



Name _____

The Pre-experimental Stage: Questions and Predictions

SAFETY: Use care handling the tubes; they will break!

Background Information: Frequently making observations about our world leads to QUESTIONS. The questions that scientists try to answer are called RESEARCH QUESTIONS. Research questions can be answered by doing some type of INVESTIGATION.

Investigations use different types of scientific methods or processes. Different kinds of questions need different kinds of scientific methods.

Some scientific investigations involve observing and describing objects, organisms, or events; some involve collecting specimens; some involve researching more information; some involve doing a fair test or experimenting; some involve discovery of new objects and phenomena; and some involve making models.

We can divide investigations into two general categories: **descriptive or qualitative** and **experimental or quantitative**.

Descriptive or qualitative investigations include building models, inventing, dissecting, making observations and describing them, interviewing, collecting specimens among others. Although these are sometimes called experiments, they are not really experimental.

Experimental or quantitative investigations involve the control or manipulation of variables. Variables are the parts of the experiment that can change, or vary.

- Independent variables or manipulated variables are those that can cause changes in other variables. This means it is the ONE thing that has been chosen to be changed or manipulated by the scientist. It is what the investigator is testing; the difference between groups.
- Dependent variables or responding variables are those that change in response to the manipulation of another variable. It is the response that can be observed and measured.
- Controlled variables or constants are those that are kept the same or constant. They could be changed, but the scientist keeps them constant so that they will not interfere with the investigation.

Effect and **affect** are good words to use when writing a research question. **Effect** is a noun; it refers to the outcome or result of an investigation. **Affect** is a verb; it means to influence or act upon something. Examples: What is the effect of different types of fertilizer on the growth of plants? How do different types of fertilizer affect the growth of plants?

Materials:

Set of three tubes	Meter stick	Stopwatch
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Procedure:

1. Work with your partner
2. Read the procedure carefully.
3. Pick one tube (it does not matter which one).
4. Move the tube so that the bubble inside tube moves up and down the tube.
5. Observe what happens.
6. Move the tube in different ways, at different speeds, or any other way you can to move the bubble.
7. Repeat with the other tubes.

A good descriptive research question identifies exactly what will be observed during the investigation.

A good experimental research question identifies exactly what will be tested and observed & measured during the investigation.

List at least three (3) questions you can ask about the movement of the bubble.

Classify each question as descriptive or experimental.

- 1 _____
- 2 _____
- 3 _____

Pick one of the experimental questions you asked, and identify the independent / manipulated, dependent / responding, and controlled variables / constants.

Question: _____

Independent / manipulated variable: _____

Dependent / responding variable: _____

Controlled variable / constant: _____

Background Information: Investigations frequently have some type of PREDICTION to help guide the scientists. A prediction is an educated guess about the outcome of the investigation.

When scientists are conducting an experimental investigation, they use a special kind of prediction called a **HYPOTHESIS**. A hypothesis is an educated guess about the relationship between the independent and dependent variable. A hypothesis is testable; an experimental investigation can be done based on the hypothesis. This is frequently called a **RESEARCH HYPOTHESIS** or an **ALTERNATIVE HYPOTHESIS**. It is based on prior knowledge and observations.

In professional investigations, scientists often use a **NULL HYPOTHESIS**. A null hypothesis is a statement that the independent variable will have no effect on the dependent variable in an experiment. It is used in statistics to determine **SIGNIFICANCE**. Significance refers to the probability that the observed results (data) was a result of the independent variable and not chance.

A research hypothesis is true if the null hypothesis is false.

One way to write a hypothesis is to use an "If..., Then..." statement. An If, Then statement shows cause and effect. In other words, what effect does the independent variable have on the dependent variable? Or what does the independent variable cause the dependent variable to do?

Write a research hypothesis using this format: **IF** the independent variable changes, **THEN** the dependent variable will change.

Write a null hypothesis using this format: **IF** the independent variable changes, **THEN** there will be no change in the dependent variable.

Of course, in a real hypothesis, you will state the actual variables and describe the type of changes you expect.

Procedure:

1. Work with your partner
2. Pick one of the experimental questions and re-write it if necessary, using the word affect or effect. For example: Does the color of the liquid affect the speed at which the bubble moves? Or: What is the effect of the color of the liquid on the speed of the bubble in the tube?

AFFECT - verb - to act upon, to change or to cause a change

EFFECT - noun - result; consequence

When you affect something, you produce an effect on it.

3. After you have written your question, write a hypothesis using an If,...Then... statement.

Question: _____

Research hypothesis: If _____,

then _____.

Null hypothesis: If _____,

then _____.