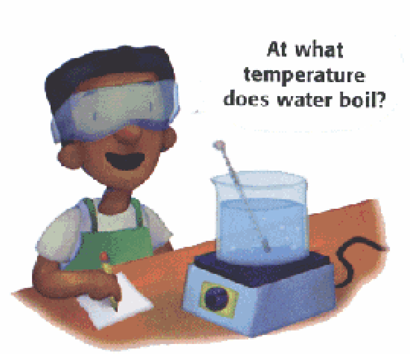
Asking Questions

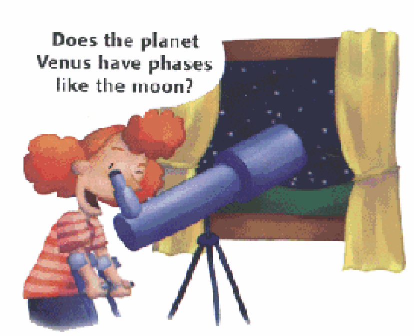
Not all questions are scientific questions

This is not a scientific question because "big" and "small" mean different things to different people.

This is a scientific question because you can measure the depth of the puddlet

Different kinds of scientific questions require different kinds of investigations.



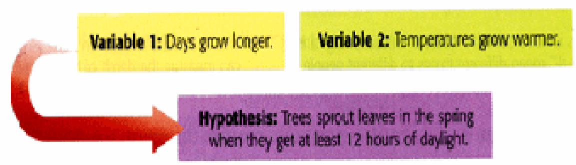


To find the answer to this question, you would need a thermometer, some water, a heatproof container,and a source of heat. You also need to wear safety goggles. The investigation might take only 5 minutes.

To answer this question, you would need a telescope and a notebook or calendar for recording your observations. You would need to observe Venus for several months.

Making a Hypothesis

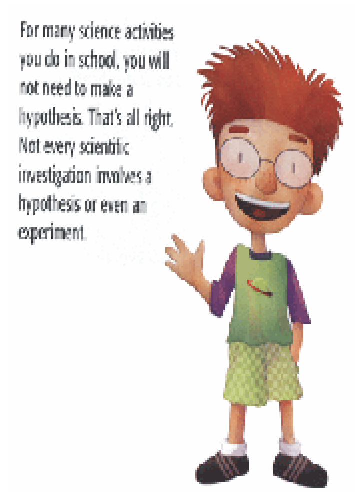
Hypothesis: Trees sprout leaves in the spring when they get at least 12 hours of daylight



Once you have decided on a question you want to answer, you need to come up with a hypothesis. A hypothesis is an idea that can be tested by an experiment or an observation. Here's an example of how you might come up with a hypothesis

You know that the trees in your neighborhood sprout new leaves every spring. You ask yourself, "What makes trees sprout leaves in the spring?" Based on your experience, you think of two changes that occur in the spring. Days become longer in the spring, and temperatures become warmer. You decide to investigate "days become longer." Then you write a hypothesis that you can test.

Your hypothesis is testable. You can shine light on different indoor trees for different amounts of time and see which tree sprouted leaves first.



Planning the Investigation

Before you go on an outing, you plan what you will need and what you will do. That way, your outing will go smoothly. Different outings require different equipment and supplies.

Careful planning makes an investigation run smoothly.

The same is true for a science investigation. Different science investigations require different tools and equipment. Different investigations also have different steps. What you are trying to answer

For example, should you do your investigation indoors or outdoors? If you are studying changes in the population of robins in your neighborhood, you will work outdoors. If you want to find out what causes a bottle of cold soda to suddenly fizz when you twist off its cap, you will probably work indoors.

Before you begin your investigation, list the steps you will follow. Important steps are listed here. You might want to add more steps, too.

1.Learn as much as you can about the topic of your investigation. Also learn about similar investigations that other people have done

2. Decide what equipment you will need for your investigation and where you can get it.

3. Ask your teacher for help or advice.

4. Find out whether there is anything dangerous in your investigation. Find out how you can do the investigation safely.

Controlling Variables

Hypothesis: Trees sprout leaves in the spring when they get at least 12 hours of daylight

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Many things , or factors, might make one tree sprout leave sooner or later than another tree. The amount of water that the trees receive might make a difference. Changes in temperature might make a difference, too. These factors are called variables. A variable is any factor that can change in an experiment.

