Modeling Data in Excel

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Section 8

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Introduction

Motivation:

Perceiving the flexibility and importance of spreadsheets in modeling data.

Objectives:

1. Calculating volumes and surface areas of cones using spreadsheets.
2. Viewing the obtained results in form of graphs.
3. Using Mathtype to demonstrate the mathematical equations.

Overview:

In this document we are interested in calculating the volume and surface area of a cone while being able to change inputs (i.e heights and radii). This task can be done in several ways including the usage of a programming language, spreadsheets etc… In what follows, we are going to use spreadsheets to perform the task since these require much less skills than programming.

Outline

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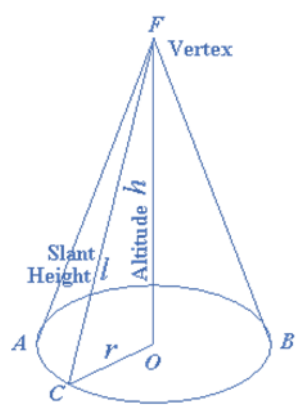
Background

"A cone is a solid figure generated by a line, one end of which is fixed and the other end describe a closed curve in a plane. A circular cone is a solid figure whose base is a circle and whose lateral surface area (i.e. curved surface area) tapers uniformly to a point: which is called the vertex or apex. The axis of the cone is a straight line drawn from the vertex to the center of the base. A right circular cone is a cone whose base is a circle and whose axis is perpendicular to the base. Such a cone can also be described as solid formed by a right triangle rotated about one of its sides as an axis; it may, therefore, be called a cone of revolution. The figure below represents a right circular cone." [1]



In the next sections we will be dealing with right circular cones for the purpose of simplicity.

Work Description

Cone Equations: [2]

The general formula of a cone in the xyz plane is $z=\sqrt{x^2+y^2}$ *where* $x=r=$ *radius*

According to Fubini's Theorem the volume of the cone $h=\sqrt{x^2+y^2}$

where h is the elevation (height) is given by $\int_{-h}^{h}\int_{-\sqrt{h^2-x^2}}^{\sqrt{h^2-x^2}}\sqrt{x^2+y^2}\,dydx$

Double integrating would give $\boxed{V=\frac{1}{3}\pi\, x\, r^2\, x\, h}$

Similarly, the surface area of the cone is given by $S=\int_{-h}^{h}\int_{-\sqrt{h^2-x^2}}^{\sqrt{h^2-x^2}}1\,dydx$

Double integrating yields $\boxed{S=\pi\, x\, r\, x\sqrt{r^2+h^2}}$

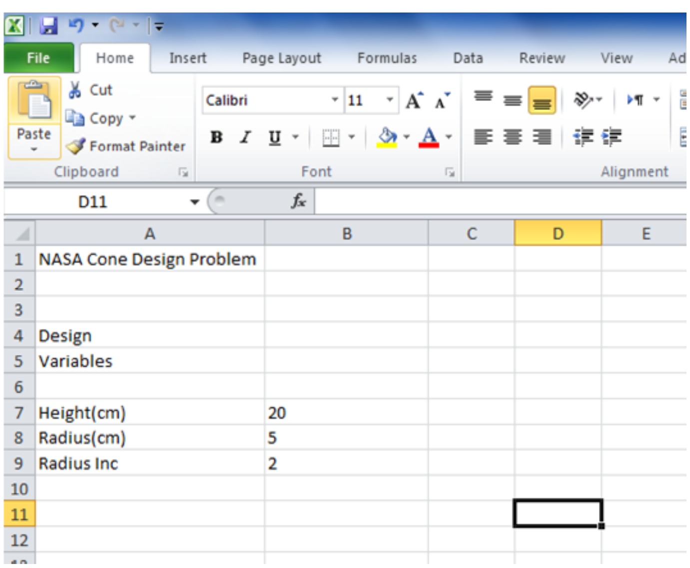
Development of the model:

(Assuming the user is familiar with inputting data in Excel, if not refer to the appendix)

