

WAMC Lab Template

Math Concept(s): Geometric Constructions

Source / Text:

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Attach the following documents:

- Lab Instructions
- Student Handout(s)
- Rubric and/or Assessment Tool

Short Description (Be sure to include where in your instruction this lab takes place):

Students will use geometric constructions to recreate geometric designs. This activity supports the use of geometry constructions and allows students to practice them independently and use them to foster creativity.

Lab Plan

Lab Title: Geometric Designs

Prerequisite skills:

- Basic geometric constructions using a compass.

Lab objective: Students will recreate designs using a compass and geometric construction principles.

Standards: (Note SPECIFIC relationship to Science, Technology, and/or Engineering)

Mathematics K–12 Learning Standards:

- G.CO.D.12 Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). Copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line.
- G.CO.D.13 Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.
- G.C.A.3 Construct the inscribed and circumscribed circles of a triangle and prove properties of angles for a quadrilateral inscribed in a circle.

Standards for Mathematical Practice:

- Make sense of problems and persevere in solving them.
- Reason abstractly and quantitatively.
- Mathematically proficient students make sense of quantities.
- Use appropriate tools strategically.
- Attend to precision.

Art Standards

- Performance Standard (VA:Cr2.1.II) Through experimentation, practice, and persistence, demonstrate acquisition of skills and knowledge in a chosen art form.
- Performance Standard (VA:Cr2.2.1) Demonstrate safe and proper procedures for using materials, tools, and equipment while making art.

Leadership/21st Century Skills:

21st Century Interdisciplinary themes (Check those that apply to the above activity.)

- Global Awareness Financial/Economic/Business/Entrepreneurial Literacy Civic Literacy
 Health/Safety Literacy Environmental Literacy

21st Century Skills (Check those that students will demonstrate in the above activity.)

LEARNING AND INNOVATION

Creativity and Innovation

- Think Creatively
 Work Creatively with Others
 Implement Innovations

Critical Thinking and Problem Solving

- Reason Effectively
 Use Systems Thinking
 Make Judgments and Decisions
 Solve Problems

Communication and Collaboration

- Communicate Clearly
 Collaborate with Others

INFORMATION, MEDIA & TECHNOLOGY SKILLS

Information Literacy

- Access and Evaluate Information
 Use and manage Information

Media Literacy

- Analyze Media
 Create Media Products

Information, Communications and Technology (ICT Literacy)

- Apply Technology Effectively

LIFE & CAREER SKILLS

Flexibility and Adaptability

- Adapt to Change

- Be Flexible

Initiative and Self-Direction

- Manage Goals and Time

- Work Independently

- Be Self-Directed Learners

Social and Cross-Cultural

- Interact Effectively with Others

- Work Effectively in Diverse Teams

Productivity and

Accountability

- Manage Projects

- Produce Results

Leadership and

Responsibility

- Guide and Lead Others

- Be Responsible to Others

Math Council

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Teacher Preparation: (What materials and set-up are required for this lab?)

Materials

- Pencil
- Colored pencils and markers
- Geometry compass
- Straight edge/Ruler
- Computer paper
- Posterboard

Set-Up Required:

- Make copies of the design packets for each student.

Lab Organization Strategies:

Leadership (Connect to 21st Century Skills selected):

- Students will need to be creative and manage their time wisely. They will likely become frustrated and need to work through that frustration.

Cooperative Learning:

- Optional: students could work in pairs to create images, this may help for those who struggle to see where the constructions should be applied to the image.

Expectations:

- Students will create a poster with 4 recreated images and 1 original image using only a compass and straight edge.

Timeline:

- 3-4 class days more or less could be given if working outside of class. This should follow a lesson on the basics of constructions.

Post Lab Follow-Up/Conclusions:

Career Applications

- CAD/Architecture
- Graphic Design
- Artist

Optional or Extension Activities

- Find the scale factor between the original image and the created image.

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Math 250 GEOMETRY CONSTRUCTION PROJECT

For your second project of the semester, you will explore the use of a compass and a straight edge to create accurate designs. Please follow the directions below in creating your project:

Expectations:



- ❖ Choose **four** of the designs from the sheets attached to this one. Figure out what must be done to duplicate a design that is similar to the design on the paper.
- ❖ Use a pencil, compass and a straight edge to **create** on plain white paper the **four designs** that you have chosen.
- ❖ When finished, erase unnecessary marks, and color the designs you have constructed with pens, pencils, crayons, or markers.
- ❖ **Create one original design** using the compass and straight edge only.
- ❖ Mount the four duplicated designs and your original design on a construction paper, mat board, or poster board and submit all together as your **Geometry Construction Project**.