Tree A: 12 hours of light each day

Tree B: 10 hours of light each day

Imagine that in your experiment, you give your trees different amounts of water and you expose them to different amounts of light and you keep them at different temperatures.

Suppose that Tree A sprouted leaves before Tree B. How can you tell which variable made Tree A sprout leaves first? You can't tell because you don't know which variable caused the earlier sprouting.

In every experiment, you have to keep all the variables the same except the one you are testing.

In this experiment, all the variables except light are controlled. Both trees get the same amount of water. Both trees are kept at the same temperature. Only the amount of light hitting the trees is different. What caused Tree A to sprout leaves earlier than Tree B? More light!

Collecting Materials

Many investigation require materials. The materials might be special tools, such as a microscope, or just paper and pencil.

You will need to collect different kinds of materials for different investigations. You will also need to know where you can get the materials

To investigate the structure of a leaf, you will need a magnifier. If you want to record your observations in a drawing, you will also need paper and colored pencils, markers, or crayons.

How many breaths do you take in one minutes?

To find out how many breaths you take in a minute, you will need a stopwatch or a watch with a second hand. You will also need paper and a pencil to record the count.

To measure the weight of an apple, you will need an apple and a small scale. You will also need paper and a pencil to record the measurements.

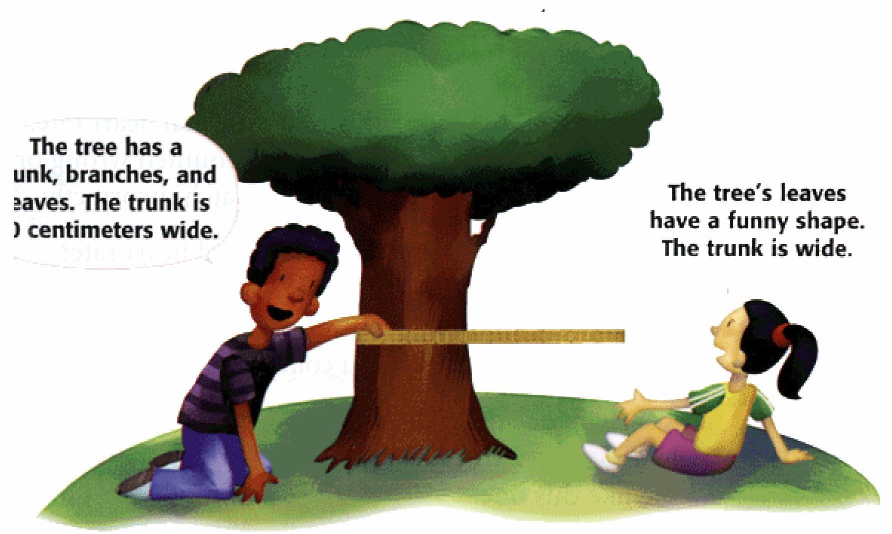
Collecting & Recording Data

Data	Tools Used
weight and length of kitten	scale, tape measure
features on the moon's surface	binoculars or telescope
speed of crawling ant	ruler, stopwatch
temperature	thermometer

Every investigation gives you information. The pieces of information collected in an investigation are called data. There are may kinds of data. Some data are simple observations. Other data are measurements.

Making Scientific Observations

Scientists are trained observers. What is a scientific observation? It's an observation that anyone can make and the result will always be the same. What's an unscientific observation? It's an observation that not everyone would agree on.



These are scientific observations. Everyone who looks at the tree can see that it has a trunk, branches, and leaves. Everyone who measures the trunk would get the same results.

These are not scientific observations because "a funny shape" and "wide" means diferent things to different people.

Many tools can be used to collect data that everyone agreess on. What's your normal body temperature? A thermometer can tell you. What's the structure of a strand of your hair? Look through a magnifier or a microscopic, and you will find the answer. What's the weight of a brick? A scale will give you the answer. Could you just say a brick was heavy? Yes, but that would not be a scientific observation. The word "heavy" means different things to different people.

Repeating Trials

Suppse you want to find the normal heart rate of your friend Roxanne. Heart rate is the number of times a heart beats in one minute.

You can feel heartbeats if you hold your fingers on the side of your neck or the inside of your wrist. The beats you feel are called your pulse.

You take Roxanne's pulse and count 92 beats in one minute. But you can't say for sure that this is her normal heart rate. Maybe you counted wrong or read your watch incorrectly.

