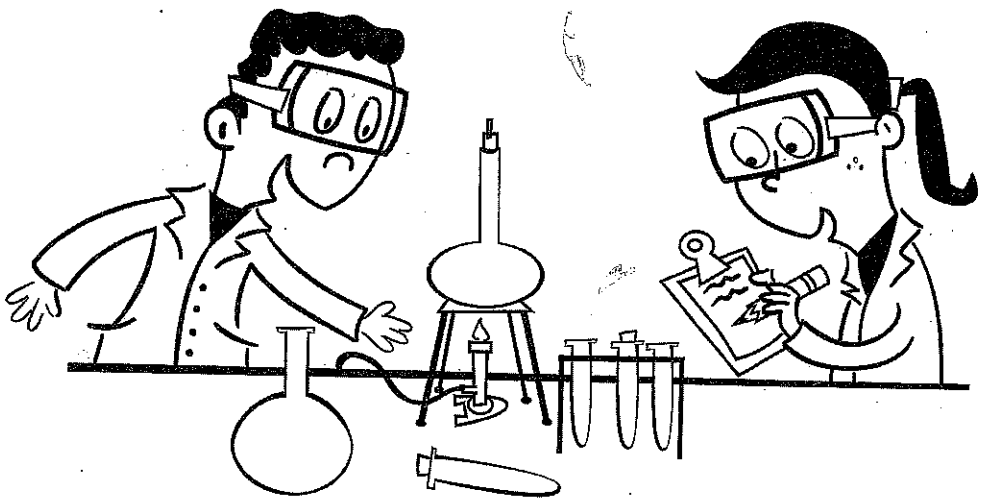
1 So You Have to Do a Science Fair Project

Steps to the Scientific Method

Name: _____ **Date:** _____

Your teacher has just announced that there's going to be a science fair this year, and that your project needs to follow the scientific method—the step-by-step process that scientists follow when they perform an experiment. Where should you begin? Step One: Don't panic! Step Two: Check out the cheat sheet below. It outlines the scientific method.



1. **Make an observation. Then, propose a research question based on your observation.**
   A good science-fair project question is testable and measurable. For example: *Which brand of bubble gum keeps its flavor longest?* You can test this by chewing different brands of gum and measuring how long the flavor lasts for each brand. The best questions are usually ones that you have a genuine interest in answering.

2. **Identify the variables.**
   A science-fair project involves *variables,* or things that change or could be changed. There are two types of variables: independent and dependent variables. An *independent variable* is one that you change on purpose. For instance, if you were experimenting to find out which brand of gum keeps its flavor longest, you may choose to test three different brands of bubble gum. The *dependent variable,* or the factor that responds to a change in the independent variable, would be the amount of time that the flavor lasts.

   You'll also want to identify your *constants,* or things that will stay unchanged. For instance, you might test only bubble gum that is sugar free. And to make sure that the amount of gum you test is equal each time, you might choose to test only sticks of gum—not gumballs.

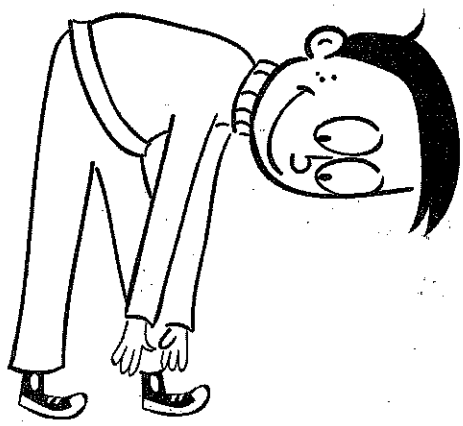
Sample Project One: Stretch Test

Name: _____ **Date:** _____

Below is an example of a science project from start to finish.
You can use this as your guide as you work on your own project.

Project Topic: How a Person's Flexibility Changes Throughout a Workout

Project Title: Stretch Test



1. My Question

The question I plan to answer with my experiment is: Are people able to stretch farther before or after hanging in a forward bend?

2. My Purpose

Rewrite your question to complete the following sentence. The purpose of my experiment is to: find out when people are most flexible–at the start or end of a workout.

3. My Variables

My *independent variable,* or the one thing I plan to change, is: the total length of time spent hanging in a forward bend before giving a stretch test.

My *dependent variable,* or the change I will measure, is: the distance that people stretch.

My *controlled variables,* or the things I will keep the same, are: people will perform the same stretch test. I will make sure that the room temperature stays constant throughout the workout because people's muscles loosen up in warmer temperatures. I will have people perform the stretch test three days in a row, always at the same time of the day.

4. My Research

Go to the library, perform Internet research, or interview an expert to gather information about your topic. Keep notes on your findings:

It is best to do light stretching before a workout and a more thorough stretching routine after a workout. Stretching your muscles when they're cold increases your risk of pulled muscles. Source: Mayo Clinic staff, Stretching: Focus on flexibility, The Mayo Clinic, http://www.mayoclinic.com/health/stretching/HQ01447

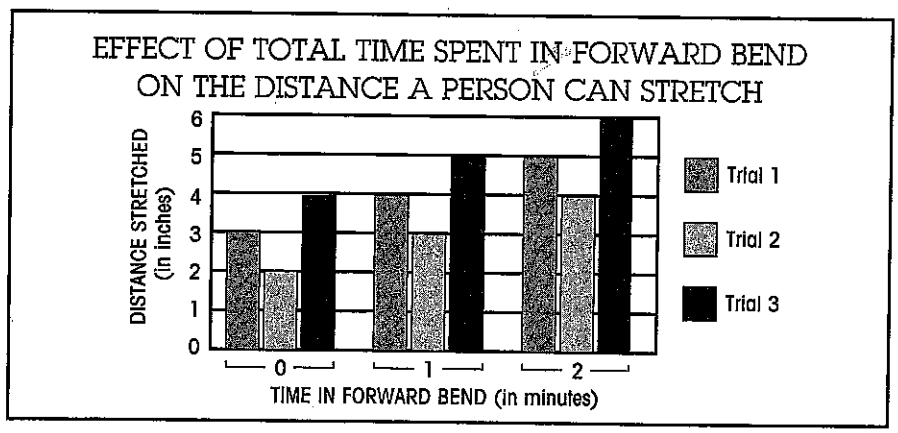
Sample Project One: Stretch Test

(continued)

7. My Data

Independent Variable: Total length of time in forward bend	**Dependent Variable:** Distance stretched (in inches)			
	Trial 1	**Trial 2**	**Trial 3**	**Average**
0 minute	3 inches	2 inches	4 inches	3 inches
1 minute	4 inches	3 inches	5 inches	4 inches
2 minutes	5 inches	4 inches	6 inches	5 inches

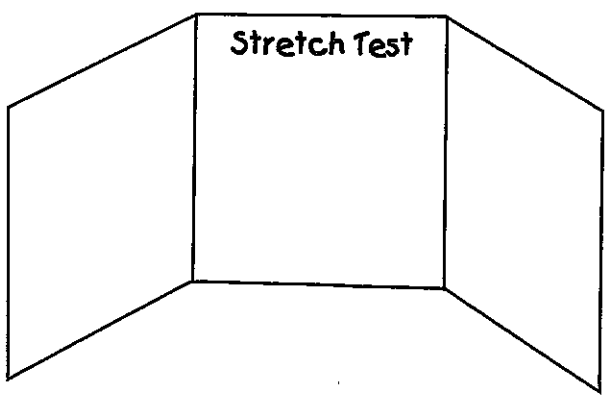
8. Graph of My Data



9. My Conclusions

Based on my results, I conclude that my hypothesis was correct. The longer a person works out before stretching, the farther the person will be able to stretch. I would like to see how other forms of workout affect the distance a person can stretch. For instance, would doing jumping jacks help a person stretch farther?

10. A Sketch of My Display



Sample Project Two: Drip Dry

(continued)

4. My Research

Go to the library, perform Internet research, or interview an expert to gather information about your topic. Keep notes on your findings.

I interviewed two experts in fabrics: the owner of my local dry cleaner, who said that satin is a very fast-drying material, and a fashion designer, who said the same thing.

