

Mathematica-Compatible Notebook

This notebook can be used on any computer system with Mathematica 3.0, MathReader 3.0, or any compatible application. The data for the notebook starts with the line of stars above.

To get the notebook into a Mathematica-compatible application, do one of the following:

- * Save the data starting with the line of stars above into a file with a name ending in .nb, then open the file inside the application;
- * Copy the data starting with the line of stars above to the clipboard, then use the Paste menu command inside the application.

Data for notebooks contains only printable 7-bit ASCII and can be sent directly in email or through ftp in text mode. Newlines can be CR, LF or CRLF (Unix, Macintosh or MS-DOS style).

NOTE: If you modify the data for this notebook not in a Mathematica-compatible application, you must delete the line below containing the word CacheID, otherwise Mathematica-compatible applications may try to use invalid cache data.

For more information on notebooks and Mathematica-compatible applications, contact Wolfram Research:

web: <http://www.wolfram.com>
email: info@wolfram.com
phone: +1-217-398-0700 (U.S.)

Notebook reader applications are available free of charge from Wolfram Research.

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(*CacheID: 232*)

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(*NotebookFileLineBreakTest
NotebookFileLineBreakTest*)
(*NotebookOptionsPosition[ 111936, 2397]*)
(*NotebookOutlinePosition[ 113082, 2433]*)
(* CellTagsIndexPosition[ 113038, 2429]*)
(*WindowFrame->Normal*)
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```
Notebook[{
Cell[CellGroupData[{
Cell[TextData[
StyleBox["A Gentle Introduction\nto ",
FontColor->RGBColor[1, 0, 0]],
StyleBox["Mathematica",
FontSlant->"Italic",
FontColor->RGBColor[1, 0, 0]],
StyleBox["",
FontSlant->"Italic"]
```

```

}], "Title",
  Evaluatable->False,
  AspectRatioFixed->True],

Cell[CellGroupData[{

Cell[TextData[{
  "What is Mathematica ?",
  StyleBox["",
    FontSlant->"Italic"]
}], "Section",
  Evaluatable->False,
  AspectRatioFixed->True],

Cell[TextData[{
  StyleBox["Mathematica",
    FontSlant->"Italic"],
  " is what is known as a ",
  StyleBox["Computer Algebra System, ",
    FontWeight->"Bold"],
  "or CAS for short.  Imagine a calculator which can not only add, subtract,
  \
multiply and divide numbers, and graph functions, but which can also simplify
  \
algebraic expressions, solve equations ",
  StyleBox["exactly, ",
    FontSlant->"Italic"],
  "and",
  StyleBox[" ",
    FontSlant->"Italic"],
  "compute derivatives and integrals symbolically, and you begin to have an \
idea of what CAS's are all about.\n\n",
  StyleBox["Mathematica",
    FontSlant->"Italic"],
  " is just one CAS among many:  Macsyma, Reduce, Maple, Axiom, Derive, etc.
  \
In the USC Mathematics Computing Labs you can use ",
  StyleBox["Mathematica",
    FontSlant->"Italic"],
  ", Maple, or Derive; related programs, MATLAB and Theorist are also \
available.  You are welcome to use any of these programs, but your professor
  \
is likely to make assignments based on only one."
}], "Text",
  Evaluatable->False,
  AspectRatioFixed->True]
}, Open  ]],

Cell[CellGroupData[{

Cell[TextData["How Do I Use Mathematica ?"], "Section",
  Evaluatable->False,
  AspectRatioFixed->True],

Cell[TextData[{
  "In the USC Mathematics Computing Labs you can use ",
  StyleBox["Mathematica",

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```

    FontSlant->"Italic"],
    " on any of the Macintoshes or PC clones which run Windows. In this \
introduction we will assume you are using a Macintosh, since those are the \
fastest computers we have.\n\nTo begin with, you should learn how to ",
    StyleBox["use ",
    FontWeight->"Bold"],
    "a Macintosh. The Macintosh operating system, as well as Windows, is based
\
on a ",
    StyleBox["graphical user interface ",
    FontWeight->"Bold"],
    "(GUI) which can be disconcerting if you're used to text-based, \
command-line user interfaces. If you've never used a Mac before, you should
\
start off with Macintosh Basics, a tutorial program which teaches you how to
\
point and click with the mouse, select regions, pull down menus, etc. Ask \
your TA to show you where Macintosh Basics is.\n\nFrom now on, we'll assume \
you know the basics of using a Macintosh. They're very easy, and GUIs have \
the tremendous advantage that they present a unified user interface. Once \
you've learned how to use one Mac program, you've learned how to use just \
about every Mac program, because they all do things the same way.\n\nYou \
begin ",
    StyleBox["Mathematica",
    FontSlant->"Italic"],
    " by ",
    StyleBox["double-clicking ",
    FontWeight->"Bold"],
    "the application, or by double-clicking an alias to ",
    StyleBox["Mathematica",
    FontSlant->"Italic"],
    ", or by double-clicking a file which was created with ",
    StyleBox["Mathematica",
    FontSlant->"Italic"],
    ". This lesson is an example; it's a Notebook created using ",
    StyleBox["Mathematica",
    FontSlant->"Italic"],
    ", and if you click its icon twice in rapid succession, ",
    StyleBox["Mathematica",
    FontSlant->"Italic"],
    " will start up and open the Notebook. It may a few seconds to start up, \
because it has a lot to do\[Ellipsis]"
}], "Text",
    Evaluatable->False,
    AspectRatioFixed->True]
}, Open ]],

