Introduction to doing mathematics on the computer using <u>Sagemath</u>

Warm-up

Your instructor will give you a quick, live demonstration of Sagemath. A quick-reference guide is <u>here</u>. You can watch some very short videos about this all here: <u>Why Sagemath?</u> <u>Basic number crunching</u>, <u>using variables</u>, <u>plotting</u>.

Do this

1. Log on to your cloud.sagemath.com account. If you haven't already, click the big blue "New Project" button and make a project called 'phys133' or something like that.

2. Next, click on your new project name when it appears in the list. Then click on the "Create or Import a File, Worksheet…." link. Lastly, click on the "Sage Worksheet" button. You will be greeted with a blank screen that you may use to being doing math.

3. To start, perform some basic arithmetic calculations. Note the computer only evaluates math when you press [Shift]-[Enter] after a line. So on a new line, type 2+2 then press [Shift]-[Enter]. You should get 4. Try a few other simple math problems.

4. Experiment with + (addition), - (subtraction), * (multiply), / (divide), and ^ (for exponent). Use the "e" notation for scientific notation, as in $9x10^9$ would be put in as 9e9 (e means $\times$ 10). Avagadro's number would be put in as 6.02e23. Try 9e9*(10e-9)^2/0.1^2, which would be the force beteween to 10nC charges 10 cm apart. Try to visualize doing math *without using your calculator at all.*

5. Test the ability to define and use variables. Try this:
   > a=2 [Shift]-[Enter]
   > b=5 [Shift]-[Enter]
   > a+b [Shift]-[Enter]
   > a^b [Shift]-[Enter]
   > a/b [Shift]-[Enter]

6. Now, do #5 and #6 on your homework.

Algebra

Try these (press [Shift]-[Enter] after each line)

> expand((x+5)^4)
> typeset_mode(True)   Note: your output should look like "real math" now.
> expand((x+1)^20)
> factor(x^2+4*x+4)
> factor(x^2+3*x-4)
> solve(2*x+50*x-10==0,x)
> solve(2*x^2+5*x+3==0,x)   Note: Quick solution to a quadratic equation.

plot(sin(x),(x,-5,5))   Note: Plot sin(x) from -5 to 5.

Note on computers, a single = sign means assignment as in a=5 (put the value of 5 into a). Two equal signs == mean "test for equality" 3==5 which would evaluate to true or false. The == is also used with solving equations, as in solve(2*x^2+5*x+3==0,x), which means "find values of x that make the equation equal to 0."

The Race

Get someone in your group on their calculator. The other on Sagemath. Use Coulomb's Law to compute the force between a 5nC and 3nC change, which are 50cm apart.   On a 3-2-1 "go" command, have both the calculator person and the Sagemath person work to find answer to this problem. See who finishes first.

OOPS! The charges were supposed to be 10cm apart. See how quickly the calculator and Sagemath people can get in, make a change, then recompute the result.

Next, consider the quadratic the equation $x^2 + 3x - 4 = 0$ On a 3-2-1 "go" command, have both the calculator person and the Sagemath person work to find solutions to this equation. Who finishes first?

Repeat the race, but now have them race to plot the function $y = x^2 + 3x - 4$ from -10 to 10 and identify zeros from the graph.

Research Project

After reading the section on "Defining Functions" in the tutorial, can you define a function F(q1,q2,r) that will tell you the force between two charges q1 and q2 that are a distance r away? Test it for a few cases. Verify the results with your calculator.