

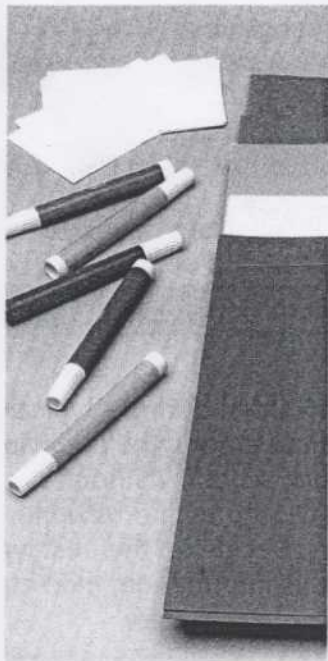
# Design **ACTIVITY 7**

## Bedroom Design

### Materials

You will need:

- card stock or index cards
- colored paper
- foam board or cardboard
- markers



### Problem Situation

You are moving to a new house that is being built for your family. The architect designing the house needs information regarding your family's living style to determine the best design. You have been told that you can design your own bedroom, but there is a catch: You have a \$15,000 budget. This amount can be increased by \$2,000 if you have a disability, such as blindness or being wheelchair-bound, that requires special facilities.

### Your Challenge

You and your teammates are to design a bedroom. You will build a scale model of the bedroom, including all its furnishings.

Go to your **Student Activity Guide, Design Activity 7**. Complete the activity in your Guide, and state the design challenge in your own words.

### 1 Clarify the Design Specifications and Constraints

To solve the problem, your design must meet the following specifications and constraints:

- The window area must be equal to at least 20% of the floor area.
- The minimum room size is 120 square feet, and the minimum closet size is 8 square feet. The minimum height of all ceilings is 8 feet.
- The room has two outside walls and two interior walls.
- The bedroom budget is \$15,000.
- The cost of basic construction is estimated at \$75 per square foot of floor area.

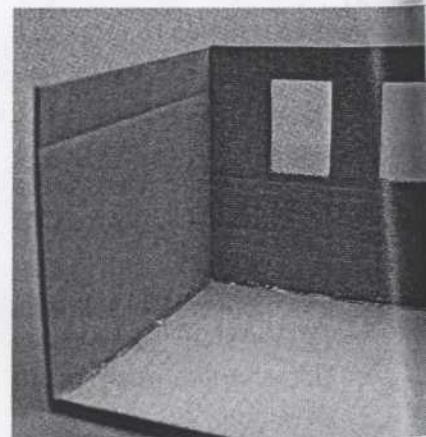
In your Guide, state the design specifications and constraints. Add any others that your team or your teacher included.

### 2 Research and Investigate

To better complete the design challenge, you need to first gather information to help you build a knowledge base.

In your Guide, complete:

- Knowledge and Skill Builder 1: Geometric Shapes.
- Knowledge and Skill Builder 2: Ratio and Proportion.



- Knowledge and Skill Builder 3: Sketching.
- Knowledge and Skill Builder 4: Aesthetics.
- Knowledge and Skill Builder 5: Pricing Information.

### 3 Generate Alternative Designs

In your Guide, describe two possible solutions that your team has created for the problem. Your solutions should be based on the knowledge you have gained so far.

### 4 Choose and Justify the Optimal Solution

Refer to your Guide. Explain why you selected the solution you did, and why it was the better choice.

### 5 Develop a Prototype

Construct a scale model of your bedroom, including the furnishings. Include a drawing or a photograph of your final design in your Guide.

In any technological activity, you will use seven resources: people, capital, time, information, energy, materials, and tools & machines. In your Guide, indicate which resources were most important in this activity, and how you made trade-offs among them.

### 6 Test and Evaluate

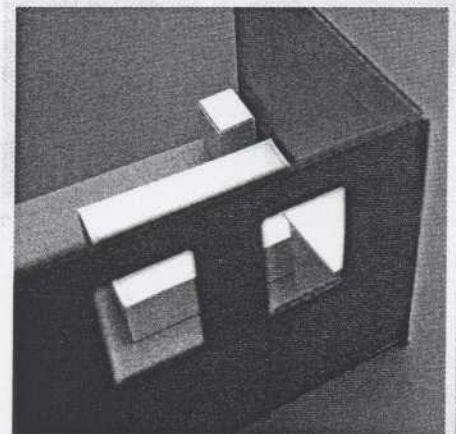
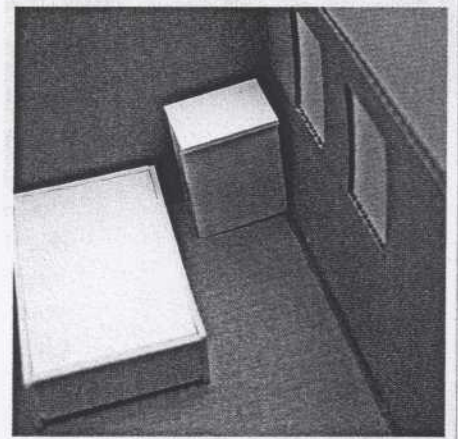
How will you test and evaluate your design? In your Guide, describe the testing procedure. Explain how the results show that the design solves the problem and meets the specifications and constraints. Describe the calculations you used.

### 7 Redesign the Solution

Respond to the questions in your Guide about how you would redesign your solution. The redesign should be based on the knowledge and information that you gained during the activity.

### 8 Communicate Your Achievements

In your Guide, describe the plan you will use to present your solution to your class. Show any handouts or overheads that you will use.



