A good scientist asks many questions. However, only questions which are testable using scientific investigation are *useful* to a scientist.

Testable questions are NOT:

- _____ eg. What is the best brand of cereal?
- _____ eg. What is the freezing point of water?
- _____ eg. What does smoking do to the body?

For each question, circle whether it is based on an opinion (O), can be found through research alone (R), is too broad to test (B), or is a good, testable question.

O R B **T** 1. Does the air pressure in a room change during the day?

O R B **T** 2. Do cats eat more in the daytime or the nighttime?

O R B **T** 3. What is the best brand of breakfast cereal?

O R B **T** 4. Which subject makes Zalma 5th graders happiest?

O R B **T** 5. Will soil heat and cool faster than water?

O R B **T** 6. What kinds of poisonous snakes can be found in Southeast Missouri?

O R B **T** 7. On which continents can rainforests be found?

O R B **T** 8. Will shining light through different fabrics affect the intensity of a shadow?

O R B **T** 9. Which brand of dish soap makes the most bubbles?

O R B **T** 10. What would happen to a student if he didn't sleep for 48 hours?

The following are some testable questions and one person's hypothesis. NOTICE that the underlined sections match!

Question: Does the length of string affect a guitar's pitch?
Hypothesis: If the length of string is longer, then the pitch will be lower.

What will the scientist change in this investigation?

_____

Question: Does the amount of daylight affect the number of eggs laid by a chicken?
Hypothesis: If the daylight increases, then the chicken will lay more eggs.

What will the scientist change in this investigation?

_____

Question: What is the relationship between room temperature and student performance?
Hypothesis: If the room temperature is hot, then the student performance will decrease.

What will the scientist change in this investigation?

_____

Use the following questions to write a hypothesis. Remember to use the correct format.

Question: Does the amount of sunlight affect the growth of a plant?

Hypothesis:_____

What will change in this investigation? _____

Question: How does the color of surface affect its temperature?

Hypothesis:_____

What will change in this investigation? _____

Question: Does talking to a plant affect its growth?

Hypothesis:_____

What will change in this investigation? _____

The **procedure step** is where you write the materials used and the steps followed when conducting an investigation. The materials list must be complete and the steps to follow must be very specific so that anyone can follow the directions. The steps of a procedure are always numbered. Write in short, complete, imperative sentences.

Bad example:

First, you play the short one and then you play the long one and see what sound is higher.

Good example:

1. Go to Changing Sounds website (give the website).
2. Move the guitar string to the shortest setting.
3. Play the sound.
4. Move the guitar string to the medium setting.
5. Play the sound and compare to the short string sound.
6. Record data.
7. Repeat steps 2-5 three times.

Just for fun:

Below write directions for making a peanut butter and jelly sandwich. Pretend like you are writing procedure directions for an investigation. Remember to include every material needed, number the steps, and write in imperative sentences.

Materials:

Procedure:

1.

Important Vocabulary Review:

Variables –_____

Independent variable- _____

Otherwise known as _____

eg. In our reaction time investigation – the hand we used

Dependent variable– **_____**

Otherwise known as _____

eg. In our reaction time investigation – our reaction time

Constant Variable- _____

Otherwise known as _____

eg. In our reaction time investigation:

- same person doing the test
- same mouse
- same amount of light
- same amount of food in belly room
- same distance from the computer screen
- same computer
- same time of day
- same day
- same amount of noise in the
- same room temperature
- same reaction time website

-Other???

- etc. etc. etc. (there are COUNTLESS constants!)

Important Vocabulary:

Variables –____what is changed or can be changed

Independent variable - _ what the scientist change on purpose _ (IV)

Otherwise known as____ manipulated variable

eg. In our reaction time investigation – the hand we used

Dependent variable – what we are measuring (DV)

Otherwise known as responding variable

eg. In our reaction time investigation – our reaction time

Constant Variable- _things that are kept the same- to make it a fair test Otherwise known as Constant Condition

eg. In our reaction time investigation:

- same person doing the test
- same mouse
- same amount of light
- same amount of food in belly room
- same distance from the computer screen
- same computer
- same time of day
- same day
- same amount of noise in the
- same room temperature
- same reaction time website
- etc. etc. etc. (there are COUNTLESS constants!)

The independent variable is the thing that the scientist is purposely changing or looking at.

Example: A scientist wants to know the relationship between the brand of paper towel and how much water it holds. The independent variable in this investigation is the brand of paper towel.

Now, think back to the experiments we've done so far. List the independent variable for each. The first one is done for you.

Changing Sounds – the length of the guitar string

Reaction Time - _____

Let's try a few more:

Someone conducted an investigation to see the relationship between the amount of fertilizer and the growth of a plant. What is the independent variable in this experiment?

_____

Someone conducted an investigation to test the effect of different kinds of music on plant growth. What is the independent variable in this experiment?

_____

Someone conducted an investigation to see whether Energizer, Duracell, or Wal-mart batteries lasted longer. What is the independent variable in this experiment? _____

The **dependent variable** is what the scientist is watching for and measuring.

Example: A scientist wants to know the relationship between the brand of paper towel and how much water it holds. The independent variable in this investigation is the brand of paper towel. The dependent variable is _____.

Now, think back to the experiments we've done so far. List the dependent variable for each. The first one is done for you.

