# Ring Around the Rose Window

# Elaborate

## Purpose:
To acquire a deeper understanding of how technology can elevate the level of problem solving in the application of geometric concepts. Generate a list of attributes to guide judicious use of technology.

## Descriptor:
Participants will utilize technology to plan, construct, and analyze a complex geometric figure. They will compare and contrast a pencil and paper approach and a technology based approach.

## Duration:
2 hours

## TEKS:

G.1A    develop an awareness of the structure of a mathematical system, connecting definitions, postulates, logical reasoning, and theorems;

G.2B    use constructions to explore attributes of geometric figures and to make conjectures about geometric relationships;

G.3B    construct and justify statements about geometric figures and their properties;

G.4     select an appropriate representation (concrete, pictorial, graphical, verbal, or symbolic) in order to solve problems.

G.5C    use properties of transformations and their compositions to make connections between mathematics and the real world, such as tessellations; and

G.9C    formulate and test conjectures about the properties and attributes of circles and the lines that intersect them based on explorations and concrete models; and

G.10A   use congruence transformations to make conjectures and justify properties of geometric figures including figures represented on a coordinate plane; and

G.11A   use and extend similarity properties and transformations to explore and justify conjectures about geometric figures;

G.11B   use ratios to solve problems involving similar figures;

## TAKS Objectives:
- Objective 6: Geometric Relationships and Spatial Reasoning
- Objective 7: Two- and Three-Dimensional Representations of geometric relationships and shapes
- Objective 8: Concepts and Uses of Measurement and Similarity
- Objective 10: Mathematical Processes and Tools

## Technology:

- Dynamic geometry software such as Geometer's sketchpad

## Materials:

**Advance Preparation:**

- Participant access to computers with Geometer's Sketchpad (latest version update available from http://www.keypress.com/sketchpad) and/or a projection device to use Geometer's Sketchpad as a whole group demonstration tool
- Sketchpad sketch **Rose** (for leaders use)
- **Rose Hint Cards** copied on cardstock and cut out
- **Transparency:  Rose Window**
- **Transparency 1:  Looks Like—Sounds Like**
- **Transparency 2:  Looks Like—Sounds Like**
- **Transparency:  Teaching Strategies**
- **Transparency:  Student Research**

**For each participant:**

- Ruler
- Protractor
- Compass
- Patty paper
- **Ring Around the Rose Window** activity sheets
- **Understanding the Problem and Planning the Solution** activity sheets
- **Constructing the Rose** activity sheet

**For each group of 2 participants:**

- Computers with Geometer's Sketchpad and Microsoft Excel
- Copy of the Technology Tutorial $T^2$

# Ring Around the Rose Window—Leader Notes

*This activity asks the participants to construct a complex two-dimensional figure that integrates a variety of geometric concepts. The determination of when, where and how to apply those concepts requires a great deal of problem-solving. This activity was designed for teachers. The construction with technology provides A successful backdrop for problem-solving. It is highly recommended that leaders work through the construction prior to presenting this activity*

## Posing the Problem:

*Use the transparency, Rose Window to pose the problem*

**A common architectural feature used in construction during the renaissance was the rose window. It can be found on palaces, cathedrals, and other buildings of that time. Originally made of stone and glass the windows consisted of a large circle with decorative features arranged like spokes of a wheel in the interior of the circle.**

**Attributes of the window:**
- **The window (figure 1) is made up of a central circle with twelve spokes**
- **The distance from *A* to *C* is three times the distance from *A* to *B***
- **The smaller circles are tangent to each other**
- **The arcs at the outer edge of the circle are tangent to each other and tangent to the smaller circle on its spoke**

