

G302 - Graphing Techniques Applied to Earth Science

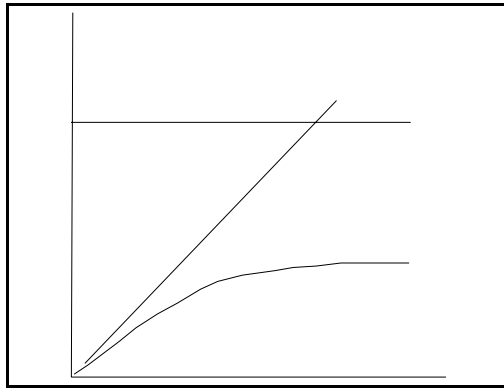
I. Graphing Review

- A. Purpose of graphing - to plot data and allow general relationships to be visualized.
- B. Basic X-Y (scatterplot) graph
 - 1. Axis
 - a. Y axis = vertical axis (ordinate)
 - b. X axis = horizontal axis (abscissa)
- C. Graph Trends (see attached figures)
 - 1. Linear Increase / Decrease
 - 2. Constant
 - 3. Parabolic (curvilinear) Increase / Decrease

Linear Increase

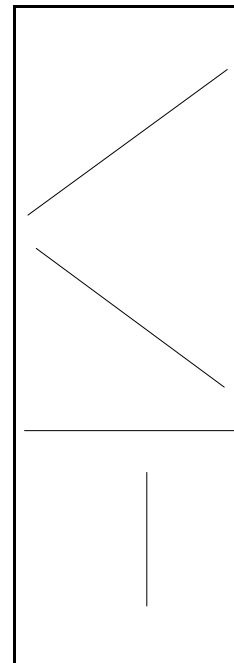
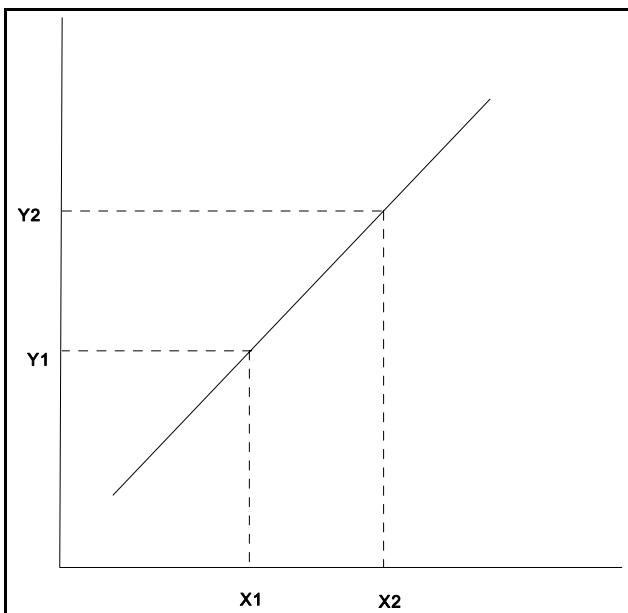
Constant

Parabolic



D. Determining Slopes of Lines

- 1. slope of any line on a graph = rise / run = $(Y_2 - Y_1) / (X_2 - X_1)$



Positive Slope

Negative Slope

Zero Slope

Undefined Slope

E. Linear Relationships - represented by uniform change of y relative to x

1. General Equation for Line: $Y = mX + B$

where Y = variable on ordinate axis, X = variable on abscissa, m = slope of line, B = y-intercept (value on y axis where line intercepts it)

- a. Sloping line downward to right = negative slope
- b. sloping line downward to left = positive slope

F. Relationships other than linear

1. Quadratic Equation

a. form: $Y = aX^2 + bX + C$

where y is a function of x, while a,b, and c are constants

2. Polynomial Functions of higher order (expanded quadratic equation)

a. e.g. form: $Y = aX^4 + bX^3 + cX^2 + dX + e$

3. Power Functions

a. form: $Y = aX^b$ equivalent to: $\ln Y = b(\ln X) + a$

4. Log Function

a. form: $Y = b(\ln X) + a$

5. Exponential Function

a. form: $\ln Y = bX + a$ equivalent to: $Y = aX^{bX}$

G. Best-Fit Functions

1. process of fitting functions to data using regression analysis

a. regression - curve fitting process that maximizes the trend of the fitted curve with the distribution of data

