Exercise 1: Scientific Notation

Table 1: Standard Notation Conversions to Scientific Notation

Standard Notation	Scientific Notation
36000 kg	3.6×10^4 kg
30500000 mL	$3.05 \quad X\ 10^7$
0.0000936	9.36×10^{-5} m
236.1 g	2.361×10^2 g
84,300,000,000,000 mm	8.43×10^{13} mm

Table 2: Scientific Notation Conversions to Standard Notation

Standard Notation	Scientific Notation
8.13×10^5 mL	813,000 mL
2.01×10^{-3}	0.00201 m
9.01×10^4 mg	90,100 mg
4.48×10^{-6} L	0.00000448 L
5.52×10^9 mm	5,200,000,000 mm

Question 1

Why is scientific notation often used when recording experimental measurements?

Scientific measurements often produce very long numbers. Using scientific notation allows measurements to be recorded in a condensed format.

Question 2

A scientist weighed three laboratory samples and recorded the data below.

a) Calculate the total weight by adding the weights of the samples.

b) Record the calculated value using both standard and scientific notation.

Sample 1: 0.00261 grams
Sample 2: 0.00362 grams
Sample 3: 0.00080 grams

Sum using standard notation = 0.00703. Sum using scientific notation = 7.03×10^{-3}.

Exercise 2: Converting Units

Table 3: Single-Step Conversions

Conversion to Perform	Answer
32 cm to m	0.32 m
53.5 kg to g	53500 g
96.3 mL to L	0.0963 L
4.00 miles to km	6.44 km
0.25 oz to mL	7.4 mL

Table 4: Multi-Step Conversions

Conversion to Perform	Answer
500.0 mL to qt	0.5280 qt
0.750 yd to cm	68.58 cm
0.834 gal to mL	3160 mL
15.00 lb to kg	6.804 kg
542 in to m	13.8 m