## Bedroom Design Activity – Teacher’s Guide

*Suggested Activity Length 3 weeks*

**Scenario:** Great news! You are moving to a new home being built just for your family. An architect has been hired to design the house and needs information regarding your family’s living style to determine the best design. You have been told you can design your own bedroom, including the furnishings that are in it, but there is a catch, you have a \$15,000 budget to operate within. This amount can be increased by \$2000 if you have a disability, such as being wheelchair bound or being visually impaired, which requires special facilities.

**Challenge:** You and your team members have to design a bedroom that meets the following specifications and constraints. You will build a scale model of the bedroom, including all its furnishings.

**Objectives:** One of the primary objectives of this activity is to reinforce two and three dimensional renderings of objects. The use of *scale*, and *ratio and proportion* are fundamental to good design. In the process students will also learn about the importance of tradeoffs, especially those associated with cost.

### **KSB 1— Geometric Shapes**

A. Area of geometric forms is an important middle school concept. In this situation, the area of a rectangle is length times width. Thus, there are several arrangements that will create 24 square units—for example 24 x 1, 2 x 12, 3 x 8, or 4 x 6. This exercise, which may be given as a homework assignment, reinforces this.

B. This activity encourages students to measure accurately, in inches. The square is 2 inches per side, so the area is  $2 \times 2 = 4$  square inches, and the perimeter is  $2 + 2 + 2 + 2 = 8$  inches. The circle’s circumference (perimeter) is  $2\pi r$ , where  $r$  is the radius; the circle’s area is  $\pi r^2$ . The diameter measures 3 inches, the radius is 1.5 inches, so the circumference is  $2 \pi 1.5 = 3 \pi = 9.42$  inches, where  $\pi = 3.1416$ . The area is  $\pi 1.5^2 = 7.07$  square inches. For triangles, the area is the one-half the base times the height. The isosceles triangle has a base of 3 inches and a height of 4 inches (students measure the height), so the area is  $\frac{1}{2} \times 3 \times 4 = 6$  square inches. Students will measure the sides to be 4.25 inches, so the perimeter is  $4.25 + 4.25 + 3 = 11.5$  inches. For the right triangle, the base is 2.5 inches; the height is 3 inches, so the area is  $\frac{1}{2} \times 3 \times 2.5 = 3.75$  square inches. The perimeter is  $3 + 2.5 + 3 \frac{7}{8} = 3 + 2 \frac{4}{8} + 3 \frac{7}{8} = 8 \frac{11}{8} = 9 \frac{3}{8}$  inches. The circumference (perimeter) of a semi-circle is one half that of a circle plus the base, or  $\frac{1}{2}(2 \pi r) + 2r$ . The radius measures 1.5 inches, so the circumference is  $\pi 1.5 + 2 \times 1.5 = 7.71$  square inches.

C. In this problem we are seeking that the students know the area and calculate reasonable dimensions.

$$\text{Area} = 120 \text{ square feet} = \frac{1}{2} \text{ base} \times \text{height}$$

Assume the base is 10 feet, and then the height could be calculated to be

$$120 = (\frac{1}{2})(10)H \quad \text{or} \quad H = 120/5 = 24 \text{ feet.}$$

This would yield a long, skinny room, difficult to put furniture in. A base of 15 feet yields

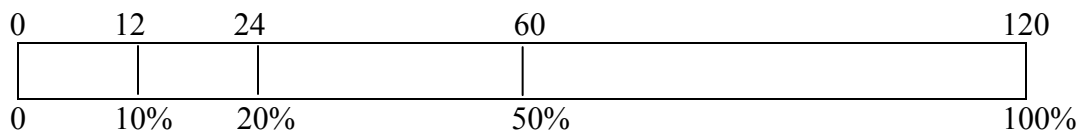
$$120 = (\frac{1}{2})(15)H \quad \text{or} \quad H = 120/10 = 16 \text{ feet}$$

In this situation the sides are nearer the same length. You may want students to draw sketches of the triangles on graph paper so they can visualize their results.

## **KSB 2 - Ratio and Proportion**

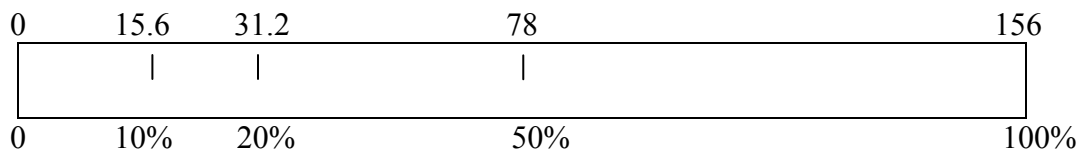
Scaling, the use of ratio and proportion, is important to designers and mathematicians. This concept will be reinforced in many design activities. You may want to provide students with in-class guidance and then extend the activity as a homework assignment.

1. The scale drawing that provides the greatest information is one with the greatest scale factor, e.g. 2 inches equals one foot.
2.  $10\%$  of  $120 = 0.10 \times 120 = 12$  square feet. You may want to introduce the percent graph as shown below.



