**Project Title:** Stars Are Not Pointless

**Project Idea:** You are engineers working for Architect Designs & Innovations. A major competitor claims that their n-point, 3-dimensional stars are more aesthetically pleasing than other stars on the market.  After purchasing several stars from the major competitor and analyzing their shape and design, the research department of your company found that the Golden Ratio is not present in the shape of their stars. Your graphics art department concluded that incorporating the Divine Proportion into the shape and design of the stars would increase the aesthetic beauty, thus surpassing that of the competitor’s stars. Your potential customers would be asked to provide the radius and number of points they desire in their 3-dimensional star. Prepare a presentation to the design branch of Architect Designs & Innovations that includes detailed drawings, derivation of all formulas and numerical justifications of formulas for two different stars. Your drawings need to show the use of the Golden Ratio, the radius of the star, the horizontal distance (on the wall) from the center of the star to the vertex of the interior angles (interior radius), the measure of the interior angle between the points of the star, the measure of the angle at the tip of each point (on the wall), the height of the star at the center (distance from the wall at the center), the measures of the angles of each triangular face and the lengths of sides of each triangular face. You should also develop formulas to find the area of each triangular face and the total area of the triangular faces. To minimize cost, each triangular section of the star will be a separate piece punched from a rectangular sheet of material and assembled in the factory. Your presentation should include the procedure to find the dimensions of the rectangular sheet with the least area needed to construct the star. Provide sound mathematical evidence for each detail.

**Entry Event:**

Invite a representative from a local decorations and/or architectural design businesses to initiate student interest by sharing his knowledge about using the golden ratio in art, decorations and architectural design. Provide the representative with the following ideas to guide their presentation.

Discuss the Golden Ratio in nature.

Discuss using the Golden Ratio in art, decorations and architectural design.

Look at [Golden Ratio Resources](#GoldenRatioResources).

Discuss how Country Stars can be found all over the nation.

Look at [Pictures of Country Stars](#PicturesOfCountryStars).

**West Virginia College- and Career Readiness Standards:**

|  |  |
| --- | --- |
| **Objectives Directly Taught or Learned Through Inquiry/Discovery** | **Evidence of Student Mastery of Content** |
| 1. Make sense of problems and persevere in solving them. 2. Reason abstractly and quantitatively. 3. Construct viable arguments and critique the reasoning of others. 4. Model with mathematics. 5. Use appropriate tools strategically. 6. Attend to precision. 7. Look for and make use of structure. 8. Look for and express regularity in repeated reasoning. | Proficient students clarify the meaning of real world problems and identify entry points to their solution. They choose appropriate tools and make sense of quantities and relationships in problem situations. Students use assumptions and previously-established results to construct arguments and explore them. They justify conclusions, communicate using clear definitions, and respond to arguments, deciding if the arguments make sense. They ask clarifying questions. Students reflect on solutions to decide if outcomes make sense. They discern a pattern or structure and notice if calculations are repeated, while looking for both general methods and shortcuts. As they monitor and evaluate their progress, they will change course if necessary. |
| M.3HS.25 (+,^)  Derive the formula *A* = 1/2 *ab* sin(*C*) for the area of a triangle by drawing an auxiliary line from a vertex perpendicular to the opposite side. | The student will demonstrate mastery by completing activity sheets from "Discovering Formulas to Solve Oblique Triangles," notes from "Investigating Formulas to Solve and Find the Area of Oblique Triangles," the activity sheet from "Explore Oblique Triangles for the SAS case" and the response sheet from "Explore Oblique Triangles for the SSA case" at a level of success designated by the teacher.  The student will demonstrate mastery by completing [3-D Example](#ThreeDExample), [Demonstrating and Applying the Derived Formulas](#DemonstratingAndApplyingTheDerivedForm) and [Project Scenario](#ProjectScenario) at a level of success designated by the teacher. |
| M.3HS.26 (+,^)  Prove the Laws of Sines and Cosines and use them to solve problems. Instructional Note: With respect to the general case of the Laws of Sines and Cosines, the definitions of sine and cosine must be extended to obtuse angles. | The student will demonstrate mastery by completing activity sheets from "Discovering Formulas to Solve Oblique Triangles," notes from "Investigating Formulas to Solve and Find the Area of Oblique Triangles," the activity sheet from "Explore Oblique Triangles for the SAS case" and the response sheet from "Explore Oblique Triangles for the SSA case" at a level of success designated by the teacher.  The student will demonstrate mastery by completing [2-D Silhouette Example](#TwoDSilhouetteExample), [3-D Example](#ThreeDExample) and [Demonstrating and Applying the Derived Formulas](#DemonstratingAndApplyingTheDerivedForm) at a level of success designated by the teacher. |
| M.3HS.27(+,^)  Understand and apply the Law of Sines and the Law of Cosines to find unknown measurements in right and non-right triangles (e.g., surveying problems and/or resultant forces). | The student will demonstrate mastery by completing activity sheets from "Discovering Formulas to Solve Oblique Triangles," notes from "Investigating Formulas to Solve and Find the Area of Oblique Triangles," the activity sheet from "Explore Oblique Triangles for the SAS case" and the response sheet from "Explore Oblique Triangles for the SSA case" at a level of success designated by the teacher.  The student will demonstrate mastery by completing [2-D Silhouette Example](#TwoDSilhouetteExample), [3-D Example](#ThreeDExample) and [Demonstrating and Applying the Derived Formulas](#DemonstratingAndApplyingTheDerivedForm) at a level of success designated by the teacher. |

**Performance Objectives:**

**Know**

Recognize information needed for problem solving

Know the Law of Sines and the Law of Cosines

Know the definitions that relate the trigonometric functions to the sides of a right triangle

Know Heron’s formula

Know the formulas to find area of a triangle given SAS, AAS or ASA

**Do**

Find all the missing parts of a triangle

Make a drawing to represent a specific example

Use the appropriate formula to find the area of a triangle and the area of figures

Use technology tools and multiple media sources to analyze a real-world problem

Use multiple perspectives and can represent a problem in more than one way

Exhibit positive leadership through interpersonal and problem-solving skills that contribute to achieving the goal

Work collaboratively to acquire information from electronic resources

Engage in a problem solving process by formulating questions and applying complex strategies in order to independently solve problems

Use multiple electronic sources of information and multiple technology tools

Make informed choices among available advanced technology systems, resources and services

Use technology to seek strategies and information to address limits in knowledge

Use advanced features of word processing and spreadsheet software

Create information using advanced skills of analysis, synthesis and evaluation and shares this information through a variety of oral, written and multimedia communications

**Driving Question:**

How can trigonometry be used to determine the design requirements of an n-point, 3-dimensional star?

**Assessment Plan:**

[2-D Silhouette Example](#TwoDSilhouetteExample): The foreman of your engineering division is asking each member of your team to construct a 2-D silhouette example (outline of the star by tracing its borders on the wall) of an n-point, 3-dimensional star, to be used as models to check your team's final formulas. Each member of your team needs to choose the radius and the number of points for their star. To check the integrity of your final formulas, your team members should choose a variety of radii and number of points for their models. Create a spreadsheet that contains the information that will be needed to check your final formulas. Your team must prepare a presentation to your engineering division that details how each member constructed their star and determined the data values in the spreadsheet. Provide sound mathematical evidence for each detail.

[3-D Example](#ThreeDExample): The foreman of your engineering division is asking each member of your team to construct a 3-D example of an n-point, 3-dimensional star that can be placed on their 2-D silhouette example. This model will also be used to check your team's final formulas. Each member of your team will use the radius and the number of points from their 2-D silhouette example. Add information that will be needed to check your final formulas to your spreadsheet from your 2-D silhouette example. Your team must prepare a presentation to your engineering division that details how each member constructed their star and determined the data values in the spreadsheet. Provide sound mathematical evidence for each detail.

[Demonstrating and Applying the Derived Formulas](#DemonstratingAndApplyingTheDerivedForm): In only a few days, your engineering team will make their presentation to the design branch of Architect Designs & Innovations, detailing the derivation of formulas, and graphical representations that models the rectangular sheet with least area and the dimensions of an n-point, 3-dimensional star, given the radius and the number of points. The Chief Engineer is requesting from each of you, a persuasive essay that shows the derivation of formulas, demonstrates the use of formulas, shows drawings of your 2-D silhouette example and 3-D example, includes a detailed spreadsheet, and justifies the measures of your 2-D and 3-D examples using the derived formulas. Provide sound mathematical evidence for each detail.

