

**RULES FOR SEQUENCE OF MATHEMATICAL OPERATIONS**  
<http://cba.unomaha.edu/faculty/mohara/web/MICf10-Math-Rules.pdf>

Please Excuse Me, Dear Aunt Sally

- |    |  |                                       |
|----|--|---------------------------------------|
| 1. | Do all work within <b>P</b> arenthesis?                              | Accordingly,                          |
| 2. | Do all <b>E</b> xponents and roots.                                  | $1 + 2 - 3^2 / 4 * 5 = - 8.25$        |
| 3. | Do all <b>M</b> ultiplications and <b>D</b> ivisions, left to right. | but,                                  |
| 4. | Do all <b>A</b> dditions and <b>S</b> ubtractions, left to right.    | $\{(1 + 2) - [3^2 / 4]\} * 5 = +3.75$ |

**QUADRATIC EQUATION**

when  $0 = ax^2 + bx + c$  then  $x = [ -b \pm \sqrt{ (b^2 - 4ac) } ] \div 2a$

**RULES FOR EXPONENTS**

- |    |                     |    |                                   |
|----|---------------------|----|-----------------------------------|
| 1. | $x^0 = x^0 = 1$     | 5. | $[x \div y]^z = x^z \div y^z$     |
| 2. | $x^1 = x^1 = x$     | 6. | $x^y \div x^z = x^{y-z}$          |
| 3. | $[xy]^z = x^zy^z$   | 7. | $x^{-y} = [1 \div x^y]$           |
| 4. | $x^y x^z = x^{y+z}$ | 8. | $\ln e = 1$                       |
| 5. | $[x^y]^z = x^{yz}$  | 9. | $\exp(22) \text{ equals } e^{22}$ |

**RULES FOR FRACTIONAL EXPONENTS**

1.  $x^{1/z} = z\sqrt{x}$
2.  $x^{y/z} = [z\sqrt{x}]^y = [z\sqrt{x^y}]$

**RULES FOR ROOTS**

1.  $z\sqrt{x^z} = x$
2.  $z\sqrt{[ab]} = [z\sqrt{a}] [z\sqrt{b}]$
3.  $z\sqrt{[a \div b]} = [z\sqrt{a}] \div [z\sqrt{b}]$
4.  $y\sqrt{[z\sqrt{x}]} = yz\sqrt{x}$
5.  $z\sqrt{x^y} = [z\sqrt{x}]^y = x^{y \div z}$

## RULES FOR SUMMATIONS

1.  $\sum [x + y] = [\sum x] + [\sum y]$
2.  $[\sum xy] \neq [\sum x] [\sum y]$
3.  $[\sum x^y] \neq [\sum x]^y$
4. For a constant  $k$  and summation over  $n$  items,
  - a.  $\sum k = nk$
  - b.  $\sum [x + k] = [\sum x] + nk$
  - c.  $[\sum kx] = k[\sum x]$

## RULES FOR LOGS

1. If  $b^x = y$ , then  $x = \log_b y$     *See #5 below re  $b = 10$ .*
2.  $\log_b [xw] = \log_b x + \log_b w$
3.  $\log_b [x \div w] = \log_b x - \log_b w$
4.  $\log_b [x^z] = z \log_b x$
5. With log base 10 (i.e.,  $\log_{10}$ )  
may use mantissas and characteristic.
6. Natural logs, written  $\ln$ , use a base of  $e$ .  
 $e \approx 2.718$     also, recall     $\ln e = 1$ .
7. When  $e$  is raised to a power it is written as "exp"  
or as "Exp". For example,  $\exp(22)$  equals  $e^{22}$ .

## RULES FOR THE CALCULUS

1.  $\frac{dY}{dX} = \lim_{\Delta X \rightarrow 0} \frac{\Delta Y}{\Delta X}$

2. if  $Y = k$  a constant, then  $\frac{dY}{dX} = 0$

3. if  $Y = aX^b$  then  $\frac{dY}{dX} = b a X^{b-1}$

### Second Derivative:

and then **NOTE: (-) = max (+) = min**

$$\frac{d^2Y}{dX^2} = (b-1) b a X^{(b-1)-1}$$

**if  $U = g(X)$  and  $W = h(X)$**

4. if  $Y = U + W$  then  $\frac{dY}{dX} = \frac{dU}{dX} + \frac{dW}{dX}$

5. if  $Y = U - W$  then  $\frac{dY}{dX} = \frac{dU}{dX} - \frac{dW}{dX}$

6. if  $Y = U * W$  then  $\frac{dY}{dX} = U \frac{dW}{dX} + W \frac{dU}{dX}$

7. if  $Y = U \div W$  then  $\frac{dY}{dX} = \frac{W \frac{dU}{dX} - U \frac{dW}{dX}}{W^2}$

Chain Rule: Function of a Function

8. if  $Y = f(W)$  and  $W = g(X)$  then  $\frac{dY}{dX} = \frac{dY}{dW} * \frac{dW}{dX}$

### 9. Partial Derivatives:

if  $Y = f(W,Z)$  where  $Y = k + aW^b + aZ^c + aW^bZ^c$   
 which is equal to  $Y = kW^0Z^0 + aW^bZ^0 + aW^0Z^c + aW^bZ^c$   
**then**

$$\frac{\delta Y}{\delta W} = 0 + b a W^{b-1} + 0 + b a W^{b-1} Z^c \text{ hints: recall } X^0 = 1 \text{ and note } 0 * X = 0$$

**and**

$$\frac{\delta Y}{\delta Z} = 0 + 0 + c a Z^{c-1} + c a W^b Z^{c-1}$$