3. The area of a 12 by 13 foot room is  $12 \times 13 = 156$  square feet

The window area is 20% of floor area, or  $0.20 \times 156 = 31.2$  square feet



A square window with an area of 31.2 square feet has sides of what length. Let the side length be  $L$ , thus

$$31.2 = L \times L = L^2$$

Take the square root of both sides (using a calculator)

$$5.58 = L \quad \text{or the length of one side is 5.58 feet}$$

For a rectangular window, let the one side have length L and the other length W, thus the area is

$$31.2 = L \times W$$

Students will need to make an assumption about the proportion of length to width, perhaps length is twice the width, or  $L = 2W$ .

$$31.2 = (2W)(W) = 2W^2$$

Divide both sides by 2,

$$15.6 = W^2$$

Take the square root of both sides (using a calculator)

$$3.95 = W \quad \text{or the width is 3.95 feet and length is } 2 \times 3.95 = 7.9 \text{ feet}$$

For a triangular window, the area is  $\frac{1}{2}$  base times height. Again we will need to make an assumption about the proportion of base to height, in this case let the height be twice the base, or  $H = 2B$ .

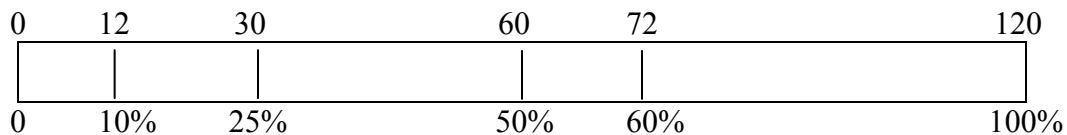
$$31.2 = \frac{1}{2}(B)(2B) = \frac{1}{2}(2)(B^2) = B^2$$

Take the square root of both sides,

$$5.58 = B \text{ and } H = 2 \times 5.58 = 11.16$$

4. For a room with dimensions of 10 x 12, the area is 120 square feet, the rug has dimensions of 5 x 6, or 30 square feet. The percent that 30 is 120 is

$$\frac{30 \times 100}{120} = 25\%$$



If the rug were 8 x 9, the area would be 72 square feet

$$\frac{72 \times 100}{120} = 60\%$$

### **KSB 3—Sketching**

This activity can be accomplished in one period or for homework. In this situation the students must realize that the lines on the graph paper are  $\frac{1}{4}$  inch, while the scale is  $\frac{1}{2}$  inch per foot.

Room: 5 “ by 6 “ or 10 ft by 12 ft Area = 120 square feet

Bed: 1.5” by 3” or 3 ft by 6 ft Area = 18 square feet

Night Stand: 0.75 “by 0.75” or 1.5 feet by 1.5 feet Area = 2.25 square feet

Dresser: 1” by 2 “ or 2 ft by 4 ft Area = 8 square feet

Desk: 1.25” by 2.5” or 2.5 ft by 5 ft Area = 12.5 square feet

Chair: 1” by 1” or 2 ft by 2 ft Area = 4 square feet

Total furniture area =  $18 + 2.25 + 8 + 12.5 + 4 = 44.75$

$$\frac{44.75 \times 100}{120} = 37.3\%$$

### **KSB 4—Aesthetics**

This activity encourages students to think of different colors, room arrangements. Aesthetics is an important part of design. Having colored markers or colored paper (less messy) will assist.

### **KSB 5—Pricing Information**

The table represents reasonable prices for construction, furniture, and other items. Students may update the list with current prices found in catalogs, from visiting actual stores. As students design their rooms, there will be trade-offs made because of cost, just as in real life.

## Design Test/Evaluation

There is no physical test for this design, rather the students should show that their design meets the specifications and indicate calculations. They may want to devise peer review for aesthetic considerations.

## Redesign

Encourage students to think about aspects of other designs that they might like to include next time. They will not be able to calculate the alternatives at this point, and probably will be disinterested in doing so; however, there may be other trade-offs they would make and discussing trade-offs as part of design is important.

PERIOD	FOCUS MODEL COMPONENT (For Teacher)	INFORMED DESIGN LOOP COMPONENT (For Student)	ACTIVITY
1	<b>Focus</b> discussion on Problem Context	Clarify Design Specifications and Constraints	Begin Discussion of Module Overview
1	<b>Organize</b> for Informed Design		Discussion of design process and recording/reporting requirements
2-7	<b>Coordinate</b> Student Progress	Research and Investigation	Conduct KSB 1— Geometric Shapes  Conduct KSB 2— Ratio and Proportion  Conduct KSB 3— Sketching  Conduct KSB 4—Aesthetics  Conduct KSB 5—Pricing Information
8-9	<b>Coordinate</b> Student Progress	Generate Alternative Designs	Create Sketches and/or Models of Alternative Design Solutions
9	<b>Coordinate</b> Student Progress	Choose and Justify Optimal Design	Select and Defend Choice of Preferred Alternative Solution
10-14	<b>Coordinate</b> Student Progress	Construct a Working Model	Develop Plans for Construction and Build Model
15	<b>Unite</b> Class Thinking Accomplishments	Test and Evaluate the Design Solution	Develop Plans for Testing and Test the Design Solution
16	<b>Sum</b> up Progress on Learning Goals		Class Presentations of Methods and Results.

# Bedroom Design – Student Worksheets



**Class and Period** \_\_\_\_\_ **Date:** \_\_\_\_\_

**List students in Group:**

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**Materials you will need:**  card stock or index cards  colored paper  
 foam board or cardboard  markers

**State what the design challenge is:**

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## 1. Clarify the Design Specifications and Constraints

What are the specifications and constraints the design must meet?

