Doing A Meaningful Scientific Discovery STEM Fair Project

The Scientific Discovery Process

These are the required steps when doing a project using the Scientific Discovery Process.

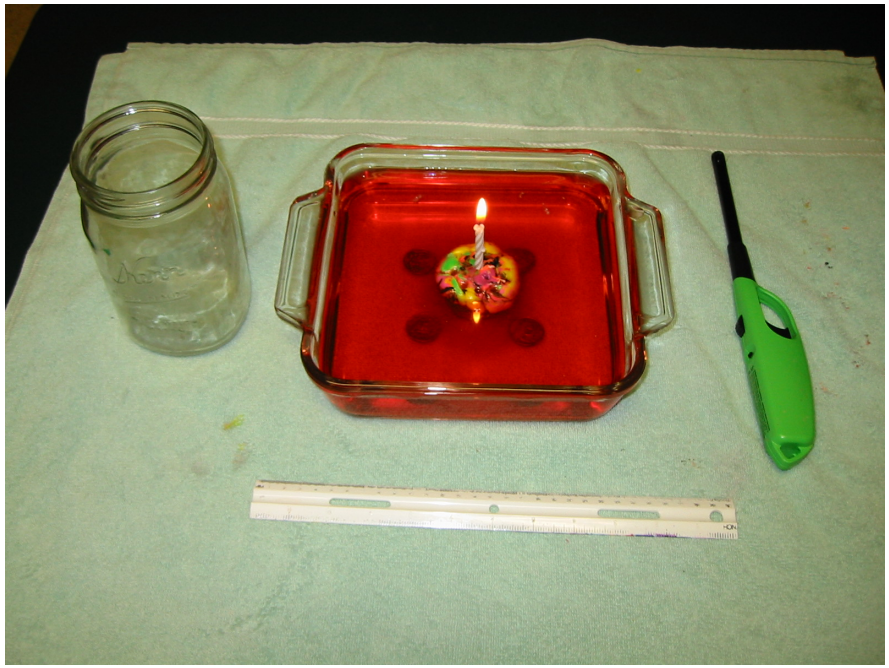
- Purpose
- Research
- Hypothesis
- Designed Plan and Data Gathering Methodology:
  - Write down the materials you will need
  - Write the step-by-step instructions you will follow
  - Write the variables of the experiment
  - Write the data gathering plan you are using
- Execution: Data Collection and Analysis
- Interpretation

What is Your Purpose?

- The purpose shows that you are going to solve a problem or find out something you don't know. **Write your purpose in your journal.** This is what you want to investigate.

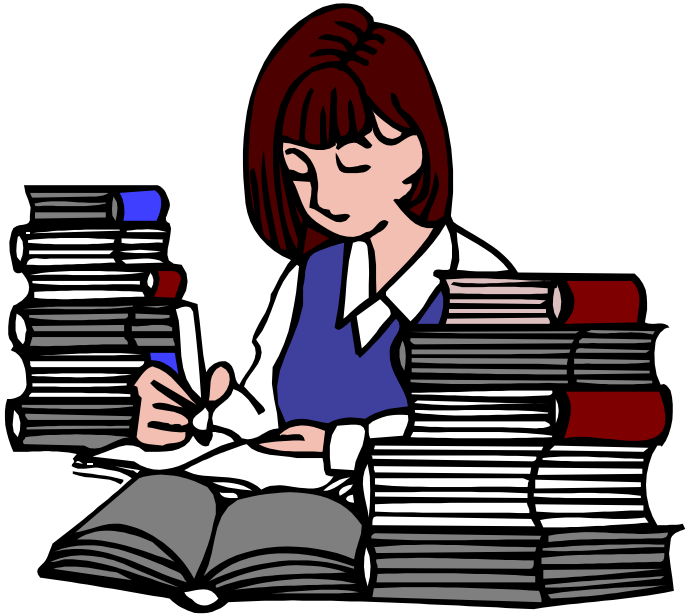
The Purpose

Does changing the amount of heat in a bottle produce a lesser air pressure in a bottle?



Research Your Topic

- Before you begin experimenting, you some background information by using some of these resources:
  - Encyclopedias
  - Science Magazines
  - Science Textbooks
  - Library Books
  - Internet
  - Interviews
  - Letters
  - Phone Calls
- You need to research your topic by using at least three resources.
- Record the information you learned about in your journal.



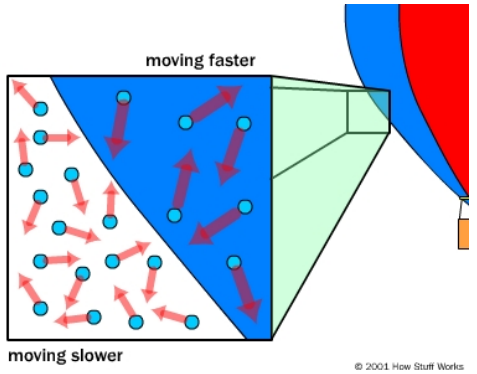
Heat and Pressure Research

(Textbook) Pressure

ScienceSaurus (2002) Page 295

All air and liquids are called fluids. These fluids flow exerting pressure as they flow. As they flow, their particles move around and bump into the surfaces made of other matter. Sometimes they bump into these surfaces with different forces called pressure. Pressure is the amount of force exerted by fluid particles while they are bumping into different surfaces. To find out how much pressure it exerts is found by dividing the force by the area over which the force is exerted.

The pressure of water increases with depth. The pressure of air decreases with height.

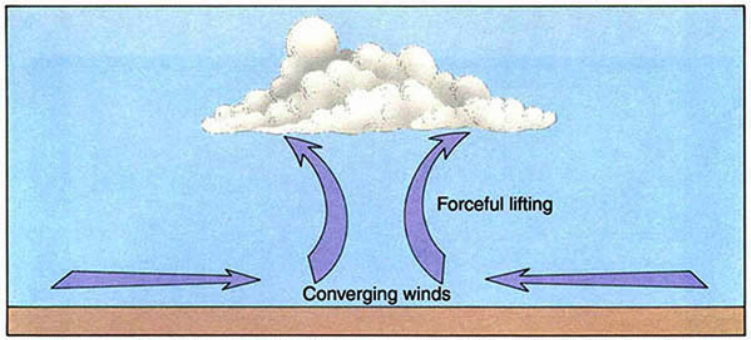


(Website)

Low Pressure

www.weatherquestions.com/What_causes_low_pressure.htm

One way low pressure can occur is when a column of air is warmed by the sun. The warming causes the air layer to expand upward and outward, causing the air particles spread apart in the air within the column. It will then reduce the surface air pressure. A very extreme example of this is the strong low pressure that forms in center column of the hurricane called the eye. Heat is released from the rain forming in the hurricane that causes warming of the air column within the eye. The air particles separate and causes a huge low pressure.

