

## MathCAD Example: Exponential Regression

Problem 3.18 - Graph Counts per second ,C, vs. plate thickness, W, for a Geiger counter on a semi-log graph and determine an equation representing the data.

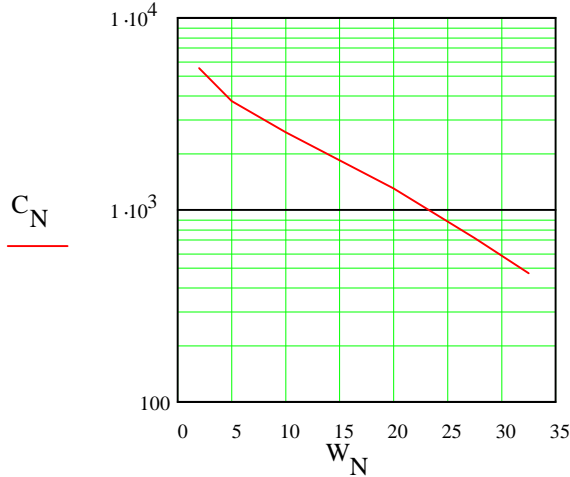
ORIGIN := 1

N := 1..6

Note: There are 6 data points.

Plate Thickness W, mm	Geiger Counter C, Counts Per Second
$W := \begin{bmatrix} 2.0 \\ 5.0 \\ 10.0 \\ 20.0 \\ 27.5 \\ 32.5 \end{bmatrix}$	$C := \begin{bmatrix} 5500 \\ 3700 \\ 2550 \\ 1300 \\ 715 \\ 470 \end{bmatrix}$

Geiger Counter  
 Counts per second vs plate thickness



Note: Double-click on the graph and change the y-axis to a log scale.

Note: To determine the exponential equation representing the data we recall that the exponential formula can be expressed as:

$$y = be^{mx} \quad \text{or} \quad \ln(y) = mx + \ln(b)$$

so the slope  $m = \frac{\text{change in } \ln(y)}{\text{change in } x}$  and the intercept  $b = \ln(b)$

so we need to generate a new function  $\ln(y)$  for finding the slope.

Note: A new column has been generated for regression analysis:

$$\text{LNC}_N := \ln(C_N) \qquad \text{LNC} = \begin{bmatrix} 8.613 \\ 8.216 \\ 7.844 \\ 7.17 \\ 6.572 \\ 6.153 \end{bmatrix}$$

$m := \text{slope}(W, \text{LNC})$        $m = -0.077$       Note: form is slope(x,y)  
 $\text{lnb} := \text{intercept}(W, \text{LNC})$        $\text{lnb} = 8.675$       Note: Intercept = ln(b), not b

so  $b := e^{\text{lnb}}$        $b = 5.856 \cdot 10^3$

Result:  $y = be^{mx}$       or       $C = 5856e^{-0.077W}$

Note: If we want to graph the results using the empirical formula just determined to generate a straight line, we should do the following:

1. Graph the original data showing points only
2. Form a new set of values, CNEW, using the empirical formula
3. Graph the new set of values showing only the line

$$\text{CNEW}_N := b \cdot e^{m \cdot W_N} \qquad \text{CNEW} = \begin{bmatrix} 5.018 \cdot 10^3 \\ 3.982 \cdot 10^3 \\ 2.707 \cdot 10^3 \\ 1.252 \cdot 10^3 \\ 701.755 \\ 477.156 \end{bmatrix}$$

Geiger Counter  
Counts per second vs plate thickness