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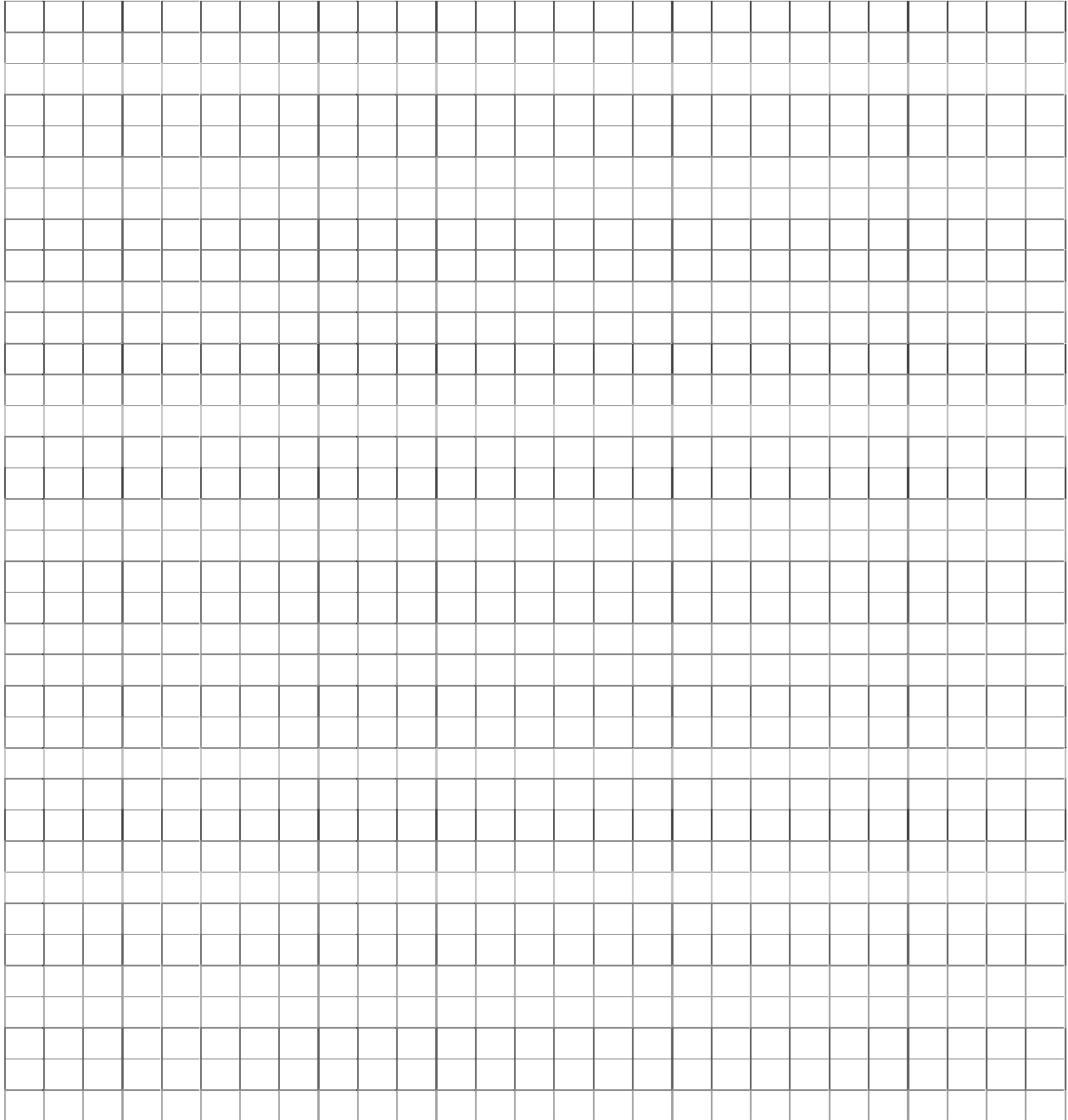
## 2. Research and Investigate

In order to better complete the design challenge, you need to first gather information to help you build a knowledge base. Completing the Knowledge and Skill Builders that follow will enhance your ability to design a cost-effective and functional bedroom.