5. My Hypothesis

A *hypothesis* is a possible answer to a research question. Reread your question in Step 1. Based on my research, my hypothesis is:

satin pillowcases will dry faster than flannel or cotton pillowcases. Cotton pillowcases will dry the slowest.

6. My Procedure

Materials:

standard-size satin pillowcase
standard-size cotton pillowcase
standard-size flannel pillowcase
washtub
cold water
bathroom scale
drying rack
bathtub
clock
pencil
paper

Procedure Steps:

1. Weigh each pillowcase and record its dry weight.
2. Fill the washtub completely with cold water.
3. Place all three pillowcases in the water.
4. Leave the pillowcases in the water for 1 hour to soak.
5. While the pillowcases are soaking, set up the drying rack in the bathtub.
6. After allowing the pillowcases to soak for 1 hour, remove them from the water and weigh each one again. Record each pillowcase's wet weight.
7. Hang each pillowcase on a top bar of the drying rack.
8. Close the shower curtain to keep any stray breezes from hitting the towels.
9. Allow the pillowcases to line dry.
10. Weigh each pillowcase every 2 hours.
11. The first pillowcase to reach its dry weight from step 1 is the fastest drying.
12. Continue to let the remaining pillowcases dry. Continue weighing them every 2 hours until all three have reached their dry weight from step 1.

2 Where Do You Begin?

Project Ideas

What Makes a Good Question?

Name: _____ **Date:** _____

The key to a good science-fair project is coming up with a good question. But what makes a good question? It should be measurable and testable. The questions below are <u>not</u> good science-fair questions. Rewrite each question to make it measurable and testable. See the examples below. (Hint: There is more than one right answer. There are many ways to turn these questions into good ones!)

Example 1:

Bad Question: How is one brand of battery different from another?

Good Question: Which lasts longer: a brand-name battery or a store-brand battery?

Example 2:

Bad Question: Which brand of popcorn is best?

Good Question: Which brand of microwave popcorn leaves the fewest unpopped kernels?

1. **Bad Question:** Is one brand of cereal better than another?

2. **Bad Question:** Is it bad to watch TV while studying?

3. **Bad Question:** Does staying up late make you tired?

4. **Bad Question:** Are you flexible?

5. **Bad Question:** How well does a paper airplane fly?

6. **Bad Question:** Does practice really make perfect?

7. **Bad Question:** How can a baseball player hit the ball farther?

8. **Bad Question:** Can a paper towel absorb milk?

9. **Bad Question:** How can you keep hot chocolate warm?

10. **Bad Question:** Is skating good exercise?

Are you still stumped for a project idea? This chapter has plenty of ideas for you to consider. As you think about possibilities for your science fair project, remember to pick a question that interests you! After all, you're going to have to research the subject, write a paper, and design an experiment. A science fair project involves more than just building a model or making a drawing to show something. So choose a topic that will be fun and that you think will make a good experiment.

Biological Projects

Grades 1–3

Projects about plants

- How does fertilizer affect plants' rates of growth?
- How does light affect the ripening of fruit?
- How does heat affect the ripening of fruit?
- Does the depth of planting affect the height of a seedling?
- Will seedlings planted upside down grow upside down?
- Do plants grow toward sunlight?

Projects about animals

- Which foods do cats (dogs, fishes, etc.) prefer?
- Do birds prefer popped or unpopped corn?
- Can a mouse (gerbil, hamster) learn to run a maze?
- Which color of fishing lure catches the most fish?
- Which foods attract/repel insects?

Projects about people

- Are boys my age taller than girls my age?
- Do kids my age prefer one soft drink over another?
- Which brand of fast-food french fries do kids my age like best?
- Are left thumbprints identical to right thumbprints?

Read through the list and write down any questions that interest you. Then discuss those ideas with your teacher or parent.

Miscellaneous

- Does temperature affect odor?
- Is soil a better insulator than air?

Grades 4–6

Projects about plants

- How do plants get nitrogen?
- How does water move through a plant?
- How do changes in the length of the day affect plant growth?
- What is the effect of organic matter on the growth of plants?
- What is the effect of temperature on the germination of seeds?
- What is the effect of microwave radiation on the germination of seeds?
- Does presoaking seeds affect the germination and growth of plants?
- What is the effect of electric current on plants?
- What is the effect of secondhand smoke on plants?
- Do vegetables grown in lead-contaminated soil contain lead?

Projects about animals

- Do hamsters (mice, gerbils) need vitamins?
- Under what conditions do butterflies hatch faster?
- How do earthworms affect the soil they live in?
- Can flatworms (planaria) regrow heads or tails?
- Whose mouth has the most bacteria, humans' or dogs'?
- Which soap kills the most germs?
- Which kind of bread grows the most mold, white or wheat?
- Can bacteria be found in canned baby formula?
- Can lysozyme kill bacteria?
- Do marine sponges kill bacteria?

Projects about people

- Who remembers dreams more often, boys or girls?
- Do girls or boys my age have better short-term memory?
- How does listening to different kinds of music affect a person's heart rate?
- Do babies prefer certain colors?

- Do certain colors affect people's moods?
- What are the effects of video games on a person's heart rate?
- How does music affect short-term memory?
- How does left-brain dominance compare to right-brain dominance in people?
- Is brain dominance inherited?
- How does eating different sweeteners affect a person's weight?

Miscellaneous

- How does a tooth decay?
- How safe are soda cans?
- Are homes cleaner eating places than public places?

Physical Projects

Grades 1–3

Projects about electricity

- Which metals conduct electricity (heat) best?
- How can heat produce electricity?
- Which battery lasts longest?
- How do waves carry energy?
- How does the amount of oxygen affect the rate of burning?
- What products result from burning a candle?
- Do fluorescent lights last longer than filament bulbs?

Projects about geology

- How are rocks classified?
- What factors affect the growth of crystals?

Projects about chemistry

- Which brand of orange juice has the highest vitamin C content?
- Which detergent (toothpaste, deodorant, shampoo) works best?
- Which gum blows the biggest bubbles?
- Which metal rusts faster?

Miscellaneous

- How does surface area affect evaporation time?

- Do some numbers come up in the lottery more frequently than others?
- Is a black shirt hotter than a white one on a sunny day?

Grades 4–6

Projects about electricity

- How is electrical current affected by the type of conductor (temperature, filament)?
- Can a potato generate electricity?

Projects about chemistry

- What is the effect of salt on the freezing point of water and other liquids?
- What happens to the volume of water when it freezes?
- Does temperature affect solubility?
- Are some substances more soluble than others?
- What is the effect of temperature on the solubility of a gas in a liquid?
- How is light affected by passing through water?
- Which gas is most dense?
- What gas is produced when seltzer reacts with water?
- Can I blow square bubbles?
- What is an anti-bubble?
- How can the oxidation of fruits be prevented?
- What is the tensile strength of fibers exposed to water (salt, bleach, soil, flames)?

Miscellaneous

- Can the thickness of ice at the center of a lake be determined by measuring the ice at the shore?
- What is the effect of inflation pressure on the distance a soccer ball can be kicked?
- Which rocket fin design is the most aerodynamically stable?
- Does wing shape affect velocity?
- What is the best wing shape for an airplane?
- What limits the speed of a boat (truck)?
- How accurate are homemade weather-detecting instruments?
- How does baseball filler (cork, sawdust, rubber) affect the distance a ball travels?

- Can I hit a baseball with an aluminum bat better than with a wooden one?
- What kinds of structures hold the most weight?
- Which magnet is the strongest?
- How do metals compare in density and buoyancy?
- How does gravity affect weight?
- Can a model train be run by a computer?
- What is the relationship between the size of kernels and the size of popped popcorn?
- How does temperature affect the rate of popcorn popping?
- Which method pops popcorn faster, air or oil?

Environmental Projects

Grades 1–3

Projects about plants

- How can I grow plants hydroponically?
- How can soil erosion be prevented?
- How is water passing through the ground naturally filtered?
- How does composting help the garden?

Projects about pollution

- What causes air (water) pollution?
- How does air pollution (carbon dioxide) affect plants?
- How can air pollution be cleaned up?
- How does acid rain affect the acidity of soil?

