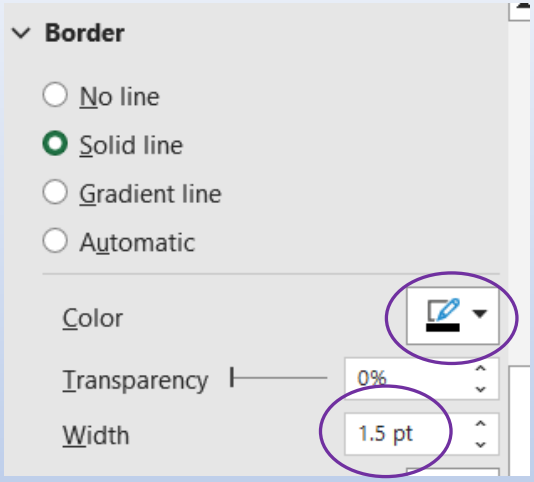


select the series (not an individual marker)





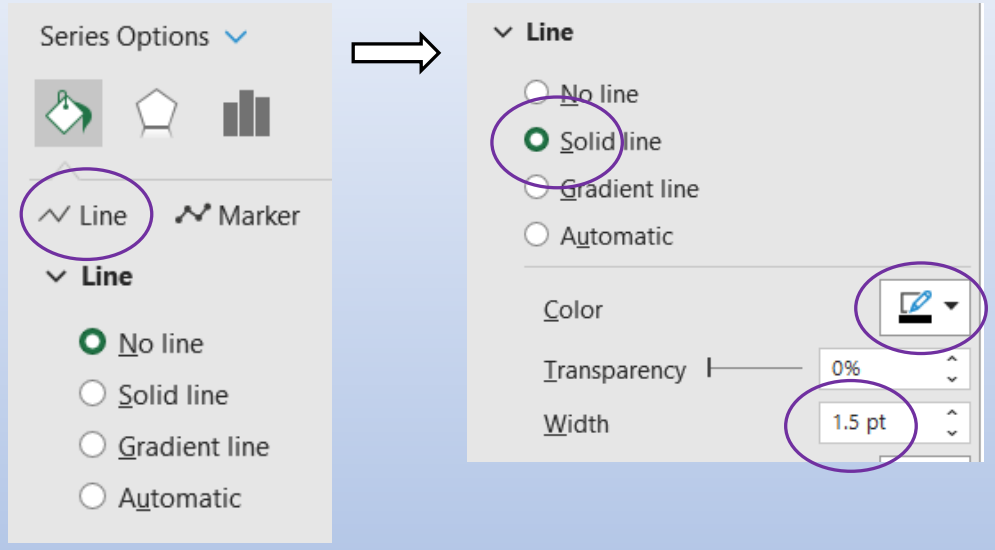
enlarge marker
choose no fill

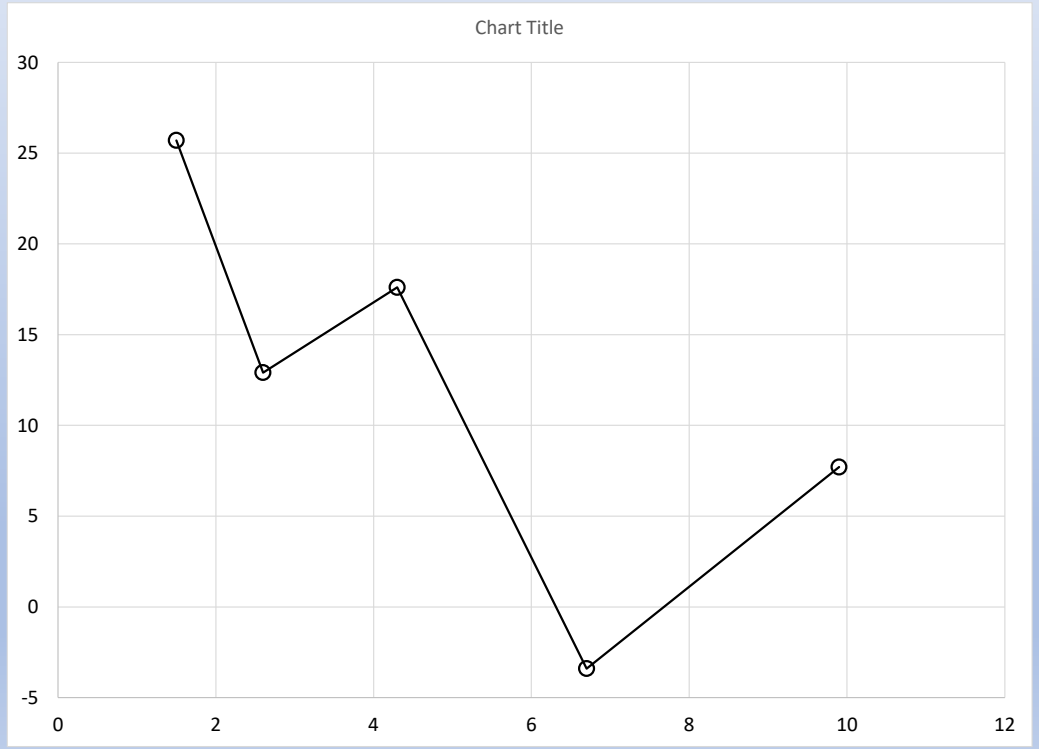


change border color
increase line width

Creating Simple Plots

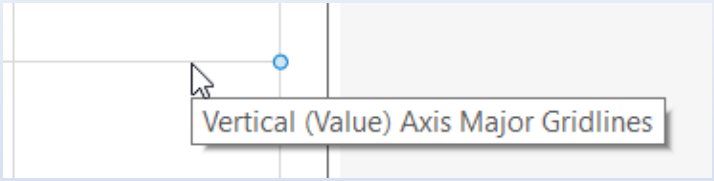
Adjust markers and lines – possibly add interconnecting lines



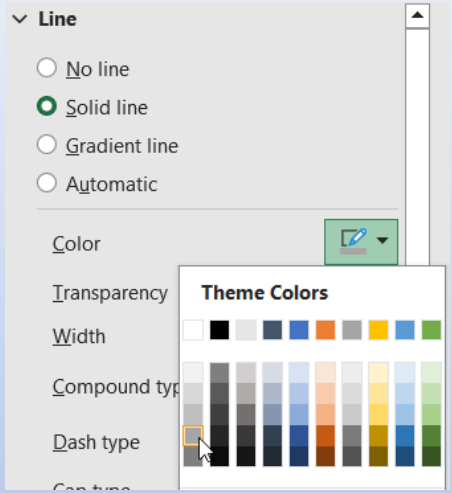


Creating Simple Plots

Adjust markers and lines – increase intensity of gridlines



select horizontal gridlines

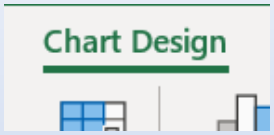


select solid line
and adjust intensity
to suit

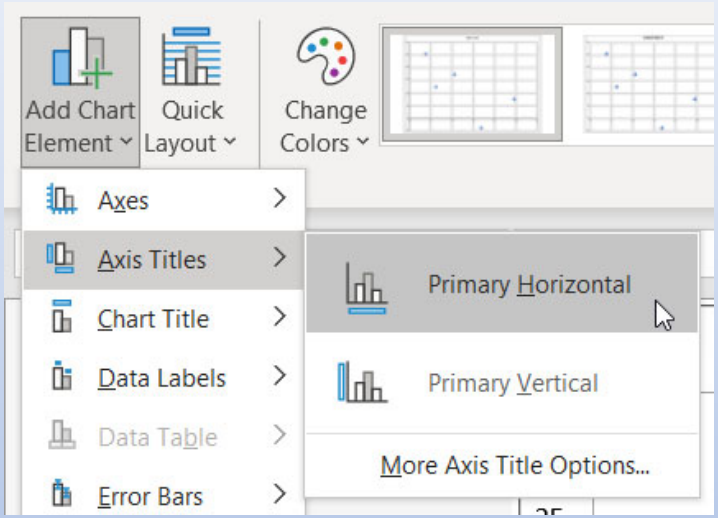
Format the vertical gridlines similarly,
the plot outline, and the axes borders.

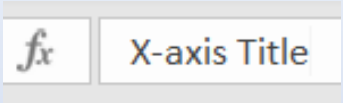
Creating Simple Plots

Add axis titles and chart title

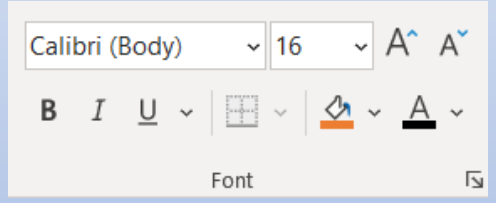


select the chart and Chart Design tab

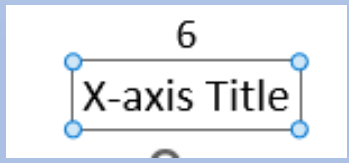




enter title in the Formula Bar or in place



adjust font size and color

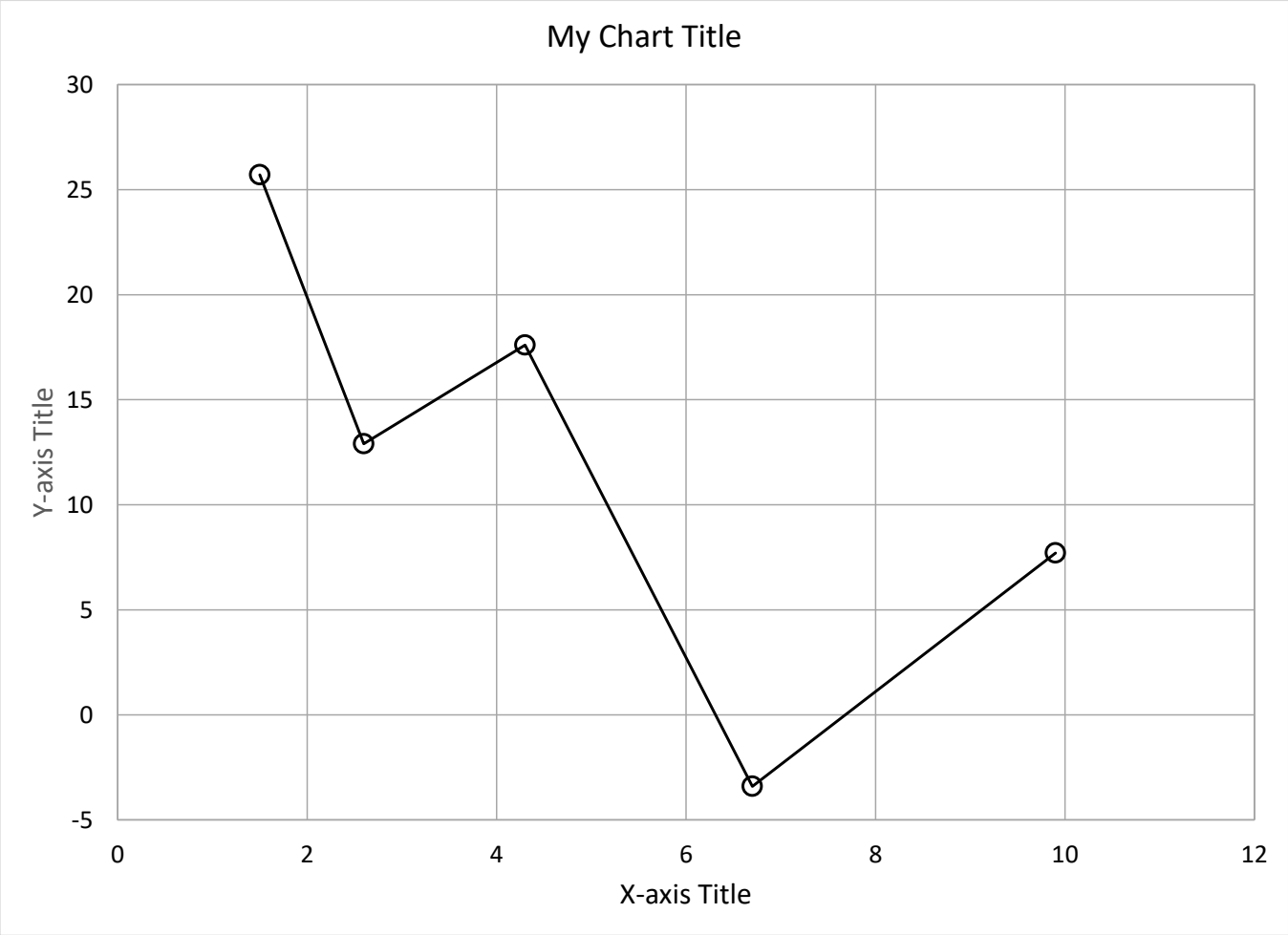


Carry out similar entry and formatting of Primary Vertical Axis Title and Chart Title

Note: Can change font style, if desired.

