

THE STAINED GLASS WINDOW

Performance Standard 9B.H

Analyze a scale drawing to determine the actual size of pieces of a stained glass window:

- *Mathematical knowledge:* Measure drawing, use proportional reasoning to determine measurements of actual figure;
- *Strategic knowledge:* Solve problem using proportions, tables or charts;
- *Explanation:* Explain completely what was done and why it was done.

Procedures

1. Provide students with sufficient learning opportunities to develop the following in order identify, describe, classify, and compare relationships using points, lines, planes and solids:
 - Create and analyze scale models using proportional reasoning.
 - Solve problems involving similar figures.
2. Provide students with the assessment task worksheet and a ruler with markings of cm and mm. Have students work individually. Calculators may be used.

Use measurement techniques, and be as accurate as your measuring tools will allow. The diagram at the right is a scale drawing of a stained-glass window that is known to have a dimension of 36 in. by 36 in. What is the measure of one side of the smaller regular decagon in the center of the real window? What is the length of one side of the larger decagon near the exterior of the window? Explain your reasoning.
3. Use the standard scoring rubric. Give each student a score in each of the three categories. A score of 4 should indicate completely correct solutions to all parts of the problem, with complete and correct justifications of their reasoning. A three should represent correct or nearly correct solutions to all parts, with only minor computational errors making their solutions inaccurate, their rationale should be sound, but may not be completely explained. A two would indicate that students have some idea about how to answer the questions, but make major errors in computation and or reasoning that effects their answers. A one may have a correct answer for one part, but generally shows little understanding in their rationale for their procedures and processes. A score of zero generally reflects no correct responses and no logical rationale for their procedures and processes.
4. Minor errors in computation include making errors in the actual addition or multiplication, rounding incorrectly. Major errors include using the wrong operations or formulas to relate terms.
5. The window pictured measures 7 cm x 7 cm, and which corresponds to 36 in x 36 in. The inner decagon measures 0.7 cm per side, so it would correspond to a measure of 3.6 inches in the full sized window. The larger decagon would have a side measuring about 2.2 cm, corresponding to approximately 11.3 inches in the original window. Students should show some sort of proportional reasoning to arrive at these answers, either by actually setting up proportions and solving, or by using tables or charts and patterns to help. In any case a written explanation of what they are doing and a justification for why they set up the proportion, or table, etc is also needed. This should include a description about what each quantity represents as well as the relationship between the quantities.

Examples of Student Work follow

Time Requirements

- One class period

Resources

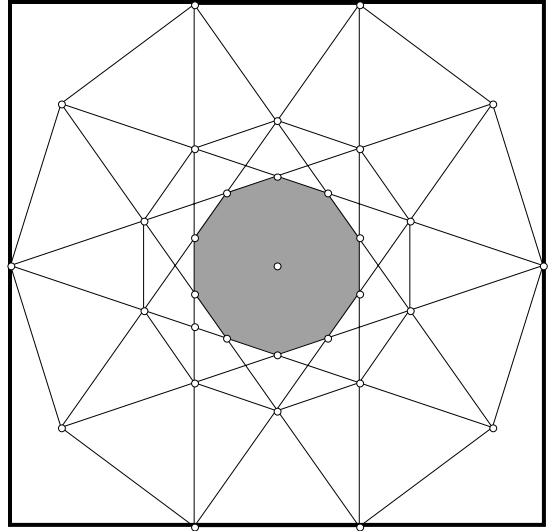
- Copies of “The Stained Glass Window” task sheet
- Ruler containing cm and mm markings
- Writing utensil
- Calculators may be used
- Mathematics Rubric

NAME _____ DATE _____

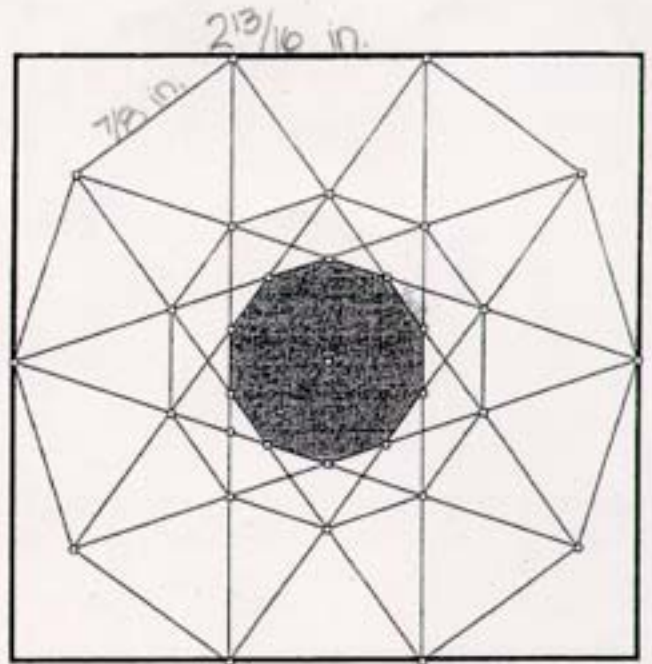
THE STAINED GLASS WINDOW

Student Task Sheet

Use measurement techniques, and be as accurate as your measuring tools will allow. The diagram at the right is a scale drawing of a stained-glass window that is known to have a dimension of 36 in. by 36 in. What is the measure of one side of the smaller regular decagon in the center of the real window? What is the length of one side of the larger decagon near the exterior of the window? Explain your reasoning.



Use measurement techniques, and be as accurate as your measuring tools will allow. The diagram at the right is a scale drawing of a stained-glass window that is known to have a dimension of 36 in. by 36 in. What is the measure of one side of the smaller regular decagon in the center of the real window? What is the length of one side of the larger decagon near the exterior of the window? Explain your reasoning.



