**Objective**

This report is to show how to find the best-fit function that models the carbon dioxide levels of Earth’s atmosphere using mathematical regression.

The data you are to use for this project is from CO2 readings taken at **“Mauna Loa”**

[**https://www.epa.gov/climate-indicators/climate-change-indicators-atmospheric-concentrations-greenhouse-gases**](https://www.epa.gov/climate-indicators/climate-change-indicators-atmospheric-concentrations-greenhouse-gases)

The readings measure the carbon dioxide concentration in parts per million.

First create a table in word and excel (you may use Google docs and Google spreadsheets) that shows the average CO2 readings taken at **“Mauna Loa”** for January 1st of each year from 1960. The table must be labeled to make it easy to understand.

**Part 1**

1. Let ***zero*** represent ***the year 1960***.
2. Draw ***scatter plot*** for the data from 1960 to 2020 (Please recall 1960 should be represented with Zero). ***(Copy and paste the scatter plot from Excel)***

MAKE SURE TO ADD THIS !!!!!!!!!!!!!!

1. Just by looking, does the data appear to be modeled best with a linear, quadratic, or exponential model?

To me it looks linear but I’m guessing its not.

1. Now find the linear, quadratic and exponential models that best fits the data. Give your reasoning for your selection. Give all three equations and their corresponding R2 values.

Linear:

y = 1.6279x + 308.36  
R² = 0.9834

Linear was my first guess based on a quick glance but after inserting the different lines of best fit I can see that this is not the best option.

Quadratic:

y = 0.013x2 + 0.836x + 316.27  
R² = 0.9994

The quadratic line of best fit does seem superior compared to the others. Visually it fits the best, however it also has the highest R² value making it the best option.

Exponential:

y = 310.84e0.0045x  
R² = 0.9912

The exponential line of best fit is better than the linear one however it fails to model the beginning or the end of the graph effectively.

1. Display the scatter plot and best-fit line/curves, with their corresponding equations and R2 values, in

excel. ***(Copy and paste each of the three charts from Excel)***

**Part 2**

The data in the table you created represents the carbon dioxide levels for January of each year. However, throughout each year, the level oscillates as follows. In April of each year, the average reading was about 2.5 ppm higher than the average reading in January of the same year. In July of each year, the average reading was the same as the average reading in January of the same year. In October, the average reading was about 2.5 ppm lower than the average reading in January of the same year.

1. Create a new table that also includes the quarterly oscillations described above. ***(Copy and paste the chart with smooth lines from Excel)***

***This “New” table should be on a new sheet, but in the same excel (worksheet) file. Copy and paste the data from the first sheet into the second sheet. Use the “copy” to answer questions in Part 2.***

1. Make an excel (or Google sheets) graph of the model for year one; that is from Jan 1960 to Jan 1961. ***(Copy and paste from Excel)***
2. Use a sine function to rewrite the model that shows the described oscillations. Show how you came up with the sine function.

Amplitude:

Chart, line chart

Description automatically generated

To get the amplitude I subtract the Minimum value from the maximum then divide that by two. This is also the maximum distance from the average value.

The curve is increasing after the Y axis of the graph. This means that the “a” value will be positive. In this case the amplitude is +2.5.

Period:

Chart, line chart

Description automatically generated

To determine the period graphically I will measure the distance between every other zero / average value of the graph. In this case the period Is one year.

The b value is found with the equation: 🡪 🡪

Sine Formula:

There is no phase shift in the equation, so I don’t have to worry about that part. The base equation for a sine wave is y=a\*sin(bx+c)+d. We don’t have a “c” value so we can just remove that part. I will substitute the “a” value I found doing the amplitude and the “b” value found doing the period. The d value is the average value or the initial value for the year.

Our final equation looks like:

1. Create a mathematical model that incorporates the described oscillations as well as the annual growth.

To create this, I will replace the d value in my sin function with the quadratic function I created earlier.

0.013x2 + 0.836x + 316.27

1. Use Excel (or Google sheets) to graph the revised model. ***(Copy and paste from Excel)***
2. What physical factors on earth would contribute to the oscillation in carbon dioxide level during the year?