[Project Scenario](#ProjectScenario): You are engineers working for Architect Designs & Innovations. A major competitor claims that their n-point, 3-dimensional stars are more aesthetically pleasing than other stars on the market.  After purchasing several stars from the major competitor and analyzing their shape and design, the research department of your company found that the Golden Ratio is not present in the shape of their stars. Your graphics art department concluded that incorporating the Divine Proportion into the shape and design of the stars would increase the aesthetic beauty, thus surpassing that of the competitor’s stars. Your potential customers would be asked to provide the radius and number of points they desire in their 3-dimensional star. Prepare a presentation to the design branch of Architect Designs & Innovations that includes detailed drawings, derivation of all formulas and numerical justifications of formulas for two different stars. Your drawings need to show the use of the Golden Ratio, the radius of the star, the horizontal distance (on the wall) from the center of the star to the vertex of the interior angles (interior radius), the measure of the interior angle between the points of the star, the measure of the angle at the tip of each point (on the wall), the height of the star at the center (distance from the wall at the center), the measures of the angles of each triangular face and the lengths of sides of each triangular face. You should also develop formulas to find the area of each triangular face and the total area of the triangular faces. To minimize cost, each triangular section of the star will be a separate piece punched from a rectangular sheet of material and assembled in the factory. Your presentation should include the procedure to find the dimensions of the rectangular sheet with the least area needed to construct the star. Provide sound mathematical evidence for each detail.

|  |  |
| --- | --- |
| **Major Group Products** | [2-D Silhouette Example](#TwoDSilhouetteExample): Multimedia presentation that requires creating an organized spreadsheet and justification of numerical values in a two-dimensional model.  [3-D Example](#ThreeDExample): Multimedia presentation that requires updating an organized spreadsheet and justification of numerical values in a three-dimensional model.  Culminating Assessment ([Project Scenario](#ProjectScenario)): Multimedia presentation, research summary that requires the use of trigonometry to derive and apply formulas from 2-D and 3-D drawings and/or models. |
| **Major Individual Projects** | [Demonstrating and Applying the Derived Formulas](#DemonstratingAndApplyingTheDerivedForm): Persuasive essay that shows the derivation of formulas, demonstrates the use of formulas, shows 2-D and 3-D drawings and/or models, includes a detailed spreadsheet, and justifies the derived formulas to verify measurements in the 2-D and 3-D examples. |

**Assessment and Reflection:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Rubric(s) I will use:** (Check all that apply.) | Collaboration |  | Written Communication  [Demonstrating and Applying the Derived Formulas Rubric](#DemonstratingAndApplyingTheDerivedForm) | X |
| Critical Thinking & Problem Solving  [2-D Silhouette Example Rubric](#TwoDSilhouetteExample)  [3-D Example Rubric](#ThreeDExample)  [Demonstrating and Applying the Derived Formulas Rubric](#DemonstratingAndApplyingTheDerivedForm)  [Project Scenario Rubric](#ProjectScenario) | X | Content Knowledge  [2-D Silhouette Example Rubric](#TwoDSilhouetteExample)  [3-D Example Rubric](#ThreeDExample)  [Demonstrating and Applying the Derived Formulas Rubric](#DemonstratingAndApplyingTheDerivedForm)  [Project Scenario Rubric](#ProjectScenario) | X |
| Oral Communication  [2-D Silhouette Example Rubric](#TwoDSilhouetteExample)  [3-D Example Rubric](#ThreeDExample)  [Project Scenario Rubric](#ProjectScenario) | X | Other |  |
| **Other classroom assessments for learning:** (Check all that apply) | Quizzes/ tests  Teacher made quizzes/tests | X | Practice presentations  [Practice Presentation Checklist](#PracticePresentationChecklist) | X |
| Self-evaluation  [Architect Designs & Innovations Self-Team Final Evaluation](#SelfTeamFinalEvaluation) | X | Notes  Individual student notes | X |
| Peer evaluation  [Architect Designs & Innovations Self-Team Final Evaluation](#SelfTeamFinalEvaluation) | X | Checklists/observations  [Architect Designs & Innovations Adapted Knowledge Rating Scale Vocabulary Development](#KnowledgeRatingScale)  [Architect Designs & Innovations Checklist](#Checklist) | X |
| Online tests and exams |  | Concept maps |  |
| **Reflections:** (Check all that apply) | Survey  [Architect Designs & Innovations Final Evaluation](#FinalEvaluation) | X | Focus Group |  |
| Discussion  Essential questions | X | Task Management Chart  [Architect Designs & Innovations Checklist](#Checklist) | X |
| Journal Writing/ Learning Log  Daily Writing Journal that includes accomplishments and a reflection of lessons learned | X | Other  [Know-Need to Know Log](#KnowNeedToKnowLog) | X |

**Map the Project:**

[Project Storyboard](#ProjectStoryboard)

**Product:** [Project Scenario](#ProjectScenario)

|  |  |  |  |
| --- | --- | --- | --- |
| **Knowledge and Skills Needed** | **Already Have Learned** | **Taught Before the Project** | **Taught During the Project** |
| 1. Recognize information needed for problem solving |  | X |  |
| 2. Know the law of sines and cosines |  |  | X |
| 3. Know the definitions that relate the trigonometric functions to the sides of a right triangle |  | X |  |
| 4. Know Heron’s formula |  |  | X |
| 5. Know the formulas to find area of a triangle given SAS, AAS or ASA |  |  | X |
| 6. Find all the missing parts of a triangle |  |  | X |
| 7. Make a drawing to represent a specific example | X |  |  |
| 8. Use the appropriate formula to find the area of a triangle and area of figures |  |  | X |
| 9. Use technology tools and multiple media sources to analyze a real-world problem |  | X |  |
| 10. Use multiple perspectives and can represent a problem in more than one way | X |  |  |
| 11. Exhibit positive leadership through interpersonal and problem-solving skills that contribute to achieving the goal |  | X |  |
| 12. Work collaboratively to acquire information from electronic resources |  |  | X |
| 13. Engage in a problem solving process by formulating questions and applying complex strategies in order to independently solve problems |  | X |  |
| 14. Use multiple electronic sources of information and multiple technology tools |  |  | X |
| 15. Make informed choices among available advanced technology systems, resources and services |  |  | X |
| 16. Use technology to seek strategies and information to address limits in knowledge |  |  | X |
| 17. Use advanced features of word processing and spreadsheet software |  |  | X |
| 18. Create information using advanced skills of analysis, synthesis and evaluation and shares this information through a variety of oral, written and multimedia communications |  |  | X |

**Resources:  
School-based Individuals:**

Technology Integration Specialist

Language Arts Teachers

**Technology:**

Computer Lab

Internet Browser with Java enabled

Word Processing Software

Spreadsheet Software

Presentation Center

**Community:**

Representatives from Decorations and/or Architectural Design Businesses

**Materials:**

Rulers

Protractors

Compasses

Graph paper

Graphing calculator

Poster board or other construction material

**Websites:**

See descriptions of [Websites Used by Stars Are Not Pointless](#WebsitesUsedByStarsAreNotPointless)

**Manage the Process:**

Allow approximately 5 weeks. See[Project Storyboard](#ProjectStoryboard) **for a brief overview of each step in Manage the Process.**

**See** [Steps to Manage the Process](#StepsToManageTheProcess) **for more details.**

Differentiation: Classroom format includes a mix of whole group, collaborative group, paired and individual activities. Quadratic functions are modeled in a wide variety of ways using physical and virtual manipulatives, graphing technology and Internet web sites. Explorations offer a variety of entry points. A Resource/Learning Center is provided that includes materials to meet the needs of all learners. Step-by-step instructions should be provided for the special needs student.

**Project Evaluation:**

Distribute [Architect Designs & Innovations Final Evaluation](#FinalEvaluation) to each team member.

**Key Words:**

Heron’s formula, law of cosines, law of sines, oblique triangle

**Websites Used by Stars Are Not Pointless**

Google - [http://www.google.com](http://www.google.com/) is used as a search engine to allow students to have choices of websites that they will use.

nctm.org - <http://illuminations.nctm.org/uploadedFiles/Content/Lessons/Resources/9-12/LawSines-AS-Discover.pdf> is an activity sheet on the Law of Sines.

nctm.org - <http://illuminations.nctm.org/Lesson.aspx?id=2433> provides a lesson on the Law of Sines.

nctm.org - <http://illuminations.nctm.org/uploadedFiles/Content/Lessons/Resources/9-12/LawCosinesGeo-AS-SquareTriangle.pdf> is an activity sheet on the Law of Cosines.

nctm.org - <http://illuminations.nctm.org/Lesson.aspx?id=2441> provides a lesson on the Law of Cosines.

Trigonometry: Oblique Triangles - Law of Sines - <http://www.algebralab.org/studyaids/studyaid.aspx?file=Trigonometry_LawSines.xml> guides students in investigating the use of the Law of Sines to solve and find the area of oblique triangles.

Trigonometry: Oblique Triangles - Law of Cosines - <http://www.algebralab.org/studyaids/studyaid.aspx?file=Trigonometry_LawCosines.xml> guides students in investigating the use of the Law of Cosines to solve and find the area of oblique triangles for the SAS case.

Curriculum Pathways - <http://www.sascurriculumpathways.com> give students an opportunity to find more general forms of the formulas for finding the area of oblique triangles for the SAS (Inquiry 1047) and SSA (Inquiry 116) cases.

Writing persuasive or argumentative essays - <http://www.studygs.net/wrtstr4.htm> provides students with elements toward building a good persuasive essay.

**Architect Designs & Innovations**

**Project Storyboard**

**Demonstrating and Applying the Derived Formulas Challenge**

Assign

Individual work/practice time

**3-D Example Challenge**

Outline

Oral presentation practice

Final presentation

**3-D Example Challenge**

Assign

Group work/practice time

**2-D Silhouette Example Challenge**

Outline

Oral presentation practice

Final presentation

**Launch the Project**

Introduce Driving Question

Entry Event

Project Scenario

Know/Need to Know Log

Team Contract

Architect Designs & Innovations Checklist

Vocabulary Development Checklist

**Teach/Learn/Assess**

Explore Oblique Triangles to solve and find the area for the SAS case

Explore Oblique Triangles to solve and find the area for the SSA case

Draft and develop “3-D Example Challenge" Presentation

**Teach/Learn/Assess**

Investigating Formulas to Solve and Find the Area of Oblique Triangles

Research and develop notes summarizing Law of Sines and the area of Oblique Triangle

Research and develop notes summarizing Law of Cosines and the area of Oblique Triangle

**Before the Project Begins**

Divide the students into groups

Prepare a Resource/Learning Center

**2-D Silhouette Example Challenge**

Assign

Group work/practice time

**Teach/Learn/Assess**

Discovering Formulas to Solve Oblique Triangles

Discover Law of Sines

Discover Law of Cosines

**Reflect**

Self/Team Evaluation

Architect Designs & Innovations Final Evaluation

**Project Scenario**

Final presentations

**Project Scenario**

Outline

Oral presentation practice

Collect “Demonstrating and Applying the Derived Formulas” Persuasive Essay

**Demonstrating and Applying the Derived Formulas**

Draft and develop “Demonstrating and Applying the Derived Formulas” Persuasive Essay

**Project Scenario**

Draft and develop "Project Scenario" Presentation

**Steps to Manage the Process**

**Step 1: Before the project begins**

Divide students into teams of 3 or 4 students for major group products and projects.

Prepare a Resource/Learning Center for differentiating and tiering. Include the following possible tips or hints (mathematical knowledge students will need to know to complete this project) in the project Resource/Learning Center:

[Area Resources](#AreaResources)

[Constructing Stars](#ConstructingStars)

[Derivations and Proofs of Formulas](#DerivationAndProofsOfFormulas)

[Golden Ratio Resources](#GoldenRatioResources)

[Law of Cosines](#LawOfCosines)

[Law of Sines](#LawOfSines)

[Oblique Triangle Resources](#ObliqueTriangleResources)

[Pictures of Country Stars](#PicturesOfCountryStars)

As a homework assignment at the end of each day, each student will use a word processor to keep a daily writing journal that includes accomplishments and reflections of lessons learned. All entries will be in complete sentences.

**Step 2: Launch the Project**

Driving Question: How can trigonometry be used to determine the design requirements of an n-point, 3-dimensional star?

Entry Event: Invite a representative from a local decorations and/or architectural design businesses to initiate student interest by sharing his knowledge about using the golden ratio in art, decorations and architectural design. Provide the representative with the following ideas to guide his presentation.

Discuss the Golden Ratio in nature.

Discuss using the Golden Ratio in art, decorations and architectural design.

Look at [Golden Ratio Resources](#GoldenRatioResources).

Look at [Pictures of Country Stars](#PicturesOfCountryStars).

Discuss how Country Stars can be found all over the nation.

Distribute the [Project Scenario](#ProjectScenario) and rubric to each student.

Distribute [Know/Need to Know Log](#KnowNeedToKnowLog) to individual teams to be used as periodic formative assessment.

Distribute [Architect Designs & Innovations Team Roles](#TeamRoles) descriptions to each student. For groups of 4 students, two of the students can share the responsibilities of Design Engineer or Research Engineer. As an assignment, each team submits a Team Contract. Examples and ideas for writing contracts can be found at Google - <http://www.google.com> and searching “employment agreement contracts.”

Distribute [Architect Designs & Innovations Checklist](#Checklist) to each team.

Distribute [Architect Designs & Innovations Adapted Knowledge Rating Scale Vocabulary Development](#KnowledgeRatingScale) to each student. Use as formative assessment. Students update the vocabulary development throughout the PBL experience.

Students will use a word processor to begin a daily writing journal that reflects on a summary of the lessons learned.

**Step 3: Discovering Formulas to Solve Oblique Triangles**

Essential Question: How can geometry and right triangle trigonometry be used to solve oblique triangles?

Students will work in pairs or teams to investigate and explore the Law of Sines. Print nctm.org - <http://illuminations.nctm.org/uploadedFiles/Content/Lessons/Resources/9-12/LawSines-AS-Discover.pdf>

(The Law of Sines) Activity Sheet. Each team completes the activity sheet and submits a copy for evaluation.

Students will work in pairs or teams to investigate and explore squares on a triangle to discover the Law of Cosines. Print nctm.org - <http://illuminations.nctm.org/uploadedFiles/Content/Lessons/Resources/9-12/LawCosinesGeo-AS-SquareTriangle.pdf> (Squares on a Triangle) Activity Sheet. Each team completes the activity sheet and submits a copy for evaluation.

**Step 4: 2-D Silhouette Example Challenge**

Essential Question: How can a 2-dimensional model help to understand 3-dimensional space?

Distribute [2-D Silhouette Example](#TwoDSilhouetteExample) challenge and rubric to each team.

**Step 5: Investigating Formulas to Solve and Find the Area of Oblique Triangles**

Essential Question: How can solving and finding the area of oblique triangles be useful in the real world?

Students will use a word processor and work in pairs or teams to take notes from Trigonometry: Oblique Triangles - Law of Sines - <http://www.algebralab.org/studyaids/studyaid.aspx?file=Trigonometry_LawSines.xml> on the Law of Sines and the area of Oblique Triangles. Each team will submit a copy of their notes for evaluation.

Students will use a word processor and work in pairs or teams to take notes from Trigonometry: Oblique Triangles - Law of Cosines - <http://www.algebralab.org/studyaids/studyaid.aspx?file=Trigonometry_LawCosines.xml> on the Law of Cosines and the area of Oblique Triangles. Each team will submit a copy of their notes for evaluation.

**Step 6: 3-D Example Challenge**

Essential Question: Why is the use of a scale model important in mathematics?

Distribute [3-D Example](#ThreeDExample) challenge and rubric to each team.

**Step 7: Teams present 2-D Silhouette Example**

(This presentation can be used as a practice presentation. For the practice presentation, use [Practice Presentation Checklist](#PracticePresentationChecklist).)

**Step 8: Explore Oblique Triangles for the SAS case**

Essential Question: How can the right triangle, area formula be used to derive other area formulas?

Students will work in teams to investigate and explore oblique triangles. Students will use their notes from

"Investigating Formulas to Solve and Find the Area of Oblique Triangles." Teams use SAS Curriculum Pathways - <http://www.sascurriculumpathways.com> -> Mathematics -> Trigonometry -> Triangles: Right & Oblique -> Classroom Activity 1047 to explore oblique triangles, in particular the case in which two sides and the included angle (SAS) are given. Completion of "Finding a More General Formula Activity Sheet" from Activity 1047 can be used as formative assessment.

**Step 9: Explore Oblique Triangles for the SSA case**

Essential Question: Does every triangle have a unique solution?

Students will work in teams to investigate and explore oblique triangles. Students will use their notes from

"Investigating Formulas to Solve and Find the Area of Oblique Triangles." Teams use <http://www.sascurriculumpathways.com> -> Mathematics -> Trigonometry -> Triangles: Right & Oblique -> Web Inquiry 116 to explore oblique triangles, in particular the case in which two sides and the non-included angle (SSA) are given. The Response Sheet can be used as formative assessment.

**Step 10: Demonstrating and Applying the Derived Formulas Challenge**

Essential Question: Why is the use of models important in mathematics?

Distribute [Demonstrating and Applying the Derived Formulas](#DemonstratingAndApplyingTheDerivedForm) challenge and rubric to each team member. For help with elements of a persuasive essay, students should visit Writing persuasive or argumentative essays - <http://www.studygs.net/wrtstr4.htm>.

**Step 11: Teams present 3-D Example**

(This presentation can be used to refine their presentation skills. For the practice presentation, use [Practice Presentation Checklist](#PracticePresentationChecklist).)

**Step 12: Teams present Project Scenario**

(For the practice presentation, use [Practice Presentation Checklist](#PracticePresentationChecklist).)

Invite parents, administrators and members of the community to be present during the presentation.

**Step 13: Self/Team Evaluation**

Distribute [Architect Designs & Innovations Self-Team Final Evaluation](#SelfTeamFinalEvaluation) to each team member. Each team member completes a self- evaluation and evaluates all other members of the team.

**Area Resources**

**Area of triangles and other regions:**

mathdemos.org - <http://www.mathdemos.org/mathdemos/trianglearea/trianglearea.html>

**Area of a triangle SAS case:**

Area of a triangle - <http://www.clarku.edu/~djoyce/trig/area.html>

**Area of a triangle SSS case:**

Area of a triangle given three sides - Heron's Formula - Math Open Reference - <http://www.mathopenref.com/heronsformula.html>

Heron's Formula for Area of a Triangle - Geometry Calculator - <http://www.analyzemath.com/Geometry_calculators/herons_area_triangle.html>

**Constructing Stars**

Draw five-point star pentagram, pentacle, pentagon. Other stars how-to - <http://www.hyperflight.com/pentagon-construct.htm>

Star Construction of Shapes of Constant Width - <http://www.cut-the-knot.org/Curriculum/Geometry/CWStar.shtml>

**Derivation and Proofs of Formulas**

Laws of Cosines & Sines - <http://www.clarku.edu/~djoyce/trig/laws.html>

Trigonometry: Oblique Triangles - Law of Sines - <http://www.algebralab.org/studyaids/studyaid.aspx?file=Trigonometry_LawSines.xml>

Trigonometry: Oblique Triangles - Law of Cosines - <http://www.algebralab.org/studyaids/studyaid.aspx?file=Trigonometry_LawCosines.xml>

**Golden Ratio Resources**

The Math Behind the Beauty - <http://www.intmath.com/Numbers/mathOfBeauty.php>

Phi, 1.618, the Golden Ratio and Fibonacci series and its applications - <http://goldennumber.net/>

Golden Ratio - <https://www.mathsisfun.com/numbers/golden-ratio.html>

**Law of Cosines**

The Law of Cosines - Math Open Reference - [http://www.mathopenref.com/lawofcosines.html](http://www.mathopenref.com/lawofcosines.html%20)

Law of Cosines - <http://home.windstream.net/okrebs/page94.html>

**Law of Sines**

Sine Law - Ambiguous case - applet - <http://www.analyzemath.com/Triangle/SineLaw.html>

LawOfSines - <http://www.slu.edu/classes/maymk/SketchpadApplets/LawOfSines.html>

The Law of Sines - Math Open Reference - <http://www.mathopenref.com/lawofsines.html>