Assessment of the Project:

Your completed project will be evaluated on the following criteria.

- ◆ **Accuracy**—All lines must be carefully drawn with a pencil using only a compass and a straight edge. There should be no freehand drawing.
- ◆ **Neatness**—Attention to the look and neatness of the designs is important.
- ◆ **Creativity**—The original design and the coloring of the 4 duplicated designs should be unique and show some planning and effort.
- ◆ **Effort** – The more detailed, planned, colored, etc. the better!
- ◆ **Meeting Deadlines / Following Directions** – The project must satisfy the above expectations and be completed on time.



- ❖ **PRESENTATION** – The 5 designs should be carefully presented together on your chosen background ... remember these are going to be graded together by your fellow students and instructor at class on Tuesday December 10th, so the better it looks, the better your grade. Wow factor is big here!

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Geometry Construction Project Grading Rubric

Accuracy:

8-10	<ul style="list-style-type: none"> • Angles, circles, polygons, etc. are correctly constructed when used. • All line segments are straight. • All line segments end at the appropriate endpoints.
5-7	<ul style="list-style-type: none"> • Most angles, circles, polygons, etc. are correctly constructed when used. • Most line segments are straight. • Most line segments end at the appropriate endpoints.
3-4	<ul style="list-style-type: none"> • Some angles, circles, polygons, etc. are correctly constructed when used. • Some line segments are straight. • Some line segments end at the appropriate endpoints.
0-2	<ul style="list-style-type: none"> • Few angles, circles, polygons, etc. are correctly constructed when used. • Few line segments are straight. • Few line segments end at the appropriate endpoints.

Neatness:

16-20	<ul style="list-style-type: none"> • Erasures are well made..there is little to no evidence of original construction marks. • There are no smudges. • Coloring is neatly done and is pleasing to the eye. • Care is taken in terms of the presentation of the design (e.g., it is centered; backgrounds are used; name, title, date, etc. are displayed; design is of a large size and takes up most of the posterboard)
10-15	<ul style="list-style-type: none"> • Erasures are mostly well made..there is little evidence of original construction marks. • There are few smudges (1-3, but no more). • Coloring is neatly done in most instances and is mostly pleasing to the eye. • A good degree of care is taken in terms of the presentation of the design (e.g., it is centered; name, title, date, etc. are displayed, design is of a large size, but there is a little too much whitespace around the design)
5-9	<ul style="list-style-type: none"> • Erasures are sometimes well made..there is some evidence of original construction marks. • There are smudges (4-5, but no more). • Coloring is neatly done in some instances but only partially pleasing to the eye. • Some care is taken in terms of the presentation of the design (e.g., name, title, date, etc. are displayed, design is of a medium size and there is a little too much whitespace around the design).
0-4	<ul style="list-style-type: none"> • Erasures are not well made..there is much evidence of original construction marks. • There are many smudges (more than 5). • Coloring is not neatly done and/or is not pleasing to the eye. No coloring is done. • Little care is taken in terms of the presentation of the design (e.g., design is not centered; name, title, date, etc. are not displayed, design is of a small size and there is too much whitespace around the design).

Geometry Construction Project Grading Rubric

Creativity:

16-20	<ul style="list-style-type: none"> Original design is very clever; creatively designed Original design is either completely original or combines non-original designs in an original way. Coloring, etc. on all designs is creative and shows care and creativity.
10-15	<ul style="list-style-type: none"> Original design displays creative thinking Some portion of the original design is copied from another source, but most is original. Coloring, etc. on most designs is creative and shows care and creativity.
5-9	<ul style="list-style-type: none"> Original design shows some creative thinking Most of the original design is copied from another source, but some portions are original in nature. Coloring, etc. on designs is somewhat creative and shows some care and creativity.
0-4	<ul style="list-style-type: none"> Original design lacks creativity “Original” design is fully copied from another source. Designs are not colored and little care is shown.

