The Scientific Method

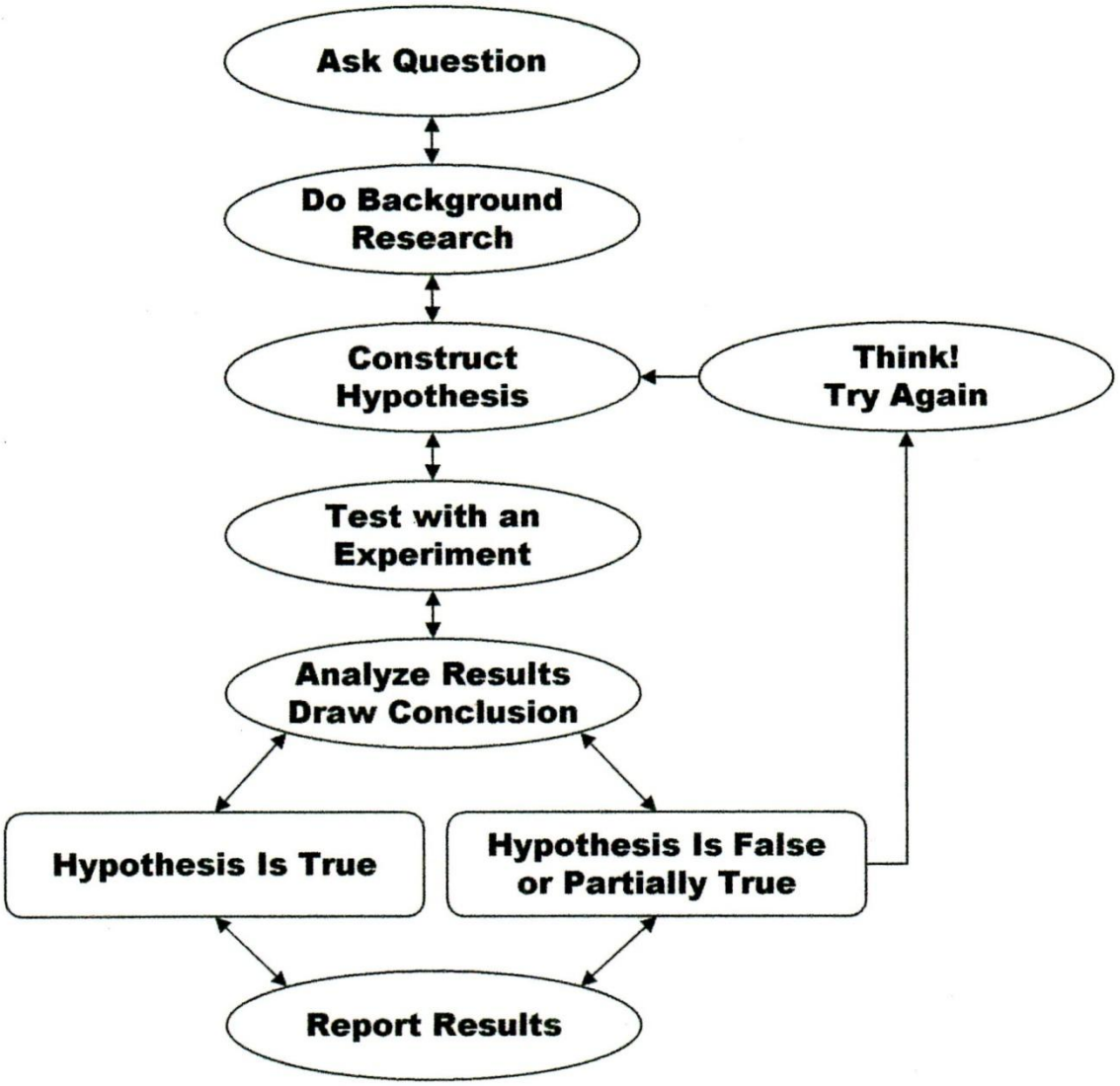
Scientific Enquiry

The Scientific Method is the foundation of all good science. It is a systematic way of answering questions in a manner that minimizes personal bias. The Scientific method has 6 components:

1. **Ask a question** about something you observe: how, what, when, who, which, why, or where? In order to answer your question you need to be able to measure something, preferably with a number (quantitative data).
2. **Background research or literature review**- this is where you learn from others who how have previously researched similar topics/questions.
3. **Development of a Hypothesis-** hypothesis is an educated guess about how things work: "If (I do this) then (this) will happen." You must state your hypothesis in a way that you can easily measure and answers the question you started with.
4. E**xperimentation**- your experiment tests whether your hypothesis is true or false. It is important for your experiment to be a fair test. You conduct a fair test by making sure you change only one factor (or variable) at a time while keeping all other conditions the same. Repeat your experiment several times to make sure that the first results weren't just an accident.
5. **Data analysis**- look at your data to see if your hypothesis is true or not. If your data does not support your hypothesis then go back to step three.
6. **Communicating your results**-this consists of your written report and presentation.

The Scientific Method

Even though this diagram shows the scientific method as a series of steps, keep in mind that new information or thinking might cause a scientist to back up and repeat steps at any point during the process. A process like the scientific method that involves such backing up and repeating is called an **iterative process**.



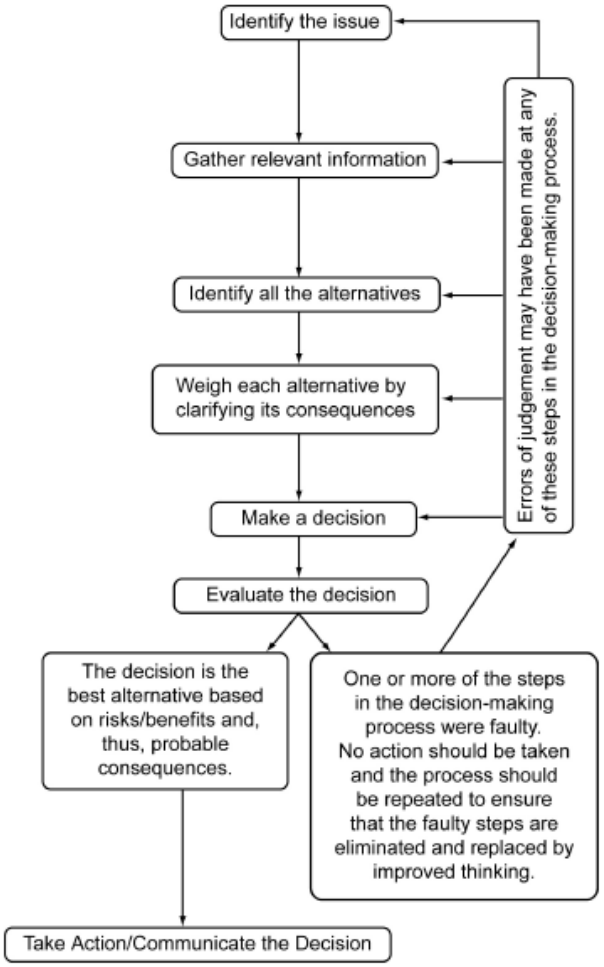
Making Decisions Flowchart

Goal • Become familiar with steps for making science decisions that affect people.

What to Do

- Follow the flowchart as you complete the outline for the issue you are considering.
- Answer the questions that follow.

Developing Decision-making Skills



- Identify the issue:

_____
_____
_____
_____

- Gather information:

_____
_____
_____
_____

- Identify possible choices:

_____
_____
_____
_____
_____

- List potential risks and benefits of each alternative:

_____
_____
_____
_____
_____

- List ways to communicate the decision:

_____
_____
_____
_____
_____

Questions

1. Expand each alternative in more detail.

2. If people are affected by the decision, explain who is affected and how.

3. If there is a possible effect on the environment, describe the effect.

4. How likely is it that each of the possible risks will cause harm?

5. How likely is it for each of the benefits to occur?

6. Explain how the decision can be evaluated.

Developing an Hypothesis

Goal • Become familiar with the development of hypotheses in science inquiry.

Think About It

In their inquiries, scientists investigate proposals they refer to as hypotheses. Hypotheses identify and discuss cause and effect.

What to Do

- Learn more about the hypothesis in science by reading the discussion on pages 463–464 in *BC Science 9*. Then do the activities below.

Questions

1. Define "hypothesis," giving an example you have learned from science.

_____

_____

2. An hypothesis statement may start with "if" (referring to cause), followed by the word "then" (referring to an effect). For example. ***If*** I brush my teeth twice a day, ***then*** I can protect my teeth from decay.

   Complete the following hypothesis statements:

   (a) **If** heat is applied to a liquid, **then** _____.

   (b) **If** _____,

   then in living things in that ecosystem will be affected.

3. (a) Identify the manipulated variable (cause) and the responding variable (effect).

   – The "if" part of each statement is the _____ variable.

   – The "then" part of each statement is the _____ variable.

   (b) Explain how the relationship between cause and effect can be an hypothesis.

_____

_____

4. Develop an hypothesis for what may happen in the following situations.

   (a) You have a long distance to travel when your gas needle signals empty.

   Hypothesis: _____

Reasoning: _____

(b) The element on top of your stove is a bright red colour.

Hypothesis: _____

Reasoning: _____

(c) The soup you are eating is much too salty.

Hypothesis: _____

Reasoning: _____

5. Complete the chart provided with your responses to question 4.

Manipulated Variable	Responding Variable	Hypothesis

Variables in Science

Goal • Learn about the difference between a manipulated variable and a responding variable.

Think About It

When doing investigations, scientists refer to a possible cause as a **manipulated variable.** A possible effect is referred to as a **responding variable.**

Cause and effect are closely related. As a result, any change to the manipulated variable results in a corresponding change to the responding variable.

What to Do

- Fill in the blanks in the chart so that the relationship between the cause and effect (or manipulated and responding variables) is clear.
- Answer the questions following the chart.

Manipulated Variable (possible cause)	Responding Variable (possible effect)	Explanation (reason for relationship)
1. As a student increases the hours spent studying,	_____	because studying prepares students for assignments.
2. As air temperatures decrease in fall,	the water in shallow ponds may _____	because
3. As you increase the shaking of a warm soft drink can,	the pop inside may _____	because
4. As you increase the pressure on a tube of toothpaste,	_____	because

5. (a) Explain what "responding" means.

_____

(b) How does this definition help you understand the relationship between cause and effect in a science investigation?

_____

_____

Constructing Line Graphs

Goal • Practise developing line graphs.

Follow these general guidelines when drawing graphs.

- Always include a title. Use the variables as a title, e.g., Effect of Amount of Light on Plant Growth.
- Always label the manipulated variable on the *x*-axis and the responding variable on the *y*-axis.
- If there are units, place them with the heading at the top of the column.
- Use marks on the axes to show which lines the scale numbers relate to.

Line Graphs

Use the following steps to construct line graphs from the data below.

1. Identify the manipulated and responding variable.
2. Draw and label the *x*- and *y*-axis on grid paper (remember to place the manipulated variable on the *x*-axis and the responding variable on the *y*-axis).
3. Give your graph a title.
4. Study the data in the chart and decide on a scale for the *x*- and *y*-axis. The scale will probably not be the same for each axis. When choosing your scale, remember that the graph should fit on one piece of graph paper and that it should be large enough to fill most of the page. Your scale must increase by regular amounts for the entire axis (i.e., increase by twos, by fives, by tens, etc.). Your scale need not start at zero if it is not suitable for your data.
5. Mark the scale on the axes. Make sure you have placed marks so that it is easy to see which line the scale number goes with.
6. Plot the points on the graph. Draw a small circle around each point. If you are plotting more than one set of data on the graph, use different shapes or colours to surround the points.
7. Do not draw a straight line from one point to the next. Doing this makes a broken line graph, which is rarely used in "real" science. Draw a smooth line through the points, as close to each point as you can. This is called a "line of best fit." This type of line shows the trend of the data. Graphs in science are used for showing relationships and for making predictions. The "line of best fit" serves both purposes.

Reading and Interpreting Graphs

Goal • Practise reading and interpreting various types of graphs.

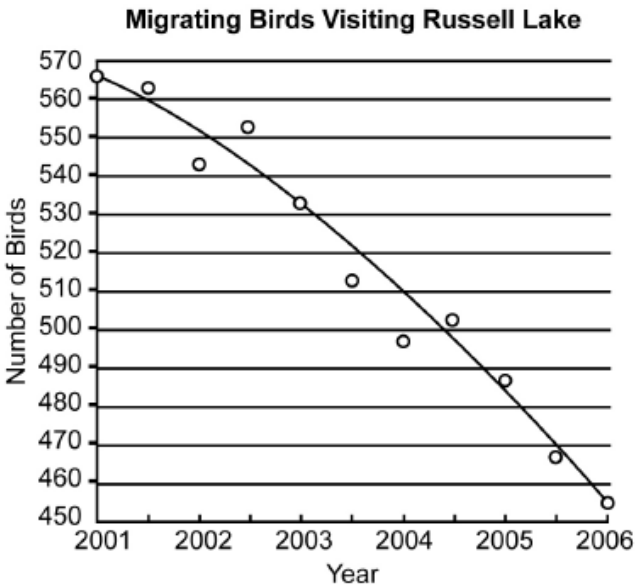
What to Do

- Use the graph to answer the questions that follow.

Part A Line Graphs

Single-Line Graph

A group of scientists has been studying the effect of urban development on the number of migrating birds that visit a local lake every year. The data they have collected are represented in the line graph below.



1. (a) How many migrating birds visited the lake in the first year of the study?_____
   (b) How many migrating birds visited the lake in 2004?_____
   (c) In what year did the fewest birds visit the lake?_____

2. Describe how the number of birds that visit the lake has changed over time.

   _____

3. Based on the information in the graph, what do you think we can expect to see happen to the number of birds visiting the lake over the next 10 years?

   _____

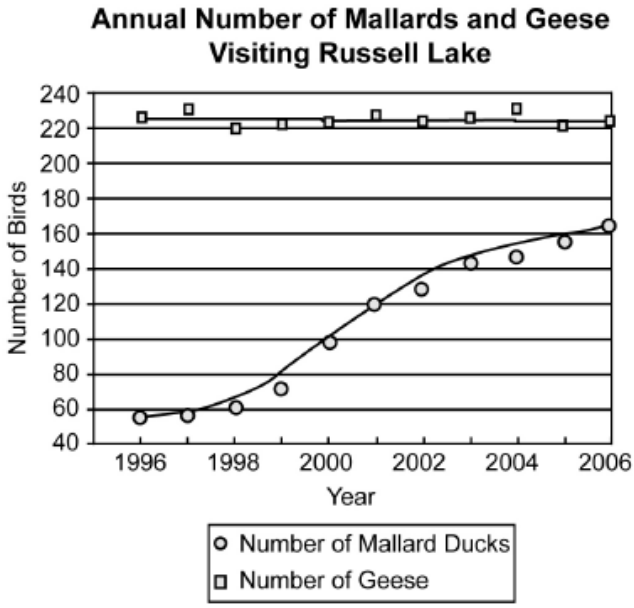
4. (a) What is the responding variable in the study? _____

   (b) What is the manipulated variable in the study? _____

Double-line Graph

A double line graph is used when you are working with two sets of data. Scientists have been recording data in an attempt to determine the effect of urban development on the number of mallards and geese visiting a local lake. The data that have been collected over a 11-year period are displayed in the chart and graph below.

Year	Number of Mallard Ducks	Number of Geese
1996	56	225
1997	58	230
1998	62	220
1999	72	222
2000	99	223
2001	120	227
2002	130	223
2003	142	225
2004	147	230
2005	156	221
2006	164	223