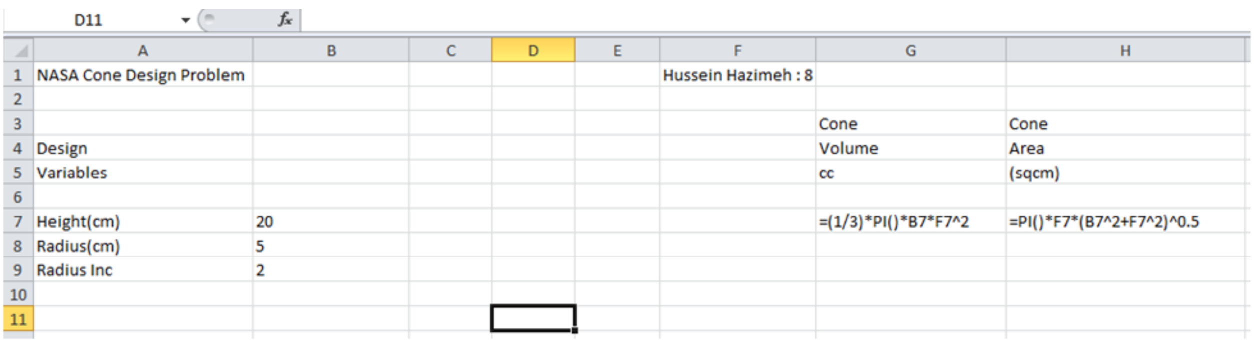
The Microsoft Excel spreadsheet should be organized to be easily read by others.

Reserve the left-hand side to enter the project's tile and input variables (i.e radius and height).

The spreadsheet should look similar to the figure below:



Now we will reserve the right-hand side for the author's name and outputs (i.e Volume and area of the cone). The formula of the volume should be entered in the cell as: "=(1/3)*pi()*B7*F7^2" (excluding quotations). Moreover, the formula of the area should be entered as "=pi()*F7*(B7^2+F7^2)^0.5". To see the formulas instead of values in the output cells, click on "Show Formulas" button in the "Formulas" tab. For now, the spreadsheet looks like below:



Try changing the input variables and you should be able to see the change in cells G7 and H7 representing the volume and area respectively.

Useful Tools in Excel:

In order to get the output values over an incremented set of input, it is essential to have an overview about "Absolute Addresses" in Excel. Normally, if we expand the formula B1=A1+A2 to B2 and B3 using the "fill handle", then B2=A2+A3, B3=A3+A4 (Just an example for sake of simplicity). This is because Excel uses "Relative Addresses" in default. However, if we want to increment A2 only and keep A1 the same, we should change A1 into an absolute address. To change A1 to an absolute address surround A1 by $ signs (i.e $A$1).

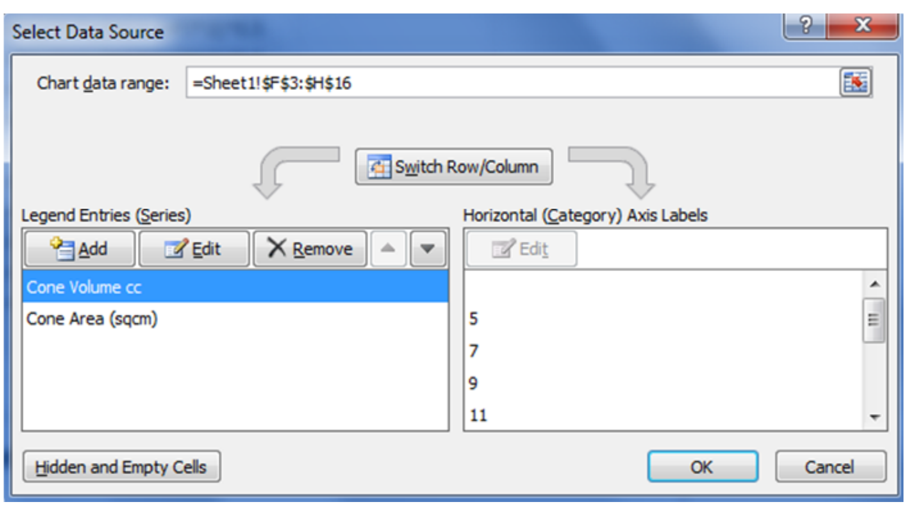
Now add an “increment” input for the radius and increment the radius over 10 values.

