Using the TI89 to solve equations

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The purpose of this document is to walk you through the solution of a nonlinear equation using a TI89 calculator. Specifically, we will be solving the equation that arises in section 9.3 of my textbook, *A Life Scientist's Guide to Physical Chemistry*, after equation (9.11) on page 197:

$$s - \frac{1.14 \times 10^{-3}\,\text{mol/L}}{e^{-4.039\sqrt{s}}} = 0.$$

(Note that the value 4.025 in the exponential in the equation in the textbook is a typo.)

1. If you're not on the apps screen, press the APPS key. Select `Numeric So...` and press ENTER. You should see the following on your screen:

   ```
   Enter Equation
   eqn:
   ```

   If there is anything to the right of `eqn:`, just hit the CLEAR key.

2. Enter your equation after the colon. Remember, an equation has to have two sides, so you need an equal sign somewhere in there. Use the alpha key when you need a variable name (perhaps `s` in this case). The easiest way to enter the square root is to use an exponent of 1/2. Give or take some scrolling off the left edge of my screen, here is what my equation looked like as I was typing it:

```
eqn:s-1.14E-3/e^(-4.039*s^(1/2))=0
```

The TI89 doesn't require that your equation be written with a zero on the right-hand side. For example, we could have based our solution on a direct combination of equations (9.10) and (9.11):

```
eqn:s=1.14E-3/e^(-4.039*s^(1/2))
```

3. Press ENTER. You should see a line that says `s=`. There may be a number after the equal sign. This is where you need to enter a guess for the solution. The text suggests 1.14×10^{-3}, but really, anything reasonably close to this will do. Even zero works sometimes, although not reliably. In this case, I enter

   ```
   s=1E-3
   ```

4. You can also set the bounds in the line following this one. This is useful when an equation has multiple solutions and the calculator is finding the wrong one (usually only a problem if your initial guess is bad). We're just going to leave that alone.

5. The "tabs" at the top of the screen give the meanings of the function keys in this context. Note the tab that says `F2 Solve`. With the cursor still on the `s=1E-3` line, press F2. The calculator will think about it for a second or two, and should produce the following output.

   ```
   s-0.00114/e^(-4.039*s^(1/2))
   s=.0013202004218054
   bound={-1.E14,1.E14}
   left-rt=0.
   ```

   The last line is important because it tells you the calculator actually found a solution. You can read the value of s off the screen. It is also stored in the variable `s` of your calculator.