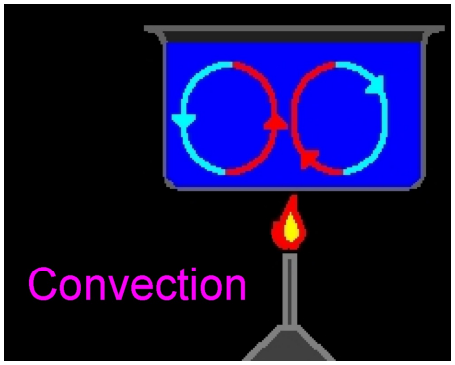


Convergence results in forceful lifting of air. whenever air converges horizontally, it must increase in height to allow for the decreased area it occupies.

(Teacher Resource Book) Convection Heat

State Science Teacher Resource Book (2005)

Convection heat transfer is the transfer of heat in liquids and gases as particles circulate in currents. This transfer of energy causes warm substance to rise and and cool substances to sink. In convection heat transfer, the particles in a liquid or gas speed up as they are heated. This causes the liquid particles to move apart and be lighter in weight and they rise. As the liquid particles get cooler they slow down and gather together and become heavier in weight and sink. This creates convection current.



Make a Hypothesis

- You are ready to make a prediction of what you think the results of your experiment will be in your journal.
- Based on your research, what do you think will happen when you do your experiment?
- **You also need to put an explanation in your journal as to "why" you chose this hypothesis**.
- **Example:**

  Hypothesis:

  When light shines on an object, the object will become hotter at a direct angle than on an indirect angle.

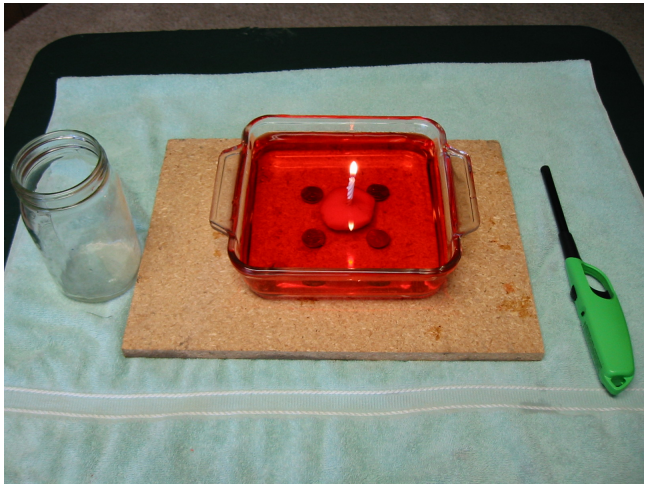
  Explanation:

  Light shining straight down covers a smaller area than shining on an angle. When on an angle, more heat is spread out causing less heat on the object.

Hypothesis

Increasing the heat in the glass bottle will increase the low pressure making the water rise higher in the bottle each time a candle is added.

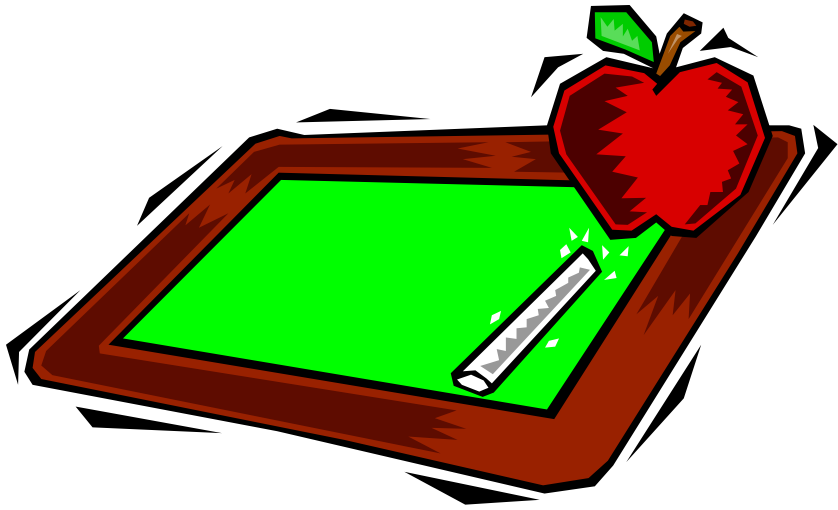
When there is more heat heating the air inside the bottle, it will cause the air particles in the bottle to expand more causing a lower pressure each time.



Designed Plan and Data Gathering Methodology

"List of Materials"

- At this time you need to make a list in your journal of materials you are going to need for your experiment.
- Be sure to make your list very complete with describing words.
- Tell of all measurements and quantities you are going to use.



Designed Plan and Data Gathering Methodology

"List of Materials"

- 2 Glass quart canning jars
- 1 22 cm x 22 cm x 6 cm glass pan
- 55 Birthday candles
- 1 Play Dough ball
- 1 Bar-B-Q lighter
- 1 Centimeter ruler
- 1 Measuring jar
- 5 Cups of water
- 4 Quarters
- 8 1 3/4" x 1/8" washers
- 1 Bottle of Food Coloring

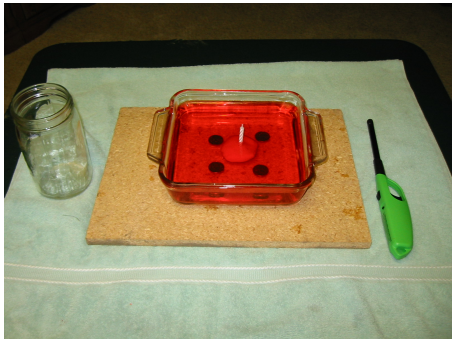
Designed Plan and Data Gathering Methodology

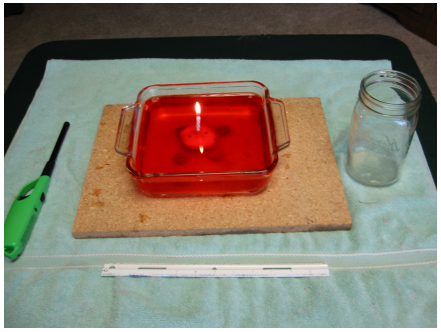
"Step-by-Step Directions"

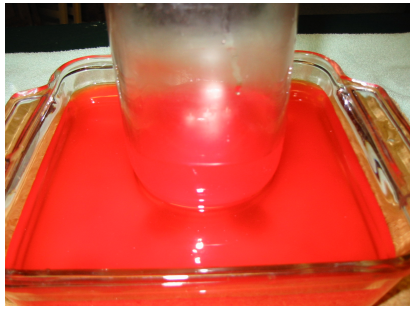
- You need to write the directions of the procedure you are going to follow to do the experiment in your journal.
- These directions tell exactly the process you are going to follow as you do your experiment.
- As you write your directions in your journal, you have to be sure your test is fair. Keep all the conditions the same each time you do the experiment.