***Needs URL, APA Citation, preferably with multiple sites***

The shifts are caused by the growth and decay of vegetation in the northern part of the world. This could look like trees, algae, and other growth that die and regrow over the seasons. This happens specifically in the northern regions because they get extremely cold during their winter and stop processing the CO2 during their winter season, while the southern hemisphere does this during its whole cycle in many areas.

https://www.amnh.org/exhibitions/climate-change/changing-atmosphere/the-ups-and-downs-of-co2

<https://svs.gsfc.nasa.gov/4565>

NASA. (2017, May 4). *SVS: Seasonal changes in carbon dioxide*. NASA. Retrieved December 7, 2022, from https://svs.gsfc.nasa.gov/4565

*The ups and downs of CO2: AMNH*. American Museum of Natural History. (n.d.). Retrieved December 7, 2022, from https://www.amnh.org/exhibitions/climate-change/changing-atmosphere/the-ups-and-downs-of-co2

1. Use the model to estimate the level of carbon dioxide in the Earth’s atmosphere in the following years 2022, 2030 and 2040.

***You need a formula to plug in the correct variables into and solve for the y-value***

CO2 (in ppm) for 2022:

y = 0.013x2 + 0.836x + 316.27 This model will find the average level at the beginning of the year.  
I just need to input the date in terms of years since 1960. For 2022 this will be 2022-1960=62. I substitute the values and get y = 0.013(62)2 + 0.836(62) + 316.27 which gives me y = 418.074 (ppm).

CO2 (in ppm) for 2032:

72 years --- gives me y = 443.854(ppm)

CO2 (in ppm) for 2042:

82 years --- returns y = 472.234(ppm)

1. What significance does the trend in the carbon dioxide level in Earth’s atmosphere have? Please provide sources using the APA format.

***Needs URL, APA Citation, preferably with multiple sites***

CO2 is the most prevalent greenhouse gas in the atmosphere radiating heat back to the earth. In the right amounts this gas keeps the earth from freezing and at a stable temperature for life. However, humans have artificially inflated the concentrations as you can see in the data. Due to this the global average temperature is rising. This warming is altering many animals and plants across the globe and damaging carefully balanced Ecosystems.

Due to global warming some plants bloom earlier which extends traditional growing seasons. This is an issue because seasonal shifts can become more dramatic with longer plant growth seasons (Copernicus). This can be seen as the teeth or smaller waves in the graph having a larger amplitude over time.

Lindsey, R. (2022, June 23). *Climate change: Atmospheric carbon dioxide*. NOAA Climate.gov. Retrieved December 8, 2022, from https://www.climate.gov/news-features/understanding-climate/climate-change-atmospheric-carbon-dioxide#:~:text=Without%20carbon%20dioxide%2C%20Earth's%20natural,causing%20global%20temperature%20to%20rise.

copernicus. (2019, May 28). *Carbon dioxide levels are rising: Is it really that simple?* Homepage. Retrieved December 8, 2022, from https://atmosphere.copernicus.eu/carbon-dioxide-levels-are-rising-it-really-simple

**The Report …**

* Must include a title page (title, your name, the date, the class, the instructor's name, relevant picture)
* Must be typed; including the formulas (use equation editor, if possible)
* Questions must be provided in your report, and answered in complete sentences. The reader must understand the question and answer. ***You must assume the reader (your client) does not already know your project material***.

**Grading Rubric**

* Title page (Title of topic, your name, class, date, instructor name) 5 points
* Typed; including the formulas and equations 5 points
* Questions and answers in full sentences. 10 points
* The report must be written as if for our campus director Ms. Stacie Maple, who is not aware of your project topic, or criteria. 5 points

***Excel (Spreadsheets) graphs must be copied and pasted into the report.***

***The Excel, or Google spreadsheet files must be submitted through canvas separate   
from their Report.***

* Question “b” needs its own scatter plot. 5 points
* Question “d” must include 3 graphs along with their corresponding equations, and R2 values. 10 points
* Give the sources of your research and include the resources in the appropriate sections of the report and in a citations section of your report. 5 points

***If you received the source from a classmate, then you must give them credit in the citations.***

* Questions 6 thru 8 (these answers must include APA citation and URL address) 15 points

**Excel Spreadsheet (must be turned in separately from the report)**

* Each sheet must be named and needs a description at the top of the sheet. 5 points
* Tables must be titled, and the *x, y -* axes must be labeled. 15 points
* If a graph requires an equation, or R2 value, then must be included on the graph. 15 points

***This Project is 7% of your grade.***

***There are test preps and quiz retakes, but there is homework for the remainder of the   
Fall Semester.***

***Please start early, and submit your work on time.***

***You will have no homework, and two full class periods over the project,  
 but there is a lot of work.***

***The Due Date is Dec 14th.***