Cell[CellGroupData[{

Cell[TextData["Hey, Where'd Everybody Go?"], "Section",
    Evaluatable->False,
    AspectRatioFixed->True],

Cell[TextData[{
    "What you see below this section is just the ",
    StyleBox["titles ",
    FontSlant->"Italic"],

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"of the next sections. The sections themselves are \"collapsed\" (and most
\
",
  StyleBox["Mathematica",
    FontSlant->"Italic"],
  " notebooks come that way, to help you see the structure of the notebook \
better). Do you see the lines along the right side of the screen? The \
collapsed sections have lines with little barbs on the end. Double-click the \
\
line with the barb to expand that section. Try it now with the next \
section."
}], "Text",
  Evaluatable->False,
  AspectRatioFixed->True]
}, Open ],

Cell[CellGroupData[{

Cell[TextData["OK, I've Got it Running. Now What?"], "Section",
  Evaluatable->False,
  AspectRatioFixed->True],

Cell[TextData[{
  "The first thing to notice is the scroll bar on the right side of this \
window. If you click the mouse on the small arrow which points downward \
(close to the bottom right corner) you'll see the lesson scroll by; click it \
\
on the up arrow near the top right, and the lesson will scroll back to the \
top. (If you're reading these words on the computer, you've already had to \
do this.)\n\nThere's also a ",
  StyleBox["thumb wheel",
    FontWeight->"Bold"],
  "\[LongDash]a little \"elevator\" which travels between the two arrows and \
\
which allows you to move quickly throughout the file (move the cursor to the \
\
elevator, click and hold the mouse button down, and move the elevator up and \
\
down).",
}], "Text",
  Evaluatable->False,
  AspectRatioFixed->True],

Cell[TextData[{
  "Now move the cursor (which right now looks like an I-beam) until it's \
somewhere in the bold-faced line below (the one which says \"",
  StyleBox["2+2",
    FontWeight->"Bold"],
  "\"") and ",
  StyleBox["click the mouse. ",
    FontWeight->"Bold"],
  "The cursor should leave a blinking vertical line, called an ",
  StyleBox["insertion point",
    FontWeight->"Bold"],
  ". Once you've got it to do this, hit the ",
  StyleBox["Enter ",
    FontWeight->"Bold"],

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"key (the one in the lower right corner of the keyboard). ",
StyleBox["The Enter key is different from the Return key",
  FontWeight->"Bold",
  FontSlant->"Italic",
  FontColor->RGBColor[1, 0, 0]],
StyleBox[". ",
  FontWeight->"Bold",
  FontColor->RGBColor[1, 0, 0]],
StyleBox[" ",
  FontWeight->"Bold"],
"Go ahead and try it."
}], "Text",
Evaluatable->False,
AspectRatioFixed->True],

Cell[BoxData[
  \ (2 + 2\)], "Input",
AspectRatioFixed->True],

Cell[TextData[{
  StyleBox["Mathematica",
    FontSlant->"Italic"],
  " has calculated the answer, and changed the original line by adding ",
  StyleBox["In[1] := ",
    FontSlant->"Italic"],
  "at the start; the answer is prefaced by ",
  StyleBox["Out[1] := . ",
    FontSlant->"Italic"],
  "The ",
  StyleBox["In ",
    FontSlant->"Italic"],
  "line simply means this is the problem ",
  StyleBox["Mathematica",
    FontSlant->"Italic"],
  " is trying to solve; the input the program is working on. The ",
  StyleBox["Out ",
    FontSlant->"Italic"],
  "line is ",
  StyleBox["Mathematica",
    FontSlant->"Italic"],
  "'s way of putting a tag on its answer, so that you can refer to its ",
  StyleBox["Output ",
    FontSlant->"Italic"],
  "more conveniently later."
}], "Text",
Evaluatable->False,
AspectRatioFixed->True],

Cell[TextData[{
  "Notice how an \"input cell\", like the ",
  StyleBox["2+2",
    FontFamily->"Courier",
    FontWeight->"Bold"],
  " above, differs from the explanatory cells (such as this one); input cells
  \
  appear in a different font (the \"typewriter font\", Courier) and in ",
  StyleBox["boldface",

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    FontWeight->"Bold"],
    ". An input cell is an \"active cell\"--- the only kind of cell in which
",

    StyleBox["Mathematica",
      FontSlant->"Italic"],
    " will perform a calculation. But ",
    StyleBox["Mathematica",
      FontSlant->"Italic"],
    " will completely ignore the cell until you click somewhere in it and hit \
the Enter key!"
  ]], "MathCaption"],

Cell[TextData[{
  "\nLet's try another example. Move the cursor somewhere in the next line,
\
click the mouse, and hit the ",
  StyleBox["Enter ",
    FontWeight->"Bold"],
  "key."
}], "Text",
  Evaluatable->False,
  AspectRatioFixed->True],

Cell[BoxData[
  \ (176*234\)], "Input",
  AspectRatioFixed->True],

Cell[TextData[{
  "You probably knew that the asterisk is Computerese for multiplication; and
\
",
  StyleBox["Mathematica",
    FontSlant->"Italic"],
  " has indeed multiplied 176 times 234. Let's try something a little \
farther past sixth grade (from now on, I'm going to quit reminding you to \
move the cursor into the next line, click the mouse, and hit the ",
  StyleBox["Enter ",
    FontWeight->"Bold"],
  "key):"
}], "Text",
  Evaluatable->False,
  AspectRatioFixed->True],

