Step 1: State the Question (Part 1)

Imagine that you're enjoying a package of M&M's when your little sister spills a glass of water on the table, drenching your candies. As you scramble to save them, you notice the color starts to run off many of the M&M's. This makes you wonder why the candy is reacting in such a way. You decide to get scientific and experiment with your favorite candy!

All experiments begin with a testable research question. This question often stems from an experience you've had or observations you've made in the past. Your research question must be testable. This means you can design an investigation, make observations, and gather evidence to answer the question. Scientific questions CANNOT be based on opinions or personal judgments.

Testable Research Question: Will M&M color dissolve faster in water or in vinegar?
Non-Testable Question: Which color M&M tastes better?

1. List at least four other testable research questions you can think of to investigate M&M's.

____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________

As mentioned above, scientific questions don't just come to you from out of nowhere. Instead, questions come from experiences you've had or observations you've made in the past.

2. Think of times that you have observed something unusual or unexpected. Write those observations on the lines below. Then list a research question that could be used to investigate each observation. An example has been done for you.

Example:
Observation: I noticed the crickets were chirping very loudly outside my window last night.
Research Question: Do crickets chirp louder when the temperature is higher?

Observation: ____________________________________________________________
Research Question: __________________________________________________________

Observation: ____________________________________________________________
Research Question: __________________________________________________________

Observation: ____________________________________________________________
Research Question: __________________________________________________________

© 2007 McDONALD PUBLISHING CO.
Step 1: State the Question (Part 2)

Remember that the key to a good research question is that it can be tested. An experiment could be designed to find an answer to the question. If the question is based on opinions or personal preferences, then it is not testable.

Read each research question below. If it is testable, circle “YES.” If it cannot be tested, circle “NO.”

1. Does the amount of fertilizer affect how tall a flower grows?  
   YES  NO
2. Are roses prettier flowers than tulips?  
   YES  NO
3. How can we make cut flowers stay fresher for a longer period of time?  
   YES  NO
4. Can daisies grow in different types of soil?  
   YES  NO
5. Do daffodils smell better than carnations?  
   YES  NO

Read each situation below. Then write the testable research question for the researcher. An example has been done for you.

Example:
Aaron and Sam want to grow some tomato plants this summer. They're trying to decide where to plant them so the plants receive the right amount of sunlight to produce the most tomatoes.
Research Question: What amount of sunlight makes tomato plants produce the most tomatoes?

6. Andre and Marie love popcorn, but they don't have much money to spend. They want to decide if more expensive brands of popcorn really pop better than others.
Research Question: ____________________________________________________________

7. Sheri is tired of buying light bulbs. She wants to find out whether Brand A or Brand B light bulbs will last longer in her lamp.
Research Question: ____________________________________________________________

8. Jerome's brother told him to fill the ice cube trays with warm water instead of cold water because warm water freezes faster. Jerome wants to find out if this is true.
Research Question: ____________________________________________________________

Challenge Activity: Write your own scientific situation on a separate piece of paper. Trade papers with a classmate and have him or her write the research question that goes with your scientific situation.
Step 2: Collect Information (Part 1)

After choosing a topic to investigate and writing a testable research question, it's time to find information about your topic. However, some topics are very broad. You must narrow your topic enough to focus on the most important parts relating to your experiment and research only those parts. The most important parts of your experiment are the variables. Variables are all the factors that can change in an experiment, possibly affecting the results. It's important that you test only one variable at a time; this way, you can be sure it's the one thing that caused the results.

In any scientific investigation, there are three kinds of variables:

1. The Independent (or manipulated) Variable is the ONE factor or condition that is intentionally changed by the experimenter.
2. The Dependent (or responding) Variable is the factor or condition that may be affected as a result of changing the independent variable. The dependent variable is what you measure or observe to obtain your results.
3. The Constant Variables are all the factors or conditions that must be kept the same in an experiment.

Imagine that you are investigating this research question: Will M&M color dissolve faster in water or in another clear liquid? The three types of variables in the experiment are identified below.

Independent Variable (IV): Type of clear liquid
Dependent Variable (DV): Time it takes for color to dissolve
Constant Variables (CV): Color of M&M, amount of liquid, type of M&M (e.g., plain, peanut), time at which M&M's are dropped into liquid, etc.

Read each research question below. Identify the IV, DV, and CV of each experiment.

1. What amount of sunlight makes pea plants grow tallest?
   IV: ________________________________
   DV: ________________________________
   CV: ________________________________

2. Which type of soda has more sugar: Brand X, Brand Y, or Brand Z?
   IV: ________________________________  DV: ________________________________
   CV: ________________________________

3. Is the height of a ball's bounce affected by the height from which the ball is dropped?
   IV: ________________________________  DV: ________________________________
   CV: ________________________________

4. Which battery will last the longest: Superlast or Energy Star?
   IV: ________________________________  DV: ________________________________
   CV: ________________________________

5. Is the water temperature of Lake Michigan affected by the depth of the water?
   IV: ________________________________  DV: ________________________________
   CV: ________________________________
Step 2: Collect Information (Part 2)

Write IV, DV, or CV in the blank after each description below to identify which type of variable is described.

<table>
<thead>
<tr>
<th>IV = Independent Variable</th>
<th>DV = Dependent Variable</th>
<th>CV = Constant Variable</th>
</tr>
</thead>
</table>

1. The factors that are kept the same in an experiment. ______
2. This is also known as the responding variable. ______
3. This is the one thing that is changed by the experimenter. ______
4. This is also called the manipulated variable. ______
5. This is the factor that is affected as a result of changing the manipulated variable. ______
6. This variable must be measurable to obtain results. ______
7. There may be many of this type of variable in an experiment. ______

Carefully read each of the experiments below. Then examine the independent variable (IV), dependent variable (DV), and constant variables (CV) that are listed. ONE of these variables is incorrect. Identify which variable is incorrect AND write the correct description of that variable on the line provided. Be careful! Only ONE variable is wrong in each experiment!

8. Two groups of students were timed to compare how fast they could complete a set of math problems. Each group was given the same problems. One group used calculators. The other group did not use calculators.
   - IV: Using or not using calculators
   - DV: Amount of problems solved correctly
   - CV: Same math problems

   The _____ is wrong. Here is what it should be: __________

9. Students of different ages were given the same puzzle to put together. The time it took each student to complete the puzzle was compared.
   - IV: Boy or girl students
   - DV: Time to complete the puzzle
   - CV: Same puzzle

   The _____ is wrong. Here is what it should be: __________

10. Amy wants to find out if Retro nail polish will last longer than Viva nail polish. She put one coat of Viva on the nails on her left hand and one coat of Retro on the nails on her right hand.
    - IV: Brand of nail polish
    - DV: Time the nail polish lasts
    - CV: Which hand she puts the nail polish on

    The _____ is wrong. Here is what it should be: __________

11. Jason thinks that a heavier paper airplane will fly farther. He is adding small paper clips to his paper airplane to decide what amount of weight makes the airplane fly the farthest.
    - IV: Type of paper airplane
    - DV: Distance the airplane flies
    - CV: Size of paper clips

    The _____ is wrong. Here is what it should be: __________