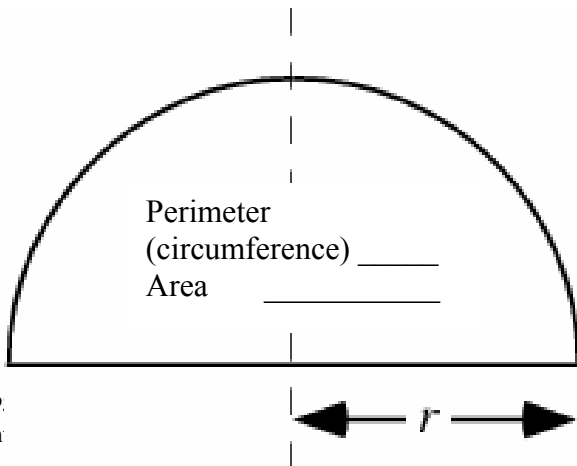
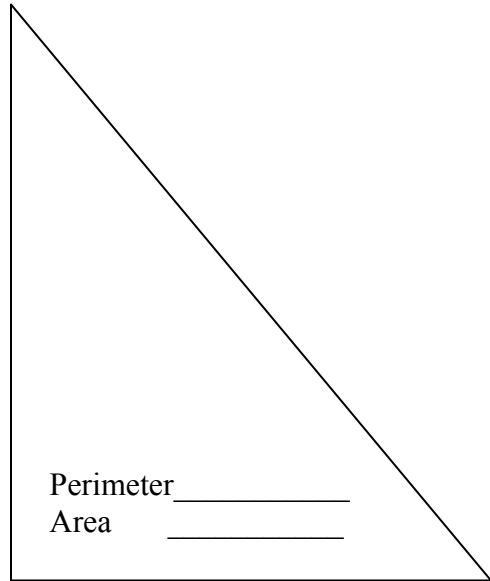
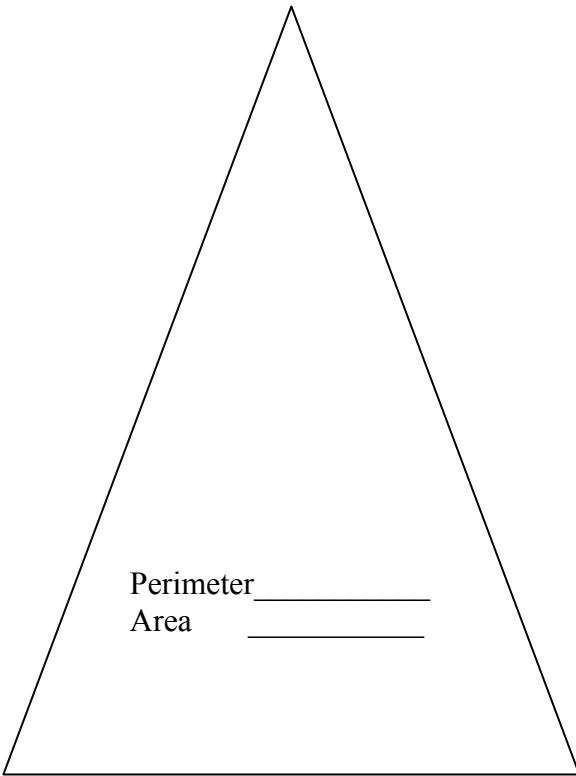
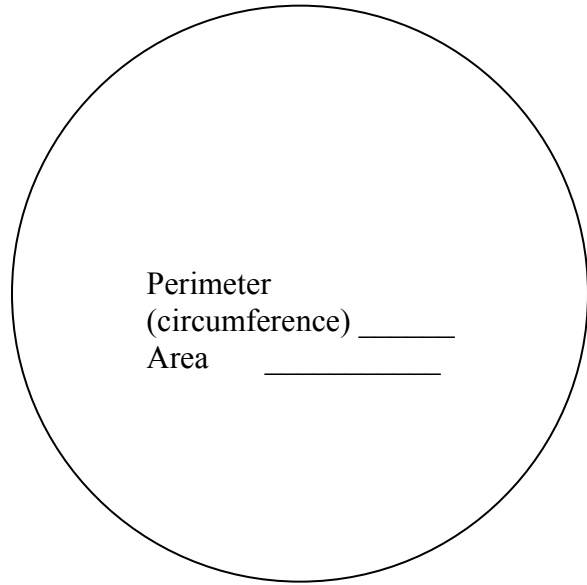
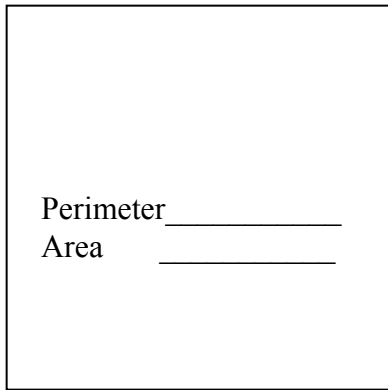
### Knowledge and Skill Builder 1: Geometric Shapes

Your room will be rectangular, but the windows may be any shape. Also, part of the floor may be hardwood; the rest may be carpeted. It is important to understand different geometric shapes so you can use them in your design. In this KSB you will draw different geometric shapes and determine their areas and perimeters.

A. Sketch several different rectangles that have an area of 24 square units. (Show the whole numbers used for the dimensions).



B. Measure the dimensions of the following shapes, in inches, and determine their perimeters (in inches) and their areas (in square inches).



C. If you wanted to have a triangular room, what might be a logical set of dimensions (remember, the area must be at least 120 square feet).

Base \_\_\_\_\_ Height (of triangle, not wall height) \_\_\_\_\_

Area \_\_\_\_\_ (in square feet)

## Knowledge and Skill Builder 2. Ratio and Proportion

Scale models help in visualizing what the finished room will look like. Instead of making a full-size drawing, we can use a scale in which 1 inch equals 1 foot. If the full-size dimension is 12 feet, the scaled dimension – the line we draw to represent 12 feet – is 12 inches long.

1. On separate sheets of paper, make three scale drawings of a room that measures 12 feet by 15 feet. Make one drawing for each ration:  $\frac{1}{2}$  inch = 1 foot, 1 inch = 1 foot, and 2 inches = 1 foot (You will need to use large sheets of paper for the last two drawings).

Which scale drawing can provide the most detail? Why?