Cell[BoxData[
  \ (2\^10\)], "Input",
  AspectRatioFixed->True],

Cell[TextData[{
  "We've asked ",
  StyleBox["Mathematica",
    FontSlant->"Italic"],
  " to raise 2 to the 10th power. The answer is 1024, and it would only take
\
you a few seconds to do it by hand. Now try"
}], "Text",
  Evaluatable->False,

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AspectRatioFixed->True],
```

```
Cell[BoxData[  
  \ (2\^100\)], "Input",
```

```
Cell[TextData[{  
  "A much bigger number! How long would it take you to do ",  
  StyleBox["that ",  
    FontSlant->"Italic"],  
  "by hand?\n\nNow let's try some factorials. You remember that n! (read \"n  
\  
factorial\") is the product of the integers 1, 2, 3, \[Ellipsis], through n.  
\  
Thus 5! = 1*2*3*4*5 = 120."  
}], "Text",  
  Evaluatable->False,  
  AspectRatioFixed->True],
```

```
Cell[BoxData[  
  \ (\ (100!\) \)], "Input",  
  AspectRatioFixed->True],
```

```
Cell[TextData[{  
  "Something new happens with this answer: it was too long to fit on one \  
line (or even two lines), so ",  
  StyleBox["Mathematica",  
    FontSlant->"Italic"],  
  " inserted a \"continuation character\" (the backslash, \\\) at the end of a  
\  
line to indicate the answer continues on the next line.\nThere's another way  
\  
to calculate 100!, and that's to use the factorial function:"  
}], "Text",  
  Evaluatable->False,  
  AspectRatioFixed->True],
```

```
Cell[BoxData[  
  \ (Factorial[100]\)], "Input",  
  AspectRatioFixed->True],
```

```
Cell[TextData[{  
  "This is equivalent to writing 100!, but it illustrates two very important  
\  
principles which ",  
  StyleBox["you absolutely must master: ",  
    FontWeight->"Bold"],  
  "first, ",  
  StyleBox["Mathematica",  
    FontSlant->"Italic"],  
  " uses ",  
  StyleBox["square brackets [] ",  
    FontWeight->"Bold"],  
  "instead of ",  
  StyleBox["parentheses (), ",  
    FontWeight->"Bold"],  
  "which you're probably more used to. Try clicking in the next line and \  
hitting Enter!"
```

```

}], "Text",
  Evaluatable->False,
  AspectRatioFixed->True],

Cell[BoxData[
  \((Factorial \((100)\)\)\)], "Input",
  AspectRatioFixed->True],

Cell[TextData[{
  StyleBox["Mathematica",
    FontSlant->"Italic"],
  " isn't so friendly this time. It knows there's been a mistake, and pretty
  \
  accurately diagnoses that you forgot and used parentheses instead of \
  brackets, but instead of proceeding under that assumption, it gives you a \
  very rude error message, followed by a more useful warning. The output from
  \
  that cell is useless. (The explanation of the output is this: ",
  StyleBox["Mathematica",
    FontSlant->"Italic"],
  " thought you were ",
  StyleBox["multiplying",
    FontSlant->"Italic"],
  " Factorial by 100.)\n\nThe ",
  StyleBox["second ",
    FontWeight->"Bold"],
  "important principle is that ",
  StyleBox["Mathematica",
    FontWeight->"Bold",
    FontSlant->"Italic"],
  StyleBox[
  " makes the first character of just about every command upper-case. ",
    FontWeight->"Bold"],
  "Try the following:"
}], "Text",
  Evaluatable->False,
  AspectRatioFixed->True],

Cell[BoxData[
  \((factorial[100]\)\)], "Input",
  AspectRatioFixed->True],

Cell[TextData[{
  StyleBox["Mathematica",
    FontSlant->"Italic"],
  " has again guessed your probable mistake, but it's not willing to override
  \
  your judgment.\nIn fact, ",
  StyleBox["Mathematica",
    FontSlant->"Italic"],
  " can go somewhat berserk over spelling. If we try"
}], "Text",
  Evaluatable->False,
  AspectRatioFixed->True],

Cell[BoxData[
  \((Factor[x\^2 - y\^2]\)\)], "Input",

```



```

    AspectRatioFixed->True],

Cell[TextData[{
  "we get a very nice algebraic identity (which you shouldn't need ",
  StyleBox["Mathematica",
    FontSlant->"Italic"],
  " to do for you); but to factor an INTEGER we have to write"
}], "Text",
  Evaluatable->False,
  AspectRatioFixed->True],

Cell[BoxData[
  \ (FactorInteger[30]\)], "Input",
  AspectRatioFixed->True],

Cell[TextData[{
  "The output will take a little explaining, but right now our point is that
  \
  we had to capitalize the \"I\" in \"Integer\". If we hadn't, we would have \
  got a \"Possible spelling error\" again (and no answer, bizarre-looking or \
  not). ",
  StyleBox["Mathematica",
    FontSlant->"Italic"],
  " commands are often very wordy\[LongDash]in fact, they're often several \
  words run together, and the rule is: capitalize each of the several words, \
  even though they ",
  StyleBox["were ",
    FontSlant->"Italic"],
  "run together and you end up capitalizing letters in the middle of a word."
}], "Text",
  Evaluatable->False,
  AspectRatioFixed->True],

Cell[CellGroupData[{

Cell[TextData[{
  StyleBox["A Little Practice",
    FontColor->RGBColor[1, 0, 0]],
  ""
}], "Subsection",
  Evaluatable->False,
  AspectRatioFixed->True],

