Note that in old versions of Maple the ditto " was used to refer to the last output, a technique which saves retyping a result. One now uses the percent symbol % instead of ".

The restart command clears Maple's memory. (It does not change outputs printed in a worksheet.)

One can put problem numbers and text before a > math prompt by Insert > Paragraph > Before Cursor.

a) One of the best ways to see what a Maple command does is to enter it in a worksheet and try it out. For example, to see what x$2 does, we simply enter it on the command line.

One can use shift-enter to get two Maple commands that execute together, but which sit on separate lines for greater ease in viewing,

```
> restart:
x$2;
```

In particular, the sequence operator x$2 simply makes two x's separated by a comma. If one wants to take the 5th derivative of f, one can use either diff(f,x,x,x,x,x); or diff(f,x$5).

b) Similarly, the sequence operator with a range 1..4 makes a loop that runs from 1 to 4.

```
> $1..4;
```

Maple does not plot equations, it plots expressions. Hence, we would plot \( x^{\frac{2}{3}} \) rather than \( y = x^{\frac{2}{3}} \).

One also has to be aware that Maple works naturally with complex numbers, not real
numbers. In particular, when one asks Maple to plot $x^{\frac{2}{3}}$, only half the graph appears, since Maple interprets the cube root as one of the complex valued cube roots when $x$ is negative. Since the complex cube root does not plot, it appears that half the curve is missing.

```maple
> plot(x^(2/3), x=-1..1);
plot(surd(x^2,3), x=-1..1);
```

p. 15 # 4.
Maple is much more powerful than the hand calculators that you are accustomed to use. In particular, it has the ability to work with numbers in other than floating point decimal form. In this problem we explore what the differences are between exact numbers and floats.

Nops is the Maple command to see how many pieces there are when a number is stored. op(x,y) will give you the x-th part of a number y.

a) Here, we assign a name a to $\sqrt{2}$, so that we do not have to retype sqrt(2) when we again want it. Think of it as a nickname.

\[
\begin{align*}
  & a := \sqrt{2} \\
  & nops(%) \\
  & a := \sqrt{2} \\
  & 2
\end{align*}
\]

b) When one stores the exact number $\sqrt{2}$, there are two pieces, the base 2 and the rational exponent 1/2.

\[
\begin{align*}
  & op(1, a) \\
  & op(2, a) \\
  & 2 \\
  & \frac{1}{2}
\end{align*}
\]

c) We can convert the exact number sqrt(2) into a float, or floating point decimal, the only kind of number available on most hand calculators. That changes the internal storage method and introduces roundoff errors which are not there when we store the number in exact form.

\[
\begin{align*}
  & b := \text{evalf}(a) \\
  & nops(b) \\
  & b := 1.414213562 \\
  & 2 \\
  & 1.414213562
\end{align*}
\]

d) Floats are not stored in the same manner. They also have two pieces, but the pieces are the mantissa, which carries all the digits, and the exponent which tells the number of places from the right hand side where the decimal point sits.

\[
\begin{align*}
  & op(1, b) \\
  & op(2, b) \\
  & 1414213562 \\
  & -9
\end{align*}
\]
Note that there is a difference between $a^2$ and $b^2$ because of roundoff error. The roundoff error builds as more and more operations are performed. Often one is better off entering fractions not as decimals but as an integer over an integer, $1/2$ rather than 0.5.

$$\begin{align*}
  \text{> } & a^2; \\
  & b^2; \\
  & \quad 2 \\
  & \quad 1.999999999 \\
\end{align*}$$

p. 15 #5.

The Maple command \texttt{expand} does different things to different expressions. It will apply the binomial theorem to a power of a binomial.

$$\begin{align*}
  \text{> } & (x^2-1)^5; \\
  & \quad \texttt{expand(\%)}; \\
  & \quad (x^2-1)^5 \\
  & \quad x^{10} - 5x^8 + 10x^6 - 10x^4 + 5x^2 - 1 \\
\end{align*}$$

When applied to a sine of the sum of two angles, it will give the appropriate formula for the sine of the sum of two angles.

$$\begin{align*}
  \text{> } & \sin(a+b); \\
  & \quad \texttt{expand(\%)}; \\
  & \quad \sin(\sqrt{2} + 1.414213562) \\
  & \quad 0.1559436951 \sin(\sqrt{2}) + 0.9877659459 \cos(\sqrt{2}) \\
\end{align*}$$

When applied to a fraction, \texttt{expand} puts each entry in the numerator over its own copy of the denominator. This command sometimes makes Maple's output more closely resemble the form in which we would write it by hand, as you will see in the homework solutions.

$$\begin{align*}
  \text{> } & \frac{a+b}{c}; \\
  & \quad \texttt{expand(\%)}; \\
  & \quad \frac{a+b}{c} \\
  & \quad \frac{a}{c} + \frac{b}{c} \\
\end{align*}$$

d) The arithmetic rule that "The log of a product is the sum of the logs" applies only to positive real numbers. Hence, since Maple thinks of all letter variables as being complex numbers, she does not apply that rule.
If one gently explains to Maple that we are thinking of \(a\) and \(b\) as positive numbers, then she will apply the appropriate rule.

\[
> \text{assume}(a>0); \text{additionally}(b>0);
\]
\[
> \log(a*b);
\]
\[
\text{expand}(%);
\]
\[
\ln(a) + \ln(b) \quad (12)
\]

Note that the exponential function uses \(\text{exp}(\ )\), not \(e^\) or \(\text{exp}^\). This is a frequent student error, that you can easily avoid. Also, functions always require parentheses around their arguments: \(\sin x\) is a nasal decongestant and \(\sin(x)\) is math. Note that all multiplications require an asterisk. Putting two objects side by side without an * does not result in a multiplication.

Here, we have "collected terms" or "factored out" the \(\sin(x)\) that is common to all terms in the expression.

\[
> \exp(2*x)*\sin(x) + \sin(x) * \cos(x) + 4 * \sin(x);
\]
\[
\text{collect}(\%, \sin(x));
\]
\[
e^{2x} \sin(x) + \sin(x) \cos(x) + 4 \sin(x)
\]
\[
(e^{2x} + \cos(x) + 4) \sin(x) \quad (13)
\]

One may solve an equation in different ways in Maple, depending on the kinds of answers that are desired/acceptable. The command \text{solve} tries to give exact solutions, while \text{fsolve} gives floating point decimal answers. The default for \text{fsolve} is to give only real answers, not complex numbers, but one can also get complex floats with \(I = \sqrt{-1}\) by adding the word "complex" to the command.

\[
> \text{eq}:=x^4-4;
\]
\[
eq := x^4 - 4 \quad (14)
\]
\[
> \text{solve}(\text{eq}, x);
\]
\[
\text{fsolve}(\text{eq}, x, \text{complex});
\]
\[
\sqrt{2}, -\sqrt{2}, i\sqrt{2}, -i\sqrt{2}
\]
You studied parametric curves in your calculus sequence. Both the x- and y-coordinates are written in terms of t. The question here is how to plot such a curve in Maple.

And, since we do not know, we turn to Maple Help, located at the top right hand corner in the Tool Bar. Maple Help is always available to assist with syntax questions when you don’t know how a command should be written in Maple; but as always, it is more useful to you when you have experience in how it works.

Help > Maple Help. A window opens up and you can type "plot", clicking Search. One of the entries is "plot, parametric". Clicking on that entry brings up a Help page showing how to make a parametric plot: the command is plot([function1(t), function2(t), t-range]);

> plot([cos(t), sin(t), t=0..2*Pi]);