**Your task is to use geometric tools to reproduce this window. The reproduction should be scalable with no visual defects.**
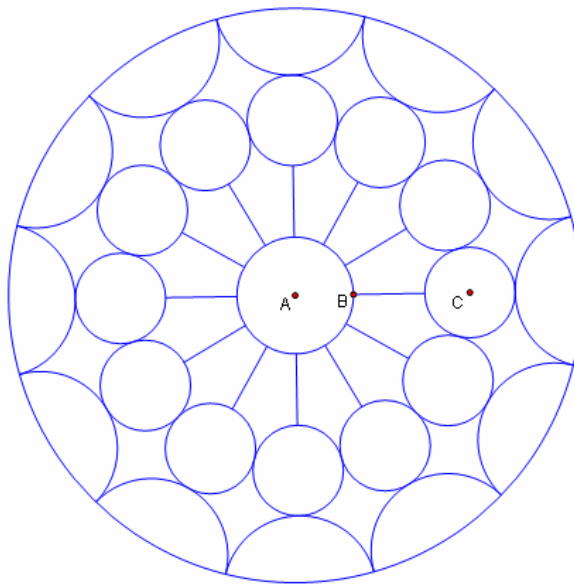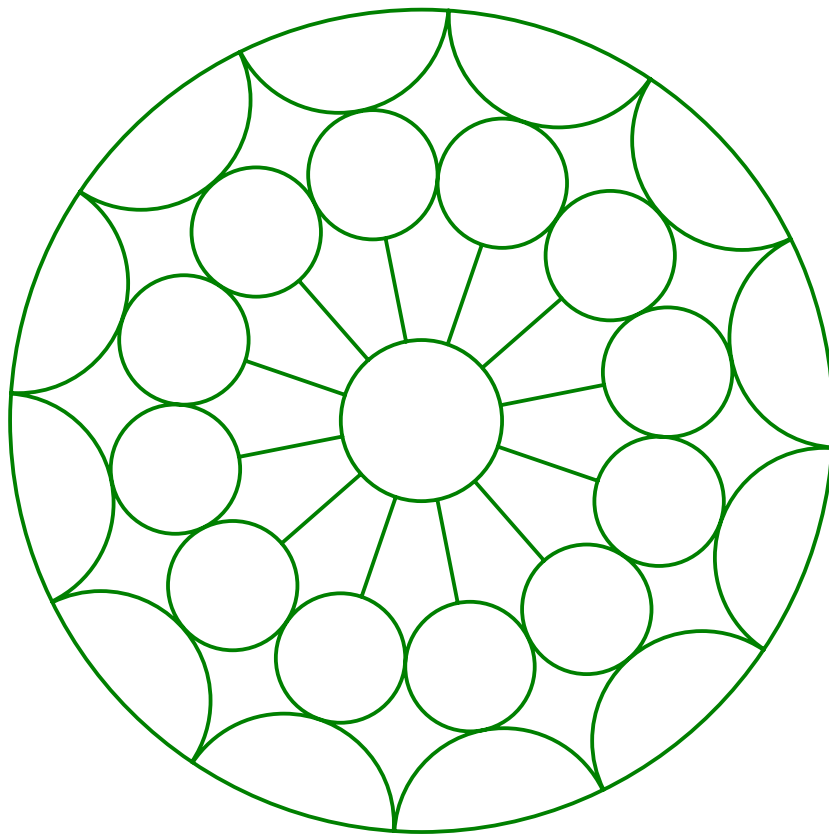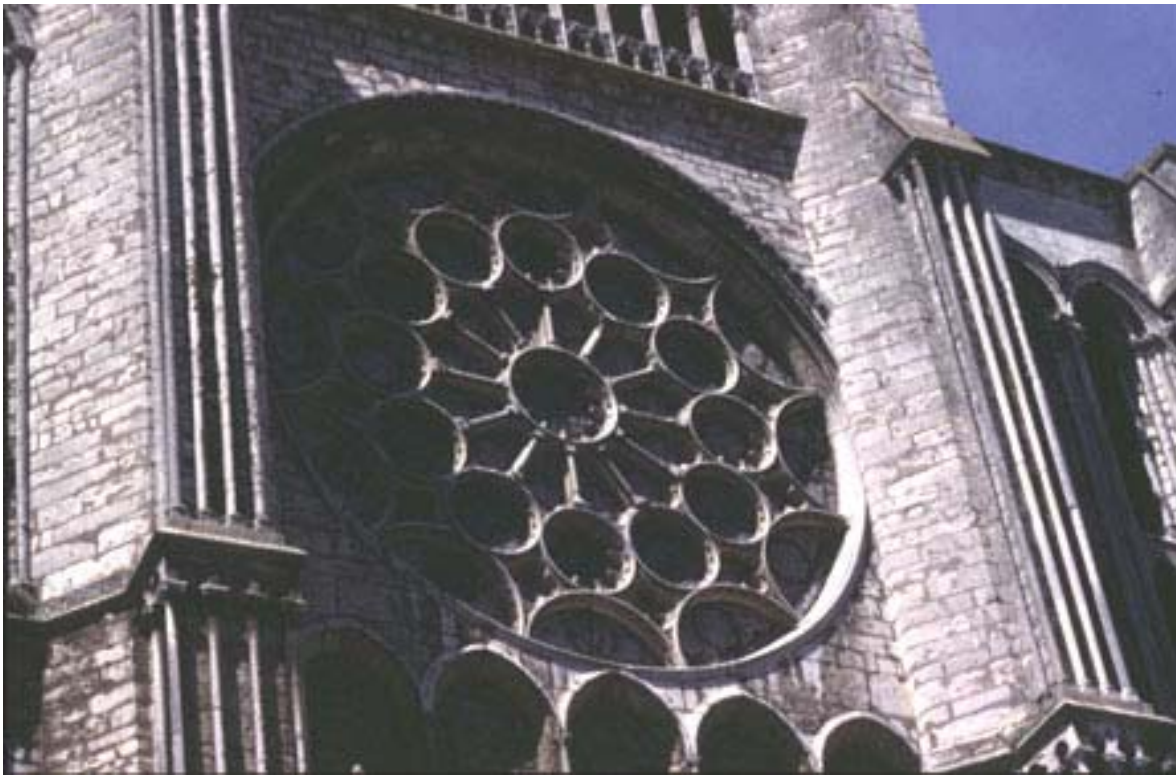
**Figure 1.**

Your task is to use geometric tools to reproduce this window. The reproduction should be scalable with no visual defects.