Photo 1: 32 cm to m Conversion

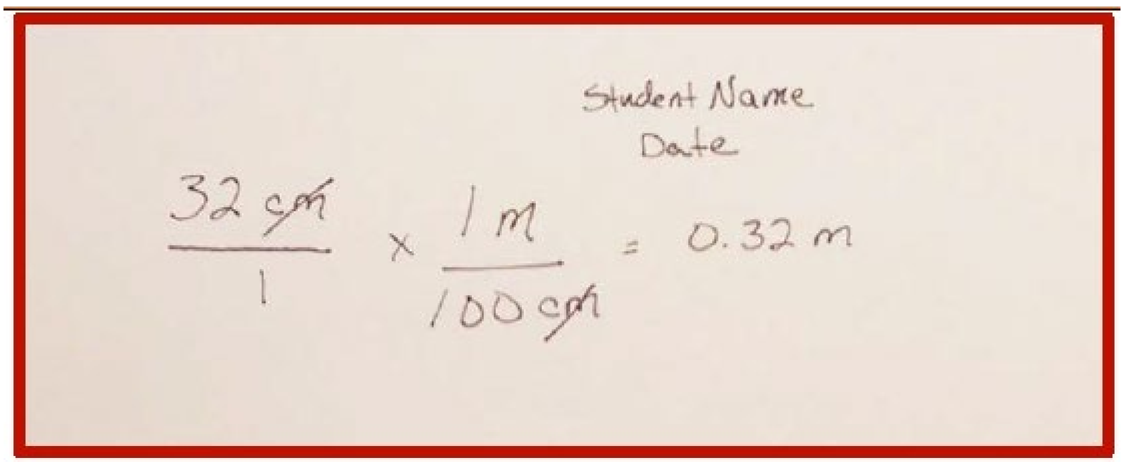


Photo 2 53.5 kg to g conversion

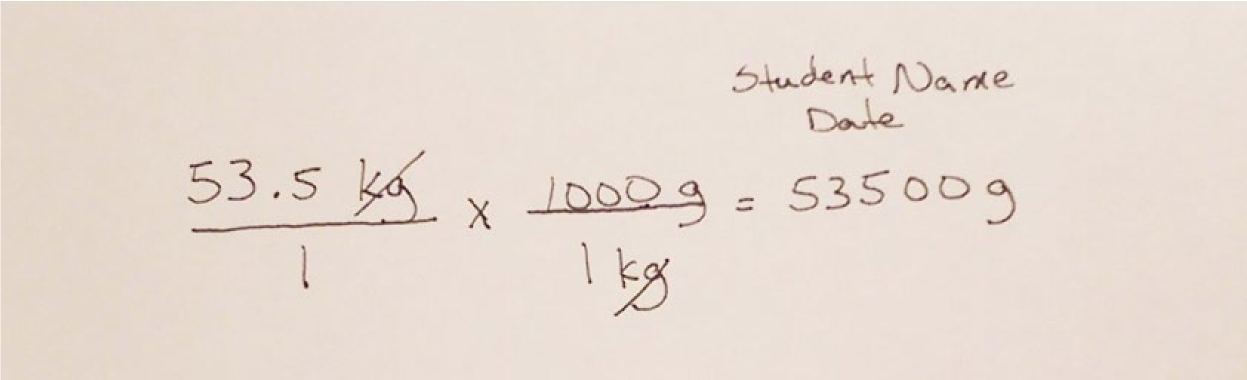


Photo 3: 96.3 mL to L Conversion

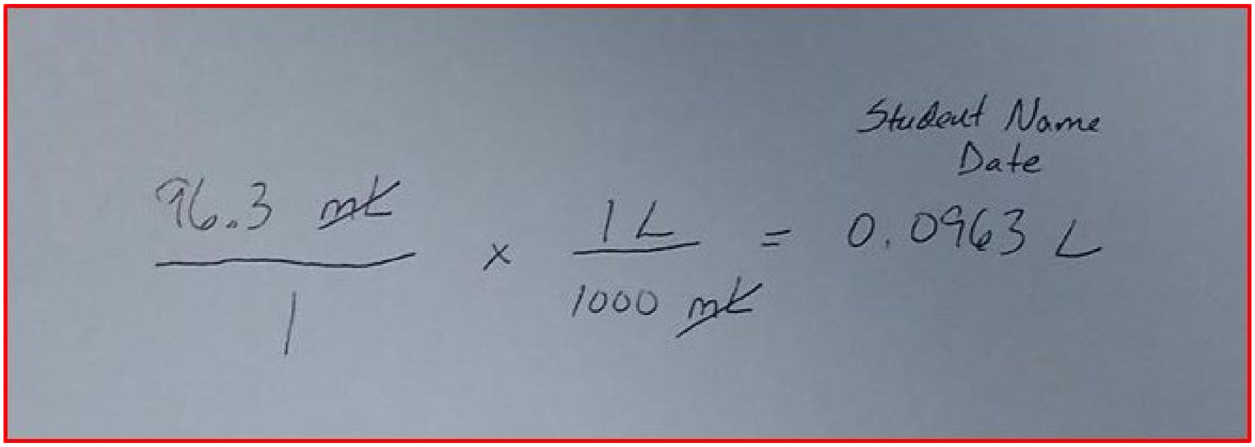


Photo 4: 4.00 miles to km Conversion

