

e. Calculate the median income for the data set given. e. _____

2. Using 20th century US census data, the population of New York state can be modeled by

$$P(t) = \frac{19.875}{1 + 57.993e^{-0.035005t}}$$

where P is the population in millions and t is the number of years since 1800. Based on the model,

a. What is the population of New York in 1852? a. _____

b. What will New York state's population be in 2015? b. _____

c. What is New York's maximum sustainable population (limit to growth)?

c. _____

3. A projectile is launched straight up from ground level with an initial velocity of 288 ft/sec. (Projectile Motion: $s = -16t^2 + v_0t + s_0$; s_0 = initial ft above ground, v_0 = initial velocity, s = vertical position t seconds after launch)

a. When will the projectile's height above ground be 1152 ft? a. _____

b. When will the projectile's height above ground be at least 1152 ft? b. _____

4. When a ball is bouncing up and down on a flat surface, its height with respect to time can be modeled using a quadratic function. One form of a quadratic function is the vertex form: $y = a(x - h)^2 + k$
In this equation, y represents the height of the ball and x represents the elapsed time. The following is sample data of a bouncing ball over time.

Time Elapsed time (seconds)	Height of the ball (meters)	Total elapsed time (seconds)	Height of the ball (meters)
0.688	0	1.118	0.828
0.731	0.155	1.161	0.811
0.774	0.309	1.204	0.766
0.817	0.441	1.247	0.721
0.860	0.553	1.290	0.650
0.903	0.643	1.333	0.563
0.946	0.716	1.376	0.452
0.989	0.773	1.419	0.322
1.032	0.809	1.462	0.169
1.075	0.828		

- a. Enter this data into your graphing calculator and create a scatter plot. Sketch that scatter plot below.

- b. Find the values of a , h and k so that the equation $y = a(x - h)^2 + k$ fits one of the bounces contained in the data plot. Do this by approximating the vertex (h, k) from the data plotted (scatter plot) and graph on your graphing calculator and solving algebraically for a . State below in equation form.

b. _____

- c. Change the values of a , h and k in the model found above and observe how the graph of the function is affected on your graphing calculator. Generalize how each of these changes affects the graph.

- d. Expand the equation you found in “4b” above so that it is in the standard quadratic form:

$$y = ax^2 + bx + c$$

d. _____

- e. Use quadratic regression in your graphing calculator to find a model for the data set above. How does this model compare with the standard quadratic form found in “4d”?

- f. Complete the square to transform the regression model to the vertex form of a quadratic and compare it to the original vertex model found in “4b”. Are they close? They should be....why?

5. As a simple pendulum swings back and forth, its displacement can be modeled using a standard sinusoidal equation of the form:

$$y = a \cos (b(x - h)) + k \text{ (or } y = a \cos (bx + c) + d \text{)}$$

where y represents the pendulum’s distance from a fixed point and x represents total elapsed time. The following data table shows a sample set of data collected as a pendulum swung back and forth.

Total elapsed time (seconds)	Distance from the rest position (meters)
a. 0	0.665
0.1	0.756
0.2	0.855
0.3	0.903
0.4	0.927
0.5	0.931
0.6	0.897
0.7	0.837
0.8	0.753
0.9	0.663
1.0	0.582
b. 1.1	0.525
1.2	0.509
1.3	0.495
1.4	0.521
1.5	0.575
1.6	0.653
1.7	0.741
1.8	0.825
1.9	0.888
2.0	0.921

a. Using your graphing calculator, create a scatter plot and sketch it below.

b. Find the values for a , b , h and k (or a , b , c and d if you prefer) so that the equation $y = a \cos(b(x - h)) + k$ (or $y = a \cos(bx + c) + d$) fits the distance versus time data plot. This can be done using calculator techniques discussed in Precalculus class this past year. You may also refer to your calculator's guidebook if needed. State below in equation form.

c. What are the physical meanings of the constants a and k (or d) in the model equation above? (Hint: what do they measure in a sinusoid graph?)

- d. Use your calculator to find the sinusoidal regression equation to model this data. Most calculators will have this in the following form: $y = a \sin (bx + c) + d$. State below.

- e. Superimpose this curve created by the equation in “5d” onto your scatter plot written in section “5a”.