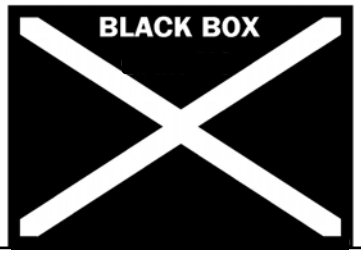
$f\Sigma\alpha\circledR$
$\eta°$
$\wedge\wedge\alpha\tau\Pi$

Rick Mealy
Wisconsin DNR



George Bowman
Wisconsin State
Lab of Hygiene

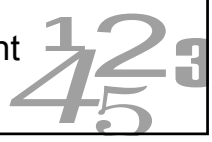
Disclaimer

Any reference to product or company names does not constitute endorsement by the Wisconsin State Laboratory of Hygiene, the University of Wisconsin, or the Department of Natural Resources.

Topics

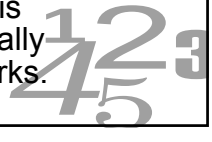
I have hardly ever known a mathematician who was capable of reasoning.
- Plato

- Math Myths
- So… Do U Sudoku?
- Allergic to Algebra
- C1V1 ≠ R2D2
- What did you Geomean by that?
- Prozac for Linear Depression
  - Surviving the Slippery Slope
  - The "Nerds" Equation
  - Not Another Favre Intercept (ion)
  - Relating to Correlation
- So…Deviation that is Standard is a Good Thing?
- 8.34 is a Magic Number
- Magical Math is not a Criss Angel Stunt



Dispelling Math Myths

- **Myth #1 It takes a math mind to be good at math.**
  Math must be nurtured with a supportive learning environment that promotes risk taking and creativity, one that focuses on problem solving.
- **Myth #2 There is one way to solve a problem.**
  There are a variety of ways to solve math problems and a variety of tools to assist with the process.
- **Myth #3 Math requires pure logic.**
  Sure, logic helps….but you need not be a 'Mr. Spock'. Creative thinking helps frame concepts such that you 'see' thing according to your particular learning style.
- **Myth #4 It's all about getting the right answer.**
  The most important aspect to learning math is understanding. Always ask yourself if you really 'understand' how and why the procedure works.



Allergic to Algebra

- Linear regression equations are in the form **Y = mX + b**
- m = slope; b = intercept
- Since X = concentration, and Y = absorbance…..
- This solves for absorbance…which we already KNOW
- Therefore we have to "re-arrange" the equation….

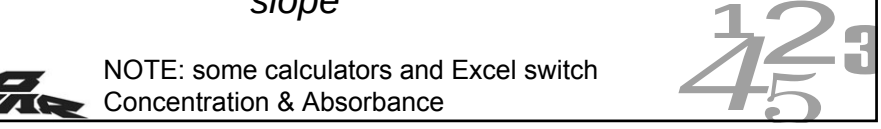
We have to get from this:

Absorbance = *slope* x Concentration + *intercept*

To this (by using simple algebra):

$$\frac{\text{Absorbance} - \textit{intercept}}{\textit{slope}} = \text{Concentration}$$

NOTE: some calculators and Excel switch Concentration & Absorbance



Allergic to Algebra?

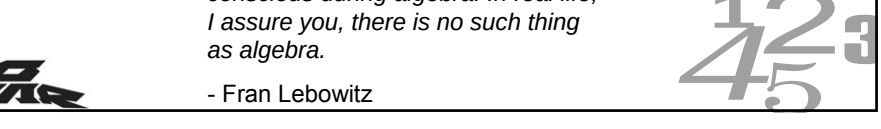
$$Y = mX + b\text{??} \quad \text{or} \quad X = \frac{(Y - b)}{m}$$

4 step solution to solving algebra problems.

1. Write a statement (equation) that involves what is known and not known:
2. Substitute values for as much as you can.
3. Treat both sides of the equation equally to SIMPLIFY the equation
4. Repeat step 3 as needed

Stand firm in your refusal to remain conscious during algebra. In real life, I assure you, there is no such thing as algebra.

- Fran Lebowitz



Allergic to Algebra 2

Order of Operations:

In order to simplify a mathematical expression:

1. **Calculate any values inside all grouping symbols; i.e. (), [ ], or { } such as { [( )] }**
2. **Simplify any terms with exponents** *(rare)*
3. **Multiply and/or divide in order from left to right**
4. **Add and/or subtract in order from left to right**

The following mnemonic saying will help to remember the order of the 'Order of Operations' :

Please **E**xcuse **M**y **D**ear **A**unt **S**ally

Parentheses
Exponents
Multiplication
Division
Addition
Subtraction

Johnny Mnemonic

- A mnemonic is a memory aid. For example the name Roy G. Biv is a mnemonic for remembering the order of the colors in a rainbow. Red Orange Yellow Green Blue Indigo Violet.

R*un Over Your Gerbil* B*ecause* I*t's* V*icious!!!*

- **Dividing Fractions: "K**e**ntucky** C**hicken** F**ried"** Notice the name is switched a little from the famous fast-food chicken joint. Use "Kentucky Chicken Fried" to remember KCF.
- **K** -- Keep (the first fraction)
- **C** -- Change (sign from ÷ to ⊗)
- **F** -- Flip (the last fraction)

$$\frac{3/4}{1/2} =$$

Johnny Mnemonic 2

Please Excuse My Dear Aunt Sally reminds us that solving math is not like simple reading from right to left.

2 + 3 x 6

Is the answer 30? or 20?

We get 30 if we perform the operation in sequence

2 + 3 = 5

Then 5 x 6 = 30

But the answer is **20**!

3 x 6 = 18

2 + 18 = 20.

Multiplication comes before addition in the mnemonic (My comes before Aunt), therefore, we must multiply before we add.

OK…Now try this!

(((4 x 3) / 2) x (9 / 3))

First try coloring the parentheses to keep things straight:

(((4 x 3) / 2) x (9 / 3))

Solve the innermost parentheses first.

((12 / 2) x 3)

Much easier! Solve for the last inner parentheses. (12/2) = 6

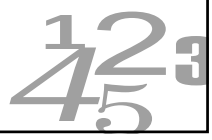
= (6 x 3)

Now we have:

(6 x 3)

= 18

It's that easy.



Allergic to Algebra 3

Simplifying Equations begins with Canceling Values/Variables

To Cancel, Do the Opposite

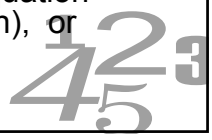
For example, the opposite of "adding 3" is "subtracting 3".

In Algebra, every operation is paired with its "opposite":

- Cancel Addition with Subtraction,
- Cancel Multiplication with Division,
- Cancel Powers with Roots, and
- Cancel Reciprocals with Reciprocals.

When trying to simplify an equation, we *really* only have two options:

- substitute an equal expression for part of an equation (which includes "simplifying" part of an equation), or
- do the same thing to both sides.



