Foundations of Math 12

Geometry

Fall 2026

NAME:

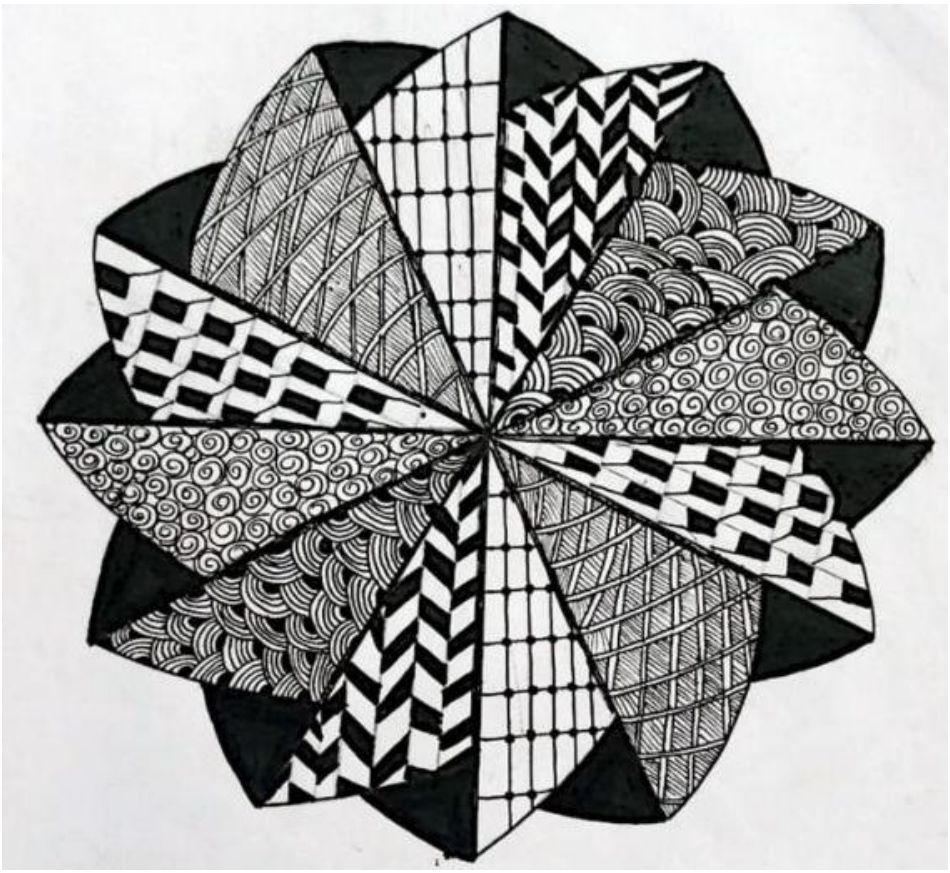

Image Source

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Lesson 1: Review of angles on parallel lines and in polygons

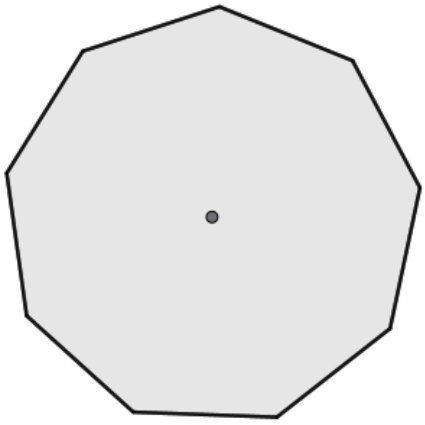
Sum of angles in a triangle:

Angles on a straight line:

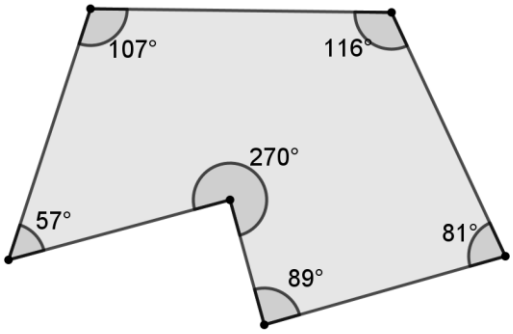
Angles around a point:

Vertically opposite:

Angles in any regular polygon (at the center. Interior, sum of interior, exterior)

