**Cube It: Student Directions**

**PHASE 0: Introduction**

Complete the two introductory worksheets, “Design Worksheet” and “Painted Shapes Worksheet.”

**PHASE 1: Design**

Description: By the time you finish this phase, you will have a starting object that is broken into smaller shapes. You will know the different dimensions for each of the shapes you are using and decide on which properties you want to observe for the object.

1. Decide on an Object - Modeling

 Our world is filled with objects. The dimensions of those objects can have a large effect on their usefulness. A box that is too small may be sturdy but not have the volume to hold what we want. A box that is too large has plenty of space but doesn’t have the strength to hold itself together. While paying attention to the short PowerPoint presentation, think about what objects you use on a regular basis, where the size determines its usefulness.

 Choose an object to study that has some importance in the real world. Make sure it is an object that you can break down into regular shapes (e.g., a building, a water tower, a chair, etc.) Once you have an object worth examining, write down the name of it on your Design Worksheet and do a quick drawing of it. This will help you break it into the separate shapes.

1. Break your Object into Regular Shapes - Identifying Patterns and Relationships

 Every object can be broken into smaller pieces. A table can be made of a large rectangular prism for the top, and four differently shaped rectangular prisms for the legs. What shapes make up your object? You may have to be creative. Is something made of half a sphere? Make sure you use only regular shapes or portions of a regular shape. (They must have equations to determine their properties; e.g., the volume of a rectangular prism of side lengths L, W, and H is L x W x H).

 You may have two or more of the same shape, make sure to specify each of them.

1. Decide on properties to observe - Justifying/Constructing an Explanation

 Two properties have already been chosen for you: volume and surface area. These are properties with equations that already exist for each of the shapes making up your object. To help you think of what other two properties you would like to examine, answer the question regarding the object’s use. The properties could be the ratio of volume to surface area, surface area exposed to a 45-degree angle, ratio of the volume of one portion to another, or anything you can think of!

1. Decide on starting dimensions for the individual regular shapes - Modeling

You will need to decide on the starting dimensions for each of your regular shapes. When coming up with the starting dimensions, keep in mind the actual size and shape of the object (remember your units!!). Follow the provided format if it helps, or come up with your own.

**PHASE 2: Analyze**

1. Write growth formulas for each individual dimension - Identifying Patterns and Relationships

Your object is going to grow over time. You need to decide on formulas for how each of your individual dimensions grows. Some of the formulas may be the same, others will be different. When deciding on the formulas you use, keep in mind the patterns that they create. Do they correspond to the kind of growth you intended for your object? Your formulas must be written in the format *y*=*f*(*x*), where *y* is the dimension and *x* is the stage of growth (1, 2, 3, 4). Answer the questions on the worksheet to help you make decisions on which equations to use. Keep in mind that your object may need to grow at certain speeds in different directions (e.g., an animal may grow taller faster than it grows thicker). Make sure to give an explanation of why you picked each of the equations that you did. This is one of the **large** parts of what you will need to explain on your poster.

1. Calculate Dimensions for individual regular shape at each of the other 3 sizes - Identifying Patterns and Relationships

 You will need to make multiple tables. The more shapes and dimensions you have, the more tables you need (one table per shape would work best). Each row needs to have the name of a dimension and the dimension at each growth stage (remember units!). Look at the worksheet for an example.

1. Calculate the properties for the entire object at each size - Identifying Patterns and Relationships

 You will now need to make one table that includes all of the properties for your object. List the value of the property at each growth stage.

1. Draw and label your object at the four different stages - Modeling & Precision

 Consider how you want to draw your object. Look at the rubric for the Cognitive Skills for Modeling and Precision to help guide how you want to present the drawings. Think about how you would present all of the information, it does not need to be only one drawing per growth stage; perhaps it would be beneficial to draw your object from multiple sides. Also, include a scale for your units (e.g., scale 1cm = 10cm). The drawings should be to scale and labeled thoroughly. These drawings will be another large part of what is used on your poster, so put some thought into them.

1. Write formulas for Properties - Identifying patterns and relationships

 Determining the formulas for the different properties will take some work. This will be another major part of your poster. The formulas may end up being quite complex and require help from another person. You should begin by analyzing the growth of the data, and then move on to guess and check (remember, the guess part of guess and check should include informed guesses, be intentional!)

 Analyze - Is it linear growth? Exponential? Does it accurately reflect what you expect?

 Guess and Check - Create an equation that is your best guess based on your analysis. If it does not fit, slowly change and alter the equation, seeing how it affects the outcomes. Try at least 3 guesses (show your work) before asking someone else for help.

**PHASE 3: Reflect**

1. Answer Reflection Questions - Making Connections and Inferences

Find the questions on the Reflection Worksheet. If you have been thoughtful and intentional while working through the project, most of these questions should have been answered already. Answering these questions thoroughly will help you in putting together a poster that fully details your object and the important information behind its growth.

1. Create a poster to present knowledge and skills learned and practiced - Modeling & Precision

Poster - Your poster will display your model and the justification of the object’s growth.

It must include the following:

* Title and Objective
* At least four drawings: one for each of the different stages of growth with all important parts labeled
* Tables: tables to organize the data for both dimensions and properties
* Written Descriptions: Written explanations to describe the growth of your object
* Analysis of the Object’s properties: Review of discoveries made during Reflection Step