**1) Math 104 Debt Lab: Scientific Notation and the National Debt**

Lab 1 p. 1 of 1

|  |  |
| --- | --- |
| **U.S. NATIONAL** **DEBT** **CLOCK**  The Outstanding Public Debt as of 21 Aug 2014 at 01:09:20 PM GMT is:   |  | | --- | | $ 1 7 , 6 9 6 , 1 3 2 , 6 0 6 , 9 8 2 . 5 3 |   The estimated population of the United States is **318,857,899** so each citizen's share of this debt is **$55,498.49**.  The National Debt has continued to increase an average of **$2.36 billion per day** since September 30, 2012! |

1) Convert the national debt amount to scientific notation. Round the decimal part to 4 decimal places.

2) At the time this snapshot was taken, convert the estimated population of the United States to scientific notation. Round to 4 decimal places.

1. Calculate each citizen's share of the national debt, ***using scientific notation and the laws of exponents*.** Show all steps as demonstrated in class. Round your answer to 4 decimal places. Then you may need to complete an additional step to be sure that your result is in “legal” scientific notation. *(That is, the decimal follows the first non-zero digit).*
2. a) Write your answer in standard form.

b) Use your result in step 4a to answer the question in step 3. Label your answer and include it in a complete sentence that includes the context of the question.

1. Now go to the website <http://www.brillig.com/debt_clock/> to find the current national debt and U.S. population. ***Print the page from your browser and attach the printout to your report.*** (Note that you only need the information at the top, so print only one page.)
2. Repeat steps #1-#4 with the amount of the current national debt reflected in #5.

7) The website shows each citizen's share of the debt. *Check your attached print-out.*

Is the amount for each citizen’s share of the debt that you calculated in step 9 exactly the same as the value displayed on the web site? Why or why not? *Answer in two complete sentences.*

**2) Math 104 Sidewalk Lab Use of the Pythagorean theorem, a2 + b2 = c2, to calculate distance on our campus**

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PART I: Watch the video clip related to The Pythagorean Theorem as presented by the author of your book, Charles McKeague, and write a paragraph that includes at least 5 sentences in which you summarize the information that is explained in the video clip.

https://www.youtube.com/watch?v=OwEA5OhLWD0

### PART II: Below is a snapshot of our campus between the Library, Clarke and Godwin buildings. Follow the following steps. Remember to READ the instructions, carefully. You will use the Pythagorean Theorem to find the length of a sidewalk segment that is represented on the map below.

**Steps** (When writing your lab report label each step and show your work, clearly.)

1. On the first page of your lab report, construct a right triangle, using a straight edge. Label “a,” “b” and “c” to designate the legs and hypotenuse of the right triangle reflected in red on the map.
2. Choose a tool for measurement other than a normal measuring tool like a yard stick or ruler. (For example, “A hockey stick, a broom handle, etc). Write a sentence that includes your tool of measurement.
3. Using the unit of measurement that you selected in step (2), measure each of the actual sidewalk segments that are noted as “a” and “b” on your map. Round to two decimal places. Record the TWO measurements on the right triangle in Step (1) next to the designated “a” and “b.” Remember to label your measurements. (For example, a= 72.21 hockey sticks.)
4. Substitute your measurements for “a” and “b” into the Pythagorean formula and find “c,” the distance of the sidewalk segment next to the Peace garden. Solve the formula to find “c.” Show all work clearly. Remember to label your final answer. Write a paragraph that includes 3 to 5 sentences in which you summarize your findings.
5. Now measure the actual sidewalk segment that is noted as “c” on your map with the same tool that you used in step (2.) Does your measurement match the solution you found in step (4)? How close is your answer? What factors would lead to different results? Write a paragraph that includes 3 to 5 sentences in which you summarize your findings.
6. Take pictures of the actual campus location designated on the map with each member of your group at the site in the process of measuring with your tool. Print out the pictures and staple them to your lab report.

Map source: Google maps found at http://maps.google.com/

**3) Math 104 Weather Lab – Modeling a Linear Function**

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Below you will see the Monthly averages and records for our area from the Hamptonsroads.com Online Weather Website (<http://hamptonroads.com/weather?icast_page=/Local/History&icast_location=USVA0557>). This data was collected on October 29, 2014.

