How Do I Display That? GED® Science Test

Information, Resources, and Strategies for the Classroom

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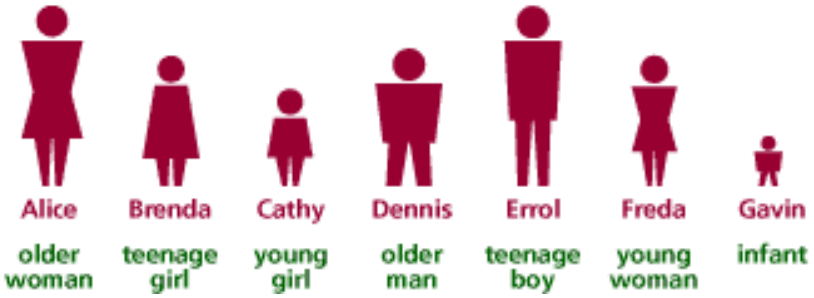
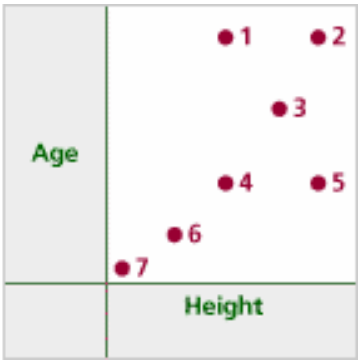
Time Out for a Graphic Starter

Look at the following graph. Who is represented by each point?





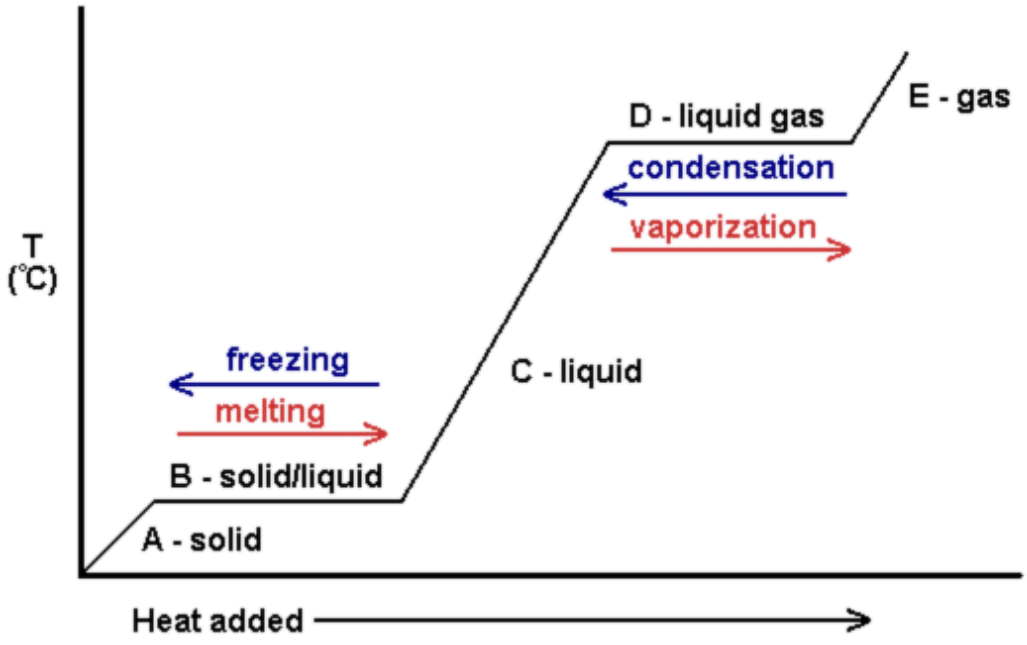
Representing Data

Think of the simplest way you can organize the data below, showing the length of nails found in a packet of assorted nails.