Allergic to Algebra 4

Example: *You receive an economic stimulus check (right!) of $525.00. You owe $150.00 on your Best Buy card with a 19.99% interest rate. Your other 5 credit cards all have similar balances and interest rates. So you want to pay off the one high interest card and make equal payments on the other 5 cards. How much of a payment will you make on each of the 5 cards.*

- Step 1: Write a statement (equation) that involves what is known and not known:

  Total stimulus check= Best Buy Card balance + 5 equal payments
- Step 2: Substitute values for as much as you can:

  $ 525 = $150 to Best Buy + 5 equal payments
- Step 3: Treat both sides of the equation equally — *subtract $150 from both sides:*

  $ 525 (-$150) = $150 (-$150) + 5 equal payments

  = $ 375 = 5 equal payments
- Step 4: Treat both sides of the equation equally — divide both sides by 5:

  $\frac{\$\ 375}{5} = \frac{5}{5}$ equal payments

  = $ 75 = 1 equal payment

Y= mX + b?? or X= (Y - b) / m

$Y = mX + b$

This solves for absorbance (response) which we already know.
What we DON'T know, is the concentration of X.

$Y - b = mX + b - b$

$\rightarrow Y - b = mX$

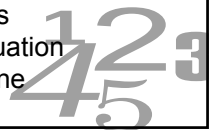
Subtracting 'b' from both sides removes 'b' from the right side of the equation.

$\frac{Y - b}{m} = \frac{\mathbf{mX}}{m}$

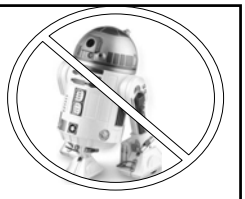
Dividing both sides by 'm' removes 'm' from the right side of the equation.

$X = \frac{Y - b}{m}$

…and that is why you'll hear an auditor use this equation. As long as X is concentration and Y is response, then this is the equation that must be used to determine sample concentration.



$C_1V_1 \neq R_2D_2$



$$C_1V_1 = C_2V_2$$

(Concentration of existing solution)

x

(Volume of existing solution)

=

(desired concentration of new solution)

x

(desired volume of new solution)

$C_1V_1 \neq R_2D_2$

Basic Rules for Solving $C_1V_1 = C_2V_2$ Problems.

(1) 3 of the 4 values must be known.

(2) The units of volume and concentration must be the same respectively.

(3) Either C_1V_1 or C_2V_2 must be known and it must be clear which is which.

(4) Any unit of volume or concentration may be used

Mathematics is the science which uses easy words for hard ideas.

--Kasner, E. and Newman, J

Tricks to $C_1V_1=C_2V_2$

$$C_1V_1 = C_2V_2$$

C1 = Concentration of original solution
C2 = Concentration of final (diluted) solution

V1 = Volume of original solution
V2 = Volume of final (diluted) solution

Serve as sort of mnemonic reminders:

$$C_1 > C_2$$

$$V_1 < V_2$$

The concentration of the original solution is always greater than that of the final (diluted) solution. And the final solution is larger in volume.

Logical: when we dilute, we ADD water, *increasing* the volume and *decreasing* the concentration.

$C_1V_1 \neq R_2D_2$

You have a 50 mg/L Phosphorus stock standard. You want to make a 'working' solution of 2 mg/L from which to prepare calibration standards. You want to make 100 mLs of this 'working' standard.

C_1 = 50 mg/L C_2 = 2 mg/L

V_1 = ? mL V_2 = 100 mL

$C_1 > C_2$ ...so 50 mg/L must be C_1

$(50 \times V_1) = (4 \times 100)$

$(50 \times V_1) = 200$ *Divide both sides by 50!!!)*

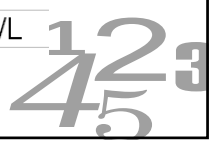
$V_1 = 200 \div 50$

$V_1 = 4$ mL

C1V1 problem
YOUR turn!

- Joe Consistent Analyst wants to make a spike for Test N Tube Phosphorus.
- The Test n Tube Volume is 5 mLs total (spike + sample)
- He wants the spike concentration to be 0.5 mg/L
- …and he wants to use 0.1 mL of spike
- What concentration spike solution must he use?

C1=	25	mg/L		C1* V1	=	C2* V2	
V1=	0.1	mL		0.1x	=	2.5	
C2=	0.5	mg/L		0.1		0.1	
V2=	5	mL		x	=	25	
				C1	=	25	mg/L



What did you geomean by that?

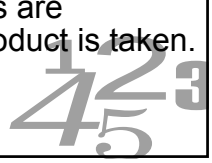
- The geometric mean answers the question, "if all the quantities had the same value, what would that value have to be in order to achieve the same product?

  A * B * C… * Zn = Product = X * X * X… * Xn

- Any time **you have a number of factors contributing to a product**, and you want to find the "average" factor, the answer is the geometric mean.
- The geometric mean is always less than the arithmetic mean. (*equal to the arithmetic mean when all individual values are the same*)

  (10,10,10,10) Arithmetic mean = 10 = Geomean

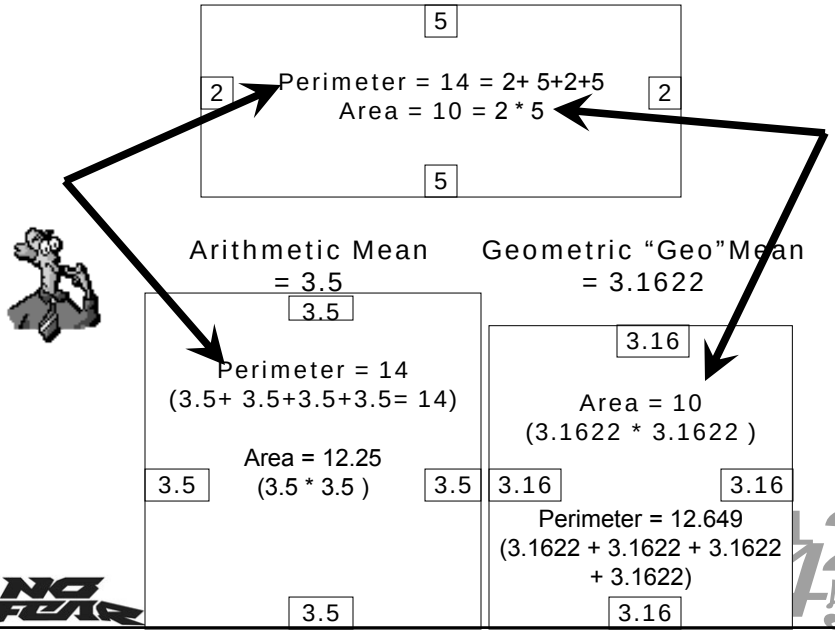
- The geometric mean is similar to the arithmetic mean, which is what most people think of with the word "average," except that instead of adding the set of numbers and then dividing the sum by the count of numbers in the set, n, the numbers are multiplied and then the nth root of the resulting product is taken.



Geomean vs. arithmetic mean

- The **arithmetic mean** is relevant any time **several quantities add together to produce a total**. The arithmetic mean answers the question, "*if all the quantities had the same value, what would that value have to be in order to achieve the same total*?"
- In the same way, the **geometric mean** is relevant any time **several quantities multiply together to produce a product**. The geometric mean answers the question, "*if all the quantities had the same value, what would that value have to be in order to achieve the same product*?"