(1) Residuals - difference between fit Y values and actual Y values of data at given X values

(2) Coefficient of Determination

$$r^2 = 1 - SSe / (SSe + SSr)$$

where r = coefficient of determination, SSe = sum of squares of all residual values, SSr = sum of squares of the difference between all actual Y values and the fit Y value at each X location where the data point occurs

(a) Interpretation:

- i) r^2 values between 0.7 - 1.0 = good fit of function to data distribution
- ii) r^2 values between 0.5-0.7 = moderate to poor fit
- iii) r^2 values < 0.5 = poor fit to data

- II. More on Logarithms
- A. logarithms = inverse of exponential functions
 - 1. examples
 - a. $Y = 10^3 = 1000$, then $\log_{10}(1000) = 3$
 - b. $Y = 10^{-2} = 0.01$, then $\log_{10}(10^{-2}) = -2$
 - c. If $Y = 10^n$, then $\log_{10}(10^n) = n$
 - d. If $Y = X^n$, then $\log_X(X^n) = n$
 - B. Uses for logarithms
 - 1. re-arranging equations containing exponential functions
 - 2. reducing exponential functions / curves to straight lines
 - 3. compressing large data ranges
 - C. Natural Logarithms - logs to the base "e", where $e = 2.718$

In-Class Example:

Logs are used in the classification of sediment grain sizes by use of the following equation:

$\phi = -\log_2(d)$ where $\phi =$ "phi" (greek letter f), and $d =$ diameter of sediment grain in millimeters

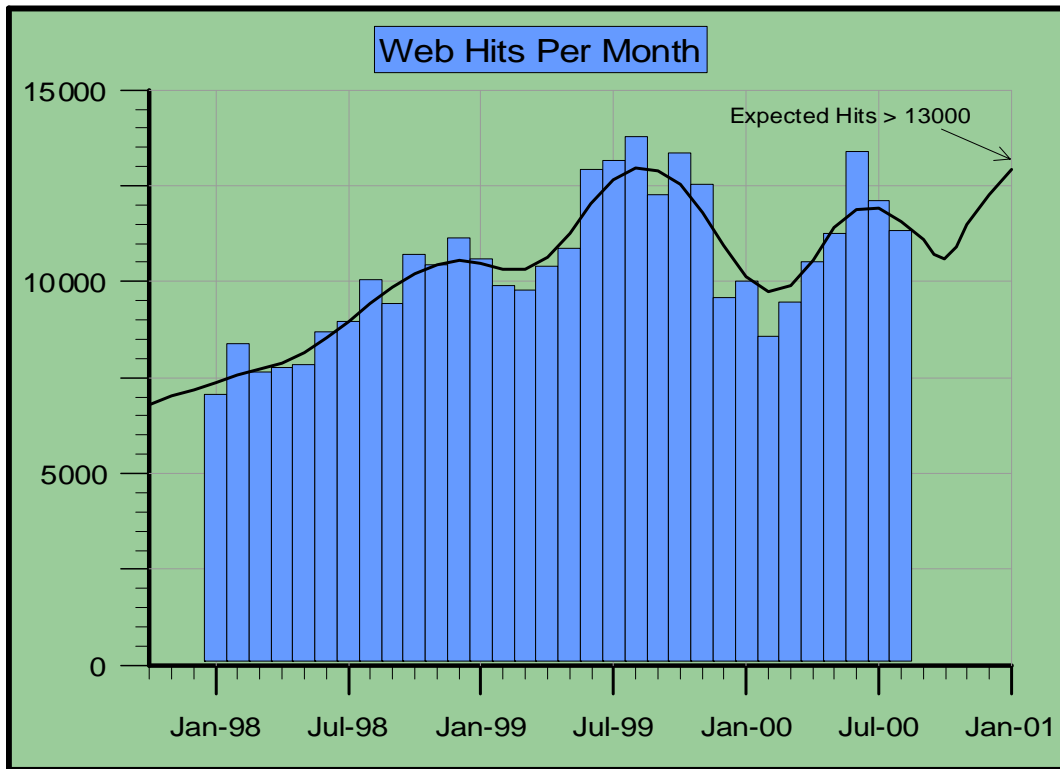
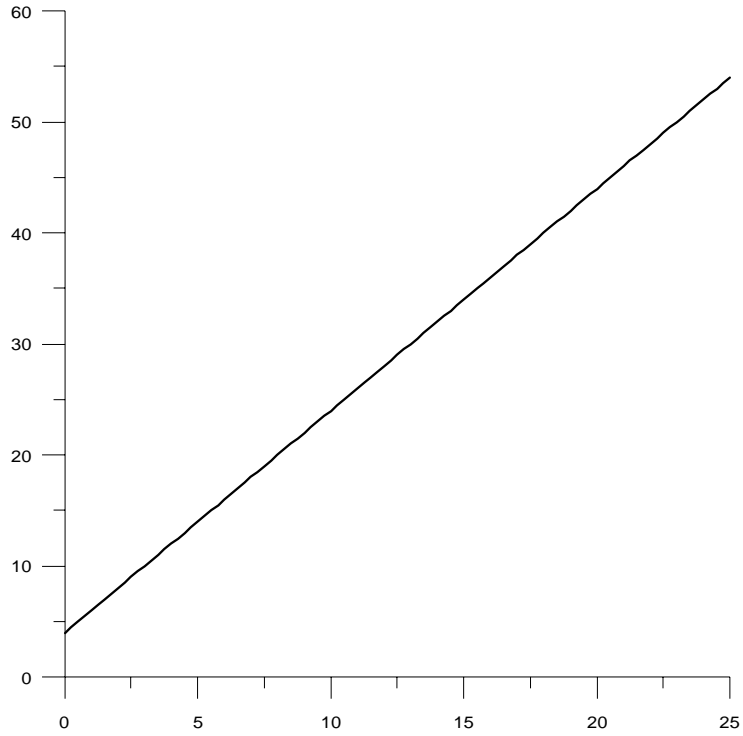
If a grain has a diameter of 8 mm, what is its corresponding "phi" size? show all work.

