Modeling CO2 Data With a Line

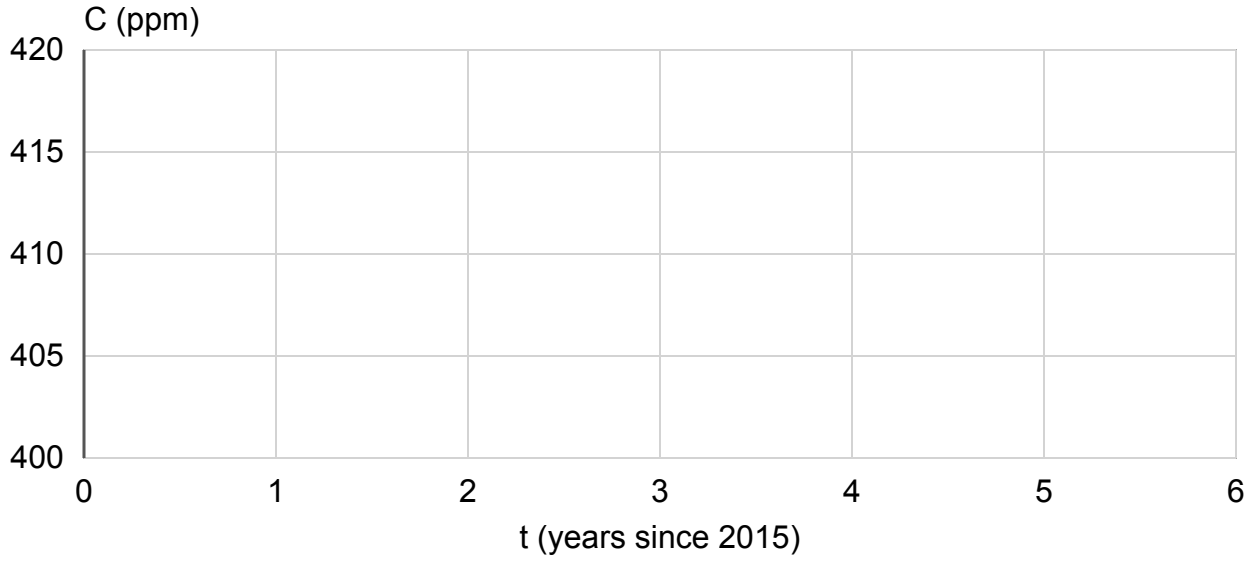
Fit a linear function to real annual data and make a careful prediction

Name: _____ Date: _____

Part 1 - Plot the sourced data

Question 1. The table gives annual mean carbon dioxide (CO2) measured at Mauna Loa. Let t be years since 2015, and let C be CO2 in ppm (dry-air mole fraction). Plot all seven points on the blank scatter plot. Do not connect the points yet.

Year	t	C (ppm)
2015	0	401.01
2016	1	404.41
2017	2	406.76
2018	3	408.72
2019	4	411.65
2020	5	414.21
2021	6	416.41



Data source: NOAA Global Monitoring Laboratory, *Mauna Loa annual mean CO2 data*, file created September 5, 2026. https://gml.noaa.gov/webdata/ccgg/trends/co2/co2_annmean_mlo.txt

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Part 2 - Fit, check, and interpret a model

Question 2. Listen while your teacher reads the calculator or spreadsheet reminder. Use linear regression on the table from Part 1. Write your model as C = a + bt. Round a and b to the nearest hundredth.

Regression result	Your value
a, the intercept	
b, the change in ppm per year	
Your equation C =	

Question 3. Check your model at t = 3. Show a substitution and compare the model value with the 2018 data value, 408.72 ppm.

Question 4. Use your model to estimate C for 2018.5 (t = 3.5) and for 2022 (t = 7). Label each prediction as interpolation or extrapolation. Then explain why one prediction needs extra caution.

Prediction and domain checklist

□ I used t = year - 2015. □ I stated ppm. □ I labeled whether each input is inside or outside 0 ≤ t ≤ 6. □ I did not call the model an exact physical law.

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Answer key and teaching notes

Materials and setup: Print and supply all student pages, keeping teacher-key pages separate. Provide a graphing calculator or a spreadsheet-capable device for each student or pair, plus pencils and rulers. Before students begin, confirm that the graph axes run from t = 0 to 6 and C = 400 to 420. Students need the Part 1 data table while completing Part 2.

Teacher-read script: “Enter t values 0 through 6 in one list or column and the CO2 values in a second list or column. Run a linear regression in the form y = a + bx. Record enough digits first, then round at the end. A spreadsheet option is SLOPE for b and INTERCEPT for a. The line summarizes this small data set; it is not an exact physical law.”

Observation method: Circulate during Questions 2-4. Check that each student enters t, not calendar year, as the input; records both coefficients; substitutes t = 3 into the same equation; and marks t = 3.5 as inside the observed domain and t = 7 as outside it. Ask a student who labels 2022 “certain” to identify the last observed year.

1. Plot: Points are (0, 401.01), (1, 404.41), (2, 406.76), (3, 408.72), (4, 411.65), (5, 414.21), and (6, 416.41). Accept accurately placed points within normal graphing tolerance.

2. Regression: A linear regression gives C approximately = 401.45036 + 2.52464t. Rounded to hundredths: C = 401.45 + 2.52t. Equivalent calculator formatting, such as C = 2.52t + 401.45, is correct. The slope means the fitted line increases about 2.52 ppm per year over this data interval.

3. Coefficient check: Using the required rounded model, C(3) = 401.45 + 2.52(3) = 409.01 ppm. This is about 0.29 ppm above the observed 2018 value, 408.72 ppm. Accept 409.02 ppm and a difference of about 0.30 ppm if a student used unrounded calculator coefficients. The values need not match because a regression line is fitted to all seven points.

4. Predictions and interpretation: Using the required rounded model, C(3.5) = 401.45 + 2.52(3.5) = 410.27 ppm. Since 3.5 is between 0 and 6, this is interpolation. Also using the rounded model, C(7) = 401.45 + 2.52(7) = 419.09 ppm. Since t = 7 is beyond the observed domain, this is extrapolation. Accept 410.29 ppm and 419.12 ppm only if a student clearly retained and used unrounded regression coefficients. Accept explanations such as: “The 2022 estimate needs more caution because the trend could change outside the years used to fit the line.” Do not require students to claim a future value will occur.

Source credit: NOAA Global Monitoring Laboratory, Mauna Loa annual mean CO2 data, file created September 5, 2026, https://gml.noaa.gov/webdata/ccgg/trends/co2/co2_annmean_mlo.txt