What are the geomean and arithmetic mean of the numbers 2,5?



Geomean simplified

The geometric mean of a data set $[a_1, a_2, \ldots, a_n]$ is given by

$$= \sqrt[n]{a_1 \cdot a_2 \cdot \cdots \cdot a_n}.$$

- ..or the nth root of each of the values in the data set multiplied together.
- If roots scare you off, "powers" can be used:
- Geomean = $(a_1 \bullet a_2 \bullet a_3 \ldots \bullet a_n)^{1/n}$

Fishing may be said to be so like mathematics that it can never be fully learned.
- Walton, Izaak

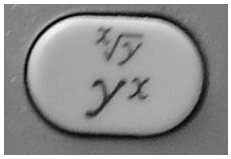
Getting square on roots

You can find any nth root of a number X, by simply raising the X to the **1/n** power *[Excel formula: = X^(1/n)]*

$2 \times 2 = 2^2 = 4$ $\qquad \sqrt[2]{4} = 4^{½}$ $4^{0.5} = 2$

$4 \times 4 \times 4 = 4^3 = 64$ $\qquad \sqrt[3]{64} = 64^{⅓}$ $64^{0.333} = 4$

Fecal counts of 28,50,112,and 94 are obtained. What is the geomean to report?



28 x 50 x 112 x 94 = 14739200
Find the 4th root of 14739200

$\sqrt[4]{14739200} = 1473920064^{¼}$

$= 14739200^{0.25} = 61.96$

14739200= 61.96 x 61.96 x 61.96 x 61.96

What did you geomean by that?

Using Excel to find the geomean of fecal coliform data: 10, 20, 18, and 50 cfu/100 mL

	A	B	C
27			
28		10	cfu/100 mL
29		20	cfu/100 mL
30		18	cfu/100 mL
31		50	cfu/100 mL
32			
33	mean	24.5	=AVERAGE(B28:B31)
34	geomean	20.598	=GEOMEAN(B28:B31)
36		20.598	=180000^0.25

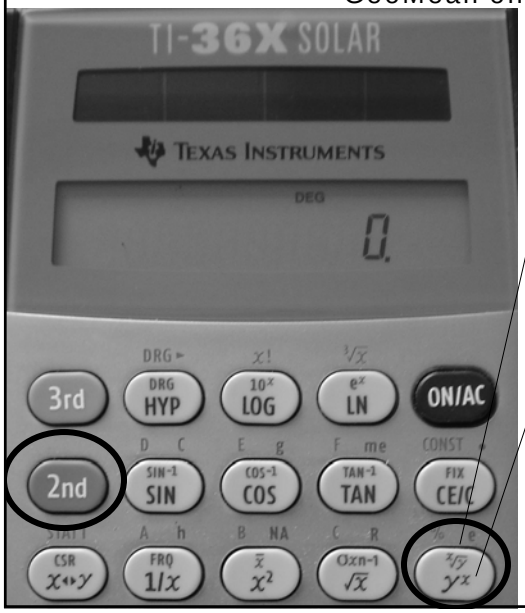
$10 \otimes 20 \otimes 18 \otimes 50 = 180000$

$\sqrt[4]{180000} = 180000^{1/4}$

$= 180000^{0.25} = 20.598$

What did you geomean by that?

GeoMean on an inexpensive calculator

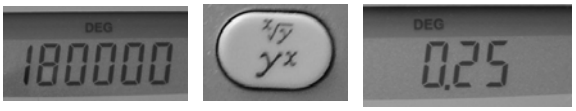


The $\sqrt[x]{y}$ key allow you to calculate any geomean. Just multiply the values together, press this key (+ 2nd) and then enter the number of values.

The y^x key also allows you to calculate any geomean. Just multiply the values together, press this key (+ 2nd) and then enter the decimal equal to 1 ÷ the number of values.

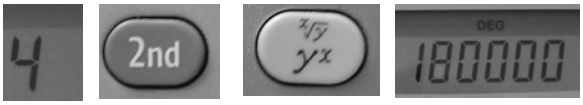
What did you geomean by that?

GeoMean on an inexpensive calculator



$180000^{1/4}$

Or…



$\sqrt[4]{180000}$

=

Geomean is used in finance

Geomean is used to determine the average return on investments over a period of years.

start with	return		$10,000.00	return	10,000.00
2004	5%		$10,500.00	-2.63%	$ 9,737.48
2005	17%		$12,285.00	-2.63%	$ 9,481.85
2006	7%		$13,144.95	-2.63%	$ 9,232.93
2007	11%		$14,590.89	-2.63%	$ 8,990.55
2008	-40%		$ 8,754.54	-2.63%	$ 8,754.53
	0%	mean			

geomean = -2.63%

Geomean is a little more realistic in saying the investment averaged a loss. But that's little comfort after losing $2000 on the initial investment and almost $6,000 in one year

On-line Geomean Calculator

Geometric Mean Calculator Results

Number of points	4	Arithmetic mean	24.50	Graphs are currently not available.
Geometric mean	20.60	Maximum value	50.00	
Standard deviation	17.54	Sum of points	98.00	
Minimum value	10.00	Equation is	y=11.80 x + -5.00	

Horton's Geometric Mean Calculator

Revised 03/21/2007

Enter 2 to 100 values. Do not leave blanks between values.
NEED HELP?

POINT 1:	10	POINT 2:	20	POINT 3:	18	POINT 4:	50
POINT 5:		POINT 6:		POINT 7:		POINT 8:	

http://www.graftacs.com/geomean.php3

More On-line Geomean help

http://instacalc.com/v0.5/

Math. Fast. instacalc

Instant results.
Variables and formulas.
Shareable. Linkable. Lovable.

Examples: BMI Hourly Wage Temperature Met
Dice Website earnings

Overview | Quickstart | Reference | About

1 POW(180000,0.25) 20.597671439071177

Easy Calculation.com

Geometric Mean - Calculator

To Calculate Geometric Mean :

www.easycalculation.com/statistics/geometric-mean.php

Enter all the numbers separated by comma ",".
E.g: 13,23,12,44,55

10,20,18,50

calculate

Results:

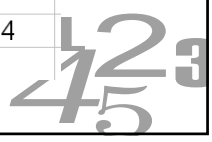
Total Numbers: 4

Geometric Mean: 20.59767

Geomean problem
YOUR turn!