Then update the equations before to ones with absolute addresses to obtain the following:

	A	B	C	D	E	F	G	H
1	NASA Cone Design Problem					Hussein Hazimeh : 8		
2								
3						Cone	Cone	Cone
4	Design					Radius	Volume	Area
5	Variables					cm	cc	(sqcm)
6								
7	Height(cm)	20				=B8	=(1/3)*PI()*$B$7*F7^2	=PI()*F7*($B$7^2+F7^2)^0.5
8	Radius(cm)	5				=F7+$B$9	=(1/3)*PI()*$B$7*F8^2	=PI()*F8*($B$7^2+F8^2)^0.5
9	Radius Inc	2				=F8+$B$9	=(1/3)*PI()*$B$7*F9^2	=PI()*F9*($B$7^2+F9^2)^0.5
10						=F9+$B$9	=(1/3)*PI()*$B$7*F10^2	=PI()*F10*($B$7^2+F10^2)^0.5
11						=F10+$B$9	=(1/3)*PI()*$B$7*F11^2	=PI()*F11*($B$7^2+F11^2)^0.5
12						=F11+$B$9	=(1/3)*PI()*$B$7*F12^2	=PI()*F12*($B$7^2+F12^2)^0.5
13						=F12+$B$9	=(1/3)*PI()*$B$7*F13^2	=PI()*F13*($B$7^2+F13^2)^0.5
14						=F13+$B$9	=(1/3)*PI()*$B$7*F14^2	=PI()*F14*($B$7^2+F14^2)^0.5
15						=F14+$B$9	=(1/3)*PI()*$B$7*F15^2	=PI()*F15*($B$7^2+F15^2)^0.5
16						=F15+$B$9	=(1/3)*PI()*$B$7*F16^2	=PI()*F16*($B$7^2+F16^2)^0.5
17								

We can easily infer that for every value of incremented radius we obtain the corresponding volume and area.

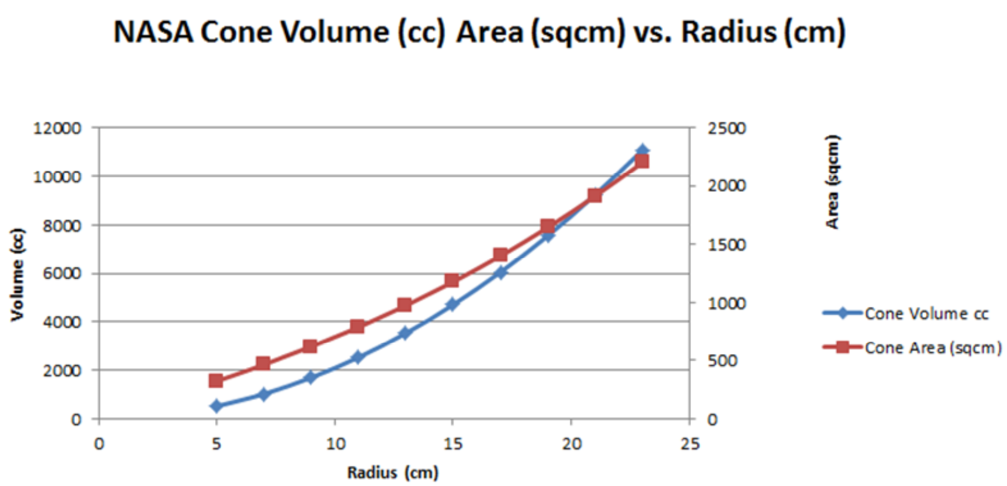
Another important tool in Excel is that of charts. We are interested in plotting the volume and area as the function of the incremented radius. To do this, insert “Scatter with smooth lines and Markers” chart from the “Scatter” tab in the “Insert” menu. Now click on “Select Data” button and choose the cells between F3 to H16 obtaining the following:



To label each axis, click on “Axis Titles” in “Layout” menu of the chart tools. In addition you might find other tools like “legend” and “chart title” useful for labeling purposes.

