

## USE OF THE SCIENTIFIC CALCULATOR

Below are some exercises to introduce the basic functions of the scientific calculator that you need to be familiar with in General Chemistry. These instructions will work for *most but not all* makes of calculators. Especially for *Graphics Calculators (such as TI 82, TI 83, TI 85)*, you may be able to do the same thing with a different combination of keystrokes.

1. **To enter an exponent**, you need to use the key labeled  $\boxed{EE}$ ,  $\boxed{EX}$ , or  $\boxed{EXP}$ . Look for this key. For simplicity,  $\boxed{EXP}$  (for exponential) is used in the entire exercise.

To enter  $3 \times 10^4$ , press 3  $\boxed{EXP}$  4.

*Display:*  $3^{04}$  or 3 04 [This does NOT mean 3 to 4<sup>th</sup> power, but  $3 \times 10^4$  or 30,000!]

**NOTE:** It is a common mistake to enter it as 3  $\boxed{X}$  10  $\boxed{EXP}$  4, which would represent  $3 \times 10^5$  instead, as you had told the calculator to do  $3 \times 10 \times 10^4$ !

2. **To enter a negative number**, use the key labeled  $\boxed{+/-}$   $\boxed{CHS}$ . For simplicity  $\boxed{+/-}$  will be used here. (Be careful not to press the key for **subtraction**. You only want to change the sign to negative.) For Graphics Calculators, negative numbers are entered by pressing  $\boxed{-}$  before pressing the number. For example, to enter  $-3$ , press  $\boxed{-}$  3.

To enter  $3 \times 10^{-4}$ , press 3  $\boxed{EXP}$  4  $\boxed{+/-}$ .

*Display:*  $3^{-04}$  or 3 -04

To enter  $-3 \times 10^4$ , press 3  $\boxed{+/-}$   $\boxed{EXP}$  4.

*Display:*  $-3^{04}$  or -3 04

### 3. Multiplication & Division of Numbers in Exponential Form

- a. Calculate  $(3 \times 10^4)(2 \times 10^3)$ .

Press 3  $\boxed{EXP}$  4  $\boxed{\times}$  2  $\boxed{EXP}$  3  $\boxed{=}$

*ans.*  $6 \times 10^7$

- b. Calculate  $(-4.827 \times 10^6)(2.17 \times 10^{-4})$ .

*ans.*  $-1047.459$

or  $-1.047459 \times 10^3$

(Record as  $-1.05 \times 10^3$ )

*If you didn't get this ans., try this:*

4.827  $\boxed{+/-}$   $\boxed{EXP}$  6  $\boxed{\times}$  2.17  $\boxed{EXP}$  4  $\boxed{+/-}$   $\boxed{=}$

c. Calculate  $\frac{(3.89 \times 10^2)(3.7 \times 10^{-4})}{(2.1 \times 10^3)(1.64 \times 10^{-6})}$

ans. 41.791521 (Record as 42)

If you didn't get this ans, try this:

3.89 [EXP] 2 [X] 3.7 [EXP] 4 [+/-] [÷] 2.1 [EXP] 3 [÷] 1.64 [EXP] 6 [+/-] [=]

d. Calculate with your calculator  $10^3 \times 10^4$  ans.  $10^7$

If you didn't get this ans, try this: 1 [EXP] 3 [X] 1 [EXP] 4 [=]

e.  $\frac{10^8 \times 10^2}{10^{-6}}$  ans.  $10^{16}$

If you didn't get this ans, try this: 1 [EXP] 8 [X] 1 [EXP] 2 [÷] 1 [EXP] 6 [+/-] [=]

#### 4. Order of Operations

The calculator will perform these functions in this order: 1) powers and roots (such as squares and square roots); 2) functions within parentheses; 3) x and ÷; 4) + and -.

a.  $\frac{3 \times 6}{2 + 4}$  ans. 3

If you didn't get this ans, try this: 3 [X] 6 [÷] ( 2 [÷] 4 ) [=]

If you simply did 3 [X] 6 [÷] 2 [÷] 4 [=], you will get the erroneous answer of 13, because you have actually told the calculator to perform  $\frac{3 \times 6}{2} + 4$ . The calculator performed “÷2” before “+4”.

b.  $\frac{3 + 7}{4 \times 5}$  ans. 0.5

If you didn't get this ans, try this: ( 3 [÷] 7 ) [÷] 4 [÷] 5 [=]. You press [÷] 5 rather than [X] 5 because 5 is in the denominator and so you want to divide by 5.

It is a common mistake to do 3 [÷] 7 [÷] 4 [X] 5, which gives you the erroneous answer of 11.75 or 12.5, depending on the model of your calculator. You have actually told the calculator to perform  $3 + \frac{7}{4} \times 5$  instead!