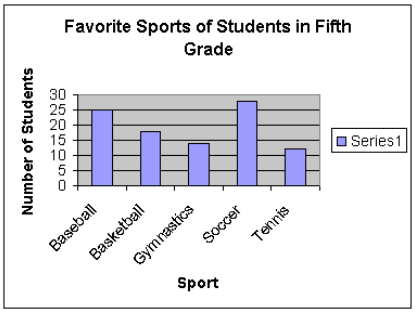
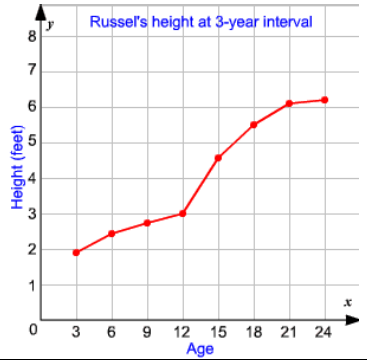
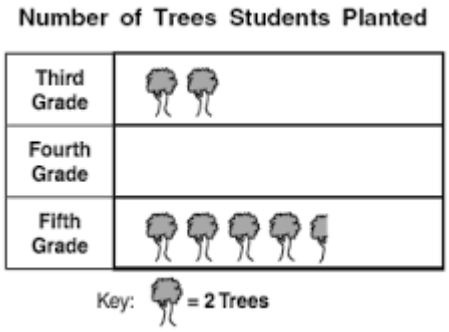
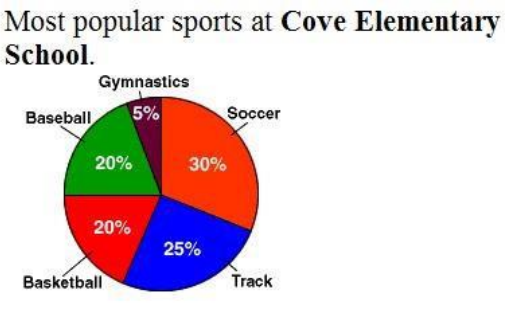
Length of Nails (mm)															
11	22	29	15	17	27	21	23	27	26	19	16	11	10	16	15	21
21	17	15	23	20	16	17	25	16	21							

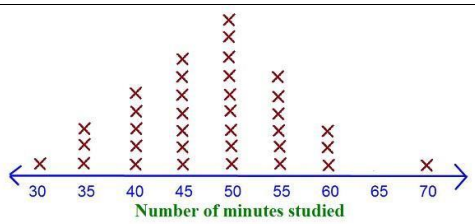
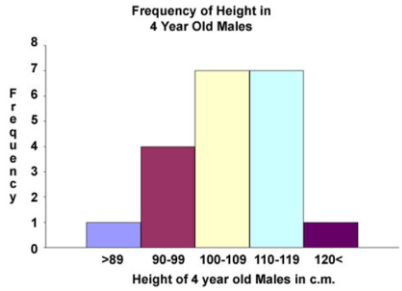
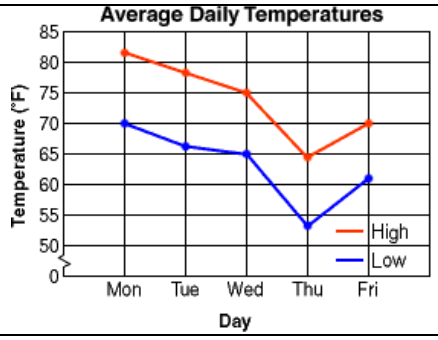
Teach Big Ideas with Graphics

Some Characteristics of Gases, Liquids and Solids and the Microscopic Explanation for the Behavior		
gas 	**liquid** 	**solid** 
assumes the shape and volume of its container particles can move past one another	assumes the shape of the part of the container which it occupies particles can move/slide past one another	retains a fixed volume and shape rigid - particles locked into place
compressible lots of free space between particles	not easily compressible little free space between particles	not easily compressible little free space between particles
flows easily particles can move past one another	flows easily particles can move/slide past one another	does not flow easily rigid - particles cannot move/slide past one another



Types of Graphs

Type of Graph	Example	When do I want to use this kind of graph?
A bar graph presents data so that comparisons of different items can be made		• Used to compare the frequency of data • Use a bar graph when you want to compare 2 or more sets of data
A line graph presents data on one item so that changes and trends over time can be identified and comparisons can be made		• Use when you have continuous data • Use when you want to show changes over time
A pictograph presents data using pictures or symbols		• Each picture or symbol represents and assigned amount of data • The key tells the number that each picture or symbol represents • Use when you have large amounts of data that is too big for a bar graph • Use when you only have 2 to 6 categories
A circle graph shows how parts are related to the whole		• Use when you want to show how a total amount of data is divided into parts • Can be used to show percentages • Use when you have 3 to 7 categories

