

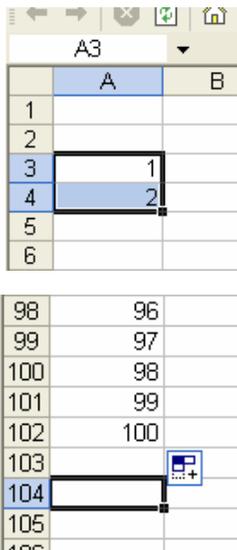
Simulation for Wave Properties

Download the [Excel file](#) from the web page if you want to start with a basic template.

Do not attach the instruction page(s) to your report. Do not copy the sentences on the page(s).

1. Basic Excel Manipulations:

- Type numbers from 1 to 100, and obtain the sum, average, and standard deviation with the built-in functions.

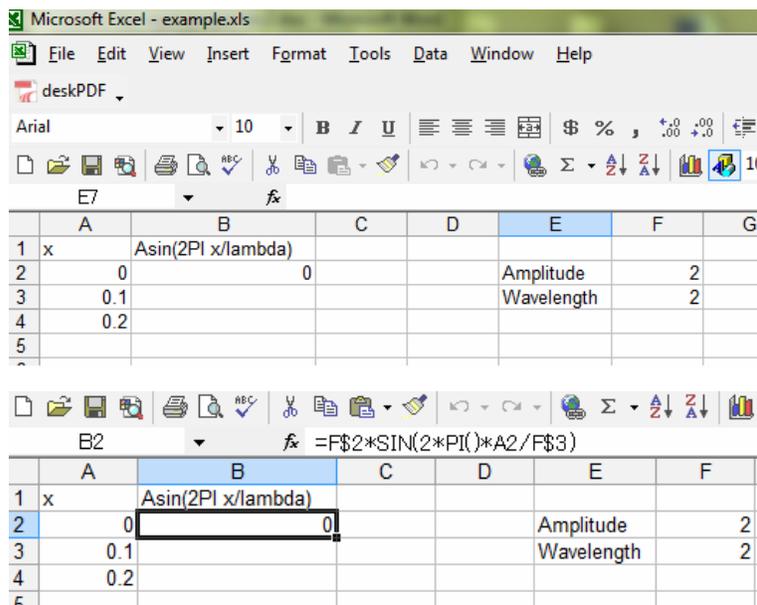


- ① Type 1 and 2; then, select as shown.
- ② Put the cursor on the small black square dot.
- ③ Click it and drag down until you get 100.
- ④ Click another cell, then type equal sign, “=”
- ⑤ After the equal sign, keep typing “SUM(a3:a102)”, then press enter.
- ⑥ “(a3:a102)” means the range of cell numbers that you calculate.
- ⑦ Do the same thing for the average and standard deviation. The commands are “AVERAGE” and “STDEV”, respectively.

Question: Do you obtain, Sum=5050; Average=50.5; and Standev=29.01 by Excel?

2. The Wave Function in Terms Position

- Plot $A \sin\left(\frac{2\pi}{\lambda} x\right)$ in Excel. Click the next tab, Harmonic wave in the spreadsheet.



★ Type the numbers and labels as shown.

★ Click the cell (B2) and type as shown. Namely, type =F\$2*SIN(2*PI()*A2/F\$3). The dollar sign is to fix the cell to use the value.

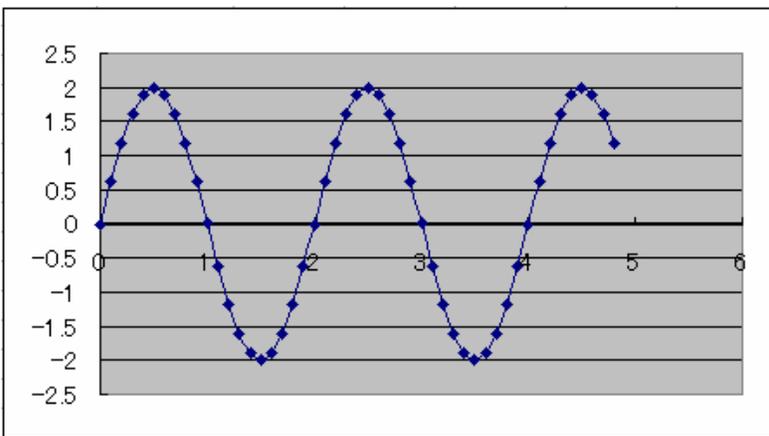
Namely, F\$2 is the amplitude and F\$3 is the wavelength as constants. “SIN()” and “PI()” are built-in functions. The symbols, * and /, represent multiplication and division.

	A	B	C	D	E	F
1	x	Asin(2PI x/lambda)				
2	0	0			Amplitude	2
3	0.1	0.618033989			Wavelength	2
4	0.2	1.175570505				
5	0.3	1.618033989				
6	0.4	1.902113033				
7	0.5	2				
8	0.6	1.902113033				
9	0.7	1.618033989				
10	0.8	1.175570505				
11	0.9	0.618033989				
12	1	2.4503E-16				
13	1.1	-0.618033989				
14	1.2	-1.175570505				

★ Then, extend the values of x and the wave function as you learned in the previous section.

