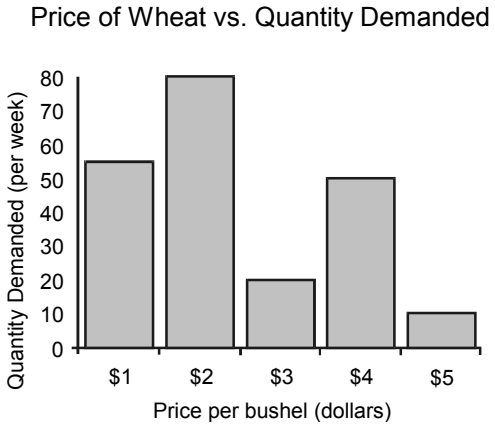
Graphing Skills
Reading, Constructing and Analyzing Graphs

Bar Graphs and Histograms

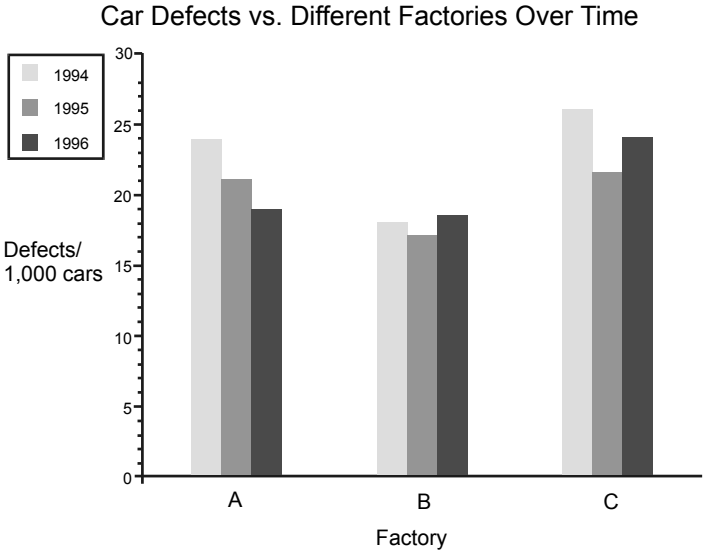
Bar graphs are very common types of graphs. They are found in almost all science books, magazines, and newspapers. They can be useful tools in scientific study by allowing us to visually compare amounts or frequency of occurrences between different data sets. Bar graphs can be used to show how something changes over time or to compare items with one another. When reading or constructing this type of graph you should pay close attention to the title, the label on the axes, the unit or scale of the axes, and the bars.

In a simple bar graph the specific group or experimental subject is assigned the *x*-axis (horizontal) and the *y*-axis (vertical) is known as the frequency axis. In general, the *x*-axis will be divided into time periods or measurements while the *y*-axis is designated for the frequency of occurrences. When data is grouped, the *x*-axis always represents the grouped data while the y-axis shows the frequency data. A composite bar graph is often useful when displaying the sum of various dependent variables when the values are a fraction of the whole. Histograms are very similar to simple bar graphs with one exception — the bar represents a range of values rather than one single value and the intervals must all be of equal magnitude. Study the sample graphs below before completing this exercise.

