Science Tools

Concepts

- Using the *SciTools* APP to perform conversions between different types of units
- Using the *SciTools* APP to perform calculations that result in the correct number of significant figures

Materials

- TI-84 Plus
- *SciTools* APP

Overview

SciTools is a powerful calculator application (APP) with many features useful for science. This activity demonstrates how to use *SciTools* (1) to do unit conversions and (2) to do calculations that result in the correct number of significant figures.

Unit Conversions

1. Press the [APPS] key on the TI-84.

   Scroll down (or press [ALPHA] "S") to *SciTools*, and press [ENTER] (Figure 1).

2. Pressing [ENTER] again brings up the SELECT A TOOL menu.
   - Scroll down to 2:UNIT CONVERTER, and press [ENTER] (Figure 2).

3. Press the [9] key to select 9:PRESSURE (Figure 3).

Figure 1

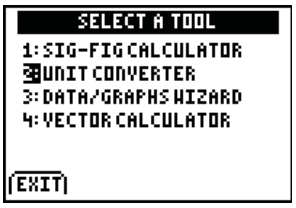

Figure 2

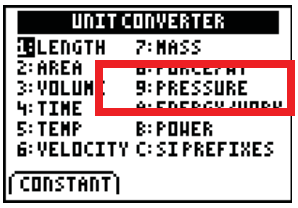

Figure 3

Hg to atm

1. To find out how many mm Hg is equivalent to a pressure of 1.0 atm, move the cursor to 'atm' and press [1] [ENTER] (Figure 4).

Figure 4

2. Move the cursor back to 'mmHg', and press ENTER again (Figure 5).

kPa to atm

1. To find out how many kPa is equivalent to a pressure of 1.0 atm, move the cursor to 'atm' and press 1 ENTER.
2. Now move back to 'kPa', and press ENTER again (Figure 6).

Constants

1. To determine the value of a constant, such as Avogadro's number N_A, select CONSTANT (press the WINDOW key—see Figure 6).
2. Scroll to highlight 'N_A' (Figure 7).
3. Move the cursor to **R** to get the universal gas law constant.
   - Notice that the units for R are J/K-mol (Figure 8).

Volume of One Mole of Gas at 1 atm

1. To determine the volume of one mole of a gas at 1 atm and 25°C (= 298 K), use the ideal gas equation

   $$V = nRT/P$$

   (= RT, since n = 1 mol and P = 1 atm)
2. To express R in terms of L-atm/K-mol, copy R and convert from J to L-atm.
   - Select COPY (press the TRACE key).
   - Select A:ENERGY/WORK.
   - Scroll to 'J' (the symbol for joules). Press ENTER (Figure 9).
   - Scroll to 'l-atm'.
   - Press ENTER (Figure 10).
   - Export (EXPT) this value of R by pressing the ZOOM key.

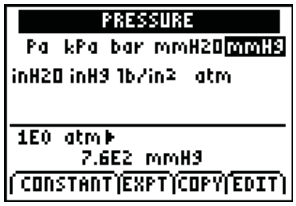

Figure 5

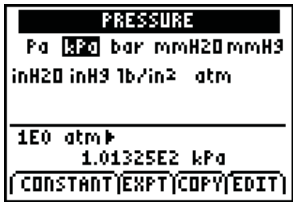

Figure 6

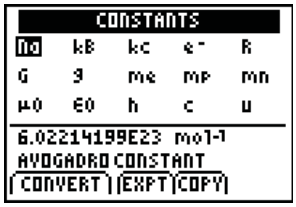

Figure 7

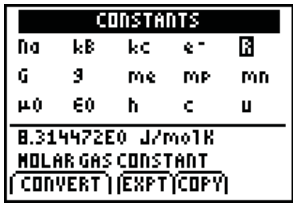

Figure 8

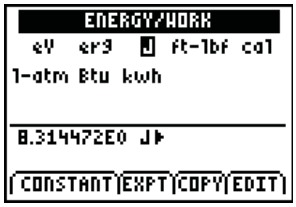

Figure 9

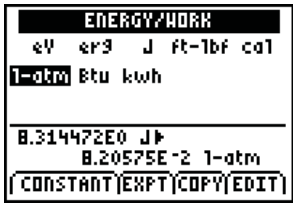

Figure 10

3. Press [2nd] [QUIT] and [2nd] [QUIT] again and then [Y=] to exit *SciTools*.

- The value of R in L-atm/K-mol should now appear on the calculator screen (Figure 11).

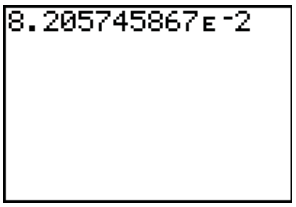

Figure 11

- Multiply R by 298 K to determine the volume in L of one mole of a gas at 1 atm and 298 K (Figure 12).
- Recall that V = RT for n = 1 mole and P = 1 atm.