	A	B	C	D	E
1	x	Asin(2PI x/lambda)			
2	0	0			Amplitude
3	0.1	0.618033989			Wavelength
4	0.2	1.175570505			
5	0.3	1.618033989			
6	0.4	1.902113033			
7	0.5	2			
8	0.6	1.902113033			
9	0.7	1.618033989			
10	0.8	1.175570505			
11	0.9	0.618033989			
12	1	2.4503E-16			
13	1.1	-0.618033989			
14	1.2	-1.175570505			

★ Select all the values of x and the function as shown. Then, click “Insert” tab to choose “Scatter.”; and then, select “Scatter with only Markers.” Then click “Finish” to plot.



★ The plot looks as shown.

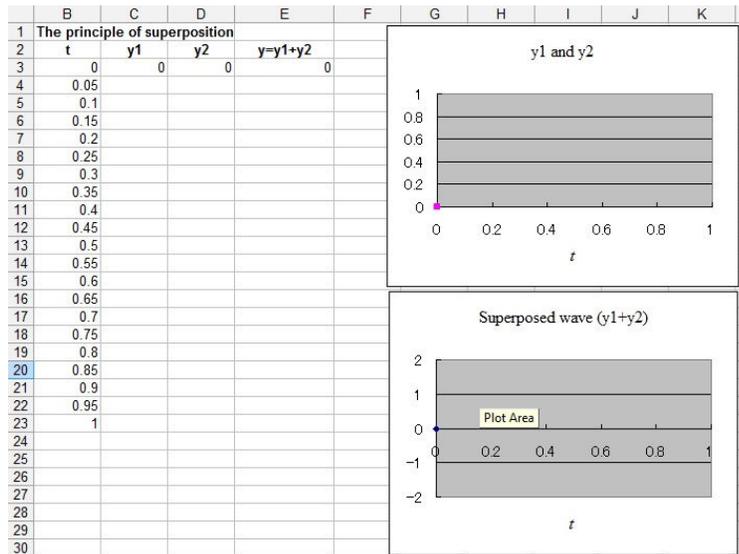
Questions:

- ① Change the value of the amplitude with the same wavelength. How will the shape of the wave be changed?
- ② Change the value of the wavelength with the same amplitude. How will the shape of the wave be changed?

3. The Principle of Superposition

Click the tab, Superposition. The initial spreadsheet looks as follows:

◆ Constructive interference



★ Click the cell C3 and check if the equation expressed is $\text{SIN}(2*\text{PI}()*\text{B3})$. B3 is the time. The amplitude and frequency are 1 in this case.

★ Click also the cell D3 and check if the equation expressed is the same as C3.

★ E3 is the sum of waves, y1 and y2. (Superposition)

	B	C	D	E
1	The principle of superposition			
2	t	y1	y2	y=y1+y2
3	0	0	0	0
4	0.05	0.309017	0.309017	0.618033989
5	0.1	0.587785	0.587785	1.175570505
6	0.15	0.809017	0.809017	1.618033989
7	0.2	0.951057	0.951057	1.902113033
8	0.25	1	1	2
9	0.3	0.951057	0.951057	1.902113033
10	0.35	0.809017	0.809017	1.618033989
11	0.4	0.587785	0.587785	1.175570505
12	0.45	0.309017	0.309017	0.618033989
13	0.5	1.23E-16	1.23E-16	2.4503E-16
14	0.55	-0.30902	-0.30902	-0.618033989
15	0.6	-0.58779	-0.58779	-1.175570505
16	0.65	-0.80902	-0.80902	-1.618033989
17	0.7	-0.95106	-0.95106	-1.902113033
18	0.75	-1	-1	-2
19	0.8	-0.95106	-0.95106	-1.902113033
20	0.85	-0.80902	-0.80902	-1.618033989
21	0.9	-0.58779	-0.58779	-1.175570505
22	0.95	-0.30902	-0.30902	-0.618033989
23	1	-2.5E-16	-2.5E-16	-4.90059E-16

★ Drag down to obtain the values for all and check if you have a proper plot.

Questions: Describe the superposed wave. How is the amplitude changed? How about the frequency? Does the result make sense to you?

◆ Destructive interference [Right click on the tab, “superposition” and select “Move or Copy.” Check “Create a copy” to duplicate the sheet so you can keep the previous result.]

- ★ Keep everything else except y2. Click D3 to change the equation.
- ★ The original is $\text{SIN}(2*\text{PI}()*\text{B3})$. Add a phase shift by 180° which is PI radians.
- ★ Namely, it will be $\text{SIN}(2*\text{PI}()*\text{B3}+\text{PI}())$.
- ★ Then, drag it down again to obtain the new values. Then, check the plots.

Questions: Describe the superposed wave. How is the amplitude changed? How about the frequency? Does the result make sense to you?

Lab report: Write the introduction, conclusions and discussion. Answer the questions to your report. Copy and paste only the plots in sections 2 (two plots) and 3 (constructive and destructive interferences).