Roxanne's average heart rate was 91. An average of the trials gives you a more accurate idea of Roxanne's heart rate than the results of any single trial. (See data chart below)

How can you be sure of Roxanne's normal heart rate? You can do more trials. A trial is a repeat of a test or an observation. The more trials you do, the more you can trust the data that you collect.

Suppose you decide to do six trials. You record the data in a table like this one.

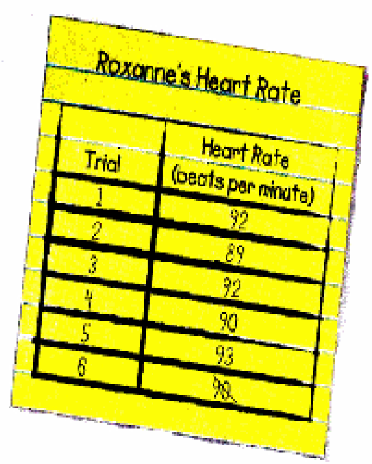
The six trials tell you that Roxanne's normal heart rate falls in a range between 89 and 93 beats per minute.

You can also find Roxanne's average heart rate. First, add the heart rates you found in each trial.

$$92+89+92+90+93+90=546$$

Then divide by the numbers of trials

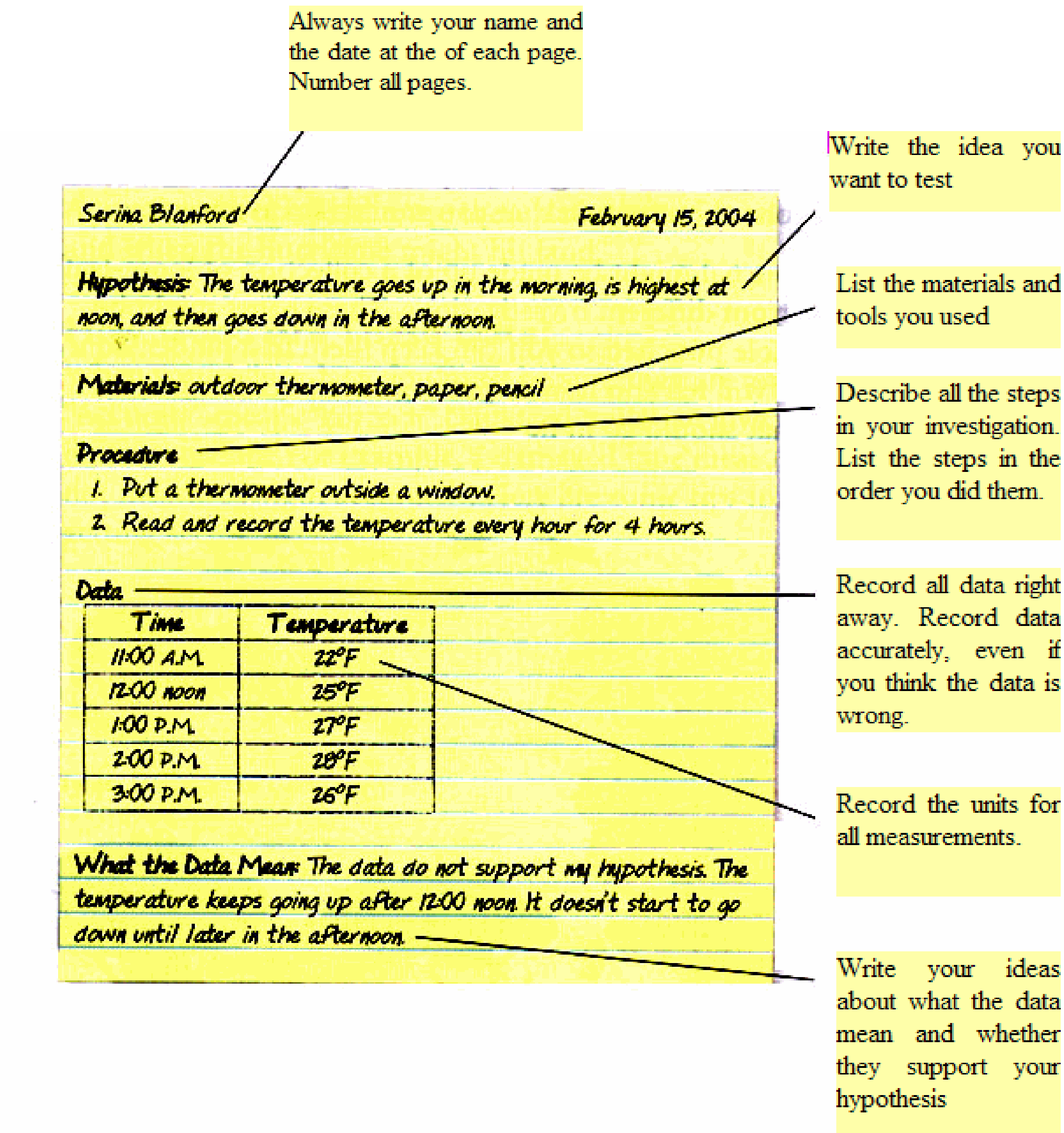
546 divided by 6 equals 91



Roxanne's Heart Rate

Trial	Heart Rate (beats per minute)
1	92
2	89
3	92
4	90
5	93
6	90

Scientists keep careful records of their investigations. So should you. This page shows what a careful record should look like.



Science Alert!!!!!

Never cross out and change data so that your results come out the way you think they should. Remember, you are trying to answer a question. Don't decide on the answer before you finish the investigation.

Keeping a Journal

A science journal is a kind of science diary. It's a place to record what you have done in science over a long period of time. It's also a place to jot down notes about what you would like to do in the future. You can also write down day-to-day observations that you are curious about. These observations might lead you to ask yourself questions about nature that you would like to answer.

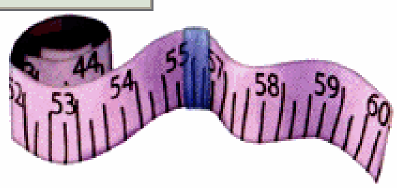
Your journal might be made up of a collection of loose-leaf pages from different investigations. These pages might be three-hole punched so you can keep them in a binder. Your teacher will tell you how to put together a science journal and what should go in it.

After you collect data, you need to look at them and ask yourself,"What do the data tell me?"

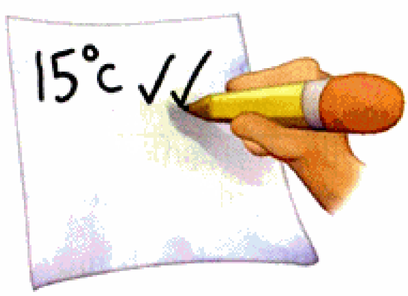
For example, a weather forecaster mght collect data about a hurricane. The data might include where the hurricane is, how fast it is moving, and in which direction it is moving. A weather forecaster can use these data to predict where and when the hurricane might hit land.

How Good Are These Data?

When you collect data, you must be sure they are accurate. "Accurate" means "correct." Damaged tools can give you inaccurate data. For example, a damaged tape measure may not measure length accurately. Here are some tips for getting accurate data.



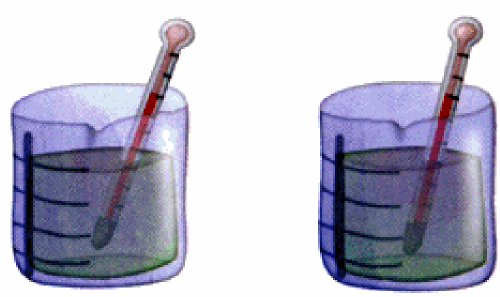
Tools: Tools that don't work well can produce bad data.



Record: Record your data right away. If you wait until later, you might forget what you observed.

Double-Check: Double-check all your measurements.