Cell[TextData[{
  "OK, let's practice what we've learned. In each of the following cells, \
  position the cursor somewhere in the formula, click the mouse, then hit \
  \"Enter\". ("
  StyleBox["Mathematica",
    FontSlant->"Italic"],
  " tip: holding down the \"Shift\" key when you hit \"Return\" is the same
  \
  as hitting \"Enter\", and doesn't require you to look away from the screen if
  \
  you're a touch typist.)"
}], "Text",
  Evaluatable->False,
  AspectRatioFixed->True],

```

```
Cell[BoxData[
  \(\Expand[\((1 + x)\)*\((3 - x)\)]\), "Input",
  AspectRatioFixed->True],
```

```
Cell[BoxData[
  \(\Expand[\((1 + x)\)\ \((3 - x)\)]\), "Input",
  AspectRatioFixed->True],
```

```
Cell[TextData[{
  "Hmmm, that was interesting. Fact is, ",
  StyleBox["Mathematica",
    FontSlant->"Italic"],
  " is willing to give up Computerese if it can figure out what you mean. \
And \"Expand\" is a nice catch-all command to remember. Let's see if we can \
reverse it:"
}], "Text",
  Evaluatable->False,
  AspectRatioFixed->True],
```

```
Cell[BoxData[
  \(\Factor[3 + 2\ x - x\^2]\), "Input",
  AspectRatioFixed->True],
```

```
Cell[TextData[{
  "Say, how long did it take you to learn how to factor in Algebra I?! Can \
you see, somewhere on the screen, how long it took ",
  StyleBox["Mathematica",
    FontSlant->"Italic"],
  " to do this? (Look around.) Notice, too, in this example, that we wrote \
\",
  StyleBox["2x",
    FontWeight->"Bold"],
  "\" instead of ",
  StyleBox["\"2*x",
    FontWeight->"Bold"],
  "\"\[LongDash]",
  StyleBox["Mathematica",
    FontSlant->"Italic"],
  " knew what we meant, there was no ambiguity. (Maple, by contrast, \
doggedly insists on the full \"2*x\".)"
}], "Text",
  Evaluatable->False,
  AspectRatioFixed->True],
```

```
Cell[BoxData[
  \(\Factor[30 + 47\ x + 14\ x\^2 - 5\ x\^3 - 2\ x\^4]\), "Input",
  AspectRatioFixed->True],
```

```
Cell[TextData[
  "We could go on like this all day. We calculated 100! before. Let's try \
calculating 10! But wait!! Maybe you're kind of bored, and aren't \
interested in calculating the factorial of 10. Move the cursor down to the \
\"1\" below, click the mouse, and drag it over the 1 and the 0, so that both \
\
```

```

digits are highlighted; then release the mouse. Next, type in your favorite
\
integer (maybe your age\[LongDash]notice that it instantly replaces the \
\"10\"), then hit enter:]", "Text",
  Evaluatable->False,
  AspectRatioFixed->True],

Cell[BoxData[
  \(\(10!\)\)], "Input",
  AspectRatioFixed->True],

Cell[TextData[{
  "See, you're not limited to what's in the notebook. You can ",
  StyleBox["edit ",
    FontWeight->"Bold"],
  "the line and change it to anything you want. You can ",
  StyleBox["still ",
    FontWeight->"Bold"],
  "go back and change it again: click-drag over the stuff before the \
exclamation mark, and replace it with 1000. Notice that 1000! is kinda big.
\
I suggest you ",
  StyleBox["not ",
    FontSlant->"Italic"],
  "try 10000! It will take a long time..."
}], "Text",
  Evaluatable->False,
  AspectRatioFixed->True]
}, Open ]]
}, Closed]],

Cell[CellGroupData[{

Cell[TextData["Getting By With a Little Help From My Friends"], "Section",
  Evaluatable->False,
  AspectRatioFixed->True],

Cell[TextData[{
  "In the last section we used two new commands, \"Expand\" and \"Factor\".
\
You could probably figure out what these mean; but what do you make of \
\"LerchPhi\", or \"HasseDiagram\", or \"CholeskyDecomposition\"?\n\nFact is,
\
there are more than 1500 commands in ",
  StyleBox["Mathematica",
    FontSlant->"Italic"],
  ", each with its own quirks and foibles, and more are being added every \
day. There's a company, Variable Symbols, whose ",
  StyleBox["sole business activity ",
    FontSlant->"Italic"],
  "is making help sheets and reference guides for computer algebra systems \
such as ",
  StyleBox["Mathematica",
    FontSlant->"Italic"],
  "! One of the reasons there are so many ",
  StyleBox["Mathematica",
    FontSlant->"Italic"],

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" commands is that ",
StyleBox["anyone ",
  FontWeight->"Bold"],
"can write their own; if enough people like what's written, it's likely to
\
be adopted in lots of different places. Wolfram Research maintains a WWW \
server which contains hundreds of special-purpose packages written by
users.\n\
\nVery few people know all of ",
  StyleBox["Mathematica",
    FontSlant->"Italic"],
"'s commands (or ",
  StyleBox["need ",
    FontSlant->"Italic"],
"to know them all). You can get along fine in this course with just one or
\
two dozen. It's like the English language; it has hundreds of thousands of \
words, but most people will speak only a few hundred different words in the \
course of a week.\n\n",
  StyleBox["Mathematica",
    FontSlant->"Italic"],
" provides help for those moments when you can't quite remember the details
\
of a command. Look at the menu bar at the top of the Mac. Do you see the \
pull-down menu item called \"Help\"? Go to it now and select \"Help...\" \
When you're done exploring with the Help Browser, click its close box (the \
box in the upper left of the window) to return here. (Or you can just leave
\
the function browser in the background and return to this window by clicking
\
in it. It's nice to have the help browser around)"
}], "Text",
  Evaluatable->False,
  AspectRatioFixed->True],

