



## INTERNATIONAL TENNIS HALL OF FAME

### The Science of Tennis

**Unit Overview:** As students work through the activities in this unit they will be introduced to the scientific method. Students will develop their own hypotheses and experimental design, as well as analyze data in order to draw conclusions. The unit covers all the steps of the scientific method to allow students to think like scientists and extend their knowledge to create experiments using tennis balls.

#### **Objectives:**

Students will be able to-

- Describe the steps of the scientific method
- Understand how scientists use the scientific method
- State a hypothesis and how it differs from a question or prediction
- Conduct experiments using tennis balls to test their hypothesis
- Draw conclusion from data and support claims with evidence]
- Understand how Hall of Famer Mike Davies helped change the game of tennis

#### **Common Core Standards:**

##### **READING SCIENCE & TECHNICAL SUBJECTS:**

**RST.6-8.1** Cite specific textual evidence to support analysis of science and technical texts

**RST.6-8.3** Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks

**RST.6-8.7** Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g. in a flowchart, diagram, model, graph, or table)

**RST.6-8.8** Distinguish among facts, reasoned judgment based on research findings, and speculation in a text

##### **WRITING HISTORY & SCIENCE:**

**WHST.6-8.1** Write arguments focused on discipline-specific content

**WHST.6-8.2** Write informative/explanatory texts, including narration of historical events, scientific procedures/experiments, or technical processes

**WHST.6-8.4** Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose and audience

**WHST.6-8.7.** Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.

**WHST.6-8.9** Draw evidence from informational texts to support analysis reflection, and research

**Corresponding College and Career Readiness (CCR) Anchor Standard**

7. Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.



### Hall of Famer Mike Davies (pronounced Davis)

Mike Davies was one of the most important people in history for the business of tennis. Every professional player and every professional tournament benefitted from the innovations and leadership that Davies gave to the game. Davies was born in Swansea, Wales in 1936 and took up tennis at the age of 11. In the days before the Open Era, he joined Jack Kramer's barnstorming professional tour, which helped to give him his nickname "Tennis Rebel." He was banned from playing in Davis Cup and the four majors (or Grand Slams). Once his playing days were over, Davies became an executive and oversaw some important changes. Under his leadership, tennis went from a white ball to a yellow one, a move that made it easier for fans to follow on television. He also ushered in a new era of tennis fashion, as the business moved away from traditional white tennis clothing. Davies continued to innovate tennis until his death in 2015. Learn more about [Mike Davies](#) on his Hall of Famer page.

### Mike Davies Objects on Display in the Museum



#### *Tennis Rebel*

(author) Mike Davies (Welsh, 1936- )

(publisher) Stanley Paul & Co. LTD (British)

1962

Mike Davies was the top British player in 1957 and 1958, and became a controversial player when he became the first British man to join Jack Kramer's professional tour in 1960. Competing on the pro tour from 1960-1967, Davies was an instrumental figure in opening up the sport to all players.

Bequest of the Estate of Ted Tinling

PUB.1962.3

*Location: Area 3, ATP Case, WCT section*

## Lessons (These lessons should be completed over a 6-7 day time period)

1. The teacher will introduce student to the Scientific Method through a step by step process using the PowerPoint presentation *Steps of the Scientific Method - Let's Experiment*.
2. The teacher will familiarize students with the overall essential steps of the Scientific Method, including its definition (slide 2 of the PowerPoint presentation) and the six (6) essential steps of the process scientist use when conducting experiments (slide 4 of the PowerPoint presentation) and present students with a guide sheet *What the Heck is the Scientific Method?* highlighting the six essential steps. The teacher will discuss with students the importance of each step and how the process of using the Scientific Method provides an objective, standardized approach to conducting experiments and in doing so, improves the results of the work of a scientist.
3. The teacher will discuss step one (1) of the Scientific Method with students by continuing with the PowerPoint presentation (slide 5 Problem/Question). Students will be presented with examples of problems/questions that can be solved through experimentation as reflected on slide 5. The teacher will present students with effect questions, how does affect questions and which/what and verb questions to provide students with an idea of how to construct a good question *Coming up with a Good Question..* Students will individually create their own question using either the effect question, how does affect question or which/what and verb question. Students will share their questions with the whole class.
4. The teacher will discuss step two (2) of the Scientific Method with students by continuing with the PowerPoint presentation (slide 6 Observation/Research). Student will be present *Doing Some Research*. Together the teacher and students will discuss research practices. Students will be broken up into small groups. Using researching practices, students will conduct research on the history of the tennis ball using *Tennis Ball Research*. Each group will share their research and their two (2) additional researched facts related to the tennis ball with the class. \*\*Here students can take a moment to learn about Hall of Famer Mike Davies and how he helped changed the game of tennis (including introducing yellow tennis balls!) <https://www.tennisfame.com/hall-of-famers/inductees/mike-davies/>.\*\*
5. The teacher will discuss step three (3) of the Scientific Method with students by continuing with the PowerPoint presentation (slide 7 Formulating a Hypothesis) The teacher will introduce the concept of a hypothesis to reading