Creating Simple Plots

Example Formatted Plot



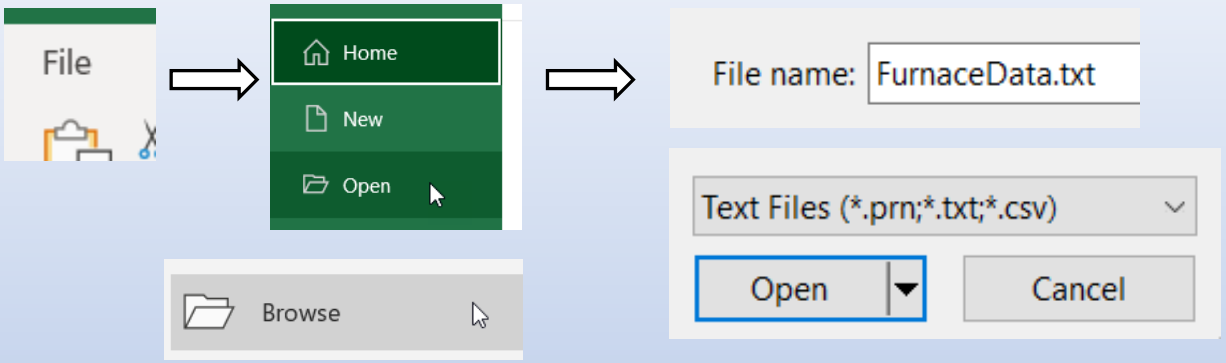
Creating Plots with Multiple Series

Possible features:

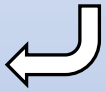
- Acquiring data from a text (.txt or .csv) file
- Distinguishing markers and/or line styles
- Legend to identify series
- Lines only for large data series or analytical functions

Creating Plots with Multiple Series

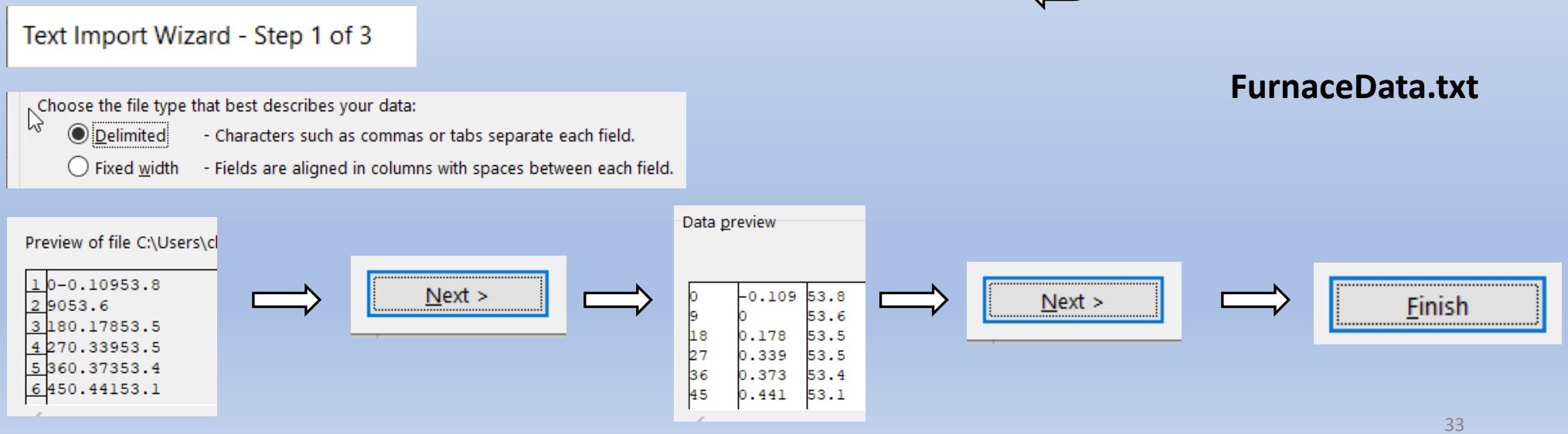
Acquiring data from a text (.txt or .csv) file



change file type
to Text Files and
locate file
click Open



FurnaceData.txt



Creating Plots with Multiple Series

Acquiring data from a text (.txt or .csv) file

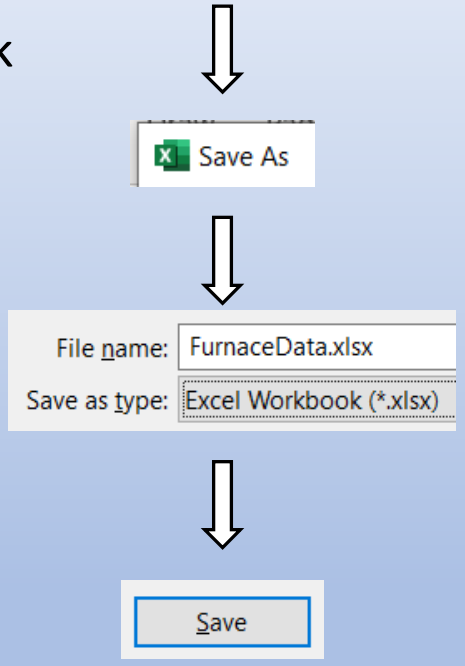
	A	B	C
1	0	-0.109	53.8
2	9	0	53.6
3	18	0.178	53.5
4	27	0.339	53.5
5	36	0.373	53.4
6	45	0.441	53.1

	A	B	C
292	2619	0.195	58.5
293	2628	0.131	58.3
294	2637	0.017	57.8
295	2646	-0.182	57.3
296	2655	-0.262	57

296 data entries
time, y1, and y2

Save As
Excel Workbook

F12

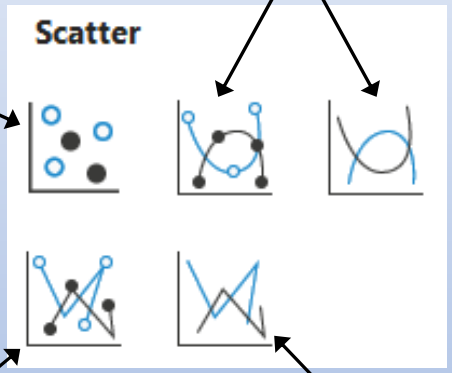


Creating Plots with Multiple Series

Different X-Y Scatter Plot Styles

artificial smoothing
recommend against

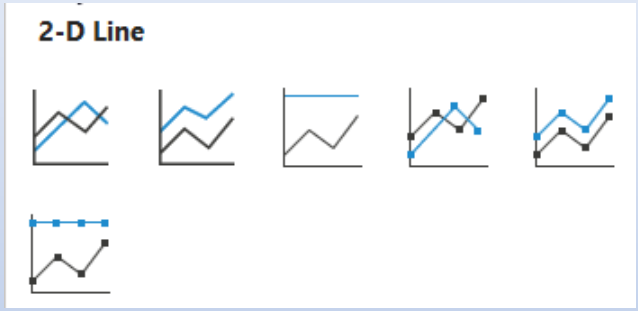
experimental data
small sample
(n < 50-to-100)



experimental data
small sample (n < 50-to-100)
interconnecting lines
for pattern recognition

experimental data
large sample (n < 50-to-100)
markers would clutter
interconnecting lines
or analytical functions

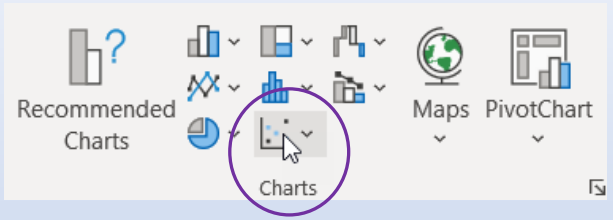
recommend against using
Line plot which are intended
for categorical x-axis