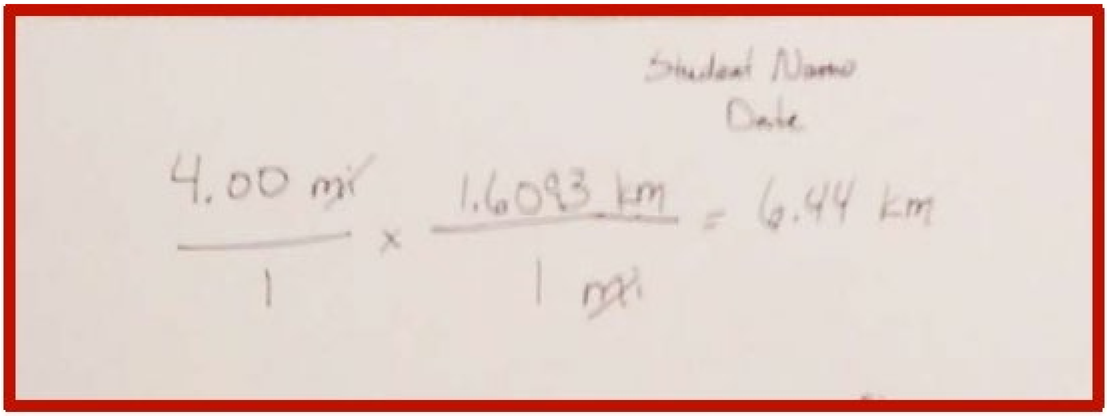


Photo 5: 0.25 oz to mL Conversion

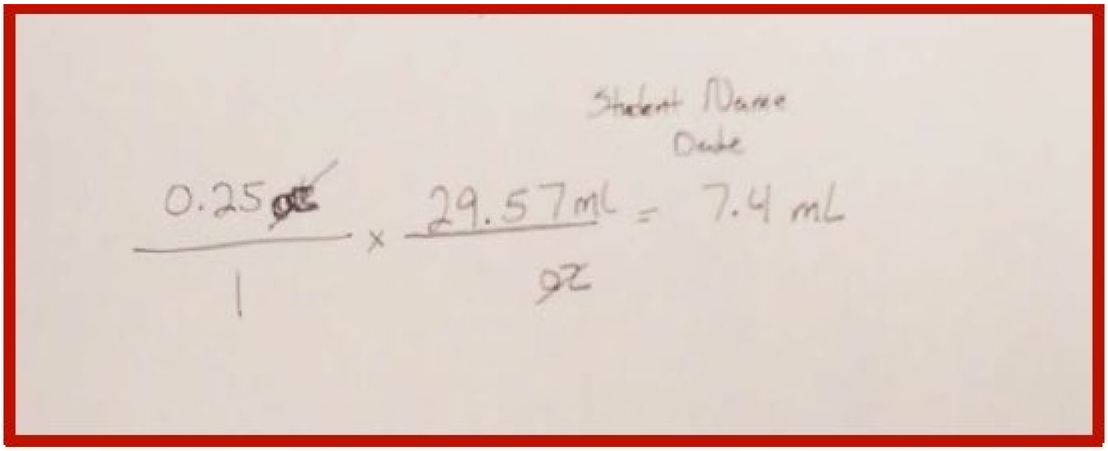


Photo 6: 500.0 mL to qt Conversion

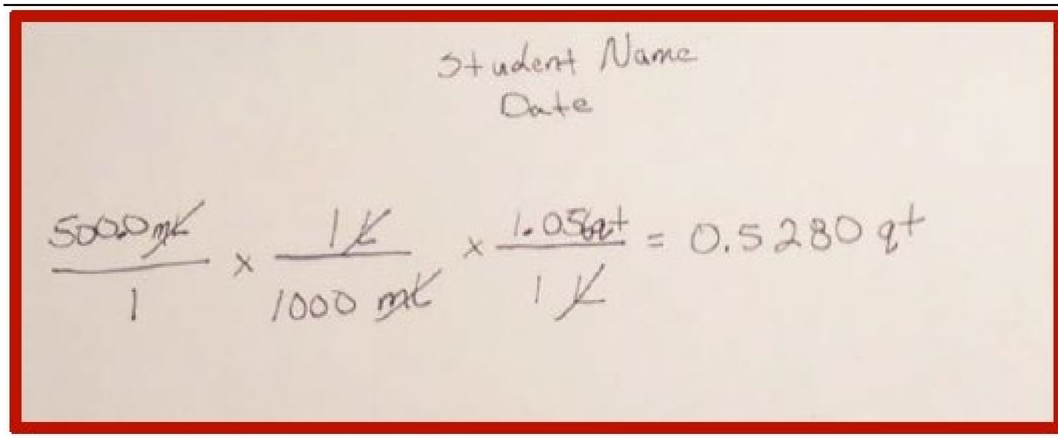


Photo 7: 0.750 yd to cm Conversion