Law of Sines - <http://home.windstream.net/okrebs/page93.html>

Law of Sines - <http://illuminations.nctm.org/Lesson.aspx?id=2433>

**Oblique Triangle Resources**

Wolfram Demonstrations Project: Solving Oblique Triangles - <http://demonstrations.wolfram.com/SolvingObliqueTriangles/>

coastal.edu - <http://www.coastal.edu/mathcenter/HelpPages/Handouts/oblique.PDF>

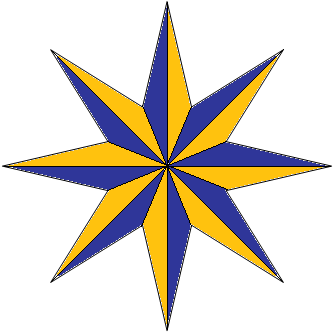
Oblique Triangles - <http://www.clarku.edu/~djoyce/trig/oblique.html>

**Pictures of Country Stars**

Amish Barn Stars - <http://www.amishwares.com/site/1504461/page/3115828>

oldeglory.co.uk - <http://www.oldeglory.co.uk/images/home_accents/tinware/pd_colstars.jpg>

Popular Items for Barn Stars - <https://www.etsy.com/market/barn_stars>

**Architect Designs & Innovations**

**Project Scenario**



You are engineers working for Architect Designs & Innovations. A major competitor claims that their n-point, 3-dimensional stars are more aesthetically pleasing than other stars on the market.  After purchasing several stars from the major competitor and analyzing their shape and design, the research department of your company found that the Golden Ratio is not present in the shape of their stars. Your graphics art department concluded that incorporating the Divine Proportion into the shape and design of the stars would increase the aesthetic beauty, thus surpassing that of the competitor’s stars. Your potential customers would be asked to provide the radius and number of points they desire in their 3-dimensional star. Prepare a presentation to the design branch of Architect Designs & Innovations that includes detailed drawings, derivation of all formulas and numerical justifications of formulas for two different stars. Your drawings need to show the use of the Golden Ratio, the radius of the star, the horizontal distance (on the wall) from the center of the star to the vertex of the interior angles (interior radius), the measure of the interior angle between the points of the star, the measure of the angle at the tip of each point (on the wall), the height of the star at the center (distance from the wall at the center), the measures of the angles of each triangular face and the lengths of sides of each triangular face. You should also develop formulas to find the area of each triangular face and the total area of the triangular faces. To minimize cost, each triangular section of the star will be a separate piece punched from a rectangular sheet of material and assembled in the factory. Your presentation should include the procedure to find the dimensions of the rectangular sheet with the least area needed to construct the star. Provide sound mathematical evidence for each detail.

**Project Scenario Rubric**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | | **Below Standard** | **At Standard** | **Above Standard** |
| **Knowledge > Comprehension** | **Application > Analysis** | **Evaluation > Synthesis** |
| **Presentation's Physical Attributes** | **0.2** | My team members did not dress appropriately.  My team members did not maintain proper body language.  My team members did not maintain eye contact with audience.  My team members fidget, hide behind objects, and play with objects, etc.  My team members did not face audience. | My team members dress appropriately.  My team members maintain proper body language.  My team members did not maintain eye contact with audience.  My team members refrain from fidgeting, hiding behind objects, and playing with objects, etc.  My team members did face audience. | In addition to the At Standard criteria:  My team members dress to enhance the purpose of the presentation.  My team members use body language to enhance the purpose of presentation.  My team members use physical space and movements to enhance the purpose of the presentation. |
| **0.0**........................................................................**0.33** | **0.34**......................................................................**0.66** | **0.67**......................................................................**1.00** |
| **Presentation's Oral & Verbal Skills** | **0.2** | My team members use oral fillers (uh, ok, etc.)  My team members pronounce words incorrectly.  My team members do not speak loudly and clearly.  My team members use tone and pace that obscures communication.  Text contains errors.  My team members read from notes. | My team members use minimum of oral fillers (uh, ok, etc.)  My team members pronounce words correctly and in Standard English.  My team members speak loudly and clearly.  My team members speak at a pace and in a tone that allows clear communication to the audience.  Text displayed during the presentation is free of spelling, usage and mechanical errors.  My team members possess notes but do not read from them. | In addition to the At Standard criteria:  My team members modify pronunciation of words to enhance presentation.  My team members modulate volume and tone to enhance presentation.  My team members modulate pace to enhance presentation.  My team members use slang, jargon or technical language to enhance presentation.  My team members speak from memory and makes only passing reference to notes or cards. |
| **0.0**........................................................................**0.33** | **0.34**......................................................................**0.66** | **0.67**......................................................................**1.00** |
| **Presentation's Organization & Structure** | **0.2** | My team does not begin and end on time.  My team does not provide preview/review.  My team does not provide clear and definable opening and closing.  My team does not have all required materials ready.  My team members have not practiced presentation.  My team members do not demonstrate flexibility.  My team uses only one member of the team for the entire presentation.  My team did not submit an outline before our presentation. | My team begins and ends on time.  My team provides preview/review of main ideas.  My team provides clear and definable opening and closing.  My team has all required materials ready for use.  My team members practiced order of presentation.  My team members demonstrate flexibility in the face of technical or contextual problems.  All members of my team present.  My team submitted an outline before our presentation. | In addition to the At Standard criteria:  My team provides written notes, brochures, overviews, etc.  My team create an opening that is engaging (provides a hook for audience) and a closing that re-enforces key understandings.  My team demonstrates planning for technical and contextual problems.  Each of my team members present using their area of expertise to enhance the presentation.  My team members followed the outline during the entire presentation. |
| **0.0**........................................................................**0.33** | **0.34**......................................................................**0.66** | **0.67**......................................................................**1.00** |
| **Presentation's Technical Attributes** | **0.2** | My team members use of display boards, presentation software, websites, audio, video, etc., distract audience from the content and purpose of presentation.  My team members do not demonstrate care in creation, including editing, proofreading and finishing. | My team members use of display boards, presentation software, websites, audio, video, etc. does not distract audience from the content and purpose of the presentation.  My team members demonstrate care in creation, including editing, proofreading and finishing. | In addition to the At Standard criteria:  My team members use advance features and utilities of presentation software, creates web-enabled presentations, creates non-linear presentation, and uses audio, video, movie maker programs, webpage design software, etc. to enhance the purpose of the presentation.  My team members use advanced features of word processing software, i.e. outline, table of contents, index feature, draw tool, headers and footers, hyperlinks to other file formats to enhance presentation. |
| **0.0**........................................................................**0.33** | **0.34**......................................................................**0.66** | **0.67**......................................................................**1.00** |
| **Presentation's Response to Audience** | **0.2** | My team members do not provide appropriate oral responses to audience questions, concerns and comments.  My team members do not adapt the presentation based on questions, concerns or comments from audience. | My team members provide appropriate oral responses to audience questions, concerns and comments.  My team members make minor modifications to the presentation based on questions, concerns or comments from audience. | In addition to the At Standard criteria:  My team members incorporate audience questions, comments and concerns into the presentation.  My team members display willingness and ability to move away from the script/plan and modify presentation based on audience response. |
| **0.0**........................................................................**0.33** | **0.34**......................................................................**0.66** | **0.67**......................................................................**1.00** |
| **Construction of a Drawings** | **0.75** | My team haphazardly constructs drawings and/or may not be large enough to be viewed by all members in the board room.  My team mislabels several dimensions in their drawings. | My team constructs neat drawings that are large enough to be viewed by all members in the board room.  My team uses the Golden Ratio and labels the dimensions of all parts of the drawings with only minor errors. | My team constructs drawings with superior precision that are large enough to be viewed by all members in the board room.  My team properly uses the Golden Ratio and accurately labels the dimensions of all parts of the drawings. |
| **0.0**........................................................................**0.33** | **0.34**......................................................................**0.66** | **0.67**......................................................................**1.00** |
| **Derivation of Formula** | **0.75** | My team's derivations are incomplete or several formulas are missing.  My team does not summarize the derivation of formulas. | My team uses trigonometry to derive formulas for measures of angles, lengths of sides and area of triangles with minor errors.  My team derives formulas with minor errors for the following: The horizontal distance (on the wall) from the center of the star to the vertex of the interior angles (interior radius), the measure of the interior angle between the points of the star, the measure of the angle at the tip of each point (on the wall), the height of the star at the center (distance from the wall at the center), the measures of the angles of each triangular face, the lengths of sides of each triangular face, area of each triangular face, the total area of the triangular faces and the dimensions of the rectangular sheet with the least area.  My team summarizes the derivation of formulas with minor errors. | My team uses trigonometry to accurately derive formulas for measures of angles, lengths of sides and area of triangles.  My team accurately derives formulas for the following: The horizontal distance (on the wall) from the center of the star to the vertex of the interior angles (interior radius), the measure of the interior angle between the points of the star, the measure of the angle at the tip of each point (on the wall), the height of the star at the center (distance from the wall at the center), the measures of the angles of each triangular face, the lengths of sides of each triangular face, area of each triangular face, the total area of the triangular faces and the dimensions of the rectangular sheet with the least area.  My team uses advanced features of word processing, spreadsheets and/or other software to accurately present the derivations. |
| **0.0**........................................................................**0.33** | **0.34**......................................................................**0.66** | **0.67**......................................................................**1.00** |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | | **Below Standard** | **At Standard** | **Above Standard** |
| **Knowledge > Comprehension** | **Application > Analysis** | **Evaluation > Synthesis** |
| **Summarizing the Formulas with Numerical Justification** | **0.75** | My team members' numerical justifications are incomplete and/or do not support several of our formulas. | My team members include numerical justifications that verifies our formulas with minor errors for the following: The horizontal distance (on the wall) from the center of the star to the vertex of the interior angles (interior radius), the measure of the interior angle between the points of the star, the measure of the angle at the tip of each point (on the wall), the height of the star at the center (distance from the wall at the center), the measures of the angles of each triangular face, the lengths of sides of each triangular face, area of each triangular face, the total area of the triangular faces and the dimensions of the rectangular sheet with the least area. | My team members include numerical justifications that actually verifies our formulas for the following: The horizontal distance (on the wall) from the center of the star to the vertex of the interior angles (interior radius), the measure of the interior angle between the points of the star, the measure of the angle at the tip of each point (on the wall), the height of the star at the center (distance from the wall at the center), the measures of the angles of each triangular face, the lengths of sides of each triangular face, area of each triangular face, the total area of the triangular faces and the dimensions of the rectangular sheet with the least area.  My team uses advanced features of word processing, spreadsheets and/or other software to accurately present the numerical verifications. |
| **0.0**........................................................................**0.33** | **0.34**......................................................................**0.66** | **0.67**......................................................................**1.00** |
| **Mathematical Explanation** | **0.75** | My team members' mathematical explanations do not describe methods used and/or do not support several of our formulas. | My team includes an explanation that, for the most part, describes the mathematics behind the method used to determine our formulas with minor errors for the following: The horizontal distance (on the wall) from the center of the star to the vertex of the interior angles (interior radius), the measure of the interior angle between the points of the star, the measure of the angle at the tip of each point (on the wall), the height of the star at the center (distance from the wall at the center), the measures of the angles of each triangular face, the lengths of sides of each triangular face, area of each triangular face, the total area of the triangular faces and the dimensions of the rectangular sheet with the least area. | My team includes a detailed explanation that accurately describes the mathematics behind the method used to determine our formulas for the following: The horizontal distance (on the wall) from the center of the star to the vertex of the interior angles (interior radius), the measure of the interior angle between the points of the star, the measure of the angle at the tip of each point (on the wall), the height of the star at the center (distance from the wall at the center), the measures of the angles of each triangular face, the lengths of sides of each triangular face, area of each triangular face, the total area of the triangular faces and the dimensions of the rectangular sheet with the least area.  My team uses advanced features of word processing, spreadsheets and/or other software to accurately present the mathematical explanations. |
| **0.0**........................................................................**0.33** | **0.34**......................................................................**0.66** | **0.67**......................................................................**1.00** |