Effort:

8-10	<ul style="list-style-type: none"> The project clearly shows that much effort was put into producing an excellent design. The project looks complete – nothing was left undone. Risks were taken in terms of design (design is complex, materials used are unique, etc.)
5-7	<ul style="list-style-type: none"> The project shows that good effort was put into producing the design. The project looks mostly complete – some touch up is still required. Some risks were taken in terms of design (design is relatively complex, materials used are mostly unique, etc.)
3-4	<ul style="list-style-type: none"> The project looks like parts of it were thrown together at the last minute. The project does not look complete – a lot of work is still required. Few risks were taken in terms of design (design is relatively simple, materials used are predictable, etc.)
0-2	<ul style="list-style-type: none"> The project looks as if it were put together in a hurry. The project is not complete. No risks were taken in terms of design (design is very simple)

Meeting Deadlines/Following Directions:

8-10	<ul style="list-style-type: none"> The project is handed in on time. The project goes beyond the requirements as presented.
5-7	<ul style="list-style-type: none"> The project is handed in on time. The project meets all the requirements as presented.
3-4	<ul style="list-style-type: none"> The project is handed in no more than one day late. The project meets some of the requirements as presented.
0-2	<ul style="list-style-type: none"> The project is handed in more than one day late. The project meets few of the requirements as presented.

To Copy A Line Segment

1. Objective: Copy \overline{AB}



Draw a segment longer than \overline{AB} .

3.



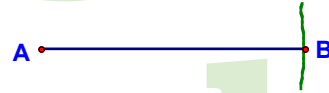
Find the hole # on your compass that allows you to construct an arc through B centered at A.

2.



Establish point C on the longer line that correspond with A on \overline{AB} .

4.



Draw an arc centered at point C using the same hole # and intersecting the longer line. The point of intersection of this arc and the line will be point D. $\overline{CD} \cong \overline{AB}$.

To Bisect a Line Segment

Objective: Bisect \overline{AB}



2.



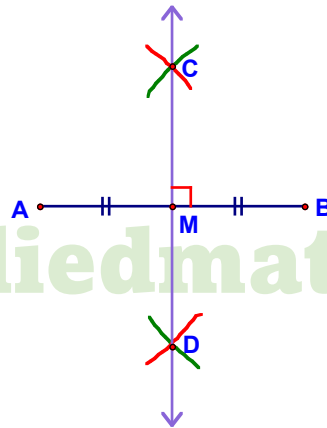
Using the same hole as for Step 1, center your compass at B and draw arcs which intercept the first two arcs, creating points C and D.

1.



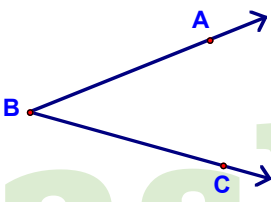
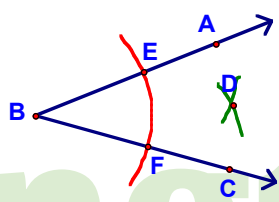
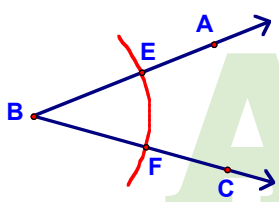
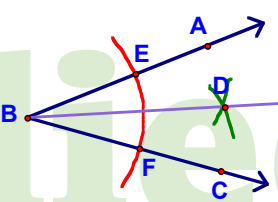
Center your compass at A and pick a hole that is more than half way to B. Now draw arcs above and below \overline{AB} .

3.

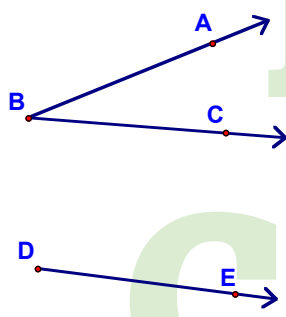
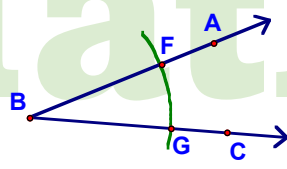
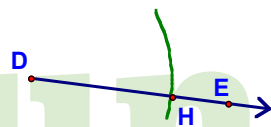
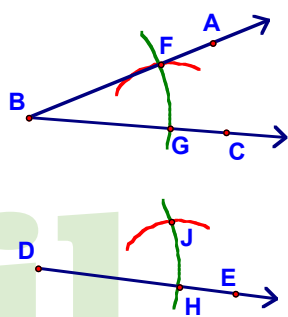
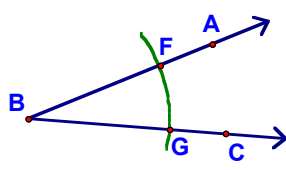
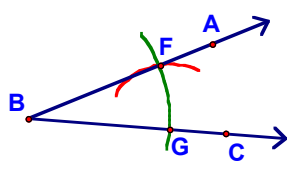
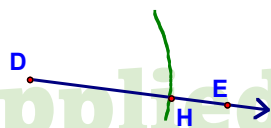
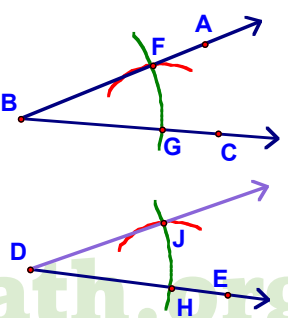