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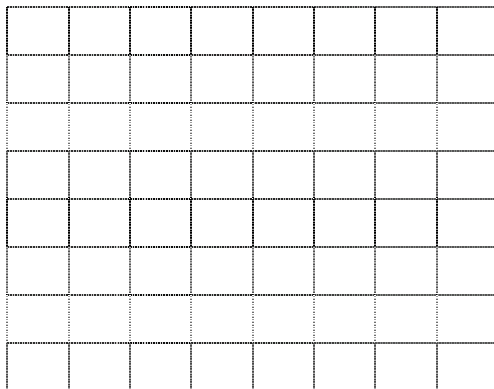
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2. What is 10% of 120 square feet? \_\_\_\_\_ How might you use this answer to find 20% of 120 square feet? \_\_\_\_\_  
What is 20% of 120 square feet? \_\_\_\_\_

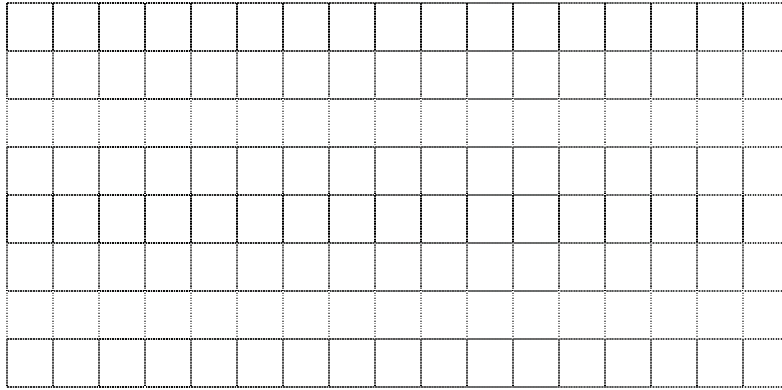
3. Assume that a room you are designing has dimensions of 12 feet by 13 feet. What is the floor area? \_\_\_\_\_

If the window area must be 20% of the floor area, what is the total window area? \_\_\_\_\_

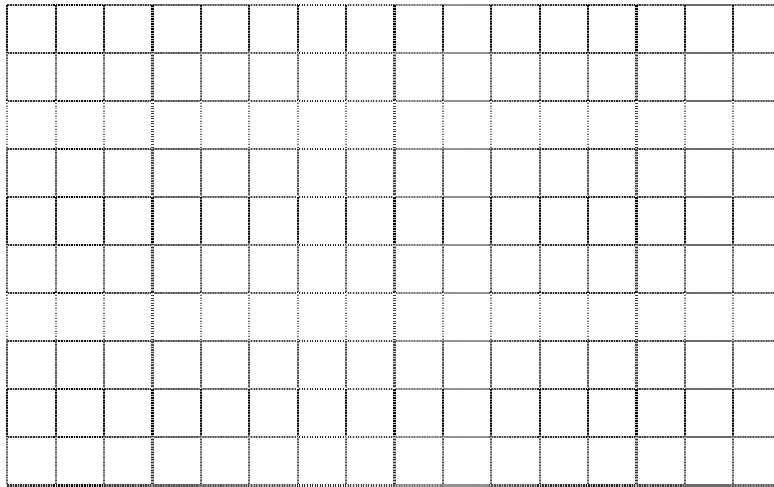
What could be the dimensions of a square window? \_\_\_\_\_  
Sketch a possible square window on the grid below using a scale of  $\frac{1}{4}$ " = one foot.



What could be the dimensions of a rectangular window? \_\_\_\_\_  
Sketch a possible rectangular window on the grid below using a scale of  $\frac{1}{4}$ " = one foot.



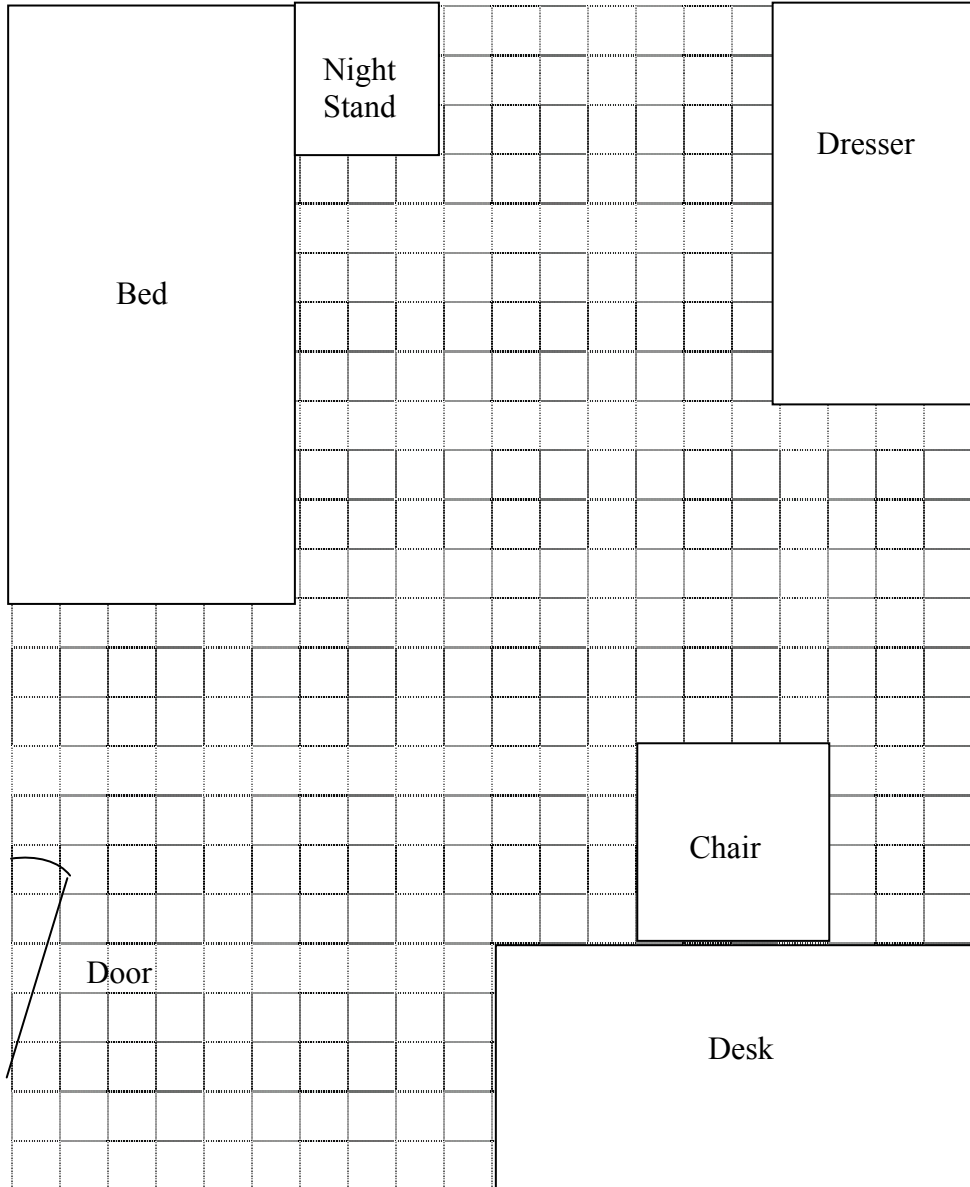
What could be the dimensions of a triangular window? \_\_\_\_\_  
Sketch a possible triangular window on the grid below using a scale of  $\frac{1}{4}$ " = one foot.