1. During which year was there the greatest difference between mallards and geese visiting Russell Lake? _____

2. How many more geese than mallards visited Russell Lake in 2002? _____

3. Describe the effect urban development has had on the number of geese visiting Russell Lake.

   _____

4. Describe the effect urban development has had on the number of mallards visiting Russell Lake.

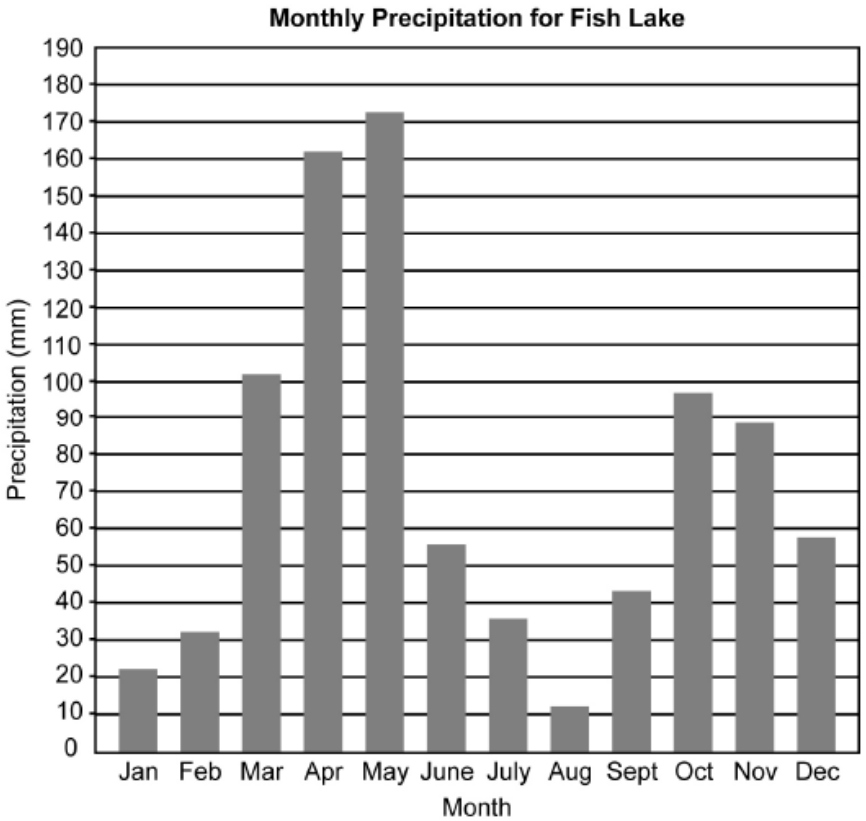
   _____

5. Based on the information in the graph, predict what will happen to the number of mallards and geese over the next few years.

   _____

Part B Bar Graphs

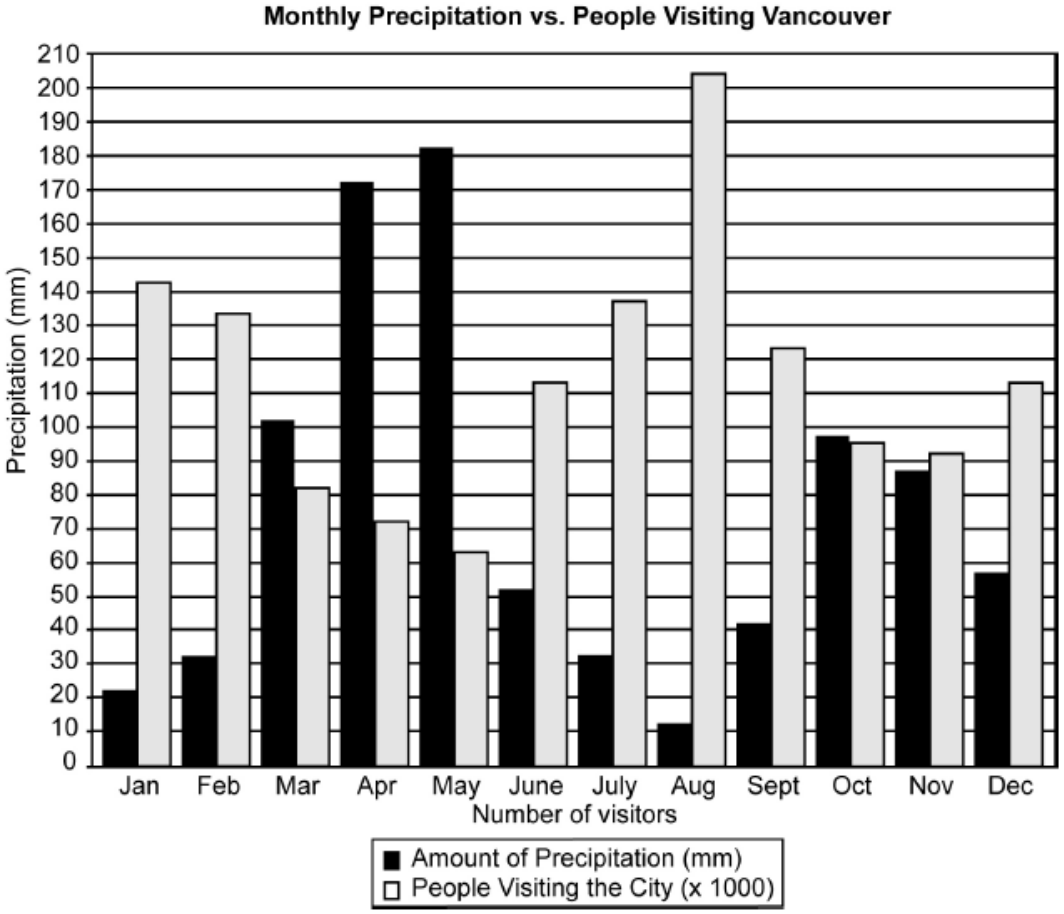
Like line graphs, bar graphs can be used to represent one set of data or several sets. A scientist has been studying the monthly rainfall (rain or snow) at Fish Lake. The data collected are represented in the bar graph below.



1. Which month had the greatest amount of precipitation?_____
2. Which month had the least amount of precipitation? _____
3. Which season had the greatest amount of *precipitation*?_____
4. What was the total precipitation for July? _____ For November?_____

Double–Bar Graph

A scientist has been comparing the monthly precipitation at the city of Vancouver, British Columbia, to the number of visitors to the city. The data collected are presented in the bar be graph below.



1. How many people visited Vancouver in: February? _____ August? _____
2. How much precipitation was there in January? _____ November?_____
3. In which month did the greatest number of people visit Vancouver?_____
4. In which month did the least number of people visit Vancouver? _____
5. Which month had the most precipitation? _____
6. Which month had the least amount of precipitation? _____
7. State the relationship that the graphs show between of the amount of precipitation and the number of people who visit Vancouver. _____

Claremont Science Fair 2012
Research Plan

What is the *question* you are going to try to answer with your experiment?

What are some key words and phrases from your question and about your topic in general?

Now use your keywords to build some questions to guide your background research.

School Databases found under E-resources on Library home page.

A database containing over 9 million articles from various resources.
Library ID: vict16206

A fully integrated database containing thousands of primary documents, biographies, topical essays, background information, critical analyses, full-text coverage of over 1,000 magazines, newspapers.

A collection of **e-book** reference sources for multidisciplinary research.

Check out this database full of controversial topics where both sides are presented.
Library ID: vict16206

Use subject trees, citation features, email articles to yourself. These are our best sources of vetted and evaluated materials.

APA format

To record your sources use bibme.org or http://citationmachine.net/

For examples see APA format on library page.

***Remember to consult the Teacher Librarian, Ms. Ippen, for help with accessing resources and for formatting the reference list that credits the sources you consulted accurately.**

Name: _____ Date: _____

Keyword Searching

How to use search engines to help research your topic.

While researching your topic you will likely use a search engine. There are search techniques that can help you quickly find what you are looking for. In this case, we'll use Google to research a paper on Tybalt's revenge in *Romeo and Juliet*.

Terms Search – a word or string of words

Be specific in your use of keywords. For example, the term Romeo and Juliet will produce millions of results on Google. This is far too broad. Focus your search to fit the exact topic. For example, the terms Romeo and Juliet revenge Tybalt produce about 20,000 results. This is a much more manageable amount of information.

Write down four keyword terms for your topic.

Keyword terms	What do you hope to find with these terms?
1	
2	
3	
4	

Phrase Search – a string of words in quotation marks

Using quotation marks around a phrase will produce that exact string of words. This is helpful if you know precisely what you need. For example, the phrase "Tybalt kills Mercutio" produces about 1,500 results. This is helpful if you need to find where certain lines in the play are found.

Write down four phrases for your topic.

Phrases	What do you hope to find with these phrases?
1	
2	
3	
4	

For more information on searching visit: http://www.google.com/help/basics.html