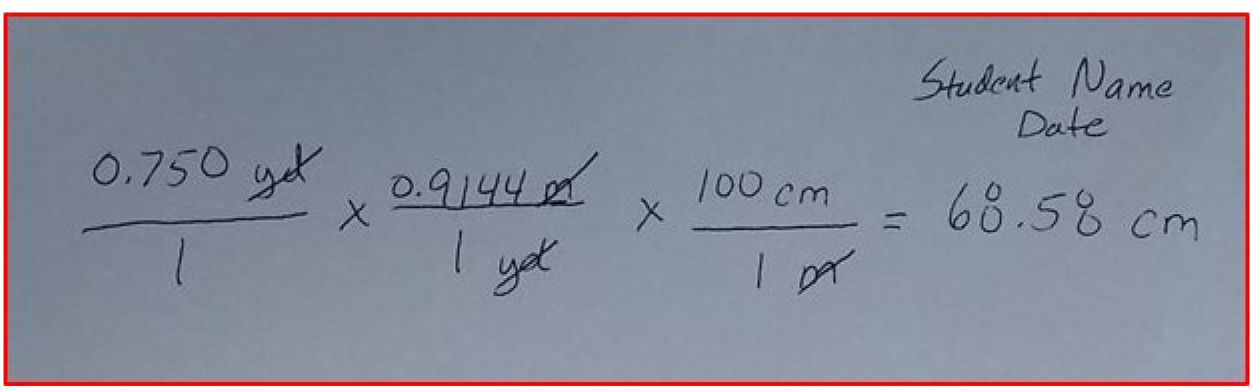


Photo 8: 0.834 gal to mL Conversion

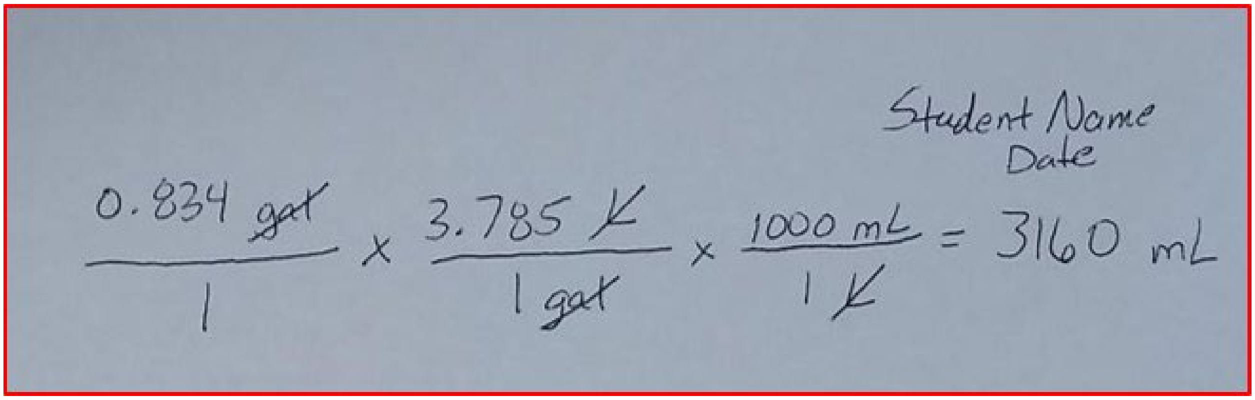


Photo 9: 15.00 lb to kg Conversion

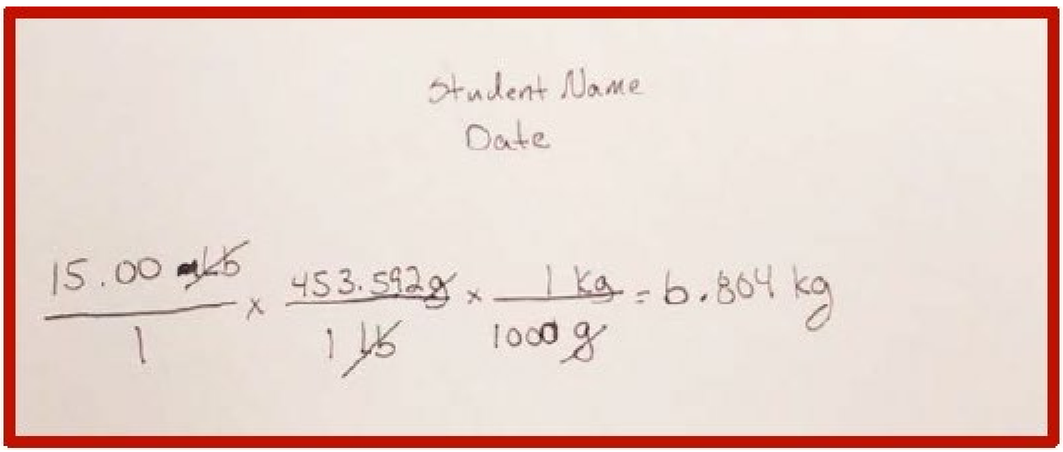
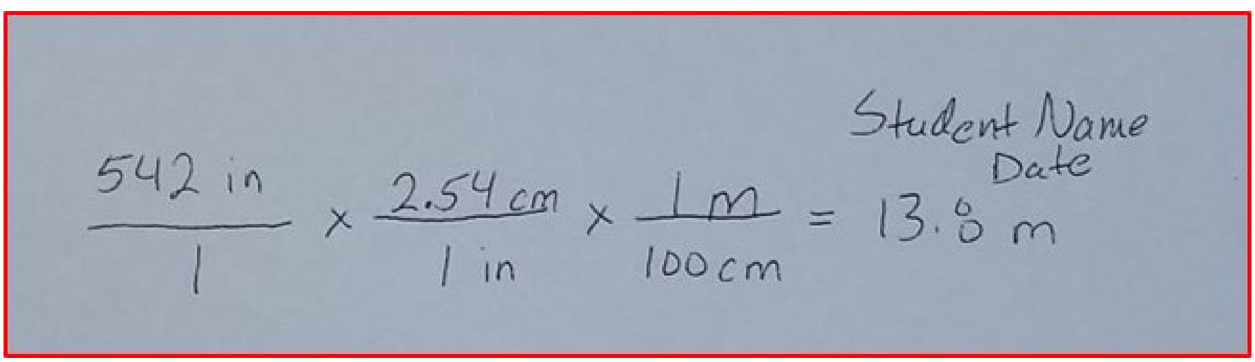