Designed Plan and Data Gathering Methodology
"Step-by-Step Directions"

1. Measure 5 cups of water and put it in the glass pan.
2. Put food coloring in the water.
3. Put the four quarters in the water in a square with the washers in the middle.
4. Put the Play Dough on top of the washers.
5. Push one candle into the Play Dough.
6. Light the candle.
7. Put the open end of the jar over the candle until the jar rests on the four quarters.
8. After the candle has gone out and the water has risen in the bottle, measure the height of the water in the jar in millimeters.
9. Write the measurement in the journal.
10. Take the jar off and just remove the candle.
11. Repeat directions 5 through 10 adding one candle each time.







Designed Plan and Data Gathering Methodology "Controlled and Experimental Variables"

- **"Variable"** means something can change. Everything around us has the possibility of changing so we live among variables. Variables are all the factors that have an effect on your experiment.
- You want to control most of the variable so they are called **controlled variables.**
- You only want to change one variable to have a different outcome each time you do your experiment. This is called the **experimental variable.**
- Write your controlled variables and the one experimental variable in your journal.

Designed Plan and Data Gathering Methodology "Controlled and Experimental Variables"

- The Controlled Variables
  - 2 Bottles
  - 8 Washers
  - 4 Quarters
  - 1 Glass pan
  - 5 Cups water
  - 1 Ball Play Dough
  - 1 Bottle food coloring
  - 1 Measuring jar
  - 1 BBQ Lighter
  - 1 Centimeter ruler

- The Experimental Variable
  - 55 Candles

Designed Plan and Data Gathering Methodology "Data Gathering Plan"

- Before you begin your experiment, you need to write in detail your Data Gathering Plan.
  - Be sure it is:
    - Well designed
    - Well organized
    - And Systematic

Designed Plan and Data Gathering Methodology

"Data Gathering Plan"

- Each time I light the candle, I add one more candle
- I will see how far the water goes up the glass
- For this purpose I will see if there is more air lost in the jar when the candles are burning.

The Execution:
Data Collection and Analysis
"Data Collection"

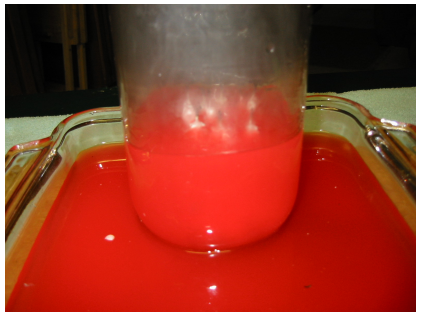
- Be sure to write down the data you are observing in your journal.
- Be sure to collect sufficient data to make a reasonable conclusion.
- Organize your raw data into a chart or table in your journal.
- Test your experiment at least twice so it is valid.

The Execution: Data Collection and Analysis

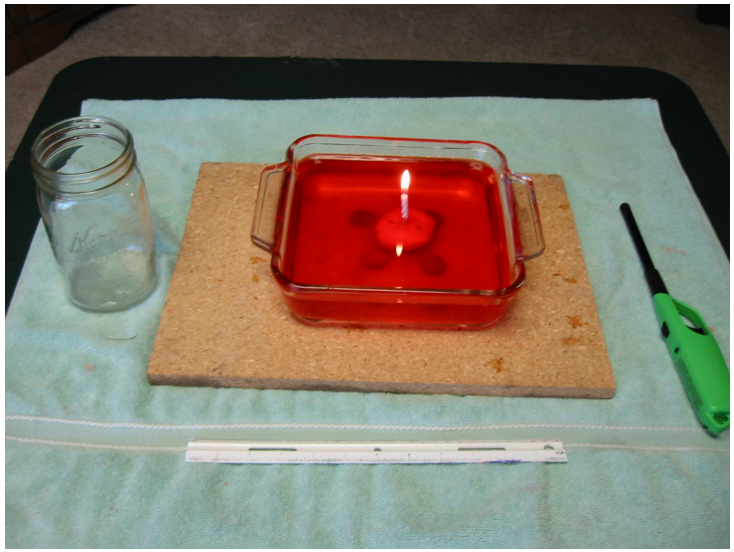
"Data Collection"

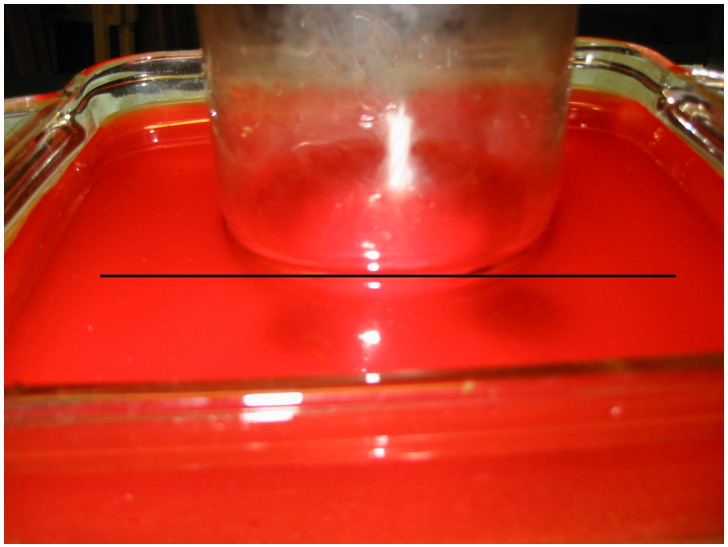
Raw Data

1 Candle	**45 mm**	**6 Candles**	**84 mm**
2 Candles	**59 mm**	**7 Candles**	**86 mm**
3 Candles	**63 mm**	**8 Candles**	**87 mm**
4 Candles	**69 mm**	**9 Candles**	**88 mm**
5 Candles	**74 mm**	**10 Candles**	**89 mm**

