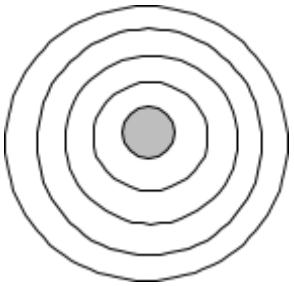
NAME:_____ Date_____ Section_____

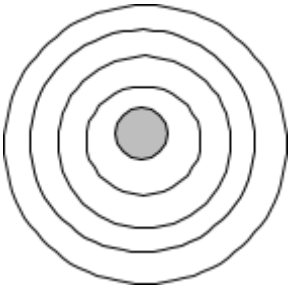
Accuracy and Precision

1. **Define the terms "accuracy" and "precision".**

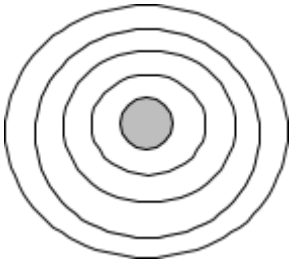
2. **Draw a target diagram that shows high precision but low accuracy**



3. **Draw a target diagram that shows high accuracy but low precision**



4. **Draw a target diagram that shows both high accuracy and precision**



5. **Each of five students used the same ruler to measure the length of the same pencil.These data resulted: 15.33 cm, 15.34 cm, 15.33 cm, 15.33 cm, 15.34 cm. The actual length of the pencil was 15.85 cm. Describe the accuracy and precision for these measurements.**

6.Mr. Andrej asks you and two of your classmates to determine the mass of a sample of aluminum (Al). Mr. Andrej also weighs the mass of aluminum. You perform the weighing three times, and obtain the following data: 6.74, 6.70, and 6.71 g**. The actual value is 6.70 g. Here are the other results:**

Classmate #1: 6.50, 6.49, and 6.52 g
Classmate #2: 6.57, 6.82, and 6.71 g
Andrej: 6.61, 6.70, and 6.87 g
A.Which results are most precise? Explain!

B. Which results are most accurate? Explain!

C. Which results have the highest accuracy *and* precision? Explain!

7) 82,23,59,94,70, 26, 32, 83, 87, 94, 32 (show your work)

Mean _____

Median _____

Mode _____

Range _____

8) 67,70,49,95,40, 97, 62, 54, 42 (show your work)

Mean _____

Median _____

Mode _____

Range _____

The Scientific Method

The basic **scientific method** includes the steps scientists use and follow when trying to solve a problem or prove or disprove a theory. The methods are used by scientists all over the world. This is done so scientists can work together to solve some of the same problems.

There are usually five steps which are a part of the scientific method. The steps can occur in any order, but the first step is usually **observation**. An observation is the use of one or more of the five senses, which include seeing, hearing, feeling, smelling, and tasting. The five senses are used to learn about or identify an event or object the scientist wants to study. For example, while observing a spider a scientist may observe the pattern or size of the spider's web. Observations lead to questions.

The second step of the scientific method is the statement being researched, the **hypothesis**. A good hypothesis includes three things; the explanation for the observations, if it is able to be tested by other scientists, and it will usually predict new outcomes or conclusions. The scientist observing the spider building the web may have a question about the strength of the web. Usually a hypothesis is written as an "If…then…because" statement. An example of the hypothesis might be: If the spider is larger, then the web will be stronger because the silk is bigger. This hypothesis includes the explanation for the observation, it can be tested, and new conclusions may be reached.

The third step of the scientific method is the **experiment.** An experiment is a test which will either challenge or support the hypothesis. The hypothesis will then be true or false. Using the spider hypothesis, a scientist may experiment by measuring spider webs in relation to a spider's size.

Often, even when a hypothesis is disproved much can still be learned during the experiment. For example, while measuring the strength of spider webs the scientist may discover something new about them. It is important to test only one variable at a time. If we test several different things in an experiment it will be very difficult to understand which variable caused the change. We collect **data** during an experiment. Data can be recorded through written words, graphs, charts, and/or illustrations.