Draw \overline{CD} . $\overline{AM} \cong \overline{MB}$ and $\overline{CD} \perp \overline{AB}$. M is the midpoint of \overline{AB} .

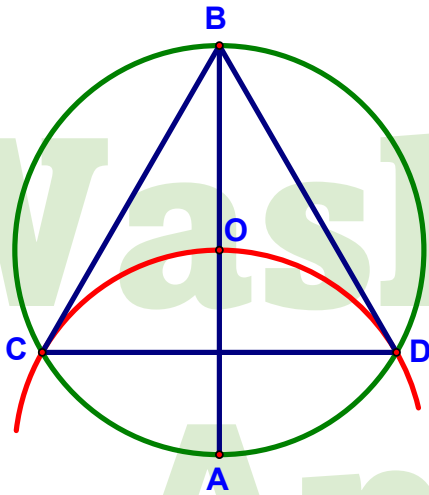
To Bisect an Angle

<p>Objective: Bisect $\angle ABC$</p> 	<p>2.</p>  <p>Using E and F as centers, draw two arcs with equal radii intersecting at point D.</p>
<p>1.</p>  <p>Center your compass at B and draw an arc which intersects \overline{BA} and \overline{BC} at E and F.</p>	<p>3.</p>  <p>Draw \overline{BD}. \overline{BD} bisects $\angle ABC$.</p>

To Copy an Angle

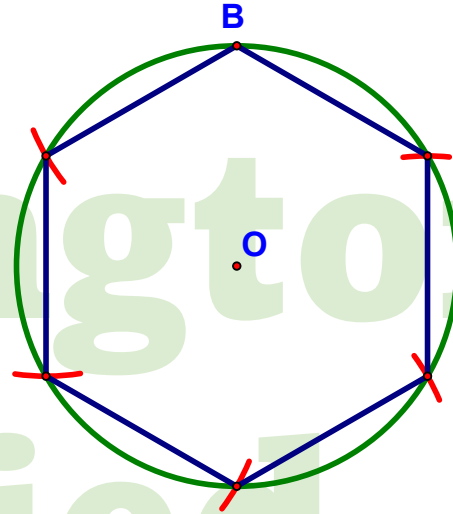
<p>1. Objective: Copy $\angle ABC$</p>  <p>Draw \overline{DE}.</p>	<p>3.</p>   <p>Draw an arc with the same radius as in Step 2 centered at D.</p>	<p>4.</p>  <p>Draw an arc of length GF centered at H. It should intersect the previous arc at J.</p>
<p>2.</p>  <p>Draw an arc centered at B which intersects \overline{BA} and \overline{BC} at F and G.</p>	<p>5.</p>   <p>Draw an arc centered at G that goes through F - remember the hole #!!</p>	<p>6.</p>  <p>Draw \overline{DJ}. $\angle JDH \cong \angle ABC$.</p>

Inscribing Regular Polygons



Inscribe an equilateral triangle:

1. In the given $\odot O$, draw a diameter \overline{AB} .
2. Using A as a center and AO as a radius, draw an arc intersecting the circle at C and D.
3. Connect B, C, and D to form a triangle.



Inscribe a regular hexagon:

1. Draw $\odot O$, remember the radius!
2. Pick a point on the circle (B in this case) and with the same radius, draw an arc that intersects with the circle (to the left of B in this case).
3. Using the new point (created where the arc meets the circle) as the center and with the same radius, make another arc on the circle. Continue making arcs around the circle until you have six points. These are the vertices of the regular hexagon.