I conclude that the length of the larger decagon is $11\frac{1}{5}$ in. The smaller decagon's side is equal to $3\frac{1}{5}$ in.

I started by using a ruler - since the problem stated to "use measurement techniques" - ; measuring the sides of the square. It measured up to $2\frac{13}{16}$ in. I continued measuring one side of the larger decagon ; one side of the smallest decagon. The decagon measured up to $\frac{7}{8}$ in. ; the smallest decagon measured to $\frac{1}{4}$ in. I decided to set up a proportion to help me solve for the sides on the scale drawing.

$$\frac{\text{the reality measure of the length of square} - 2\frac{13}{16}}{\text{the reality measure of the length of the largest decagon} - \frac{7}{8}} = \frac{36 - \text{the length of square on the scale drawing}}{x - \text{the side of the largest decagon on the scale drawing}}$$

I then cross multiply :

$$\frac{2^{13}/16x}{2^{13}/16} = \frac{31\frac{1}{2}}{2^{13}/16} \quad (\text{I cross-multiplied})$$

I divided by $2^{13}/16$ by $2^{13}/16 \dots$

$x = 11\frac{1}{5}$; got $x = 11\frac{1}{5}$ in. (the largest decagon's side length)

I set up a second proportion:

the reality measure of the square

the reality measure of the smallest decagon's side

$$\frac{2^{13}/16}{1/4}$$

$$\frac{36}{y}$$

- based on diagram drawing, the length of the square
- the side length of the smallest square

I cross-multiplied to solve:

$$\frac{2^{13}/16 y}{2^{13}/16} = \frac{9}{2^{13}/16}$$

I divided 9 by $2^{13}/16$ to solve for y.

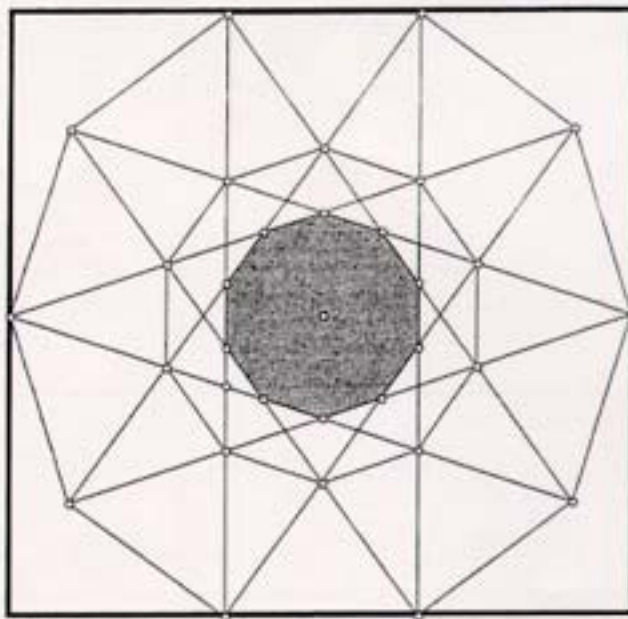
$$y = 3\frac{1}{5}$$

So the smallest decagon's side length is $3\frac{1}{5}$ in.

So I conclude that the smallest decagon's side length is $3\frac{1}{5}$ in. ; the largest decagon's side length is $11\frac{1}{5}$ in.

Student Task Sheet

Use measurement techniques, and be as accurate as your measuring tools will allow. The diagram at the right is a scale drawing of a stained-glass window that is known to have a dimension of 36 in. by 36 in. What is the measure of one side of the smaller regular decagon in the center of the real window? What is the length of one side of the larger decagon near the exterior of the window? Explain your reasoning.



scale
 $36 \text{ in} = 70 \text{ mm}$

small decagon = $7 \text{ mm} = 3\frac{3}{5} \text{ in}$
 large decagon = $22 \text{ mm} =$

$2 \times \frac{36 \text{ in}}{70 \text{ mm}} = \frac{? \text{ in}}{22 \text{ mm}} \times \frac{22 \text{ mm}}{1} = 11.31 \text{ in.}$

First, in solving this problem I found the scale. I did this by measuring the length of the drawn square, and comparing that to the measurements of the actual window. I did this so I could convert the other measurements I make to the measurements of the actual window. I found that the scale is 36 in : 70 mm. With this in mind, I measured the length of the smallest decagon, and got 7 mm. Since 7 mm is $\frac{1}{10}$ of 70 mm, I just took $\frac{1}{10}$ of 36 in. to get $3\frac{3}{5}$ in., which is the length of the smallest decagon in the real window. Next, I measured the side of the largest decagon, and got 22 mm. Since this number has no direct relationship with the number 70, I used ratios. In my ratio, I put 36 in over 70 mm ($\frac{36}{70}$) because that is my original ratio that was found. I then put that to equaling $\frac{?}{22}$ since the question mark is what I'm trying to find. Then, to get rid of the 22, I had to multiply both sides by 22 because what is done to one side must be done to the other. I then could cancel out all the labels that were mm, and the 22's because they were diagonal from each other. What I was left with was $22 \times \frac{36}{70}$. So I multiplied 22 by 36 & got 792. I then divided this by 70, and got ≈ 11.31 in. Therefore, the window picture measures 70 mm by 70 mm, which corresponds to 36 in. by 36 in. The inner decagon measures 7 mm per side, which corresponds to $3\frac{3}{5}$ in. per side. Finally, the large decagon measures 22 mm per side, which corresponds to 11.31 in. per side.