The final step in the scientific method is the **conclusion**. The conclusion will either clearly support the hypothesis or it will not. If the results (data) support the hypothesis, a conclusion can be written. If it does not support the hypothesis, the scientist may choose to change the hypothesis or write a new one based on what was learned during the experiment. In the example, if the scientist proves that larger spiders build stronger webs, then that is the conclusion. If it was not proven, the scientist may change the hypothesis to: The size of a spider has no bearing on the strength of its web.

The scientific method is used for simple experiments students may do in the classroom or very complex or difficult experiments being done all over the world. The spider experiment may be done by a scientist in Jacksonville, Washington D.C., or Brazil.

In summary, the **scientific method** includes the steps scientists use to solve a problem or to prove or disprove a theory. There are five basic steps involved with the scientific method. The usual steps include **observation, hypothesis, experiment, collecting data** and **making a conclusion.** The steps may not always be completed in the same order. Following the five steps, the results of the experiment will either support the hypothesis or will not support the hypothesis. Scientists are always free to change or write a new hypothesis and start the five steps all over again. The scientific method is used for simple experiments or for more difficult experiments.

Hypothesis Activity

The format for writing a hypothesis is…

If (describe specifically what you will do in the experiment) **then** (predict the outcome of the experiment based on your "if" statement.)

For each problem or question write a hypothesis.

Example: I wonder if chocolate may cause pimples?

If ___*I eat a chocolate candy bar*_____, then
_____*I will get pimples*_____.

1. Will plant growth may be affected by the color of the light?
If _____,
then _____.

2. Are there more bacteria on the toilet handle or on my science desk?
If _____,
then _____.

3. Which lunch will give me more energy, chicken sandwich or pizza?
If _____,
then _____.

4. Do birds with longer or shorter wings fly faster?
If _____,
then _____.

5. Does caterpillar poop weigh the same as the leaf it eats?
If _____,
then _____.

6. Bob wondered if giving detentions for missing homework would lower the amount of homework missed in his local middle school. He recorded the number of missed homework for 30 days, and then the school agreed to assign detentions for each missed homework assignment. He then compared the numbers to see if the policy had any effect.
If _____,
then _____.

7. Does T.V. time seem to affect the reading scores of fourth graders?
If _____,
then _____.

8. Does wing length affect the distance a plane flies?
If _____,
then _____.

9. Bob wants to see if different smells travel at the same speed. He sprays a can of hairspray, peppermint air freshener, and insect repellant at the same time. Six friends stand around him in a large circle, five feet from the center of the circle where Bob stood.
If _____,
then _____.

Scientific Method

For each experiment, fill in the correct step of the Scientific Method on the blank line above the description. Use the words below.

Question/Problem	Hypothesis	Experiment	Collect & Analyze data	Conclusion

Bean Plants

1. _____
Measure the growth of the bean plants and determine how the plants in both environments progressed over the course of the three weeks. Find an average between the two indoor plants to determine the "typical" indoor plant growth, doing the same for the two outdoor plants to calculate the "typical" outdoor plant growth.

2. _____
I want to know if a bean plant will grow more quickly outside or inside.

3. _____
Based on the data you collected, determine if a bean plant placed inside or outside will grow more quickly.

4. _____
If I plant bean plants outside, then they will grow more quickly than if I planted them inside.

5. _____
Plant four bean plants in identical pots using the same type of soil. Place two of these in an outdoor location and place the other two in an indoor location. Choose locations where the plants will get a similar amount of sunlight. Care for the plants in an identical way, like giving the same amount of water. Then, each day for the three-week experimental period, observe and measure plant growth. Carefully record the size of each plant in a notebook.

Sugar Water & Plants

1. _____
Look at the time it took for each container of water to freeze. Write down your observations in a table and then graph your results in a line graph. Did the water with sugar added take a significantly longer or shorter amount of time to freeze?

2. _____
If water has sugar added to it, then it will not freeze as fast as plain water.

3. _____
Fill two identical containers with the same amount of room temperature water. Add a measured amount of sugar to one of the containers. Place the two containers into the freezer. At regular intervals of 15 minutes, open the freezer and observe the status of the water in each container. Continue until both have completely frozen. Write down the time it took for each container of water to reach a fully frozen level.