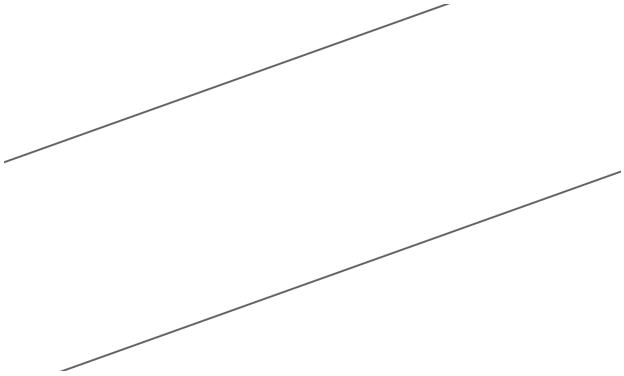


Angles in any irregular polygon

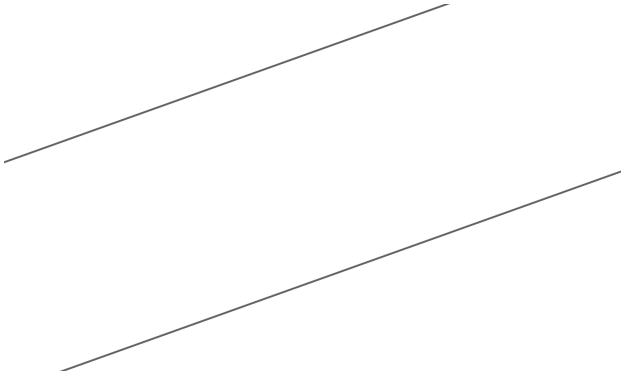


Angles on parallel lines

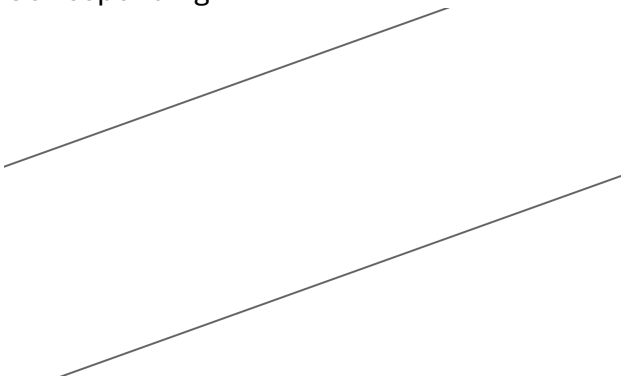
Transversal



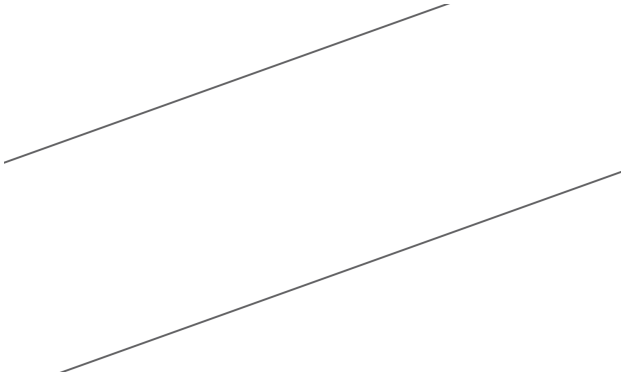
Alternate



Corresponding

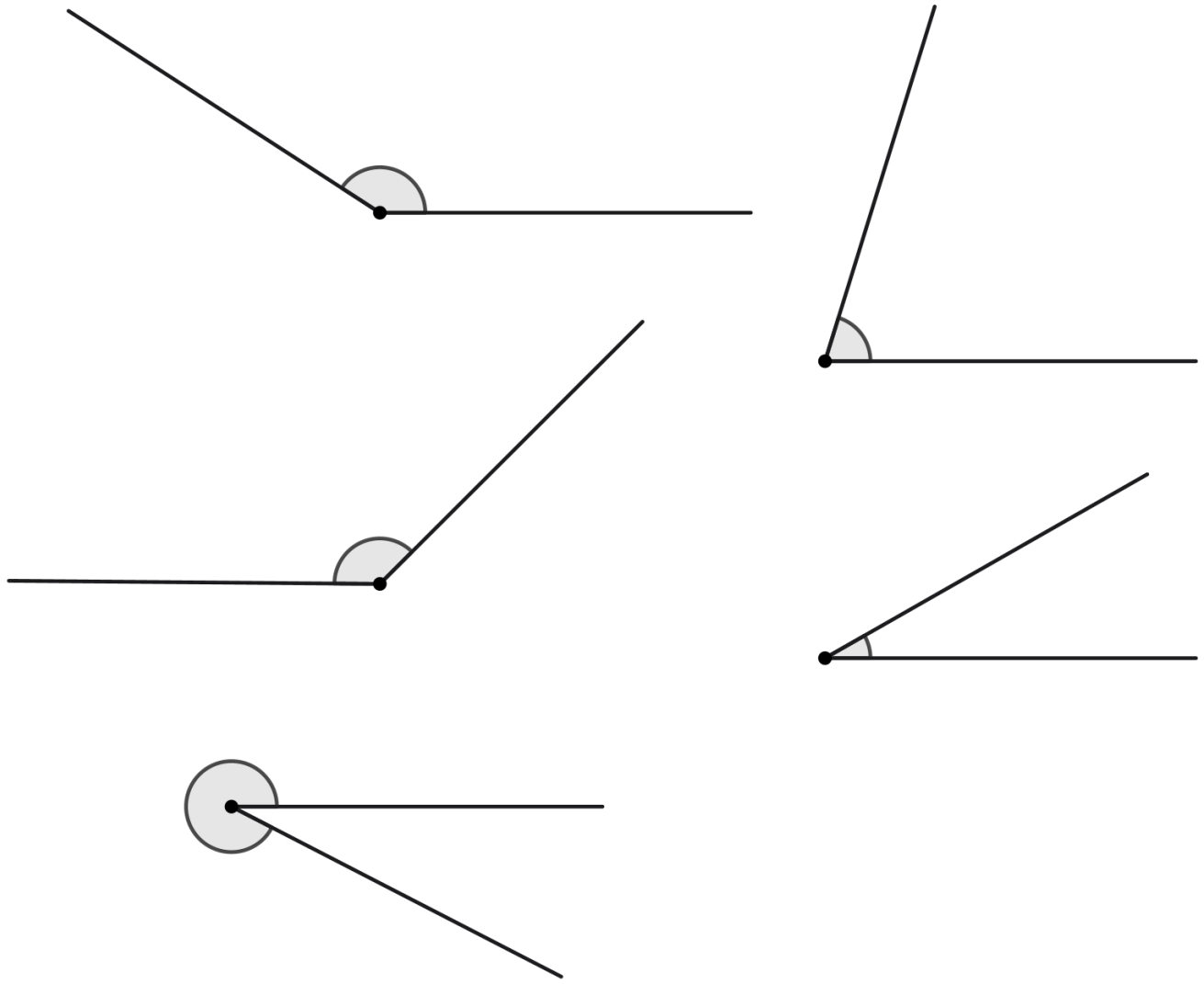


Co-Interior



Review exercise: corbettmaths: Parallel lines, Polygons

Measure each of these angles:



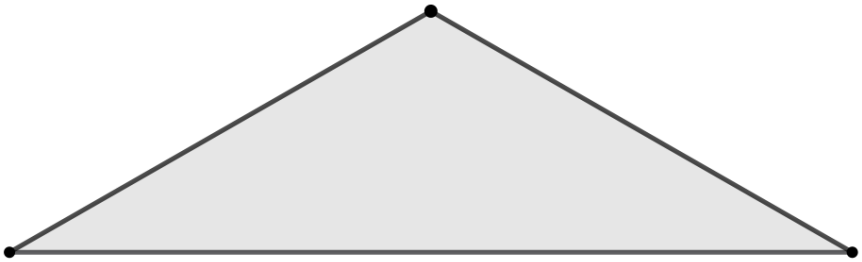