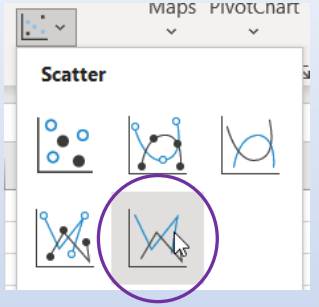


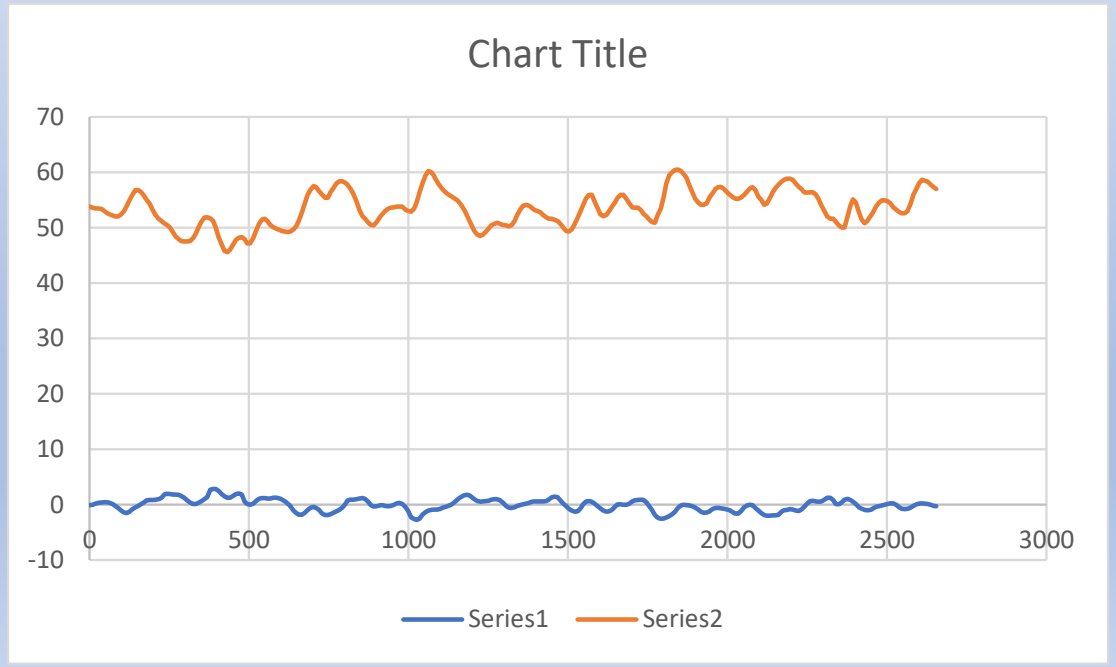
Creating Plots with Multiple Series

X-Y Plot – Straight Lines, No Markers

	A	B	C
1	0	-0.109	53.8
2	9	0	53.6
3	18	0.178	53.5
4	27	0.339	53.5
5	36	0.373	53.4



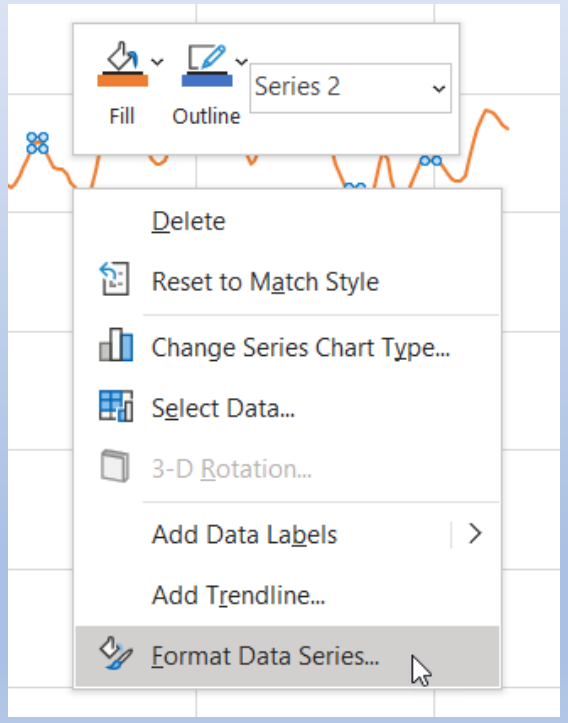


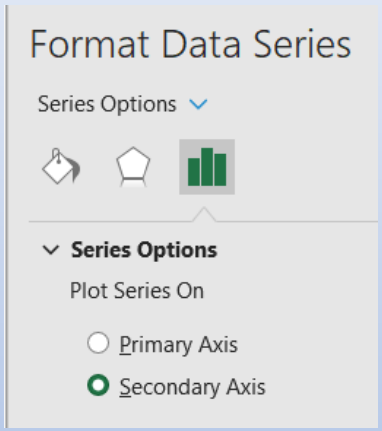


Creating Plots with Multiple Series

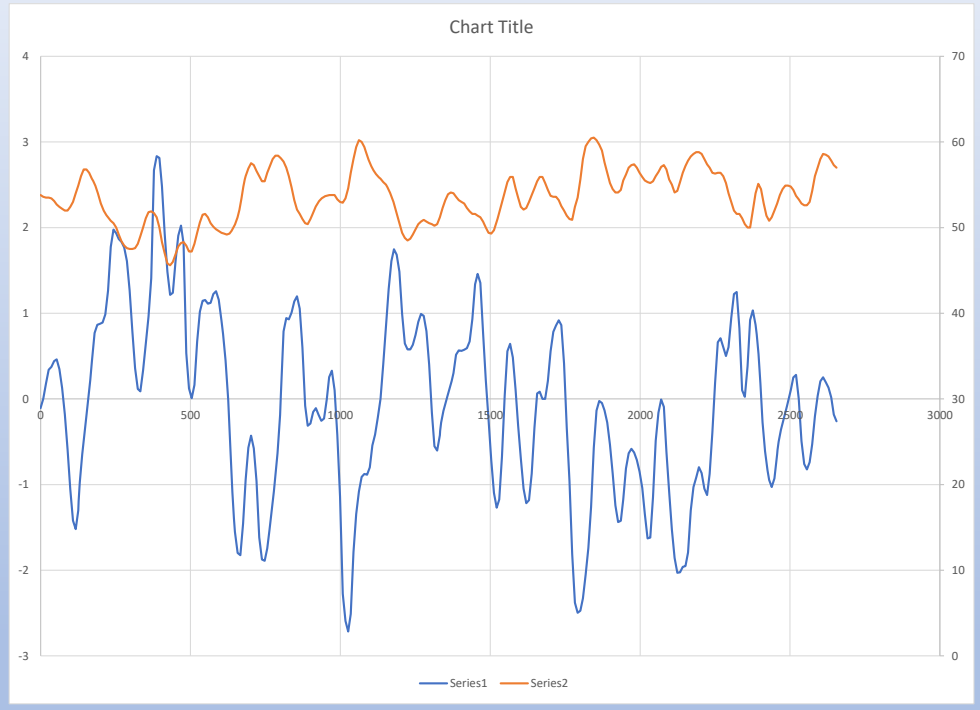
X-Y Plot – Straight Lines, No Markers

select one series, here y2
(could be either)



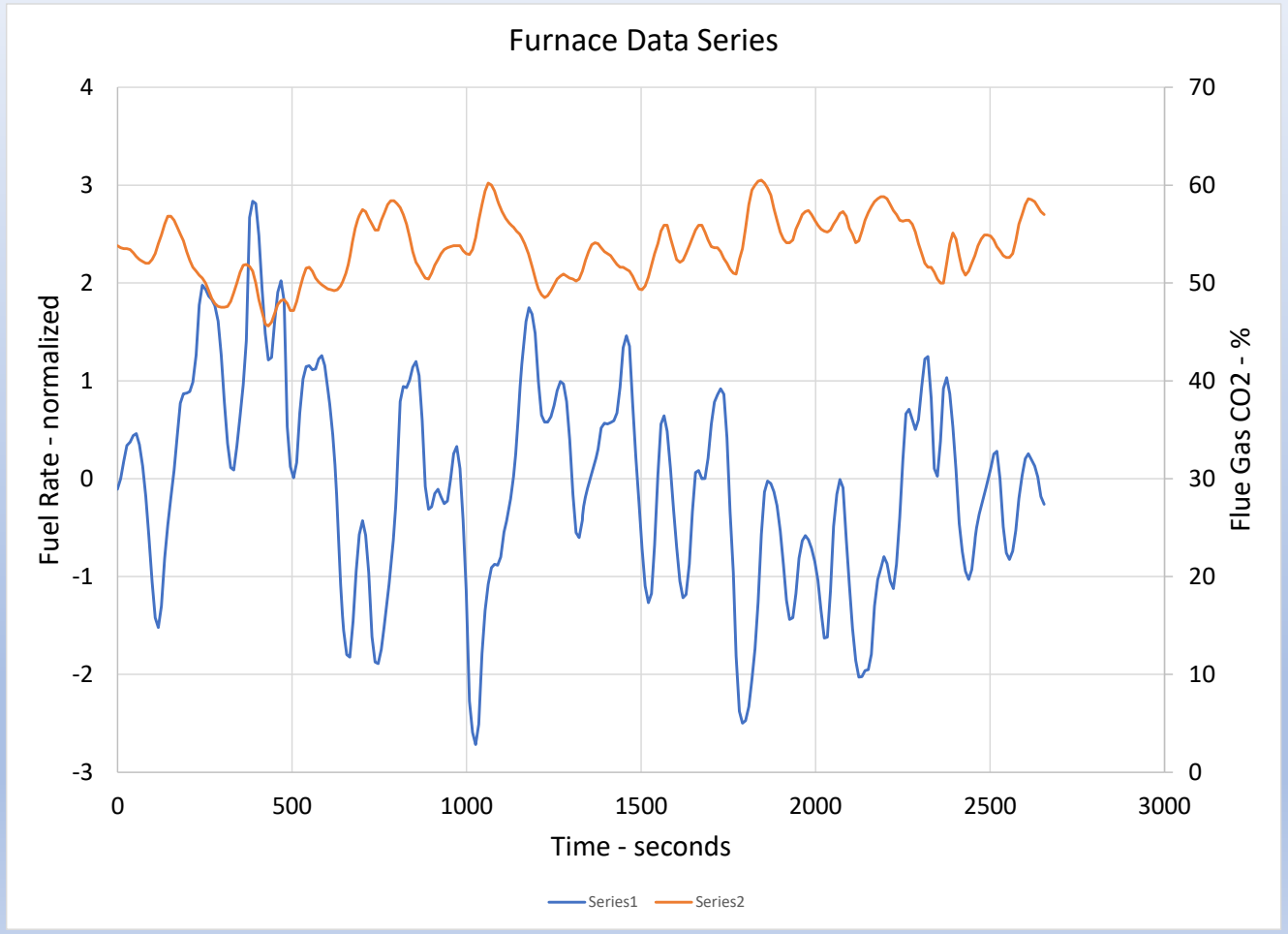


move to Secondary
(right) axis



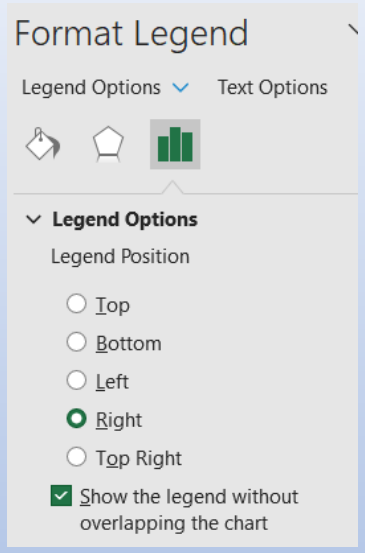
Creating Plots with Multiple Series

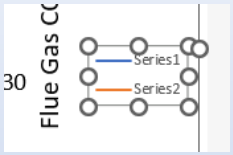
Format Axes and Add Titles

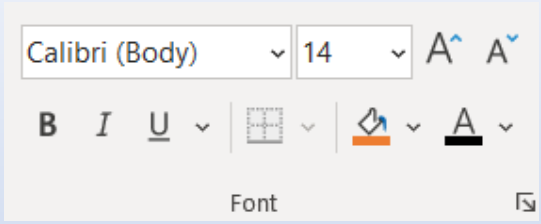


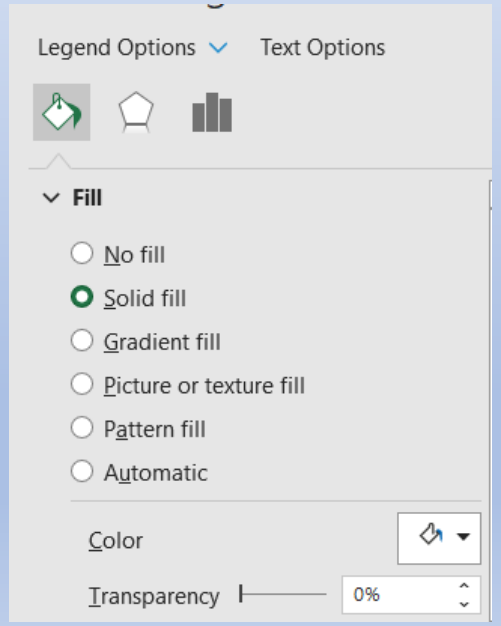
Creating Plots with Multiple Series

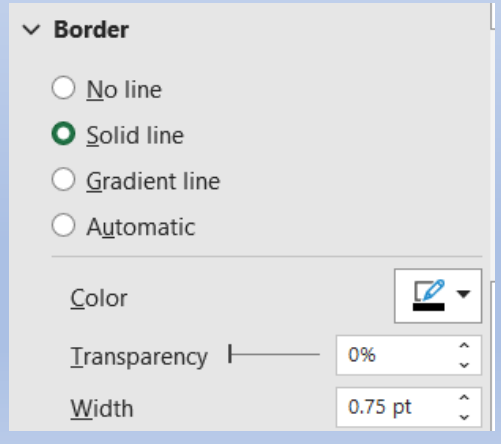
Move and Format Legend

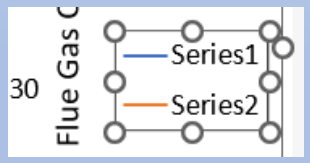






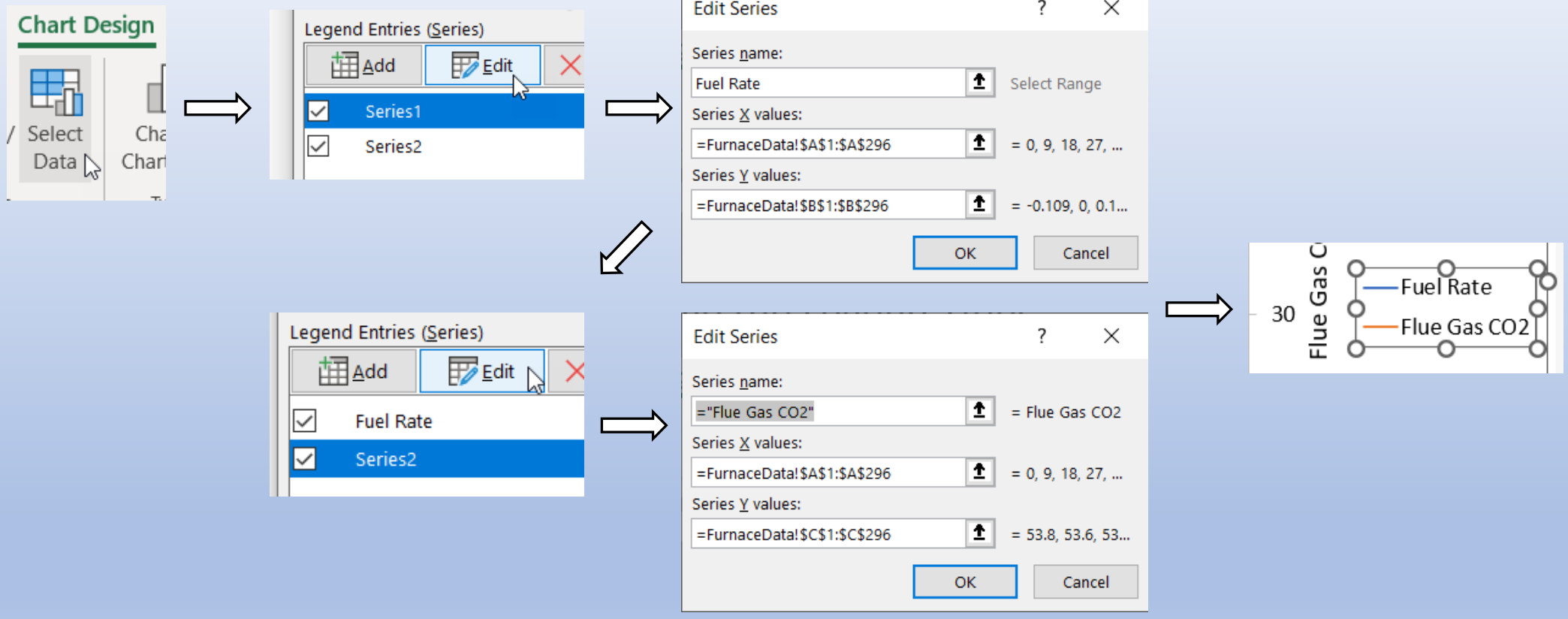






Creating Plots with Multiple Series

Change the Legend Titles

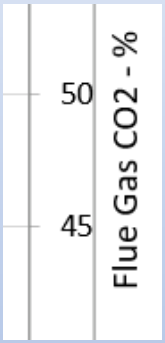


Creating Plots with Multiple Series

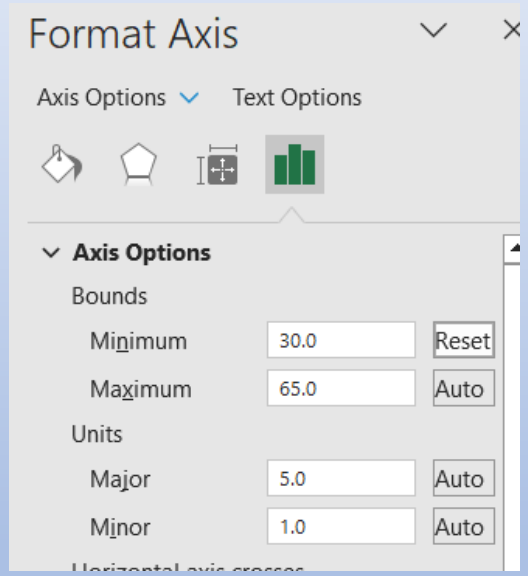
Change Right Vertical Axis Scale

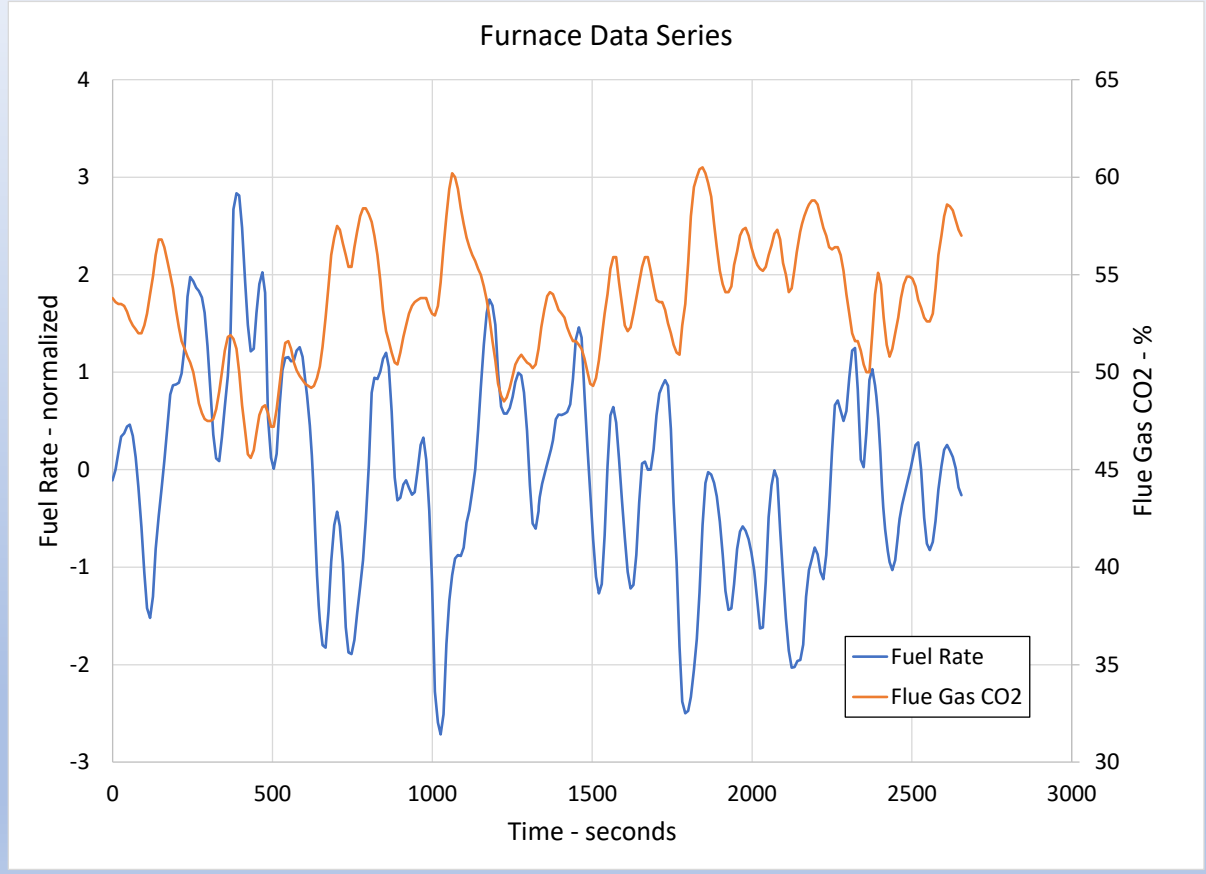
Move Legend Into the Plot

Stretch the Plot



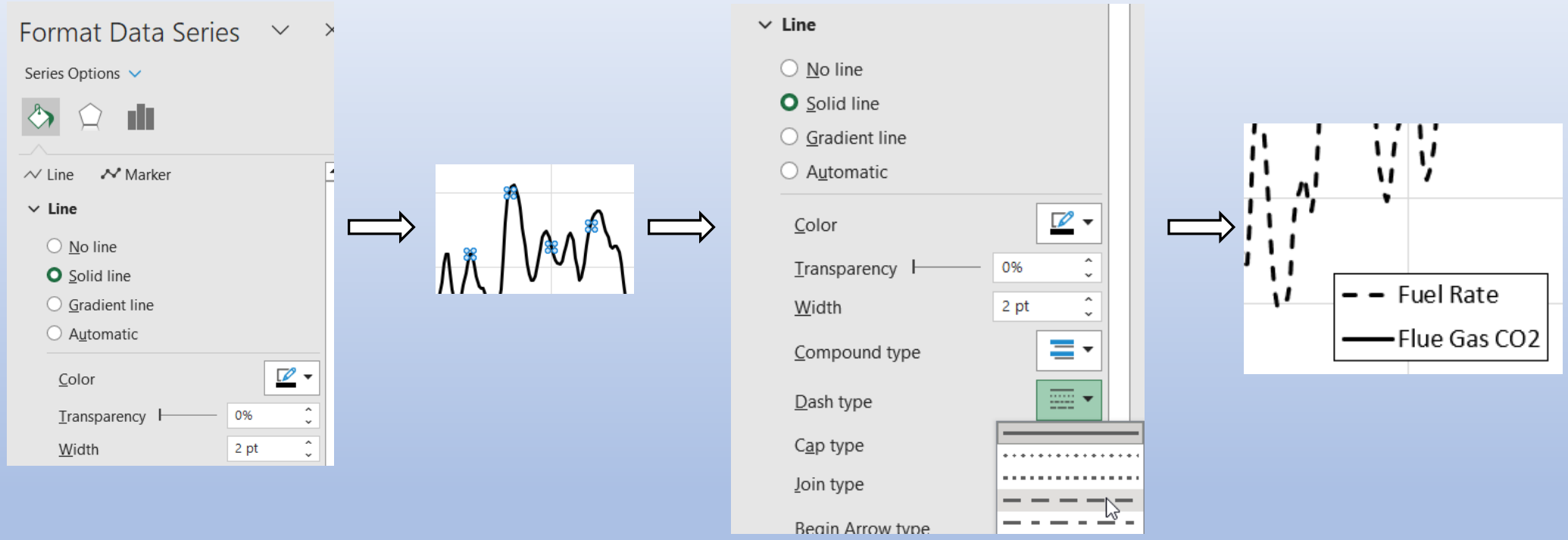
Select Secondary axis scale





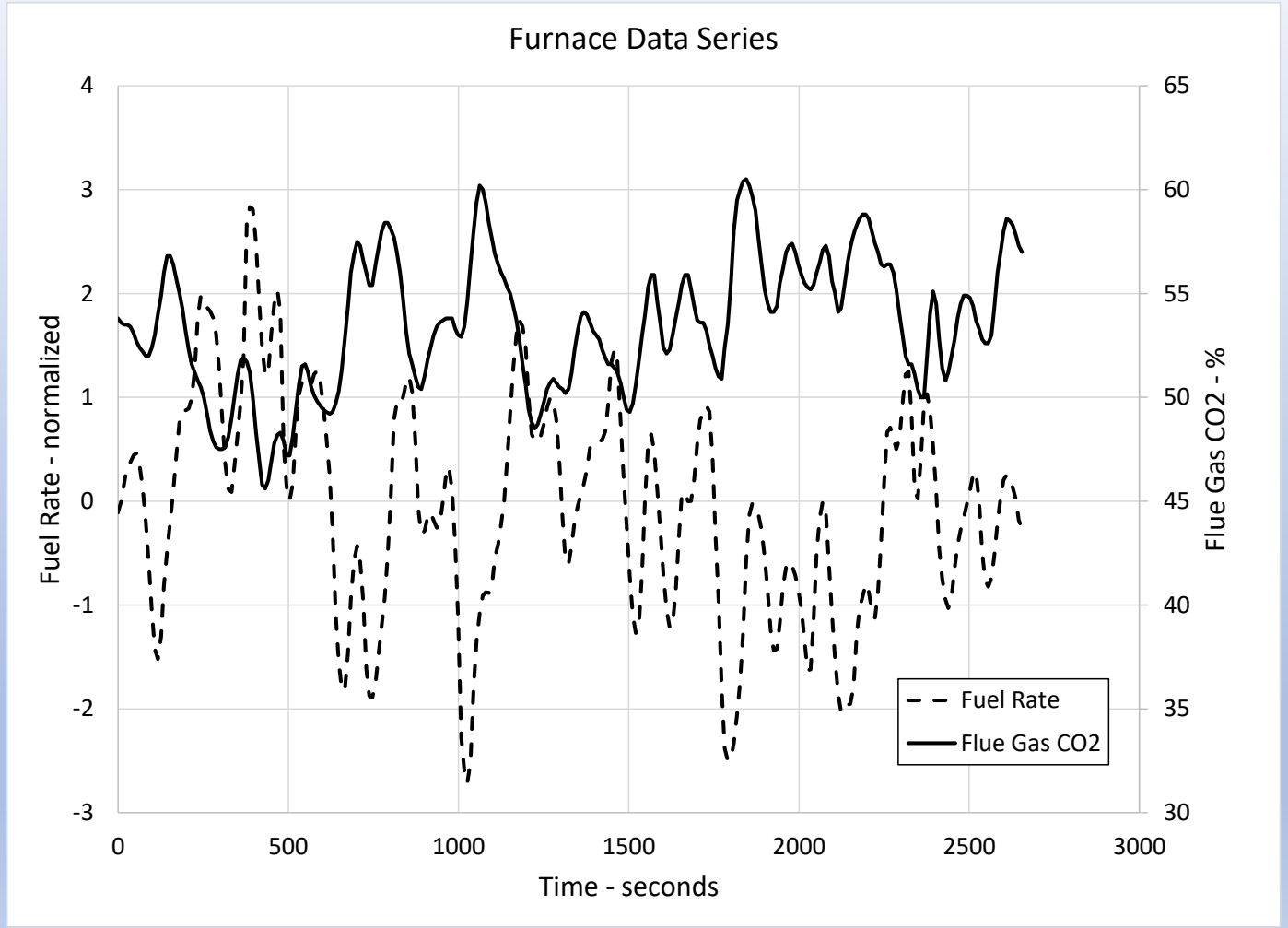
Creating Plots with Multiple Series

Change Line Styles for B&W Presentation



Creating Plots with Multiple Series

Final Plot



Plots with Logarithmic Scale(s)