a book where something is happening, but you can't quite figure it out, using the example of a mystery book. Through a collaborative guided discussion using a mystery book as an example the teacher will discuss with students the idea that a mystery book often gives you clues as to what might happen next, sometimes making you guess or predict as to what is going to happen at the end of the book by using clues as to what already happen in the book. The teacher guides students through discussion to connect the concept of "making a guess or prediction" to the science world's guess or prediction know as a "hypothesis." The teacher will present students with ***Writing A Hypothesis*** and work with students collaboratively on the first half to the document through example and discussion. Student will work independently to complete the back portion of ***Writing A Hypothesis***. Students will share their independently writing work with the class.

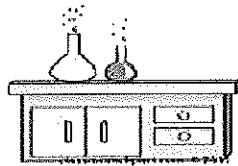
6. The teacher will discuss step four (4) of the Scientific Method with students by continuing with the PowerPoint presentation (slide 8 Experiment). The teacher will discuss the definition of experiment, develop and follow a procedure. The teacher will present students with ***Testing Your Hypothesis by Doing an Experiment*** and will familiarize students of the overall steps in to prove or disprove a hypothesis. The teacher will present students with ***Giving Hypotheses***. The teacher will bring students outside or in a large open area. Students will be broken up into partners. The teacher will remind students of the experiment process they discussed in class and ask students to work with their partner to follow the steps outlined on ***Giving Hypotheses***. Once students complete ***Giving Hypotheses*** they will share their results with the class.
7. The teacher will discuss step five (5) of the Scientific Method with students by continuing with the PowerPoint presentation (side 9 Collect and Analyze Results). The teacher will define what data is and its relationship to the Scientific Method with students in collaborative discussion referring to slide 9 of the PowerPoint presentation. Students will be presented with ***How Do You Collect Data*** as part of the class discussion and the teacher will showcase "data tools" that can be used to collect data (i.e. science journals, tables, charts, diagrams, graphs, etc.). Students will be presented with ***Comparing Presentation Methods***. As a class the teacher and students will work on ***Comparing Presentation Methods***. Students will be presented with ***Graphing Data*** and will work independently to reinforce step 5 of the Scientific Method.
8. The teacher will discuss step six (6) of the Scientific Method with students by continuing with the PowerPoint presentation (slide 10 Conclusion). The teacher will define conclusion and its relation to the Scientific Method with

students in a collaborative discussion referring to slide 10 of the PowerPoint presentation. The teacher will work collaboratively guiding students in discussion using *In Conclusion*.

9. The teacher will continue to use the PowerPoint presentation with students (slide 11 and 12). Students will conduct their own science experiment use the Question/Problem giving to them. Students will conduct an experiment using the question *How does temperature affect the bounce of a tennis ball?* Student will use *My Experiment* to guide them in their experiment.

## Steps of the Scientific Method

Let's Experiment



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## The Scientific Method

What the heck???



The Scientific Method involves a series of steps that are used to investigate a natural occurrence.

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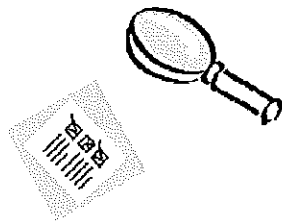
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## Let's Take a Closer Look Step By Step



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### Scientific Method

- Problem/Question
- Observation/Research
- Formulate a Hypothesis
- Experiment
- Collection and Analyze Results
- Conclusion

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### Steps of the Scientific Method



Problem/Question  
Develop a question or problem that can be solved through experimentation.

What is the effect of sunlight on the growth of plants?

How does the humidity affect the growth of fungi?

What paper towel is most absorbent?

Let's stop here. Now it is your turn to take step #1. Let's learn and work on good questions.

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### Steps of the Scientific Method



Observation/Research  
Make observations and research a topic of interest.

Let's stop here. Now it is your turn to take step #2. Let's learn about observation and research. No turning back. You're a scientist!

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### Steps of the Scientific Method



**Formulate a Hypothesis**  
Predict a possible answer to the problem or question.

For example – If soil temperatures reise, then plant growth will increase.

Let's stop here. Now it is your turn to take step #3. It is time to PREDICT! Let's learn how to write hypothesis.

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### Steps of the Scientific Method



**Experiment**  
Develop and follow a procedure.  
Include a detailed materials list.  
The outcomes must be measurable (quantifiable).

Let's stop here. Now it is your turn to take step #4. Let's learn the procedure to follow when conducting an experiment.

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### Steps of the Scientific Method



**Collect and Analyze Results**  
Modify the procedure if needed.  
Confirm the results by retesting.

Great tools to help collect

- Keep a science Journal
- Use tables, Charts, Diagrams
- Graphs are great too

Let's stop here. Now it is your turn to take step #5. Let's learn how to collect and track our information.

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### Steps of the Scientific Method

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#### Conclusion

Include a statement that accepts or rejects the hypothesis. Make recommendations for further study and possible improvements to the procedure.

Let's stop here. Now it is your turn to take step #6. Let's learn how to wrap everything up with a conclusion.

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### Ok Let's Experiment!!

Let's put our knowledge of the Scientific Method to work by conducting an experiment using tennis balls



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We will get you start with a question.

How does temperature affect the bounce of a tennis ball?

Ready  
Set  
Experiment



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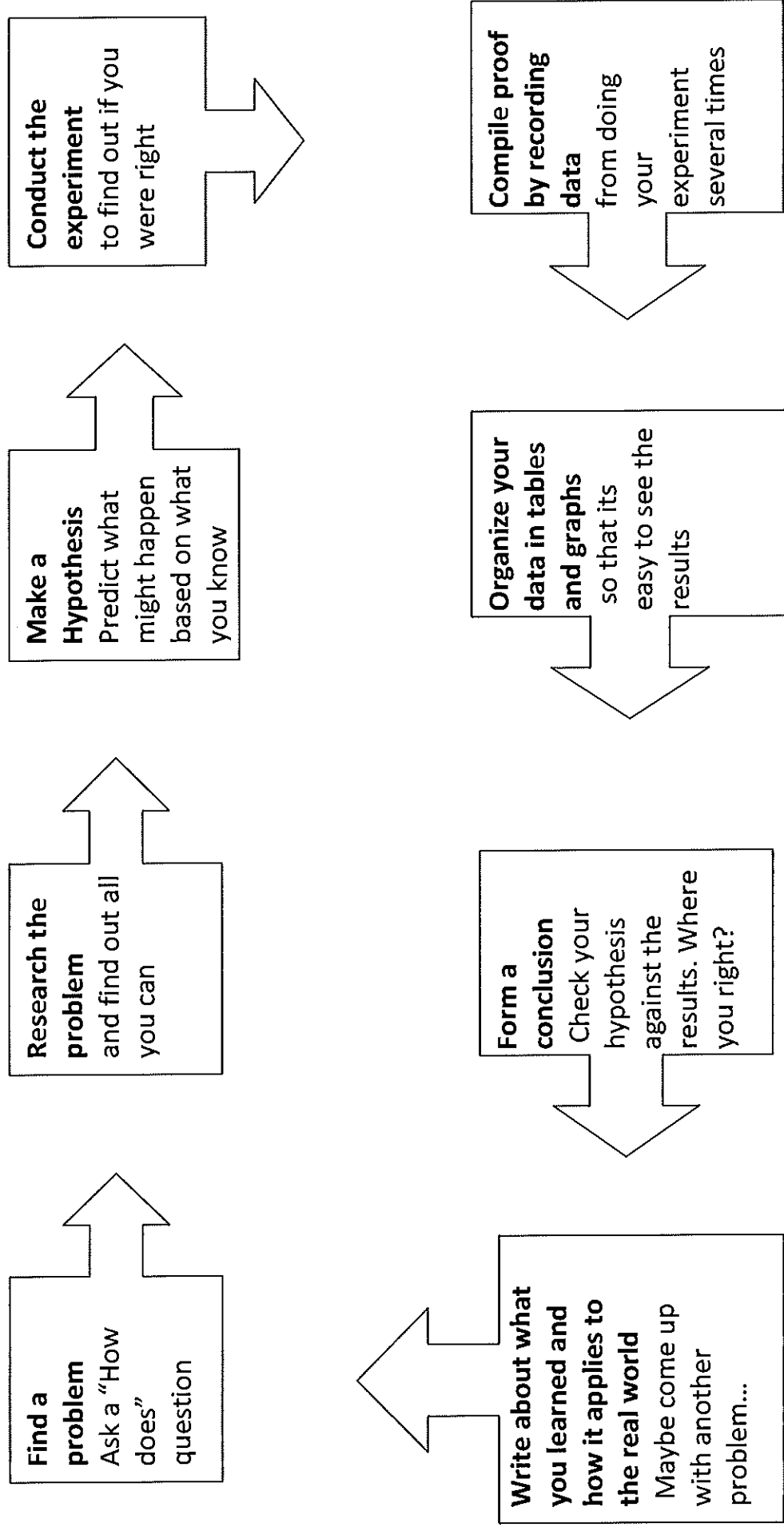
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# What the Heck is the Scientific Method?