If you have trouble with remembering the order of operations, you might want to routinely write in parentheses for the numerator and for the denominator:  $\frac{(3+7)}{(4 \times 5)}$

c.  $\frac{3 \times 6}{4 \times 5}$  ans. 0.9

d.  $\frac{(3 - 7)(4 + 6)}{-(2 + 3)}$  *ans.* 8

g.  $\frac{3 \times 4}{7 \times 8/9}$  *ans.* 1.9285714

5. Calculate  $0.000\ 000\ 000\ 25 \times 12345678999$

*ans.* 3.1

(Graphics calculators give 3.08641975, which should then be recorded as 3.1)

*Unless you have a graphics calculator, you probably cannot enter this many digits. The solution is to express your number in scientific notation and/or round off to a more manageable number of digits. In this example, 0.000 000 000 25 must be entered as  $2.5 \times 10^{-10}$  and 12345678999 entered as  $1.23 \times 10^{10}$  to give 3.075 which is rounded to 3.1. (Rules on significant figures and rounding off numbers are covered elsewhere.)*

6. Do you know how to **interconvert between nonexponential mode and scientific mode**? You can do this in your head, but here is how your calculator can do it for you.

Enter 187.85. Can you convert the display to show  $1.8785 \times 10^2$ ? Your calculator most likely uses one of the following procedures for the interconversion:

*TI 81 , TI 82 , TI 83:* Press Mode , use → to highlight NORM or SCI on display  
 Press ENTER  
 Press CLR or EXIT to return to regular screen  
 Enter the number then press ENTER  
*You could enter the number first, then do the steps described above.*

*Casio fx 250:* Mode 9 is normal (nonexponential), Mode 8 is scientific notation

Use Mode 8 9 to show scientific notation with 9 digits.

*Display:*  $1.87850000 \times 10^2$

Use Mode 8 2 to show scientific notation with 2 digits.

*Display:*  $1.9 \times 10^2$

Use Mode 9 to return to nonexponential form.

*Display:* 187.85

*other Casios:* Mode 1 is FIX

Mode 2 is SCI

Mode 3 is NORM

Use Mode 2 9 to show scientific notation with 9 digits.

Use Mode 3 1 to show nonexponential which automatically switches to sci. notation when the number is less than .01

Use Mode 3 1 to show nonexponential which automatically switches to sci. notation when number is less than .000001

TI 25x: Press  $\boxed{\text{X}} 1 \boxed{\text{EE}}$  = to switch to scientific notation  
Press  $\boxed{2^{\text{nd}}} \boxed{\text{EE}}$  to switch back to nonexponential form

Sharp, & some others:  $\boxed{\text{INV}} \boxed{\text{EE}}$  converts numbers to nonexponential form  
 $1 \boxed{\text{X}} \boxed{\text{EE}}$  converts numbers to scientific notation

Certain models: Use  $\boxed{2^{\text{nd}}} \boxed{\text{F}}$  and  $\boxed{\text{FSE}}$  where F or FD means floating decimal (normal display)  
S or SCI means scientific notation  
E means engineering

**For Gen Chem I students, you can skip this next section on log and natural log and go to the “Extra Calculator Drill” on the last page of this tutorial.**

**For Gen Chem II students, you do need to know how to find log and antilog ( $\log^{-1}$ ) of a number. Continue with Step 7 below.**

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## 7. Log and Antilog

To find the log of a number you simply enter the number and then press LOG.

To find the antilog of a number you enter the number and then press the  $10^x$  key. Usually this is the second function of the same key you used for LOG. In most calculators, the label for  $10^x$  appears above the key for LOG. To access that function you press the INV or SHIFT or  $2^{\text{nd}}$  key (depending on what brand of calculator you have) before pressing LOG.

- a.  $\log 5$  *ans.* 0.69897 (recorded as 0.7 for proper sig. fig. \*)
- b.  $\text{antilog } 5$  *ans.* 100000 or  $10^5$
- c.  $\log \text{ of } 5.2 \times 10^{-3}$  *ans.*  $-2.2839967$  (recorded as  $-2.28$  for proper sig. fig.)  
(\*Rules on treatment of significant figures for log and antilog are covered on the next page.)

*If you get an error message you probably did not enter the number in the proper format.*

*You should enter it as 5.2 EXP  $-3$  LOG rather than  $5.2 \times 10^{-3}$  LOG because the calculator is going to calculate log of  $-3$ , which is impossible because you cannot calculate the log of a negative number. By entering 5.2 EXP  $-3$ , the calculator is treating it as ONE number ( $5.2 \times 10^{-3}$ ). By entering  $5.2 \times 10^{-3}$ , the calculator is treating it as TWO numbers that you want multiplied: 5.2 and  $10^{-3}$ . When you press LOG, it “thinks” you want the log of the last number ( $-3$ ).*

d.  $\log$  of  $\frac{3.85 \times 10^4}{2.00}$  *ans.* 4.284430734... (recorded as 4.284)