Cell[TextData[
"Another way to get help, especially if you don't like mousing around, is by
\
using the question mark. For example, suppose we wanted to know about \
\"Factor\". You could just type:], "Text",
  Evaluatable->False,
  AspectRatioFixed->True],

Cell[BoxData[
  \(\(\(?Factor\)\)\)], "Input",
  AspectRatioFixed->True],

Cell[TextData[{
  StyleBox["Mathematica",
    FontSlant->"Italic"],
  " informs you that Factor factors a polynomial over the integers. Most \
functions and procedures in ",
  StyleBox["Mathematica",
    FontSlant->"Italic"],
  " have options; to discover these for Factor, we type"
}], "Text",
  Evaluatable->False,

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AspectRatioFixed->True],

Cell[BoxData[
  \ (Options[Factor]\)], "Input",
  AspectRatioFixed->True],

Cell[TextData[{
  "and ",
  StyleBox["Mathematica",
    FontSlant->"Italic"],
  " mentions, among others, ",
  StyleBox["GaussianIntegers->False",
    FontFamily->"Courier",
    FontWeight->"Bold"],
  ". This means that \"",
  StyleBox["GaussianIntegers",
    FontFamily->"Courier",
    FontWeight->"Bold"],
  "\" is an option for Factor whose default value (the value it will take if
  \
  you don't do anything about it) will be \"False\". Let's try a factorization
  \
  where we take ",
  StyleBox["GaussianIntegers",
    FontFamily->"Courier",
    FontWeight->"Bold"],
  " to be True:"
}], "Text",
  Evaluatable->False,
  AspectRatioFixed->True],

Cell[BoxData[
  \ (Factor[x^2 + 1, GaussianIntegers \[Rule] True]\)], "Input",
  AspectRatioFixed->True],

Cell[TextData[{
  "Aha! It factors ",
  StyleBox["x^2 + 1",
    FontFamily->"Courier",
    FontSize->12],
  " as ",
  StyleBox["(x + I)(x-I)",
    FontFamily->"Courier",
    FontSize->12],
  ", where",
  StyleBox[" I ",
    FontFamily->"Courier"],
  "is the symbol which ",
  StyleBox["Mathematica",
    FontSlant->"Italic"],
  " uses to represent the square root of -1. (",
  StyleBox["Mathematica",
    FontSlant->"Italic"],
  " always capitalizes the first letter, remember?---even if it's the ",
  StyleBox["only ",
    FontSlant->"Italic"],
  "letter.) You won't need to use them in this course, but Gaussian integers

```

```

\
are complex numbers of the form  $m + n*I$ , where  $m$  and  $n$  are ordinary integers.
\
When you set the option GaussianIntegers to True, ",
  StyleBox["Mathematica",
    FontSlant->"Italic"],
  " will allow Gaussian integers as coefficients of the factors (and both  $I$  \
and  $-I$  are Gaussian integers).\n\nThe final tip is what to do when you can \
only remember a few letters of a command's name. If they're in the middle of \
\
the name, ",
  StyleBox["Mathematica",
    FontSlant->"Italic"],
  " won't help you, but if you remember the first few letters, ",
  StyleBox["Mathematica",
    FontSlant->"Italic"],
  " has a ",
  StyleBox["completion ",
    FontSlant->"Italic"],
  "facility: if you type the letters you know, then type \"command-k\" (hold \
\
down the Command key, the ones with the picture of the little Apple on them, \
\
at the same time you press the \"k\" key), ",
  StyleBox["Mathematica",
    FontSlant->"Italic"],
  " will generate a pop-up menu with ",
  StyleBox["all ",
    FontSlant->"Italic"],
  "of its commands which start that way. (If there's only one such command, \
\
it won't show the pop-up menu, it will just insert the rest of the word where \
\
you were typing.) Try it with"
}], "Text",
  Evaluatable->False,
  AspectRatioFixed->True],

Cell[BoxData[
  \(\(\(?Fac\)\)\), "Input",
  AspectRatioFixed->True],

Cell[TextData[{
  "You can click on the command you want with the mouse, or use the scrolling \
\
arrow keys to move to the selection you want, and then press Return. \
\
Combined with the help question mark, this is a ",
  StyleBox["very ",
    FontSlant->"Italic"],
  "useful thing to remember."
}], "Text",
  Evaluatable->False,
  AspectRatioFixed->True]
}, Closed]],

Cell[CellGroupData[{

```

```
Cell[TextData["Mathematica Does Plots"], "Section",
  Evaluatable->False,
  AspectRatioFixed->True],
```

```
Cell[TextData[{
  "One of the things that ",
  StyleBox["Mathematica",
    FontSlant->"Italic"],
  " does best is plot functions. Try the following:"
}], "Text",
  Evaluatable->False,
  AspectRatioFixed->True],
```

```
Cell[BoxData[
  \ (Plot[x^2, {x, 0, 1}]\), "Input",
  AspectRatioFixed->True],
```

```
Cell[TextData[{
  "Voil\ [AGrave]! It's pretty self-explanatory; we plotted the function ",
  StyleBox["f[x] = x^2 ",
    FontFamily->"Courier",
    FontSize->12],
  " on the interval 0 \ [LessEqual] x \ [LessEqual] 1. No doubt you remembered
  \
  that \\"",
  StyleBox["Plot",
    FontFamily->"Courier",
    FontSize->12],
  "\" should be capitalized, and that you need to enclose the arguments to ",
  StyleBox["Plot",
    FontFamily->"Courier",
    FontSize->12],
  " in ",
  StyleBox["square brackets [] ",
    FontWeight->"Bold"],
  " instead of parentheses; the x^2 is pretty clear; the only indelicate point
  \
  is the strange way ",
  StyleBox["Mathematica",
    FontSlant->"Italic"],
  " has of specifying we're plotting from x = 0 to x = 1.\n\nThe curly-brace
  \
  is the notation ",
  StyleBox["Mathematica",
    FontSlant->"Italic"],
  " uses for a ",
  StyleBox["list. ",
    FontWeight->"Bold"],
  " A list is a sequence of objects, in a particular order, and what ",
  StyleBox["Mathematica",
    FontSlant->"Italic"],
  " needs to know (after you've specified the function to be plotted) is (a)
  \
  ",
  StyleBox["what was the variable?, ",
    FontWeight->"Bold"],
  "(b) ",
```

```

StyleBox["what was the starting value of the variable, ",
  FontWeight->"Bold"],
"and (c) ",
StyleBox["what was the ending value of the variable? ",
  FontWeight->"Bold"],
"It asks for those three things, in that order, by demanding a ",
StyleBox["list",
  FontWeight->"Bold"],
" of those three things."
}], "Text",
Evaluatable->False,
AspectRatioFixed->True],

Cell[TextData["Let's try a more complicated function:"], "Text",
  Evaluatable->False,
  AspectRatioFixed->True],

Cell[BoxData[
  \ (Plot[Sin[x] + Sin[2\ x] + Sin[3\ x], {x, 0, 2\ \[Pi]}\]), "Input",
  AspectRatioFixed->True],

Cell[TextData[{
  "Ahhh, now this is a handsome graph! It's got nothing to do with the Ten \
  Commandments, of course; ",
  StyleBox["Sin",
    FontFamily->"Courier",
    FontSize->12],
  " is just ",
  StyleBox["Mathematica",
    FontSlant->"Italic"],
  "'s way of writing the sine function. What do you think Cos means? Log?
  \
  (Careful about that one\ [Ellipsis])\n\nMaybe the graph of our \
  triple-sine-function looks a little small. Try the following: move the \
  cursor so it's hovering somewhere in the graph (it will look like a circle \
  with a crosshair in it). Now click the mouse. Notice that the graph is \
  suddenly surrounded by a rectangle, with eight black squares? These squares
  \
  are called ",
  StyleBox["handles, ",
    FontSlant->"Italic"],
  "and are used to adjust and resize the graph. Move the cursor (which now \
  looks like two crossed arrows) until it's just over the lower right handle; \
  it will turn into a diagonal cursor. Click the mouse button and hold it down
  \
  (this is called ",
  StyleBox["grabbing ",
    FontWeight->"Bold"],
  "the",
  StyleBox[" ",
    FontWeight->"Bold"],
  "handle), then move the mouse around; you'll see the rectangle adjust its \
  size and position. When you release the mouse, the graph will adjust itself
  \
  to its new bounding box. When you're done, click anywhere outside the graph
  \
  to de-select the plot. You can make the graph quite large this way (bigger \

```



```

than the screen, even).\n\nDid you notice that funny symbol \[Pi] the last \
Plot command? Surely you know what \[Pi] is? Just in case you don't, try \
this:"
]], "Text",
  Evaluatable->False,
  AspectRatioFixed->True],

Cell[BoxData[
  \[N[\[Pi]]], "Input",
  AspectRatioFixed->True],

Cell[TextData[{
  "I hope you know what it is now! (And you may also have figured out how to
\
evaluate things ",
  StyleBox["N",
    FontWeight->"Bold"],
  "umerically.) If five decimal places isn't good enough for you, try it to
\
30:"
}], "Text",
  Evaluatable->False,
  AspectRatioFixed->True],

Cell[BoxData[
  \[N[\[Pi], 30]], "Input",
  AspectRatioFixed->True],

Cell[TextData[{
  "And if 30 isn't enough, go back, edit the \"30\" to \"300\" or \"3000\" \
and try again.\n\nHave you ever had a math teacher tell you the answer to a \
problem was ",
  StyleBox["not ",
    FontWeight->"Bold"],
  "1.4142, it was ",
  Cell[BoxData[
    \[TraditionalForm\`@\@2]],
  "? That's because ",
  Cell[BoxData[
    \[TraditionalForm\`@\@2]],
  ", the square root of 2, is a numerical quantity which is awkward to \
express as a decimal; it requires infinitely many digits to represent it. ",
  StyleBox["Mathematica",
    FontSlant->"Italic"],
  " prefers to think of numbers like \[Pi] and ",
  Cell[BoxData[
    \[TraditionalForm\`@\@(2\ \)]],
  "as symbolic quantities, not decimal numbers. That's the major difference
\
between ",
  StyleBox["Mathematica",
    FontSlant->"Italic"],
  " and your pocket calculator; ",
  StyleBox["Mathematica",
    FontSlant->"Italic"],
  " ",
  StyleBox["does symbolic calculations. ",

```

```

    FontSlant->"Italic"],
    "You have to ",
    StyleBox["ask ",
        FontWeight->"Bold"],
    StyleBox["Mathematica",
        FontSlant->"Italic"],
    " to do the conversion to decimals. Usually you're better off to wait \
until the very end of a problem to ask it to do this conversion, since that \
way your intermediate calculations are exact.\n\nLet's have a little fun:"
}], "Text",
    Evaluatable->False,
    AspectRatioFixed->True],

```

