Mathematica troubleshooting
Math 3350
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First rule of computer work: **DETAILS MATTER**

Computers are literal-minded, and do **exactly** what you **tell** them to do**.** It's critical to use very precise language.
In conversation with a human, I can write cos(x), Cos(x), cos[x], Cos[x], cos x, or Cos x, and the human will understand from context that I mean "cosine of x." A computer cannot understand anything from context. If the cosine function is defined to be Cos[x], a computer cannot understand that cos[x] is supposed to be a cosine, no matter how obvious it is to **you** that it's a cosine.

If, in an example, I have typed Integrate[Cos[x], x], you will only get the same results if you use **exactly** the same syntax, including spelling, capitalization, commas, brackets [] instead of parentheses (), and so on.

Capitalize built-in function names, and use brackets [] not parentheses () for function arguments

It's Cos[x], not cos[x], Cos(x), cos(x), or cos x.

cos[Pi] doesn't do anything, because the cos function is undefined.

  cos[Pi]

  $\cos(\pi)$

Try Cos[Pi] instead, which will evaluate $\cos\pi = -1$ correctly:

  Cos[Pi]

  -1

Use either Exp[x] or E^x for the exponential function e^x, not e^x.

  f[x_] = e^x

  e^x

Here are some examples of what will happen: derivatives and integrals won't be simplified correctly.

  Integrate[f[x], x]

  $\dfrac{e^x}{\log(e)}$

  D[f[x], x]

  $e^x \log(e)$

These calculations are actually correct, but they're not in the form you'd expect because *Mathematica* can't know that you intend the symbol "e" to mean the number $e \approx 2.718281828459045$. Because it doesn't know what is meant by "e", the

best it can do is leave $\log(e)$ in the expressions, unevaluated. The log of e is one, of course.

Instead, use E or the Exp[ ] function:

```
Integrate[Exp[x], x]
```

e^x

or

```
Integrate[E^x, x]
```

e^x

That's better.

Similar errors with familiar functions

What's wrong with

```
Integrate[Cos[pi x], {x, 0, 1}]
```

$\dfrac{\sin(\text{pi})}{\text{pi}}$

and

```
Integrate[cos[Pi x], {x, 0, 1}]
```

$\displaystyle\int_0^1 \cos(\pi x)\, dx$

and

```
Integrate[cos[pi x], {x, 0, 1}]
```

$\displaystyle\int_0^1 \cos(\text{pi}\, x)\, dx$

and

```
Integrate[Cos Pi x, {x, 0, 1}]
```

$\dfrac{\text{Cos}\,\pi}{2}$

and

```
Integrate[CosPix, {x, 0, 1}]
```
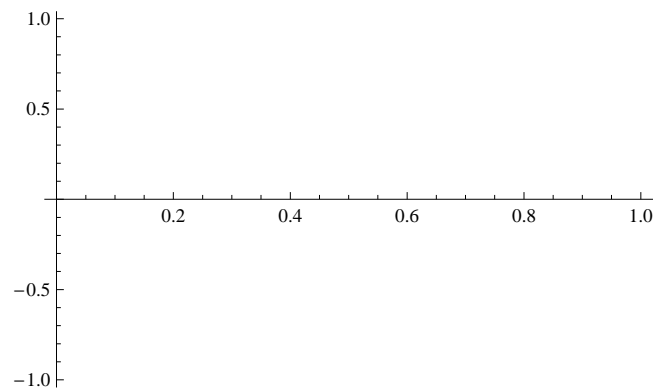
CosPix

Can you do the calculation correctly?