# Understanding the Problem and Planning the Solution
*(30 minutes)*

1.  **Which geometric concepts and skills can be identified in the picture?**

    *Possible responses might include; rotational symmetry, transformation, rotation, dilation, tangent, proportion, circle angle properties, and circle arc properties.*

2.  **List as many problem-solving strategies as you can recall. Which strategies will you use to perform your construction?**

    *Possible responses might include; simplify the problem, draw a picture or diagram, apply a rule, look for a pattern, write a number sentence, guess and check, make a model, act out the problem, make an organized list or table, divide into smaller simpler problems, and work backwards*

    *Participants might use divide into smaller simpler problems, draw a picture, simplify the problem, and apply a rule.*

3.  **Determine a plan for your construction utilizing pencil and paper techniques. What will you do first, second, etc…? Write your plan below including any diagrams or rough sketches and justifications.**

    *The intention at this point is to have participants think through the construction not formally construct it by hand.*

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**Facilitation Questions**
- What impact can enlarging or reducing the figure have on visual defects?
  *Often a defect is not visible until the figure is enlarged*
- How might you construct a circle whose center is one and one-half times the length of the radius of the center circle from the center of the original circle?
  *Reflect the original circle over a line perpendicular to the radius of the original circle.*
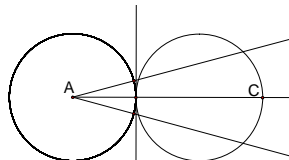


- How might you construct a circle tangent to a line?
  *Recall that a tangent and a radius of the circle are perpendicular. Construct a perpendicular to the desired line through the point that will serve as the center of the circle.*

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4. **What geometric concepts will you utilize to carry out your plan?**

   *Possible responses might include; reflection, rotation, translation, dilation and scaling, tangent, proportion, circle angle properties, and circle arc properties.*

5. **How can you determine if your pencil and paper construction is scalable with no visual defects?**

   *Possible responses might include using a copy machine to enlarge or reduce the figure.*

6. **What are some of the challenges to constructing the figure with pencil and paper?**

   *Possible responses might include; accuracy, knowledge of construction techniques, etc…*

# Constructing the Rose
*(1 hour)*

**1. Construct the rose window using Geometer's Sketchpad**

*Leaders can find one possible solution in the Rose Technology Tutorial.*
*Leaders can provide assistance to participants by using the Rose Hint Cards. When participants are stuck or need a small amount of help just hand them a hint card for the part of the construction they are working on. If time is running short and participants are not finishing their construction, direct them to the tutorial. Leaders can demonstrate the tutorial to allow participants to see a completed construction. Participants will need to use proportional reasoning at some point during their construction. Many may choose to use cross products. If they do, ask them to explain how the cross product is connected to the geometric relationship, in other words, where does the cross product comes from.*

We are trying to determine x, the distance from A, for the placement of the center of the circle used to create an arc that is tangent to circle C and to the rays that make up the central angle that contains the arc.

$$\frac{AB = 6.09\ cm}{AC = 8.22\ cm} = \frac{AD = 10.35\ cm}{x}$$
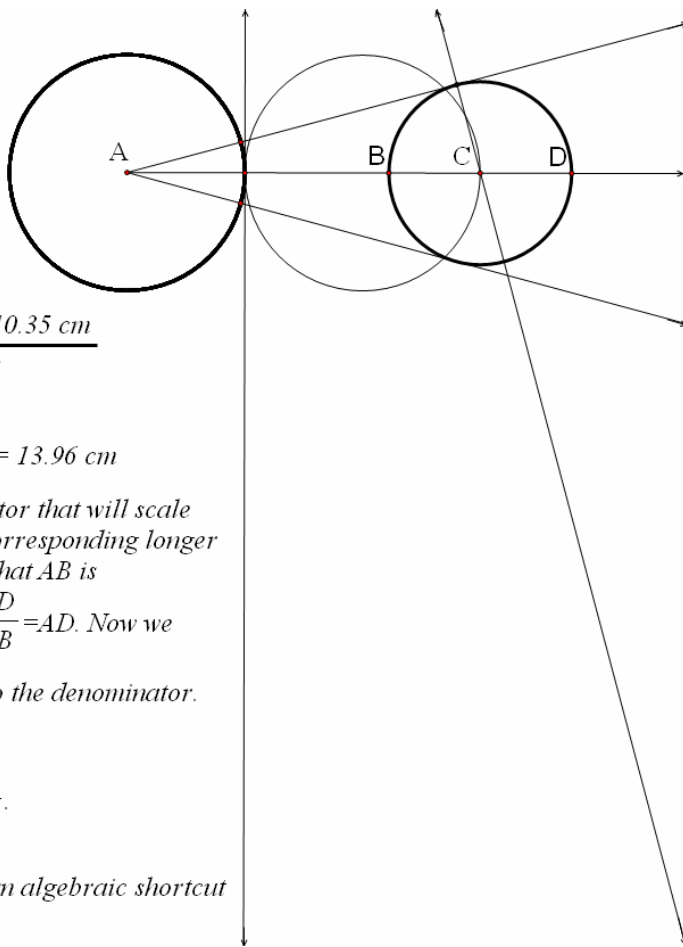
$$x = \frac{AC \cdot AD}{AB} = 13.96\ cm$$