Monthly Averages & Records - °**F** | [°C](http://hamptonroads.com/weather?icast_page=/Local/History&icast_location=USVA0797&icast_unit=C)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Date | Average Low | **Average High** | Record Low | Record High | Average Precipitation | Average Snow |
| [January](http://hamptonroads.com/weather?icast_page=/Local/History&icast_location=USVA0797&icast_month=1) | 32° | **49°** | NA (N/A) | NA (N/A) | 3.86" | NA |
| [February](http://hamptonroads.com/weather?icast_page=/Local/History&icast_location=USVA0797&icast_month=2) | 34° | **52°** | NA (N/A) | NA (N/A) | 3.35" | NA |
| [March](http://hamptonroads.com/weather?icast_page=/Local/History&icast_location=USVA0797&icast_month=3) | 40° | **59°** | NA (N/A) | NA (N/A) | 3.92" | NA |
| [April](http://hamptonroads.com/weather?icast_page=/Local/History&icast_location=USVA0797&icast_month=4) | 48° | **67°** | NA (N/A) | NA (N/A) | 2.91" | NA |
| [May](http://hamptonroads.com/weather?icast_page=/Local/History&icast_location=USVA0797&icast_month=5) | 57° | **75°** | NA (N/A) | NA (N/A) | 3.63" | NA |
| [June](http://hamptonroads.com/weather?icast_page=/Local/History&icast_location=USVA0797&icast_month=6) | 65° | **83°** | NA (N/A) | NA (N/A) | 3.36" | NA |
| [July](http://hamptonroads.com/weather?icast_page=/Local/History&icast_location=USVA0797&icast_month=7) | 71° | **87°** | NA (N/A) | NA (N/A) | 5.08" | NA |
| [August](http://hamptonroads.com/weather?icast_page=/Local/History&icast_location=USVA0797&icast_month=8) | 70° | **85°** | NA (N/A) | NA (N/A) | 5.19" | NA |
| [September](http://hamptonroads.com/weather?icast_page=/Local/History&icast_location=USVA0797&icast_month=9) | 65° | **80°** | NA (N/A) | NA (N/A) | 4.01" | NA |
| [October](http://hamptonroads.com/weather?icast_page=/Local/History&icast_location=USVA0797&icast_month=10) | 53° | **71°** | NA (N/A) | NA (N/A) | 3.46" | NA |

**Part I. Creating your data in a table and graphing your Line.**

1. Record the month (x) and its average temperature (y) into the table below for the 10 months presented. You should have 10 data points. (The first ordered pair has been inserted for you.)

|  |  |
| --- | --- |
| Data Points | |
| X (month) | Y (temp) |
| **1** | **49** |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

2. Plot your 10 data points on the graph provided on the last page. (Label your x axis and y axis.)

3. Do the points you plotted represent a straight line? Explain why in a complete sentence using information related to defining a line.

**Part II. Develop the equation of the line segment connecting the two endpoints of the selected section of the graph.**

1.a) Record: The first endpoint is ( \_\_\_\_\_\_ , \_\_\_\_\_\_ ) and the last endpoint is (\_\_\_\_\_\_ , \_\_\_\_\_\_ ) from your table and label these points on your graph in pencil.

b) Connect the first and last endpoints using a line segment and label this **“Endpoint Line #1”** in pencil. Do NOT connect the data points between the end points!

2. Does this line increase, decrease, or is it constant?

3. Now calculate the slope (***m***) of the segment connecting these endpoints. Show your work.

4. Use the information you found and the point-slope form: y =y1 + m(x-x1) or y-y1=m(x-x1) to write the equation of the line segment in slope-intercept form: y = mx + b. Show all steps.

Write the equation in slope-intercept form.

5. Graph the line you found above on the graph provided on the last sheet. Note: this is the same line that you drew in Part II #1.

**Part III. Using Your Graphing Calculator and Linear Regression to develop another equation to approximate your section of the graph**

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The equation you developed in Part II approximates the graph of the data points you selected, but is it really the ***best*** approximation of that section of the original graph? The answer is “probably not,” so now you are going to use a technique called linear regression to develop a better approximation. Linear regression calculates the slope and y-intercept value of the linear equation that passes as closely as possible to ***all*** of the data points in your segment, quite possibly without directly passing through ***any*** of them. We are going to use our TI-83 or TI-84 graphing calculators to find this equation.

6. Determine the linear regression equation in the form of **Y = mx + b**: Entering your values for X in **L1 and Y in L2 under STAT, EDIT**. Now with the Key Strokes go to: **STAT; CALC; 4: LINREG L1, L2 ENTER**.

Y=

Write the Linear Regression equation of the line you just found:

*(Round your slope and y-intercept of your equation to 2 decimal places.)*

7. a) Type your equation from #6 in “Y=” on your graphing calculator. Go to your TABLE on your graphing calculator and record your results to the following x values*. (Round your “y” results to 2 decimal places.)*

*(X = 1, y = \_\_\_\_\_\_\_\_\_\_) and ( x = 10, y = \_\_\_\_\_\_\_)*

b) **Plot and label** the two points from your table to the right on the same graph on the last page.

c) Connect the points with a straight line using a colored pencil.