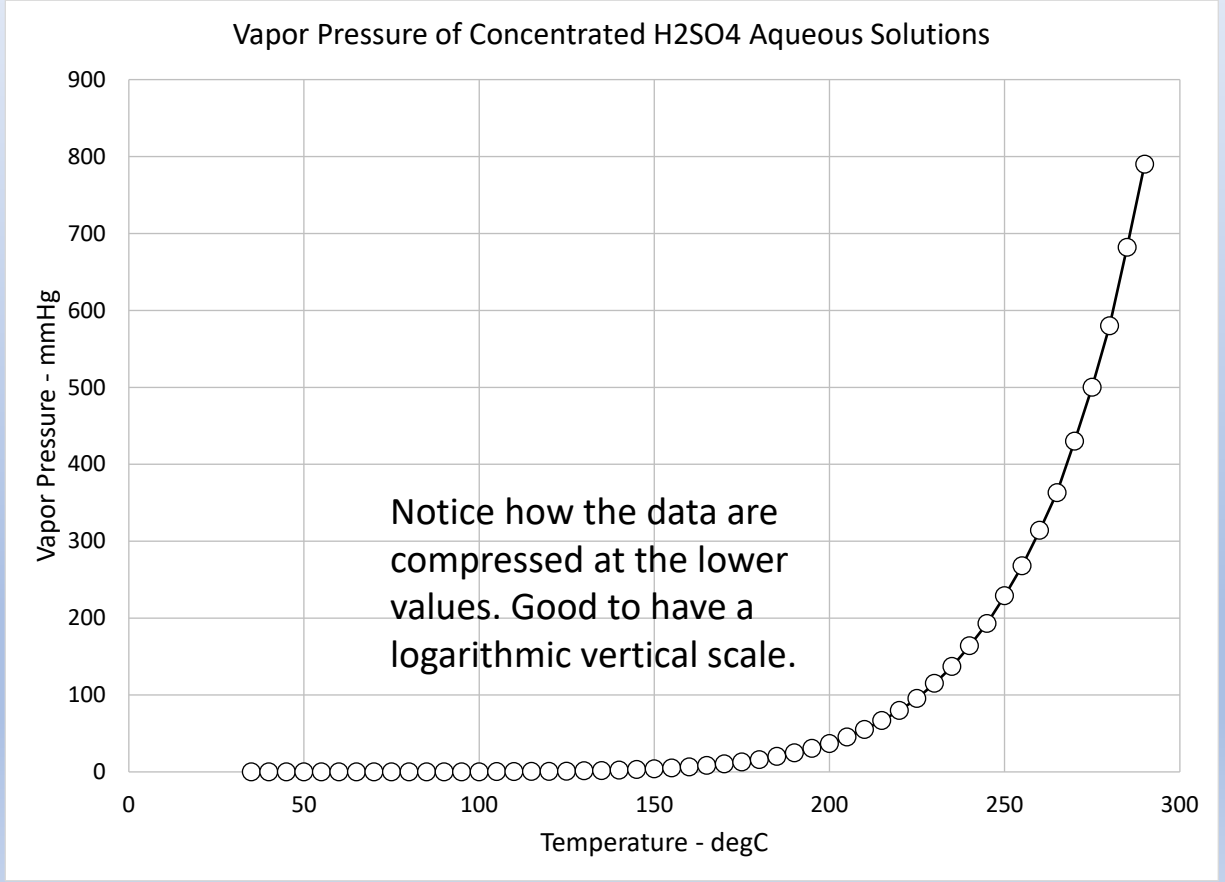
H2SO4VaporPressureStarter.xlsx

Vapor Pressure of 95%(wt) Sulfuric Acid Aqueous Solution

	A	B
2	Temperature (degC)	Vapor Pressure (torr)
3	35	0.0015
4	40	0.00235
5	45	0.0037
6	50	0.0058
7	55	0.00877

50	270	430
51	275	500
52	280	580
53	285	682
54	290	790

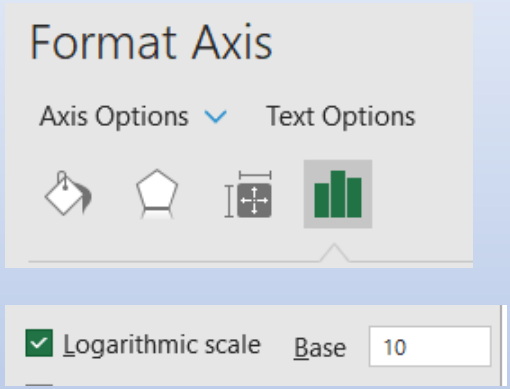
Create X-Y plot with markers and lines

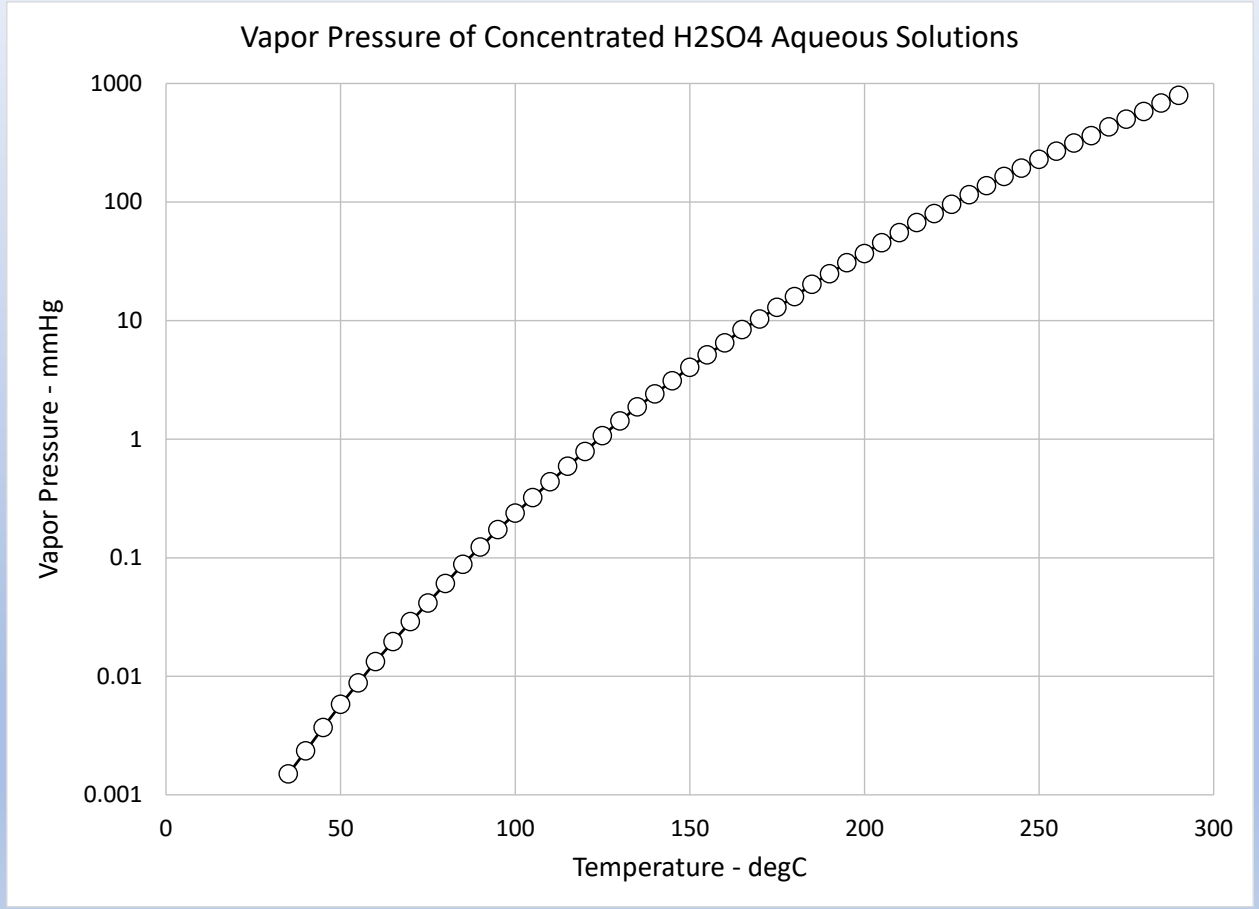


Plots with Logarithmic Scale(s)

Vapor Pressure of 95%(wt) Sulfuric Acid Aqueous Solution

Logarithmic vertical scale

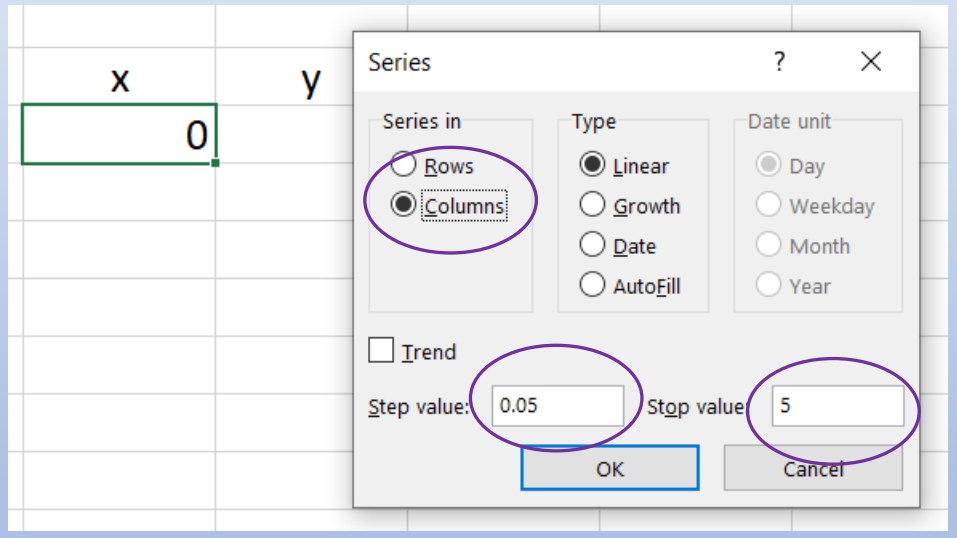


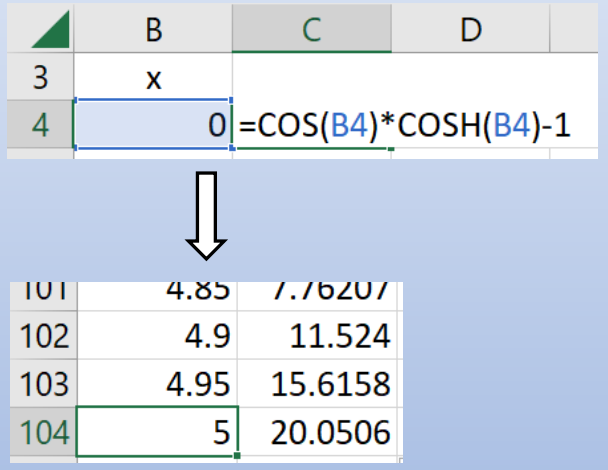


Creating Plots of Analytical Functions

Create table of function values

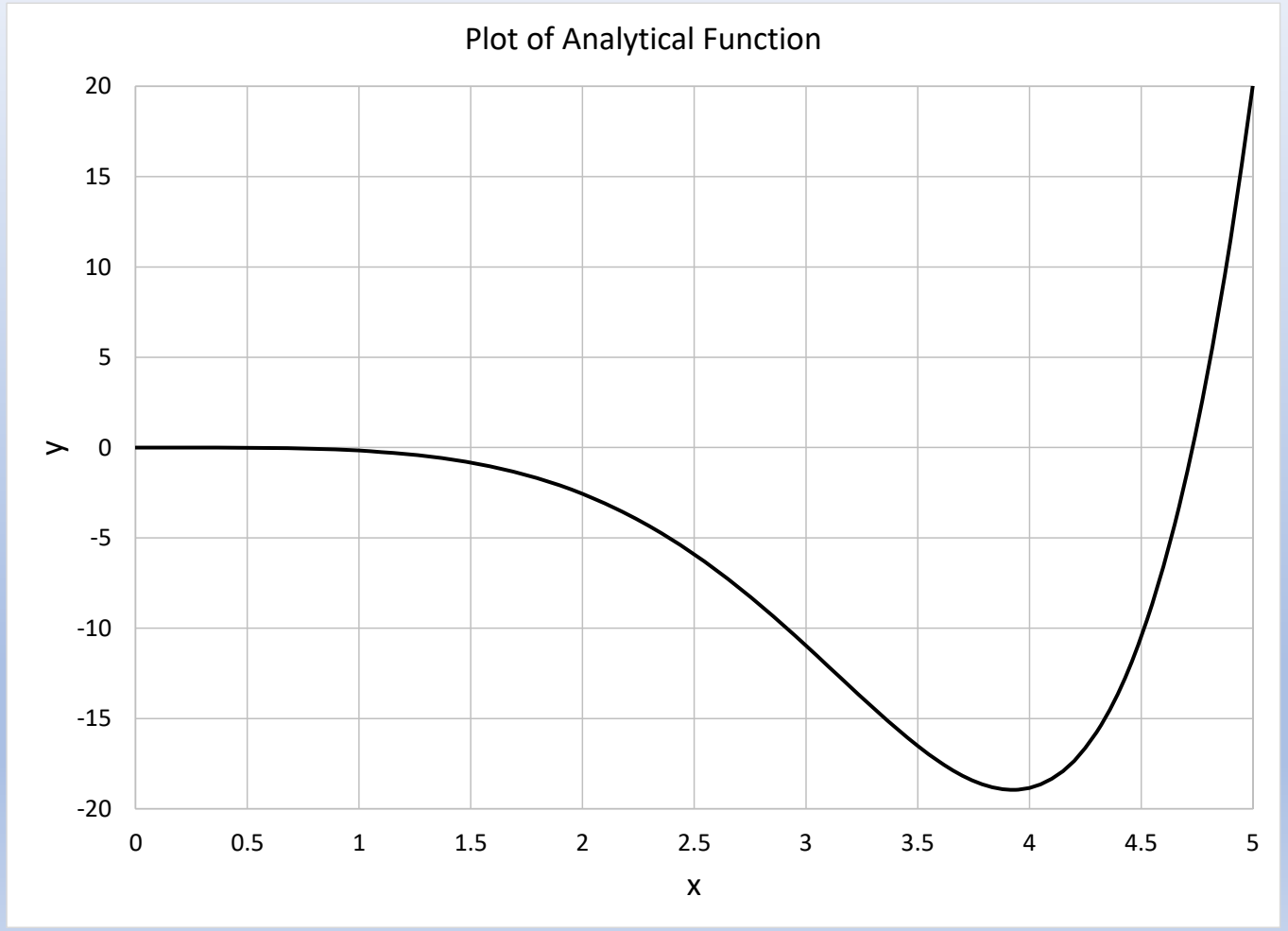
$$y = \cos(x) \cdot \cosh(x) - 1 \qquad 0 \le x \le 5$$