4. _____
Based on the results of your experiment, decide if water with sugar freezes faster, slower, or at the same rate as water without sugar added.

5. _____
I have noticed that popsicles that have lots of sugar don't seem to freeze as fast plain ice cubes. I wonder if the amount of sugar has an effect on freezing time.

Graphing Practice (page 1 of 2)

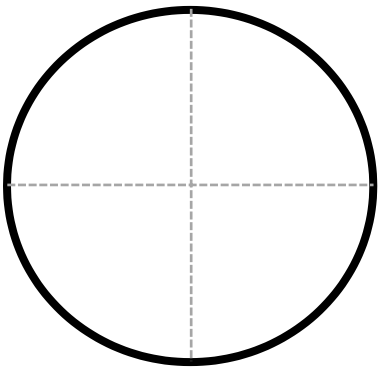
Watch the following StudyJams: Bar Graphs, Circle Graphs, and Choosing the Correct Graph. Follow the instructions below for each of the sections.

Construct a Pie Chart A pie chart is useful when you want to show data for parts of a whole (for example, groups of students within a class). The following data table shows the results from a survey done from a class of 30 students.

Favorite App	Percentage of Class
Facebook	10%
Instagram	20%
SnapChat	30%
TikTok	40%

Directions:

- Use the data table to the right to construct a pie chart
- Include a title and key
- The dotted lines have divided the chart into 25% sections, so use these lines to help you estimate where to draw lines. **Your chart does not have to use these lines.**



Key:

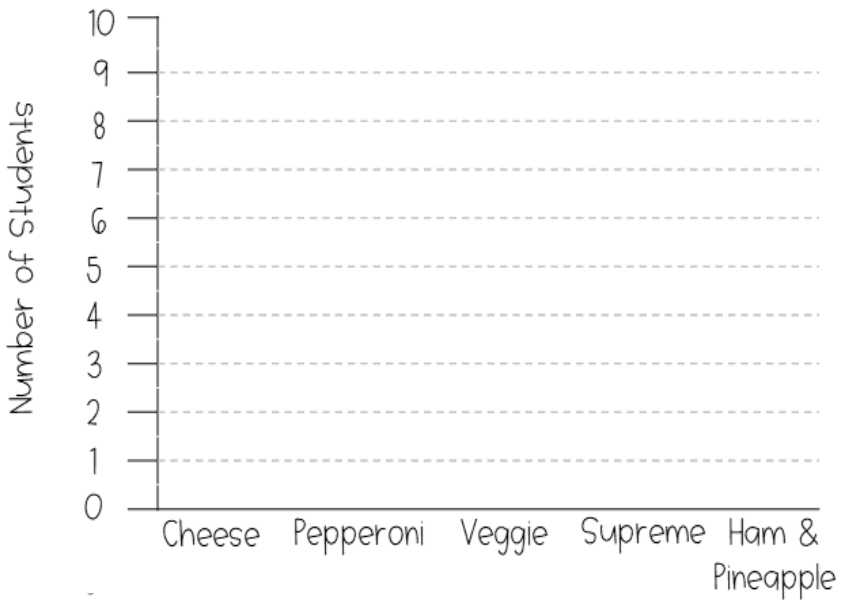
- ☐ Facebook
- ☐ Instagram
- ☐ SnapChat
- ☐ TikTok

Construct a Bar Chart Bar charts are useful when you want to show comparison between groups, such as comparing how many students like different kinds of pizza. The following data table shows the results of a survey done from a class of 30 students.