```

Cell[BoxData[
    \ (Plot3D[
        Sin[y + x] + Sin[y - x^2], {x, \(-\[\Pi]\), \[\Pi]}, {y, \(-\[\Pi]\),
        \[\Pi]}\)], "Input",
    AspectRatioFixed->True],

```

```

Cell[TextData[
    "\"But that isn't Calculus I or II!\" you cry. No, it's Calculus III, \
multivariable calculus, but can you figure out what it's doing anyway?\"",
    "Text",
    Evaluatable->False,
    AspectRatioFixed->True]
}, Closed]],

```

```

Cell[CellGroupData[{

```

```

    Cell[TextData["Mathematica Goes Hollywood!"], "Section",
        Evaluatable->False,
        AspectRatioFixed->True],

```

```

    Cell[TextData[{
        StyleBox["Mathematica",
            FontSlant->"Italic"],
        " can also make animations. What we'll do next is plot the graphs of \
Sin[x] + Sin[3x]/3 ... + Sin[(2n+1) x]/(2n+1) for n from 0 to 5, and then \
animate the graph. You'll learn two new commands here, ",
        StyleBox["Do",
            FontFamily->"Courier",
            FontSize->12],
        " and ",
        StyleBox["Sum",
            FontFamily->"Courier",
            FontSize->12],
        ":",
    }], "Text",
    Evaluatable->False,
    AspectRatioFixed->True],

```

```

Cell[BoxData[
    \ (Do[Plot[
        \ (Sum)\+\(k = 0)\%n Sin[\((2\ k + 1)\)\ x]\/(2\ k + 1), {x, 0,
        2\ \[\Pi]}, PlotRange \[Rule] {\(-1\), 1}], {n, 0, 5}]\)], "Input",
    AspectRatioFixed->True],

```

```

Cell[TextData[{
  "Ordinarily ",
  StyleBox["Mathematica",
    FontSlant->"Italic"],
  " will decide the maximum and minimum y values to display; here we've \
forced it to only plot from y = -1 to y = 1, so that all the graphs are of \
comparable size.\n\nDouble-click on any one of the graphs. Instant \
Hollywood!\n\nTo stop the animation, just click the mouse. To adjust the \
speed (it may be a little fast!), notice that down in the bottom left-hand \
corner of this window there are what look like a double arrow pointing up and \
\
a double arrow pointing down. Each time you click the up arrow, ",
  StyleBox["Mathematica",
    FontSlant->"Italic"],
  " speeds up the animation; each time you click the down arrow, it slows it \
\
down. The arrows which point right and left determine the ",
  StyleBox["direction ",
    FontSlant->"Italic"],
  "the film moves in. You can also select \"Animation...\" under the Graph \
menu, and adjust the number of frames per second to whatever you like."
}], "Text",
  Evaluatable->False,
  AspectRatioFixed->True]
}, Closed]],

```

```

Cell[CellGroupData[{

```

```

  Cell[TextData["Review"], "Section",
    Evaluatable->False,
    AspectRatioFixed->True],

```