Geometric 'constructions' are about drawing perfect shapes using only a straight edge and a compass.

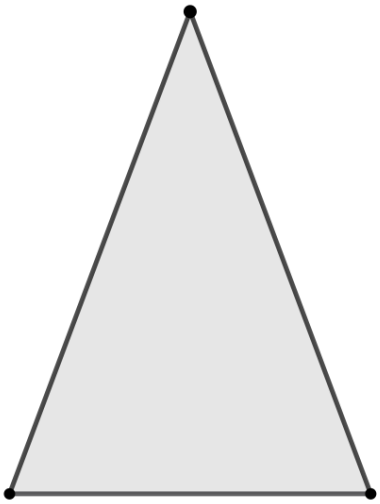
Angles above are:

147°,135°,73°,30°,333°

A compass can be used to ‘store’ a length.

Use a compass to construct a reflection of each of these isosceles triangles:

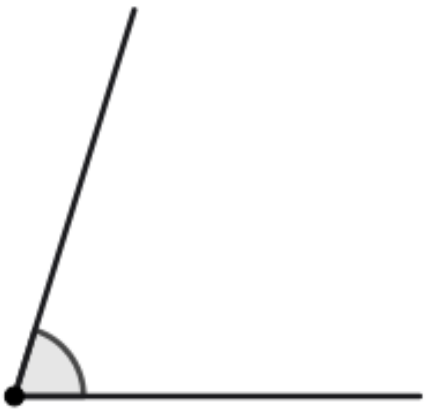




Use a compass to cut this line perfectly in half:



Use a compass to bisect this angle (cut it in half):