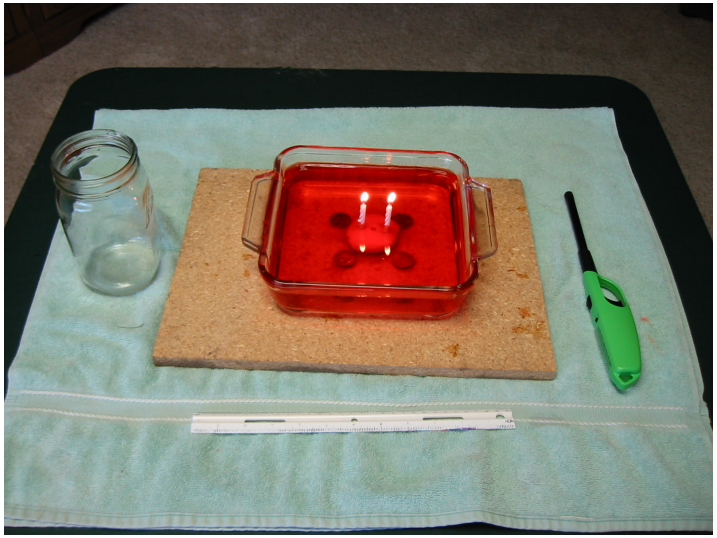


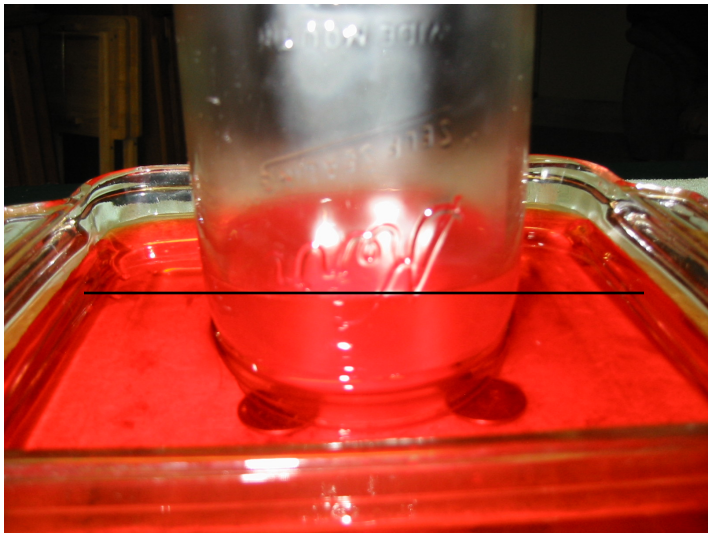
1 Candle 45 mm



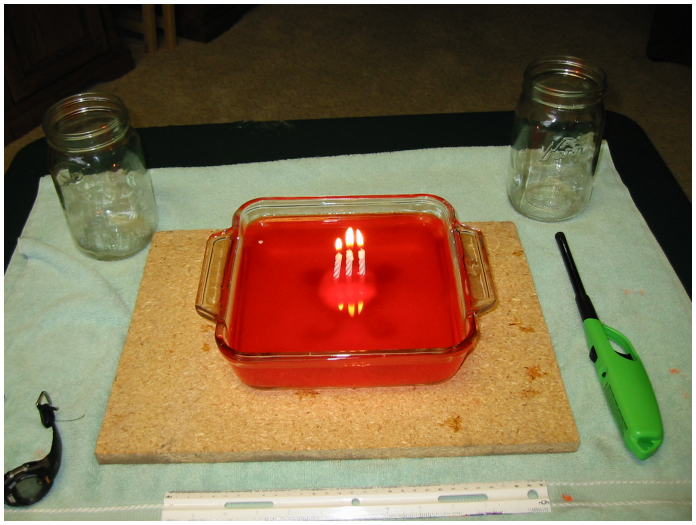


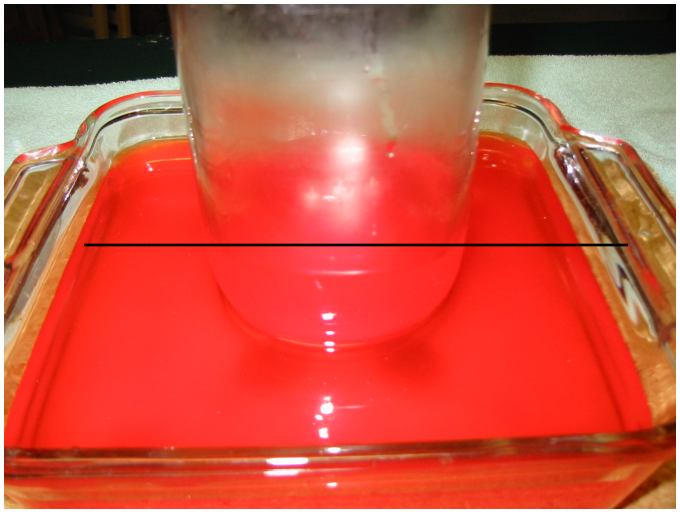
2 Candles 59 mm



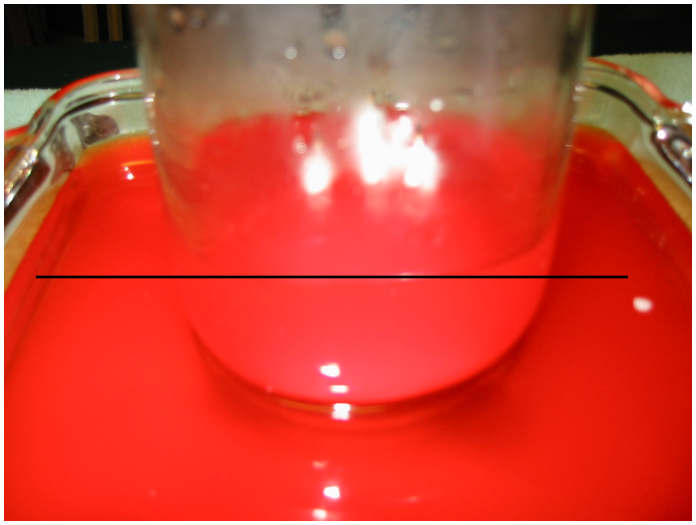


3 Candles 63 mm