Miscellaneous

- How can solar energy be used to heat a room?
- Is there a relationship between temperature and humidity?
- How can heat be spread more evenly throughout a house?
- What is the best insulation for homes?

Grades 4–6

Projects about plants

- How can pests be controlled naturally?

- What can be learned from tree rings?
- Do vegetables grown using pesticides differ in flavor from those grown organically?
- Which fruits (vegetables) produce the best natural dyes?
- Does noise pollution affect the growth of plants?
- How does acid rain affect plants?
- How does overcrowding affect plant growth?
- How are lichens (mosses, ferns) affected by acid rain?
- Do some plants absorb more carbon dioxide than others?
- Are some plants more resistant to air pollution than others?

Projects about pollution

- Paper or plastic bags—which is better for the environment?
- Under which conditions will plastic bags biodegrade best?
- How much trash does the average household in my community create per week? How can this amount be reduced?
- What percentage of the families in my community participate in municipal recycling programs? How does this compare to the national average?
- What is the most common roadside litter in my community?
- Which commercial water purifier works best?
- Can acid rain be detected in my community? If so, what can be done about it?
- How does acid rain affect buildings (statues)?
- Can fertilizer runoff be found in my community's river? If so, what can be done about it?
- How can a pollutant such as phosphate be removed from water?
- What is the best way to soak up oil from oil spills?

Miscellaneous

- Can salt be removed from seawater by freezing the water?
- What introduced species of plants (or animals) can be found in my community? How do they impact its native species?
- Does noise pollution affect mental concentration?
- Is it more cost-efficient to recycle glass, aluminum, paper, or plastic?
- What does the greenhouse effect do to the surface temperature of the earth?

200 Science-Project Ideas That Will Wow Judges!

Name: _____ **Date:** _____

Read this list of 200 science-fair project ideas.
Circle all of the ones that sound interesting to you.

1. How does the temperature of a tennis ball affect the height of its bounce?
2. How does the air pressure of a soccer ball affect how far it travels when kicked?
3. Does a metal baseball bat vibrate more than a wooden one?
4. How does the weight of a bowling ball affect how many pins the ball knocks down?
5. Which increases your heart rate more: walking up and down real stairs or using a stair-master?
6. How does yoga affect your flexibility?
7. How does fast dancing affect your heart rate?
8. How does humidity affect the curliness of hair?
9. How does a shampoo's brand affect the strength of hair?
10. How does the type of material affect how long a shirt takes to dry?
11. Which nail polish best resists chipping?
12. How does the fat content of cheese affect its stretchiness?
13. How does the length of time that a soda bottle is open affect its fizziness?
14. How does the temperature of water affect the time it takes to freeze into ice cubes?
15. How will the time spent chewing bubble gum affect its bubbles' maximum size?
16. How will adding different flavors of Kool-Aid® to water affect the water's boiling point?
17. Which brand of popcorn leaves the fewest unpopped kernels?
18. Does the flavor of gelatin affect the amount of time it takes to set?
19. How does playing video games affect hand-eye coordination?
20. What is the effect of toothpaste brand on teeth-cleaning power?
21. What brand of paper towel is most absorbent?
22. What brand of trash bag can withstand the most weight before ripping?
23. How does a light bulb's wattage affect the amount of heat detected above a light?
24. Under what color light do plants grow best?
25. Which brand of mouthwash kills the most bacteria?
26. Which brand of breath mint lasts longest?
27. How does the amount of sugar in homemade ice cream affect how fast it freezes?
28. In a blind taste test, can you tell the difference between nonfat, low-fat, and whole milk?
29. When you pour soda out of a newly opened soda bottle, which produces more fizz: regular or diet soda?
30. How does brand affect ketchup's flow?
31. Given the same amount of water, how does pot size affect the amount of time it takes to boil water?
32. Where is the best place to store home-baked cookies to keep them fresh longest?
33. How does the amount of yeast affect how high bread rises?
34. Which cereal brand stays crunchy in milk the longest?
35. Which brand of chocolate bar melts fastest in the sun?
36. Which type of bread turns moldy first: store-bought or bakery bread?

200 Science-Project Ideas That Will Wow Judges!

82. How does the type of seed in a birdfeeder affect the types of birds that the feeder attracts?
83. What types of flowers attract the highest number of butterflies?
84. Which brand of potato chips has the least grease?
85. How does the material of a bandage affect its ability to stick after getting wet?
86. How does the time of day affect levels of algae in a lake?
87. How does tire pressure affect a car's fuel efficiency?
88. How does the amount of air in a balloon rocket affect how far it flies?
89. How does the type of string used in a "can and string" phone affect the phone's ability to transmit sound?
90. Does one cell-phone carrier get better reception than other carriers?
91. Do "triple roll" toilet paper rolls really last three times as long as regular rolls?
92. Are rooms with carpeted floors noisier or quieter than rooms with wooden floors?
93. How does humidity affect how often a plant needs to be watered?
94. Can people tell the difference between music played on an MP3 player, CD player, tape player, and turntable?
95. How does temperature affect the growth of mold?
96. How does meditation affect your heart rate?
97. Which has a longer life: an LED or an incandescent light bulb?
98. Is the incidence of asthma in a region related to the area's level of air pollution?
99. How does the color of a shirt affect the amount of heat it absorbs?
100. How does the amount of daylight that enters your room affect how late you sleep?
101. How does the type of stuffing in a pillow affect its fluffiness?
102. How does the time of year affect the number of hours of daylight in a 24-hour period?
103. How does the magnification of binoculars affect how far you can see?
104. Do all chocolate candies have the same melting point?
105. Do different types of onions make your eyes tear up more than others?
106. Which is better at cleaning mold and mildew: vinegar or commercial cleaning agents?
107. Does maple syrup's "grade" affect its flow?
108. Do different brands of batteries last longer than others?
109. Which uses more water: a shower or a bath?
110. Which type of cup will keep a hot drink warm longer: paper, plastic, Styrofoam, or glass?
111. Do natural mosquito repellants keep more mosquitoes away than artificial repellants?
112. How do gas stations affect the soil around them?
113. Which cleans teeth more effectively: baking soda or toothpaste?
114. Does the length of a clock's pendulum affect its period?
115. Which holds hair in place for a longer period of time: gel or hairspray?
116. Does listening to music while studying affect your performance on a memory test?
117. Does a person's height affect his or her ability to successfully make a jump shot in basketball?
118. How much trash do you keep out of a landfill by recycling paper and plastics?
119. Which type of photos do people hold on to longer before making prints: digital or film?
120. Do mood rings accurately predict a person's emotions?
121. Is a person's favorite subject in school influenced by gender?

200 Science-Project Ideas That Will Wow Judges!

161. Does your dog prefer water directly from the faucet or tap water that's been refrigerated?

162. How often can people accurately tell if someone is happy, sad, or mad just by looking at the person's eyes?

163. How often can people correctly determine if a person is left-handed or right-handed just by looking at the person's handwriting?

164. What melts ice the fastest: sand, cat litter, or mineral rock salt?

165. Does temperature affect the growth rate of shoots on a potato?

166. Which type of container traps the most heat: a shoebox covered in aluminum foil, plastic wrap, or wax paper?

167. How does the shape of a boat's hull affect its speed?

168. How does water pressure vary with depth?

169. Which best helps prevent soil erosion on a slope: plants, rocks, or mulch?

170. Does one brand of antacid neutralize acids faster than another?

171. Do gym shoes have more bacteria than sandals?

172. Does sunlight fade the paper more in books or in magazines?

173. In which room of the house do plants grow the highest?

174. Which toothbrushes last longest: ones with natural or nylon bristles?

175. Which air freshener lasts longest?

176. Do mildew-resistant shower curtains really keep mildew away longer than regular shower curtains?

177. Does a person's weight vary throughout the day?

178. Do certain bicycle helmets hold up better after an impact than others?

179. Can you skate faster with in-line skates or roller skates?

180. Do thunderstorms happen more often in the afternoon than in the morning?

181. Does bread stay fresher longer when it is kept in the refrigerator or on the counter?

182. Which kind of gum keeps its flavor longer: sugar-free or regular?

183. Which lightens stains better: vinegar or lemon juice?

184. Which type of bread toasts fastest?

185. Do bigger lemons have more seeds than smaller ones?

186. Does squinting improve your vision?

187. Do fans really make you cooler or do they just make you feel like you're cooler?

188. Do taller people take longer strides than shorter people?

189. Can you judge depth as well using just one eye than using two?

190. Does your "handedness" have any relation to which eye is stronger?

191. Does exercise increase or decrease your energy level?

192. How does your sight affect your balance?

193. Which do people prefer: a booth or a table toward the middle of a restaurant?

194. Do plants inside a mall grow faster under artificial light or under a skylight?

195. Does listening to rock music make you eat faster than listening to classical music?

196. Does eye color affect how well a person sees?

197. Does toothpaste with whitener whiten teeth more than regular toothpaste?

198. Does washing your hands reduce the amount of bacteria on them more than not washing?

199. Does using conditioner leave your hair with fewer knots than not using conditioner?

200. Does hair take longer to dry when using a hair drier or when it dries naturally?

Now, reread all of the questions that you circled. Do these questions have anything in common? If so, what?

Look at your answer above. If the questions you circled have anything in common, you probably have a strong interest in that topic. You might want to think about doing a science-fair project on that topic.

3 Gathering Information

Think of It as a Treasure Hunt

Now that you've selected a topic or question for your project, you're off on the hunt for information. Like a pirate searching for buried treasure, you must find everything you need to know in order to plan your experiment. It helps a lot to know *what* you're looking for and *where* to look. Be warned, however, that researching your project can take more time than doing the actual experiment, so allow yourself plenty of time for this part of your journey!

First, figure out what you already know about your project and write that down in a column in your logbook. Then think about what you might need to learn in order to answer your experimental question. Write these questions in another column in your logbook. Take a look at the samples provided here.

(Grades 1–3)

Sample Project #1

"Will Milk Spoil Faster If Left out of the Refrigerator?"

What Do I Already Know About My Question?

1. Milk spoils.
2. We store milk in a refrigerator.
3. Milk comes from cows.
4. Milk cartons have a freshness date on them.

What Else Do I Need to Know?

1. How can I tell when milk has spoiled?
2. What is the temperature inside our refrigerator and outside the refrigerator in the kitchen?
3. What happens to milk after it is taken from the cow? Is anything done to it to make it last longer?
4. Who gives milk its freshness date? Why? What does the date mean?

Sample Project #2

(Grades 1–3)

"Which Battery Lasts Longest?"

What Do I Already Know About My Question?

1. There are several different brands of batteries.
2. One brand makes the claim that it lasts longest.
3. My flashlight uses batteries.

What Else Do I Need to Know?

1. How does a battery work?
2. Do different brands work differently?
3. Can I use a flashlight to test different batteries to see which lasts longer?

Sample Project #3

(Grades 4–6)

"How Does Acid Rain Affect Plants?"

What Do I Already Know About My Question?

1. Plants need rain or water to live.
2. I've heard that acid rain is bad for plants.

What Else Do I Need to Know?

1. What is acid rain?
2. What causes acid rain?
3. How does acid rain affect plants?

Sample Project #4

(Grades 4–6)

"Does the Largest Popcorn Kernel Produce the Largest Piece of Popped Popcorn?"?"

What Do I Already Know About My Question?

1. Popped popcorn comes from kernels.
2. Popcorn comes in different varieties and colors.

What Else Do I Need to Know?

1. Do different colors or varieties of popcorn produce larger popped popcorn?
2. Does the size of the unpopped kernel affect the size of the popped piece?

What Do You Already Know and What Do You Need to Find Out?

You can wander for hours in the library or on the Internet. There is so much information out there on anything and everything you ever wanted to know! To avoid getting lost, you need to be organized in your search for information.

Where Should You Look for Information?

Take your notebook or logbook with your questions, along with pencils and a pack of index cards, and head to the library! The reference librarian can show you how to use the computers or the card file to find information about your project. "References" are the books, magazine articles, and encyclopedias that you use to look up information. Look at all of these kinds of **sources.** (A source is a place where you find information.) You may find the same information in more than one source. That is okay because you need more than one book or article as a source of information for your project.

You may check out most of the books and take them home to study them. Magazine articles and information in reference books, such as encyclopedias, usually can't be taken out of the library. Instead, you'll need to take notes at the library on those index cards. Or you might photocopy any pages you want to keep for future reference. Be sure to take plenty of change with you for the copy machine.

Think of Key Words

The easiest way to search is to identify **key words** about your project. Then search for books, newspaper or magazine articles, and encyclopedia entries that contain those key words.

What might be some key words for the sample projects in this chapter?

Using the Internet

If you have a computer and access to the Internet at home, at school, or at the local library, you may use it to do some, but definitely not all, of your research. Be aware first that the Internet is *not* a giant library and that the information you find on it may not be correct. The Internet is a great place to find an idea for a project and get some

Sample Key Words

Project Question	Possible Key Words
Will milk spoil faster if left out of the refrigerator?	Milk Dairy cow Spoiling Refrigeration Expiration date
Which battery lasts longest?	Battery Electricity Volts
How does acid rain affect plants?	Acid rain Pollution Watering plants
Does the largest popcorn kernel produce the largest piece of popped popcorn?	Popcorn Kernel

general background on your idea. The Internet should *never* be your only source of information about your project. The Internet can also be a time-waster because it is so easy to get distracted by too much information and wander away from the path of your project.

If you've never done an Internet search, ask a parent or teacher or librarian for help. You first need to open a search engine such as Yahoo.com or Google.com. From there, you just have to type in a key word or words in the box provided and click on "search." You'll most likely need to narrow the search by using several key words instead of just one.

Write down your own list of key words in your logbook before you go to the library. Don't worry if the list seems short. As you begin to look for information, you may find other key words. Keep your list handy, and add the new key words to it.

4 Guess What?

The Hypothesis

Chocolate Lover's Experiment

Name: _____ **Date:** _____

There are so many tasty varieties of chocolate: plain, candy-coated, cups with peanut-butter centers. But which one will last longest under the heat of the sun? Design an experiment to find out. Then answer the questions below.

1. What is your *independent variable,* or the detail you would change on purpose?

_____

2. What is your *dependent variable,* or the variable you would measure?

_____

3. State your *research question* for this experiment.

_____

4. State your *hypothesis.*

_____

5. List the *materials* you'll need for this experiment.

_____

6. On a separate sheet of paper, write a detailed *procedure* to test your hypothesis. Remember: Other people who read your paper should be able to follow your instructions exactly.

7. Identify your *control.*

_____

8. What variables should you hold *constant*?

_____

9. On a separate sheet of paper, design a *data table* for recording your results.

10. What kind of *graph* or *chart* would you use to present your data? Draw your graph or chart on a sheet of graph paper.

5 Test Your Guess

Experimentation

Let's check your progress so far:

- You have selected a project.
- You have done some research into the background information for your topic.
- You have made a guess, a hypothesis.

Next, you need to plan how you are going to do the experiment.

A Recipe for Success: The Procedure

The plan for your experiment is called the **procedure.** It is a step-by-step guide to test your hypothesis. Think about the steps you'll need to take and the materials you'll need. Make your plan as detailed as possible. Imagine you are making a movie about your project and you are the director telling the actors what to do.

What is the "recipe" for your experiment? Write it down step by step in your logbook. Don't worry if you don't know exactly what you will need to do, or in what order. You can always fix it as you go. Use as many steps as you think you will need. How much time are you going to need to do your experiment? Can you do it in a few hours, or will it take days to see the results? Be sure you have enough time to do your experiment before the project is due!

Here are the procedures for our sample projects:

Sample #1

"Will Milk Spoil Faster If Left out of the Refrigerator?"

Step 1: Measure one cup of milk.

Step 2: Pour the milk into a jar. Cover with the lid.

Step 3: Place the jar in a box (to keep light out) and put it on a shelf in a cupboard.