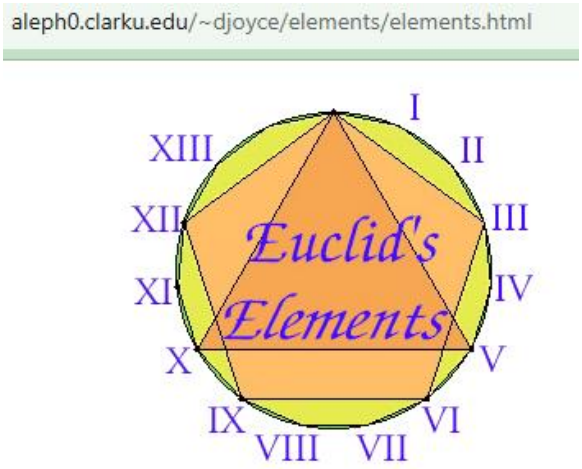


https://mathigon.org/timeline/

In approximately 300BCE, Euclid gathered together all the knowledge available to him about geometry and presented it systematically in a set of 13 'books', known as Euclid's *Elements*.

Euclid's *Elements* became the longest serving math textbook. It was used for over 2000 years!!!

We can browse the whole text translated here:



Euclid's *Elements* have been read and revered by thinkers across academic disciplines, giving rise to the value Western school math places on abstraction in mathematics. In the Euclidean system to get to any conclusion we can draw a single direct line from axioms and postulates, through all pre-requisite theorems, to the conclusion at hand. Linear, abstract thinking.

Thinking in this logical way has been consistently valued in Western philosophies to access truth and thereby the authority of truth. At the turn of the 20th century, mathematicians Gottlob Frege and Bertrand Russel attempted to describe all of mathematics as existing within the container of logical thinking. They failed.

Indigenous nations developed mathematical thinking valuing connection to context and purpose rather than abstraction. The mathematics of space for some First Nation's in North America includes (but is not limited to) the shared labour of harvesting enough food sources (quantities of space such as volume) by the whole community in the summer months to feed the whole community through the winter months. Anthropologist Alan Bishop writes "To decontextualize, in order to be able to generalise, is at the heart of western mathematics … but if your culture encourages you to believe instead that everything belongs and exists in its relationship with everything else, then removing it from its context makes it literally meaningless".

Most K-12 math taught in schools continues to value math that is decontextualized.

Common across the globe math is used for survival, economy and play. According to Bishop, the six universal uses include navigating, counting, measuring, explaining, playing and designing.

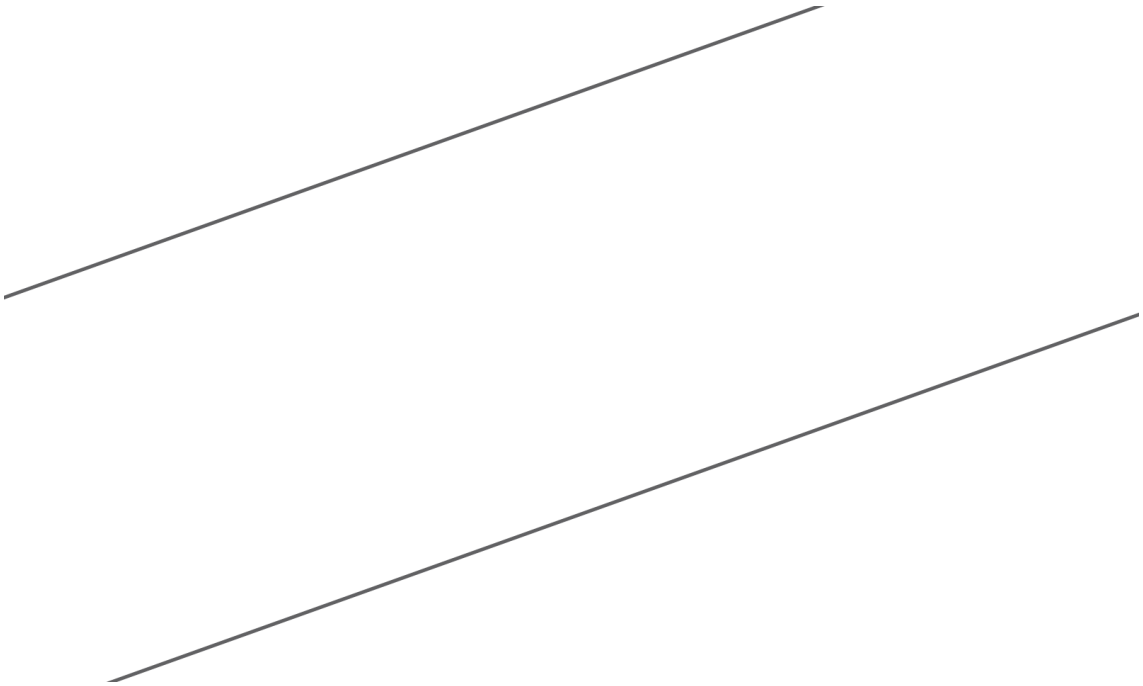
Our approach in this unit is to consider Euclidean geometry as a puzzle, to practice explaining and to see how geometry has been used in design.