If a grain has a diameter of 4 mm, what is its corresponding "phi" size? show all work.

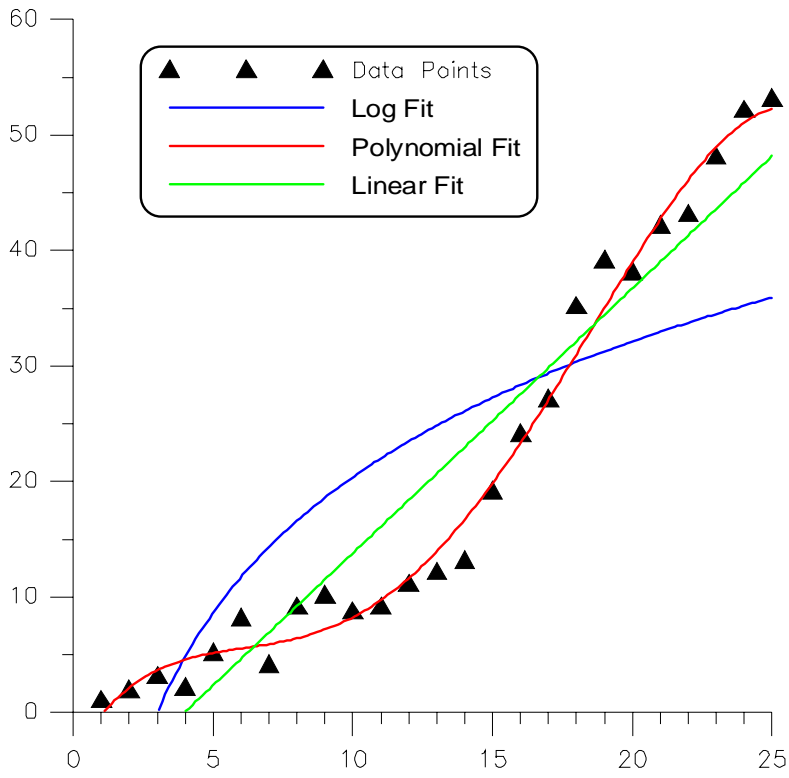
If a grain has a diameter of 0.2 mm, what is its corresponding "phi" size? show all work.

- III. Overview of Graph Types
- A. X-Y Scatterplot Graphs
 - 1. linear axes
 - 2. log-linear axes
 - 3. log-log axes
 - B. Bar Graphs
 - C. Triangular Graphs (three end-member composition plots)
 - D. Polar-Azimuthal Graphs (directional scatter plots)
 - E. Rose Plots (directional histograms)

Example Linear Graph $Y = 2X + 4$

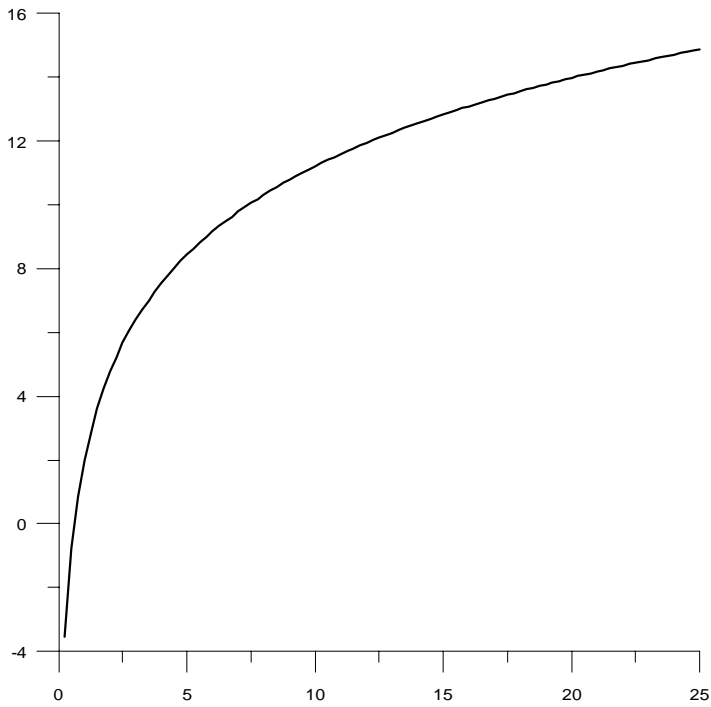


Example Bar Graph



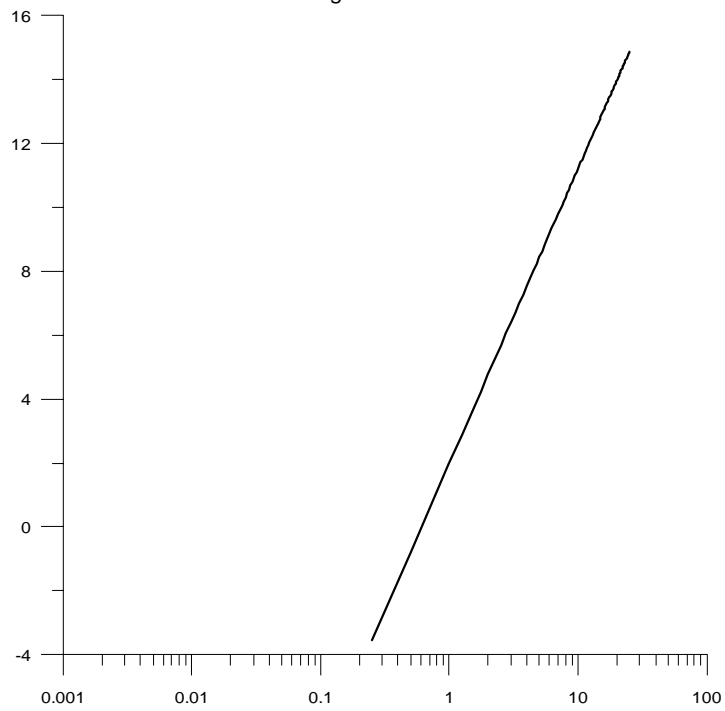
Example Log Equation $Y = 4\ln(X) + 2$

Plotted on Linear Axes



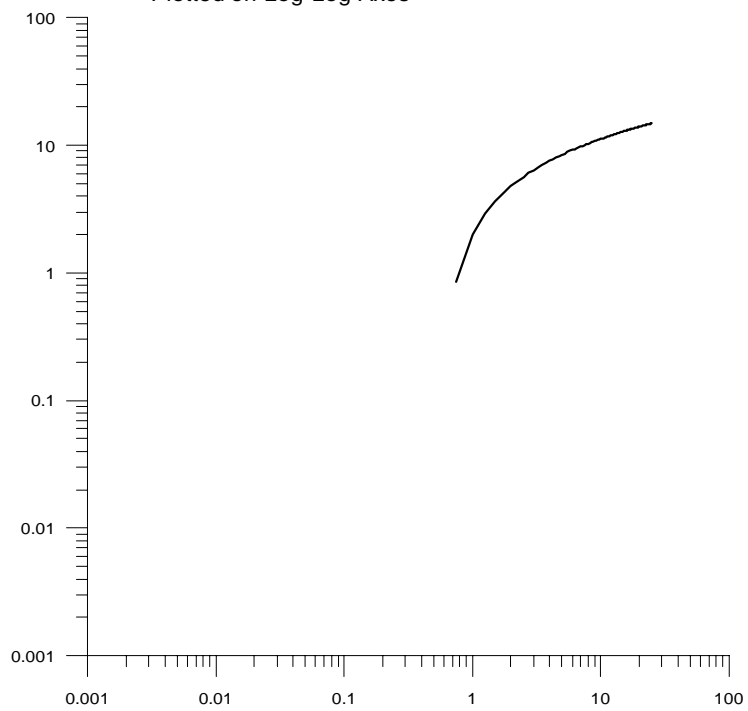
Example Log Equation $Y = 4\ln(X) + 2$

Plotted on Semi-Log Axes

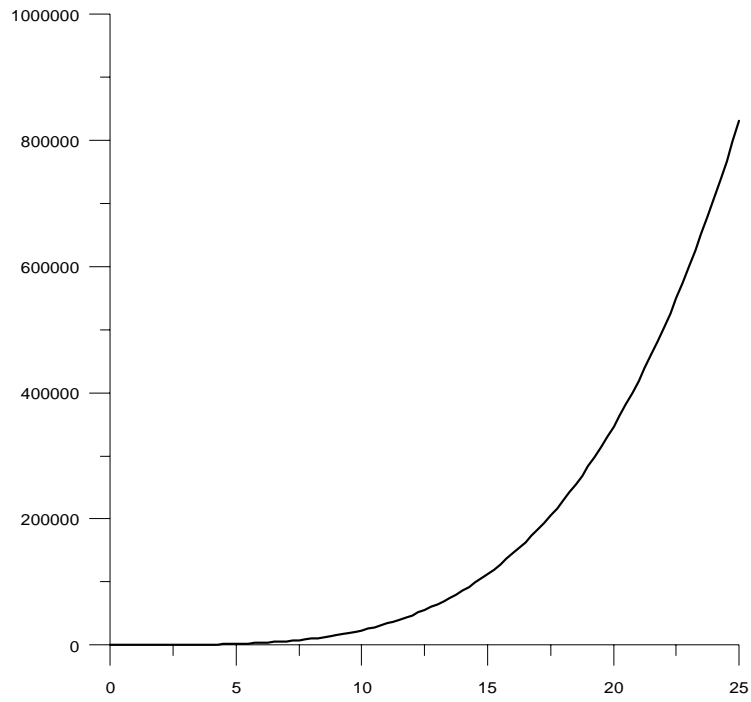