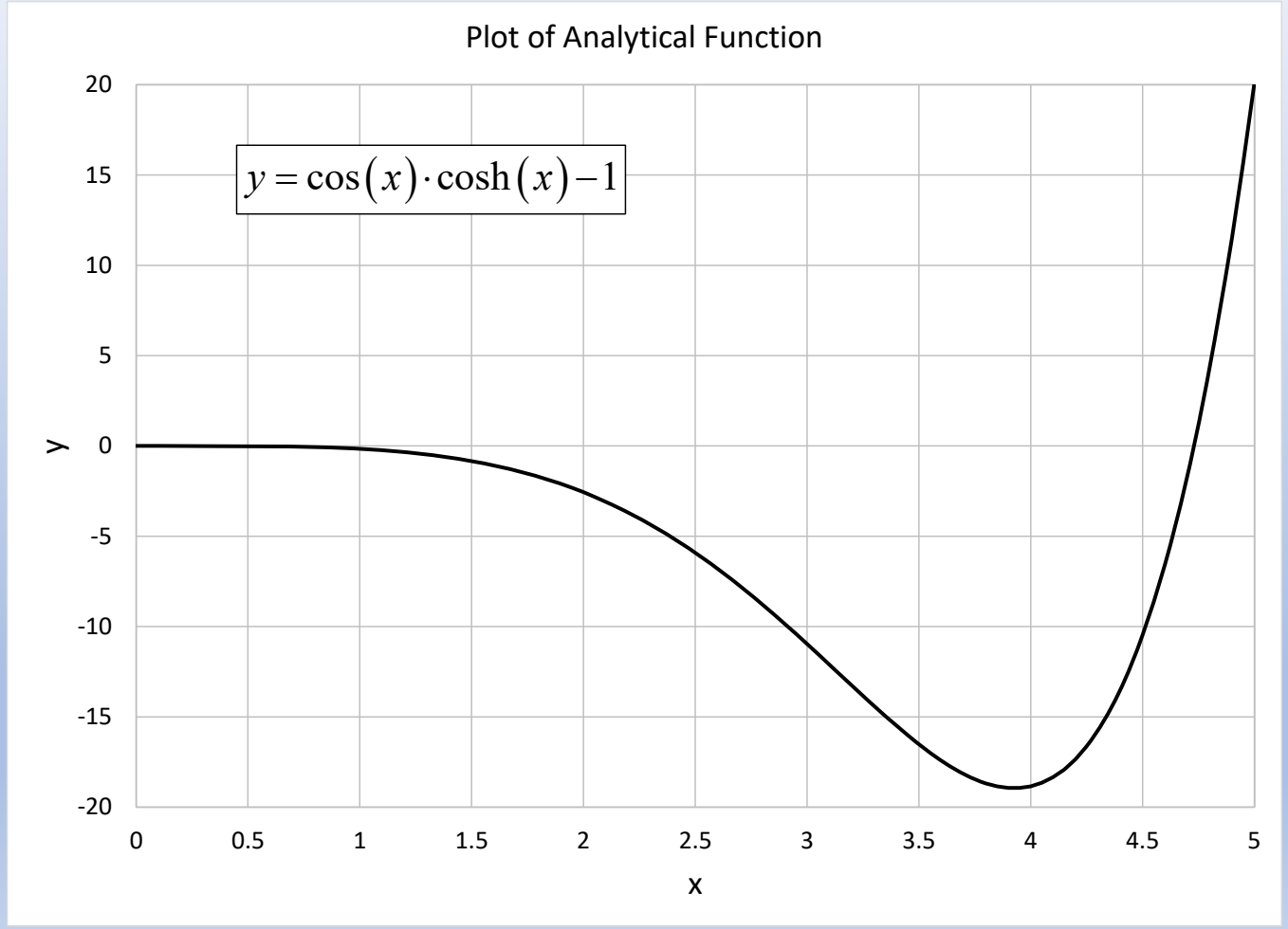
Creating Plots of Analytical Functions

Create Formatted Plot of y vs. x



Creating Plots of Analytical Functions

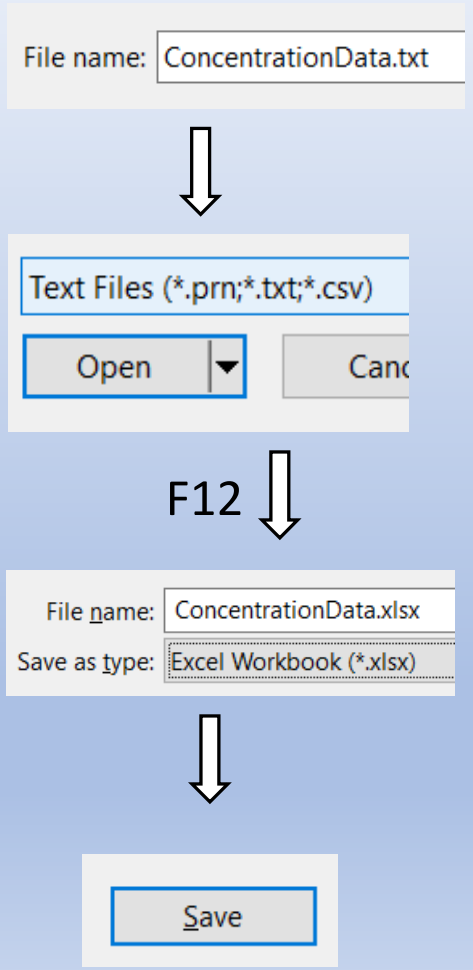
Insert Equation Object on Plot



Histogram Bar Charts

ConcentrationData.txt

Create histogram data with the FREQUENCY function



	A
1	17
2	16.6
3	16.3
4	16.1
5	17.1
6	16.9
193	17.6
194	17.8
195	17.7
196	17.2
197	17.4

name the range of data Conc

n	197
max	16.1
min	18.2

array formula
=FREQUENCY(Conc,Bins)

Bin Boundaries	Frequencies	Bin Centers
16.05	0	
16.25	3	16.15
16.45	10	16.35
16.65	17	16.55
16.85	28	16.75
17.05	42	16.95
17.25	35	17.15
17.45	34	17.35
17.65	14	17.55
17.85	9	17.75
18.05	3	17.95
18.25	2	18.15
	0	

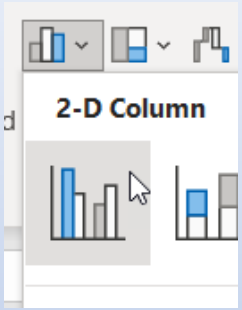
create a bar chart of frequencies versus bin centers