Technical Tips:

1. Use a sharp pencil and a high quality, accurate compass.
2. Use a pencil or pen that doesn't smear. A straight edge with an elevated edge helps prevent smearing. Drafting or masking tape on the bottom of the straight edge can be used to lift the edge off the paper.
3. Make sure the paper is not on or in a binder when you're doing your constructions. The compass does not work as well if the writing surface is not *totally* flat.
4. Larger constructions usually prove to be easier and more accurate.
5. When making ink drawings, you may wish to complete the drawing in pencil before using ink.
6. Each of these constructions starts with a regular hexagon or triangle. From there, it's all about using diagonals to find different points of intersection from which to center arcs.

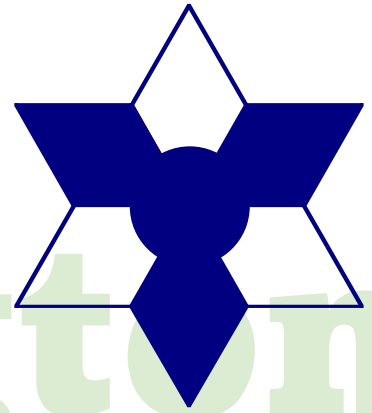
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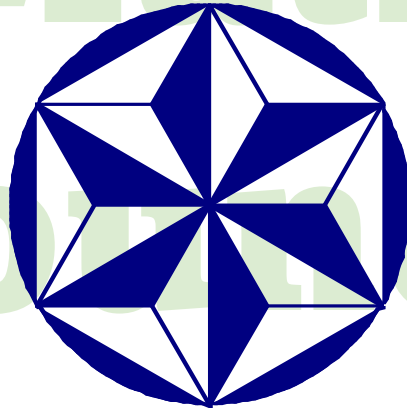
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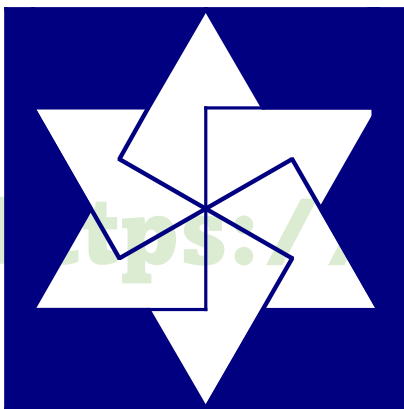
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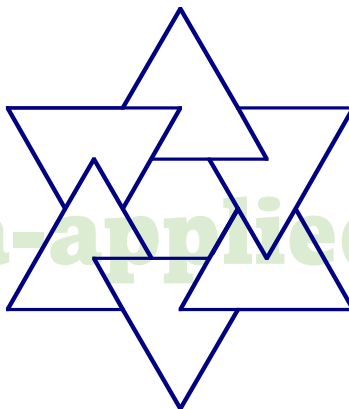
