What is the Scientific Method?

- A series of steps used by scientists to solve a problem or answer a question.
The Scientific Method

- A series of steps used by scientists to solve a problem or answer a question.
Observe and ask a question

Perform background research

Formulate a hypothesis

Conduct experiments

Analyze data/ Draw conclusions

False hypothesis

Collect &

True hypothesis

Communicate results
<table>
<thead>
<tr>
<th>Scientific Method Steps</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Observation</td>
<td>-Information gathered using your senses. You notice something in the natural world.</td>
</tr>
<tr>
<td>2. Question/Problem</td>
<td>- A question that identifies what you want to find out.</td>
</tr>
<tr>
<td>3. Background Research</td>
<td>-conduct research in books, the internet, articles, ask an expert.</td>
</tr>
</tbody>
</table>
| 4. Hypothesis           | -A possible solution to a question/problem based on research or observations.  
                         | -written as “If…then..because..”  
                         | -testable statement about how something works |
| 5. Experiment           | -A detailed, step by step procedure to test the hypothesis  
                         | -list materials  
                         | -Should be a “controlled experiment” to be a fair test. |
| 6. Collect/Organize Data| -results of the experiment (can be quantitative or qualitative)  
<pre><code>                     | -organized into charts, tables or graphs |
</code></pre>
<p>| 7. Analyze Data         | -look for relationships, patterns or trends |
| 8. Conclusion           | -the answer to the hypothesis based on data obtained from the experiment. You state whether you accept or reject your hypothesis and suggest further research. |</p>
<table>
<thead>
<tr>
<th>Scientific Method</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Make observations</td>
<td>Plants by window are larger than other plants in the room…</td>
</tr>
<tr>
<td>Develop questions</td>
<td>How does sunlight affect plant growth?</td>
</tr>
<tr>
<td>Do research</td>
<td>Learn about the importance of light to plants</td>
</tr>
<tr>
<td>Develop hypothesis</td>
<td>If you give a plant sunlight, then you will increase a plant’s growth because plants require sunlight to grow.</td>
</tr>
</tbody>
</table>
| Design controlled experiment | **Experimental group**- Set up plants in sunlight and measure their growth each week.  
**Control Group**- Set up plants with NO SUNLIGHT and measure their growth each week.  
-all conditions must be kept the same or constant except the one that is being tested (sunlight).  
-always repeat experiment (conduct multiple trials) |
| Collect/Organize data  | Record plant growth each week (centimeters) in a data table and graph their growth. |
| Analyze data           | Notice that plants given sunlight grew more than plants with no sunlight. |
| Conclusion             | The data supports the hypothesis. Plant growth increases with sunlight. |
Observation: Plants by the window are taller than plants in the back of the room.

Problem/Question: How does sunlight affect plant growth?

Research: You read about the importance of sunlight to plants.

Hypothesis: If plants are given sunlight then they will grow more than plants without sunlight because plants need sunlight to grow.

Experiment (Controlled)- Set up 2 groups of plants.

Experimental Group (gets sunlight)
Control Group (no sunlight)

*You keep everything the same about the plants in each group except one thing- Sunlight is given to the experimental group.
Collect Data: You measure the height of each plant (cm) every week and record the data in a table.

Analyze Data: You review the data and notice that plants given sunlight grew taller than plants given no sunlight.

Conclusion: You accept your hypothesis. Plants that are given sunlight do grow taller than plants not given sunlight.
Control Group  Experimental Group

No Sunlight

Sunlight
What is a Controlled Experiment?

**Controlled Experiment:** an experiment where everything is the kept the **same** between the experimental and control groups **except** the one thing that is being tested. (the independent variable).

1. **Experimental Group:** the group of subjects that are given the test or treatment (independent variable).
   **Example:** Plants in sunlight
2. **Control Group:** the group of subjects that are **NOT** given the test or treatment (independent variable).

**Example** - Plants given NO sunlight

- They may be given nothing at all or some inactive substance (sugar pill). This is known as the “Control”. **Example** - No sunlight

**Subject:** individuals that are in your experimental and control groups and are part of the experiment.

**Example** - Plants
Independent vs. Dependent Variables

Variables: factors in an experiment that can be changed.