Step 4: Put a thermometer next to the box.

Step 5: Measure another cup of milk.

Step 6: Pour the milk into another jar. Cover with the lid.

Step 7: Place the jar in a box and put it on a shelf in the refrigerator

Step 8: Put a thermometer next to the box.

Step 9: Check the jars every day at the same time of the day. Smell the milk. Look at its color and character. Check the temperature reading of each thermometer.

Step 10: In your logbook, write down each temperature and your observations each day.

Sample #2

"Which Battery Lasts Longer?"

Step 1: Place one Brand A battery into a flashlight and turn it on.

Step 2: With the stopwatch, time how long the battery lights the flashlight. Repeat this procedure for a second Brand A battery (with a second flashlight).

Step 3: Write down the times in the logbook.

Step 4: Repeat Steps 1 through 3 with each brand of battery.

Perfecting Your Procedure

Name: _____ **Date:** _____

Suppose you want to conduct an experiment to answer the research question: *What brand of paper towel is most absorbent?* The following is a very basic description of the steps you would take to answer your question. Think about how you would conduct the experiment and rewrite the procedure on a separate sheet of paper. Make it very detailed so that someone else could repeat your experiment exactly the way you did it.

Procedure:

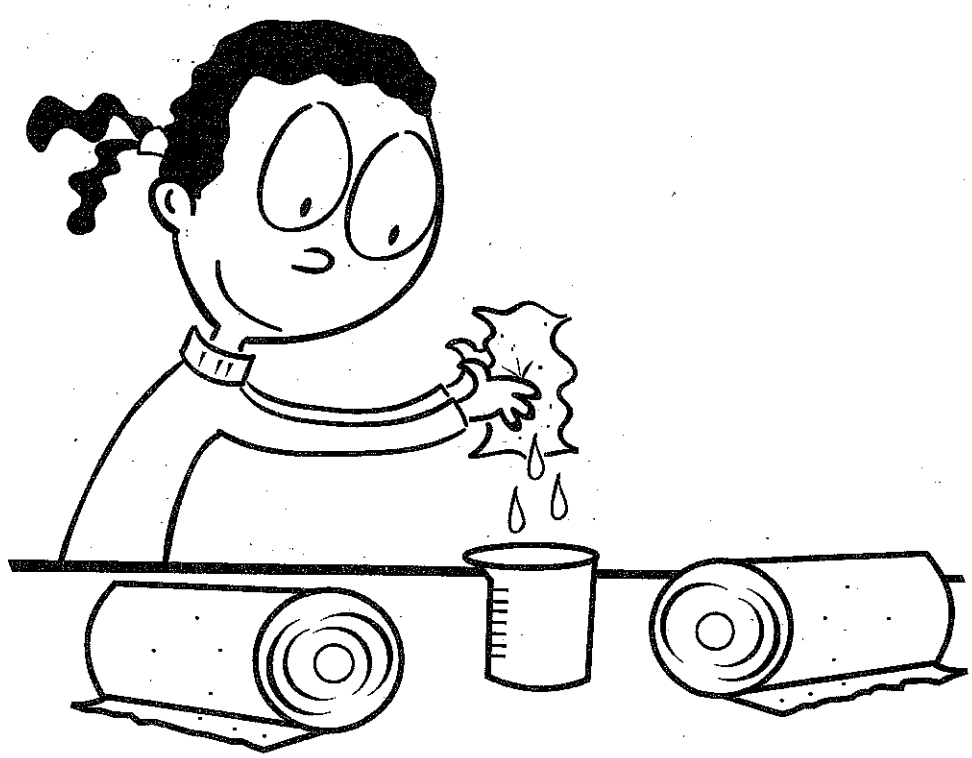
1. Purchase different brands of paper towels.

2. Let them soak in a liquid.

3. Squeeze all of the absorbed liquid out.

4. Measure how much liquid each brand absorbed.

5. Compare your results.



In your logbook, write down the list of materials you will need for your experiment. Use your procedure as a guide. Don't worry if you forget something. You can add to this list as you work. Are any of the items going to be hard to find? Or too expensive? Be certain you know in advance where you're going to get the items and about how much they're going to cost.

Talk to your teacher or a parent if any materials are hard to find or too expensive. You may need to replace that item with something else. For example, in the plant experiment, perhaps 40 rose plants would cost too much, but 40 marigolds would be okay.

In addition to the obvious, such as popcorn for the popcorn project, don't forget things like:

- Electricity
- Water
- Sunlight
- Heat
- Cold
- Storage space
- Special equipment

Sample material lists

Sample #1

"Will Milk Spoil Faster If Left out of the Refrigerator?"

Materials:

1 carton of whole milk
refrigerator
1-cup measuring cup
2 glass jars with lids
2 Fahrenheit thermometers
2 cardboard boxes

Sample #2

"Which Battery Lasts Longest?"

Materials:

2 batteries each (same size) of 4 different brands of batteries
8 identical, brand-new flashlights that require only 1 battery each
stopwatch

Sample #3

"How Does Acid Rain Affect Plants?"

Materials:

9 pots
marigold seeds
potting soil
distilled white vinegar
purified water
2 jars
pH test strips
measuring cup for watering
marker for labeling pots
metric ruler

Sample #4

"Does the Largest Popcorn Kernel Produce the Largest Piece of Popped Popcorn?"

Materials:

bag or jar of unpopped popcorn (not microwave-type)
hot-air popcorn popper
bowl
metric ruler

Just Do It!

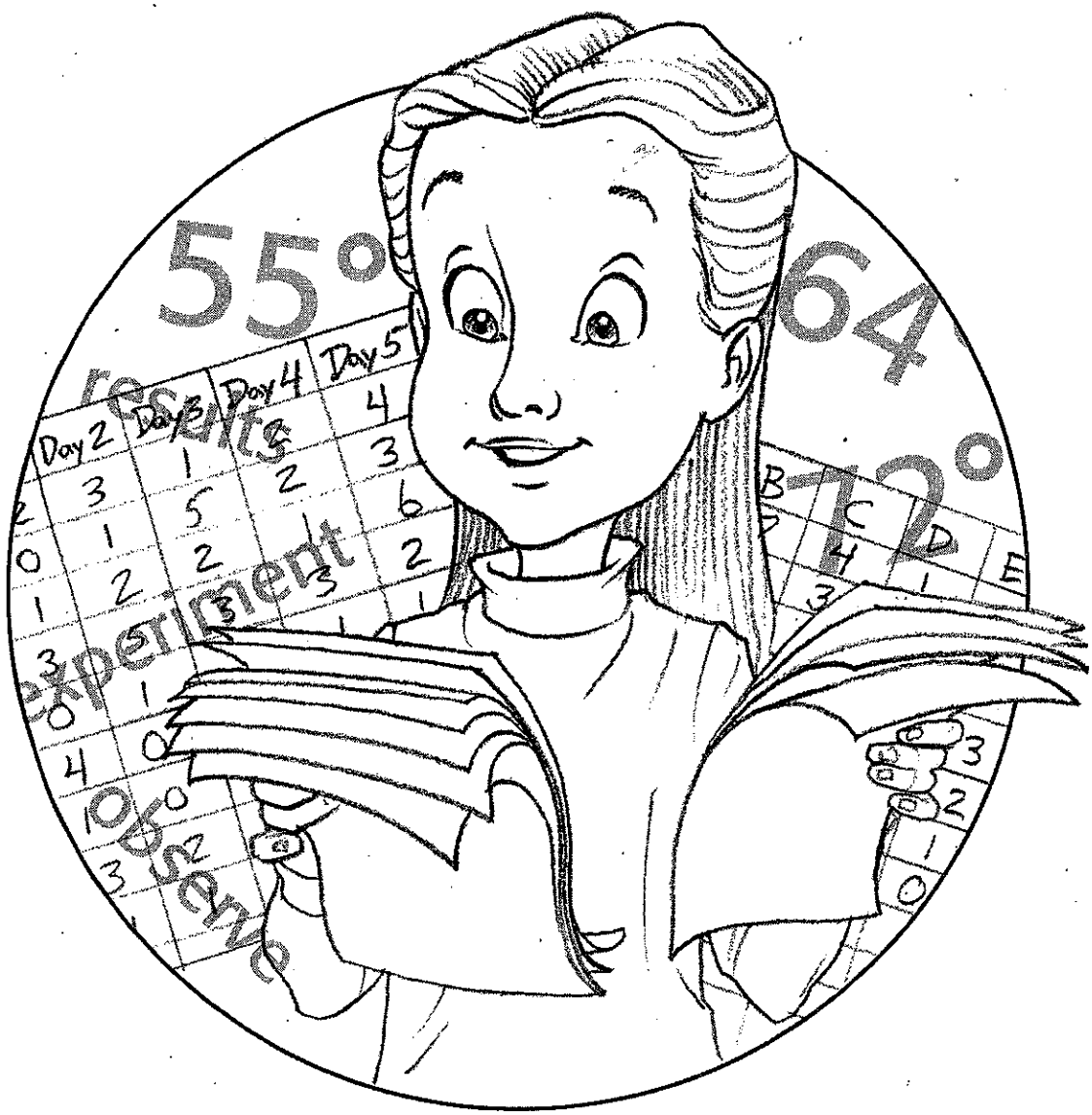
It is finally time to put your procedure into action! Remember to stick to your procedure, and try not to get distracted. (Experimenting can be so much fun that you may be tempted to keep on trying new