*If you didn't get this ans. try this:*  $\boxed{[ ( ] 3.85 \boxed{[ EXP ] 4 \boxed{[ \div ] 2.00 \boxed{[ ) ] \boxed{[ LOG ]}$

or  $3.85 \boxed{[ EXP ] 4 \boxed{[ \div ] 2.00 \boxed{[ = ] \boxed{[ LOG ]}$

*(You need to complete the division before pressing the LOG key. If you just pressed the keys in this order 3.85 EXP 4 ÷ 2.00 LOG you are asking the calculator to calculate log of 2.00 !)*

e. antilog of  $7.2 \times 10^{-2}$  *ans.* 1.18

*Try this:*  $7.2 \boxed{[ EXP ] 2 \boxed{[ +/- ] \boxed{[ 10^x ]}$

### 8. Natural log (ln) and antinatural log (antiln)

Natural logarithm works the same way. Use ln for natural log and the  $e^x$  key for antinatural log. Again,  $e^x$  is usually the second function of the same key you used for ln, to be accessed by pressing either INV, SHIFT or  $2^{nd}$  key first. (\*Rules for sig. fig. are shown in the boxed are below.)

a. ln of 3.2 *ans.* 1.1631508 (recorded as 1.16)

b. antiln of  $1.2 \times 10^{-3}$  *ans.* 1.0012007 (recorded as 1.001)  
 (Remember to enter the number as 1.2 EXP -3.)

#### **Rules for handling significant figures for log, antilog, ln and antiln:**

**When you find the log of a number, the number of significant figures of that number is the number of decimal places of the answer.**

Example 1:  $\log 5.1 = ?$  *Ans.* 0.71  
 5.1 has 2 sig. fig. so ans 0.707570... should be rounded to 2 decimal places.

Example 2:  $\log 0.0327 = ?$  *Ans.* -1.485  
 0.0327 has 3 sig. fig. so -1.4854... should be rounded to 3 decimal places.

Example 3:  $\log 2 \times 10^{-2} = ?$  *Ans.* -1.7  
 $2 \times 10^{-2}$  has 1 sig. fig. so ans -1.6989... should be rounded to 1 decimal place.

**When you find the antilog of a number, the number of decimal places of that number in NONEXPONENTIAL FORM is the number of significant figures of the answer.**

Example 4: antilog  $3.2 \times 10^{-2} = ?$   
 You must **first** convert  $3.2 \times 10^{-2}$  to **nonexponential form**: 0.032  
 0.032 has 3 decimal places so ans 1.076465... should be rounded to 1.08 (3 sig. fig.)

**Significant figures for ln and antiln work the same way:**

Example 5:  $\ln 7.5 = 2.01$  (7.5 has 2 sig. fig. so ans should be in 2 decimal places.)

Example 6: antiln  $2.7 \times 10^{-1} = 1.3$  ( $2.7 \times 10^{-1} = 0.27$  has 2 decimal places, so ans is in 2 sig. fig.)

## EXTRA CALCULATOR DRILL FOR GEN CHEM I and GEN CHEM II

Now that you have gone through the tutorial, let's see whether you have learned how to use your calculator properly. For simplicity, round your answers to 2 significant figures. Practice for significant figures is provided elsewhere. If you having trouble getting the answers provided in the drill below, get help immediately. You cannot afford to wait!

$$9. (5.2 \times 10^7)(4.9 \times 10^9) = 2.5 \times 10^{17}$$

$$10. (-2.6 \times 10^5)(7.2 \times 10^{-8}) = -1.9 \times 10^{-2}$$

$$11. \frac{(3.8 \times 10^5)(2.7 \times 10^9)}{(1.8 \times 10^7)(4.9 \times 10^6)} = 1.2 \times 10^1$$

$$12. \frac{(6.3 \times 10^6 + 2.7 \times 10^8)}{7.8 \times 10^4} = 3.5 \times 10^3$$

$$13. \frac{(2.3 \times 10^8)(5.2 \times 10^{-3})}{(7.3 \times 10^{-7}) + (6.2 \times 10^{-4})} = 1.9 \times 10^9$$

$$14. \frac{10^8 \times 10^{-12}}{10^{23} \times 10^{-19}} = 10^{-8}$$

(Although some of you can do this in your head, use your calculator to do the calculations in questions #14 thru 16 to make sure you know how to use your calculator properly.)

$$15. 3.7 \times 10^{-6} \left( \frac{10^{22}}{10^{-38}} \right) = 3.7 \times 10^{54}$$

$$16. 2.1 \times 10^{-8} \left( \frac{1}{10^{-3}} \right) \left( \frac{10^{-9}}{1} \right) = 2.1 \times 10^{-14}$$

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**For Gen Chem II students continue to 17 thru 20 for practice on the log and antilog functions.**

$$17. \text{ Find the log of } 7 \times 10^{-4} \quad \text{Ans. } -3.15490196 \text{ (recorded as } -3.2)$$

$$18. \text{ Find the antilog of } -6.92 \quad \text{Ans. } 8,317,637.711 \text{ (recorded as } 8.3 \times 10^6)$$

$$19. \text{ Find the natural log of } 5.7 \times 10^{-5} \quad \text{Ans. } -9.772459 \text{ (recorded as } -9.77)$$

$$20. \text{ Find the anti natural log of } -2.78 \times 10^{-1} \quad \text{Ans. } 0.972582864 \text{ (recorded as } 0.973)$$