You can't plot a function with undefined symbols in it

If you see an empty plot, check for undefined symbols. For example,

```
ClearAll[a]
```
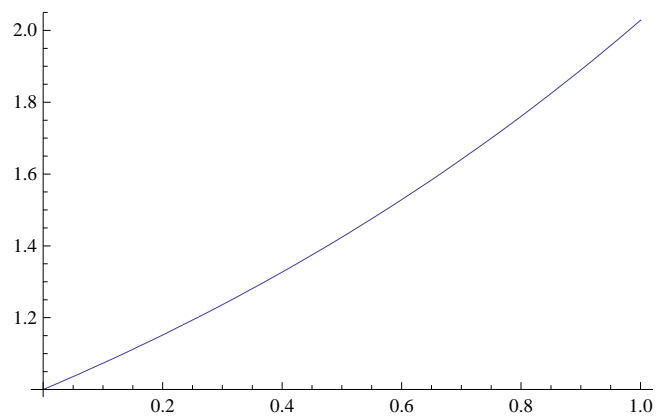
```
Plot[Exp[a x], {x, 0, 1}]
```


It's impossible to plot Exp[a x] because a hasn't been defined, and so the numerical values of e^{ax} can't be computed. If you give a a value, you can do the plot
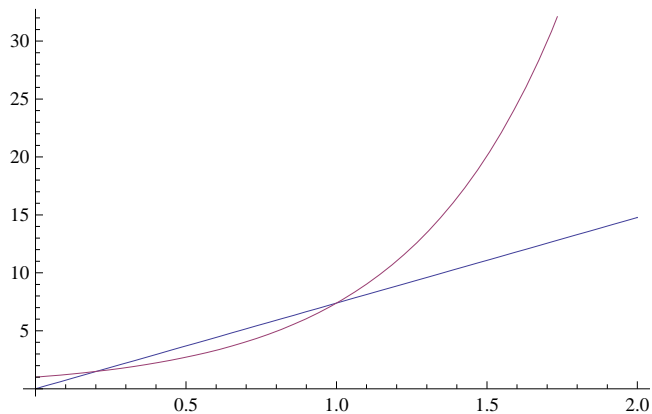
```
a = Sqrt[2] / 2
```

$$\frac{1}{\sqrt{2}}$$

```
Plot[Exp[a x], {x, 0, 1}]
```


Be careful with operator precedence

E^2 x and E^(2 x) are not the same, as you can see in the plot below

```
Plot[{E^2 x, E^(2 x)}, {x, 0, 2}]
```


Do you see what caused the problem?

I usually use Exp[z] instead of E^z, in part to help avoid this problem.

Trouble plotting derivatives

It's easy to differentiate

```
D[Sin[x], x]
```

$\cos(x)$

so you'd think it would be easy to plot a derivative
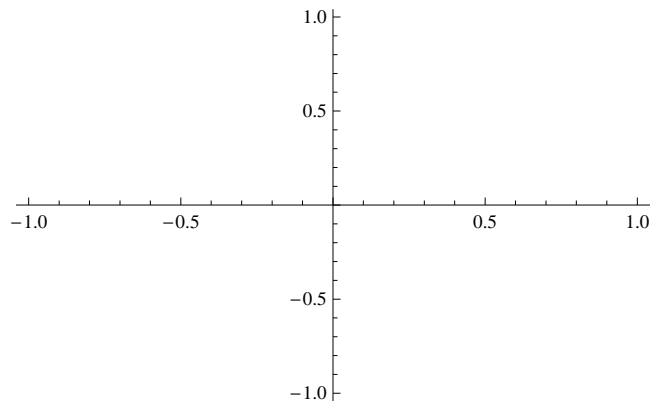
```
Plot[D[Sin[x], x], {x, -1, 1}]
```

```
General::ivar : -0.999959 is not a valid variable. ≫
```

```
General::ivar : -0.959143 is not a valid variable. ≫
```

```
General::ivar : -0.918326 is not a valid variable. ≫
```

```
General::stop :
 Further output of General::ivar will be suppressed during this calculation. ≫
```


Unfortunately, the "obvious" way to plot D[Sin[x], x] gave an error message about "not a valid variable." What went wrong? This is a *Mathematica* quirk: in doing a plot, it gives x a numerical value (say -0.99999), and then tries to compute D[Sin[x],x] with x=-0.9999. The derivative with respect to a *numerical value* is a nonsensical operation; you can only differentiate with respect to a *variable.* Hence, the error message about "not a valid variable."

So, how do you plot a derivative? Create a new function

    df[x_] = D[Sin[x], x]

$\cos(x)$

and plot df.

    Plot[df[x], {x, -1, 1}]