Example Log Equation $Y = 4\ln(X) + 2$

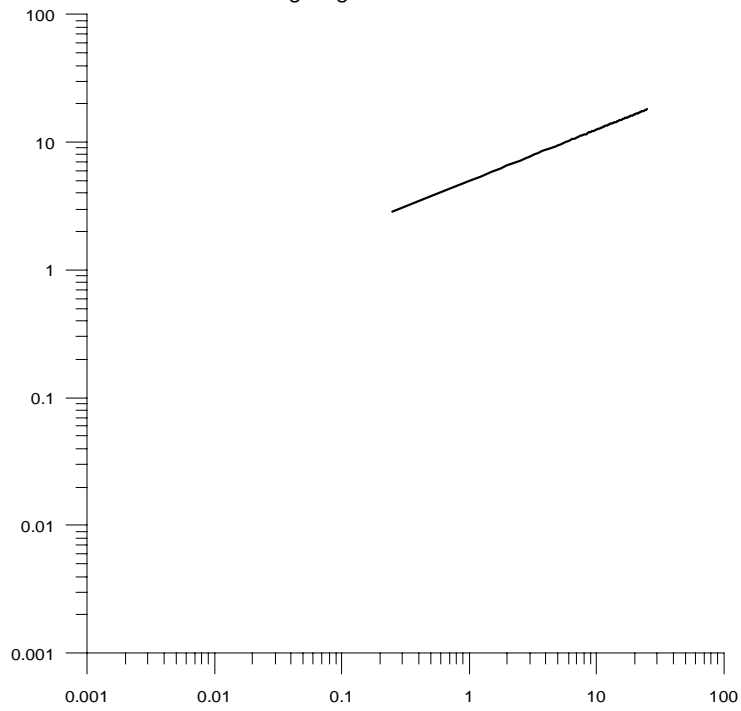
Plotted on Log-Log Axes



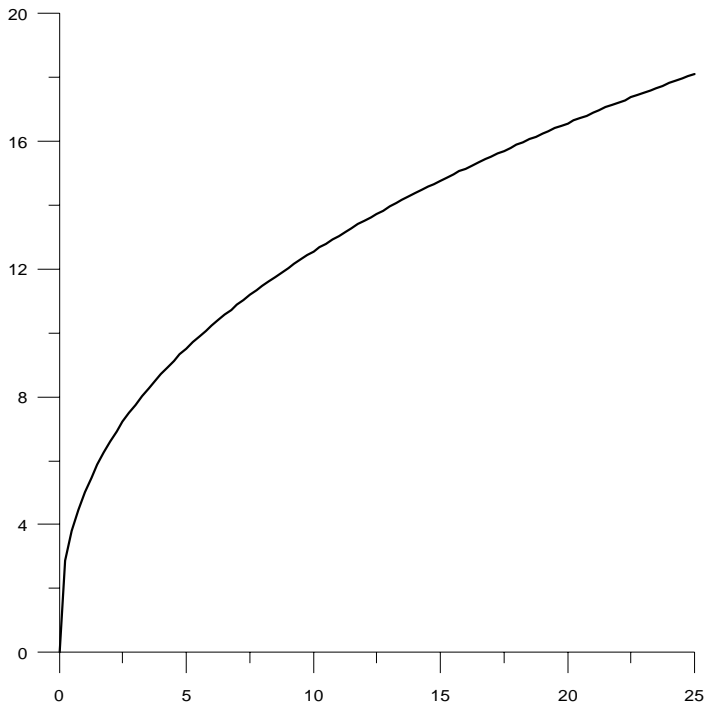
Example Polynomial Equation $Y = 2X^4 + 3X^3 + 5X^2 + 4X + 5$



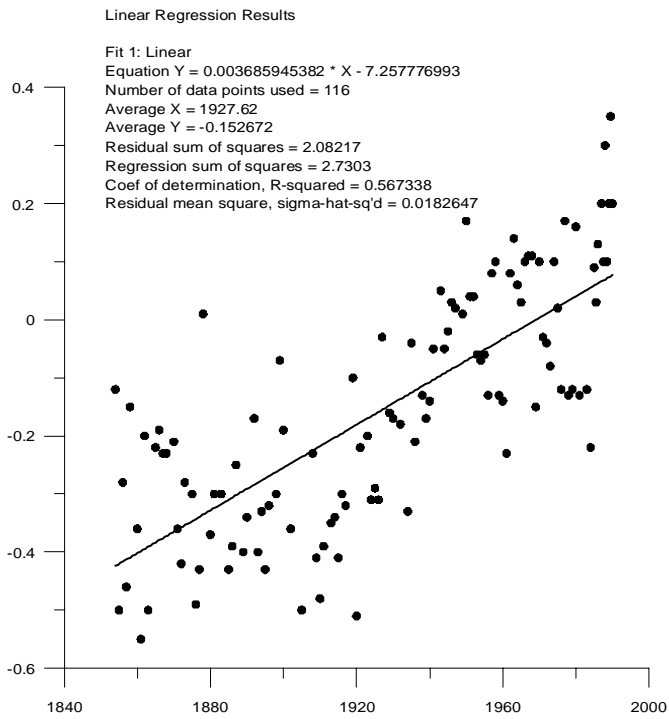
Example Power Equation $Y = 5X^{0.4}$
Plotted on Log-Log Axes