4. If a room has dimensions of 10 feet x 12 feet, and a rug on the floor has dimensions of 5 feet x 6 feet, what percent of the floor area is covered by the rug? \_\_\_\_\_  
If the rug is 8 feet x 9 feet, what percent of the floor area is covered by the rug? \_\_\_\_\_

### Knowledge and Skill Builder 3. Sketching, Measuring, and Calculating

Using the sketch of the room below, determine the percent of the floor area that is covered by each piece of furniture and the total percent of coverage. **Note that the scale is  $\frac{1}{2}$ " = 1 foot.**



Total floor area _____ square feet	Percentage of floor area _____
Area of bed _____ square feet	Percentage of floor area _____
Area of night stand _____ square feet	Percentage of floor area _____
Area of dresser _____ square feet	Percentage of floor area _____
Area of chair _____ square feet	Percentage of floor area _____
Area of desk _____ square feet	Percentage of floor area _____
Total percentage of floor area covered _____	

### Knowledge and Skill Builder 4. Aesthetics

What is the atmosphere you would like to create in your bedroom? Will it be vibrant and alive? Quiet and cozy? The shape and design of your furnishings and the location of windows and skylights can have a great effect. Describe the atmosphere you want. Indicate your preferences for the shape and design of furnishings and the placement of windows.

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Choose a color scheme. You can use pleasing color combinations wherever you like.

What color(s) should your room be? \_\_\_\_\_

What color should the floor be? \_\_\_\_\_

What color(s) should the furnishings be? \_\_\_\_\_

### Knowledge and Skill Builder 5. Pricing Information

The following worksheet can be used for prices in designing your bedroom. However, they may not represent the best prices available. Investigate costs in catalogs or newspaper advertisements and change prices to make your worksheet more accurately reflect real costs.

Bedroom Design Worksheet for \$15,000 Budget			
Variable-cost items The costs are variable because the number of square feet (or square yards) can vary according to how much you buy.	Size (sq. ft. or sq. yards)	Cost	Total Cost
Room and Closet	_____ square feet	\$75/square foot	
Carpeting	_____ square yards.	\$15/square yard	
Hardwood floors	_____ square feet	\$4/square foot	
Soundproof interior walls	_____ square feet	\$0.20/square foot	
Window	_____ square feet	\$20.00 square foot	

<b>Fixed-cost Items</b> The costs are fixed because the item has an assigned cost.	<b>Size: H x W x D (inches)</b>	<b>Cost</b>
Bed, Twin	20 x 35 x 75	\$400
Bed, Bunk	62 x 35 x 75	\$800
Bed, Double	20 x 54 x 75	\$500
High Dresser	46 x 38 x 22	\$400
Low Dresser	33 x 36 x 18	\$300
Mirror	30 x 20 x 1	\$100
Night Stand	24 x 20 x 20	\$100
Ceiling Lamp	18 diameter (D)	\$75
Desk Lamp	18 d x 20 h	\$50
Floor Lamp	14 d x 20 h	\$75
Desk	28 x 30 x 60	\$350
Desk Chair	30 x 20 x 20	\$150
High Bookcase	80 x 32 x 12	\$150
Low Bookcase	40 x 32 x 12	\$100
Easy Chair	30 x 28 x 26	\$300
Stereo Unit	9 x 24 x 15	\$300
Computer and Printer		\$1000
Telephone		\$50
Television		\$250
Phone Jack		\$75
Cable Television Jack		\$75
	<b>Subtotal Cost</b>	

Variable-Cost Subtotal = \_\_\_\_\_

Fixed-Cost Subtotal = \_\_\_\_\_

Total Cost = \_\_\_\_\_

### 3. Generate Alternative Designs

Sketch two of your possible alternative solutions to the bedroom design problem. Remember to consider the specifications and constraints. Include a description of what you consider to be each solution's strengths and weaknesses. Use additional sheets of paper if necessary.

