ChemQuest 1

*Experimental Design*

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Hour: \_\_\_\_\_

**Information: Good Scientific Questions**

There are many good questions that are not scientific. For a question to be scientific it must:

1. Have an answer that can be tested by an experiment or some measurement that you can do.
2. Lead to other good scientific questions it is answered.

**Critical Thinking Questions**

1. Consider the groups of questions. In each group, underline the best scientific question.
2. “Why is there air?” OR “What is the air made of?”
3. “Where did the Universe come from?” OR “How fast does a baseball fly when I throw it?”
4. “What is the color of the sky?” OR “What conditions cause the sky to be blue?”
5. For each of the questions in question 1, consider the ones that were poor scientific questions. What about the questions made them poor?

A)

B)

C)

**Information: Definitions and A Research Experiment**

* Dependent variable: A resultant factor in an experiment. Researchers want to find out what happens to the dependent variable. In experiments, scientists are often measuring what happens to the dependent variable.
* Independent variable: A causing factor that shapes or determines the dependent variable. Researchers purposely adjust the independent variable and look to see what effects the adjustments have on the dependent variable.
* Control: Variables that are kept constant or equal in an experiment.

Example: If you want to test how music affects plants, you might try the following experiment. You could place five plants in a room with classical music playing and place five other plants in a different room with rock music playing. At the end of one month, measure the height of the plants. The height of the plants is the dependent variable because you want to see how the height *depends* on the music. The independent variable is the music—you deliberately change the independent variable. Controls for this experiment should be things like water and sunlight—you want each plant to get equal water and sunlight.

Scenario I: “Breast cancer treatment”

A drug manufacturing company believes that a certain drug they have created will be effective in reducing the size of tumors in breast cancer patients. Researchers are testing the new drug. 15 women are participating in the study and they are divided into three groups of five. Each woman receives an MRI at the beginning of the study. Each group is administered a pill each week for 20 weeks. Group 1 receives a pill containing 20 mg of the new medication. Group 2 receives a pill containing 40 mg. Group 3 receives a pill containing no active ingredients. At the end of the 20 weeks, each participant receives another MRI and it is compared with the patient’s initial MRI and the size of the tumors are examined in order to determine if the medications were effective.

**Critical Thinking Questions**

1. What is the independent variable in this investigation?
2. What is the dependent variable in this investigation?
3. The researchers who administer the pills know which group receives the 20 mg and which receives the 40 mg and which receives the placebo. Explain how this could introduce some bias into the study.
4. After 12 weeks, a woman in Group 1 dies. A woman from Group 2 complains of side effects of the medication and drops out of the study after 14 weeks. Such events are common in these types of studies. As the researchers consider doing another 20 week study, what could they do to minimize the effects of people not completing the study?
5. Sometimes the “independent variable” is called a “manipulated variable.” Why does the term “manipulated” accurately describe the independent variable?
6. Sometimes the “dependent variable” is called a “responding variable.” Why does the term “responding” accurately describe the dependent variable?

**Information: Caffeine and Taking Tests**

Scenario II: The Effect of Caffeine on Performance

A group of High School students studied the effects of caffeine on test grades. They studied 60 chemistry students for a whole semester. Group 1 contained 30 students who drank one 12-ounce cappuccino exactly one hour before each test. Group 2 was made up of 30 students who drank nothing but water for an hour before their tests. The following data were obtained:

|  |  |  |
| --- | --- | --- |
| Exam | **Group 1 Average Score** | **Group 2 Average Score** |
| 1 | 84% | 93% |
| 2 | 79% | 89% |
| 3 | 82% | 85% |
| 4 | 76% | 81% |
| 5 | 85% | 88% |
| 6 | 77% | 91% |

**Critical Thinking Questions**

1. What is the independent variable in this study?
2. What is the dependent variable in this study?
3. The researchers concluded that caffeine has a negative effect on test performance. What are some sources of error that could challenge that conclusion? How could the researchers improve their study?
4. Let’s say you want to determine whether Brand X or Brand Y fertilizer helps plants to grow better.
5. What are some variables that you will want to control (keep constant)?
6. What will be your dependent variable?
7. What is the independent variable?
8. Provide an outline for your experiment. (You will probably need to use the back of this paper.)
9. Write a descriptive paragraph of research that could be done. Your paragraph will be similar to the ones provided on this worksheet. Try to eliminate any weaknesses in your procedure.
10. Then make up a data table for data that could be collected. Make up the measurements and put them in your data table. Pretend you actually did the experiment and enter some data into your data table that makes sense to you.
11. Write your conclusion statement. Your conclusion should be consistent with the data you have in your data table.