```

  Cell[TextData[{
    "You're got started doing some elementary ",
    StyleBox["Mathematica",
      FontSlant->"Italic"],
    ". You've learned that ",
    StyleBox["Mathematica",
      FontSlant->"Italic"],
    " organizes stuff as \"Input\" (the lines you type in) and \"Output\" (the \
\
answers it gives). (In which case, what's this stuff you're reading? \
\
[Ellipsis]But that's a story for another day.)\n\nYou've learned two ",
    StyleBox["important principles: ",
      FontWeight->"Bold"],
    "use ",
    StyleBox["square brackets, ",
      FontWeight->"Bold"],
    "and remember to ",
    StyleBox["capitalize keywords ",
      FontWeight->"Bold"],
    "(and even capitalize in the ",
    StyleBox["middle ",
      FontWeight->"Bold"],
    "of a word, if it looks like it was really two words run into one, e.g. ",
    StyleBox["FactorInteger",
      FontWeight->"Bold"],

```


e`0j]H2EKoog]H1E@3n`80kYWn00GoV@2o_oo`e`0j]H2EKoog]H1E@3n`@0
kYT0001?1P3oV@2o_ooDeP9E_ooNeP5E0?jo0P3^VOh01OnI0;noomCF0UFoomkF
0ED0o[120>jIoP05oiT0_kooe=H2EKoog]H1E@3n`@0kYT0001K1P3oV@2o_ooD
eP9E_ooae_d0l]H1E@3n`80kYWn00GoV@2o_ooDeP9E_ooae_d0l]H1E@3n`80
kYWn00GoV@2o_ooDeP9E_ooae_d0l]H1E@3n`@0kYT0001T1P3oV@2o_ooDeP9E
_ooaeP<0e]H0l]H1E@3n`80kYWn00GoV@2o_ooDeP9E_ooaeP<0e]H0l]H1E@3n
`80kYWn00GoV@2o_ooDeP9E_ooaeP<0e]H0l]H1E@3n`@0kYT0001T1P3oV@2o
_ooDeP9E_ooaeP<0e]H0l]H1E@3n`80kYWn00GoV@2o_ooDeP9E_ooaeP<0e]H0
l]H1E@3n`80kYWn00GoV@2o_ooDeP9E_ooaeP<0e]H0l]H1E@3n`@0kYT0001K
1P3oV@2o_ooDeP9E_ooae_d0l]H1E@3n`80kYWn00GoV@2o_ooDeP9E_ooae_d0
l]H1E@3n`80kYWn00GoV@2o_ooDeP9E_ooae_d0l]H1E@3n`@0kYT0001?1P3o
V@2o_ooDeP9E_ooNeP5E0?jo0P3^VOh01OnI0;noomCF0UFoomkF0ED0o[120>jI
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g]H1E@3n`@0kYT000191P3oV@2o_ooCE@6oomeE003n`80kYWn00GoV@2o_ooC
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d_l0_mco003n`@0kYT0001?1P3oV@2o_ooDeP9E_ooNeP5E0?jo0P3^VOh01OnI
0;noomCF0UFoomkF0ED0o[120>jIoP05oiT0_kooe=H2EKoog]H1E@3n`@0kYT0
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_ooNeP5E0?jo0P3^VOh01OnI0;noomCF0UFoomkF0ED0o[120>jIoP05oiT0_koo
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_oo]eP00jMH2EKoommH50=KF0=H0k]H1E@3n`80kYWn00GoV@2o_oo]eP00jMH2
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_oo^eP00j=H2EKoommKl0>gF0ED0o[120>jIoP05oiT0_kook]H00>SF0UFooooF
o03]eP5E0?jo0P3^VOh01OnI0;noonkF003XeP9E_ooege`0kMH1E@3n`@0kYT0
001W1P3oV@2o_oo^eP00j=H2EKoolmH00>gF0ED0o[120>jIoP05oiT0_kook]H0
0>SF0UFoooo?F003]eP5E0?jo0P3^VOh01OnI0;noonkF003XeP9E_ooceP00kMH1
E@3n`@0kYT0001o1P3oV@2o_oo^eP00o=Kl0?;F0UFoooo?F003le`0mmH1E@3n
`80kYWn00GoV@2o_oo^eP00o=Kl0?;F0UFoooo?F003le`0mmH1E@3n`80kYWn
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V@2o_ooceP00oMH00?cFo03beP9E_ooheP00oMH00?cFo03geP5E0?jo0P3^VOh0
1OnI0;nooo?F003meP00o=Kl0?;F0UFooooSF003meP00o=Kl0?OF0ED0o[120>jI
oP05oiT0_koolmH00?gF003le`0l]H2EKoon=H00?gF003le`0mmH1E@3n`@0
kYT0002M1P3oV@2o_ooedePD0eP3FeP3ke`0l]H2EKoonMH50=H0e]H0nmKl0?OF
0ED0o[120>jIoP05oiT0_koom=H50=H0e]H0nmKl0?;F0UFooooWF1@3F0=KF0?_F
o03geP5E0?jo0P3^VOh01OnI0;noooCF1@3F0=KF0?_Fo03beP9E_ooiePD0eP3F
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0`3FeP3ke`0mmH1E@3n`80kYWn00GoV@2o_ooobeP<0e]H0nmKl0?;F0UFooooOF
0`3FeP3ke`0mmH1E@3n`80kYWn00GoV@2o_ooobeP<0e]H0nmKl0?;F0UFooooOF
0`3FeP3ke`0mmH1E@3n`@0kYT0002;1P3oV@2o_ooaeP80eP3ke`0l]H2EKoo
m]H20=H0nmKl0?OF0ED0o[120>jIoP05oiT0_koolMH20=H0nmKl0?;F0UFooooKF
0P3F0?_Fo03geP5E0?jo0P3^VOh01OnI0;nooo7F0P3F0?_Fo03beP9E_oofeP80
eP3ke`0mmH1E@3n`@0kYT000251P3oV@2o_ooaeP400?[Fo03beP9E_oofeP40
0?[Fo03geP5E0?jo0P3^VOh01OnI0;nooo7F0@00n]Kl0?;F0UFooooKF0@00n]Kl
0?OF0ED0o[120>jIoP05oiT0_koolMH1003je`0l]H2EKoom]H1003je`0mmH1
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_ooeeP00jmH1E@3n`@0kYT0001W1P3oV@2o_oo`eP00i]H2EKoomMH00>_F0ED0
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oo3F003VeP9E_ooeeP00jmH1E@3n_`@0kYT0001?1P3oV@2o_ooDeP9E_ooNeP5E
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001?1P3oV@2o_ooDeP9E_ooNeP5E0?jo0P3^VOh01OnI0;noomCF0UFoomkF0ED0
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_ooNeP5E0?jo0P3^VOh01OnI0;noomCF0UFoomkF0ED0o[120>jIoP05oiT0_koo
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kYWn00GoV@2o_ooee_h0hmH2EKoog]H1E@3n_`80kYWn00GoV@2o_ooee_h0hmH2
EKoog]H1E@3n_`@0kYT0001W1P3oV@2o_ooFeP00o]H00>CF0UFoomkF0ED0o[12
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003neP00i=H2EKoog]H1E@3n_`@0kYT0001K1P3oV@2o_ooGeP00gmH2EKoog]H1
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_`80kYWn00GoV@2o_ooGeP00gmH2EKoog]H1E@3n_`80kYWn00GoV@2o_ooGeP00
gmH2EKoog]H1E@3n_`@0kYT0001K1P3oV@2o_ooGeP00gmH2EKoog]H1E@3n_`80
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EKoog]H1E@3n_`@0kYT0001K1P3oV@2o_ooGeP00gmH2EKoog]H1E@3n_`80kYWn
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E@3n_`@0kYT0001c1P3oV@2o_ooGeP00lMKm0??F0UFoooWfo@3ZeP5E0?jo0P3^
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