This rubric uses criteria from the presentation rubric developed by WVDE Office of Instruction.

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**Know/Need to Know Log**

Team\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

|  |  |  |
| --- | --- | --- |
| **What Do We Know?** | **What Do We Need to Know?** | **What Should We Do?**  (Keywords for searches, Questions to ask, References to use, etc.) |
|  |  |  |

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**Team Roles**

Duties and responsibilities will include, but not be limited to the following:

|  |  |  |
| --- | --- | --- |
| **Project Manager** | **Design Engineer** | **Research Engineer** |
| * Maintains the team schedule * Takes the lead on writing any proposals * Tracks team progress * Ensures completion of team reports * Recognizes and uses the strengths of other members of the team * Checks on progress * Deals with schedule changes or setbacks in the design and test process * Assists the design engineer and research engineer to ensure successful completion of project tasks | * Conceptualizes and thinks through alternate design ideas and problem solving strategies * Analyzes ideas using experimentation and testing * Thinks “outside the box” for a better, more efficient, or elegant way to accomplish a task or solve a problem * Assists the project manager with scheduling, writing and organization * Helps the research engineer develop a well justified solution and produce quality reports | * Uses mathematical concepts that are clear and easy to follow * Reports problems with derivations or justifications * Helps the project manager develop the team schedule, particularly with the research phase of the project * Assists the design engineer develop applications that can be easily tested mathematically * Takes the lead in writing derivations, justifications and applications |

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**Checklist**

Team\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* Assignment of team roles
* Team Contract
* Know/Need to Know Log
* Drawing showing the use of the Golden Ratio
* Drawing of 2-D Silhouette Examples
* Construction of 2-D Silhouette Examples
* Numerical justification of each 2-D Silhouette Example
* Organized spreadsheet that contains the data values of each 2-D Silhouette Example
* Drawing of 3-D Examples
* Construction of 3-D Examples
* Numerical justification of each 3-D Example
* Organized spreadsheet that contains the data values of each 2-D Silhouette Example with its matching 3-D Example in the same row
* Derivation of formulas to find the measures of the angles of each triangular section
* Derivation of formulas to find the length of sides of each triangular section
* Derivation of the formula to find the horizontal distance (on the wall) from the center of the star to the vertex of the interior angles
* Derivation of the formula to find the height of the star at the center (distance from the wall at the center)
* Derivation of the formula to find the measure of the interior angle between the points of the star
* Derivation of the formula to find the measure of the angle at the tip of each point (on the wall)
* Derivation of the formula to find the dimensions of the rectangular sheet with the least area needed to construct the star
* All formulas are stated in terms of radius (r) and/or number of points (p)
* Demonstrate the use of all formulas by justifying the measures of your 2-D and 3-D examples using the derived formulas.
* Suggest problems and limitations of formulas
* Support all reasoning by using sound mathematical evidence throughout the project

**Suggested vocabulary to be used throughout products:**

* ambiguous case
* cosecant
* cosine
* cotangent
* design engineer
* Golden Ratio
* Heron's formula
* Law of Cosines
* Law of Sines
* project manager
* research engineer
* secant
* sine
* tangent
* solve a triangle

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**Knowledge Rating Scale**

Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Directions: Rate each of the following vocabulary words as **K**: Know it well, **H**: Have seen or heard it, **C**: Have no clue. If you check **K**, write the definition under “What It Means.” As you learn the definition during the PBL experience, write the definition under “What It Means.”

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Vocabulary** | **K** | **H** | **C** | **What It Means** |
| ambiguous case |  |  |  |  |
| cosecant |  |  |  |  |
| cosine |  |  |  |  |
| cotangent |  |  |  |  |
| design engineer |  |  |  |  |
| Golden Ratio |  |  |  |  |
| Heron's formula |  |  |  |  |
| Law of Cosines |  |  |  |  |
| Law of Sines |  |  |  |  |
| project manager |  |  |  |  |
| research engineer |  |  |  |  |
| secant |  |  |  |  |
| sine |  |  |  |  |
| tangent |  |  |  |  |
| solve a triangle |  |  |  |  |

**Architect Designs & Innovations**

**2-D Silhouette Example**

The foreman of your engineering division is asking each member of your team to construct a 2-D silhouette example (outline of the star by tracing its borders on the wall) of an n-point, 3-dimensional star, to be used as models to check your team's final formulas. Each member of your team needs to choose the radius and the number of points for their star. To check the integrity of your final formulas, your team members should choose a variety of radii and number of points for their models. Create a spreadsheet that contains the information that will be needed to check your final formulas. Your team must prepare a presentation to your engineering division that details how each member constructed their star and determined the data values in the spreadsheet. Provide sound mathematical evidence for each detail.

**2-D Silhouette Example Rubric**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | | **Below Standard** | **At Standard** | **Above Standard** |
| **Knowledge > Comprehension** | **Application > Analysis** | **Evaluation > Synthesis** |
| **Presentation's Physical Attributes** | **0.2** | My team members did not dress appropriately.  My team members did not maintain proper body language.  My team members did not maintain eye contact with audience.  My team members fidget, hide behind objects, and play with objects, etc.  My team members did not face audience. | My team members dress appropriately.  My team members maintain proper body language.  My team members did not maintain eye contact with audience.  My team members refrain from fidgeting, hiding behind objects, and playing with objects, etc.  My team members did face audience. | In addition to the At Standard criteria:  My team members dress to enhance the purpose of the presentation.  My team members use body language to enhance the purpose of presentation.  My team members use physical space and movements to enhance the purpose of the presentation. |
| **0.0**........................................................................**0.33** | **0.34**......................................................................**0.66** | **0.67**......................................................................**1.00** |
| **Presentation's Oral & Verbal Skills** | **0.2** | My team members use oral fillers (uh, ok, etc.)  My team members pronounce words incorrectly.  My team members do not speak loudly and clearly.  My team members use tone and pace that obscures communication.  Text contains errors.  My team members read from notes. | My team members use minimum of oral fillers (uh, ok, etc.)  My team members pronounce words correctly and in Standard English.  My team members speak loudly and clearly.  My team members speak at a pace and in a tone that allows clear communication to the audience.  Text displayed during the presentation is free of spelling, usage and mechanical errors.  My team members possess notes but do not read from them. | In addition to the At Standard criteria:  My team members modify pronunciation of words to enhance presentation.  My team members modulate volume and tone to enhance presentation.  My team members modulate pace to enhance presentation.  My team members use slang, jargon or technical language to enhance presentation.  My team members speak from memory and makes only passing reference to notes or cards. |
| **0.0**........................................................................**0.33** | **0.34**......................................................................**0.66** | **0.67**......................................................................**1.00** |
| **Presentation's Organization & Structure** | **0.2** | My team does not begin and end on time.  My team does not provide preview/review.  My team does not provide clear and definable opening and closing.  My team does not have all required materials ready.  My team members have not practiced presentation.  My team members do not demonstrate flexibility.  My team uses only one member of the team for the entire presentation.  My team did not submit an outline before our presentation. | My team begins and ends on time.  My team provides preview/review of main ideas.  My team provides clear and definable opening and closing.  My team has all required materials ready for use.  My team members practiced order of presentation.  My team members demonstrate flexibility in the face of technical or contextual problems.  All members of my team present.  My team submitted an outline before our presentation. | In addition to the At Standard criteria:  My team provide written notes, brochures, overviews, etc.  My team create an opening that is engaging (provides a hook for audience) and a closing that re-enforces key understandings.  My team demonstrates planning for technical and contextual problems.  Each of my team members present using their area of expertise to enhance the presentation.  My team members followed the outline during the entire presentation. |
| **0.0**........................................................................**0.33** | **0.34**......................................................................**0.66** | **0.67**......................................................................**1.00** |
| **Presentation's Technical Attributes** | **0.2** | My team members use of display boards, presentation software, websites, audio, video, etc., distract audience from the content and purpose of presentation.  My team members do not demonstrate care in creation, including editing, proofreading and finishing. | My team members use of display boards, presentation software, websites, audio, video, etc. does not distract audience from the content and purpose of the presentation.  My team members demonstrate care in creation, including editing, proofreading and finishing. | In addition to the At Standard criteria:  My team members use advance features and utilities of presentation software, creates web-enabled presentations, creates non-linear presentation, and uses audio, video, movie maker programs, webpage design software, etc. to enhance the purpose of the presentation.  My team members use advanced features of word processing software, i.e. outline, table of contents, index feature, draw tool, headers and footers, hyperlinks to other file formats to enhance presentation. |
| **0.0**........................................................................**0.33** | **0.34**......................................................................**0.66** | **0.67**......................................................................**1.00** |
| **Presentation's Response to Audience** | **0.2** | My team members do not provide appropriate oral responses to audience questions, concerns and comments.  My team members do not adapt the presentation based on questions, concerns or comments from audience. | My team members provide appropriate oral responses to audience questions, concerns and comments.  My team members make minor modifications to the presentation based on questions, concerns or comments from audience. | In addition to the At Standard criteria:  My team members incorporate audience questions, comments and concerns into the presentation.  My team members display willingness and ability to move away from the script/plan and modify presentation based on audience response. |
| **0.0**........................................................................**0.33** | **0.34**......................................................................**0.66** | **0.67**......................................................................**1.00** |
| **Construction of a 2-D Silhouette Example** | **0.6** | My team members haphazardly construct two-dimensional silhouette examples and/or may not be large enough to be viewed by all members in the board room.  My team members' 2-D silhouettes have major errors in the spacing of the interior angles and/or points. | My team members construct neat, two-dimensional silhouette examples using cardboard, poster board, or cardstock paper that are large enough to be viewed by all members in the board room.  My team members' 2-D silhouettes have equally spaced interior angles with only minor errors.  My team members' 2-D silhouettes have equally spaced points with only minor errors. | My team members construct two-dimensional silhouette examples with superior precision using cardboard, poster board, or cardstock paper that are large enough to be viewed by all members in the board room.  My team members' 2-D silhouettes have equally spaced interior angles.  My team members' 2-D silhouettes have equally spaced points. |
| **0.0**........................................................................**0.33** | **0.34**......................................................................**0.66** | **0.67**......................................................................**1.00** |
| **Radius and Number of Points** | **0.6** | Some of my team members choose two-dimensional silhouette examples that represent stars with the same radii and/or number of points as another team member. | My team members choose a variety of two-dimensional silhouette examples that, for the most part, represent stars with different radii and different number of points. | My team members choose a variety of two-dimensional silhouette examples that represent stars with different radii and different number of points. |
| **0.0**........................................................................**0.33** | **0.34**......................................................................**0.66** | **0.67**......................................................................**1.00** |
| **Numerical Justification** | **0.6** | My team members' numerical justifications do not support the measures of their interior angles, the measures of their points and/or the measure of their interior radius. | My team members include numerical justifications for the measures of their interior angles, the measures of their points, and the measure of their interior radius with only minor errors. | My team members include numerical justifications for the measures of their interior angles, the measures of their points, and the measure of their interior radius. |
| **0.0**........................................................................**0.33** | **0.34**......................................................................**0.66** | **0.67**......................................................................**1.00** |
| **Spreadsheet Information** | **0.6** | My team's spreadsheet is not well-designed and/or does not include all categories needed to check final formulas. | My team includes a well-designed spreadsheet with categories that contain the information needed to check all final formulas with only minor errors.  My team occasionally uses spreadsheet formulas to determine data values using values from other categories. | My team includes a superior spreadsheet with categories that contain the information needed to check all final formulas.  Whenever possible, my team uses spreadsheet formulas to determine data values using values from other categories. |
| **0.0**........................................................................**0.33** | **0.34**......................................................................**0.66** | **0.67**......................................................................**1.00** |
| **Mathematical Explanation** | **0.6** | My team's mathematical explanation does not describe the method used to determine the measures of the interior angles, the measures of the points, and/or the measure of the interior radius. | My team includes an explanation that, for the most part, describes the mathematics behind the method used to determine the measures of the interior angles, the measures of the points, and the measure of the interior radius with only minor errors. | My team includes a detailed explanation that accurately describes the mathematics behind the method used to determine the measures of the interior angles, the measures of the points, and the measure of the interior radius. |
| **0.0**........................................................................**0.33** | **0.34**......................................................................**0.66** | **0.67**......................................................................**1.00** |

This rubric uses criteria from the presentation rubric developed by WVDE Office of Instruction.

**Architect Designs & Innovations**

**3-D Example**

The foreman of your engineering division is asking each member of your team to construct a 3-D example of an n-point, 3-dimensional star that can be placed on their 2-D silhouette example. This model will also be used to check your team's final formulas. Each member of your team will use the radius and the number of points from their 2-D silhouette example. Add information that will be needed to check your final formulas to your spreadsheet from your 2-D silhouette example. Your team must prepare a presentation to your engineering division that details how each member constructed their star and determined the data values in the spreadsheet. Provide sound mathematical evidence for each detail.