This is the line represented by your linear regression equation.

**Don’t forget to:**

*- Label your x axis and y axis, appropriately.*

*-Plot all of the data points from Part I in pencil.*

*- Label the endpoints of your data set. (These are the points you answered for Part II. #2)*

*- Connect these endpoints with a straight line segment.*

*- Label this line “****End point Line #1”*** *in pencil.*

*- Plot the two points from your table from Part III #7 from your Regression Line #2.*

*- Label these two points with the correct ordered pairs.*

*- Connect these two points with a straight line segment using a colored pencil.*

*- Using the same colored pencil, label this line “Regression Line #2.”*

*- Go back over the steps to be sure you completed each one, correctly.*

d) Label it “**Regression Line #2**.”



8. Write your responses in the three bulleted areas below in **complete sentences.**

1. Discuss at least **two differences** between Line #1 and Line #2. Be sure to include information related to lines, such as increasing, decreasing, slope and y-intercept.
2. Discuss at least two **similarities** that Line #1 and Line #2 share. Be sure to include information related to lines, such as increasing, decreasing, slope and y-intercept.
3. Which line (#1 or #2) do you think is a closer overall fit for your data points? Explain why?

**4) Math 104: Car Lab and the Exponential Function**

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In this lab, you will find your dream (used) car or truck. You can search in the classifieds section of a newspaper or online. Once you have found it, you will do some calculations and plot graphs to determine how it will depreciate over time, using two different depreciation rates. Finally, you will compare your results with those of a classmate. This lab will be completed outside of class.

1. What is your dream car or truck?

Find your dream car or truck in the classifieds section of the newspaper or online. The vehicle must cost between $3,000 and $25,000. Fill in the following: Year:\_\_\_\_\_\_\_\_\_\_\_\_ Color:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Make and Model:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ The purchase price for the vehicle is $\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

Staple the advertisement, which should include the year, color, make/model, and price of your vehicle, as well as a photograph, to the front of this lab sheet.

Include the URL of the site you visited: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Now, let’s use two different depreciation rates to determine how your vehicle will lose value over time. In the formula below, let *x* represent the number of years since you purchased the vehicle and let depreciation rate be the given rate expressed as a decimal.

|  |
| --- |
| f(x) = (purchase price)(1 - depreciation rate) x |

Use the home screen on your calculator to calculate the value of your vehicle after 1 year and 5 years, using a depreciation rate of **20%**. *Round to the nearest penny.*

|  |
| --- |
| f(x) = (purchase price)(1 - depreciation rate) x = ( )(1 - ) x |

1 year \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 5 years \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

|  |  |
| --- | --- |
| **# of years (x)** | **Value of vehicle given a depreciation rate of 20% (Y1)** |
| 0 | $ |
| 1 | $ |
| 3 | $ |
| 5 | $ |
| 10 | $ |
| 15 | $ |
| 20 | $ |

3. Enter your equation into your calculator as Y1. Fill in the chart below to show your vehicle’s value at different times and different depreciation rates. Use the TABLE function on your calculator to find these values. *Round to the nearest penny.*

Now view their graphs. Be sure to change your window, and record the boundaries of your window below.

Xmin: \_\_\_\_\_\_\_\_\_\_ Xmax: \_\_\_**30**\_\_\_\_\_\_ Ymin: \_\_\_\_\_\_\_\_\_ Ymax: \_\_\_\_\_\_\_\_\_\_

Examine your graph. This is definitely an example of exponential \_\_\_\_\_\_\_\_\_\_\_\_\_. Does the graph seem to drop faster or slower than you expected? Explain in a complete sentence.

4. Let’s figure out the answer to the big question: How many years will it take before your vehicle is worth less than $1000? Scroll down the TABLE to locate where “y” is just less than 1000. What is “*x*” at this point?

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After \_\_\_\_\_\_\_\_\_ years, my vehicle will be worth less than $1000, if the depreciation rate is **20%**.

5. Completing the Graph. *Note that the entire graph will be in Quadrant I.*

a) Label the *x*-axis and *y*-axis in terms of the appropriate variables (x = time in years, f(x) = value of your vehicle in $.

b) Label the unit on your x and y axis to match the problem.

c) Plot all 7 points from the table you developed above.

d) Label at least 4 points from your graph.

e) Complete a graph of your function on the graph provided.

6. Next draw the horizontal line, Y = 1000, across your entire graph, using a colored pencil. Be sure to use a straight edge.