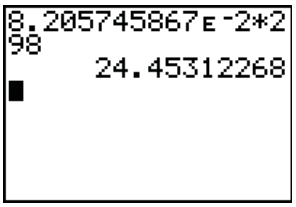

Figure 12

Practice with Conversion

Practice using the unit converter (select 2: UNIT CONVERTER in *SciTools*) to convert the following:

a. 1 m^3 to L
b. 3.0 in to cm
c. 1000 kwh to J
d. 25°C to K
e. 25°C to °F
f. 1 cup to tablespoons

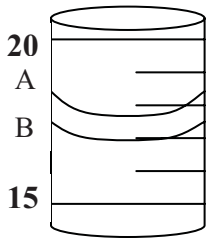

Figure 13

17 mL
17.0 mL
17.7 mL
15.4 mL

Introduction to Significant Figures

Significant figures indicate how accurately something is measured.

1. Only one digit (the last one) is uncertain.
   - Looking at Figure 13, circle and label the number below the figure which is the measurement for the liquid in the graduate to the "A" line.
   - Circle and label the number below the figure for the "B" line.

To tell how many significant figures are in a number, consider the following:

1. Non-zero digits are always significant.

2. Zeros in middle are always significant. (3.05 has 3 S.F., 1005 has 4 S.F.)

3. Leading zeros (those on the left) are never significant; they are placeholders (e.g .0072 has only 2 S.F.)

4. Trailing zeros (those on right) are only significant if they *are both to the right of the decimal point and to the right of a non zero digit*. (e.g. 350.00 has 5 S.F., 350 has only 2 S.F.)
   - Some conventions put a decimal point at the end of a number that ends in zero if they want to indicate the zero is significant (e.g. 350. has 3 S.F.)
   - In numbers like 965 000, use scientific notation to tell the number of places of accuracy in the measurement (the number of S. F.):

$$9.65 \times 10^5 \text{ (3 S.F.) or } 9.650 \times 10^5 \text{ (4 S.F.)}$$

5. Exact numbers have an infinite number of S.F. These would be counting numbers or defined quantities (e.g. 24 students or 100 cm =1 meter)

Operations

1. When *multiplying or dividing*, count the total number of S.F. in each factor.
2. Round off the answer to have the same number of S.F. as the factor with *the least number of S.F. in the entire number*.

$$842 \times 41.01 = 34120.32$$
$$= 34100$$

3. When *adding or subtracting*, round the answer to have the same number of places after the decimal point as the number with the *least number of digits after the decimal point*.

$$\begin{array}{r} 32.04 \\ +1.062 \\ \hline 32.102 = 33.10\text{g} \end{array}$$

Significant Figures

1. Determine how many significant figures are in the examples given below.

967 g	9.670
9067 cm	9.0670
2640 mL	9.00072 g
2640. mL	0.041 m
350,000 kg (put in Sci Notation using *SciTools*)	6.02×10^{23} atoms (use the EE tab on the screen)
0.0967 m	37 marbles

2. Check your answers using your TI-84 Calculator.
   - Press the APPS button, and select *SciTools*.
   - Press any key, and select 1: SIG-FIG CALCULATOR (see Figure 14).
   - Input the number, and press ENTER. The number of significant figures is indicated in the brackets, e.g. [3] for 2640 (Figure 15).
   - Select EXACT to indicate numbers without errors, e.g. 37 marbles.

Figure 14

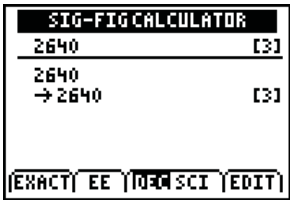

Figure 15

Practice

The following are some opportunities to use *SciTools* and the Significant Figure Calculator on the TI-84 Plus to solve typical chemistry problems expressing the answer in the correct number of S.F.

1. 159.72 g/24.0 cm^3
2. (6.63 x 10^{-34}Jsec)(4.530 x 10^{14} 1/sec)
3. 26 student x 127.3 kg/student
4. Calculate the atomic weight of Argon to three decimal places given the relative atomic masses and percent abundance of its isotopes:

Ar-36	35.968 u	0.337%
Ar-38	37.963 u	0.063%
Ar-40	39.962 u	99.600 %

5. Find the molar mass of $Ca(NO_3)_2$ to one place after the decimal point. Remember that atoms are an exact number.
   - How many moles are in 38.4 g of $Ca(NO_3)_2$?
6. Find the volume of 1.456 moles of gas that is stored in a cylinder at a pressure of 6.23 atm and a temperature of 25.0° C.
   - Use the Ideal Gas Law PV=nRT where R=.0821L·atm/(mol·K)
7. What volume of CO_2 at STP can be produced from the combustion of 752 g propane (Molar Mass = 44.1)?

$$C_3H_8 + 5O_2 \rightarrow 3\ CO_2 + 4\ H_2O$$

Answers

1. 6.66 g/cm^3

2. 3.00 x 10^{-19} J

3. 3310. kg

4. 39.947 u

5. A. 40.1 + (14.0 x 2) + (16.0 x 6) = 164.1 g/mol

6. B. (38.4 g)/(164.1 g/mol) = 0.234 moles

7. $V = \frac{1.456 \times .0821 \times 298.1}{} = 5.72$ L

8. 6.23

9. $$752\ \text{g}\ C_3H_8 \left[\frac{1\ \text{mole}\ C_3H_8}{44.1\ \text{g}}\right]\left[\frac{3\ \text{mole}\ CO_2}{1\ \text{mole}\ C_3H_8}\right]\left[\frac{22.4\ \text{L}}{1\ \text{mole}\ CO_2}\right] = 1150\ \text{L}$$