# Coming up with a Good Question

To give you an idea of how a good question can be constructed let's work together by filling in the question blanks with the following list of words.

## The Effect Question:

What is the effect of \_\_\_\_\_ on \_\_\_\_\_?

eye color	pupil dilation
temperature	the size of a balloon
oil	a ramp

Write your full Effect Questions below

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_

## The How Does Affect Question:

How does the \_\_\_\_\_ affect \_\_\_\_\_?

color of light	the growth of plants
color of a material	its absorption of heat
use of a swimming cap	a swimmers race time

Write your full How Does Affect Questions below

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_

## The Which/What and Verb Question

Which/What \_\_\_\_\_ (verb) \_\_\_\_\_ ?

paper towel	is	most absorbent
foods	do	meal worms prefer
detergent	makes	the most bubbles

Write your full Which/What and Verb Questions below

1. \_\_\_\_\_

2. \_\_\_\_\_

3. \_\_\_\_\_

**Now it is your turn:** Create your own question using either the Effect Question, the How does Affect Question or the Which/What and Verb Question

**My question:**

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

# **Doing Some Research**

**Become an expert on a topic is what real scientists do in real labs.**

**So how do you become an expert?**

## **READ**

**Read about a topic. READ books. READ magazine articles. READ articles from the internet. Take notes of any new science works you learn and use them. Before you know it you will be an expert on the topic you RESEARCHED.**

## **YOU DISCUSS**

**Talk about it with other people, family members, teachers with another expert like Doctors, Weatherman or others work with the things you are researching. Interview those experts get their input.**

Name: \_\_\_\_\_

## Tennis Ball Research

Directions: While conducting research on the history of the tennis ball, complete each statement below by filling in the missing information.

1. The diameter of a tennis ball is \_\_\_\_\_ - \_\_\_\_\_ cm or \_\_\_\_\_ - \_\_\_\_\_ inches.
2. Yellow tennis balls were introduced in the year \_\_\_\_\_.
3. International Tennis Hall of Fame member \_\_\_\_\_ introduced the yellow tennis ball.
4. The first tennis balls dating back as early as the 15<sup>th</sup> century were made of \_\_\_\_\_ stuffed with \_\_\_\_\_.
5. Tennis balls used today are filled with air and are surfaced by uniformed \_\_\_\_\_.
6. Before 1925, tennis balls were packed in \_\_\_\_\_ and \_\_\_\_\_.