A line plot shows the frequency of data values. The range determines the number line. The x represents the data value.		• Useful when finding the range, mode, mean, and median of a set of data • Easy to identify outliers and clusters • An outlier is a piece of data that is set far apart from the rest of the data • A cluster is where data tends to group together • Best to use this graph when you have a small range
A histogram is a bar graph that shows the frequency of equal intervals of data		• Different than a bar graph because it uses intervals instead of individual numbers and the bars touch • The intervals must not overlap • Good to use with continuous data (ex: weight, height, time, etc.)
A stem and leaf plot is a special table where each data value is split into a “stem” and a “leaf”	Grades on a Science Test Stem | Leaf 7 | 2 2 4 5 6 9 8 | 1 4 5 7 7 9 9 | 0 1 3 5 8 10 | 0 0 Key: 7 / 2 means 72 percent	• The stem is the first digit(s) and the leaf is the last digit in a data value • Ex: In the number 72, the digit 7 is the stem and the digit 2 is the leaf • Useful when organizing numerical data
A double line graph is a line graph used to compare two sets of data		• Useful to compare how two things change over time • Each set of data is graphed separately but on the same grid • A key identifies the sets of data

Types of Graphs – Julie Rozier – Teachers Pay Teachers
https://www.teacherspayteachers.com/Product/Types-of-Graphs-Graphic-Organizer-2373146

Will That Vaccine Make a Difference?

In order to test the effectiveness of a new vaccine, 50 volunteers are selected and divided into two groups. One group will be the control group and the other will be the experimental group. Both groups are given a pill to take that is identical in size, shape, color and texture.

Describe the control group.

Describe the experimental group.

What variables are kept constant?

What variable is being changed?

What data would you collect?

How would you display the data?

Experiments for the Classroom – Getting Started

The Scientific Method, Statistics, and M&M's®

Objectives

Students will:

- Identify and describe the different steps of the scientific method
- Conduct a simple experiment that provides a statistical analysis of the total number and frequency of colors of M&M's® in a bag
- Compare their results to the stated M&M's® color distribution ratio
- Present their findings to the class

Materials

- Experimental Procedure worksheet
- 5 Bags of M&M's® per group (regular or fun-sized packages)
- Graph paper and colored pencils
- Calculators

Terms and Concepts

- Frequency
- Hypothesis
- Mean, Median, Mode, Range
- Numerical information
- Random Sampling
- Statistics
- Prediction
- Proportion
- Variables (independent, dependent, control/constant)

Introduction

Discuss the importance of statistics in the world of science. Share that statistics are facts or data based on a set of numerical information. This is the type of information that is used to support or not support a hypothesis. Sometimes, statistics can be unpredictable, meaning that they do not have any kind of pattern. The numerical information they are based on appears to be *random*. However, many statistics do reveal patterns and can be used to make *models*, form hypotheses, and make predictions about certain things. In statistics, how often a certain event happens is referred to as the frequency of that event.

The Mars Company states that their color blends for M&M's® were selected by conducting consumer preference tests, which indicate the assortment of colors that pleased the greatest number of people and created the most attractive overall effect. The company says that each large production batch is blended to certain ratios and mixed thoroughly. However, since the individual packages are filled by weight on high-speed equipment, and not by count, it is possible to have an unusual color distribution.

In 2008, the Mars Company stated that M&M's® milk chocolate had the following ratio:

- 24% blue, 20% orange, 16% green, 14% yellow, 13% red, 13% brown

However, plain M&M's® are now produced at two different factories in the US. The two factories do not use the same mixture of colors! Therefore, you need to look on the packaging for the manufacturing code, which is usually stamped inside a rectangle. In the middle of the code will be the letters HKP or CLV. For example, the code might read 632GCLV20.

- CLV: The Cleveland plant uses the following proportion of colors for plain M&M's®. Red=0.131, Orange=0.205, Yellow=0.135, Green=0.198, Blue=0.207, and Brown=0.124.
- HKP: The Hackettstown, NJ, plant uses the following proportion of colors for plain M&M's®. Red=0.125, Orange=0.25, Yellow=0.125, Green=0.125, Blue=0.25, and Brown=0.125.