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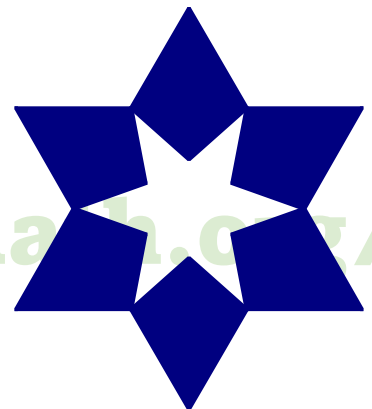
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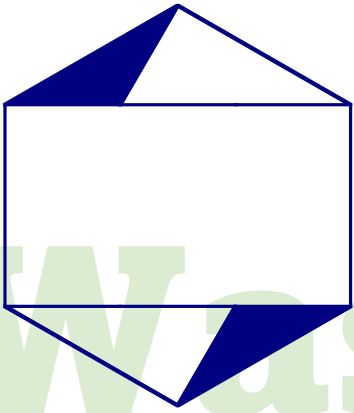
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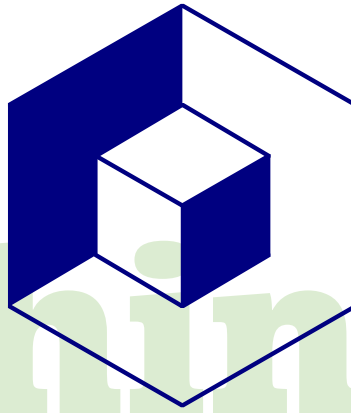
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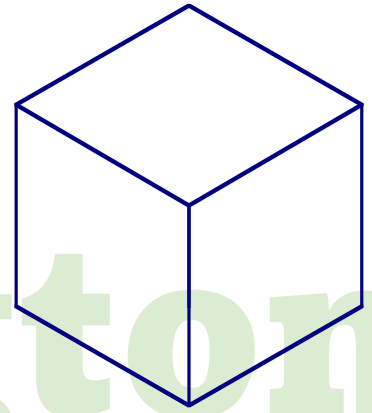
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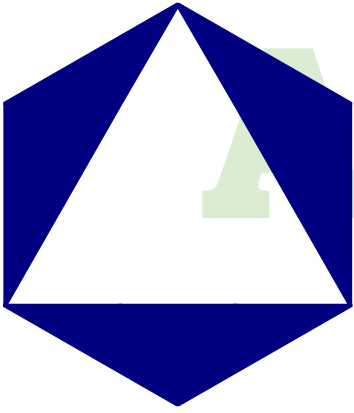
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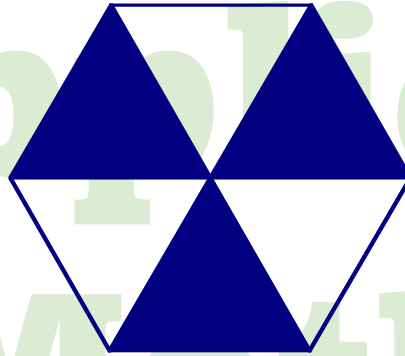
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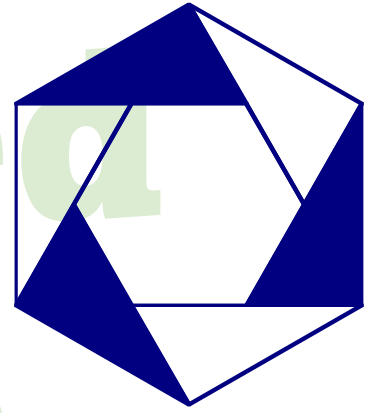
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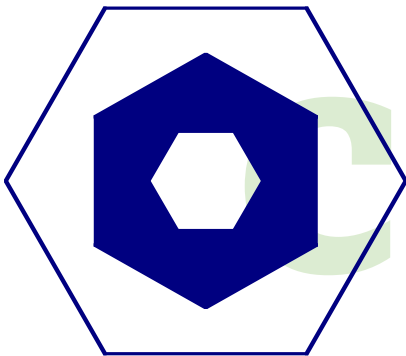
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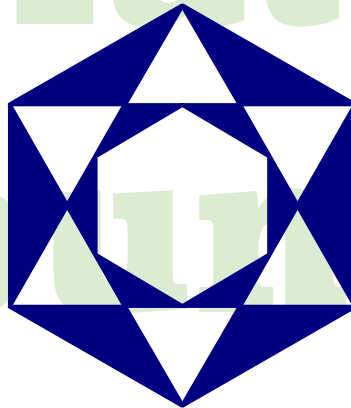
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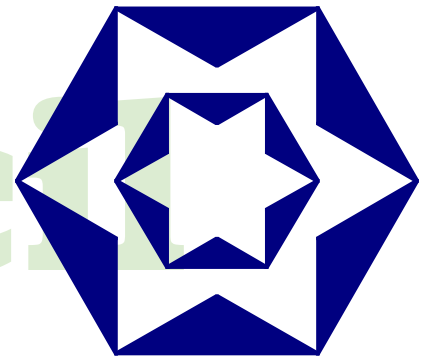
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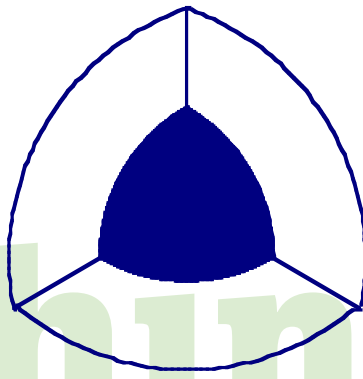
Math