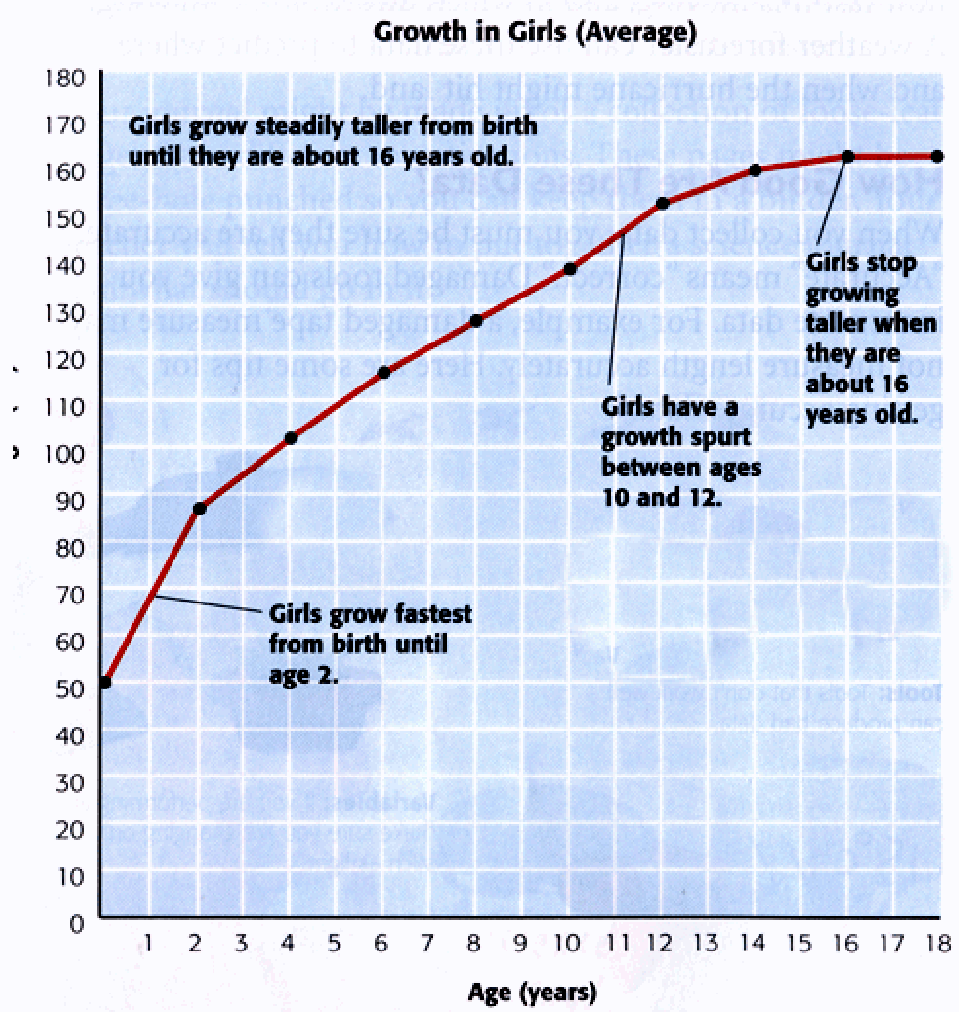
Variables: If you are performing an experiment, make sure you are changing only one variable, such as light.



Trials: Repeat the investigation.

Looking for Patterns in Data

Once you have collected your data, you can look for patterns that will give you new information. For example, humans usually get taller as they grow from a child to an adult. Look at the graph below. It shows the average height of girls from birth until age 18.



You can find patterns in other kinds of data, too. For example, as days pass, the lighted part of the moon changes shape in the same pattern every month. Scientists used this repeating pattern of data to figure out how the moon moves in space.

Comparing Your Data With Your Hypothesis

Data are often collected to test a hypothesis. A hypothesis could be a simple statement like this.

Fruit grows from flowers

Suppose you perform an investigation to test this hypothesis. You examine flowers on an apple tree every two weeks. You make drawings to record your observations. The observations are your data.

If your data do not support your hypothesis check for errors in your experiment. If you do not find any errors, your hypothesis was incorrect.

At the end of your investigation, you study your data. You ask yourself, "Do the data support my hypothesis?" Your drawings show that an apple formed where a flower once bloomed. The data that you collected support your hypothesis.

If your drawings showed that apples do not grow from flowers, the data you collected would not support your hypothesis. This result might lead you to perform another investigation to find out where apples come from.

Making Predictions

The observations you make and the data you collect in an investigation might lead you to make a prediction. A prediction is an idea about what will happen in the future.

Here's an example of a prediction. Imagine that it is the last week of school before summer vacation. You getup before dawn and check your clock just as the sun rises.. The time is 5:20 a.m. On Tuesday, you discover that the sun rises at 5:19 a.m. On Wednesday, the sun rises at 5:18 a.m. You go to school and tell the class, "I predict that the sun will rise at 5:15 a.m. on Saturday."