Changing Sounds – pitch (how high or low)

Reaction time – _____

Keeping Warm - _____

Let’s try a few more. Identify the **independent and dependent variables** for each investigation:

Two groups of students were tested to compare their speed at working math problems. One group used calculators and the other group did not.

IV: _____

DV: _____

Students of different ages were given the same puzzle to assemble. The assembly time was measured.

IV: _____

DV: _____

Someone conducted an investigation to see the relationship between the amount of sunlight and a plant’s growth.

IV: _____

DV: _____

Notes on Constant Conditions: In addition to the independent and dependent variables, there are also the constants. These are the **conditions that stay the same throughout and investigation**. To help you determine these conditions, *imagine you actually performing the experiment*! Act the experiment out in your head- visualize the whole process. This allows you to "see" what needs to be kept the same (constant condition). Keeping everything the same, except the ONE change you are allowed, which is your Independent Variable (IV), you will know that your results are because of the IV, not because you changed other things in the experiment.

Example: A scientist wants to know the relationship between the brand of paper towel and how much water it holds.

The independent variable in this investigation is the_____.

The dependent variable is _____. What are some **constant conditions** that must stay the same when a scientist does the experiment so that it doesn't affect the results? There are many possible answers.

1. _____ 2. _____

3. _____ 4. _____

5. _____ 6. _____

Now, think back to the experiments we've done so far. List three constants for each. The first one is done for you.

Changing Sounds -1. same instrument 2. same speakers 3. same plucking strength (hard or soft)

Reaction time – 1. _____ 2. _____

3. _____

Keeping Warm - 1. _____ 2. _____

3. _____

Constant Conditions- more practice

Let's try a few more. Identify the independent and dependent variables and three constants for each investigation:

Someone conducted an investigation to see if pulling a spoon catapult back farther would make a pea fly farther.

Ind. Var.: _____

Dep. Var.: _____

Constants: 1. _____
2. _____
3. _____

You want to see the relationship between the time of year and the amount of deer that visit your deer feeder.

Ind. Var.: _____

Dep. Var.: _____

Constants: 1. _____
2. _____
3. _____

During the **procedure step** of your investigation, it is important to plan how you will show your results, as well as how you will carry out the investigation. You must display your results in an organized manner. Two types of results must be shown:

Qualitative – observations using your senses

Examples "The short guitar string made a higher sound."
"The Alka Seltzer fizzed in the water and made bubbles."
"I was more tired after I ran."

Quantitative – numerical data (think "quantity = number")

Examples "With my left hand, I averaged a 1.5 second reaction time."
"The whole Alka Seltzer tablet took 15 seconds to dissolve."
"The water took 18 mn to cool to air temperature with no insulation."
"While resting, my heart rate was 45 beats per minute."

Think of the Forces in Action investigation. List each type of data you gathered.

Qualitative: _____

Quantitative: _____

Data Tables:

Tables and charts are an excellent graphic for displaying your results. The following is an example of a table used to show results in an experiment in which LifeSavers were being dissolved in different liquids. This is called a data table. *Each data table must have a title.* **The investigation's question is the best title.** On this table, both quantitative and qualitative data are listed. Identify each type of data.

Quantitative - _____

Qualitative - _____

Bar graphs:

Once data is gathered, it should be put into a graph to show the relationships in the results. The bar graph displays descriptive data that compares two or more things.

Graphs need:

a title (usually the investigation's question)

2 labels (x and y axis –the independent variable and dependent variable)

numbers labeled in even intervals (by 1's, 2's, 10's, etc.)

Examples:

"The effect of the length of a guitar string on the pitch" (3 bars - high, medium, low)

"The effect of hand used on a person's reaction time" (2 bars - dominant hand, non-dominant hand)

"How do different race track surfaces affect the distance a car will travel?" (4 bars - vinyl, wood, carpet, ice)

Line Graphs:

A line graph shows results over time. This type of data comes from watching one thing over a period of time to check for changes.

Like bar graphs, line graphs also need:

a title (usually the investigation's question)

2 labels (x and y axis –the independent variable and dependent variable)

numbers labeled in even intervals (by 1's, 2's, 10's, etc.)

Examples:

"What happens to a person's heart rate when they start exercising?"

"What happens to the temperature of ice over time?"

"What happens to the gas prices in a week?"

The final component of a science investigation is called **drawing conclusions**. When you write a conclusion, you must include two parts:

Conclusion statement:

The conclusion statement is a factual summary of data. First, was your hypothesis supported? What was your hypothesis? Then, what did your data table show? Put the data into words and only use your AVERAGE numbers. Basically, you just put the data table in words, and relate that back to your hypothesis.

Example:

"My results did not support my hypothesis. I thought that the Life Saver would dissolve fastest in the Sprite, but actually, it dissolved faster in the vinegar. The Life Saver took 29 minutes to dissolve in vinegar, 32 minutes to dissolve in water, and 33 minutes to dissolve in hand soap. It took 30 minutes to dissolve in the Sprite."

Inference statement:

The inference statement is a general statement that explains or interprets the given data. More than one inference can be made.

Example:

"It took the Life Saver the shortest amount of time to dissolve in the vinegar. This is probably because vinegar is a weak acid and speeds up the dissolving process. I knew that acid will dissolve things, but I thought that the Sprite would work faster because it has phosphoric and citric acids in it. It took the longest for the Life Saver to dissolve in the hand soap. This may be because the hand soap I used had lotion and oil in it, which would stick to the candy and form a protective barrier.