**3-D Example Rubric**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | | **Below Standard** | **At Standard** | **Above Standard** |
| **Knowledge > Comprehension** | **Application > Analysis** | **Evaluation > Synthesis** |
| **Presentation's Physical Attributes** | **0.2** | My team members did not dress appropriately.  My team members did not maintain proper body language.  My team members did not maintain eye contact with audience.  My team members fidget, hide behind objects, and play with objects, etc.  My team members did not face audience. | My team members dress appropriately.  My team members maintain proper body language.  My team members did not maintain eye contact with audience.  My team members refrain from fidgeting, hiding behind objects, and playing with objects, etc.  My team members did face audience. | In addition to the At Standard criteria:  My team members dress to enhance the purpose of the presentation.  My team members use body language to enhance the purpose of presentation.  My team members use physical space and movements to enhance the purpose of the presentation. |
| **0.0**........................................................................**0.33** | **0.34**......................................................................**0.66** | **0.67**......................................................................**1.00** |
| **Presentation's Oral & Verbal Skills** | **0.2** | My team members use oral fillers (uh, ok, etc.)  My team members pronounce words incorrectly.  My team members do not speak loudly and clearly.  My team members use tone and pace that obscures communication.  Text contains errors.  My team members read from notes. | My team members use minimum of oral fillers (uh, ok, etc.)  My team members pronounce words correctly and in Standard English.  My team members speak loudly and clearly.  My team members speak at a pace and in a tone that allows clear communication to the audience.  Text displayed during the presentation is free of spelling, usage and mechanical errors.  My team members possess notes but do not read from them. | In addition to the At Standard criteria:  My team members modify pronunciation of words to enhance presentation.  My team members modulate volume and tone to enhance presentation.  My team members modulate pace to enhance presentation.  My team members use slang, jargon or technical language to enhance presentation.  My team members speak from memory and makes only passing reference to notes or cards. |
| **0.0**........................................................................**0.33** | **0.34**......................................................................**0.66** | **0.67**......................................................................**1.00** |
| **Presentation's Organization & Structure** | **0.2** | My team does not begin and end on time.  My team does not provide preview/review.  My team does not provide clear and definable opening and closing.  My team does not have all required materials ready.  My team members have not practiced presentation.  My team members do not demonstrate flexibility.  My team uses only one member of the team for the entire presentation.  My team did not submit an outline before our presentation. | My team begins and ends on time.  My team provides preview/review of main ideas.  My team provides clear and definable opening and closing.  My team has all required materials ready for use.  My team members practiced order of presentation.  My team members demonstrate flexibility in the face of technical or contextual problems.  All members of my team present.  My team submitted an outline before our presentation. | In addition to the At Standard criteria:  My team provide written notes, brochures, overviews, etc.  My team create an opening that is engaging (provides a hook for audience) and a closing that re-enforces key understandings.  My team demonstrates planning for technical and contextual problems.  Each of my team members present using their area of expertise to enhance the presentation.  My team members followed the outline during the entire presentation. |
| **0.0**........................................................................**0.33** | **0.34**......................................................................**0.66** | **0.67**......................................................................**1.00** |
| **Presentation's Technical Attributes** | **0.2** | My team members use of display boards, presentation software, websites, audio, video, etc., distract audience from the content and purpose of presentation.  My team members do not demonstrate care in creation, including editing, proofreading and finishing. | My team members use of display boards, presentation software, websites, audio, video, etc. does not distract audience from the content and purpose of the presentation.  My team members demonstrate care in creation, including editing, proofreading and finishing. | In addition to the At Standard criteria:  My team members use advance features and utilities of presentation software, creates web-enabled presentations, creates non-linear presentation, and uses audio, video, movie maker programs, webpage design software, etc. to enhance the purpose of the presentation.  My team members use advanced features of word processing software, i.e. outline, table of contents, index feature, draw tool, headers and footers, hyperlinks to other file formats to enhance presentation. |
| **0.0**........................................................................**0.33** | **0.34**......................................................................**0.66** | **0.67**......................................................................**1.00** |
| **Presentation's Response to Audience** | **0.2** | My team members do not provide appropriate oral responses to audience questions, concerns and comments.  My team members do not adapt the presentation based on questions, concerns or comments from audience. | My team members provide appropriate oral responses to audience questions, concerns and comments.  My team members make minor modifications to the presentation based on questions, concerns or comments from audience. | In addition to the At Standard criteria:  My team members incorporate audience questions, comments and concerns into the presentation.  My team members display willingness and ability to move away from the script/plan and modify presentation based on audience response. |
| **0.0**........................................................................**0.33** | **0.34**......................................................................**0.66** | **0.67**......................................................................**1.00** |
| **Construction of a 3-D Example** | **0.6** | My team members haphazardly construct three-dimensional examples and/or may not be large enough to be viewed by all members in the board room.  My team members' 3-D examples have major errors in the spacing of the interior angles and/or points.  My team fails to show that each members' 3-D star matches their 2-D silhouette example. | My team members construct neat, three-dimensional examples using cardboard, poster board, or cardstock paper that are large enough to be viewed by all members in the board room.  My team members' 3-D examples have equally spaced interior angles with only minor errors.  My team members' 3-D examples have equally spaced points with only minor errors.  My team shows that each members' 3-D star matches their 2-D silhouette example with only minor errors. | My team members construct three-dimensional examples with superior precision using cardboard, poster board, or cardstock paper that are large enough to be viewed by all members in the board room.  My team members' 3-D examples have equally spaced interior angles.  My team members' 3-D examples have equally spaced points.  My team shows that each members' 3-D star matches their 2-D silhouette example. |
| **0.0**........................................................................**0.33** | **0.34**......................................................................**0.66** | **0.67**......................................................................**1.00** |
| **Radius and Number of Points** | **0.6** | Some of my team members choose three-dimensional examples that represent stars with the same radii and/or number of points as another team member. | My team members choose a variety of three-dimensional examples that, for the most part, represent stars with different radii and different number of points. | My team members choose a variety of three-dimensional examples that represent stars with different radii and different number of points. |
| **0.0**........................................................................**0.33** | **0.34**......................................................................**0.66** | **0.67**......................................................................**1.00** |
| **Numerical Justification** | **0.6** | My team members' numerical justifications do not support the measures of their interior angles, the measures of their points and/or the measure of their interior radius.  My team members' numerical justifications do not support the measures of the angles, lengths of sides and/or area of their triangular faces.  My team members' numerical justifications do not support the total area of their triangular faces. | My team members include numerical justifications for the measures of their interior angles, the measures of their points, and the measure of their interior radius with only minor errors.  My team members include numerical justifications for the measures of the angles, lengths of sides and area of their triangular faces with only minor errors.  My team members include numerical justifications for the total area of their triangular faces with only minor errors. | My team members include numerical justifications for the measures of their interior angles, the measures of their points, and the measure of their interior radius.  My team members include numerical justifications for the measures of the angles, lengths of sides and area of their triangular faces.  My team members include numerical justifications for the total area of their triangular faces. |
| **0.0**........................................................................**0.33** | **0.34**......................................................................**0.66** | **0.67**......................................................................**1.00** |
| **Spreadsheet Information** | **0.6** | My team's spreadsheet is not well-designed and/or does not include all categories needed to check final formulas. | My team includes a well-designed spreadsheet with categories that contain the information needed to check all final formulas with only minor errors.  My team occasionally uses spreadsheet formulas to determine data values using values from other categories. | My team includes a superior spreadsheet with categories that contain the information needed to check all final formulas.  Whenever possible, my team uses spreadsheet formulas to determine data values using values from other categories. |
| **0.0**........................................................................**0.33** | **0.34**......................................................................**0.66** | **0.67**......................................................................**1.00** |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | | **Below Standard** | **At Standard** | **Above Standard** |
| **Knowledge > Comprehension** | **Application > Analysis** | **Evaluation > Synthesis** |
| **Mathematical Explanation** | **0.6** | My team's mathematical explanation does not describe the method used to determine the measures of the interior angles, the measures of the points, and/or the measure of the interior radius.  My team's mathematical explanation does not describe the method used to determine the measures of the angles, lengths of sides and area of the triangular faces.  My team's mathematical explanation does not describe the method used to determine the total area of the triangular faces. | My team includes an explanation that, for the most part, describes the mathematics behind the method used to determine the measures of the interior angles, the measures of the points, and the measure of the interior radius with only minor errors.  My team includes an explanation that, for the most part, describes the mathematics behind the method used to determine the measures of the angles, lengths of sides and area of the triangular faces with only minor errors.  My team includes an explanation that, for the most part, describes the mathematics behind the method used to determine the total area of the triangular faces with only minor errors. | My team includes a detailed explanation that accurately describes the mathematics behind the method used to determine the measures of the interior angles, the measures of the points, and the measure of the interior radius.  My team includes an explanation that, for the most part, describes the mathematics behind the method used to determine the measures of the angles, lengths of sides and area of the triangular faces.  My team includes an explanation that, for the most part, describes the mathematics behind the method used to determine the total area of the triangular faces. |
| **0.0**........................................................................**0.33** | **0.34**......................................................................**0.66** | **0.67**......................................................................**1.00** |

This rubric uses criteria from the presentation rubric developed by WVDE Office of Instruction.

**Architect Designs & Innovations**

# **Practice Presentation Checklist**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Compelling Evidence** | **Little Evidence** | **No Evidence** |
| States the problem |  |  |  |
| Shares data gathered |  |  |  |
| Includes well designed drawings and spreadsheet |  |  |  |
| Makes connections through multiple representations |  |  |  |
| States a solution |  |  |  |
| Uses mathematics to support solutions or recommendations (based on the data analysis) |  |  |  |
| Uses correct spelling and grammar in product(s) |  |  |  |

**Comments**

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Architect Designs & Innovations**

**Demonstrating and Applying the Derived Formulas**

In only a few days, your engineering team will make their presentation to the design branch of Architect Designs & Innovations, detailing the derivation of formulas, and graphical representations that models the rectangular sheet with least area and the dimensions of an n-point, 3-dimensional star, given the radius and the number of points. The Chief Engineer is requesting from each of you, a persuasive essay that shows the derivation of formulas, demonstrates the use of formulas, shows drawings of your 2-D silhouette example and 3-D example, includes a detailed spreadsheet, and justifies the measures of your 2-D and 3-D examples using the derived formulas. Provide sound mathematical evidence for each detail.