- An operator has 4 fecal coliform results for the month of June. Calculate the geomean that s/he should report.
- Results= 81, 256, 39,81

3^4 =	**81**	$\sqrt[4]{81}$	=	3	
4^4 =	**256**	$\sqrt[4]{256}$	=	4	
2.5^4 =	**39**	$\sqrt[4]{39}$	=	2.5	
3^4 =	**81**	$\sqrt[4]{81}$	=	3	
Mean=	114.25				
Geomean=	89.964				
81 * 256 * 39 * 81=		$\frac{65505024}{\sqrt[4]{65505024}}$		= 89.964	
2.5 * 4 * 2 * 3=		89.963978			

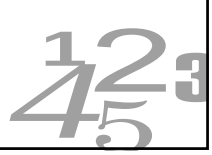


Prozac for Linear Depression

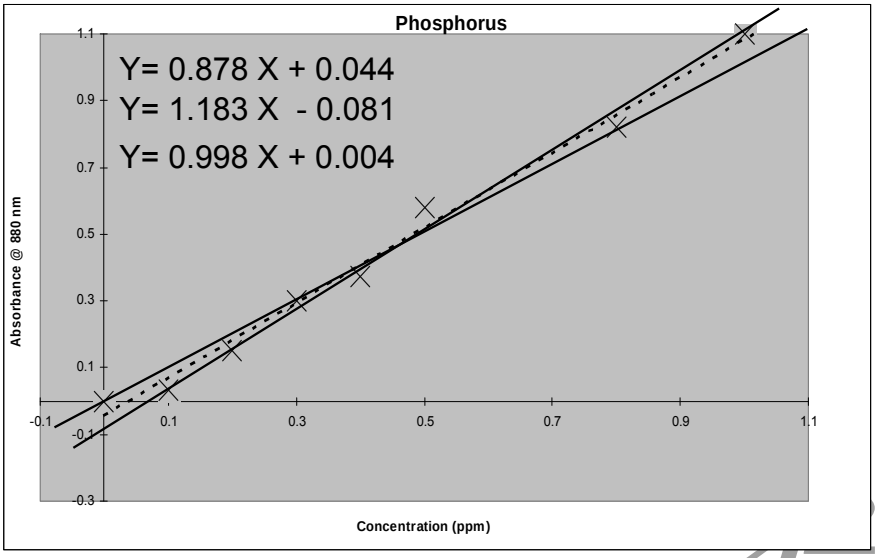
- A linear regression mathematically determines the line which minimizes the difference between each of the calibration points and the resultant line.
- It's basically a computerized "perfect" best fit line.
- The math is mightier than the eye.

Math is like love -- a simple idea but it can get complicated.

- Odd Thomas

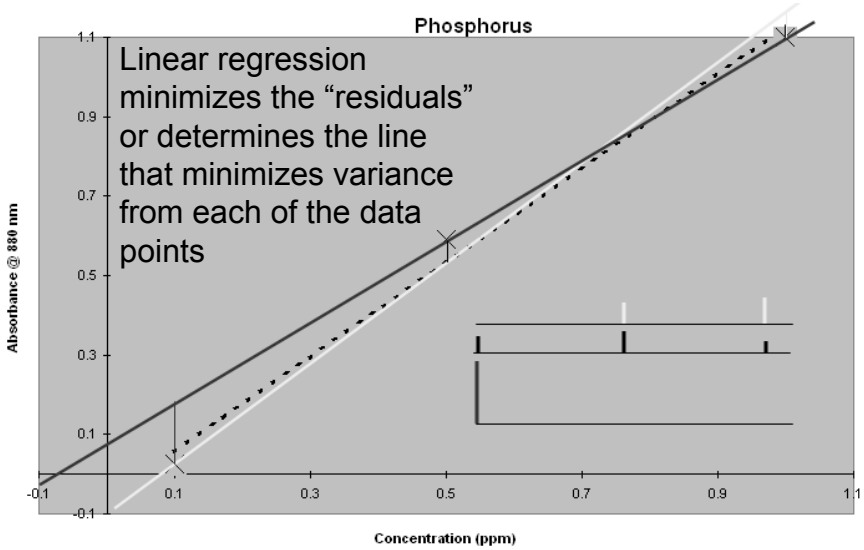


Prozac for Linear Depression



Which line is the "best fit"?

Prozac for Linear Depression



Looking at Residuals

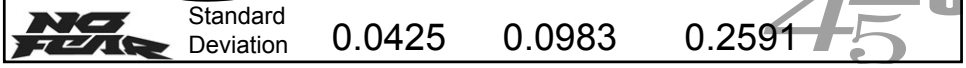
Residual = result of 'plugging' standard response into the resulting Y= mX + b equation

	Regression line	Red line	Yellow line
0.1	0.077	-0.012	0.103
0.5	0.549	0.553	0.668
1	0.974	1.063	1.178

Will always add up to zero

Difference between regression concentration and true value

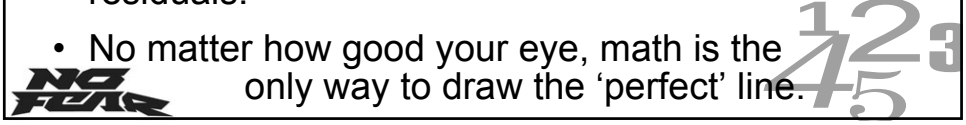
0.1	- 0.023	-0.112	0.003
0.5	0.049	0.053	- 0.332
1	- 0.026	0.063	0.178
Sum	0.000	0.004	- 0.151
Standard Deviation	0.0425	0.0983	0.2591



Prozac for Linear Depression

Summary

- The linear regression equations (slope and intercept) mathematically minimize variance at all calibration points.
- Residuals= inserting responses for calibration standards to the Y=mx+b equation to "back-calculate" standards as samples.
- Result is that the sum of residuals (*regression concentration – true concentration*) to be zero.
- Goal is to minimize the standard deviation of residuals.
- No matter how good your eye, math is the only way to draw the 'perfect' line.



The Value of Regression Coefficients

Value of the Slope (m)

- With ISE, helps tell condition of the electrode (-54 to -60)
- Can keep records to show when the analysis is changing

Value of the Intercept (b)

- Equals concentration associated with NO (0) response
- Thus gives an approximation of detection limit

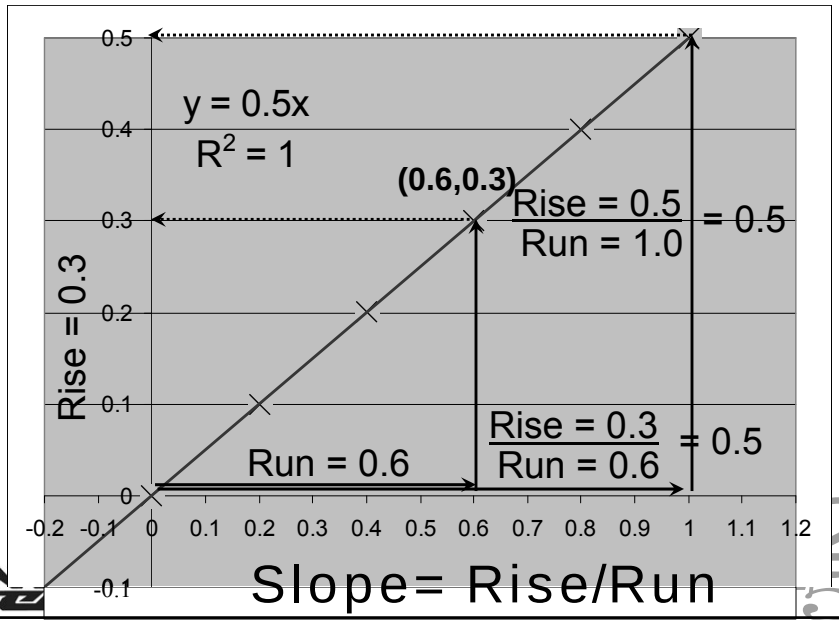
  if your intercept exceeds your LOD, there may be contamination

---

The ONLY downside to using a calculator vs. a spreadsheet program is that you do NOT get the visual evaluation power afforded by charting the data and regression line.