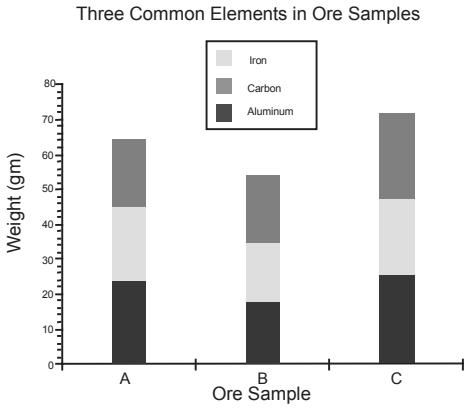
Simple Bar Graph



Grouped Bar Graph

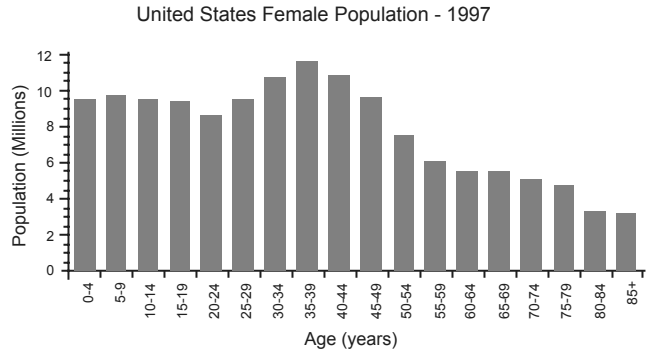


Composite Bar Graph



Histogram

Population Distribution



PURPOSE

In this exercise you will create simple bar graphs, grouped bar graphs, composite bar graphs and histograms. You will be expected to properly label each of your graphs and analyze each one by making statements about trends in the data.

MATERIALS

4 sheets of graph paper	data
pencils	straight edge

PROCEDURE

PART I: SIMPLE BAR GRAPH

1. Obtain one piece of graph paper and a pencil.

2. Study the data table below.

Leading Causes Of Death Worldwide	
Cause	Deaths Per Year (millions)
Cardiovascular disease	16.9
Cancers and tumors	7.2
Infectious diseases (includes AIDS, malaria, etc.)	13.5
Accidents and trauma	5.1
Respiratory disease	3.5
Digestive and nutritional	2.3
Diabetes	0.9

3. Choose the data to be graphed on the *x*-axis and the *y*-axis.

4. Survey the data and determine an appropriate scale for each axis. Be sure to utilize as much of the graph paper as possible o display your data. Use your pencil to lightly mark the scale of your *x* and *y*-axes. Have your teacher check your scale before proceeding any further. When making a bar graph, the individual bars should be constructed with the same width. You may decide the width of your bars.

5. When your teacher approves, construct your simple bar graph. Be sure to label each axis with units and give your graph a title.

PART II: GROUPED BAR GRAPH

1. Study the following data and follow the same procedure as Part I with a clean sheet of graph paper. This data should be graphed as a grouped bar graph and include a legend or key to indicate what each bar represents.

Some of the Most Common Chemical Elements of the Earth		
Chemical Element	Whole Earth (%)	Crust (%)
Iron (Fe)	33.3	5.8
Oxygen (O)	29.8	45.2
Silicon (Si)	15.6	27.2
Magnesium (Mg)	13.9	2.8
Aluminum (Al)	1.5	8.2

PART III: COMPOSITE BAR GRAPH

1. Study the following data and follow the same graphing procedure with a clean sheet of graph paper. This data should be graphed as a composite bar graph. You will need to include a legend and be sure to place the waste disposal methods in the same order for each bar drawn.

Solid Waste Recycled, Incerated, and Landfilled in US and Japan		
	Japan	US
Recycle (%)	50	24
Incinerate (%)	23	17
Landfill (%)	27	59

PART IV: HISTOGRAM

1. Study the following data and follow the same graphing procedure. This data should be graphed as a histogram. It is important that histograms have the same interval and width for each bar. For example, each bar might represent 10 years in the data table below.

Life Expectancies in the US	
Current Age	Remaining Years Expected
0-10	72.6
11-20	59.5
21-30	50.1
31-40	40.7
41-50	31.7
51-60	23.2
61-70	15.8
71-80	9.7
81-90	4.5

Graphing Skills
Reading, Constructing and Analyzing Graphs

Bar Graphs and Histograms

CONCLUSION QUESTIONS

Using the graphs that you constructed, answer the following questions.

PART I: SIMPLE BAR GRAPH

1. How many deaths due to accidents and trauma occur per year?

2. Can you predict the number of deaths due to cancers and tumors for the next ten years? Explain.

PART II: GROUPED BAR GRAPH

1. What element is the most abundant in the earth's crust?

2. What element is the most abundant within the earth?

PART III: COMPOSITE BAR GRAPH

1. What is the favored method of waste disposal for the Japanese population? Cite possible reasons for this.

2. What is the favored method of waste disposal for the US population? Cite possible reasons for this.

PART IV: HISTOGRAM

1. Make a prediction about the remaining years of life that would be expected for someone in the current age category of 91-100.