**Demonstrating and Applying the Derived Formula Rubric**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | | **Below Standard** | **At Standard** | **Above Standard** |
| **Knowledge > Comprehension** | **Application > Analysis** | **Evaluation > Synthesis** |
| **Claim and Support** | **0.4** | My claim is unclear.  I only paraphrase the prompt.  I provide minimal or no relevant support.  My essay is underdeveloped. | My claim is clear and I support it with some relevant reasoning and/or examples.  I show some development in the essay. | My claim is clear and I support it accurately and consistently with well-chosen reasoning and/or examples.  I use persuasive strategy to convey an argument essay. |
| **0.0**........................................................................**0.33** | **0.34**......................................................................**0.66** | **0.67**......................................................................**1.00** |
| **Negative Reasons** | **0.3** | I do not acknowledge there are any reasons against my claim. | I acknowledge that there are reasons against my claim, but I don't explain why my claim is still valid. | I discuss the reasons against my claim and explain why it is still valid. |
| **0.0**........................................................................**0.33** | **0.34**......................................................................**0.66** | **0.67**......................................................................**1.00** |
| **Organization** | **0.3** | My essay is aimless and disorganized. | My essay has a beginning, middle and end.  My essay is generally organized, but lacks transitions among sections. | My essay has a compelling opening, an informative middle and a satisfying conclusion.  My essay is focused and well organized, with effective use of transition. |
| **0.0**........................................................................**0.33** | **0.34**......................................................................**0.66** | **0.67**......................................................................**1.00** |
| **Sentence Structure** | **0.3** | My essay contains fragments or run-ons.  My essay contains awkward phrasing that makes it difficult to read.  Some of my wording is confusing.  I use the same words over and over. | I have well-constructed sentences.  I make routine word choices.  I use descriptive language or wording to communicate a personal style. | My sentences are clear, complete and vary in length.  The word choice is striking but natural.  I use descriptive language and wording to enhance and connect ideas. |
| **0.0**........................................................................**0.33** | **0.34**......................................................................**0.66** | **0.67**......................................................................**1.00** |
| **Conventions** | **0.2** | I use incorrect grammar, spelling and punctuation throughout my essay.  My errors make my paper difficult to read. | I use correct grammar, spelling and punctuation with minor errors that do not interfere with understanding. | I use correct grammar, spelling and punctuation. |
| **0.0**........................................................................**0.33** | **0.34**......................................................................**0.66** | **0.67**......................................................................**1.00** |
| **Drawings of 2-D Silhouette Example and 3-D Example** | **0.5** | My construction of drawings do not represent either the 2-D Silhouette Example or 3-D Example.  I incorrectly label or do not label several parts of the drawings.  I do free-hand sketches of drawings that represents the 2-D Silhouette Example and/or 3-D Example. | I construct neat drawings that represents my 2-D Silhouette Example and my 3-D Example.  My 2-D and 3-D star drawings have equally spaced interior angles and equally spaced points.  I use the Golden Ratio and label the dimensions of all parts of the drawings with only minor errors. | I use advanced features of word processing or other software to accurately construct drawings that represents my 2-D Silhouette Example and my 3-D Example.  I use advanced features of word processing or other software to accurately show the use the Golden Ratio and label the dimensions of all parts of the drawings. |
| **0.0**........................................................................**0.33** | **0.34**......................................................................**0.66** | **0.67**......................................................................**1.00** |
| **Derivation of Formula** | **0.5** | My derivations are incomplete or several formulas are missing.  I do not summarize the derivation of formulas.  I use pen or pencil in my essay to make my derivation complete. | I use trigonometry to derive formulas for measures of angles, lengths of sides and area of triangles with minor errors.  I derive formulas with minor errors for the following: The horizontal distance (on the wall) from the center of the star to the vertex of the interior angles (interior radius), the measure of the interior angle between the points of the star, the measure of the angle at the tip of each point (on the wall), the height of the star at the center (distance from the wall at the center), the measures of the angles of each triangular face, the lengths of sides of each triangular face, area of each triangular face, the total area of the triangular faces and the dimensions of the rectangular sheet with the least area.  I summarize the derivation of formulas with minor errors. | I use trigonometry to accurately derive formulas for measures of angles, lengths of sides and area of triangles.  I accurately derive formulas for the following: The horizontal distance (on the wall) from the center of the star to the vertex of the interior angles (interior radius), the measure of the interior angle between the points of the star, the measure of the angle at the tip of each point (on the wall), the height of the star at the center (distance from the wall at the center), the measures of the angles of each triangular face, the lengths of sides of each triangular face, area of each triangular face, the total area of the triangular faces and the dimensions of the rectangular sheet with the least area.  I use advanced features of word processing or other software to accurately show the derivations.  My derivations are easy to follow. |
| **0.0**........................................................................**0.33** | **0.34**......................................................................**0.66** | **0.67**......................................................................**1.00** |
| **Justifying Measures using the Derived Formulas** | **0.5** | My numerical justifications are incomplete and/or some measures of my 2-D and 3-D stars cannot be found using my derived formulas.  I do not summarize the use of formulas.  I use pen or pencil in my essay to make my justification complete. | I verify the measures of my 2-D and 3-D stars using my derived formulas with minor errors for the following: The horizontal distance (on the wall) from the center of the star to the vertex of the interior angles (interior radius), the measure of the interior angle between the points of the star, the measure of the angle at the tip of each point (on the wall), the height of the star at the center (distance from the wall at the center), the measures of the angles of each triangular face, the lengths of sides of each triangular face, area of each triangular face, the total area of the triangular faces and the dimensions of the rectangular sheet with the least area.  I summarize the use of formulas with minor errors. | I accurately verify the measures of my 2-D and 3-D stars using my derived formulas for the following: The horizontal distance (on the wall) from the center of the star to the vertex of the interior angles (interior radius), the measure of the interior angle between the points of the star, the measure of the angle at the tip of each point (on the wall), the height of the star at the center (distance from the wall at the center), the measures of the angles of each triangular face, the lengths of sides of each triangular face, area of each triangular face, the total area of the triangular faces and the dimensions of the rectangular sheet with the least area.  I use advanced features of word processing or other software to accurately show the numerical verifications and use of formulas.  My numerical justifications are easy to follow. |
| **0.0**........................................................................**0.33** | **0.34**......................................................................**0.66** | **0.67**......................................................................**1.00** |
| **Spreadsheet Information** | **0.5** | My spreadsheet is not well-designed and/or does not include all categories needed to check final formulas. | I include a well-designed spreadsheet with categories that contain the information needed to check all final formulas with only minor errors.  I occasionally uses spreadsheet formulas to determine data values using values from other categories. | I include a superior spreadsheet with categories that contain the information needed to check all final formulas.  Whenever possible, I use spreadsheet formulas to determine data values using values from other categories. |
| **0.0**........................................................................**0.33** | **0.34**......................................................................**0.66** | **0.67**......................................................................**1.00** |
| **Mathematical Explanation** | **0.5** | My mathematical explanations do not describe methods used and/or do not support several of my formulas. | I includes an explanation that, for the most part, describes the mathematics behind the method used to determine my formulas with minor errors for the following: The horizontal distance (on the wall) from the center of the star to the vertex of the interior angles (interior radius), the measure of the interior angle between the points of the star, the measure of the angle at the tip of each point (on the wall), the height of the star at the center (distance from the wall at the center), the measures of the angles of each triangular face, the lengths of sides of each triangular face, area of each triangular face, the total area of the triangular faces and the dimensions of the rectangular sheet with the least area. | I include a detailed explanation that accurately describes the mathematics behind the method used to determine my formulas for the following: The horizontal distance (on the wall) from the center of the star to the vertex of the interior angles (interior radius), the measure of the interior angle between the points of the star, the measure of the angle at the tip of each point (on the wall), the height of the star at the center (distance from the wall at the center), the measures of the angles of each triangular face, the lengths of sides of each triangular face, area of each triangular face, the total area of the triangular faces and the dimensions of the rectangular sheet with the least area.  My team uses advanced features of word processing, spreadsheets and/or other software to accurately show my mathematical explanations.  My mathematical explanations are easy to follow. |
|  |  | **0.0**........................................................................**0.33** | **0.34**......................................................................**0.66** | **0.67**......................................................................**1.00** |

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**Self/Team Final Evaluation**

Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Role \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Score \_\_\_\_\_\_

Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Role \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Score \_\_\_\_\_\_

Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Role \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Score \_\_\_\_\_\_

How well do you think you met the requirements of the project?

|  |  |  |  |
| --- | --- | --- | --- |
| Component | Level | | Comments |
| Your Estimate | Actual |
| Construction of a 2-D Silhouette Model |  | 10 |  |
| Numerical justification of your 2-D Silhouette Model |  | 10 |  |
| Construction of a 3-D Model |  | 10 |  |
| Numerical justification of your 3-D Model |  | 10 |  |
| Development of an organized spreadsheet |  | 10 |  |
| Derivation of all formulas |  | 20 |  |
| Demonstrate the use of all formulas by justifying the measures of your 2-D and 3-D examples using the derived formulas |  | 15 |  |
| Support all reasoning by using sound mathematical evidence throughout the project |  | 15 |  |
| Total |  | 100 |

Rate yourself and your colleagues using the following levels:

* **A**: Accomplished (unusually good)
* **C**: Competent (consistent)
* **E**: Emerging (inconsistent, but evident)
* **N**: Novice (not evident)

How well did you work with your team?

|  |  |  |  |
| --- | --- | --- | --- |
| Component | Level | | Comments |
| Your Estimate | Actual |
| Work distribution |  | 10 |  |
| Participation in problem-solving process |  | 20 |  |
| Systems for quality control |  | 20 |  |
| Total |  | 50 |

**WORK DISTRIBUTION GRAPH:** As you think about the project, make a circle graph that shows the percentage you think each of your team members contributed.

As you reflect on this project, in what ways was your team most successful? In what areas does your team still need improvement? Justify your responses.

As you reflect on this project, rate each person in your team.

**Project Manager**

Person responsible:

|  |  |  |  |
| --- | --- | --- | --- |
| Component | Level | | Comments |
| Your Estimate | Actual |
| Maintains the team schedule |  | 10 |  |
| Takes the lead on writing any proposals |  | 10 |  |
| Tracks team progress |  | 10 |  |
| Ensures completion of team reports |  | 10 |  |
| Recognizes and uses the strengths of other members of the team |  | 10 |  |
| Checks on progress |  | 10 |  |
| Deals with schedule changes or setbacks in the design and test process |  | 10 |  |
| Assists the design engineer and research engineer to ensure successful completion of project tasks |  | 30 |  |
| Total |  | 100 |

**Design Engineer**

Person responsible:

|  |  |  |  |
| --- | --- | --- | --- |
| Component | Level | | Comments |
| Your Estimate | Actual |
| Conceptualizes and thinks through alternate design ideas and problem solving strategies |  | 20 |  |
| Analyzes ideas using experimentation and testing |  | 20 |  |
| Thinks “outside the box” for a better, more efficient, or elegant way to accomplish a task or solve a problem |  | 20 |  |
| Assists the project manager with scheduling, writing and organization |  | 20 |  |
| Helps the research engineer develop a well justified solution and produce quality reports |  | 20 |  |
| Total |  | 100 |  |

**Research Engineer**

Person responsible:

|  |  |  |  |
| --- | --- | --- | --- |
| Component | Level | | Comments |
| Your Estimate | Actual |
| Uses mathematical concepts that are clear and easy to follow |  | 20 |  |
| Reports problems with derivations or justifications |  | 20 |  |
| Helps the project manager develop the team schedule, particularly with the research phase of the project |  | 20 |  |
| Assists the design engineer develop applications that can be easily tested mathematically |  | 20 |  |
| Takes the lead in writing derivations, justifications and applications |  | 20 |  |
| Total |  | 100 |  |

**Architect Designs & Innovations**

**Final Evaluation**

Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Directions: Rate each of the following by place a check mark under either SD: Strongly Disagree, D: Disagree, N: Neutral, A: Agree, or SA: Strongly Agree.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | SD | D | N | A | SA | Comments |
| 1 | Overall, I did an outstanding job on this project. (Think in terms of personal contributions, mindful of deadlines and lessons learned.) |  |  |  |  |  |  |
| 2 | I learned important ideas about using trigonometry in the design process. |  |  |  |  |  |  |
| 3 | I enjoyed the process and project. |  |  |  |  |  |  |
| 4 | I worked effectively as a team member. |  |  |  |  |  |  |
| 5 | My team worked effectively together to produce the final products. |  |  |  |  |  |  |
| 6 | I learned valuable lessons about working together as a team through this project. |  |  |  |  |  |  |

Directions: Rate each of the following by place a check mark under either E: Eliminate, N: Neutral, or K: Keep.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  | E | N | K | Comments |
| 1 | Checklist |  |  |  |  |
| 2 | Team Contracts |  |  |  |  |
| 3 | Writing Journal Learning Log |  |  |  |  |
| 4 | Self Evaluation |  |  |  |  |
| 5 | Team Evaluation |  |  |  |  |
| 6 | Construction of a 2-D Silhouette Example |  |  |  |  |
| 7 | Construction of a 3-D Example |  |  |  |  |
| 8 | Demonstrating and Applying the Derived Formulas |  |  |  |  |