6 Write It Down

Recording Your Observations

7 Get It All Together

Organizing Your Data



Stay Cool

Name: _____ **Date:** _____

Suppose your friend conducted an experiment to find out what type of container keeps ice cream from melting longest. Below is your friend's data table. Look at the data to answer the questions that follow.

THE EFFECT OF CONTAINER TYPE
ON ICE CREAM'S MELTING TIME

Type of Container	**Melting Time** (in minutes)			
	Trial 1	Trial 2	Trial 3	Average
Paper	60	58	62	60
Plastic	47	54	52	51
Styrofoam	77	75	73	75

Questions:

1. How many trials for each type of cup did your friend conduct?

_____

2. What was your friend's *independent variable,* or the detail that was changed on purpose?

_____

3. What was your friend's *dependent variable,* or the variable that changed in response to a change in the independent variable?

_____

4. On average, in which cup did the ice cream melt fastest?

_____

5. What can you conclude from your friend's results?

_____

_____

8 Pick up the Pieces

The Research Paper

"How Does Acid Rain Affect Plants?"

Materials

9 pots
tomato seeds
potting soil
distilled white vinegar
purified water
2 jars
pH test strips
measuring cup for watering
marker for labeling pots
metric ruler

"How Does Acid Rain Affect Plants?"

Procedure

Step 1: *Plant nine tomato seeds in nine pots of soil.*

Step 2: *Give each potted plant one of the following labels: "Control 1," "Control 2," "Control 3," "Acidic 1," "Acidic 2," "Acidic 3," "Very Acidic 1," "Very Acidic 2," "Very Acidic 3."*

Step 3: *In a jar, mix some vinegar with purified water. Use pH strips to test the acidity. Continue to add vinegar until the pH equals 4.5. Label this jar "Acidic."*

Step 4: *In another jar, mix more vinegar with purified water. Use pH strips to test the acidity. Continue to add vinegar until the pH equals 4.0. Label this jar "Very Acidic."*

Step 5: *Water plants in each group using the frequency and amount recommended by a local nursery or plant guide. Be sure to give each plant the same amount of water. Water plants in the control group with purified water (pH ~7.0). Water plants in the acidic group with water from the "Acidic" jar (pH 4.5), and plants in the very acidic group with water from the "Very Acidic" jar (pH 4.0).*

Step 6: *Using a metric ruler, measure each plant's height from the soil to the top of the plant on Day 10, and then every five days after that.*

Step 7: *Also record observations of the color and character of the stalk and leaves for each plant.*

Results

After the procedure, you can write the **results.** First, describe your observations, then state the measurements you used to determine your results.

You can copy the tables from your logbook and put them in this section of the paper. Add a copy of the graphs you made, and the paper is almost finished! These last two items will also appear on your backboard or display, but it's still a good idea to include them in your paper. This makes a complete record of all you have done from start to finish.

Remember, it is okay when a project does not support or prove the hypothesis. Some experiments do not turn out the way you expect them to. The most important part is that you followed the scientific method, and you are following it again now in your paper.

Conclusions

In the last part of your paper, state the **conclusions** you formed because of your experiment. Explain why you think the results of your experiment proved (supported) your hypothesis or rejected it.

Be sure to restate your hypothesis in the conclusion. And remember that it's okay when a project does not prove or support the hypothesis. Some experiments do not turn out the way you expect them to. The most important part is that you followed the scientific method.

The Bibliography

Next, you need to include your sources of background information. Remember that, on the backs of the index cards, you wrote down the name of every author and book or magazine article that you consulted. Now you need to do something with that information. You're going to write a bibliography for your paper.

The items in a bibliography are always in alphabetical order according to the author's last name. Go back to your index cards, sort through them, and put them in that order. (See Chapter 3 for samples of how to write the information for the bibliography.)

When you have written the bibliography, you are done with the paper. Give yourself a pat on the back.

Finishing Touches

Writing the paper is often the hardest part of the project, and you're done with that. Congratulations! You've finished the basics of your paper. But there's still a little more to do.

9 Show It Off

The Backboard

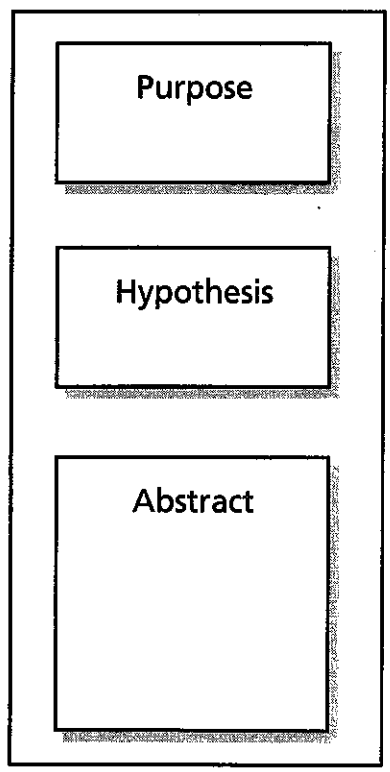
paper cutter. Be very careful. You may want to ask an adult to help you with this step.

Cut each mat to the size listed on the chart. If you want to mat your abstract, for example, hand-write or print a copy. Using a glue stick, put glue on the back of the paper and attach it to the mat. Be sure the paper is centered and wrinkle-free. Then, with double-sided tape, tape the mat to the backboard in the spot you've marked for the abstract. Prepare all of the single-sheet pages the same way and attach them to the board.

What Goes Where

Your teacher may suggest the layout of the board, or you can use these guidelines. Three items go on the left side of the board: the purpose, the hypothesis, and the abstract. First, measure from the bottom of the board going up, and with a pencil, mark a space for the abstract. It should be placed at least half an inch up from the bottom of the panel. However, don't stick anything on yet.