7. Now go to the graph on your graphing calculator and enter Y2 = 1000 and find the coordinates that represent the cut-off of the exact number of years it will take your vehicle to be valued at less than $1000. *Round your x value to two decimal places.*

At **20%** depreciation: (\_\_\_\_\_\_\_\_\_\_\_\_\_\_,\_\_\_\_\_\_\_\_\_\_\_\_\_)



Compare the number of years it will take your vehicle to be valued at less than $1000 with the answers found by another student in class. Write a conclusion paragraph that contains at *least three complete sentences* in which you summarize the comparison results as they relate to the number of years and depreciation value of your vehicle and your fellow student’s findings.

8.

***Labs # 5 and # 6: Golf Lab and Winter Session Lab are Not Included in this packet.***

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**7) Math 104: Garden Lab and the Quadratic function Warm – up Exercise**

The photo of the raised garden below can be built into one of four shapes. Assume you have been given 12 feet of fencing and would like to use the fencing to close in a garden and would like to plant the maximum number of plants. Below you will find 3 possible shapes that would be possible with your fencing.



1) First verify, that each possible shape consists of 12 feet of fencing.

2) Next, find the area of each garden fencing shape.

3) Which would provide you with the maximum gardening area? Explain why in 3 complete sentences.

B

A

3 ft

3 ft 3 ft

3 ft

C

5 ft

1 ft 1 ft

5 ft

4 ft

2 ft 2 ft

4 ft

**Math 104: Garden Lab and the Quadratic Function In-class Component of Lab**

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The goal of this lab is to build a garden with the dimensions that create the largest four-sided garden possible.  If you only have a given length of fence to determine the space, how can you make the most of your space?

**Part A: Experimental Model**

1. Each group will be given strips of paper, each representing the group’s specific total fence length in feet. Remember that the total length of your fence will represent the perimeter of your garden in **feet**.

Your total fence length (perimeter) represents ­­­­­ \_\_\_\_\_\_\_\_ feet long.

2. Set up a table as follows, including all possible whole number lengths and widths. (Start by filling in your fence perimeter in each cell in the “Perimeter” column. Note that “1” has been designated for the first cell of your width in feet.) Find the corresponding width that would be needed to match up to your perimeter. Then find the corresponding area.

|  |  |  |  |
| --- | --- | --- | --- |
| Perimeter | Width (ft)  **x** | Length (ft) | Area (ft2)  **y** |
|  | 1 |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

1. On the graph below, create a scatter plot. Plot **width** on the x-axis and **area** on the y-axis. Make sure you choose an appropriate interval (size for each grid box) and label both axes. Recall that in a scatter plot, the ordered pairs are not connected.



4. Enter your data in your graphing calculator under STAT, 1:EDIT. Enter your width (***x***) values into the column L1 and your corresponding area (***y***) values into the column L2. Determine the equation of the quadratic function that fits your scatter plot under STAT, CALC, 5:QuadReg. When your screen displays QuadReg at the top, hit ENTER. This will give you the general form of a quadratic equation, followed by, for your data, the values for the coefficients a, b, and c. Use this information to write the quadratic equation in the space below; this quadratic equation is an experimental model, based on your data from the table above, for the area of your garden.

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Y1=\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (This is your modeled equation based on your data.)

**Part B: Algebraic Model**

1. Develop the equation for the area of your garden:

a. Using ***x*** as your variable for width and  **L** as your variable for length, write a ***general equation for perimeter P*** of your garden**. (Remember: Perimeter = twice the width + twice the length)**

***P*** = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

b. Rewrite the equation, replacing ***P*** with the number that represents your total fence length as designated by the number of cells (each representing 1 ft) on your strip (Your fence perimeter.)

\_\_\_\_\_ = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

c. Now solve this equation for **L** . Show your work below.

**L** = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

d. Recall that Area (***A***) is length times width. Write an equation for Area using only the variable x on the right-hand side of your equation.

***A*** = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

2. Rewrite your area equation in standard form, replacing A with Y2; this quadratic equation is an algebraic model for the area of your garden.

Y2=\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (This is your equation based on the formula.)

**Part C: Tying it Together**

1. The equation from your experimental model (Y1) should match the equation you derived algebraically (Y2). Demonstrate this by graphing Y1 and Y2 on your calculator (the two graphs should overlap completely).

2. Compare the table (2nd TABLE) of values on your calculator for Y2 to the table of values that you developed in Part A. Are there ordered pairs in common? Explain.

3. Which width gave you the maximum area? What is the maximum area you found?

4. Draw and label a sketch of your garden below using the width and length that yielded the maximum area. What is the geometric shape of your garden? Do you think this shape is the optimal shape to maximize area for any given perimeter? Why or why not? (Write your answer in at least 3 complete sentences.)

5. Note that the graphs that are represented in this problem are parabolas. What are the coordinates of the ordered pair (width, area) that yielded the maximum area on your parabola? What term is given for this ordered pair on any parabola?