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**Calculator Lesson 14**

**Definite Integral**

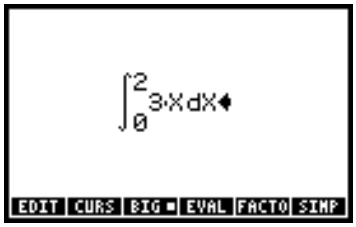
In this lesson we will learn to compute $\int_a^b f(x)dx$ on the calculator. There are two methods and we will use $\int_0^2 3xdx$ to demonstrate both methods. Notice that this is simply the area of a triangle so we know the integral is 6. It will not be a problem with this simple integral, but it is a good idea to set the calculator to FIX 5 or so, or the integration process could take a very long time. The calculator will use approximation techniques that will try to get an answer accurate to the level you have requested based on the display setting. The more accuracy you demand, the longer it will take the calculator to find the approximation. It is also advisable to set the calculator to approximate mode.

The first method is using RPN. Put *a* (0 in this example) on level 4 of the stack, *b* (2 in this example) on level 3, the integrand ( 3*x* in this example) on level 2, and the variable with respect to which we are integrating (*x* in this example) on level 1. Now press RS $\int$. The answer 6.00000 should now show on the stack, assuming the display is set to FIX 5.

The second method is to use the equation writer. Get into the equation writer and key in the following sequence:

RS $\int$ 0 RA 2 RA 3 × X RA X

The screen should now look like the figure to the right. Press ENTER then EVAL or RS →NUM and the answer 6.00000 will now show on the stack. Press VAR and you will see that a new variable called IERR has been added to your list of variables. As mentioned above, the calculator uses an approximation technique to find the integral, and IERR has the error bound, the maximum error, in the approximation. Press F1-IERR and you will see its value is .00006. The answer to your integral is $6.00000 \pm .00006$. In this case the approximation is actually the exact answer, but that will not always be the case. Whenever an approximation method is used to solve a mathematical problem, being able to give an error bound is a very important part of the solution. Error bounding is generally covered in a numerical analysis course.




To see why it is important to set the calculator to approximate mode set the mode to exact. Now try to evaluate $\int_0^{2\pi} \sqrt{1+\cos^2(x)+\sin^2(x)}dx$. To write the expression in the equation writer type the sequence:

RS EQW RS $\int$ 0 RA 2 × LS π UA RA $\sqrt{X}$ 1 + COS X
UA UA $Y^X$ 2 UA UA + SIN X UA UA $Y^X$ 2 RA X ENTER

Press ENTER 3 or 4 more times to get several copies of this expression on the stack. If you now press EVAL, you will get an error message. Press CANCEL to clear the error message and now try RS →NUM. This time you get you will get 8.88577, which is correct to five decimal places. The exact solution to this integral is $2\sqrt{2}\pi$. You will also get the correct answer with all of the methods if the calculator is in approximate mode. Try it with the other copies of the integral that you saved on the stack.

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