Photo 10: 542 in to m Conversion



Question 1

Why should dimensional analysis be used to convert units of measure?

Dimensional analysis is used to convert known measurements and conversion factors to fractions, which allows units to be cancelled during fraction multiplication.

Question 2

A researcher combines three liquid samples with the volumes listed below. How much total liquid in liters does the researcher have? Include your calculations in your answer.

Sample 1: 250 mL
Sample 2: 1.4 L
Sample 3: 30.00 fluid ounces

250 ml x (1 L/1000 mL) =0.2500 L
30.00 ounces x (1 L/33.814 ounces) = 0.8872 L
0.25 L + 1.4 L + 0.8872 L = 2.5372 L = 2.5 L

Exercise 3: Solving Equations

Table 5: Equation Solutions

Equation	Value of X
5x + 12 = 42	6
3x – 3 = 4	2.3
(5 + 7)/x = 24	0.5
18 = 30 – x	12
20 – 4 = 32x	0.5

Question 1

How are solutions checked after solving an equation?

Solutions are checked by inserting the value of x into the original equation, performing the calculations, and making sure both values on either side of the equation are equal.

Question 2

The theory of relativity is stated as the equation $E = mc^2$ where:

E = energy
m = mass
c = speed of light

A scientist has data for the speed of light and energy variables. What form of the equation should the scientist use to determine the mass of an object?

The scientist would solve the equation for the unknown variable m. The equation would be stated as $m = E/c^2$.

Exercise 4: Graphing

Table 6: Bacteria Numbers Dataset

	Name	Explanation	Axis and Title
Independent Variable	Time	Time is not determined by the other variable in the experiment.	x-axis to be titled “Time (hr)”
Dependent Variable	Cell Count	Cell count is determined by the other variable in the experiment.	y-axis to be titled “Cell Count”

Panel 1: Explanation

A line graph was selected because each cell count is related to prior cell counts. Datasets that have time as an independent variable are most often displayed in line graphs.

Graph 1: Bacteria Numbers Over Time

Note to Instructors: Acceptable answers include graphs drawn by hand and graphs generated with software.