Construction (i): Isosceles Triangle

Construction (ii): A square

Construction (iii): A hexagon

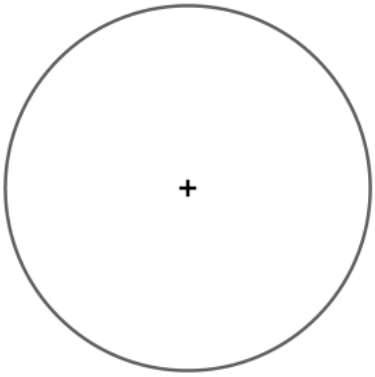
Construction (iv): A third line, parallel to the existing parallel lines, equidistant from both

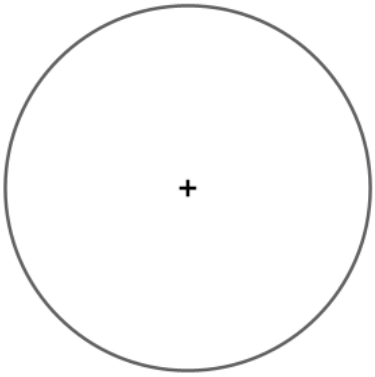


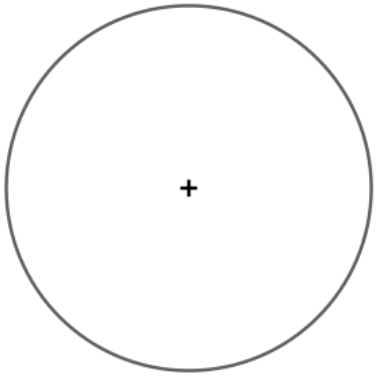
Construction (v): An Octagon

Lesson 3: Circle Theorems (i)

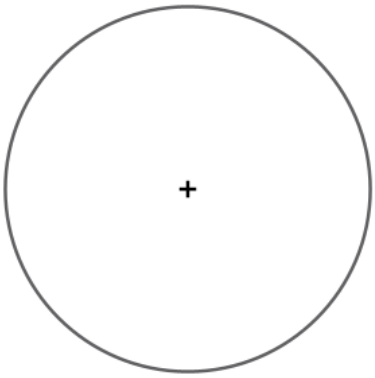
Vocabulary

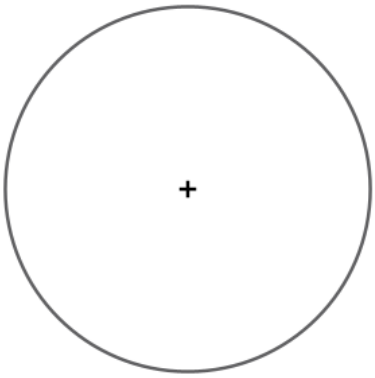






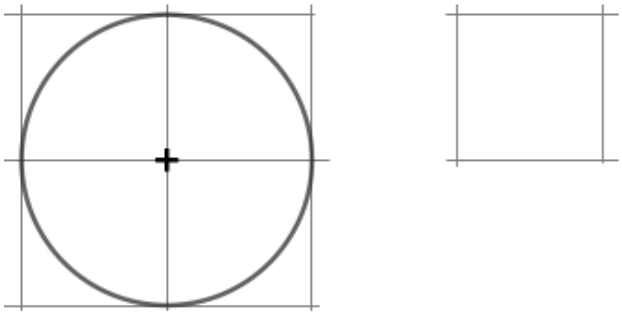
Diameter Radius Circumference	Chord Minor Segment Major Segment	Sector Minor sector Major sector



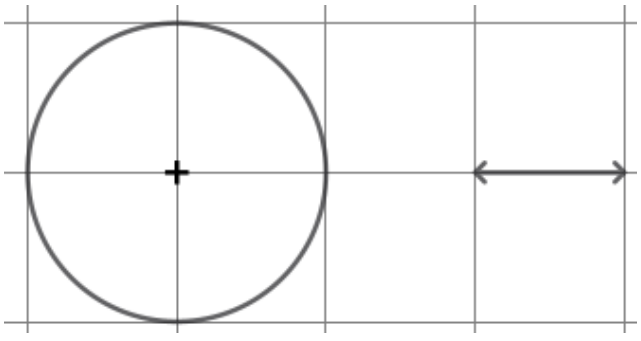


'The chord AB subtends an angle θ at the center'	'The chord AB subtends an angle θ on the circumference'

Area:



Circumference:



Thales Theorem

Angle at the Center

Cyclic Quadrilateral

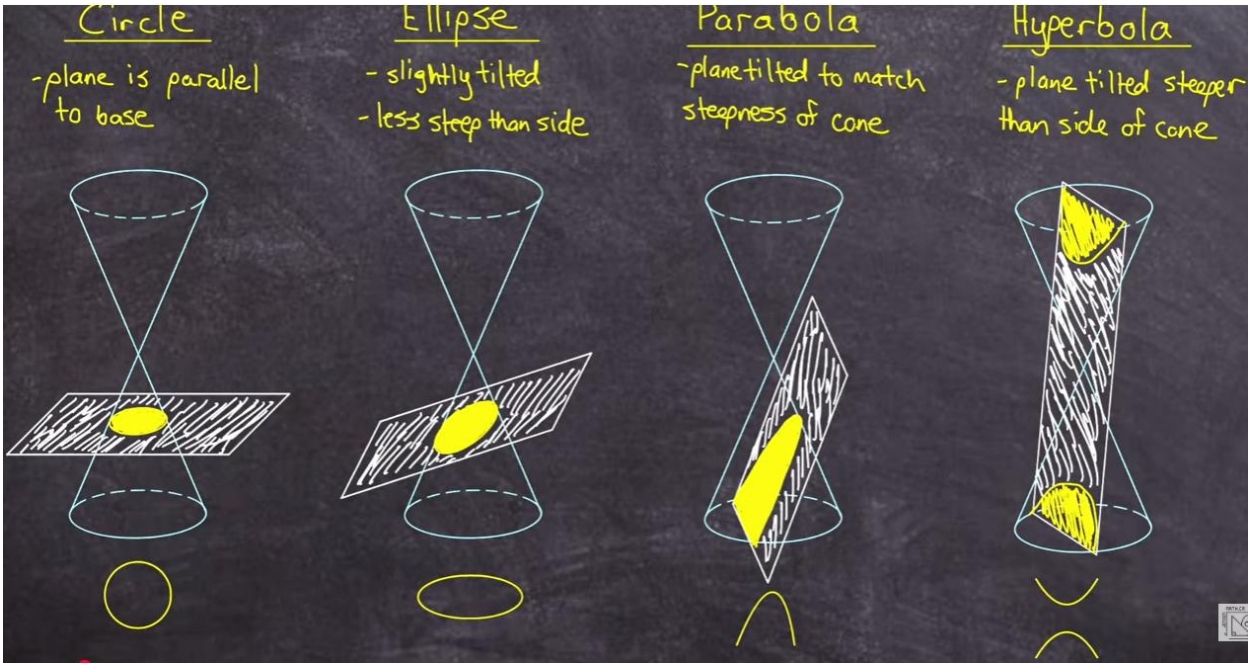
Angle in the alternate segment

Angles in a segment

Circumcenter of a Triangle

Lesson 5: Conic Sections,

Image From: https://www.jensenmath.ca/fun-videos , otherwise, mathisfun.org.



A Locus is a set of points that share a property.

Example: A Circle is:

"**the set of all points** on a plane that are a fixed distance from a central point".

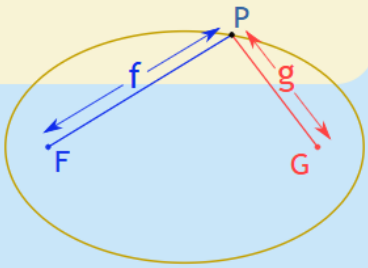


So, just a few points start to *look like a circle*, but when we collect ALL the points we will actually **have** a circle.

Example: An ellipse is the **locus** of points whose distance from two fixed points add up to a constant.

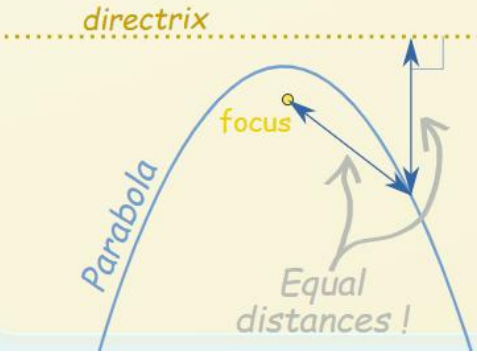
So, no matter where we are on the ellipse, we can add up the distance to point "F" and to point "G" and it will always be the same result.