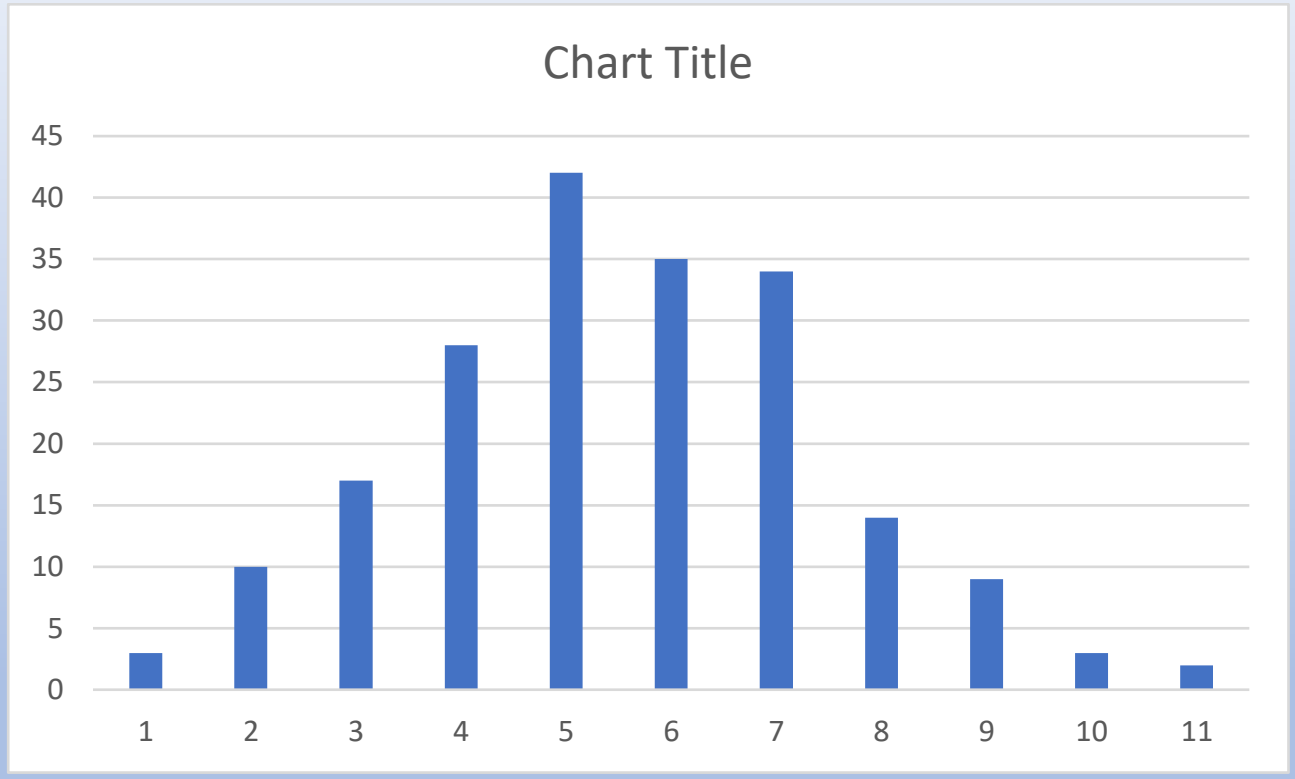
2 data
>= 18.05
< 18.25

Histogram Bar Charts

Create bar chart based on histogram data

Frequencies
0
3
10
17
28
42
35
34
14
9
3
2

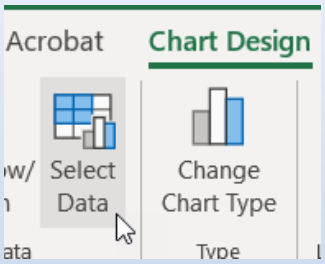


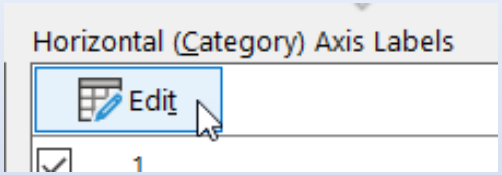


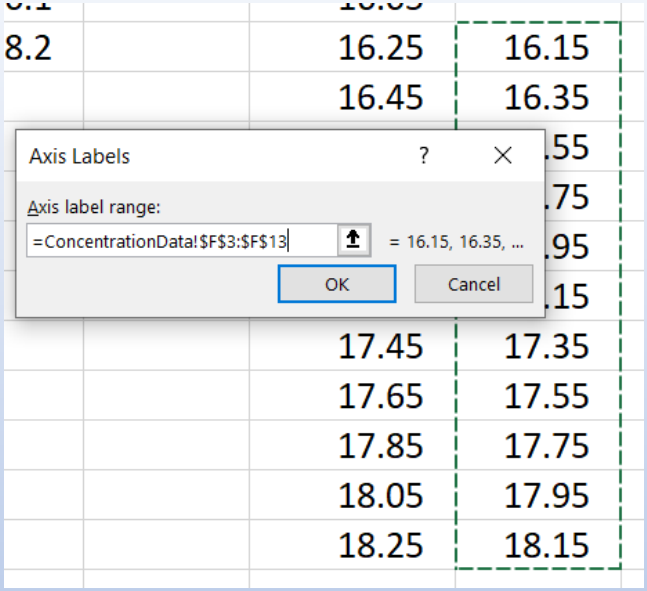
move the chart to its own sheet

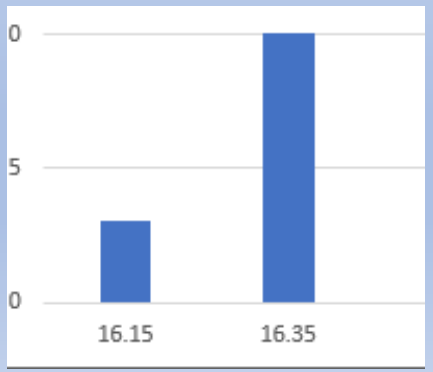
Histogram Bar Charts

Change x-axis labels to bin centers



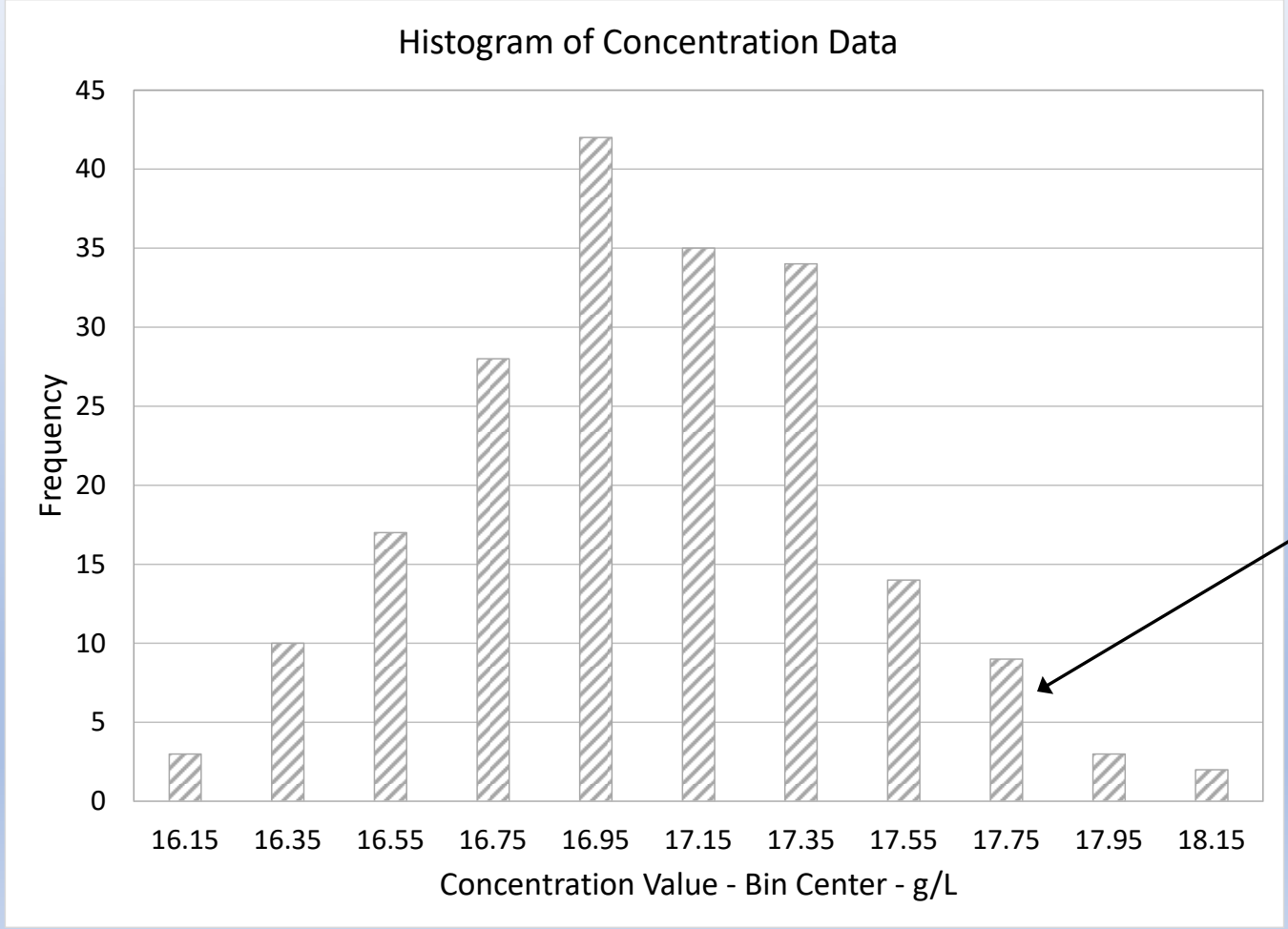






Histogram Bar Charts

Complete formatting of the chart



change bar fill to a dark gray pattern

Contour and Surface Plots

AnalyticalFunctionStarter.xlsx

Illustrate with an analytical function

$$z = f(x, y) = 89 + 0.04x - 0.16y - 8.09x^2 - 5.78y^2 - 5.89xy$$
$$-2 \le x, y \le 2$$

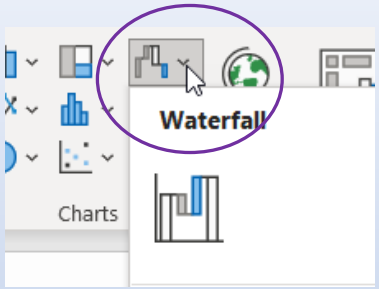
Set up a 2-way data table

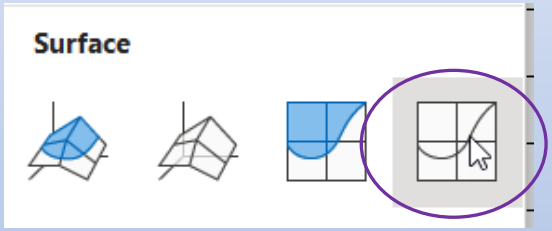
	A	B	C	D	E	F
1						
2	x	0.5		87.105	-2	-1.9
3	y	-0.5		-2	10.20	14.54
4	z	87.105		-1.9	13.62	17.89
5				-1.8	16.92	
6				-1.7	20.10	
7				-1.6	23.17	
8				-1.5	26.13	

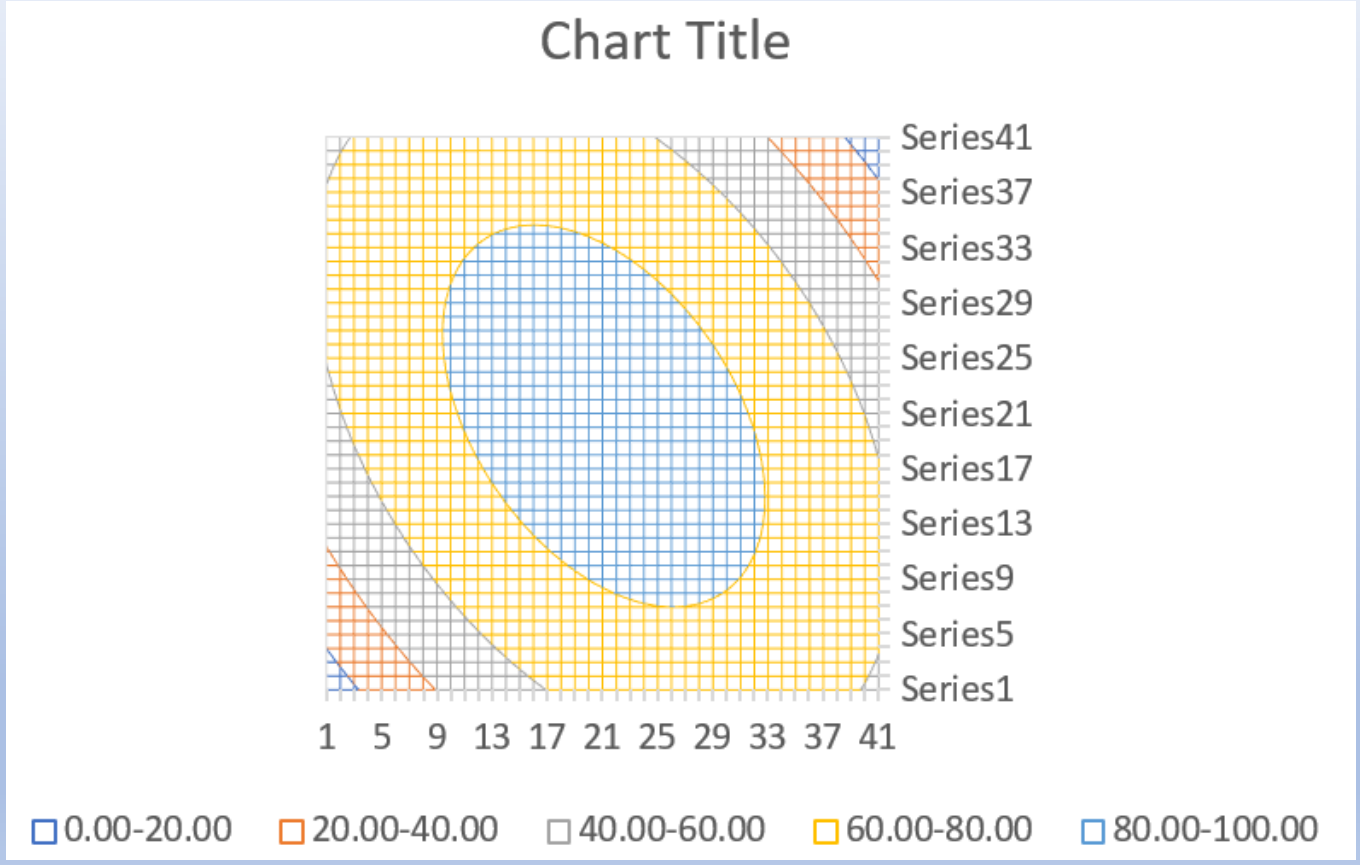
	AP	AQ	AR	AS
38	37.42	33.71	29.84	25.81
39	34.61	30.84	26.91	22.82
40	31.69	27.86	23.87	19.72
41	28.65	24.76	20.71	16.50
42	25.49	21.55	17.44	13.17
43	22.22	18.22	14.05	9.72