We need to determine the factor that will scale the shorter lengths to their corresponding longer lengths. We can use the fact that AB is proportional to AD. So $AB \cdot \frac{AD}{AB} = AD$. Now we apply the scale factor $\frac{AD}{AB}$ to the denominator.

$$\frac{AB \cdot \frac{AD}{AB}}{AC \cdot \frac{AD}{AB}} = \frac{AD}{x}. \text{ So } x = \frac{AC \cdot AD}{AB}.$$

The cross product is merely an algebraic shortcut for this process.

**2. Did you have to alter your plan for constructing the figure? If so, how and why.**

*There are construction techniques that are specific to the technology software just as there are to ruler compass or paper folding. These techniques typically rely more heavily on transformations than pencil and paper methods*

# Technology Reflection

*(30 minutes)*

1.  *Upon completion of their construction, prompt participants to work in pairs to brainstorm the role(s) technology played in the construction versus a pencil and paper approach*

2.  *Repost the Venn diagram summaries from the Engage phase.*

3.  *Prompt the participants to collect the "green sheets" from each Explore/Explain phases, the summaries about the intentional use of data that followed each Explore/Explain phase.*

4.  *Display the* **Transparency:  Teaching Strategies** *and prompt participants to reflect on the following question, "How do the summaries on the Venn diagrams, our summaries about the use of data, and the activities reflect the following four teaching strategies for developing judicious users of technology?"*

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Facilitation Questions
- How have the experiences in this professional development promoted careful decision-making about the appropriate use of technology?
  *Participant responses might include:*
  *Measuring the polygons and using the technology helped to see how students could use technology to explore different relationships in a limited amount of time.*
  *The sketchpad activities show that as a learning tool, technology should be available to students whenever possible.*
- How was technology used in the teaching and the learning of the TEKS?
  *Participant response might include:*
  *Technology was used as a tool to collect and explore data.*
  *Technology was used as a tool to explore algebraic relationships.*
- When was technology use promoted? Why?
  *Participant responses might include:*
  *Technology was promoted when we measured the polygon perimeters and radii so we could compare traditional measurement techniques to technological measurement techniques.*
  *Technology was promoted in the geometric properties exploration to allow a plethora of applications of geometry.*
  *Technology was promoted in the circle exploration to enhance the understanding of possible relationships within circles.*
  *Technology was promoted in the Rose construction to make a complicated construction more manageable.*

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Facilitation Questions (continued)

- When was technology use restricted? Why?
  *Participant responses might include:*
  *Technology was restricted when we measured the polygon perimeters and radii so we could compare traditional measurement techniques to technological measurement techniques.*
  *Technology was restricted when we constructed parallel line on the magazine cover so we could compare traditional construction techniques to technological construction techniques.*
- How did the technology support anticipatory, or "what if…," thinking about "algebraic and geometric insight?"
  *Participant responses might include:*
  *Technology addressed the "what if" the polygon is bigger question.*
  *Technology allowed an unlimited number of applications of geometric properties.*
  *Technology answered the relationship question for circles.*
  *Technology allowed a difficult construction to become more manageable.*

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5. *Prompt the participants to respond to the following statement and question: "A successful teacher is one who uses technology judiciously. What does this ideal teacher look like and sound like?" as described on* **Transparency 1: Looks Like—Sounds Like** *Record the participants' responses on sentence strips Post the sentence strips randomly so that they are visible to the entire group Use participants as scribes as needed to facilitate the recording process.*

6. *Prompt the participants to respond to the following statement and question: "A successful student is one who uses technology judiciously. What does this ideal student look like and sound like during the completion of this activity?" as described on* **Transparency 2: Looks Like – Sounds Like.** *Record the participant responses on sentence strips. Post the sentence strips so that they are visible to the entire group.*

7. *Direct the participants to work in small groups to brainstorm categories for classifying the "looks like" and "sounds like" responses.*

**Facilitation Questions**

- Do any of these responses require the teacher or the student to make decisions about technology use? Is this important? Should we add some responses?
  *Answers may vary.*
- Do any of these responses reflect decision making about how to best integrate technology? Is this important? Should we add some responses?
  *Answers may vary.*
- Do any of these responses reflect decision making about when to use or when not to use technology? Is this important? Should we add some responses?
  *Answers may vary.*
- Do any of these responses reflect the need for thinking about how the technology provides "geometric insight?" Is this important? Should we add some responses?
  *Answers may vary.*

8. *As a whole group, debrief the categories created by small groups. Reorganize the sentence strips into broad categories. As a whole group, create titles for each of these categories. Record each title on a separate sheet of chart paper. Post the chart paper and reorganize the related sentence strips as shown below. Enlist participants to help with this process.*

*Sample Category:*
Student Choice

The teacher allows students to select the computer or the graphing calculator and refrains from commenting while students decide.

The student chooses to use a scatterplot instead of a table to represent her data.

9. *Prompt the participants to consider adding additional statements to any of the categories listed above that are not already posted. Reorganize "looks like, sounds like" sentence strips as needed*

10. *Distribute sentence strips to each group that are a different color than the previously used sentence strips. Prompt each group to generate two classroom suggestions for each category. Examples may include "The teacher should ask, 'Should we use the spreadsheet to make our prediction or verify our prediction? Why:?'", "Students monitor their own use and misuse of technology," "Include examples that require technology use," "Do not allow students to use technology until after prediction are made and justified."*

*11. Prompt participants to post their sentence strips as shown below.*

> *Sample Category:*
> Student Choice

> The teacher allows students to select the computer or the graphing calculator and refrains from commenting while students decide.

> The teacher posts a transparency that says, "Which tool will you use? Go there!"

> The teacher provides students with a "pros and cons" chart to develop for the computer and the graphing calculator and then directs students to select a tool.

*12. Ask the participants to summarize any trends or patterns observed in the classroom suggestions.*

*13. Read the statement by Ball and Stacey found on **Transparency: Student Research** as a closing thought to this phase of the professional development.*

# Transparency: Rose Window
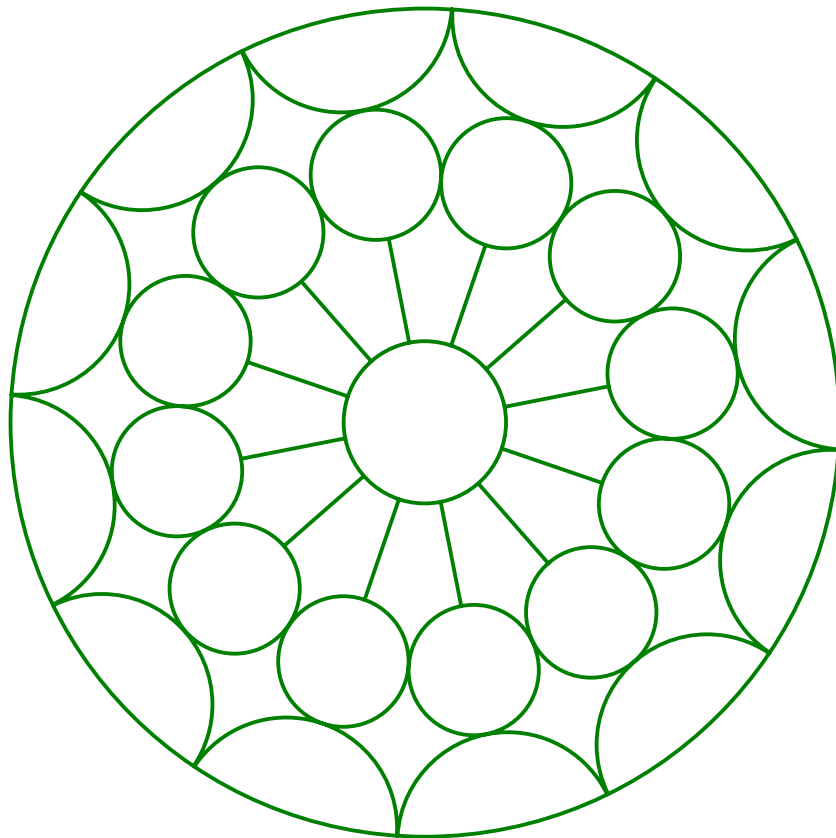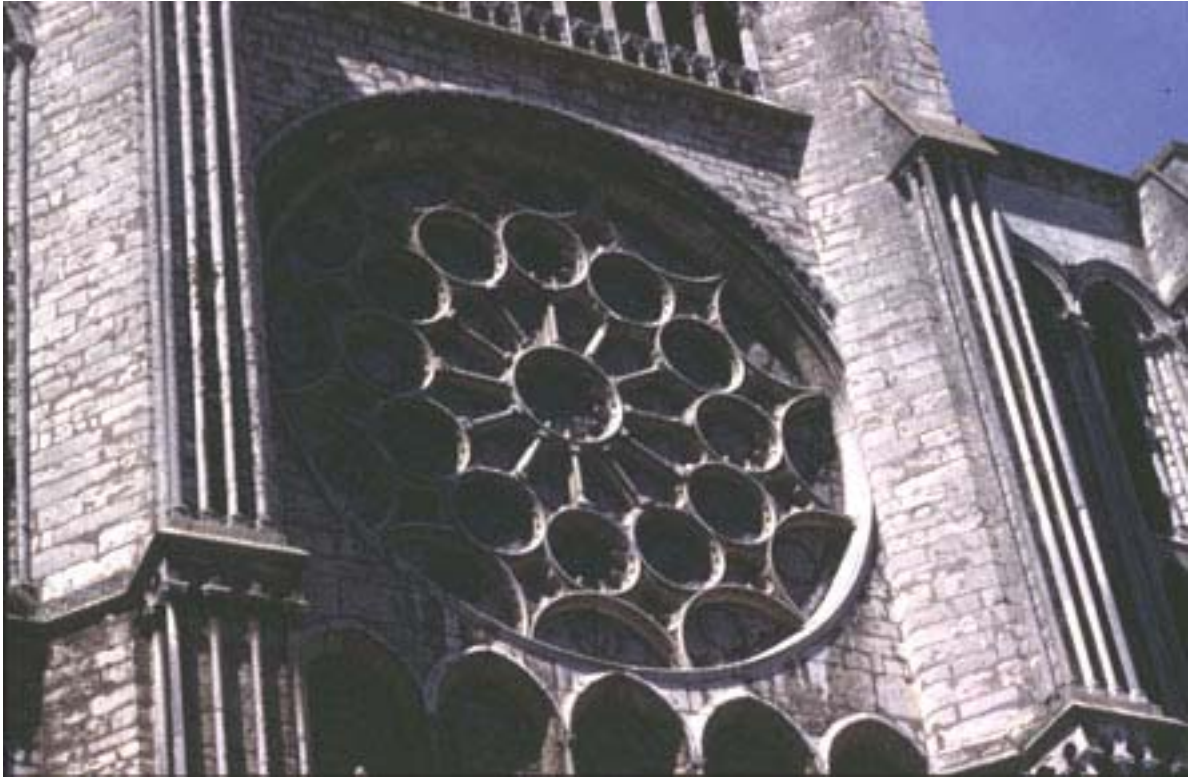
# Transparency 1: Looks Like – Sounds Like

A successful teacher is one who uses technology judiciously.

What does this ideal teacher look like and sound like in this activity?

| Looks like… | Sounds like… |
| --- | --- |
|  |  |

# Transparency 2: Looks Like – Sounds Like

A successful student is one who uses technology judiciously.

What does this ideal student look like and sound like during the completion of this activity?

| Looks like… | Sounds like… |
| --- | --- |
|  |  |

# Transparency: Teaching Strategies

"How do the summaries on the Venn diagrams, our summaries about the use of data, and the activities reflect to the following four teaching strategies for developing judicious users of technology?"

Judicious users of technology:

a. Promote careful decision-making about the appropriate use of technology.

b. Integrate technology whenever relevant to the mathematical learning goals.

c. Promote and restrict the use of technology when appropriate for promoting mathematical learning.

d. Promote anticipatory thinking about "geometric insight."

# Transparency: Student Research

Research by Pierce (2002) indicates that some students are always judicious users and others persist with passive or random, unthinking use. However, she found that a large, middle group can be helped to learn to work judiciously.

Ball & Stacey, 2005, p5

Ball, L., & Stacey, K(2005)Teaching strategies for developing judicious technology use. In Masalski, WJ., & Elliott, PC(Eds.), *Technology-supported mathematics learning environments, sixty-seventh yearbook*, pp3-16Reston, VA: National Council of Teachers of Mathematics.
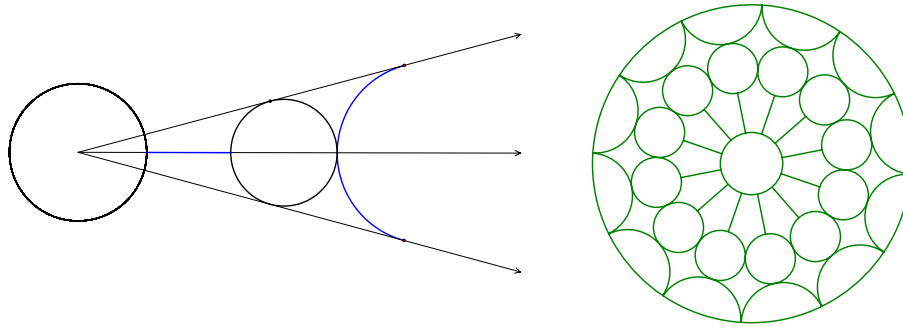
## Activity Master

# Rose Hint Cards

**BREAK A LARGE PROBLEM INTO SMALLER PARTS**
Since there are 12 congruent spokes in the figure focus on one spoke, then rotate it around the circle.

**USING TRANSFORMATIONS TO FIND A DISTANCE**
To find a point that is one and one-half times the radius of circle *A,* from *A* reflect circle *A* over a line tangent to circle *A.* In this example *C* is one and one-half times the radius of circle *A* from *A.*
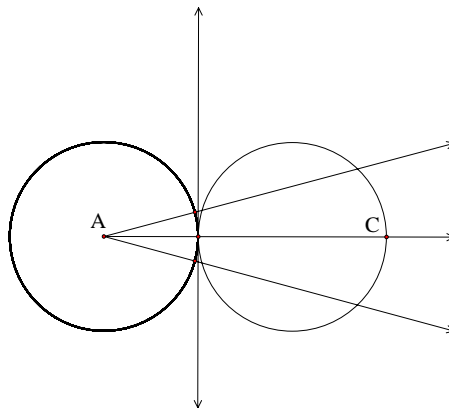
**CONSTRUCTING A CIRCLE TANGENT TO A RAY**
Recall that a tangent is perpendicular to the radius of the circle.
Construct a perpendicular to $\overrightarrow{AT}$ through *C*. Construct a circle with center *C* and radius $\overline{CT}$ .
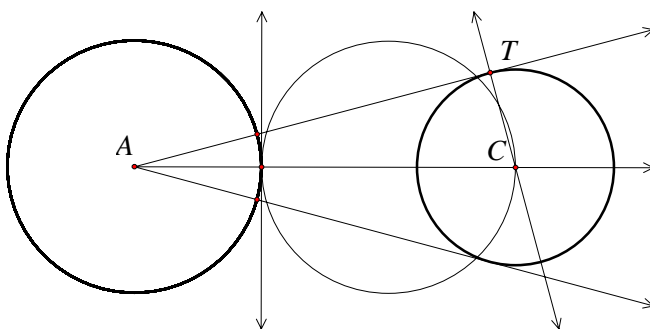


**DETERMINING A PROPORTIONAL DISTANCE**
Since we are dealing with a dilation, *AB* is proportional to *AD* and *AC* is proportional to *AF* or *x* in the equation. Solve the proportion and set the distance $\dfrac{AC \cdot AD}{AB}$ as a marked distance. Next translate *A* by that marked distance. It doesn't matter what direction. Finally construct a circle with center *A* and radius $\overline{AA'}$ . The intersection of the circle and $\overrightarrow{AC}$ yields *F* for *AF*.

$$\frac{AB = 2.29\ cm}{AC = 3.08\ cm} = \frac{AD = 3.88\ cm}{x}$$

$$x = \frac{AC \cdot AD}{AB} = 5.24\ cm$$
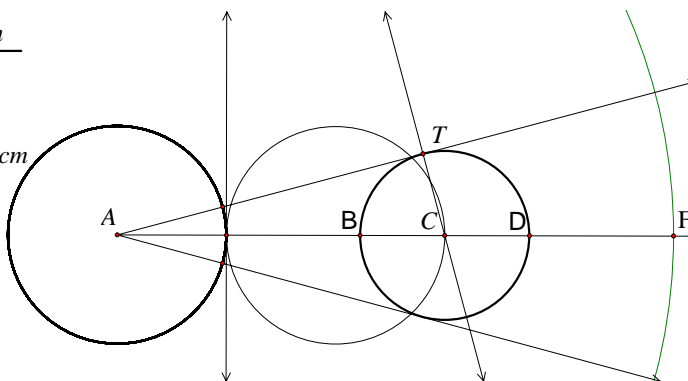
# Ring Around the Rose Window

A common architectural feature used in construction during the renaissance was the rose window. It can be found on palaces, cathedrals, and other buildings of that time. Originally made of stone and glass the windows consisted of a large circle with decorative features arranged like spokes of a wheel in the interior of the circle.

**Attributes of the window:**
- **The window (figure 1) is made up of a central circle with twelve spokes.**
- **The distance from A to C is three times the distance for A to B.**
- **The smaller circles are tangent to each other.**
- **The arcs at the outer edge of the circle are tangent to each other and tangent to the smaller circle on its spoke.**

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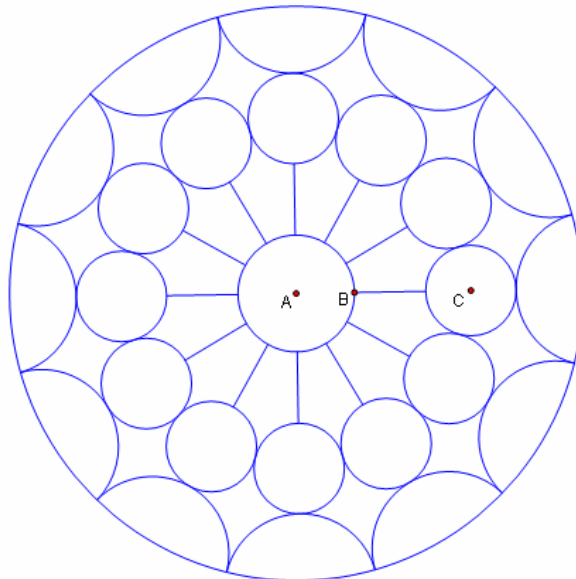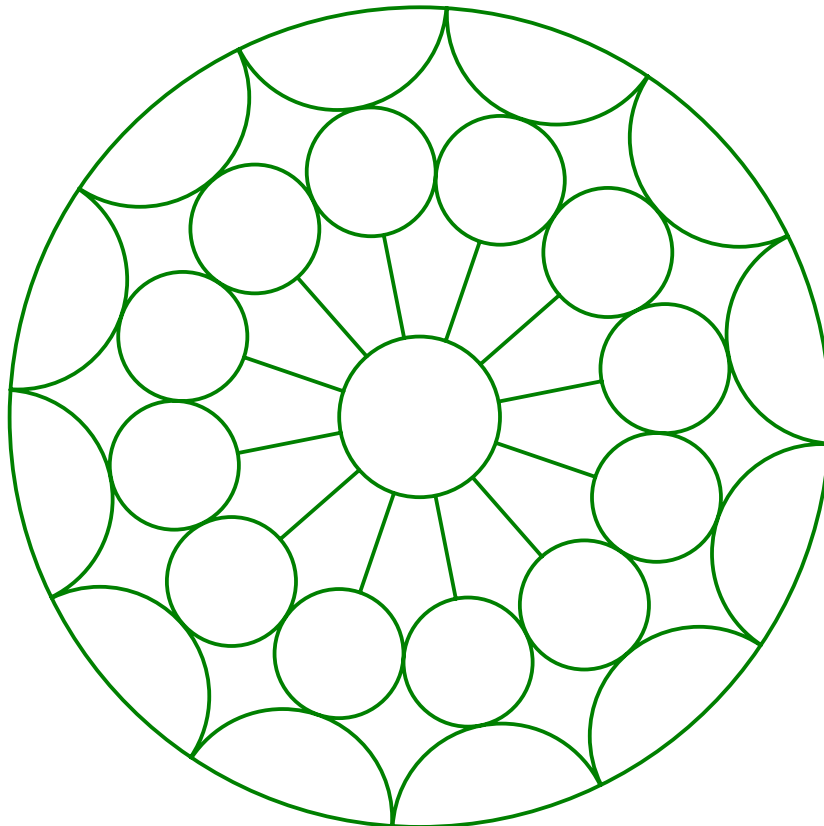
**Figure 1.**

## Understanding the Problem and Planning the Solution

1. Which geometric concepts and skills can be identified in the picture?

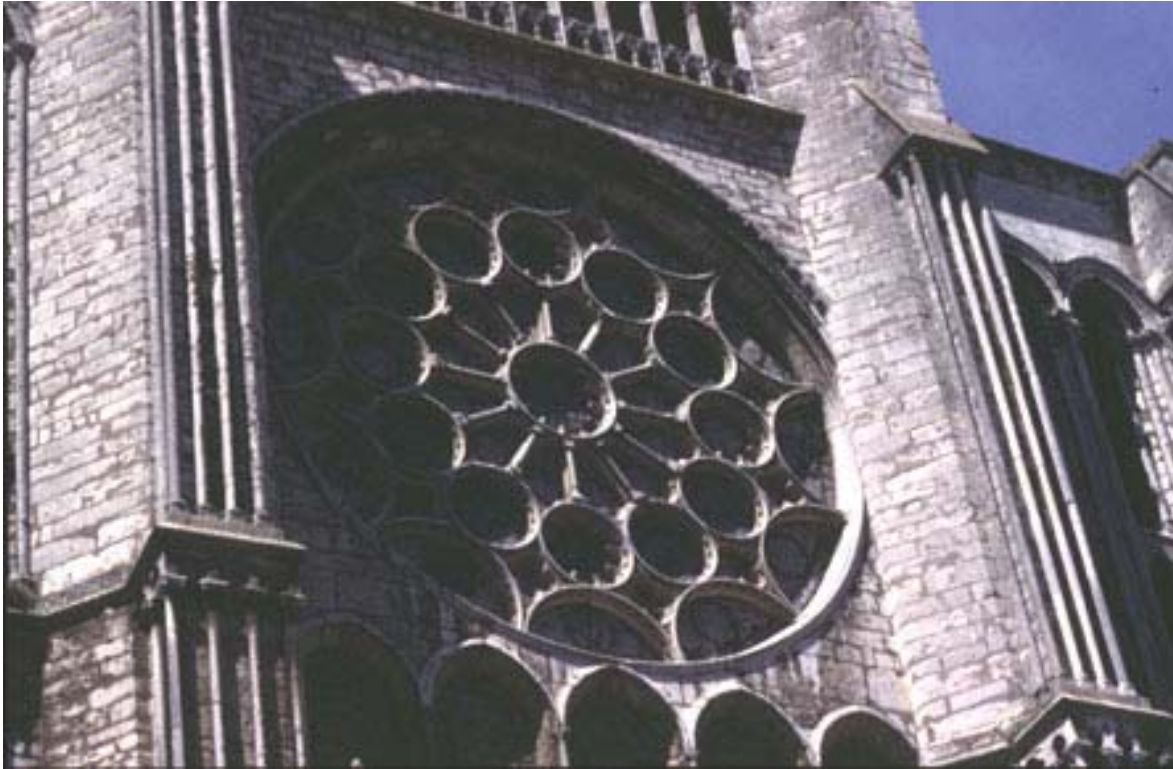2. List as many problem-solving strategies as you can recall. Which strategies will you use to perform your construction?

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# Constructing the Rose

1. Construct the rose window using Geometer's Sketchpad.

2. Did you have to alter your plan for constructing the figure? If so, how and why.