**Expanded your research tell us two more facts about the tennis ball not mentioned above.**

1. \_\_\_\_\_  
\_\_\_\_\_
2. \_\_\_\_\_  
\_\_\_\_\_



## Writing a Hypothesis

Now it is time to predict what you think will happen if you test a problem. This type of “SMART GUESS” or PREDICTION is what areal scientists call a HYPOTHESIS.

How do you begin?

**Answer this very simple question (even before you start your experiment):**

What do you think will happen...

**Example of Problem:**

Which paper towel is more absorbent?

**Example Hypothesis:**

I think Brad X will be more absorbent because it's a more popular brand, it is thicker and the people I interviewed said that the more expensive brands would work better.

The above example not only predicts what will happen in the experiment, but also shows that the “Scientist” uses research to back up his production.

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### Now You Try

A student is interested in designing several experiments to test the factors that affect how quickly an Alka-Seltzer® tablet dissolves in water (solution rate). For each question write an appropriate hypothesis that could be tested with an experiment. Be sure each hypothesis is in a proper “If ...then....because...” format

**Yet another example to get you rolling!**

**Question:** What effect does stirring have on solution rate?

**Hypothesis:** If the water is stirred, then the tablet will dissolve faster because stirring increases solution.

## It Your Turn

**Question:** What effect does the water temperature have on solution rate?

**Hypothesis:** \_\_\_\_\_

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**Question:** What effect does crushing the tablet have on solution rate?

**Hypothesis:** \_\_\_\_\_

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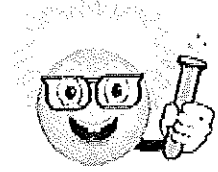
**Question:** What effect does adding soda to the water have on solution rate?

**Hypothesis:** \_\_\_\_\_

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# Testing Your Hypothesis by Doing an Experiment

Here is how a scientist proves or disproves a hypothesis.  
Follow these steps when experimenting.



**First:** Gather up your materials. What will you need to perform your experiment?

**Second:** Write a PROCEDURE. A procedure is a list of steps that you did to perform an experiment. What do you need to write down? Think of it as writing down your recipe of your favorite dinner. If someone wants to make your favorite dinner they will have to follow the step by step recipe.

**Third:** Identify you variables. The **variables are any factors that can change in an experiment.** Remember that when you are testing your experiment you should only test one variable at a time in order to get accurate results. For example if you want to test the affect that water has on plant growth, then all the plants you test should be in the same condition, these are called **controlled variables:** same type of dirt, same type of plant, same type of location, same amount of sunlight . The only variable you would change from plant to plant would be the amount of water it received. This is called the **independent or manipulated variable.** The independent variable is the factor you are testing. The results of the test that you do are the **depended or responding variable.** The respond variable is what happened as a result of your test. Knowing your variable is important because if you don't know them you won't be able to collect your data and read results.

**Forth:** TEST,TEST,TEST. Results of an experiment are expected to be consistent. In other words, when you cook from a recipe you expect the outcomes to be the same if you followed the directions (or procedure) step by step. This means you need to do the experiment more than once in order to test it properly. **More is better!** Try it at least five times.

**Fifth:** Collect your DATA: Write down or record your results for the experiment every time you test it. Remember when we were testing our hypothesis, with each jump, standing or running we recorded our results. Be sure to be organized and neat. Most scientists use tables or graphs to show their results.

**Sixth:** Conclusion: Tell everyone what you learned. Did your experiment work? Why did it work or why didn't it work? What do the results tell you? Write a statement!

# Giving Hypotheses

Follow these steps

Step 1 – Give your hypothesis. Do you think you can jump farther from a standing position or from a running start?

Step 2 – Test your hypothesis

Step 3 – Make each jump 4 times. Take turns with your partner. Don't forget to record your trial results below.

	Standing Jump	Running Jump
Trail # 1		
Trail #2		
Trail #3		
Trail #4		

Step 4 – Did you jump farther from a standing position or with a running start? Compare your results with your partner.