2. Is the answer to question 7 an accurate number? Why or why not? Cite specific reasons.

3. What type of data is easily represented by a bar graph?

4. Why is a legend (or key) necessary in the grouped and composite bar graphs?

5. Explain why it is difficult to make direct comparisons between recycling in Japan and the US using the composite bar graph that you drew.

6. What is the importance of scaling?

7. Distinguish between the dependent and the independent variable for each of the graphs that were constructed. On which axis should the independent variable be placed?

	Dependent Variable	**Independent Variable**
Simple Bar Graph		
Grouped Bar Graph		
Composite Bar Graph		
Histogram		

Graphing Skills
Reading, Constructing and Analyzing Graphs

Pie Charts

Pie charts are very commonly found in newspapers, magazines and textbooks. A pie chart is a very good way to represent percentages.

PURPOSE
In this activity you will practice constructing and analyzing basic pie charts.

MATERIALS

blank paper	data
pencil	protractor
compass	colored pencils

Safety Alert
1. The sharp point on the compass should only be placed on paper.

PROCEDURE
1. After observing your teacher demonstrate the use of the compass and protractor, use Sample Data Set 1 to construct a pie chart on a piece of blank paper. Use different colors to represent different sections of your graph.

2. Be sure to label your chart with an appropriate title and be sure to provide a legend or key that distinguishes each component.

Sample Data Set 1: Sources of Nitrogen Oxide Air Pollution

Sources of Nitrogen Oxides	Percentages (%)
Power plants	53%
Transportation	68%
Industry	27%
Non-road	32%
Other	20%

3. Use Sample Data Set 2 to construct a second pie chart on another blank piece of paper. Be sure to label appropriately. *Note*: Before beginning construction of this graph, you must calculate component percentages. Show your work on the student answer page.

Sample Data Set 2: 500 adults between the ages of 25-30 were polled as to which science courses they completed in their high school years. The following data was collected.

Science Courses Completed	Number of Adults
No science courses	0
Biology only	45
Biology and Chemistry only	205
Biology, Chemistry and Physics only	180
Other classes not listed (AP, etc.)	70

Name _____

Period _____

Graphing Skills
Reading, Constructing and Analyzing Graphs

Pie Charts

ANALYSIS

1. Staple your two graphs behind this answer page.

2. Show your work here for Sample Data 2 - percentage calculations.

CONCLUSION QUESTIONS

Using the graphs that you constructed, answer the following questions:

Sample Data Set 1: Sources of Nitrogen Oxide Air Pollution

1. How much nitrogen oxide air pollution is due to transportation?

2. Not taking into account the set of data labeled "other", what category contributes the least nitrogen oxide air pollutants into our environment?

3. Can you predict from a graph of this type the amount of nitrogen oxide air pollution that will be contributed by industry in the next ten years? Explain your reasoning.

Sample Data Set 2:

1. Why must a percentage calculation be performed on the data before making the graph?

2. Describe the trend displayed by this pie chart. Be specific.

3. Most adults polled between the ages of 25-30 years of age completed which science courses during their high school career?

4. Describe the type of data that can be displayed using pie charts. List three specific places where you might see pie charts printed.

Name _____

Period _____

Graphing Skills
Reading, Constructing and Analyzing Graphs

Line Graphs

There are all kinds of charts and graphs used in the science classroom. Graphs are useful tools in science. Trends in data are easy to visualize when represented graphically. A line graph is beneficial in the classroom for many different types of data. Line graphs are probably the most widely used scientific graph. They can be used to show how something changes over time, the relationship of two quantities, and can be readily used to *interpolate* (predict between measured points on the graph) and *extrapolate* (predict beyond the measured points along the same slope) data points that were not actually measured in the lab setting. The analysis of these graphs provides very valuable information.

PURPOSE
In this activity you will learn the basic procedure for constructing and analyzing line graphs.

MATERIALS

4 sheets of graph paper	data
pencil	ruler

PROCEDURE

1. Follow along with your teacher as a sample line graph is constructed. Label a blank piece of graph paper as your teacher explains the important components of a line graph.