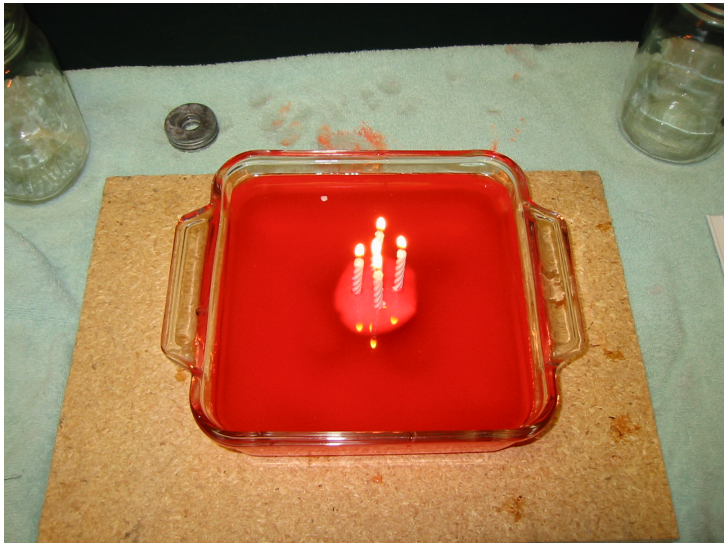


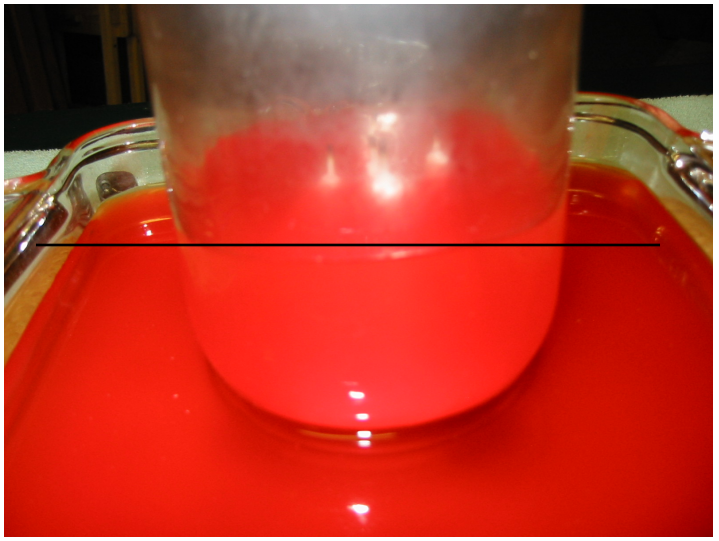


4 Candles 69 mm

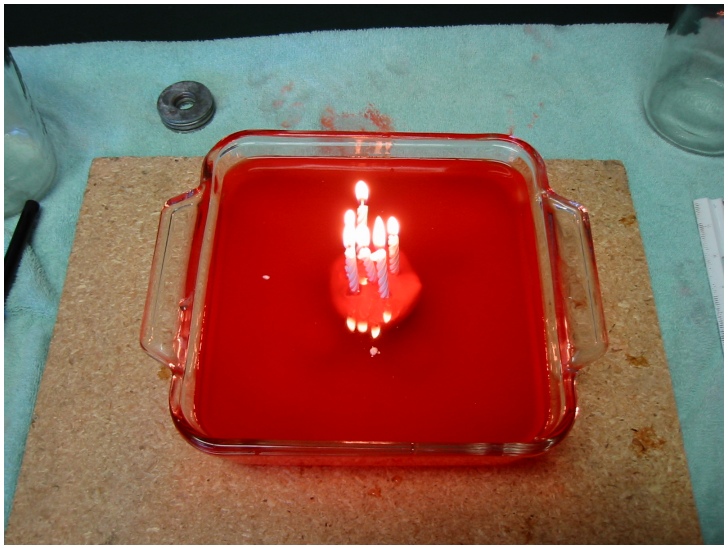


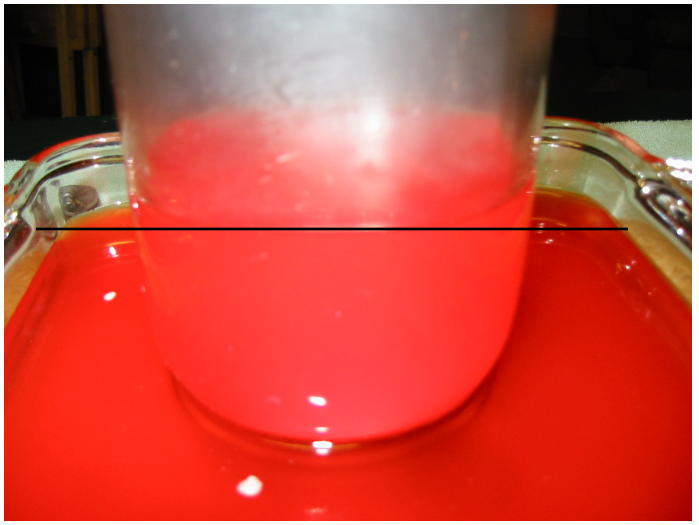
5 Candles 74 mm



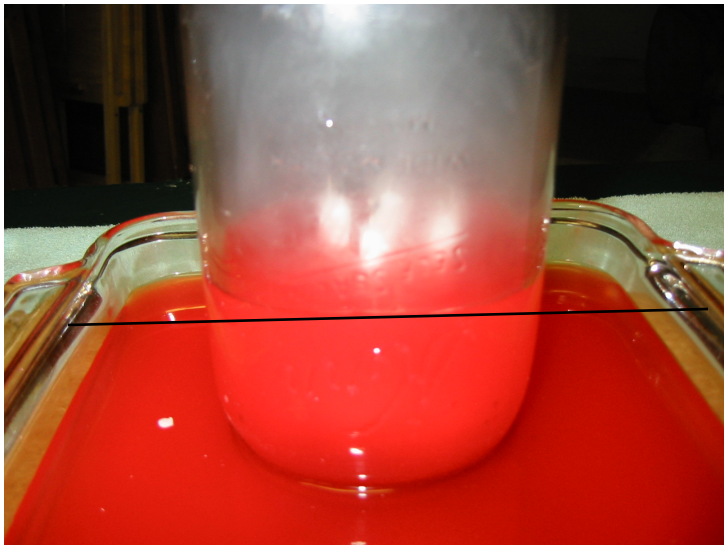


6 Candles 84 mm

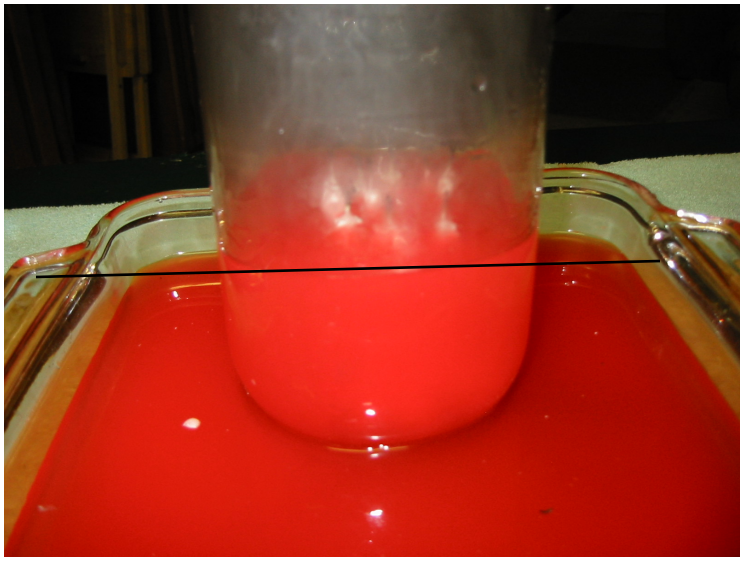