Think about it: Was your hypothesis correct? Why or why not?

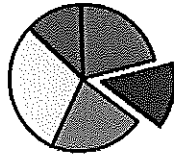
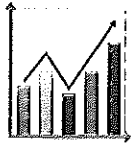
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# How Do You Collect Data?



Day	Temp	Wind
1/22	85	10
1/23	88	12
1/24	90	15



There are a few collection tools to help keep all of your data organized when conducting experiments. Try them out real scientist use them!

**Keep a science journal:** A science journal is a type of science diary that you can keep especially if your experiment is taking place over a long period of time, a week or more. In your journal you can record observations, collect research, draw and diagram pictures and jot down any additional questions you might have for later.

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**Tables, charts and diagrams** are generally the way scientist keep track of experiment trials. A table is organized in columns and rows and ALWAYS has labels or headings telling what the columns or row mean. When using tables and charts make sure you record your data in the correct column or row, write neatly and record your data as soon as you collect it SO YOU DON'T FORGET WHAT HAPPEN.

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**Use the right graph for your experimnet.** There are all different types of graph designs. Here are a few common ones used when doing science experiments.

- **Pie graphs** are great to use when you are showing percentages of groups.
- **Bar graphs** are used when comparing amount of things. The bars show the amounts in an easy to read way.
- **Line graphs** are used to show how changes occurred in your experiments over time.

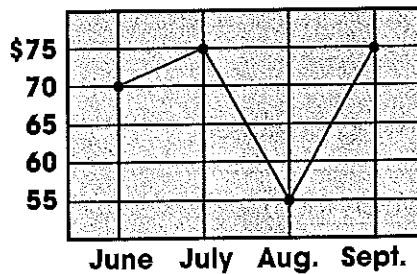
# Comparing Presentation Methods

Tables and different kinds of graphs have different purposes. Some are more helpful for certain kinds of information. The table and three graphs below all show basically the same information—the amount of money Mike and Margaret made in their lawn-mowing business over a 4-month period.

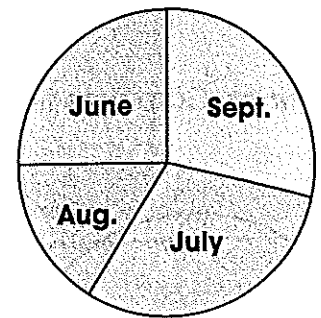
**Combined Income per Month**

	Mike	Margaret
June	\$34	\$36
July	41	35
August	27	28
Sept.	36	40
<b>Totals</b>	<b>\$138</b>	<b>\$139</b>

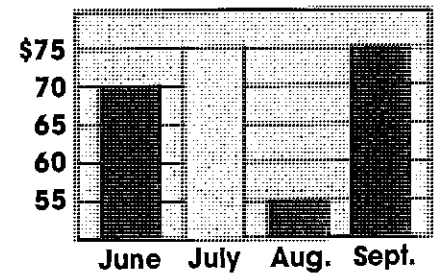
**Combined Income per Month**



**Combined Income per Month**



**Combined Income per Month**



**Directions:** Study the graphs and table. Then circle the one that answers each question below.

- Which one shows the fraction of the total income that Mike and Margaret made in August?
 

table                       line graph                       bar graph                       circle graph
- Which one compares Mike's earnings with Margaret's?
 

table                       line graph                       bar graph                       circle graph
- Which one has the most exact numbers?
 

table                       line graph                       bar graph                       circle graph
- Which one has no numbers?
 

table                       line graph                       bar graph                       circle graph
- Which two best show how Mike and Margaret's income changed from month to month?
 

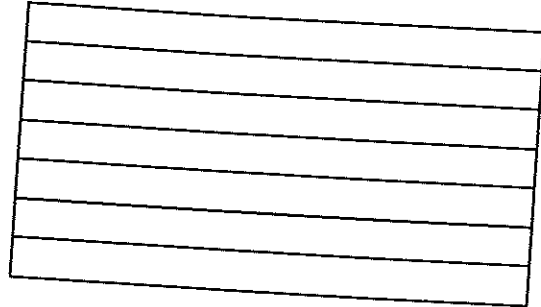
table                       line graph                       bar graph                       circle graph

# Graphing Data

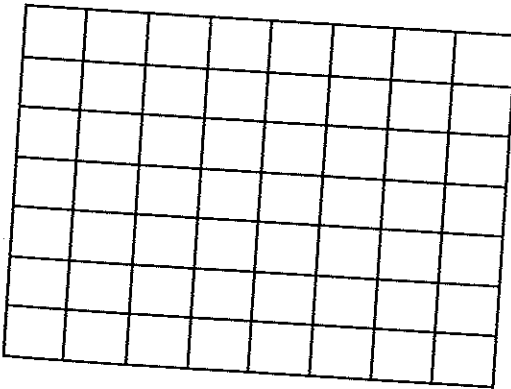
**Directions:** Complete the following exercises.

1. Use the following information to create a bar graph.

Cities	Population (in 1,000's)
Dover	20
Newton Falls	12
Springdale	25
Hampton	17
Riverside	5



2. Study the data and create a line graph showing the number of baskets Jonah scored during the season.

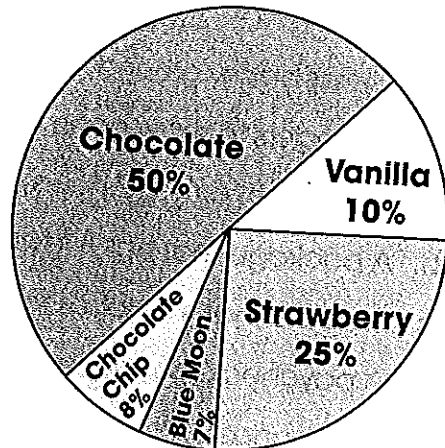


- Game 1 — 10
- Game 2 — 7
- Game 3 — 11
- Game 4 — 10
- Game 5 — 9
- Game 6 — 5
- Game 7 — 9

- Fill in the blanks.
- a. High game: \_\_\_\_\_
  - b. Low game: \_\_\_\_\_
  - c. Average baskets per game: \_\_\_\_\_

3. Study the graph, then answer the questions.

- a. Which flavor is the most popular? \_\_\_\_\_
- b. Which flavor sold the least? \_\_\_\_\_
- c. What decimal represents the two highest sellers? \_\_\_\_\_
- d. Which flavor had  $\frac{1}{10}$  of the sales? \_\_\_\_\_



**Ice-Cream Sales**

# In Conclusion!

A conclusion paragraph contains a description of the purpose of the experiment. In other words, **WHAT HAPPENED.**

## What Did You Learn - 5 Keys Elements

Restate the overall purpose of the experiment.

- The purpose of the experiment was to investigate the effect of .....

What were the major findings?

- Summarize your data and graph results.

Was the hypothesis supported by the data?

- The hypothesis that ..... was supported

How could this experiment be improved?

- This experiment relied on ..... Perhaps this experiment could be improved by .....

What could be studied next after the experiment? What new experiment could continue study of the topic?

- Additional investigation using ..... would be a good additional experiment.

# My Experiment

## Materials:

List all the materials that you will need for your science experiment here:

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## Variables:

List the variable that you will control, the variable that you will change and the variables that will be the result of your experiment:

My control variables are (the stuff that will always stay the same) \_\_\_\_\_

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My independent variable is (this is the thing that changes from one experiment to the next, it is what you are testing). \_\_\_\_\_

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My responding variables might be (in other words, the results of the experiment)

## Procedure: (the steps)

List the steps that you have to do in order to perform the experiment here:

1<sup>st</sup> \_\_\_\_\_

2<sup>nd</sup> \_\_\_\_\_

3<sup>rd</sup> \_\_\_\_\_

Keep going until you have no more steps left

Design a table, chart, graph here to collect your data information.

### Conclusion:

New tell us what you learned from this and if you were able to prove your hypothesis. Did it work? Why did it work or why didn't it work? What did the results tell you? Sometimes not being able to prove hypothesis is important because you still proved something. What did you prove?

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