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
15	sunrise 5:20 A.M. 16	sunrise 5:19 A.M. 17	sunrise 5:18 A.M. 18	19	20	Prediction: sunrise 5:15 A.M. 21

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
15	sunrise 5:20 A.M. 16	sunrise 5:19 A.M. 17	sunrise 5:18 A.M. 18	19	20	Prediction: sunrise 5:15 A.M. 21

Your prediction is based on observations you made and data you collected for three days in a row. You noticed a pattern. The sun rose one minute earlier each day. Saturday is three days after Wednesday. So the sun should rise three minutes earlier on Saturday than on Wednesday. You do some simple arithmetic: 5:18 A.M. minus 3 minutes equals 5:15 A.M.

Sharing Results

One person's discoveries can lead to new discoveries by other people. But this can only happen if people share their results.

When a scientist shares the results of an experiement, other scientists can check the results by repeating the experiment. If many people get the same results, everyone can be pretty sure the results are correct.

You can share the results of your experiments by doing these things:

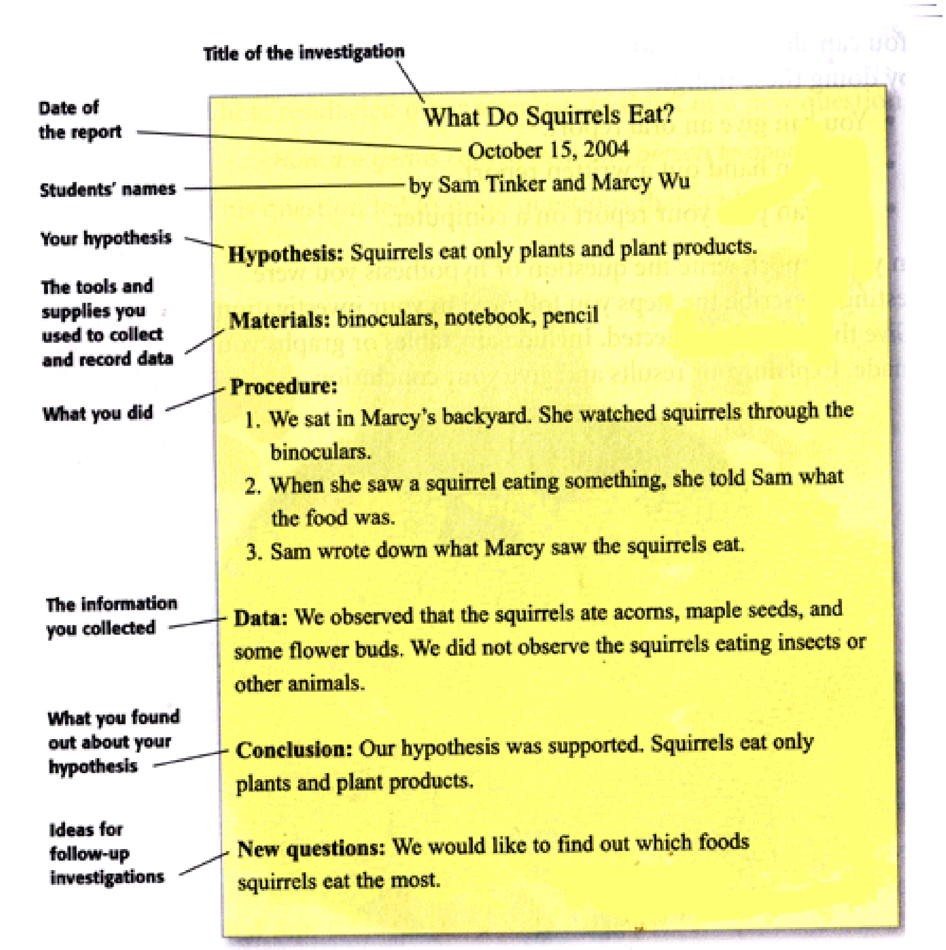
1. **You can give an oral report**
2. **You can hand out a written report**
3. **You can post your report on a computer**

In your report, write the question or hypothesis ou were testing. Describe the steps you followed in your investigation. Give the data you collected. Include any tables or graphs you made. Explain your results and give your conclusions.

Sample Report #1

The best way to share your work is to write a report that describes what you did and what you found out. Writing a report can be helpful to you, too. It may help you find errors in your work. It may also lead you to ask new questions. These questions might spark new investigations.

Here is a good way to set up a written report



What Do Squirrels Eat?
October 15, 2004
by Sam Tinker and Marcy Wu

Hypothesis: Squirrels eat only plants and plant products.