Provide students with the distribution ratio that you wish them to use.

Questions

- What is statistics? How is it used to explain something?
- How is frequency related to an event?
- Which color do you think will be the most common one in a package of M&M's?
- Do you think that each package will match the ratio distribution set by the Mars Company? Why or why not?
- If you are using the manufacturing location, ask students if they know where the candy is manufactured? Why would this be important?

Observation and Prior Knowledge

Ask your students what they already know about M&M's®. Have them write these facts and insights in their log.

Ask students to make some observations of the package (without opening the package) and create a list of initial observations in their log.

Question/Problem

Discuss that today their research questions will be related to how many of each color of M&M's® are in a bag and whether or not their findings match the Mars Company's ratio distribution. Make sure that students are provided with the ratio distribution that they should use.

Hypothesis

Have students identify the control group and the dependent and independent variables.
Note: Because there are so many variables in this experiment, it is not a true controlled experiment. However, you want the students to make this determination based on their questioning. Have students determine what types of things do stay the same, what they are testing and what they are measuring.

Example:

- Control Variables (conditions that stay the same) - Distribution ratio provided by the Mars Company, net weight of each bag
- Independent Variable (what you are testing) – Number of each color in an M&M's® per bag

- Dependent Variable: (what you are measuring). Amount of M&M's® and their colors found in each bag

Have students write a hypothesis based on the research question.

Sample hypothesis could be:

If the Mars Company sorters are working properly, then any difference between the color percentage in an actual package of M&M's® and the color percentage posted on the web site should be due to random chance.

If the Mars Company sorters are working properly, then the probability of getting a blue M&M® is 24%, an orange 20%, a green 16%, a yellow 14%, a red 13%, and a brown 13%.

Experiment and Document Data

Have students conduct their experiments and record their data. Using the data chart, have students determine the total number of candies per bag, as well as the frequency and the percentage of each candy color.

Have students determine the average of mean, as well as the median and mode for the total number of M&M's® per bag and the number of each color.

Students should notice that there is a variance in data for each bag of M&M's®.

Analyze the Data and Form a Conclusion

Have students review the data and determine whether or not the distribution ratio provided by the Mars Company is accurate. Have students graph the data in histograms, bar graphs, and/or pie charts (color-coded graphs follow easily from the M&M's® colors).

Questions (Bar Graphs)

Have students discuss frequency of each color of M&M's® in the package. It is useful for comparing the frequencies of each individual color to each of the other individual colors.

- In the average package of M&M's®, which color occurs most often (highest frequency)?
- Which color is the rarest (lowest frequency)?
- Do any of the colors have the same frequencies?
- Do you see any other trends in your data in the bar graph?

Questions (Pie Chart)

This chart will identify what each portion of the whole bag is of each color. It is useful for comparing the relative proportion of each individual color to the whole population.

- What is the percentage of each color of M&M's® in the package?
- Looking at your data table and graphs, do you think you can predict what color(s) M&M's® you are most likely to pick from a package (probability)? If so, what color(s) is it?

Conclusion

Is the hypothesis correct or not? Why? How confident are you in your conclusion? Why? Why Not? Looking at your data table and graphs, do you think you can predict what color(s) M&M's® you are most likely to pick from a package? If so, what color(s) is it?

Follow-up

Discuss that by collecting the data from different bags of M&M's® they have what is termed multiple trials. The class should discover that the number of M&M's® per bag is not constant, nor is the number of each color in the bag resulting in variation between M&M's® bags and the potential for calculations using the data. Using the data from the class, address the idea of variance in data. Ask: *From our data, what would be an accurate way to determine the number of M&M's in a random bag that I pick up at the grocery store?* Discuss that the average of the numbers provides an accurate description of the number of M&M's® in a randomly chosen bag.

Extensions

Let students brainstorm additional research questions and have them conduct the experiment.

Experimental Procedure

In this experiment, you will be collecting statistical data that will either support or refute your hypothesis.

Observation and Prior Knowledge

- What do you already know about M&M's®?

- As you look at the package, what do you observe without opening the package?