2. Use the sample sets of data below to construct line graphs. Place only one graph on each sheet of graph paper and use as much of the graph as possible to display your points. ***Do not connect the dots!*** Draw the best smooth curve or line of best fit as your teacher demonstrated.

3. Following the steps below will help ensure that all components of the graph are correctly displayed.
   a. **Identify the variables**. Independent on the x-axis and dependent on the y-axis.
   b. **Determine the range**. Subtract the lowest value data point from the highest value data point—for each axis separately.
   c. **Select the scale units**. Divide each axis uniformly into appropriate units using the maximum amount of space available. (Remember that the axes may be divided differently but each square along the same axis must represent the same interval.)
   d. **Number and label each axis**. Be sure to include units where appropriate as part of the axis label.
   e. **Plot the data points as ordered pairs**. (x,y)

f. **Draw the best straight line or best smooth curve**. Use a straight edge to draw your line in such a way that equal numbers of points lie above and below the line.
g. **Title the graph**. The title should clearly describe the information contained in the graph. It is common to mention the dependent variable first followed by the independent variable.

4. After creating graphs for the 4 data sets below, use the graphs to answer the conclusion questions on your student answer page.

Sample Data Set 1: The following set of data was collected while experimenting with position and time of a miniature motorized car traveling on a straight track.

Position (meters)	Time (minutes)
0	0
15	5
30	10
45	15
60	20
75	25

Sample Data Set 2: The following set of data was collected during an experiment to find the density for an unknown metal.

Mass (g)	Volume (cm^3)
2.00	0.18
5.00	0.44
7.50	0.66
16.00	1.41
24.00	2.11

Sample Data Set 3: The following set of data was collected during an experiment studying the effect of light intensity on rate of photosynthesis.

Percent Transmittance (%)	Time (minutes)
32.5	0
54.3	5
63.5	10
65.0	15

Sample Data Set 4: The following set of data was collected during an acid-base titration experiment.

pH	Volume of NaOH (mL)
1.80	0.00
1.80	10.00
1.82	20.00
2.00	23.00
3.20	25.00
6.10	30.00
6.20	40.00
6.50	50.00
12.80	51.00
13.50	60.00
13.80	70.00

Name _____

Period _____

Graphing Skills
Reading, Constructing and Analyzing Graphs

Line Graphs

DATA AND OBSERVATIONS

Staple your completed graphs behind this answer page.

CONCLUSION QUESTIONS

Using the graphs that you constructed, answer the following questions:

Sample Data Set 1:

1. What is the independent variable for this graph? Explain.

2. What would be the position of the car after 25 minutes?

3. If the experiment were carried out for 80 minutes, what would be the position of the car?

4. Calculate the slope of the line drawn. What does the slope of this line represent? Explain.

5. Write the equation for a straight line including the value that was determined for slope.

Sample Data Set 2:

1. What values were considered when creating the scale for each axis in this experiment?

2. What does a data point on this graph actually represent?

3. What volume would a 20.00 gram sample of this substance occupy?

4. Calculate the density of the substance. (HINT: calculate the slope of the line.)

5. Write the equation for a straight line including the value that was determined for slope.

6. Use the equation and find the mass when the volume is 5.00 cm^3.

Sample Data Set 3:

1. Does this graph represent a linear relationship? Why or why not?

2. What is the dependent variable in this graph? Explain.

3. If the experiment were continued for 30 minutes, what trend in percent transmittance could be expected?

4. Calculate the slope of the line at 5 minutes. What does this represent?

Sample Data Set 4:

1. What is the pH of the solution after 20.0 mL of NaOH are added? After 30.0 mL are added? Would it have been easy to predict this answer?

2. Graphs often help us to understand the progress of a chemical reaction. In the titration graph for this set of data, there are two relatively sharp, upward curves. The middle of these steep rising portions represent equivalence points (point at which the moles of acid and base are equal). Identify the volume of NaOH needed to reach each of the equivalence points. .

3. What is the pH at 65 mL. What is the pH expected to do beyond this point with greater additions of the base NaOH? Explain.