Course

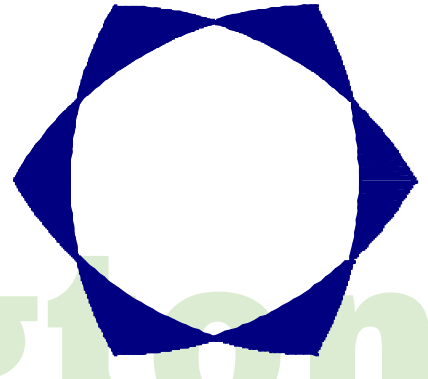
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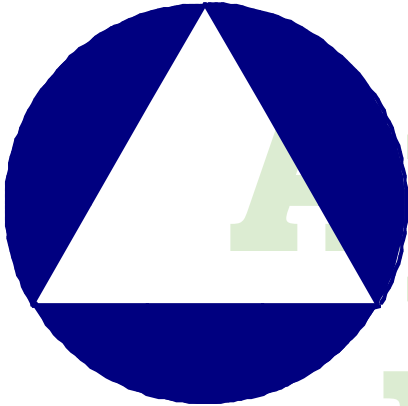
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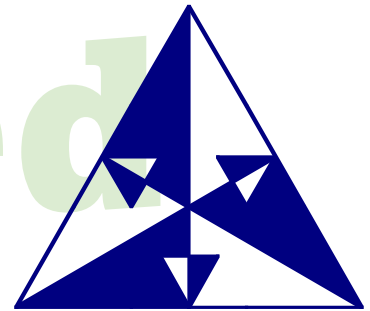
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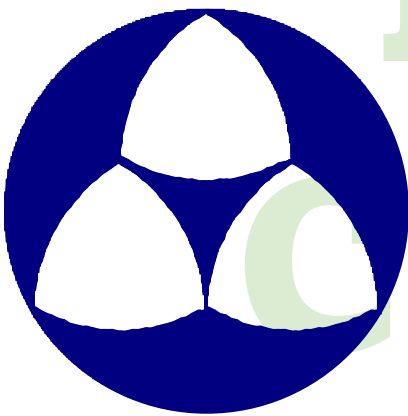
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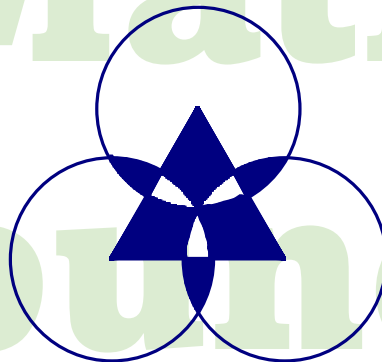
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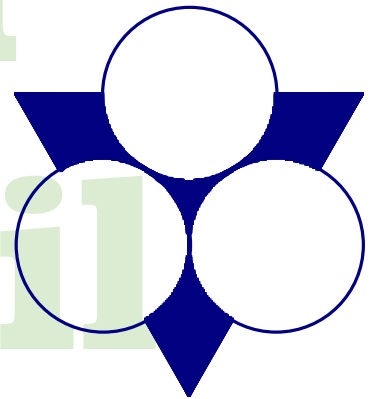
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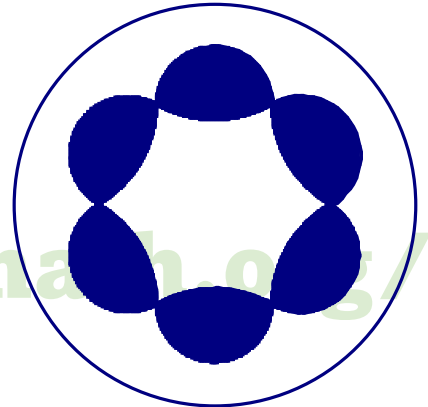
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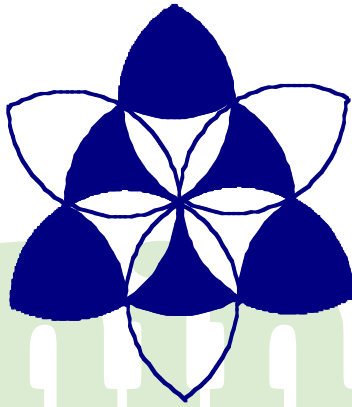