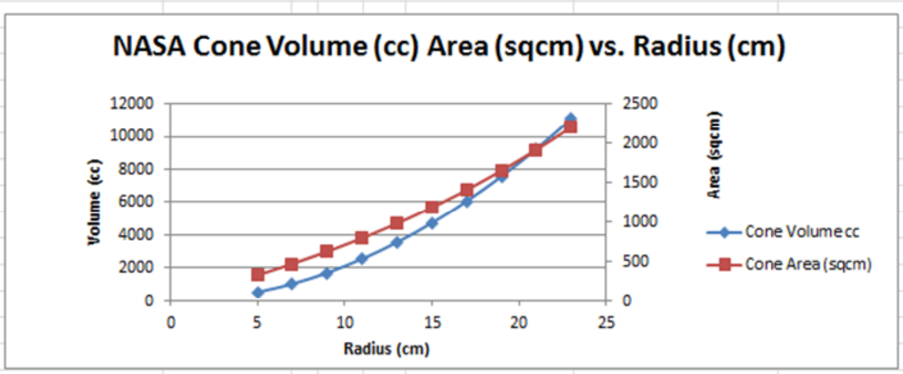
Results

After performing the above tasks the chart will look similar to what follows:



The overall spreadsheet will look similar to:

	A	B	C	D	E	F	G	H
3						Cone	Cone	Cone
4	Design					Radius	Volume	Area
5	Variables					cm	cc	(sqcm)
6								
7	Height(cm)	20				=B8	=(1/3)*PI()*$B$7*F7^2	=PI()*F7*($B$7^2+F7^2)^0.5
8	Radius(cm)	5				=F7+$B$9	=(1/3)*PI()*$B$7*F8^2	=PI()*F8*($B$7^2+F8^2)^0.5
9	Radius Inc	2				=F8+$B$9	=(1/3)*PI()*$B$7*F9^2	=PI()*F9*($B$7^2+F9^2)^0.5
10						=F9+$B$9	=(1/3)*PI()*$B$7*F10^2	=PI()*F10*($B$7^2+F10^2)^0.5
11						=F10+$B$9	=(1/3)*PI()*$B$7*F11^2	=PI()*F11*($B$7^2+F11^2)^0.5
12						=F11+$B$9	=(1/3)*PI()*$B$7*F12^2	=PI()*F12*($B$7^2+F12^2)^0.5
13						=F12+$B$9	=(1/3)*PI()*$B$7*F13^2	=PI()*F13*($B$7^2+F13^2)^0.5
14						=F13+$B$9	=(1/3)*PI()*$B$7*F14^2	=PI()*F14*($B$7^2+F14^2)^0.5
15						=F14+$B$9	=(1/3)*PI()*$B$7*F15^2	=PI()*F15*($B$7^2+F15^2)^0.5
16						=F15+$B$9	=(1/3)*PI()*$B$7*F16^2	=PI()*F16*($B$7^2+F16^2)^0.5



Discussion of Results:

i. The chart reveals that the volume and surface area of a cone are exponential in growth.
ii. It also shows the radius in which the volume is equal to the area (point of intersection of the 2 curves).
iii. One more important result is the ability to approximate graphically the volume or surface area at any radius, without using any additional computing resources!

Conclusion

To sum up, were able to implement equations and charts in Microsoft Excel to perform calculations and tabulations. It would be a good idea to try to perform the preceding task using a programming language. For example, a PHP based script is able to calculate the volume and surface area of a cone as illustrated on “http://www.calculatorsoup.com/calculators/geometry-solids/cone.php” [3]

References

1- “Introduction to Cone”.2008.Emathzone.com.Web.07 Dec, 2010.

2- Thomas, George. “Thomas Calculus”.Ed.Deirdre Lynch.12th ed.United States: Pearson, 2010.841-848.Print.

3- “Right Circular Cone Calculator”. Calculatorsoup.com.Web. 07 Dec, 2010.

4- “Basic tasks in Excel 2010”.2010. Office.microsoft.com.Web.07 Dec, 2010.

Appendix

To get more familiar with Microsoft Excel you can use “Microsoft Office Help” or “Getting Started” button located in the support submenu of the help. If you use “Getting Started” then you will be redirected to a webpage (office.microsoft.com) indicating all the basic features of Excel. [4]