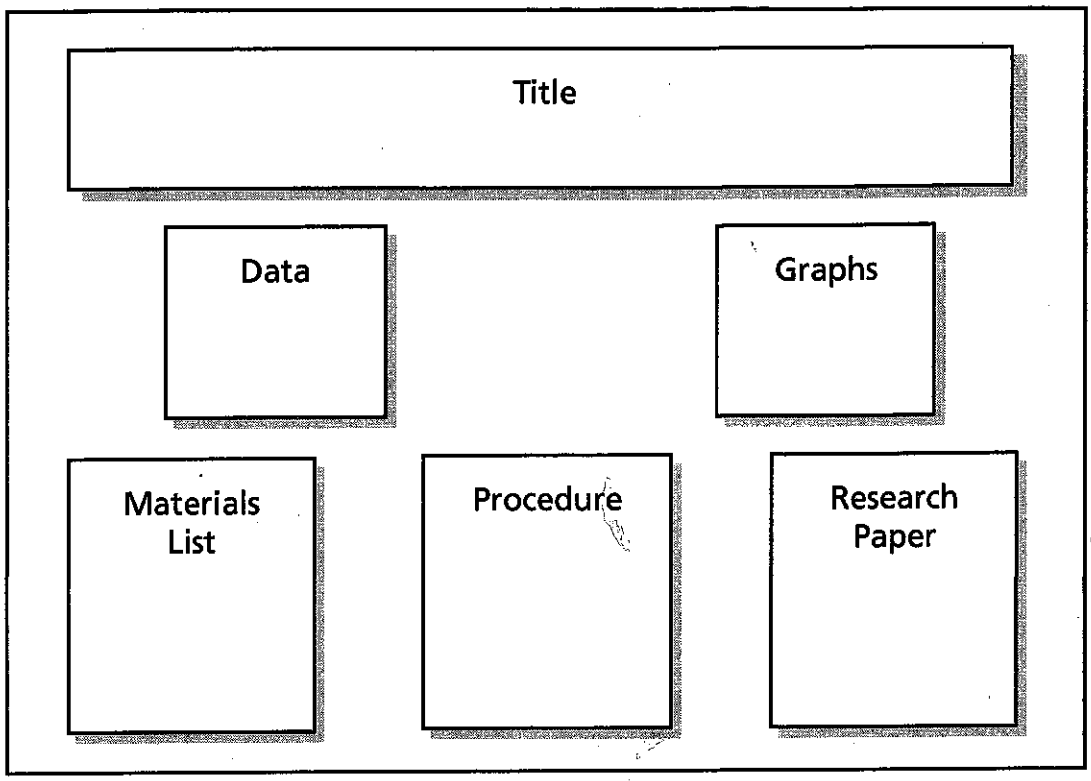
The remaining space on that panel can be divided in half for the purpose and the hypothesis. Measure and mark the space for those two items, giving them equal space. The purpose should be at least half an inch down from the top. Your first panel should look like this.



Left-hand panel of the backboard.

Now it's time to do the center panel. Make the space for the title of your project first. You may use vinyl stick-on letters to make the title stand out and attract the eye of the judge. Make sure the letters are not too bright or hard to read. For example, yellow letters on a white background are very hard to read. A dark mat behind the title makes it easier to read and looks attractive. Or you may print the title on paper. Make the letters larger than the type or printing you are using for the papers so that it can be easily read at a distance. Mount the title on a mat.

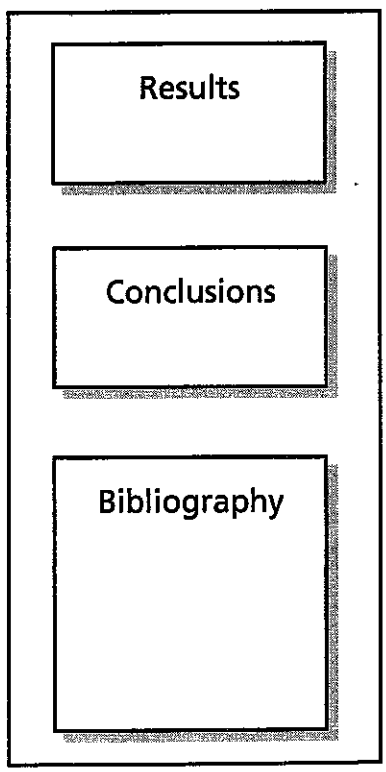
Place the title between half an inch and one inch down from the top of the board. Below the title you will need to make spaces for your data, any graphs, your materials list, the procedure,



Center panel of the backboard.

and your research paper. Here's how the center panel might look. Yours may look a little different, depending on what elements you have.

Design the right-hand panel the same as the left side, marking spaces for the results, conclusions, and bibliography.



Right-hand panel of the backboard.

Titles

If you are using mats you don't need separate titles for each section. Just type the title (Purpose, Hypothesis, Abstract, etc.) on the paper above the text. Remember to use a larger font than the text so that it is easily read at a distance.

If you are not using mats, you may want to use special lettering for the titles of each section. Vinyl stick-on lettering looks nice, but can be expensive and you must have a very steady hand to put the letters on straight and even. If you do use them, be

Judging Rubric

Name of Project: _____

Grade: _____

Student Name(s): _____

_____

Teacher: _____

How the points work:

4 points = Excellent
3 points = Good
2 points = Acceptable
1 point = Needs Work

1. Shares understanding of the scientific method through oral presentation

points	
4	Discusses the six main parts of the scientific method: hypothesis, variables, materials, procedure, data, and conclusions.
3	Discusses four or five parts of the scientific method.
2	Discusses two or three parts of the scientific method.
1	Does not seem to understand the scientific method.

2. Shows use of the scientific method through the backboard

points	
4	Clearly and neatly labels and displays the scientific method on the backboard.
3	Displays the scientific method on the backboard.
2	Has some steps to the scientific method on the backboard.
1	Lacks steps to the scientific method on the backboard.

3. Speaks knowledgeably about the project

points	
4	Shares many details of the project with the judge.
3	Shows clear understanding of the project.
2	Knows what the project is, but gives little explanation.
1	Tries to answer questions from the judge.

4. Presents data using well-organized tables, graphs, and charts

points	
4	Tables, graphs, and charts accurately and neatly display data.
3	Tables, graphs, and charts accurately display data.
2	Some tables, graphs, and charts are included on the board.
1	Lacks tables, graphs, and charts.

5. Shows enthusiasm and interest in the project

points	
4	Shows genuine enthusiasm for and interest in the topic. Offers suggestions for further investigation.
3	Shows genuine enthusiasm for and interest in the topic.
2	Seems interested in the project.
1	Does not seem to care about the project.

Points: _____ /20

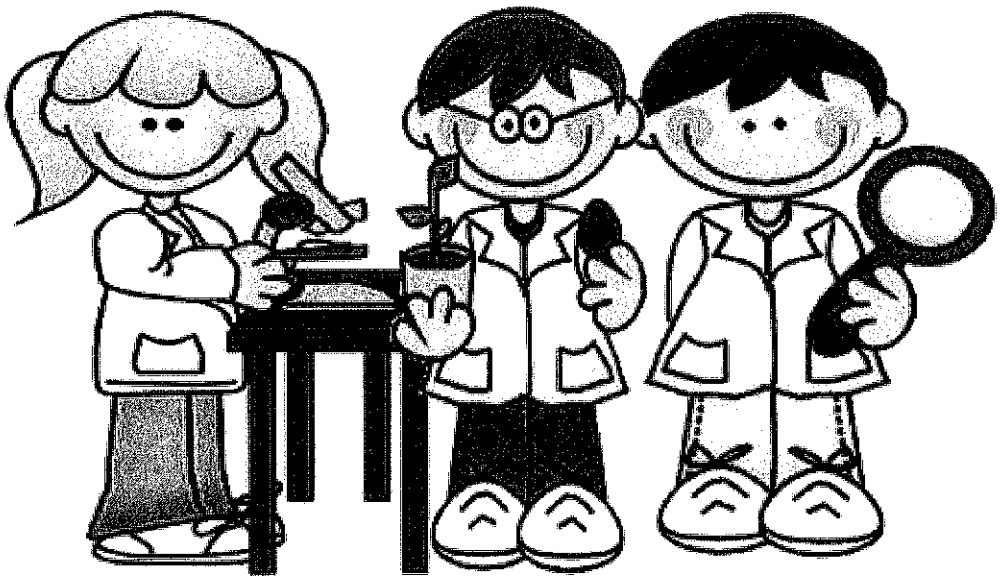
Comments: _____

_____

_____

_____'s

Science Notebook



Draft

Draft

STUDENT PAGE

KEEPING A JOURNAL

My Science Journal

(Worksheet 1)

Name: _____ **Date:** _____

Use the following worksheets to stay organized.

Project Topic:

_____

Project Title:

_____

1. My Question

The question I plan to answer with my experiment is: _____

_____

2. My Purpose

Rewrite your question to complete the following sentence. The purpose of my experiment is to:

_____

3. My Variables

My *independent variable,* or the one thing I plan to change, is:

_____

My *dependent variable,* or the change I will measure, is:

_____

My *controlled variables,* or the things I will keep the same, are:

_____

4. My Research

Go to the library, perform Internet research, or interview an expert to gather information about your topic. Keep notes on your findings. List your resources on the back of this page.

