Name Period Date

INVESTIGATING

Technological Design—Ice Cube Insulators

Your task in this investigation is to design an ice cube insulator. Before electric refrigerators, people had ice boxes that used blocks of ice to keep food cool. Can you design a way to keep a single ice cube from melting? This activity will guide you through a technological design investigation that makes use of the scientific processes that you have been learning. To begin, do some research of resources that will help you with your design. Your teacher will provide materials for your design.

1. PROBLEM STATEMENT

Consider the problem that you are trying to solve. Write your problem statement in the form of a question. Remember that your problem should not have a "yes" or "no" answer. Begin the problem with a word such as *how, which,* or *what.*

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2. RESEARCH AND DEVELOP

Gather information to develop an initial design. You could consult sources such as magazine articles or Internet sites. You could also start by conducting tests of materials and designs to find a solution that you think will work. Be sure to consider design constraints such as time, materials, and tools. You will need to determine the properties of the materials you have, and then decide whether they are suitable for your project. After developing your design, follow the steps below to test and refine it.

3. HYPOTHESIS

Based on your background research, form your hypothesis. The way you write your hypothesis will shape the type of experiment you will carry out, so give it some thought. Write your hypothesis below in the form of an "If . . . , then . . . , because . . ." statement.

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4. VARIABLES

The independent variable comes after the *if* in your hypothesis and is the variable that is being manipulated. The dependent variable comes after *then,* and is the variable that is being measured. Identify each in the spaces below.

a. Independent variable: _____

b. Dependent variable: _____

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5. OPERATIONAL DEFINITION

Recall that your operational definition describes the one particular way in which you will measure the dependent variable. Keep in mind that you must have the resources available in the classroom to carry out your measurements. Write your operational definition below.

6. CONSTANTS

After completing your hypothesis and your dependent and independent variables, you have a framework for an investigation. Think carefully about how you will carry out the investigation. Which factors will be constants in order to properly test your independent variable?

7. MATERIALS

Decide what materials you will need to conduct your investigation. Make a list of everything you must have in order to complete your experiment. Be sure to include quantities and sizes. After you write your procedure, it may be helpful to look back to your list to add any additional materials or delete anything you do not need.

8. PROCEDURE

Break into steps what you will need to do in order to test your hypothesis. Remember to write your procedure as precisely as possible so that someone else can copy your work exactly. To generate reliable data, design your procedure with a sufficient number of trials. Keep in mind that more data are nearly always better. Use a separate sheet of paper to write the steps of your experimental procedure. If you think it would be helpful to include illustrations that describe different parts of the procedure, be sure to include them.

9. RECORD OBSERVATIONS

Set up a data table before you begin collecting your data. Organize your table into columns and rows, and include units in the column headings. Include space for every trial, as well as a place for the means of your data. You should also leave room for any qualitative observations that you make during the experiment. Draw your data table below.

10. SUMMARIZE RESULTS

After collecting all of your data, decide how to summarize and present your results. You should include one or more graphs to make your data easy to interpret. Remember, comparative data are best shown by bar graphs, and continuous relationships between variables are best presented by line graphs. Use graph paper or computer graphing software for the actual graph(s), but show how you will set up the axes below.

11. DISCUSS

a. Describe what you found out in the investigation. Did you succeed in extending the time an ice cube will remain frozen outside the freezer? Provide evidence from the data you collected to make a case for the success or failure of your design.

b. Did your investigation reveal any other types of noteworthy data that should be described? If so, what what were they?

c. Which factors do you think were most important in affecting the outcome of your investigation? What might you have done differently to improve your design?

12. CONCLUDE

a. Discuss whether or not your data support your hypothesis. What factors do you think were responsible for keeping the ice cube frozen? Write your conclusion in complete sentences. Remember that a single investigation does not prove anything.

b. What design constraints were most important for you to consider? What constraints and trade-offs might an engineer need to consider when working on a similar real-world design?