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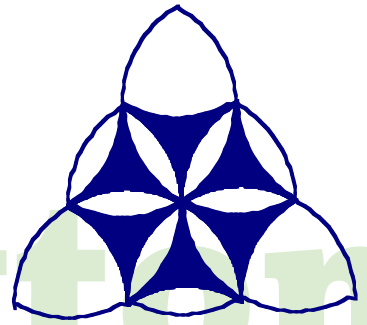
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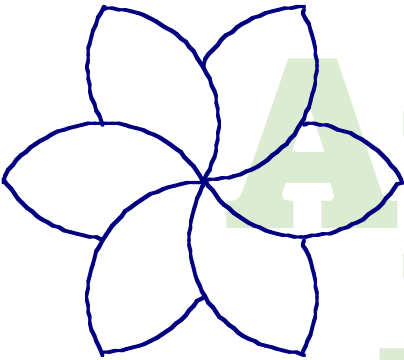
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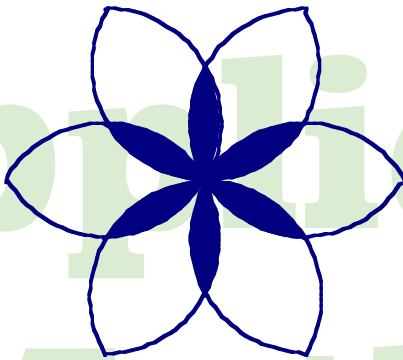
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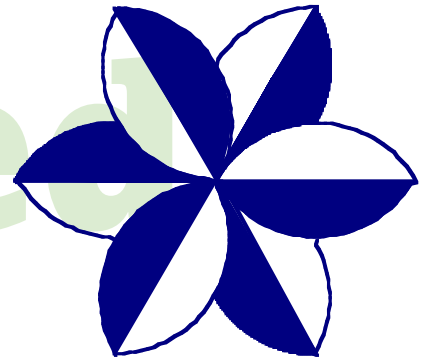
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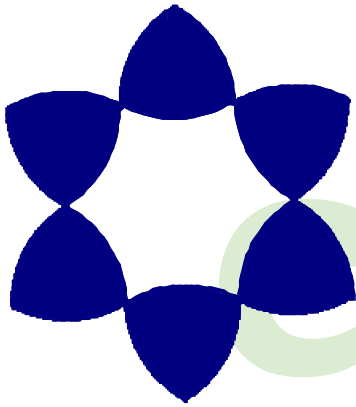
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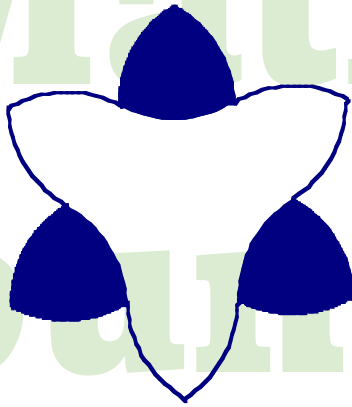
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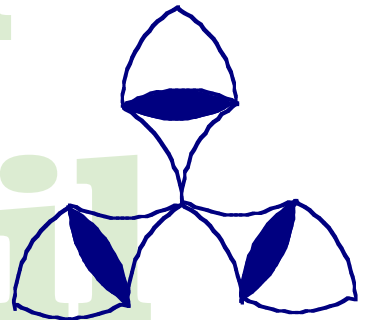
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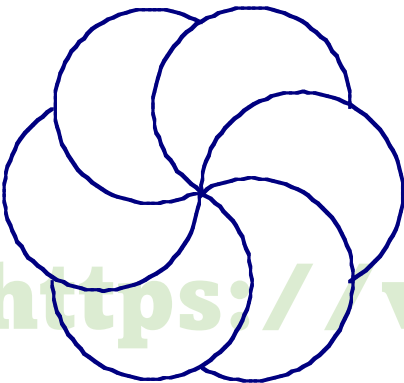
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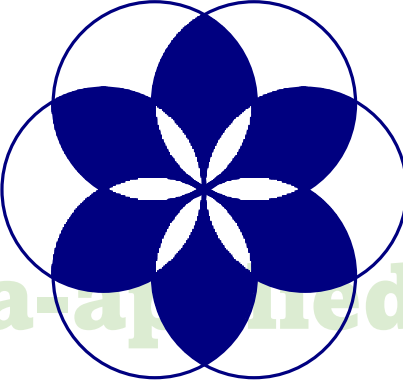
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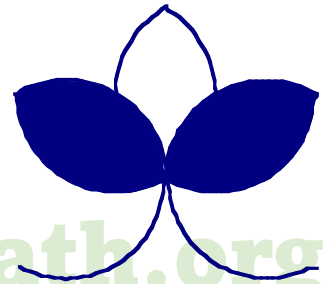
45



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