Contour and Surface Plots

Select interior of the table and create a contour plot

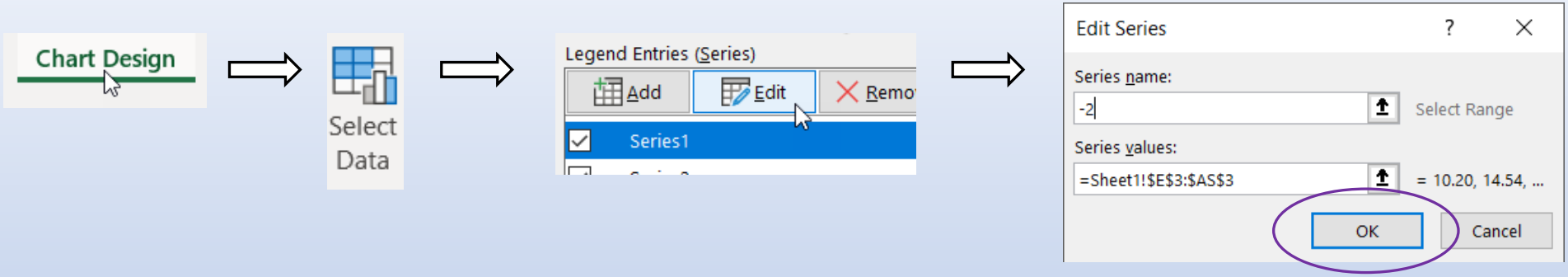






Contour and Surface Plots

Adjust contour plot settings

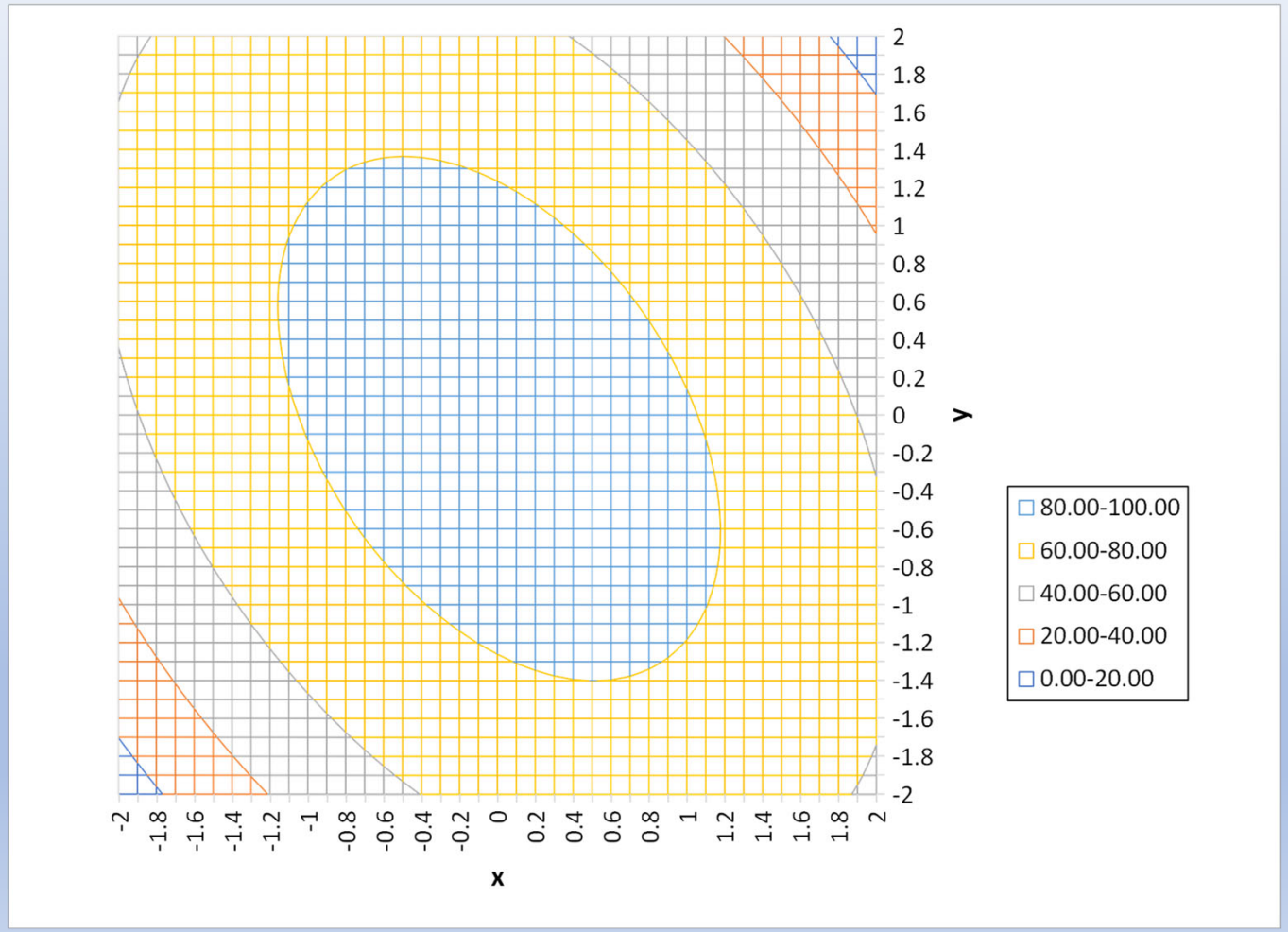


Repeat for all series (tedious!)

Add axes titles
Format axes ticks
Move and format legend

Contour and Surface Plots

Final version of contour plot



Contour and Surface Plots

Surface mesh plot of experimental data

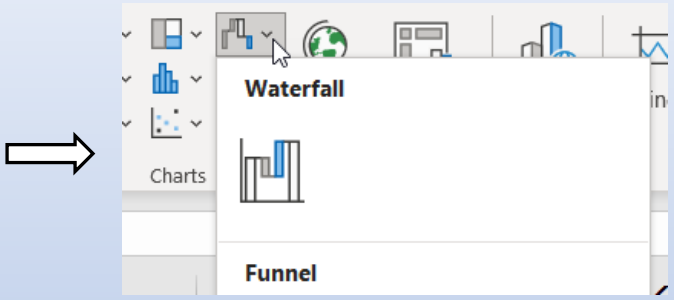
NaClDensityStarter.xlsx

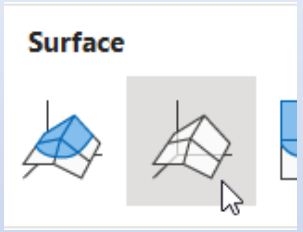
	A	B	C	D	E	F
1	Density of NaCl Aqueous Solutions					
2			Temperature			
3			0 °C	10 °C	25 °C	40 °C
4	Wt % NaCl	1	1.00747	1.00707	1.00409	0.99908
5		2	1.01509	1.01442	1.01112	1.00593
6		4	1.03038	1.02920	1.02530	1.01977
7		8	1.06121	1.05907	1.05412	1.04798
8		12	1.09244	1.08946	1.08365	1.07699
9		16	1.12419	1.12056	1.11401	1.10688
10		20	1.15663	1.15254	1.14533	1.13774
11		24	1.18999	1.18557	1.17776	1.16971
12		26	1.20709	1.20254	1.19443	1.18614

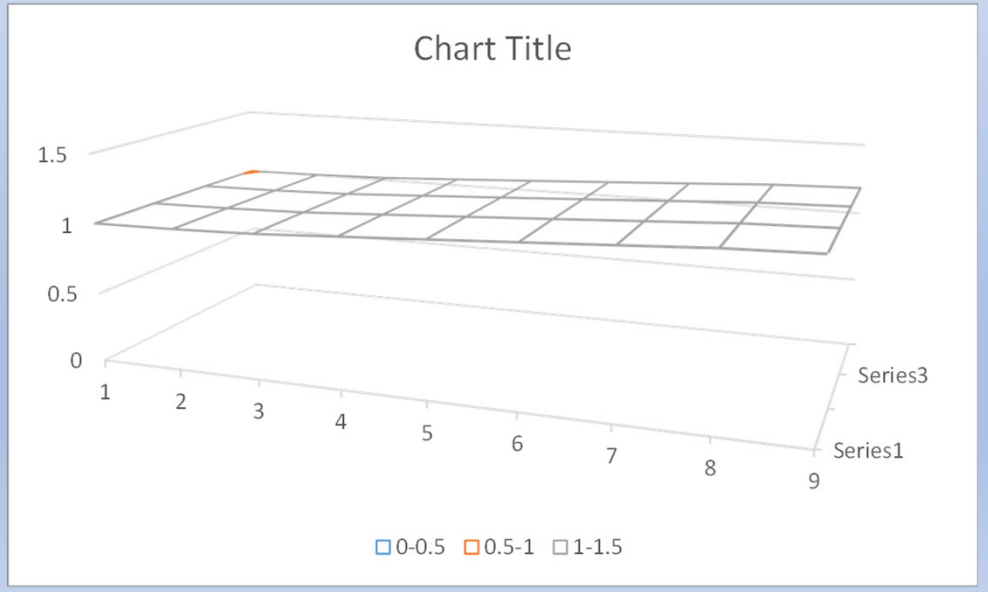
Contour and Surface Plots

Surface mesh plot of experimental data

	0 °C	10 °C	25 °C	40 °C
1	1.00747	1.00707	1.00409	0.99908
2	1.01509	1.01442	1.01112	1.00593
4	1.03038	1.02920	1.02530	1.01977
8	1.06121	1.05907	1.05412	1.04798
12	1.09244	1.08946	1.08365	1.07699
16	1.12419	1.12056	1.11401	1.10688
20	1.15663	1.15254	1.14533	1.13774
24	1.18999	1.18557	1.17776	1.16971
26	1.20709	1.20254	1.19443	1.18614







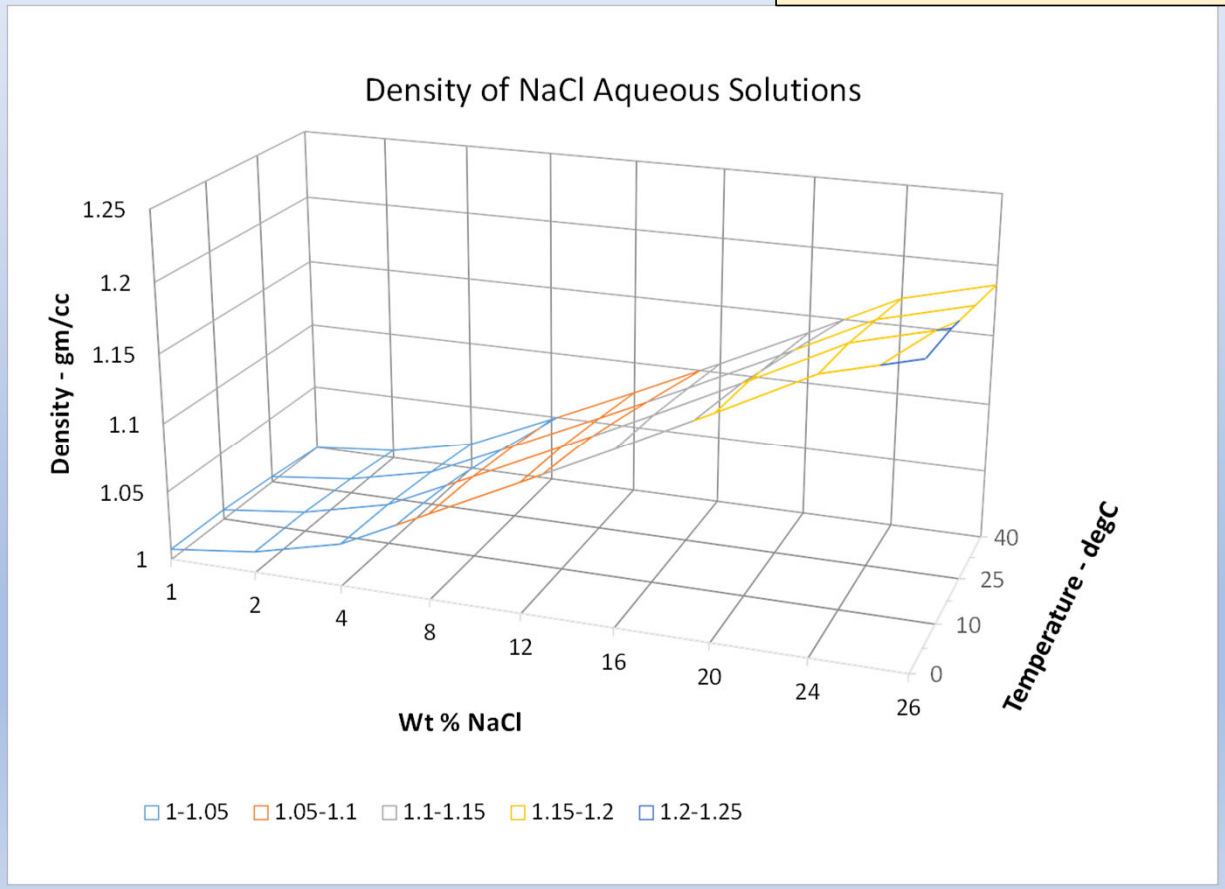
Contour and Surface Plots

Surface mesh plot of experimental data

Move plot to chart sheet and format

Note: Excel's contour and surface plots are limiting. A better choice is to use the Excel link to Matlab and create plots there.

Note: Since this is a categorical plot, both grids aren't spaced correctly.



Reference:

Spreadsheet Problem Solving and Programming for Engineers and Scientists,
David E. Clough and Steven C. Chapra,
CRC Press - Taylor & Francis Group, 2024.

"Prof. Clough, may I be excused? My brain is full."

What's next?

Excel Bootcamps 1, 2, 3 and 4

- ✓ 1: Getting up to speed with Excel
- 2: Introducing VBA
- 3: Learning to use Excel to solve typical problem scenarios
- 4: Detailed modeling of packed-bed and plug-flow reactors