Prozac for Linear Depression

Surviving the slippery SLOPE



Slope= Rise/Run

Surviving the slippery SLOPE

Slope by Hand

	X	Y	X*Y	X^2		
	-0.698970	202	-141.192	0.488559		
	0.301030	146.7	44.1611	0.090619		
	1.301030	89.1	115.9218	1.692679		
Sum	0.903090	437.8000	18.8909	2.2719		
N	3					
slope=	N*sum (XY) - sumX*sumY			-338.7	=	-56.45
	N*sumX^2 - (sumX)^2			6		

$$= \frac{3 \times 18.8909 - 0.903090 \times 437.8000}{3 \times 2.2719 - 0.903090 \times 0.903090}$$

$$= \frac{56.6728 - 395.3728}{6.81557 - 0.8155715}$$

$$= \frac{-338.7}{6} = -56.45$$

The 'Nerds' Factor

- The Nernst factor, 2.3 RT/nF, includes
  - *the Gas Law constant (R),*
  - *Faraday's constant (F),*
  - *the temperature in degrees Kelvin (T) and the*
  - *charge of the ion (n).*
- For pH, (and NH3), n = 1 ∴ the Nernst factor is 2.3 RT/F.
- Since R and F are constants, the factor and therefore electrode behavior is **dependent only on temperature**.
- The electrode slope is a measure of the electrode response to the ion being detected and is equivalent to the Nernst factor.
- When the temperature is equal to 25 °C, the Nernst factor or slope is 59.16 mV/pH unit.
- Older Orion pH meters displayed the slope as a percentage of the theoretical value. For example, a 98.5% slope is equivalent to a slope of 58.27 mV/pH unit for a two-point calibration at 25 °C.

From: "Orion pH, ORP and ISE Theory" (2004)

ISE: The 'Nerds' Factor

Calculating the Nernst (*Nerds*) Factor

$$\text{Nernst Factor} = \frac{2.303 \times R \times T}{n \times F}$$

Gas Law constant	(constant)	R=	8.31451	Joules/ mol*°Kelvin	
temperature	**(variable)**	**T=**	293.15	°Kelvin =(273) +	°C **20**
Faraday's constant	(constant)	F=	9.649E+01	coulombs/mol	
charge of the ion	(constant per ISE)	n=	1		

$$= \frac{2.303 \times 8.31451 \times 293.15}{1 \times 96.485}$$

$$= \frac{5613.3}{96.485} = \mathbf{58.18}$$

=	**59.140**	at	25	degrees C
	54.178	at	0	degrees C
	60.132	at	30	degrees C

For a given ISE, the equation has 3 constants, and only ONE variable-- temperature

Not Another Favre Interception!

Intercept by Hand

	A	B	C	D	E	F	G
2		X	Y	X*Y	X^2		
3		-0.698970	202	-141.192	0.488559		
4		0.301030	146.7	44.1611	0.090619		
5		1.301030	89.1	115.9218	1.692679		
7	Sum	0.903090	437.8000	18.8909	2.2719		
8	N	3					
9							

$$\text{intercept} = \frac{\text{sumY} - (\text{slope} * \text{sumX})}{N} = 162.926$$

$$= \frac{437.8000 - -56.45 \times 0.903090}{3}$$

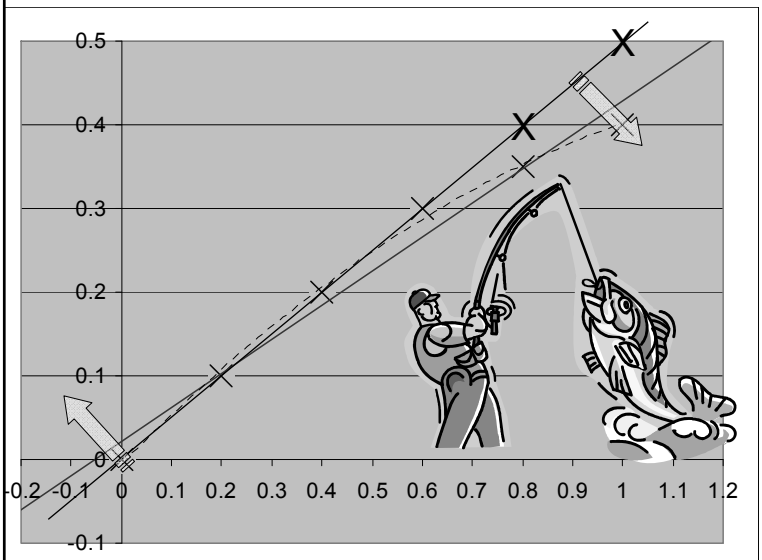
$$= \frac{437.8000 - -50.97943}{3}$$

$$= 488.7794 \div 3$$

$$= 162.926$$

What causes a positive intercept?

Non-linearity at the upper end of the calibration range (e.g., Phosphorus)



As the calibration line tips like a fish is on the line, the lower end of the regression line gets kicked up and the upper end pushed downward

Note that the effect is more pronounced at the upper end.

Prozac for Linear Depression

Surviving the slippery SLOPE

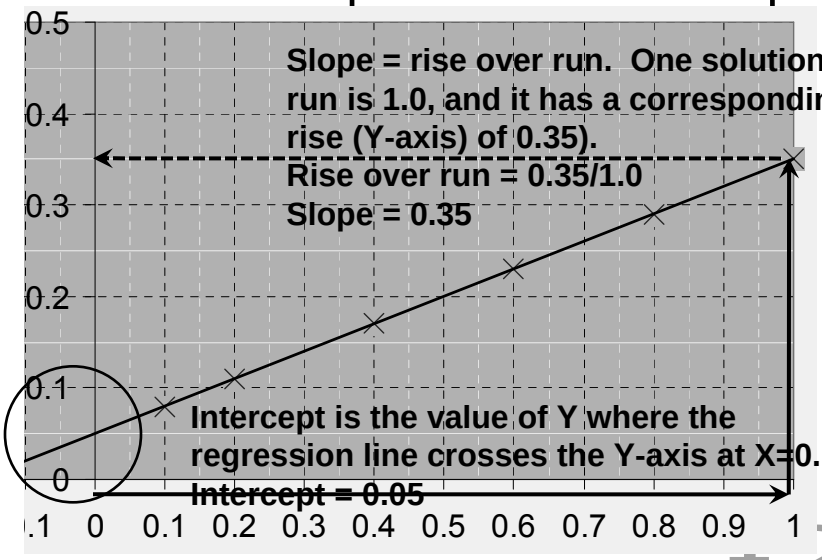
Not Another Favre Interception

	A	B	C	D	E
5			**X**	**Y**	
6		**Concentration**	**Log of**		
7		**mg/L**	**Concentration**	**mV**	
8		0.2	-0.699	202	
9		2	0.301	146.7	
10		20	1.301	89.1	
11					
12					
13		Slope=	-56.45	=SLOPE(D8:D10 , C8:C10)	
14		Intercept=	162.926	=INTERCEPT(D8:D10 , C8:C10)	
15		Correlation (r)=	-0.99993	=CORREL(D8:D10 , C8:C10)	

log X [concentration] = (Y [mV] -162.926) ÷ -56.45

NO FEAR Using Excel to generate Regression Equations

Find the slope and intercept



Y = 0.35 X + 0.05 ???