Favorite Pizza Topping	Number of Students
Cheese	9
Pepperoni	10
Veggie	3
Supreme	6
Ham & Pineapple	2

Directions:

- Use the data table to the right to construct a bar chart
- Include a title



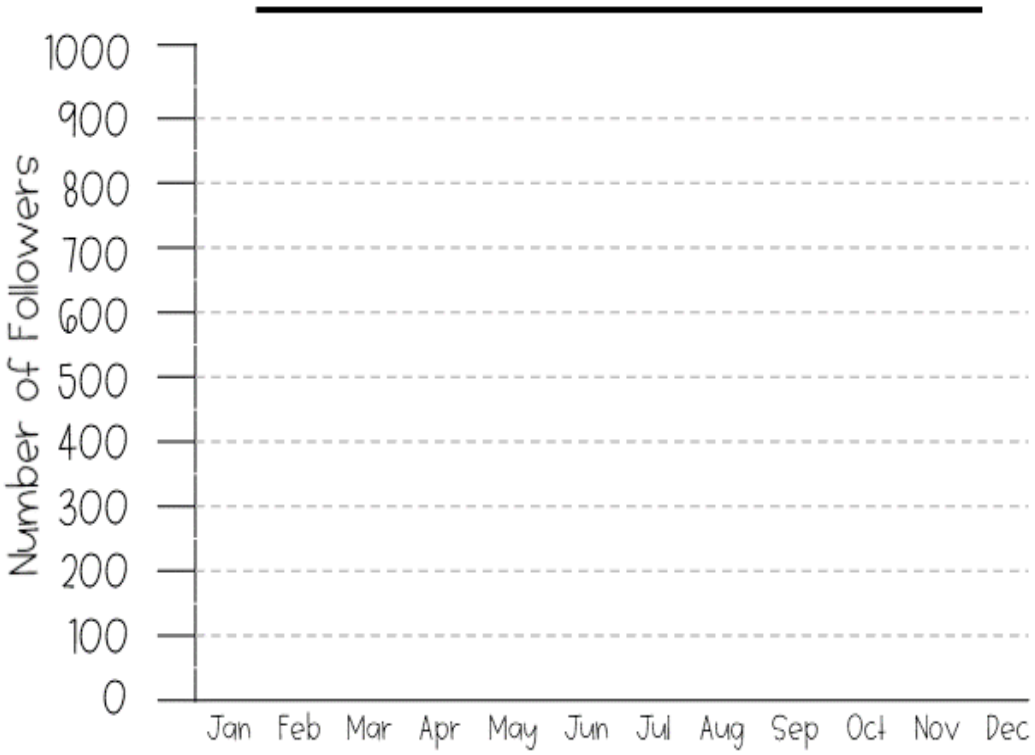
Graphing Practice (page 2 of 2)

Construct a Line Graph Line graphs are useful when you want to show change in data over time, such as showing how the number of followers you have on social media changes over time.

Directions:

- Use the data table on the right to construct a line graph
- Include a title

Month	Number of Followers
January	65
February	100
March	120
April	250
May	600
June	750
July	650
August	800
September	950
October	900
November	850
December	1,000



Scientific Method Practice The scientific method is a process that scientists follow in order to determine the answer to a problem. You are probably familiar with learning the scientific method as a process with a fixed number of steps, but the actual steps a scientist takes may change depending on the type of experiment that they are performing. The scientific method can be flexible, but usually follows the same basic order.

Directions: Put the steps of the scientific method in order from 1 to 8.

_____Do Research

_____ Design an experiment

_____Modify of repeat experiments

_____ State the problem

_____Determine if the hypothesis is rejected or accepted

_____ Analyze data

_____ Form a hypothesis

_____ Perform Experiment

Using your knowledge of the scientific method, match the steps to the parts of the scenario below.

A. State the problem
B. Do research
C. Form a hypothesis
D. Design an experiment
E. Perform experiment
F. Analyze data
G. Determine if hypothesis is rejected or accepted
H. Modify or repeat experiment

_____1. Katie makes a bar graph showing the number of times her brother eats all, part of, or none of each category of snack.

_____2. Katie is a nice sister who always fixes a snack for her little brother after school. One day, he does not want to eat the snack that she prepared. She wonders why.

_____ 3. Katie plans a menu for the next two weeks, dividing each snack two categories: “sweet” or “salty”. She prepares a data table, where she will mark if he eats all, part, or none of his snack.

_____4. Looking over her data, Katie sees that there is no clear trend as to whether her brother prefers sweet or salty snacks. She decides that she was wrong.