Examples: water, soil type, plant type, etc.

Independent Variable: variable in the experiment that is intentionally changed by the scientist.

-it is your "test"

-also called the manipulated variable

-there can only be ONE

Example- sunlight

Dependent Variable: variable that is observed and measured in an experiment.

-also called the responding variable.

Example- plant growth

Constants/Controlled Variables: things that are kept the same between the experimental and control groups.

Example- amount of water, pot size, plant type, amount of soil.
What is a Controlled Experiment?

**Controlled Experiment**: an experiment where everything is kept the same between the experimental and control groups except the one thing that is being tested (the independent variable).

**Parts of a Controlled Experiment**

1. **Experimental Group**: Group of subjects being tested
2. **Control Group**: Group of subjects NOT being tested
3. **Independent Variable**: the test
4. **Dependent Variable**: what you measure, the data collected
5. **Constants/Controlled Variables**: all factors kept the SAME in both groups.

**Example**: Does sunlight affect plant growth?

1. **Experimental Group**: plants in sunlight
2. **Control Group**: Plants given NO sunlight
3. **Independent Variable**: sunlight
4. **Dependent Variable**: Plant growth
5. **Constants/Controlled Variables**: amount of water, plant type, amount and type of soil.

**Subjects**: individuals that are in your experimental and control groups and are part of the experiment.

**Example**: Plants
Experimental Group

gets
IV

Control Group

No
IV
-gets "control"
1. Smithers’ thinks that a special juice will increase the productivity of workers. He creates two groups of 50 workers each and assigns each group the same task (in this case, they're supposed to staple a set of papers). Group A is given the special juice to drink while they work. Group B is not given the special juice. After an hour, Smithers counts how many stacks of papers each group has made (more stacks = greater productivity).

**Group A** made 1,587 stacks  
**Group B** made 2,113 stacks.
Example of an controlled experiment that follows the scientific method

He found that slugs spent an average of 47 minutes in the dark areas and 13 minutes in the light area. He wonders, “Do slugs prefer the dark?” He asks his teacher about slugs and finds out that they like to live in dark places. His original hypothesis was supported, but maybe he should continue testing other variables. He begins to think that if slugs are put in light, they will move towards the dark. He collects slugs and sets up an area that has both light and dark areas, brings slugs into the area and records their movement. He notices one day that there are lots of slugs in the dark places in his yard but not in the sunny spots. Based on these numbers, Brian sees a clear pattern, that slugs prefer a dark environment.
Think-Group-Share

-What is the Scientific Method?

-What are the steps?
Student Learning Objective: To identify the steps of the scientific method by analyzing a scenario.
Task

**Group Work:** Choose 2 scenarios from the sheet. Then, Identify each step of the scientific method based on your definitions, the example and your prior knowledge.

-share out then complete the table by putting the steps in the correct order.

**Extension & Challenge**- move on to these questions if you finish early.
Example 1 - Janice
She notices that her mother always keeps bread in the refrigerator. She wonders "How does temperature affect mold growth?" She asks her mother why and learns that the bread stays mold-free longer in the cold fridge. She thinks that if the bread is in a colder environment, it will grow mold slower. She sets up two groups of bread, one in the fridge and one out on the counter. She examines the bread everyday for two weeks and finds that all 5 outside pieces showed areas of mold, while only 1 piece inside the fridge had mold. After reviewing the data, she sees mold grew faster in the warmer environment. Her original hypothesis was supported, but maybe she should continue testing other variables.

Example 2 - Rob
He always has trouble concentrating in his first period class. She wonders, "How does the amount of breakfast affect your ability to concentrate? He reads in a magazine that breakfast is important for brain function during the day. Rob thinks that if he eats a bigger breakfast, he will be able to concentrate more in class. He sets up schedule where he eats his normal breakfast the first week, then increases by 200 calories the next week, and increases again for one more week, recording how he feels in class. Rob finds that in week 1 he felt distracted 3 out of 5 days, week 2, 4 out of 5 days, week 3 4 out of 5 days, week 4, 3 out of 5 days. After reviewing the data, Robby thinks that there is no relationship between his breakfast and his concentration levels. His original hypothesis was not supported, so maybe she should continue testing other variables.
Modeling Example- Brian- Correct order

