Name_____ Date _____

Chapter 3 Performance Task

Quonset Huts

Instructional Overview	
Launch Question	Over 153,000 Quonset huts were procured by the United States Navy during the 1940s. The most common huts were 20 feet wide and 48 feet long. How many different sizes of Quonset huts can you design that have approximately the same volume as this model? How do the surface areas of your new huts compare to the original model?
Summary	Students will calculate the volume of a standard Quonset hut and derive dimensions for new sizes of Quonset huts. Then they will calculate surface areas for the new models and brainstorm why the standard model was so popular. Data will be represented in tables.
Teacher Notes	This task is best done in groups and is an opportunity to use a spreadsheet as a tool in the lesson. Students will initially be faced with two variables in their problem solving process, so they may need guidance in choosing values for one of the variables and calculating the remaining one. Encourage students to explore different approaches to this task. For example, if they are setting the radius equal to integers in their process and finding new lengths, ask them what would happen if they had set their length to integers instead. Why might one way be better than another? As students develop their strategies and equations, encourage them to use different tools for their calculations, in particular a spreadsheet.
Supplies	Handouts, calculators, computers with a spreadsheet tool if desired
Mathematical Discourse	How does changing the shape and dimensions of a building affect the efficiency of the building?
Writing/Discussion Prompt	What compromises must an engineer make involving dimensions when designing a building? How will the decisions be different if price is not a factor? if the budget is very tight? if the building is a school? if the building is hotel?

Curriculum Content	
Content Objectives	• Write a polynomial function that describes a relationship between two quantities. • Organize and compare data. • Identify local minimums of graphs of polynomial functions.
Mathematical Practices	Mathematically proficient students make a plan to design Quonset huts of different sizes with the same volume and persevere in designing the huts and comparing their sizes.

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Chapter 3 Performance Task (continued)

Rubric

Quonset Huts	Points
1. a. The dimensions should be correctly labeled. The width should be 20 feet and the length should be 48 feet. The radius should represent only half the base of the hut. **b.** $S = 580\pi \approx 1822$ ft^2; $V = 2400\pi \approx 7540$ ft^3	**4** Total possible points **2** for each correct part
2. *Sample answer:* Find the volume of the standard hut. Then assign a value to the radius and see what is needed for the length to obtain the same volume. A calculator and spreadsheet are helpful.	**5** Detailed description of a practical plan **3** Description of a practical plan **1** Description of a plan
3. *Sample answer:* for (r, ℓ): $(7, 98)$, $(8, 75)$, $(9, 59.25)$, $(11, 39.7)$, $(12, 33.3)$, $(13, 28.4)$, $(14, 24.5)$; calculations verify volume of new design = volume of common hut ***Table used to organize calculations	**14** Total possible points **2** for each set of new dimensions with calculations verifying volume organized in a table
4. *Sample answer:* The hut has to be tall enough for the average person to stand up in, but also wide enough to easily fit things like beds; It is a compromise of useable space (ceilings tall enough and floor wide enough) to be practical while using a minimum material.	**3** Total possible points **1** for an accurate comparison **1** for a description of limitations **1** for a thorough explanation of popular dimensions
5. *Sample answer:* for (r, ℓ, S): $(7, 98, 2309)$, $(8, 75, 2086)$, $(9, 59.25, 1930)$, $(11, 39.7, 1752)$, $(12, 33.3, 1708)$, $(13, 28.4, 1691)$, $(14, 24.5, 1693)$; The surface area of the common hut is close to the average of the surface areas. ***Table used to organize and show dimensions	**8** Total possible points **1** for each correct surface area **1** for an accurate comparison
6. no; *Sample answer:* The radius required to minimize the surface area is close to zero. This radius is not realistic.	**2** Total possible points **1** for determining minimizing surface area is not reasonable **1** for a thorough explanation
Mathematical Practices: Mathematically proficient students make a plan to design Quonset huts of different sizes with the same volume and persevere in designing the huts and comparing their sizes. The students determine a process to use, what information they will need to gather, and what tools to use. Once students have followed their plan to design new huts, they compare their data.	**4** The student develops a practical plan and implements the plan to create new designs and compares these designs to the common design. Partial credit may be awarded.
Total Points	**40 points**

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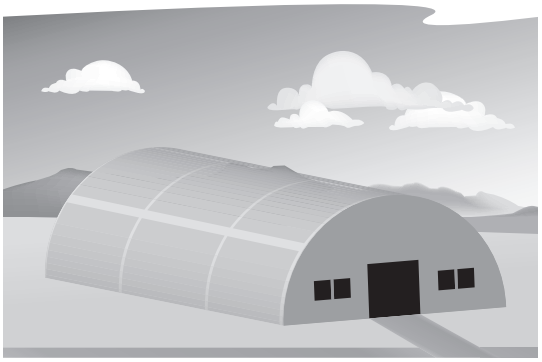
Chapter 3 Performance Task (continued)

Quonset Huts

Over 153,000 Quonset huts were procured by the United States Navy during the 1940s. The most common huts were 20 feet wide and 48 feet long. How many different sizes of Quonset huts can you design that have approximately the same volume as this model? How do the surface areas of your new huts compare to the original model?

1. Quonset huts are temporary, all-purpose structures shaped like half-cylinders.



a. Label the picture using the dimensions of the most common Quonset huts.

b. The surface area S of a hut is given by $S = \pi r^2 + \pi r\ell$, and its volume is given by $V = \frac{1}{2}\pi r^2 \ell$. Find the surface area and volume of the common hut.

2. Make a plan to design Quonset huts of different sizes that have approximately the same volume. How will you determine the new dimensions? What information do you need before you begin? What tools could help you in this task? Explain your process.

3. What new dimensions will result in the same volume as the common Quonset hut? Find the dimensions of at least seven new designs and verify that each new design has approximately the same volume as the common hut. Use a table to organize your calculations.

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Performance Task (continued)

4. Compare the dimensions of your new huts to those of the common Quonset hut. What practical limitations are there on the parameters of radius and length? Explain why the dimensions of 20 feet by 48 feet may have been so popular.

5. Calculate surface area for your new designs and include this information in your table. Compare the surface area of your new designs to that of the common hut.

6. In theory, minimizing the surface area of the hut would minimize the cost of construction. Is it reasonable to use dimensions that minimize the surface area to build a Quonset hut with the same volume as the common hut? Explain.

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Performance Task (continued)

Teacher Notes: