Activity 1: Typing Special Characters

Formatting Cheat-Sheet

Specially Formatted Characters:

Unofficial Name	How to type it	Symbol
Arrow	"->"	→
Other Arrow	":>"	:→
Fractions	Ctrl + /	$\frac{\square}{\square}$
Superscripts & Exponents	Ctrl + 6	$\square^{\square}$
Subscripts	Crtl + -	$\square_{\square}$
Square Root	Ctrl + 2	$\sqrt{\square}$
Double equals	"=="	==
Not Equal	"!="	≠

Useful ⋮esc⋮ characters

Note: The "⋮" symbol represents the escape key

Also note: These tend not to work on remote desktop! Which is the main reason why shouldn't try to use it!!

Unoffical Name	How to type it	Symbol	Additonal Notes
Partial Derivative	"⋮pd⋮"	∂	Differntiation variable is set with s
Indefineite Intergals	"⋮intt⋮"	$\int \square \times d\square$	
Defineite Intergals	"⋮dintt⋮"	$\int_{\square}^{\square} \square \times d\square$	
Sums	"sumt"	$\sum_{\square=\square}^{\square} \square$	
Product Notation	"⋮prodt⋮"	$\prod_{\square=\square}^{\square} \square$	
Gradient	"⋮grad⋮"	$\nabla_{\square} \square$	Subscript is for differetiation variables, s https : // reference.wolfram.com / language /
Laplacian	"⋮del2⋮"	$\nabla^{2}_{\square} \square$	Subscript is for differetiation variables, s https : // reference.wolfram.com / language / Laplacian
Divergence	"⋮del.⋮"	$\nabla_{\square} . \square$	Subscript is for differetiation variables, https : // reference.wolfram.com / language
Curl	"⋮delx⋮"	$\nabla_{\square} \times \square$	Subscript is for differetiation variables, s https : // reference.wolfram.com / language /
Infinity	"⋮inf⋮"	∞	
Pi	"⋮inf⋮"	π	
Euler ' s e	"⋮ee⋮"	ⅇ	
Complex i $\left(\sqrt{-1}\right)$	"⋮ii⋮"	ⅈ	
Transpose	"⋮tr⋮"	$^{\mathsf{T}}$	
Element of	"⋮elem⋮"	$\in$	
Degrees	"⋮deg⋮"	$^{\circ}$	For angles not temperatu
Distributed by	"⋮dist⋮"	$\approx$	Not too common, but very usefull if you ' r
Logical Operators	"⋮and⋮"	$\wedge$	Same for or, xor, nor, nan
Greek letters	"⋮alpha⋮"	α	Works for pretty much any gree
Sqiggly	"⋮xi⋮"	ξ	Also a greek letter, but he ' s our
Double Struck Letters	"⋮dsN⋮"	$\mathbb{N}$	Just type ds before any normal letter (upp
Many many many more			https : // reference.wolfram.com / language / gui

Tables, matrices and Piecewise functions

Matrices: To make a matrix type () and then hit Ctrl+, followed by Ctrl+Enter while your cursor is between the two parenthesis

Hitting Ctrl+, will add a new column and hitting Ctrl+Enter will add a new row

Tables: Go to insert at the top of the screen, click table, then click New...

Hitting Ctrl+, will add a new column and hitting Ctrl+Enter will add a new row

Piecewise functions: First type “⋮pw⋮” then hit Ctrl+,

Pressing Ctrl+, again will add more rows. Ex:

$$\begin{cases} 0 & x < 0 \\ 1 & \text{True} \end{cases}$$

The activity!

The point of this activity is to give you some first hand experience interacting with the special formatting in Mathematica.

Above is a list of ways to type common symbols. Feel free to reference it while trying to type out the below expressions, but try to do as much as you can from memory, and definitely don't just copy-paste from the tables!!!

First make a new "Wolfram Language Input" cell below this, and try to type out the following expressions! You can type them all in one cell if you want, but it will make it a lot easier to read if you make a new cell below each example.

1) First let's revisit my favorite internal to get some practice typing integrals, exponents and fractions.

$$\int_{-\infty}^{\infty} \frac{\text{Cos}[x]}{x^2 + 1} \, dx$$

2) Now let's try an indefinite integral

$$\int \frac{1}{\sqrt{1 - x^2}} \, dx$$

3) Then let's try Graphing the 10-term Taylor approximation of the sin function to practice typing arrows, Pi, and sums!

$$\text{Plot}\left[\text{Evaluate}\left[\left\{\text{Sin}[x], \sum_{n=0}^{10} \frac{(-1)^n \, x^{2n+1}}{(2n+1)!}\right\}\right], \{x, -5\pi, 5\pi\}, \text{PlotStyle} \to \{\text{Automatic}, \text{Dashed}\}\right]$$

4) Now let's have Mathematica do some differential calculus for us (eat your heart out symbol lab!)

Here we simply take the third derivative of the Gaussian Error function which symbol lab refuses to do

$$\text{Simplify}[\partial_{x,x}\text{Erf}[x]]$$

5) But that was too easy, now let's do some algebra and calculus at the same time

Here we're going to find where the second derivative of the erf function has local mins and maxes by finding the values of x at which the third derivative of erf is zero. This would be really annoying to do by hand.

(Make sure to type the double equals properly!!)

```
Solve[∂x,x,x Erf[x] == 0, x]
```

6) Next let’s do some linear algebra

Here we’re gonna feed a two dimensional vector into the product of a matrix and its transpose

$$\text{MatrixForm}\left[\begin{pmatrix} a & b \\ c & d \\ e & f \end{pmatrix}^{T} . \begin{pmatrix} a & b \\ c & d \\ e & f \end{pmatrix} . \begin{pmatrix} \alpha \\ \beta \end{pmatrix}\right]$$

7) Of course, Mathematica can also do much crazier things like symbolic row reduction too

$$\text{MatrixForm}\left[\text{Simplify}\left[\text{RowReduce}\left[\begin{pmatrix} 1 & 2 & 3 & a \\ -a & 3 & 5 & b \\ 10 & \frac{b}{a} & 4 & c \end{pmatrix}\right]\right]\right]$$

8) It can also handle complex numbers in any situation

$$\text{Simplify}\left[\int_{-\pi}^{\pi} \text{Sin}[n\, x]\, e^{-x\,\omega\, i}\, dx,\ \text{Assumptions} \rightarrow \{n \in \text{Integers}\}\right]$$

9) Next let’s type and graph a piecewise defined function

$$\text{Plot}\left[\begin{cases} x^2 & x \le 5 \\ \text{Sin}[10\, x] & 5 < x < 7 \\ x & x > 7 \end{cases},\ \{x, 0, 10\}\right]$$

10) And finally, let’s compute the gradient of a 2-variable function

$$\text{Simplify}\left[\nabla_{\{x,y\}} \text{Sin}\left[x^2 + y^2\right]\right]$$

Activity 2: Common Pitfalls

Part1:

The goal of this activity is to go over some common things which tend to make Mathematica a bit hard for beginners.

Before we get into specifics though, I first need to explain the kernel, which we’ll also do by way of example.

Below this are three cells which I’ve labeled with comments

For this example, evaluate the cells in the following order:

i) First Evaluate cell 1

ii) Then Evaluate Cell 2

iii) Now Evaluate Cell 1 again

iv) Now Evaluate Cell 3

v) Finally Evaluate Cell 1 again

```
(*Cell 1*)
a + b
```

```
(*Cell 2*)
a = 2;
```

```
(*Cell 3*)
b = 2;
```

Key Takeaway:

Part2:

So now we've seen that variables stick around whenever they're defined, but how far does that go?

1. Now try making a new notebook and seeing what a+b yields.

After you've done that, you've probably realized that variables stick around in potentially non-intuitive ways. They're completely global!

2. So how do we clear variables? Well, I could tell you but I think this is a perfect point to use the docs! So your next task is answering just this question, how can we clear a and b? When you figure it out, prove that it works in the cell below:

```
In[ ]:= a + b
```

Key Takeaway:

Part3:

The following cell is meant to solve a simple system of 3 equations for the variables K1, K2, and K3. However, there is a very simple mistake in the code. Before trying to fix it, however, first evaluate the cell to see what error it gives. Then **wait** for the rest of the class, don't try to fix it just yet.

Also, it's OK if you don't understand all the syntax being used below. We'll dive into NSolve, and Solve in future meetings. If you are curious right now tho, looking at the docs is always the best way to learn!

```
NSolve[{
  -0.007 = -K2/(1 + 30.4` K3),
  0.0007 = K1/(1 + 30.4` K3),
  K1 = 0.0328947368421052 (1 + 30.4 K2)/17.1
 }, {K1, K2, K3}]
```

Key Takeaway:

Part4:

For this next example, evaluate Cell 2 and then Cell 1 and then Cell 2 again

```
In[•]:= (*Cell 1*)
While[True];
```

```
In[•]:= (*Cell 2*)
RandomReal[]
```

Key Takeaway:

Part5:

Warning! Evaluating this next cell will freeze the kernel, and the GUI, and really *really* break everything

You've been warned... Now let's do it anyway:

```
In[•]:= Table[Rasterize[Graphics[Circle[]]], {i, 10000}, {i, 10000}];
```

Key Takeaway:

Part6:

First Evaluate the following cell (Don't worry, it shouldn't break anything this time)

Then place a semicolon at the end of the line and evaluate it again

```
In[•]:= circles = Table[Graphics[{RandomColor[], Disk[]}], {i, 10000}]
```

Key Takeaway:

Activity 3: Follow Along!

If we have extra time near end of the meeting I'll be going through a few other important and helpful topics, so you can use this section to follow along as we try things out!