A large grid of graph paper, consisting of 20 columns and 25 rows of small squares, intended for sketching alternative designs.

#### 4. Choose and Justify the Optimal Solution

Choose your preferred solution. Explain how your solution meets the specifications and constraints. What makes this alternative better?

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What tradeoffs if any, did you make in selecting this alternative?

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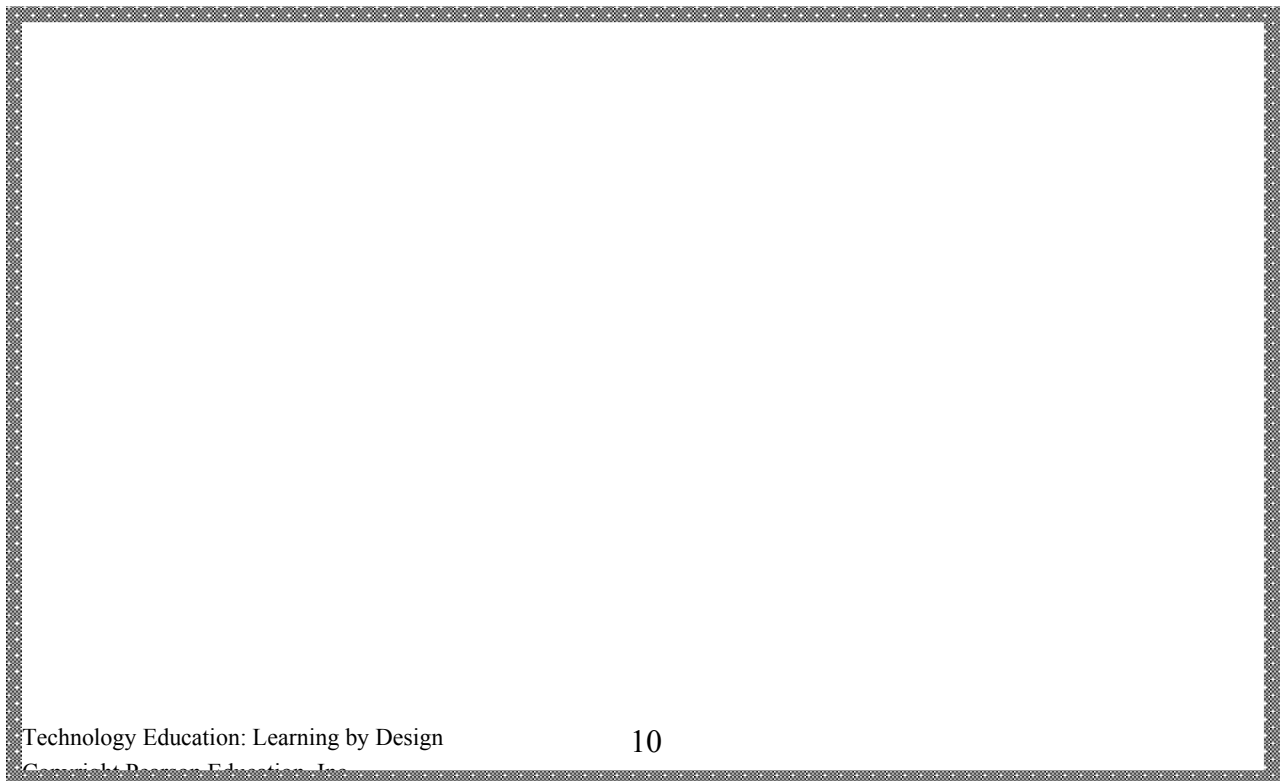
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#### 5. Develop a Prototype

Construct a scale model of your bedroom. Include an isometric drawing, orthographic drawings, or a photograph of your model.



## 6. Test and Evaluate

Did your design meet the initial specifications and constraints? Indicate the tests you conducted and the experiments you performed to verify this.

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Besides the initial specifications, did your particular design include any other specifications, such as the size of the wheels or the specific materials to be used? Describe the testing procedure and explain how the design meets all the specifications.

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## SELF-ASSESSMENT

Use this scoring guide to judge your success.

	Excellent (4)	Good (3)	Adequate (2)	Resubmit (1)
<b>Research and Investigation:</b> I completed all the Knowledge and Skill Builders. I fully answered all the questions asked within them.				
<b>Alternative Designs:</b> I provided at least two sketches with good detail and with all important elements included.				
<b>Optimal Design:</b> I justified the optimal design solution with a detailed explanation as to why it was the best alternative and why it would meet the specifications and constraints.				
<b>Constructing a Prototype:</b> I constructed a prototype based on the optimal solution. I explained changes I made. I included a final sketch of the prototype.				
<b>Testing and Evaluation:</b> I tested and evaluated the final design. The tests were conducted in a reliable and scientific fashion, and I repeated the tests. I explained why the testing was reliable.				
<b>Data Analysis:</b> I constructed data tables based on the testing and used this information to explain the results from testing.				
<b>Meeting Specifications and Constraints:</b> The design worked; it solved the problem and met the specifications and constraints.				
<b>Redesign:</b> I analyzed the results from testing and made sense of them using math, science, and technological knowledge. Based on this, I made recommendations for design improvements.				
<b>Communication:</b> I made a well-organized, clear, written and oral presentation to my class. I discussed each aspect of the design during the presentation.				
<b>Teamwork:</b> Our group worked well together during the entire project. We planned tasks and helped each other, maintaining interest and effort throughout.				
<b>TOTAL POINTS =</b>				