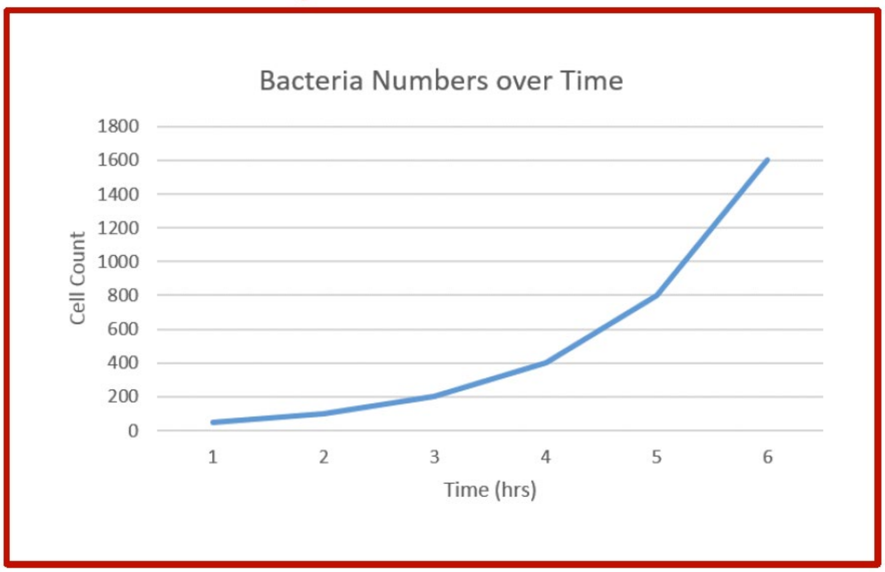


Table 7: Leaf Mass Dataset

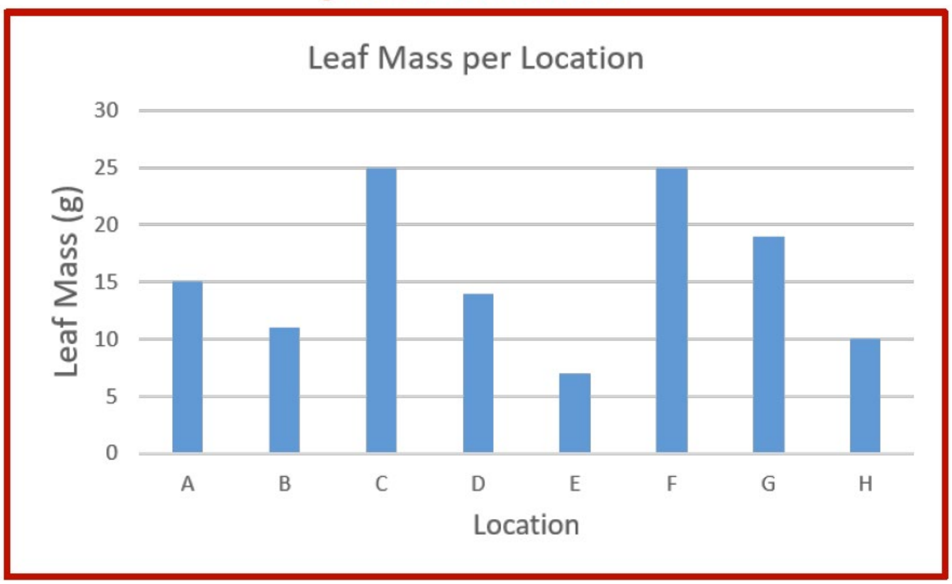
	Name	Explanation	Axis and Title
Independent Variable	Location	Location is not determined by the other variable in the experiment.	x-axis to be titled "Location"
Dependent Variable	Leaf Mass	Leaf Mass is determined by the other variable in the experiment.	y-axis to be titled "Leaf Mass (g)"

Panel 2: Explanation

A bar graph was selected because each leaf mass measurement is independent of other mass measurements since they occur in different locations.

Graph 2: Leaf Mass per Location

Note to Instructors: Acceptable answers include graphs drawn by hand and graphs generated with software.