5. My Hypothesis

A *hypothesis* is a possible answer to a research question. Reread your question in Step 1. Based on my research, my hypothesis is:

_____

My hypothesis is based on these facts that I gathered during my research:

_____

My Science Journal

(Worksheet 2)

Name: _____ **Date:** _____

6. My Procedure

Materials:

Procedure Steps:

My Science Journal

(Worksheet 3)

Name: _____ **Date:** _____

7. My Data

(You may not need all of the rows in this data table. If you need more rows, ask your teacher for a second copy of this worksheet. If this data table doesn't seem right for your project, ask your teacher for help.)

Independent Variable (Describe the thing that you will change in your experiment)	Dependent Variable			
	Trial 1	Trial 2	Trial 3	Average (Add the three numbers from your trials. Then divide by three.)

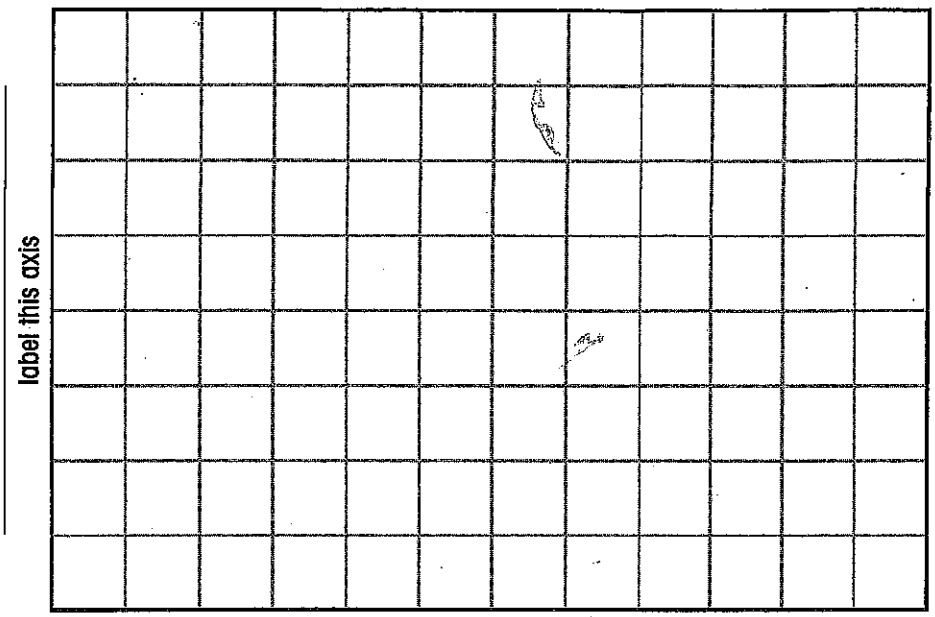
My Science Journal

(Worksheet 4)

Name: _____ **Date:** _____

8. Graph of My Data (If you have more than one graph, ask your teacher for a second copy of this worksheet.)

TITLE: _____



9. My Conclusions (What did you learn from your experiment results? Does your conclusion support your hypothesis? If not, based on your results, what would be your new hypothesis?)

_____

_____

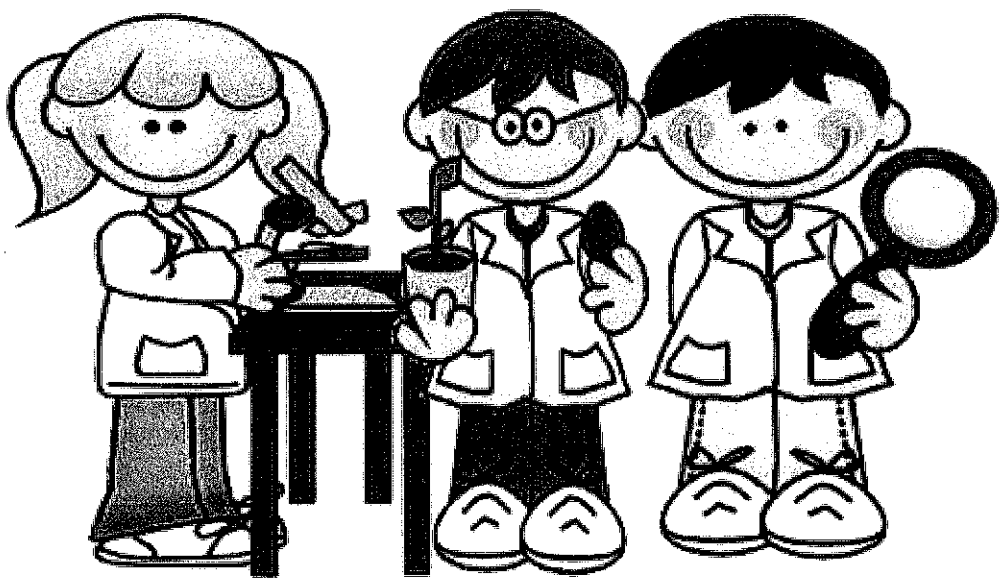
_____

_____

_____

_____'s

Science Notebook



Final

Final copy

STUDENT PAGE

KEEPING A JOURNAL

My Science Journal

(Worksheet 1)

Name: _____ **Date:** _____

Use the following worksheets to stay organized.

Project Topic:

_____

Project Title:

_____

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My hypothesis is based on these facts that I gathered during my research:

_____

My Science Journal

(Worksheet 2)

Name: _____ **Date:** _____

6. My Procedure

Materials:

Procedure Steps:

My Science Journal

(Worksheet 3)

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	Trial 1	Trial 2	Trial 3	Average (Add the three numbers from your trials. Then divide by three.)

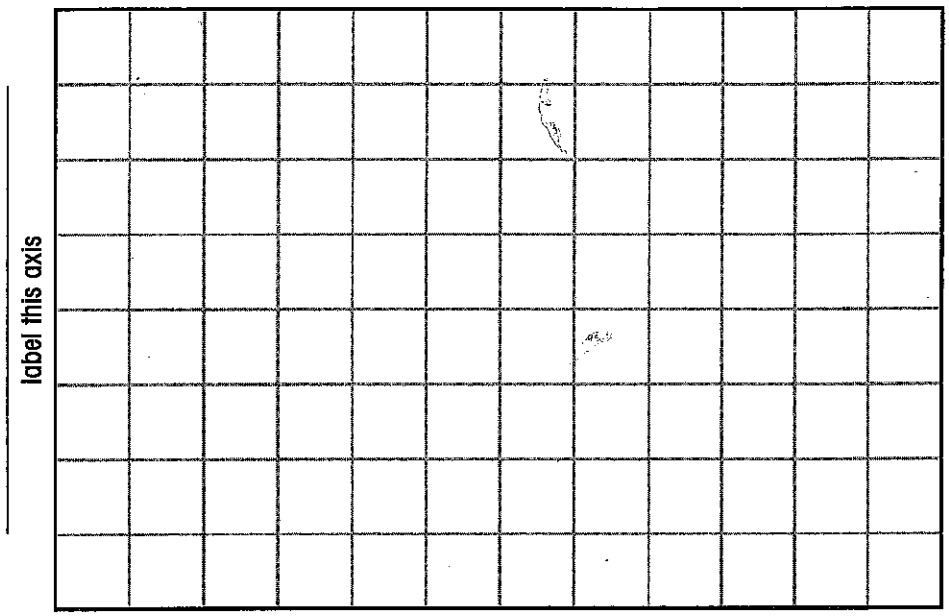
My Science Journal

(Worksheet 4)

Name: _____ **Date:** _____

8. Graph of My Data (If you have more than one graph, ask your teacher for a second copy of this worksheet.)

TITLE: _____



9. My Conclusions (What did you learn from your experiment results? Does your conclusion support your hypothesis? If not, based on your results, what would be your new hypothesis?)

_____

_____

_____

_____

_____