_____5. After determining that her original hypothesis was wrong, Katie decides that she will next measure how her brother eats after days he has gym class. Perhaps he is hungrier after gym class. She plans a new menu and makes a new data table to fill out.

_____6. Katie looks in the kitchen cabinets at home to see what food is available. She makes a list of all the snacks that she has prepared for her brother over the last month.

_____7. She hypothesizes that her brother prefers salty snacks.

_____8. Katie follows the menu for two weeks and makes observations after her brother finishes eating. She marks on her data table whether he eats all, part, or none of his snack.

Scientific Variables Read the paragraph below, then identify the variables in each experiment.

Being able to identify the scientific variables in an experiment is an important skill for any scientist. When designing an experiment, it is important that you only test one variable at a time. The variable that you are testing is known as the independent variable, or IV. The part of the experiment that responds to the IV is known as the dependent variable, or DV. The dependent variable is usually the part of the experiment that you measure to see if your hypothesis worked or not.

Independent variable – part of the experiment that is tested or changed by the scientist (starts with the letter 'i'; "I change") Dependent variable – part of the experiment that responds to changes in the independent variable; is measured for results

1. You decide to test whether charcoal helps purify water or not. You design a filter that contains charcoal and run water from a nearby stream through the filter. Afterward, you test the water for contaminants.

   Independent variable: _____

   Dependent variable: _____

2. You decide to test whether an insect repellant is effective or not. You apply insect repellant to your right arm and count how many insects land on your arm over an hour.

   Independent variable: _____

   Dependent variable: _____

Scientific Variables (Part 2) Identify the variables in the experiment.

You decide to test whether plants help prevent erosion of soil or not. You take two samples of soil, and plant grass in one of the samples. Once the grass has taken root, you pour water through both soil samples and measure how much soil is removed from each sample.

1. If you were to perform this experiment, what would your hypothesis be?

   _____

   _____

2. Independent Variable:

   _____

3. Dependent Variable:

   _____

4. Control: _____

5. Constants: _____

Definitions:
Independent variable – part of the experiment that is tested or changed by the scientist (starts with the letter 'i'; "I change")
Dependent variable – part of the experiment that responds to changes in the independent variable; is measured for results
Control– part of the experiment that is used for comparison (does not interact with the independent variable).
Constant– part of the experiment that must remain the same

Different Types of Data

Read the paragraph below, then identify each data set as quantitative (write the letter N) or qualitative (write the letter L).

In an experiment, a scientist can collect different kinds of data. Sometimes data is measured with a tool like a thermometer or ruler. This kind of data is called quantitative data. Some examples of quantitative data include the number of leaves on a plant or the temperature of a liquid. Sometimes data consists of observations that cannot be measured. This kind of data is called qualitative data. Some examples of qualitative data include the color of a leaf or smell of a mineral.

_____1. Length of a piece of rope

_____2. Amount of food a dog eats

_____3. Color of a mineral

_____4. Number of insects attracted to a location

_____5. Density of a liquid

_____6. Shape of a cloud

_____7. Temperature of a substance

_____8. How a student feels after taking a test

_____9. Scent of a leaf

_____10. How many students like each type of pizza topping

_____11. If an animal's fur is soft or spiky

_____12. Mass of a rock

Making Inferences

Read the paragraph below, then write an inference based on each observation.

Sometimes scientists must consider facts and draw conclusions based on those facts. When a scientist does this, a scientist is making an inference. For example, you might walk into your classroom and see an empty candy wrapper on your teacher's desk. You observe the candy wrapper and infer that your teacher just ate a candy bar, even though you didn't see it.

Write inferences based on the observations below.

1. Looking at your desk, there is a ring of liquid on the desk.

   _____

2. When you walk into your classroom, you see a person that you don't recognize at the teacher's desk.

   _____

3. When you leave school, the sidewalk and roads are wet.

   _____

4. When you get home from school, the house smells like tacos.

   _____

5. You hear someone honking their car horn in the parking lot.

   _____

6. When you get to gym class, you see basketballs on the floor.

   _____

7. You see cat hair on someone's shirt.

   _____