Name _____ Date _____ Class _____

SKILLS INTRODUCTION

Designing an Experiment

Have you ever timed two different routes to school or compared two kinds of shampoo? If you have, you have performed a simple experiment. You probably did not plan your experiment on paper before you carried it out. Scientists, however, design experiments carefully before actually performing them. **Designing an experiment** is making an organized plan to test a hypothesis. An experimental design usually follows a definite pattern. When you design experiments according to this pattern, you will use many individual science skills. Some of these skills are described briefly below.

Pose a Question

Scientists design experiments to answer questions or solve problems. For example, suppose you've heard people say that adding sugar to the water in a vase of flowers keeps the flowers fresh. You wonder whether that statement is true. To find out, you will perform an experiment. You write the topic to be investigated in the form of a scientific question: "Does adding sugar to water keep flowers fresh?"

Develop a Hypothesis

A hypothesis is a prediction about the outcome of an experiment. A properly worded hypothesis is in the form of an *If . . . then . . .* statement. The hypothesis you decide to test in your experiment is *"If I add sugar to the water in a vase, then the flowers will stay fresh longer."*

Plan the Procedure

The procedure describes what you plan to do and identifies the data you plan to collect. Begin by identifying the manipulated variable—the factor you will purposely change—and the responding variable—the factor you predict will change as a result of the manipulated variable. Here, the manipulated variable is the presence or absence of sugar in the water. The responding variable is the length of time that the flowers remain fresh. The procedure is a step-by-step description of how you will change the manipulated variable and observe the effects upon the responding variable. Preparing a data table for recording your observations is a key part of planning the procedure.

Before you begin carrying out the procedure, you must also identify the materials you will need. Write a list of those materials and then continue making your plan. When your plan is complete, revise the materials list, if necessary.

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Designing an Experiment *(continued)*

Controlling Variables To be sure that your results are caused only by changes in the manipulated variable, you need to control all other variables that might affect your experiment. Controlling variables means keeping conditions the same. For example, you would keep all the flowers at the same temperature. Other variables you would control include the type and size of the containers, the number of flowers in each container, and the amount of light they receive.

Writing Operational Definitions To enable anyone to repeat and test your experiment, you must write an operational definition for any key term that does not have a single, clear meaning. For example, you could define "remaining fresh" as "flowers keeping their petals." That definition tells anyone how to measure the responding variable.

Interpret the Data

During the experiment, you record all your observations. These observations are your data. Interpreting the data means explaining that data. You may make simple comparisons or look for trends or patterns. For example, if flowers in both groups kept the same number of petals, both groups of flowers stayed fresh the same length of time.

Draw Conclusions

After you interpret the data, you need to compare that interpretation with your hypothesis and decide whether the hypothesis was true or false. This step is called drawing a conclusion. This step may conclude a scientist's investigation, or it may lead the scientist to raise new questions and design new experiments.

☑ *Checkpoint* Designing an experiment properly can be a challenging task. Why do scientists take the time to plan all the details carefully before beginning work on an experiment?

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SKILLS PRACTICE

Designing an Experiment

Choose a question from the list below as a topic for an experiment. Alternatively, pose a scientific question of your own and obtain your teacher's approval to use that question.

Remember, as one of the first steps in planning your investigation, you may need to narrow your original question. Then write a hypothesis and design an experiment to answer the question. Be sure to include all the necessary parts of an experiment, such as naming the manipulated and responding variables and identifying the variables you will control. Write any operational definitions that are needed. Include a data table you could use for recording your observations. Use the back of this sheet or a separate sheet of paper for your work.

1. How is heart rate affected by exercise?

2. How are bean seedlings affected by water that has been polluted by detergent?

3. What effect does acid rain have on marble statues?

4. Does sand in the wheels of my in-line skates affect how fast they roll?

5. Will a wet sheet become dry when hung outdoors on a freezing day?

6. Is a family's health affected by using a dishwasher?

7. How is gas mileage affected by the type of gasoline used?

8. Does the presence of plants growing on a hillside change the amount of soil erosion?

9. Does cold water freeze faster than hot water?

10. Does the type of shampoo I use have an effect on how long my hair stays clean?

11. Think About It Review the experiment you just designed. What are some practical problems you might encounter if you carried out the experiment? What could you do to solve one of those problems?