Relating to Correlation

With linear regression, the correlation coefficient " r " provides a measure of the acceptability of a particular calibration curve.

- " r " = complex mathematical equation
- Values between 0 (no correlation) and 1 (perfect correlation).
- Correlation coefficients can be obtained using:
  - any scientific calculator with 2-variable statistics capability
  - most spreadsheet programs, e.g., Excel

BOTTOM LINE: "r" *SHOULD* be 0.995 or greater

$r^2 \neq r$

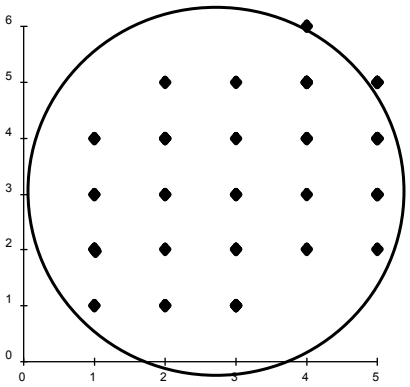
---

if your instrument/software provides r^2, then:

- take the square root of r^2 (which equals r) or
- an r^2 of 0.990 = r of 0.995

$$\sqrt{r^2} = r$$

Relating to Correlation



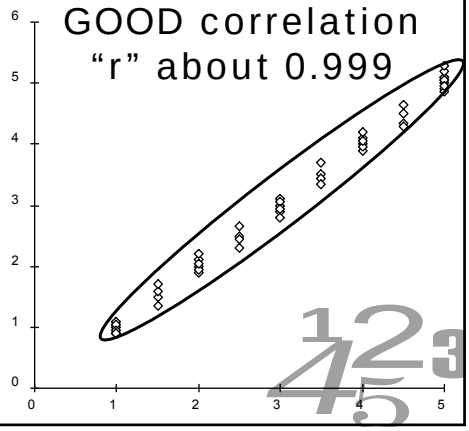
POOR correlation
"r" = 0

...the more it is stretched taut in a "cigar" shape, the higher the correlation.

The "Rubber Band" test

…simply visualize how a rubber band would "fit" the data...

GOOD correlation
"r" about 0.999



Relating to Correlation

Correlation Coefficient by Hand

$$r = \frac{n\sum xy - (\sum x)(\sum y)}{\sqrt{n(\sum x^2) - (\sum x)^2}\sqrt{n(\sum y^2) - (\sum y)^2}}$$

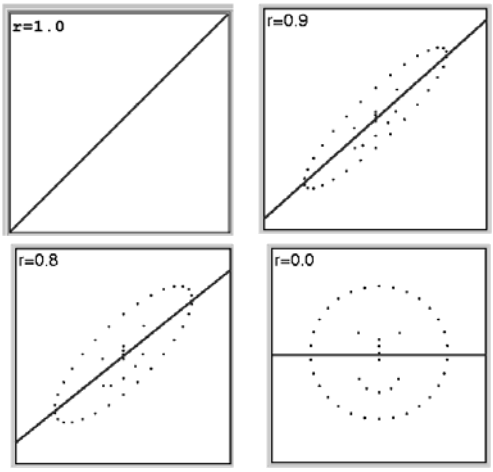
	X	Y	X*Y	X^2	Y^2
	-0.698970	202	-141.192	0.488559	40804
	0.301030	146.7	44.1611	0.090619	21520.89
	1.301030	89.1	115.9218	1.692679	7938.81
Sum	0.903090	437.8000	18.8909	2.2719	70263.7000
N	3				

$$\frac{[3*18.8909] - [0.90309 * 437.8]}{\sqrt{(3*2.2719) - (0.90309^2)} * \sqrt{3*70263.7 - 437.8^2}}$$

$$\frac{56.6727 - 395.3728}{\sqrt{(6.8157 - 0.8155715} * \sqrt{210791 - 191669}}$$

$$\frac{-338.7001}{338.727053} = -0.99992$$

The Correlation Coefficient



… doesn't always tell the tale!

So...Deviation that is Standard is a Good Thing?

The most widely used indicator of dispersion is the standard deviation which, in a nutshell, is based on the deviation of each score from the mean.

Standard deviation is used to determine:

In the lab:

- LOD
- LOQ
- Control Limits
- Outliers
- PT criteria

Daily Life:

- Fantasy sports (stats)
- Finance: investment risk
- Weather ranges
- Test scores

So...Deviation that is Standard is a Good Thing?

Fantasy Football Example: Chris Chambers or Lee Evans for WR?

week	CC	LE
1	7	1
2	11	1
3	10	0
4	2	6
5	1	0
6	6	bye
7	bye	6
8	8	16
9	4	20
10	1	5
11	6	4
12	9	1
13	3	4
14	6	16
15	5	3
16	11	9

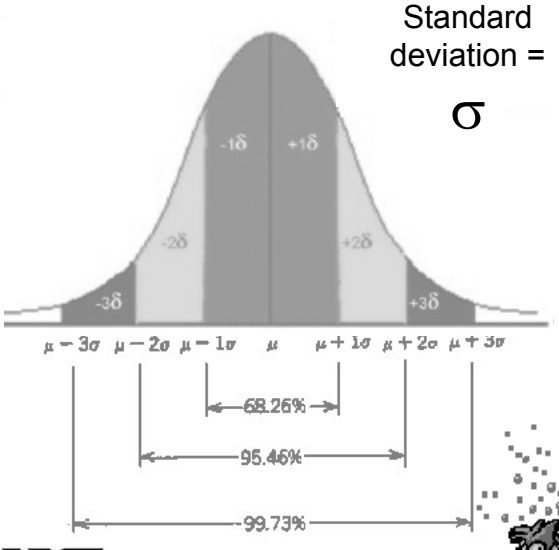
	Chambers	Evans
Mean ppg	6.00	6.13
sd	3.38	6.38
	56% RSD	104% RSD
Range	1 - 11	0 - 20
total pts	90	92

pts/game	CC	LE
0	0	2
1-5	6	7
6-10	7	3
11-15	2	0
>15	0	3

Based on SD…arguably Chambers is the more consistent player

So...Deviation that is Standard is a Good Thing?

