Ÿ Lab 1: Beginning to use Mathematica

In this lab, you will learn how to use Mathematica as an ordinary calculator, how to write functions in *Mathematica*, and how to integrate and differentiate functions. At the end of the lab you should be able to use the following comands:

f[x_]:=...
D[f, x] - The derivative of a function f with respect to x
Integrate[f, x] - The indefinite integral of f with respect to x
Integrate[f, {x,a,b}] - The definite integral of f with respect to x between a and b

You should do the following problems:

(1) Calculate 4 to the power 100, the 50th root of 10,000,000, the logarithm of the logarithm of the logarithm of 100.

(2) To define functions of a variable x you have to use the construct
f[x_]:=...

For example, to define the function 'squareroot of x' , you type:

f[x]:=Sqrt[x]
(note the capital S in Sqrt[ ]!)

Once a function is defined in that way, you can evaluate it at different values of the variable x, by simply typing f[3.1], f[5.2], etc. Define the function 'squareroot of x' as above, and use it to calculate the squareroots of 5, 20, 1,000,000.

(3) Use the command D[f,x] to take the derivative with respect to x of the following functions. Note that you can either use the command directly by typing e.g. D[4x^3,x], or you can first define a function f by typing f[x_]:=4x^3, and then using D[f,x].

4x^3
Exp[4x^3]
Log[x^5]
Sin[Sqrt[x]]

(4) Find the indefinite integral of the following functions with respect to x:

4x^3
Exp[4x^3]
Log[x^5]
Sin[Sqrt[x]]

(5) Find the definite integral of the following functions between x=0 and x=1

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4x^3
Exp[4x^3]
Log[x^5]
Sin[Sqrt[x]]
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(6) Try to find an integral that Mathematica cannot solve!

(7) In a beehive, each cell is a regular hexagonal prism, open at one end with a trihedral angle x at the other end. It is believed that bees form their cells in such a way as to minimize the surface for a given volume, thus using the least anount of wax in cell construction. Based on the geometry of the cell, it can be shown that the surface area S, as a function of the angle x, is given by

S=6*s*h - (3/2)*s*s*Cot[x]+(3*s*s*Sqrt[3]/2)*Csc[x].

Here s and h are constsnts determining the shape of the cell. (Recall form Calculus that the cosecant function Csc[x] is defined as Csc[x]=1/Sin[x].)

a) Calculate dS/dx

b) How would you determine the angle x that the bees prefer?