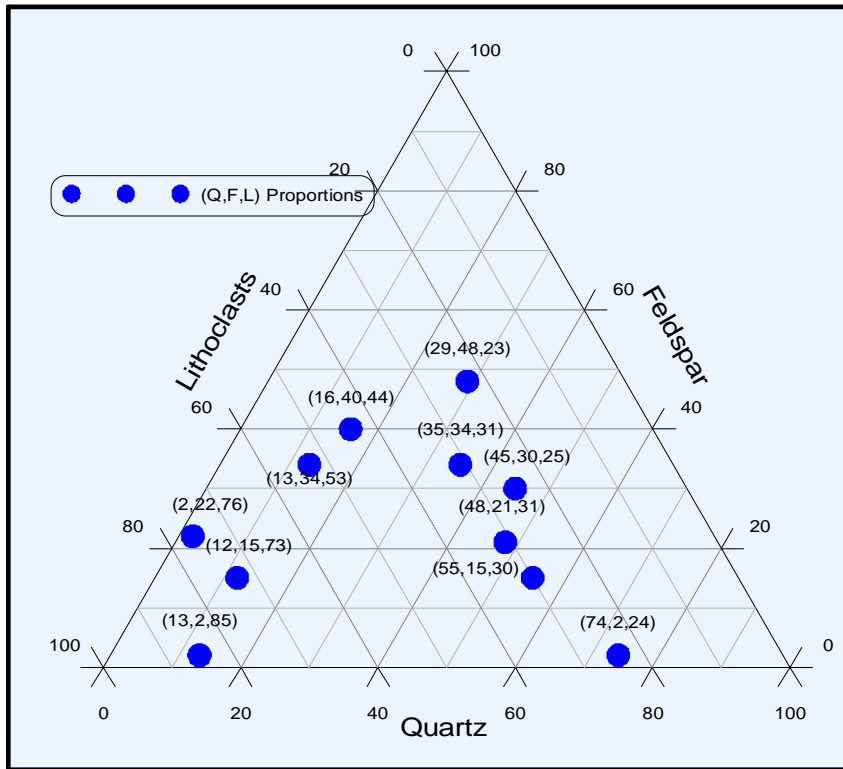
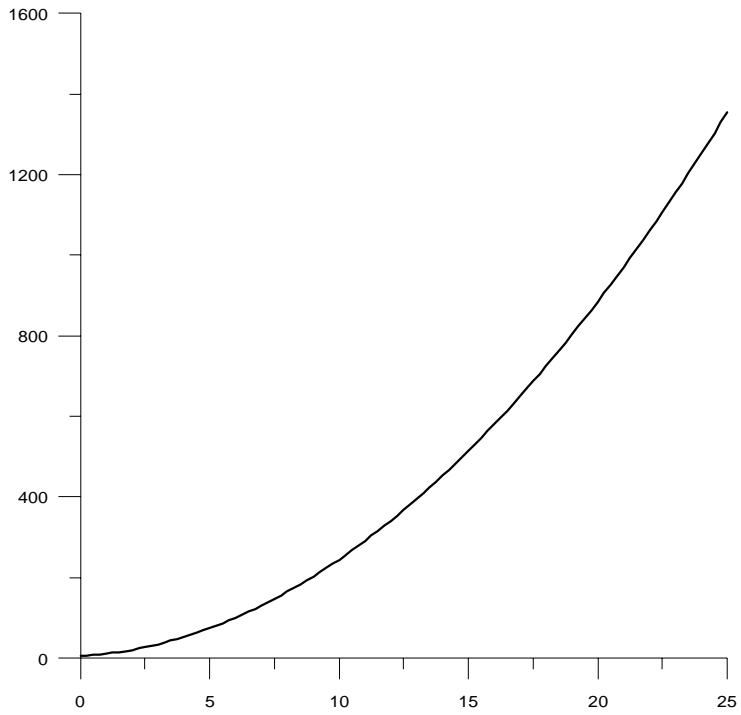
Example Power Equation $Y = 5X^{0.4}$