He notices one day that there are lots of slugs in the dark places in his yard but not in the sunny spots. He wonders, “Do slugs prefer the dark?” He asks his teacher about slugs and finds out that they like to live in dark places. He begins to think that if slugs are put in light, they will move towards the dark. He collects slugs and sets up an area that has both light and dark areas, brings slugs into the area and records their movement. He found that slugs spent an average of 47 minutes in the dark areas and 13 minutes in the light area. Based on these numbers, Brian sees a clear pattern, that slugs prefer a dark environment. His original hypothesis was supported, but maybe he should continue testing other variables.
Example 3 - Michael

He notices that his brother’s nails always grow much faster than his. He wonders "How does diet affect nail growth"? He reads about nails in his biology textbook and learns that diet can affect their growth. He thinks that if he drank more milk like his brother, then his nails would grow faster. He measures his nail growth for 3 months, increasing his milk intake by 1 cup each month; he records 1.3 cm growth in month 1, 1.7 cm growth in month 2, and 2 cm in month 3. He reviewed the data and determined that the more milk he drank, the more his nails grew. His original hypothesis was supported, but he wants to continue testing.
Reflection: Explain why scientists follow the scientific method.
Student Learning Objective: Continued...

**Do Now:** Please take out your classwork from yesterday and your homework from last night.

**Classwork:** Scientific Method (Janice, Rob, Michael)
- DISCUSS YOUR ANSWERS TO THE FIRST EXAMPLE YOU CHOSE.

**Homework:** Components of a controlled experiment.
**Student Learning Objective:** Identifying the components of a controlled experiment by applying their knowledge.

**Do Now:** List as many steps (in the correct order) of the scientific method as you can.
**Student Learning Objective:** Identifying the components of a controlled experiment by applying their knowledge.

**Do Now:** Put the steps of the scientific method in the correct order.

1. Observation
2. Problem
3. Research
4. Hypothesis
5. Experiment
6. Collect Data
7. Analyze Data
8. Conclusion
Classwork Example that had a "Controlled Experiments"

Example - Janice - two groups of bread - one in fridge and one out on counter.
**TASK**

Independent: Annotate and identify the components of a controlled experiment in order to answer the questions that follow.
- Use your notes when answering these questions.

Group: Answer the questions with your group. Be sure to use the helpful terms if you need to!
- You group will be selected to share out one example
- Be ready to **EXPLAIN WHY**
- Additional questions to think about- how can these experiments be improved? What conclusions can they draw?

Extension/Challenge: See task sheet

Reflection: Explain why is it important to have both a control and experimental group.
Example 2

An experiment was conducted to test the effect of a diet pill on weight loss. One group of people were given the diet pill. The other group received a "sugar pill" or placebo.

1. What is the Experimental Group?
People given the diet pill

2. What is the Control Group?

3. What is the "control"?

4. What is the Independent Variable?

5. What is the Dependent Variable?
Share-Out & Reflection:

Let's share out the answers!

Explain why it is important to have BOTH an experimental and control group in a controlled experiment/
An experiment was conducted to test the effect of studying on test scores. One group of students studied for an hour each night for two weeks before the test. The other group did not study at all during those two weeks.

1. What is the Experimental Group?
   The group of students who study

2. What is the Control Group?

3. What is the "control"

4. What is the Independent Variable?

5. What is the Dependent Variable?
Identifying Variables

- **Dependent Variable**
- **Independent Variable**
- **Constants or Controlled Variables**
DRY MIX and Variables

D - Dependent Variable
R - Responding Variable
Y - Y axis

M - Manipulated Variable
I - Independent Variable
X axis
Graphing Variables
Drag the correct label to each axis.

D - Dependent Variable
I - Independent Variable

X axis
Y axis

Check answers on next page when finished.
Do Now: Answer the questions below.

Let's say we wanted to know which brand of sponge could absorb the most liquid.

- The dependent variable is the one that we are measuring.
- In this case, the dependent variable is the amount of liquid absorbed.
- The independent variable is one that we are changing.
- In this case, the independent variables is the brand of sponge.
- The controls are the type of liquid, the color of sponge, the size of the sponge, measuring, changing, the amount of liquid absorbed, and room temperature.