(The points "F" and "G" are called the **foci** of the ellipse)



Ellipse

f+g always adds to the same value



Definition

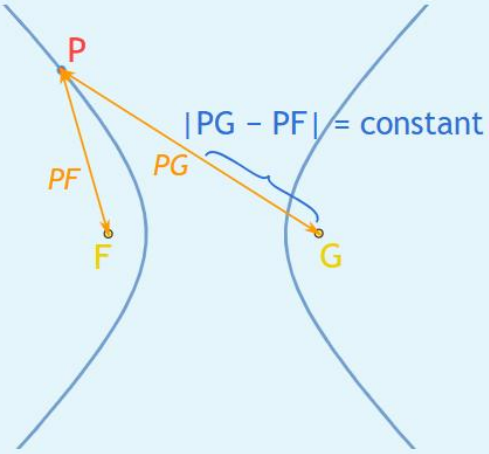
A parabola is a curve where any point is at an **equal distance** from:

- a fixed point (the **focus**), and
- a fixed straight line (the **directrix**)

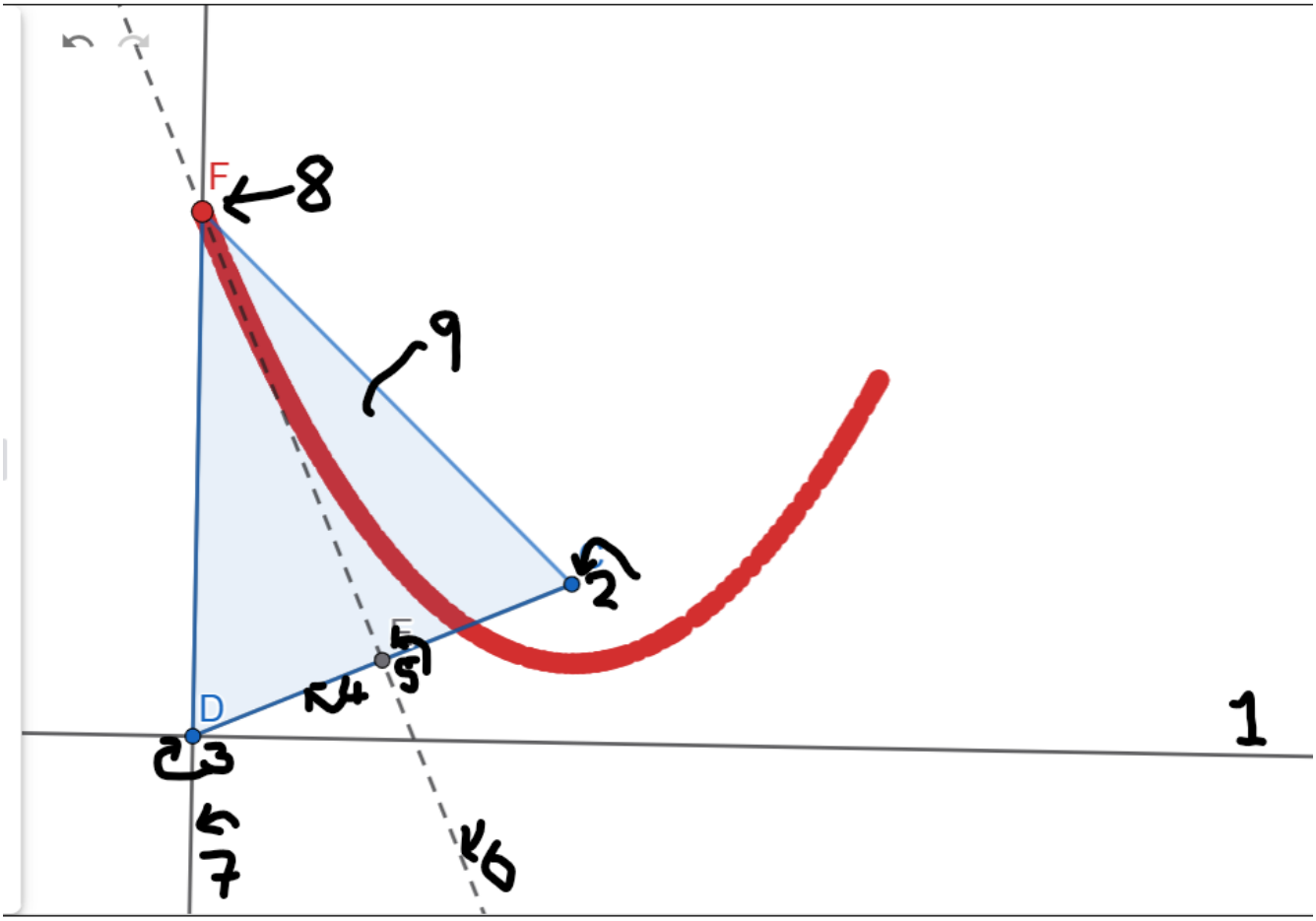
A hyperbola looks like two infinite bows, called "branches".