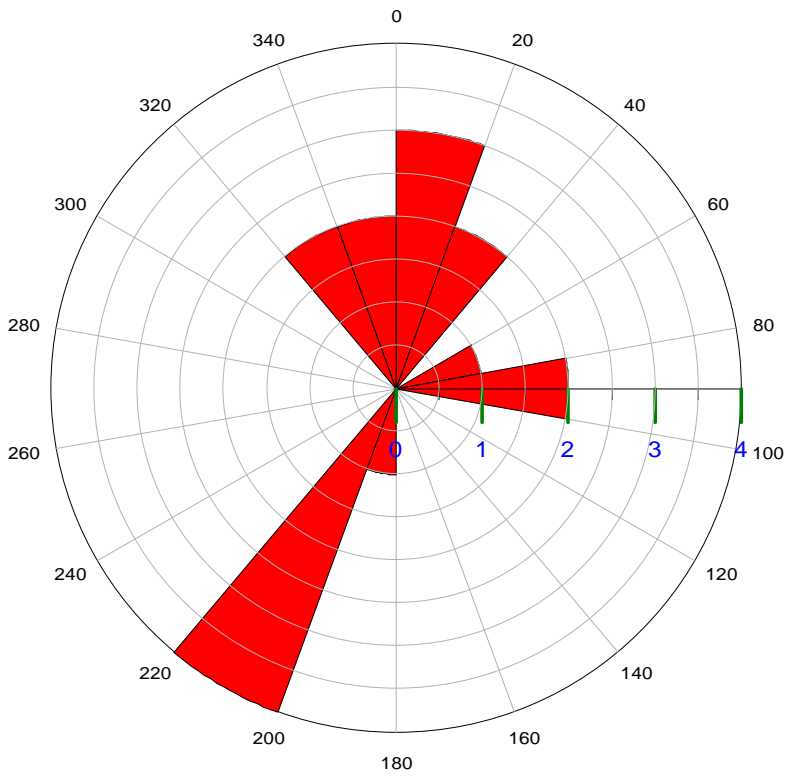


Example linear regression of scatter plot data

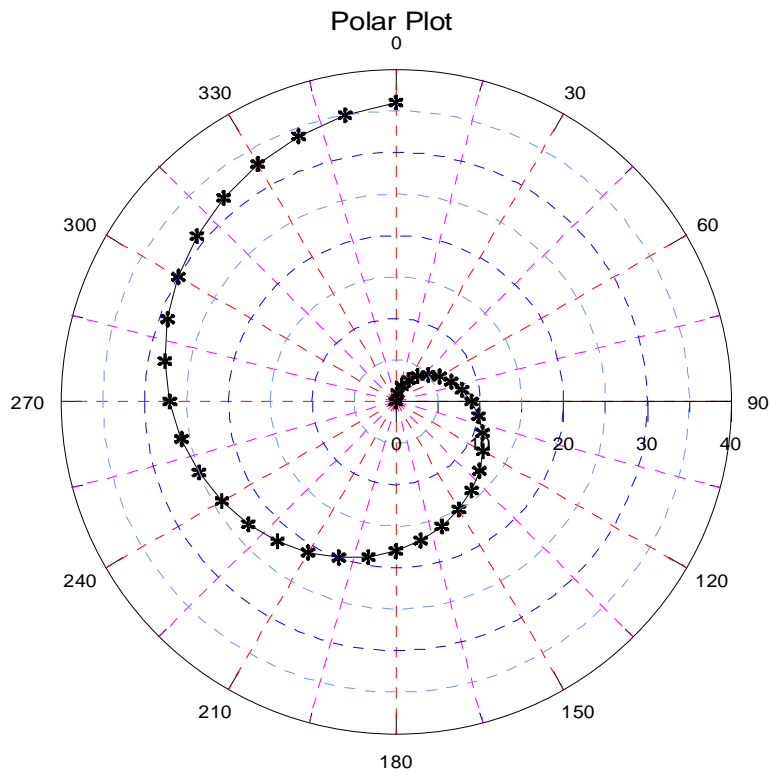


Example Quadratic Equation $Y = 2X^2 + 4X + 5$





Example Rose Diagram



Example Polar Plot