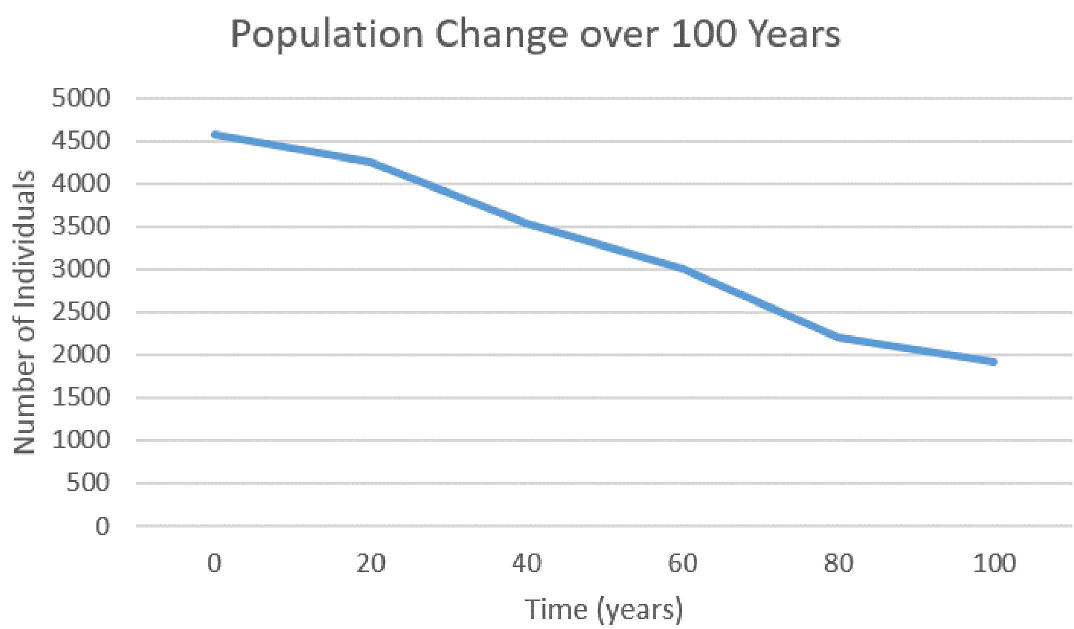
Question 1

What determines whether a bar graph or line graph is appropriate for illustrating experimental data?

The relationship between data points determines which graph type is used. Bar graphs should be used to plot data points that are unrelated to each other. Line graphs are used for illustrating related data points, and most often used when time is the independent variable.

Question 2

Data for population change over 100 years for a small town is plotted on the graph below. What is the dependent variable? What trend does the graph illustrate? What was the approximate population size in year 40?



The dependent variable is number of individuals. The graph illustrates that the population has declined over the past 100 years in the small town. The approximate population size at year 40 was 3500 individuals.

Extension Question

Dr. Jones performed an experiment to monitor the effects of sunlight exposure on stem density in aquatic plants. In the study, Dr. Jones measured the mass and volume of stems grown in 5 levels of sun exposure. The data is represented below.

Sun exposure (%)	Stem mass (g)	Stem volume (mL)
30	275	1100
45	415	1215
60	563	1425
75	815	1610
90	954	1742

a. Convert the mass measurements to kilograms (kg) and the volume measurements to cubic meters (m^3).

b. Calculate the density of the samples using the equation d = m/v.

d = density

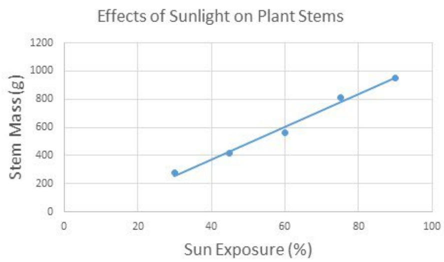
m = mass (kg)

v = volume (m^3)

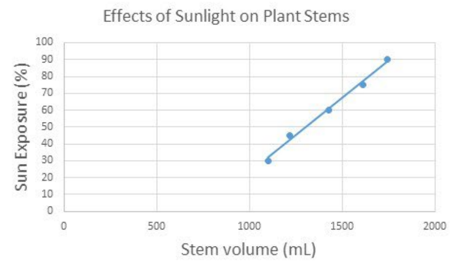
c. Convert the density values to scientific notation.

d. Select the graph that best represents the data.

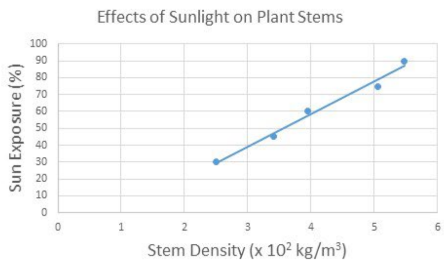
A



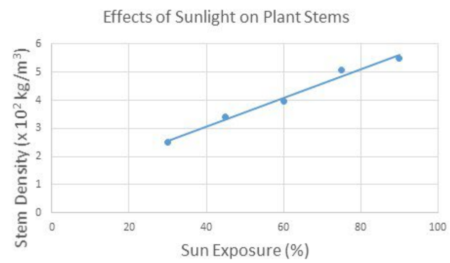
B



C



D



a. 0.275 kg, 0.415 kg, 0.563 kg, 0.815 kg, 0.954 kg, 0.0011 m^3, 0.001215 m^3, 0.001425 m^3, 0.00161 m^3, 0.001742 m^3

b. 250 kg/m^3, 342 kg/m^3, 395 kg/m^3, 506 kg/m^3, 548 kg/m^3

c. 2.50 x 10^2 kg/m^3, 3.42 x 10^2 kg/m^3, 3.95 x 10^2 kg/m^3, 5.06 x 10^2 kg/m^3, 5.48 x 10^2 kg/m^3

d. D