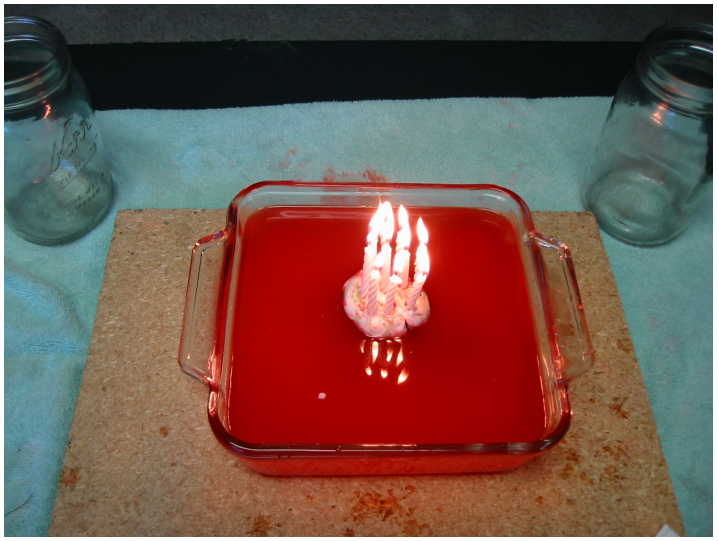
7 Candles 86 mm

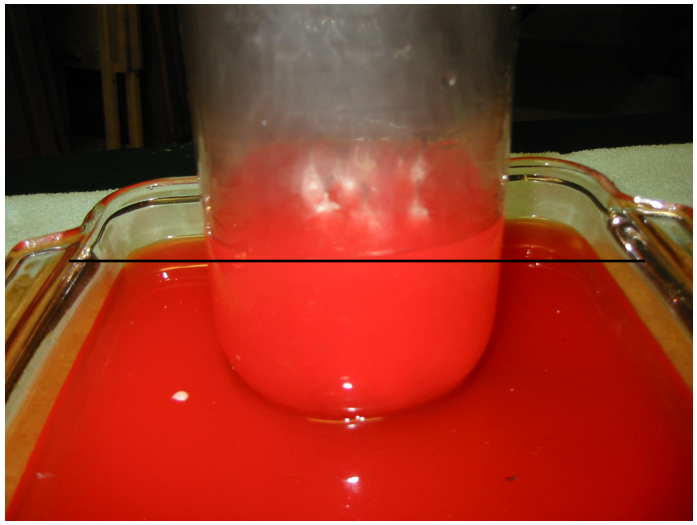


8 Candles 87 mm

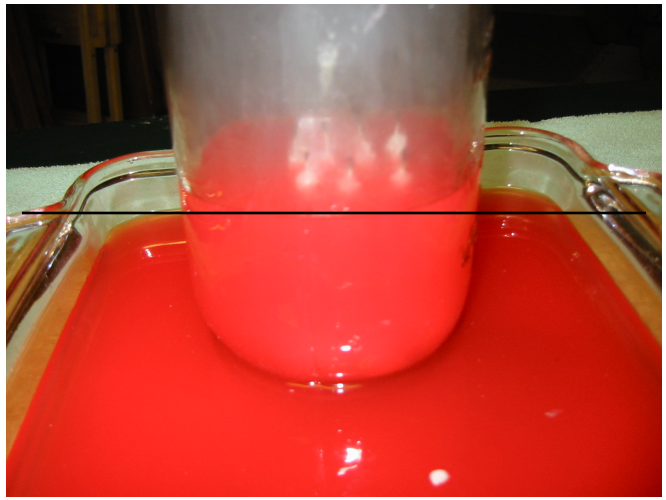


9 Candles 88 mm





10 Candles 89mm



The Execution: Data Collection and Analysis "Data Collection"