Standard deviation = σ



z^{σ}	percentage
1σ	**68.27%**
1.645σ	90%
1.96σ	**95%**
2σ	**95.45%**
2.58σ	**99%**
3σ	**99.7300%**
3.291σ	99.9%
4σ	99.993666%
5σ	99.99994267%
6σ	99.9999998027%
7σ	99.999999999744%

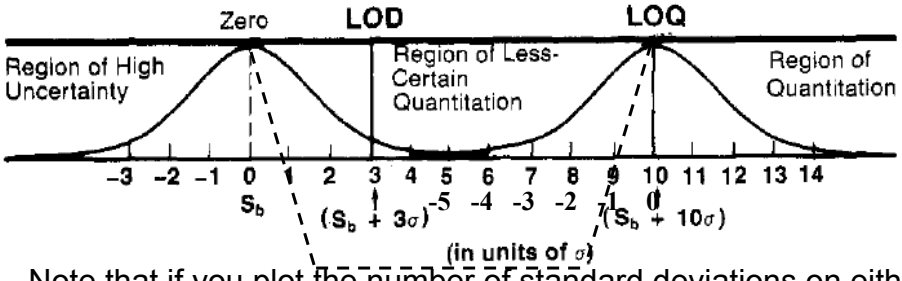
So...Deviation that is Standard is a Good Thing?

- Standard deviation is important in identifying consistent data. A low standard deviation represents consistent data.
- Standard deviation is typically viewed relative to the mean. %RSD (relative standard deviation) is used.
  - In a set of QC data, with mean = 100% and %RSD of 10%
  - 99.7% of results expected to fall between 70-130%
- 99.7% of data in a given set fall within 3 standard deviations of the mean *(this explains why data is expected to fall outside of control limits only 1 out of 100 times)*
- 95% of data fall within 2 standard deviations of the mean
- Dividing by "n" instead of "n-1", gives the <u>population</u> standard deviation (assumes every possible value)

EXCEL: =STDEV (*range of cells*)

The LOD, the LOQ, and the standard deviation

Remember when NR 149 used to define the LOQ as 10/3 time the LOD? This chart explains why.



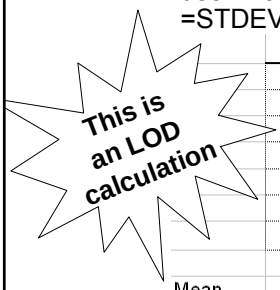
Note that if you plot the number of standard deviations on either side of the LOQ and a blank (Zero) the LOD falls in the valley between the two.

The LOD is the point at which >99% (99.73%!) confidence exists that the response is NOT equal to a blank.

So...Deviation that is Standard is a Good Thing?

1. Determine the average (mean value) of your set of numbers
2. Calculate the difference between each number and the mean
3. Square the differences
4. Add up the square of all the differences
5. Divide this by one less than the number of values in your set
6. The square root of that number is the standard deviation

use Excel: =STDEV(*range*)
=STDEV(*0.45,0.52,0.54,0.46,0.49,0.51,0.46*) = 0.034641



	X	X-mean	$(X\text{-mean})^2$
	0.45	-0.04	0.0016
	0.52	0.03	0.0009
	0.54	0.05	0.0025
	0.46	-0.03	0.0009
	0.49	0	0
	0.51	0.02	0.0004
	0.46	-0.03	0.0009
Mean	0.49		
Sum			0.0072
N=	7		
std dev			0.034641

$$\sqrt{\frac{0.0072}{(7-1)}} = \sqrt{\frac{0.0072}{6}}$$

$$= \sqrt{0.0012} = (0.0012)^{0.5}$$

$$= 0.03464$$

So...Deviation that is Standard is a Good Thing?

Standard Deviation - Calculator

To Calculate Mean, Variance, Standard deviation :
www.easycalculation.com/statistics/standard-deviation.php

Enter all the numbers separated by comma ",".
E.g: 13,23,12,44,55

0.45,0.52,0.54,0.46,0.49,0.51,0.46

calculate

Results:	
Total Numbers:	7
Mean (Average):	0.49
Standard deviation:	0.03464
Variance(Standard deviation):	0.0012
Population Standard deviation:	0.03207
Variance(Population Standard deviation):	0.00103

Mathematicians are like Frenchmen: whatever you say to them they translate Into their own language, and forthwith it is something entirely different.
- Author Unknown

So…Deviation that is Standard is a Good Thing?

1	110
2	90
3	78
4	91
5	83
6	91
7	81
8	92
9	102
10	80
11	94
12	83
13	79
14	140
15	82
16	92
17	80
18	94
19	98
20	80
Mean	**91**
stdev	**14.3966**

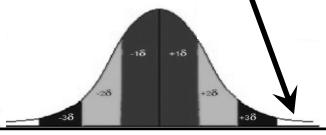
The Grubbs outlier test simply calculates how many standard deviations a suspect point lies from the mean.

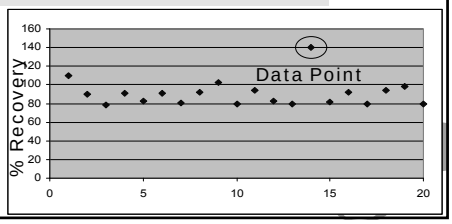
From our table of standard deviation percentages, we know that > 99.9% of a data set falls within 3.3 standard deviations.

$$Z = \frac{(140 - 91)}{14.39664}$$

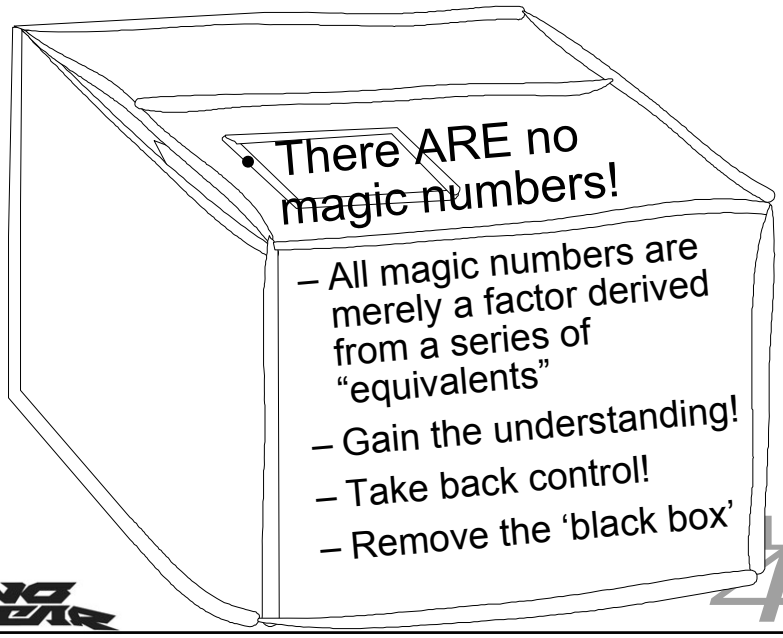
$Z =$ **3.4035726** >>> *criterion= 2.709*

REMOVE





~~8.34~~ is a Magic Number



8.34 is a Magic Number

Convert mg/L to lbs/day

When trying to calculate the amount of a parameter (*for example, 1 mg/L of total phosphorus*) that would be contained in a quantity of wastewater discharged (*for example, 1 MGD*), you may have heard that you multiply the concentration of that parameter (in mg/L), by the quantity of wastewater (in MGD), and then to multiply the result by **8.34** to get result in lbs/day.