Question/Problem

Predict the answers to the following questions:

- Are there the same number of candies in each bag?

- Are there the same number of each color in each M&M's® bag?

- Which color do you think is most common?

- Which color do you think is least common?

State the Problem

Hypothesis

Form a hypothesis

Experiment and Record the Data

Complete the following chart. Determine the frequency and the percentage of each candy color.

Candy Color	Package					Total	Average (Mean)	Percentage
	1	2	3	4	5			
Blue								
Brown								
Green								
Orange								
Red								
Yellow								
Whole Bag								

What is the range for the number of each color?

What is the median for the total number of M&M's® per bag and the number of each color?

What is the mode for the total number of M&M's® per bag and the number of each color?

Analyze the Data and Form a Conclusion

Graph the Data

To compare your results to the ratio distribution from the Mars Company:

- Create a histogram or bar graph to visually display the frequency of each color of M&M's® in an average package as provided by the Mars Company.
- Create a histogram or bar graph to visually display the frequency of each color of M&M's® in the packages that you analyzed.
- Create a pie chart that provides the ratio distribution as provided by the Mars Company.
- Create a pie chart to compare the relative proportion of each individual color to the whole population.

Write a Conclusion

Using the data, form a paragraph that answers the problem you looked to solve in the M&M's® lab, include how your actual results compared with your hypothesis. Was your hypothesis correct or not? How confident are you in your conclusion? Why? Why Not?

Looking at your data table and graphs, do you think you can predict what color(s) M&M you are most likely to pick from a package? If so, what color(s) is it?

Resources for Graphics

Analyzing and Interpreting Data – Does It Sink or Float?
https://bscs.org/sites/default/files/_media/community/downloads/analyzing_and_interpreting_data.pdf

BBC: Bitesize and Skillswise
- http://www.bbc.co.uk/schools/gcsebitesize/
- http://www.bbc.co.uk/skillswise/mathsmaths/statistics/

Create a Graph NCES
http://nces.ed.gov/nceskids/graphing/index.asp

Data Analysis, Statistics, Probability
http://www.learner.org/courses/learningmath/data/index.html

Data Representation Module 6: Unit 3
https://wikieducator.org/images/9/90/JSMath6_Part2.pdf

The Graphics Gallery
http://www.accessexcellence.org/RC/VL/GG/index.html

Graphing Lesson Plans
http://www.ngsslifescience.com/biology_lesson_plans_scientific_method.html

Graphing Stories
http://graphingstories.com/

The Great Graph Math Game
https://earthobservatory.nasa.gov/Experiments/Biome/graphindex.php

How Structure Can Affect Properties Through Phase Changes (a classroom lesson)
https://florida.pbslearningmedia.org/resource/psu06-nano.sci.phasechanges/how-structure-can-affect-properties-through-phase-changes/#.WZHIVVWGOM8

KET Targeted Math.
http://tdcms.ket.org/targetedmath/L.11GraphsChartsandTables.pdf

The Master Teacher Project – Are All Graphs Created Equal?
https://betterlesson.com/lesson/628519/are-all-graphs-created-equal-day-1-of-2

Math is Fun!
http://www.mathsisfun.com/data/

MSP2 - Handling All That Data
http://msp.ehe.osu.edu/wiki/index.php/MSP:MiddleSchoolPortal/Statistics:_Handling_all_that_Data

National Science Digital Library (lesson plans and more . . .)
https://nsdl.oercommons.org

Phase Change Diagrams
https://www.youtube.com/watch?v=JJSZbfXnBq4

Senses Lab – A Graphing Lesson Plans – The Senses
http://www.ngsslifescience.com/science.php?/biology/lessonplans/C411/

Science Net Links. What's in a Graph?
http://sciencenetlinks.com/lessons/whats-in-a-graph/

States of Matter
https://phet.colorado.edu/sims/html/states-of-matter/latest/states-of-matter_en.html

Take a Challenge! Does drinking soda affect your health?
http://figurethis.nctm.org/challenges/c68/challenge.htm

Using Data in the Classroom – National Science Digital Library
http://serc.carleton.edu/usingdata/index.html

Yummy Math (Search data lessons related to science)
https://www.yummymath.com

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