Materials: binoculars, notebook, pencil

Procedure:

1. We sat in Marcy's backyard. She watched squirrels through the binoculars.
2. When she saw a squirrel eating something, she told Sam what the food was.
3. Sam wrote down what Marcy saw the squirrels eat.

Data: We observed that the squirrels ate acorns, maple seeds, and some flower buds. We did not observe the squirrels eating insects or other animals.

Conclusion: Our hypothesis was supported. Squirrels eat only plants and plant products.

New questions: We would like to find out which foods squirrels eat the most.

Sample Report #2

Phases of the Moon

by Serena and Dustin

Questions: What is the order of the moon's main phases? How far apart do they occur? How long before they repeat?

Materials: astronomy book, large calendar, drawing pencils

Procedure: We looked for the moon twice a week. Using an astronomy book, we identified the four main phases of the moon. They are first quarter, full moon, last quarter, and new moon. A new moon is invisible because its bright side faces away from Earth. We started our investigation on November 1, 2003. On that day the moon was in its first quarter phase. We observed the moon until the next first quarter phase. On a calendar, we drew pictures of each phase on the date it appeared. On some nights, we didn't see the moon because the sky was cloudy. On November 23rd, the sky was clear but we didn't see the moon because it was a new moon.

Data: This calendar page shows what we observed.

November 2003

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri	Sat
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23 / 30	24	25	26	27	28	29

Explanation of Results: Our observations show that the phases of the moon happen in a repeated pattern.

Conclusions: The four main phases of the moon occur in this order: full moon, last quarter, new moon, first quarter, and full moon again. The time between any two phases is 7 or 8 days. The phases repeat about every 29 days.

New Questions: We would like to investigate the cause of the moon's phases.

Sample Report #3

Does Activity Change Your Heart Rate?

by Tanika, Chu, Gloria, and Richard

Hypothesis: The more active you are, the faster your heart beats.

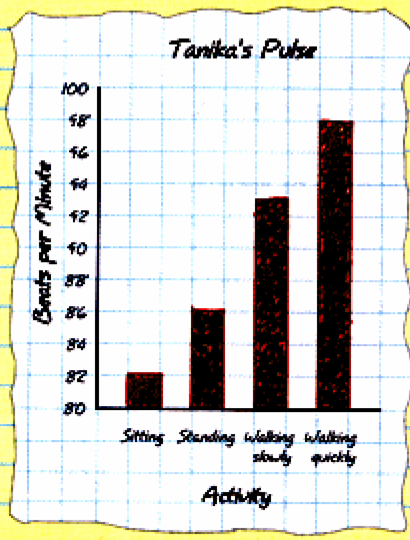
Materials: watch with second hand, graph paper, pencil

Procedure: We took Tanika's pulse while she was sitting. We then took it while she was standing. Then we took Tanika's pulse right after she walked slowly down a hallway. Then we took her pulse right after she walked quickly down the hallway.

Data: We organized the data in a table.

Activity	Heart Rate (beats per minute)
Sitting	82
Standing	86
Walking slowly	93
Walking quickly	98

We used the data to make a graph. The slowest heart rate was 82, so we labeled the vertical axis starting at 80.



Explanation of Results: Tanika's heart rate was faster when she was more active.

Conclusion: The data support our hypotheses. The more active you are, the faster your heart beats.

Sample Report #4

How Different Materials Absorb Sound

by Derek

Question: What materials absorb sound best?

Materials: CD player, music CD, bubble wrap, newspapers, aluminum foil, bathtowels, tape

Procedure: I set the volume dial to number 6 for all trials. I put a music CD in the player. For each test, I wrapped the player in one of the materials. In one test, I didn't wrap the player at all. All materials were about 2 cm thick around the player. I taped the materials in place. I left a little opening to turn on the player. In each test, I played the same song from the beginning. I then rated the sound as soft, medium, or loud.

Data: I recorded my results in this table.

Trial	Material	Rating
1	none	loud
2	bubble wrap	medium
3	aluminum foil	loud
4	bathtowels	soft
5	newspaper	medium

Explanation of Results: Aluminum foil and air are not good absorbers of sound. Paper and bubble wrap are better absorbers of sound. A fluffy material like bathtowels absorbs sound best.

Conclusion: In this investigation, towels absorbed sound best.

New Questions: I would like to find out if other materials, such as wood, rubber, and sand, absorb sound better than towels.