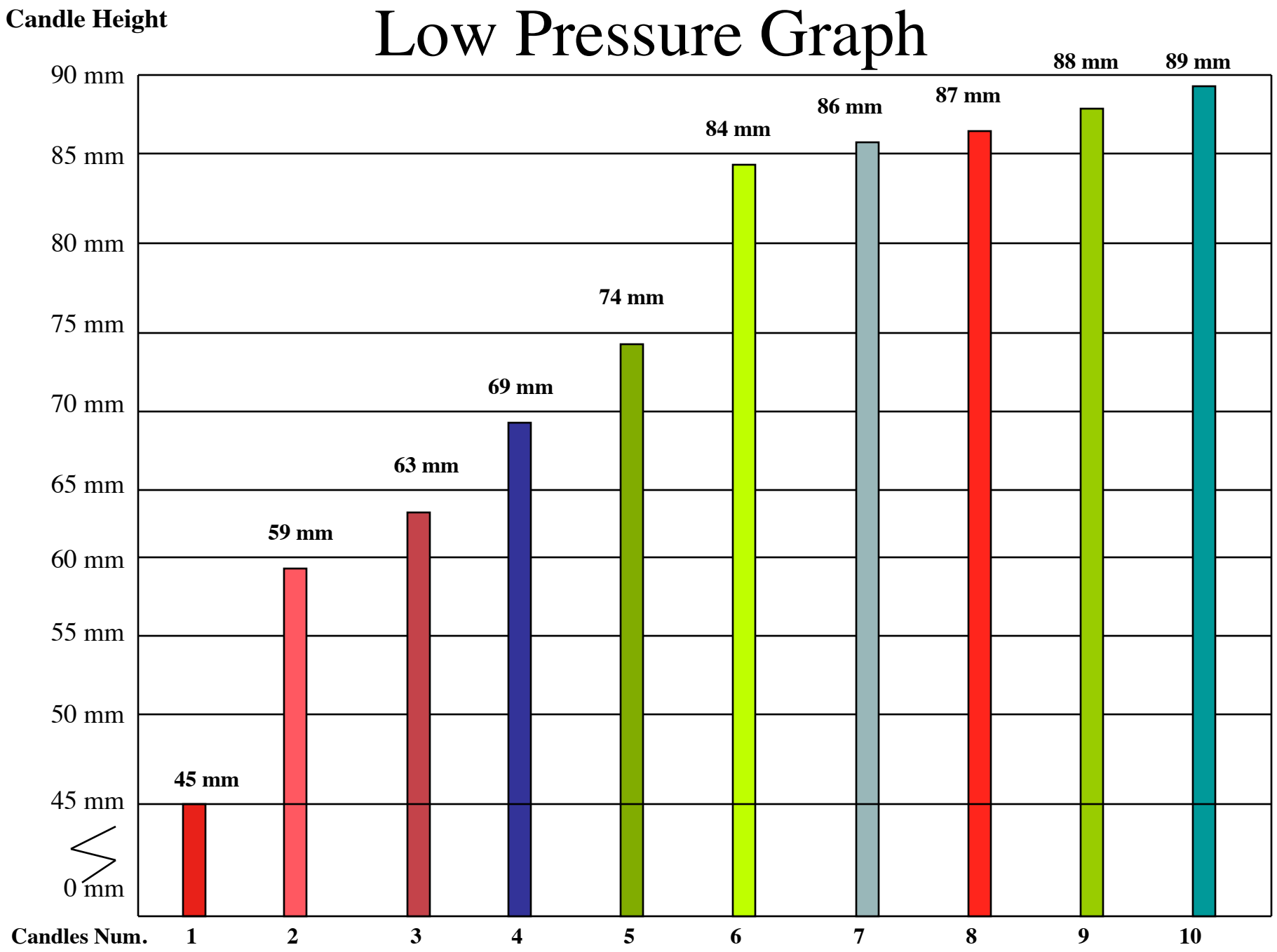
The Table

Number of Candles	Millimeters Water Raised
1 Candle	45 mm
2 Candles	59 mm
3 Candles	63 mm
4 Candles	69 mm
5 Candles	74 mm
6 Candles	84 mm
7 Candles	86 mm
8 Candles	87 mm
9 Candles	88 mm
10 Candles	89 mm

The Execution:
Data Collection and Analysis
"The Graph"

- Make a graph of your data.
- Be sure it is accurately made with all the parts labeled.
- Be sure the graph shows appropriate mathematical and statistical methods.
- Be sure the graph shows strong data comparisons
- Be sure the graph shows the reproducibility of the results.

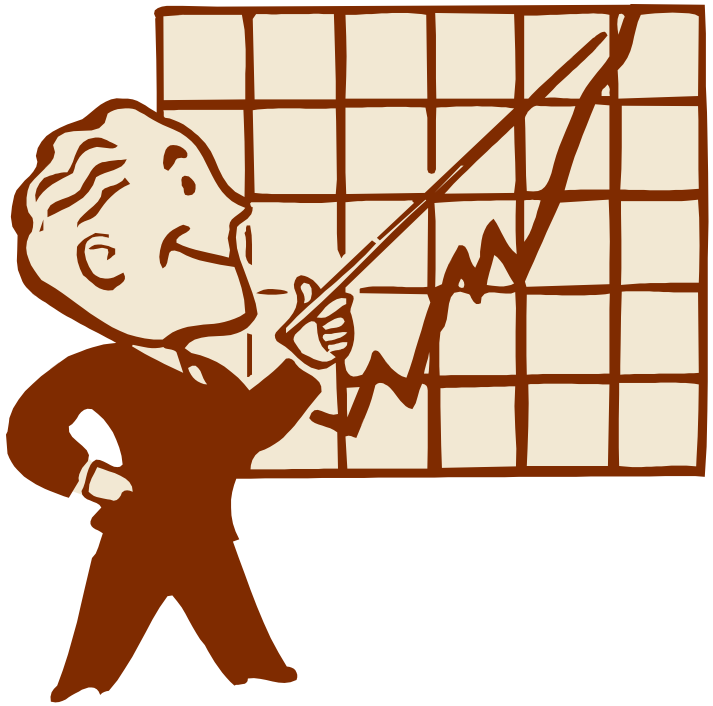
Low Pressure Graph



The Execution:
Data Collection and Analysis
"The Analysis"

To analyze mean to break something up into parts to be able to examine it. That is what you have to do with the data on the graph.

- **Write an explanation describing what the graph is telling you and the comparisons you see.**
- **Be sure the explanation is accurate and makes sense.**



The Execution:
Data Collection and Analysis "The Analysis"

