

# A Brief Mathematica Tutorial

## Part 1: Arithmetic and Simple Algebra

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### Objective

In this project we discuss some of the arithmetic and algebraic capabilities of Mathematica. Since Mathematica can be run on different types of computers and under different operating systems, and since the choice of computer and operating system used for this and future projects is yours, we make minimal platform-specific comments. Questions regarding specific platforms — including how to get Mathematica up and running, how to edit, save, and print — are left to you to resolve.

### Narrative

Mathematica combines the features of a computer algebra system with those of graphing software in one package. In this project you'll learn about some of Mathematica's basic arithmetic and algebraic features; in the next project you'll learn about some of its graphing features. To complete this project you must be able to get Mathematica up and running, edit, save, and print.

### Task

Once you have Mathematica up and running, type the command lines in the left-hand column below into Mathematica in the order in which they are listed. For the first command line, for example, type “(\* Your name and today's date \*)” (without the quote marks) into Mathematica; then, while holding down the Shift key on your keyboard, hit the Enter key. Mathematica will automatically add the “In[1] := ”, but no output will appear since this is a comment. (Comments clarify your code but they do not affect computation. It is wise, for many reasons, to document your code with at least your name, the date of your work, and the project title. You will, in fact, be asked to do this throughout these projects.) No output will appear after you type and enter the second comment line, but output should appear after you type and comment the third command line.

The effect of each command is described in the right-hand column for your reference; *do not* type what is written in the right-hand column into Mathematica! If your output does not agree with what is written in the right-hand column, then you've probably made a mistake; in this case, check what you've written: you must go back and correct your mistake before going on! A red error message also reflects a mistake that must be corrected before going on! Your lab report will be a hard copy of your typed input and Mathematica's responses.

In[1] := (* Your name and today's date *)	This is a comment. Comments clarify your code but they do not affect computation. Type <i>your</i> name and today's date.
In[2] := (* Arithmetic and Simple Algebra *)	This is the project title.
In[3] := 7+2	Add 7 and 2.
In[4] := 7+2;	Add 7 and 2, but suppress the output.
In[5] := 7-2	Subtract 2 from 7.
In[6] := 7*2	Multiply 7 and 2.
In[7] := 7/2	Divide 7 by 2, expressing the answer as a fraction.
In[8] := 7./2	Divide 7 by 2, expressing the answer as a decimal.
In[9] := 1/2+3	Add 1/2 and 3.
In[10] := 1/(2+3)	Note the difference between this and the last line. The moral: watch your parentheses!
In[11] := N[%%, 4]	Write the number you got 2 responses ago to 4 digits.

In[12] := <b>Pi</b>	Write $\pi$ .
In[13] := <b>N[% , 4]</b>	Write $\pi$ to 4 digits.
In[14] := <b>N[Pi, 40]</b>	Write $\pi$ to 40 digits.
In[15] := <b>N[PI, 40]</b>	Note that Mathematica distinguishes PI from Pi: Mathematica is <i>case sensitive</i> .
In[16] := <b>x = 5</b>	Let $x = 5$ .
In[17] := <b>x^2</b>	Find $x^2$ .
In[18] := <b>x^(1/2)</b>	Find $x^{1/2}$ .
In[19] := <b>Sqrt[x]</b>	You can also write $x^{1/2}$ as <b>Sqrt[x]</b> .
In[20] := <b>N[%]</b>	Write the number in the last response as a decimal.
In[21] := <b>Clear[x]</b>	Clear the value stored in memory for $x$ .
In[22] := <b>x^2</b>	Write $x^2$ .
In[23] := <b>20!</b>	Write 20! (“20 factorial”).
In[24] := <b>p=(x-4)(3x+2)</b>	Let $p = (x - 4)(3x + 2)$ .
In[25] := <b>Expand[%]</b>	Expand the previous result.
In[26] := <b>Factor[%]</b>	Factor the previous result.
In[27] := <b>Solve[p==0,x]</b>	Solve the equation $p = 0$ for $x$ .
In[28] := <b>Solve[{x+y==1, x-y==0}, {x,y}]</b>	Solve the equations $x + y = 1$ and $x - y = 0$ for $x$ and $y$ .

At this time, make a hard-copy of your typed input and Mathematica’s responses; this hard-copy will be your lab report.

### Comments

- As you work through this and subsequent projects, think about what you’re doing: think about what you’re typing, why you’re typing it, and what you are — or should be — getting as output. Errors often arise from simple typographical mistakes, and one of the best indicators that you’ve made a typographical mistake is that you’re getting output that is not what it should be.
- Lists are an important structural form in Mathematica. A list is designated by and appears in the form of “**{entry 1, entry 2, ...}**”. For example the following code defines the list L to be **{a, b, c}**, and then extracts the first element of L.

```
In[1] := L = {a, b, c}
In[2] := L[[1]]
```

The entries of a list can be more than just real numbers. For example, the following code assigns the value 1 to **a** and 2 to **b** in one line of code by using a list:

```
In[1] := {a=1, b=2}
```

- As indicated above, one way to put two or more commands on one **In**-line of Mathematica code is to put them in a list. Another way is to hit the Return key at the end of a line (instead of Shift-Enter), and the Shift-Enter only at the end of the second line when you are ready to have Mathematica execute the entire **In**-line. You can, more generally of course, add several lines to an **In**-line command by hitting the Return key at the end of each line, and the Shift-Enter only at the end of the last line when you are ready to have Mathematica execute the entire **In**-line.
- In summary, observe that in Mathematica:
  - A semicolon “;” suppresses output.

- (b) A number such as “ $7/2$ ” is treated as a fraction, but “ $7./2$ ” is treated as a decimal. And the decimal point that establishes this difference can be introduced anywhere in the fraction; i.e., “ $7/2.$ ” produces the same results as “ $7./2$ ”.
- (c) The function “**N**” converts a fraction into a decimal.
- (d) A percent sign “**%**” refers to the previous result.
- (e) Names are case sensitive.
- (f) The first letter in the name of constants such as  $\pi$  and  $e$  (“**Pi**” and “**E**”) is always capitalized.
- (g) The first letter of a built-in function name (such as “**N**”, “**Sqrt**”, and “**Clear**”) is capitalized, and brackets (that is, “[” and “]”) are used to identify the argument of a function. Parentheses (that is, “(” and “)”) are used only for grouping.
- (h) Multiplication signs “**\***” are not mandatory. On the other hand a multiplication sign — or at least a space — must be inserted between the **x** and **y** of the product **x\*y** to distinguish it from the (single) variable **xy**.
- (i) A single “**=**” is used to assign a value to a constant or unknown, and a double “**==**” is used for the equality of an equation.