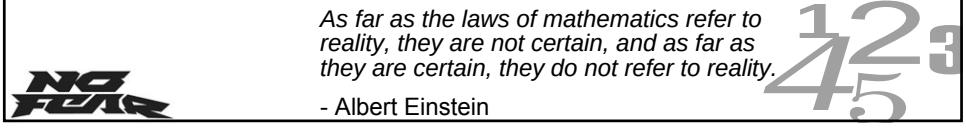
Amount (lbs/day)= 1 mg/L × 1 MGD × 8.34 = 8.34 lb/day.

8.34 must be a magic number!

8.34 also just happens to be the weight of a gallon of water. Coincidence???

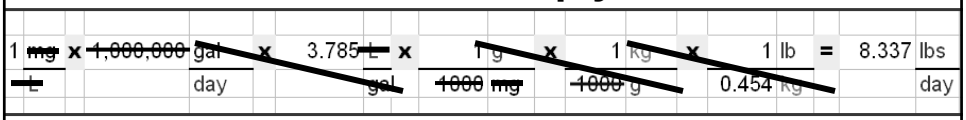
As far as the laws of mathematics refer to reality, they are not certain, and as far as they are certain, they do not refer to reality.

- Albert Einstein

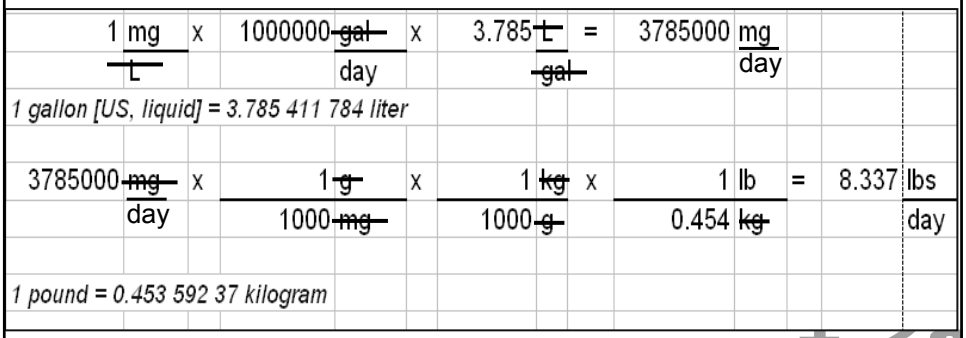


8.34 is a Magic Number

Simply cancel units!



= 3.785 ÷ 0.454 = 8.34



mg/L ⊗ # MGD ⊗ 8.34 = lbs/day

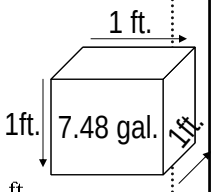
7.48 is also a magic number

You need to remember this fact forever

One cubic foot contains 7.48 gallons
To find volume of a tank, simply multiply the cubic feet by 7.48 to get gallons.

$$\frac{1\ \text{gal}}{3.78\ \mathbf{L}} \times \frac{1\ \mathbf{L}}{1000\ \mathbf{mL}} \times \frac{1\ \mathbf{mL}}{1\ \mathbf{cm}^3} \times \frac{16.387\ \mathbf{cm}^3}{1\ \mathbf{inch}^3} \times \frac{1728\ \mathbf{inch}^3}{1\ \text{ft}^3}$$

$$= \frac{28316.8466}{3781} = 7.48925\ \frac{\mathbf{gal}}{\mathbf{ft}^3}$$



1 inch = 2.54 cm

$1\ \text{inch}^3$ = = 1 inch X 1 inch X 1 inch

$1\ \text{inch}^3$ = = 2.54cm X 2.54cm X 2.54 cm

$1\ \text{inch}^3$ =16.387 cm^3

1ft = 12 inches

$1\ \text{ft}^3$ = 1 ft X 1 ft X 1 ft

$1\ \text{ft}^3$ = 12 in. X 12 in. X 12 in.

$1\ \text{ft}^3$ =1728 inch^3

Thanks to Kay Curtin for the graphic!

Any 'magic factor' can be reproduced by canceling units of a series of equivalents

Magical Math is not a Criss Angel Stunt

From: Smith, Debra L Sent: Fri 09/05/2008 1:14 PM
To: Mealy, Richard G
Cc:
Subject: FW: Unbelievable math problem

UNBELIEVABLE MATH PROBLEM

Here is a math trick so unbelievable that it will stump you.
Personally I would like to know who came up with this and why that person is not running the country.
Grab a calculator. (you won't be able to do this one in your Head)

1. Key in the first three digits of your phone number
2. Multiply by 80
3. Add 1
4. Multiply by 250
5. Add to this the last 4 digits of your phone number
6. Add to this the last 4 digits of your phone number again.
7. Subtract 250
8. Divide number by 2

Do you recognize the answer ??

Phone Magic unveiled

Yes you <u>can</u> do it in your head!

- Let X = first 3 digits phone # (264)
- Let Y be last 4 digits of your phone # (6006)

A. X ⊗ 80 = 80x
B. ⊕ 1 = 80 x + 1
C. ⊗ 250 = 20,000 x + 250
D. ⊕ Y = 20,000 x + 250 + Y
E. ⊕ Y = 20,000 x + 250 + 2Y
F. ⊖ 250 = 20,000 x + 2Y
G. ÷ 2 = 10,000 X + Y
= 10,000 ⊗ 264 ⊕ 6006
= 2640000 + 6006 = 2646006

On-line Assistance

- On-line units conversion site:
  - www.eppo.go.th/ref/UNIT-ALL.html#4%20Area
- On-line Conversions:
  - www.shodor.org/UNChem/unit_conv_tab.html
- On-line Conversions (Volume):
  - www.onlineconversion.com/Volume.htm
- On-line Conversions (Mass/Weight):
  - www.onlineconversion.com/weight_common.htm
- Lots of on-line calculators
  - statpages.org/index.html
- On-Line Math help
  - www.webmath.com/
- Dilution calculator on-line (C1V1):
  - www.spectronic.co.uk/info/dilucalc.htm
- On-Line Standard Dilution Calculator:
  - www.tocris.com/dilution.php
- Dilution Solution On-Line Dilution Calculator:
  - www.supermagnus.com/med/dilutions/index.html

I'm sorry to say that the subject I most disliked was mathematics. I have thought about it. I think the reason was that mathematics leaves no room for argument. If you made a mistake, that was all there was to it.

- Malcolm X

More On-line Assistance

- On-line Linear Regression Calculator:
  - www.xuru.org/rt/LR.asp#CopyPaste
- On-line Linear Regression with Graph
  - science.kennesaw.edu/~plaval/applets/LRegression.html
- On-line Standard Deviation
  - www.easycalculation.com/statistics/standard-deviation.php
- On-line nth root (GeoMean) calculator
  - http://instacalc.com/v0.5/
- On-line GeoMean calculator
  - www.graftacs.com/geomean.php3
- On-line GeoMean calculator
  - www.easycalculation.com/statistics/geometric-mean.php
- On-line GeoMean calculator
  - www.easycalculation.com/statistics/standard-deviation.php
- Outliers: Grubbs test on line
  - www.graphpad.com/quickcalcs/Grubbs1.cfm

Thanks for having us!

For More Information

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HA!