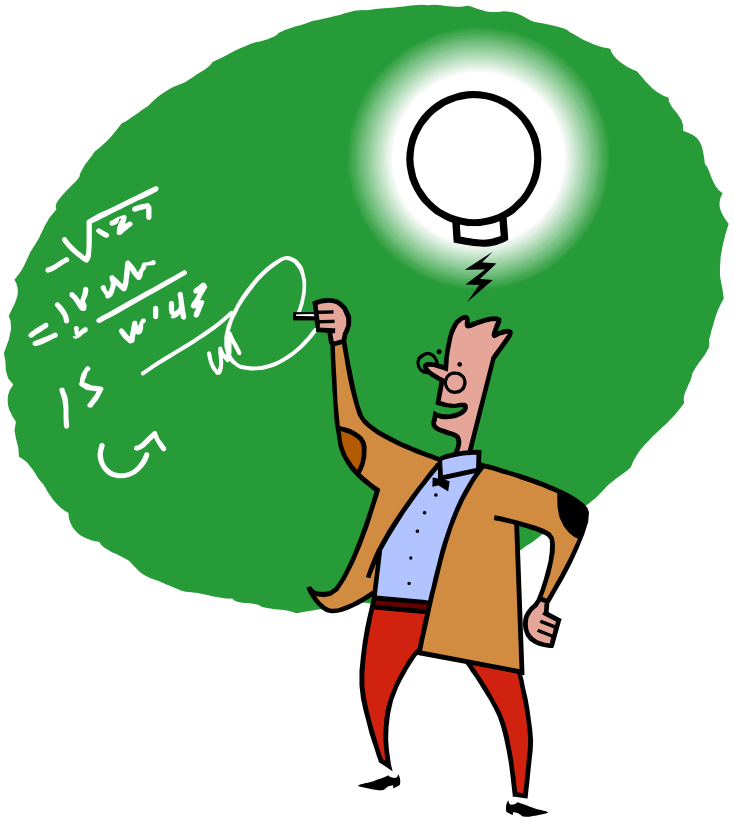
- I noticed that when a candle was added to the existing candles, each time more heat was created causing the water to rise higher each time.
- I noticed that the 1st candle didn't provide much heat causing the water only to go up a few millimeters.
- From the 2nd candle to the 5th candle much more heat was created causing the water to go up into the bottle much higher.
- The last five candles (6, 7, 8, 9, and 10) added to the existing candles made the water jump substantially higher into the glass jar.
- This tells me that even though each added candle did cause the water to go up higher, that the gathered candles can cause more heat collectively than separately.
- Adding the candles one by one, each can cause a lower pressure each time, but many candles together can cause more heat collectively causing a greater low pressure causing the water to go higher up in the bottle.

The Interpretation
"What Did You Find Out?"

Write about these ideas in your journal and anything else you can think of.

- Write if your conclusion agrees with your hypothesis.
- Write what you found out--in other words tell what the data means as it relates hypothesis.
- Write what you what you learned from your experiment.
- Write other questions you might have now.
- Write what you might do differently next time.
- Write what connection your results shows with a real world application which shows a transfer of knowledge.

Does what you write show evidences of learning?



The Interpretation "What Did You Find Out?"

- My conclusion agrees with my hypothesis. I found out that heat does cause a low pressure and the more heat there is the lower the pressure become.
- When the flames heated the air, it caused the air particles to expand, causing the air to be less dense that in turn caused a low pressure. As the air cooled the air particles gathered together becoming more dense leaving room for water to come into the bottle.
- As more candles are added the temperature rises creating a lower pressure each time. As the air cools and gathers, it leaves more room for more water to come in.
- Each time the temperature was increased this caused a lower air pressure, therefore causing more water go into the bottle.
- The pressure in the outside air is greater than the pressure in the bottle. Higher pressure always flows into a lower pressure area. This is what caused the water to go into the bottle. The outside air pressure pushed it into to lower air pressured bottle.
- This is what I would change:
  - Take the temperature in the glass jar during each experiment?
  - Make sure the jar is put over the candles the same way each time.
- I think that when the the outside temperature gets hot, it causes the air particles to expand. When the air expands it is less dense and becomes light in weight and it rises. It become a low pressure. Instead of water being pushed into the area, air is pushed into the low pressure causing winds.
- The hotter the outside temperature becomes, the faster the air rises. The faster the air rises, the lower the pressure becomes. The lower the air pressure becomes, the strong the air (wind) goes into the low pressure.

The Display Board
This is your Showcase!

You need a display board.

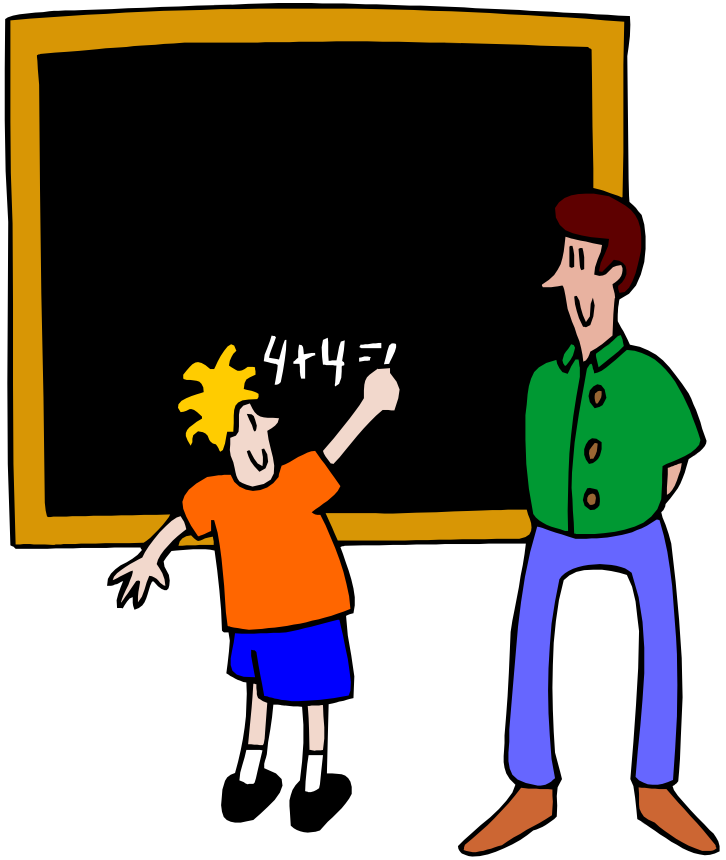
- All the steps with explanation of the Scientific Discovery Process should be on the display board: **Purpose, Research, Design Plan, Data Collection and Analysis, and Interpretation.**
- Research need not be on the board, but your reference cites needs to be on the board.
- Give yourself at least 1 week to make your display board.
- Make it:

  Neat, Creative, Easy to Follow, Errorless (no scribbles), and Informative
- Your display board should reflect your journal.

The Interview

You will be interviewed.

- Know these things:
  - Information you have read about.
  - All the things you did while following the scientific discovery process.
  - What you learned from your project.
  - How the projects has helped you better understanding the world around you.
  - Other questions you now have.
  - What you would change next time if you did the project again.



Thoroughness

- Follow through with these ideas:
  - Goals of the project
  - Creativity in the design
  - Clarity
  - Appropriate methods
  - Appropriate equipment
  - Appropriate grade level
  - Knowledge
  - Enthusiasm
  - Individual effort
  - Completed journal
  - Creative display board