Looking at the left hand branch in this diagram:

any point **P** is closer to **F** than to **G** by some constant amount



Construct a Parabola with the Directrix and the Focus



Steps:

1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	

Bezier Curves

Video: The Beauty of Bezier Curves by Freya Holmér
https://youtu.be/aVwxzDHniEw?si=_zcLYuEmjx27OHRi

Construct a Parabola with String Art

https://www.youtube.com/watch?v=aVwxzDHniEw

On GeoGebra:

1.	Plot three points, A, B, C
2.	Plot two line segments: AB, BC
3.	Create a slider a, from 0 to 1.
4.	Define 3 points: P=B+a(A-B) Q=C+a(B-C) R=P+(1-a)(Q-P)
5.	Trace the point R

Project 1: Circle Theorems

Choose one of: the angle at the center, the cyclic quadrilateral or the angle in the alternate segment theorem.

Before you begin writing this project, research a proof for the theorem online. Rehearse it on a classroom whiteboard until you can say all the steps from memory.

Page 1: Title page, name, date, course. Illustrate the theorem with a pencil and paper drawing. Use a protractor to measure the relevant angles. State the theorem.

Page 2: Give a step-by-step set of instructions on how to construct the diagram on GeoGebra. Use diagrams.

Page 3: Write the proof using your own diagrams (compass/ruler constructions or GeoGebra diagrams). Use several diagrams to convey the information in steps.

Page 4: Reflect. What is similar to or different between a logical argument (such as this proof) and a rhetorical argument? Is a good logical argument of equal, less or more value than a good rhetorical argument in today's society? Explain your thoughts in a paragraph.

Page 5: Cite sources alphabetically.

Project 2: Conic Sections & Locus

Choose two: ellipse or circle; and, parabola or hyperbola.

Page 1: Title page, name, date, course. Image and description of the four conic sections.

Page 2: Create an image of an ellipse (or circle) on the interactive conic section applet. Explain in words how an ellipse is formed with the cone and the plane.

Page 3: Explain the steps to constructing an ellipse (or circle) on GeoGebra. Include an image and a link to your GeoGebra file.

Page 4: Create an image of a parabola (or hyperbola) on the interactive conic section applet. Explain in words how an ellipse is formed with the cone and the plane.

Page 5: Explain the steps to constructing a parabola (or hyperbola) on GeoGebra. Include an image and a link to your GeoGebra file.

Page 6: Research the applications of either the ellipse or the parabola. Describe and explain two applications.

Page 7: Cite sources alphabetically.

Project 3: Art with locus

Page 1: Title page, name, date, course. Definition of 'locus'.

Page 2: Create an interesting diagram using the 'trace' of a point. List the step by step process to create the diagram. Include your geogebra link.

Page 3: Create a second interesting diagram using the 'trace' of a point. List the step by step process to create the diagram. Include your geogebra link.

Page 4: Reflect: Evaluate the strategies you used to create your art. Explain what new ideas you had and how you came to them.

Page 5: Cite sources alphabetically.

Project 4: Construct a Pentagon

Before you begin writing this project, research and learn how to construct a regular pentagon. Rehearse it on a classroom whiteboard/paper until you can recall all the steps from memory.

Page 1: Title page, name, date, course. Explain what is meant by a geometric 'construction'.

Page 2: Explain the steps to draw an isosceles triangle.

Page 3: Create a neat copy of a constructed pentagon on paper.

Page 4: Create the pentagon using GeoGebra tools.

Page 5: Create your own list of instructions on how to construct a pentagon.

Page 6: Reflect: State when & where Euclid's Elements were written. Reflect on how you think his deductive method has influenced western Epistemology (the way Western cultures think of knowledge making and truth). Start by finding Euclid on this timeline https://mathigon.org/timeline/ Don't quote AI or use it for your words, but you can use if for leads.

Page 7: Cite sources alphabetically.

Project 5: The algebra of conic sections

Calculate the equation $y = ax^2 + bx + c$ from the position of the focus and the directrix.

Before you begin writing this project, calculate the equation of a parabola starting with directrix and focus drawn on GeoGebra for a few examples. Decide what variety of examples to include.

Page 1: Title page, name, date, course. Explain the parabola drawn from directrix and focus.

Page 2, 3, 4 Examples of your parabolas & the algebra to convert to Cartesian form.

Page 5: Reflect: State when, where (&who) the Cartesian plane was invented. Reflect on the advantages of using the Cartesian plane to create & analyse the conic sections. Don't quote AI or use it for your words, but you can use if for leads. Page 6: Cite sources alphabetically.

Project Grading: 4 equally weighted grades.

Descriptors for Proficient:

Communication: o I have completed all parts of this project. o My project can be read independently of the instructions. o My project has a title page with my name, a title for the project, a sentence describing the objective of the project and perhaps a relevant image. o I have used text, diagrams and space to effectively communicate the calculations o It is evident that have thought of the reader when structuring each page. That is, the elements (text, diagrams) of each page are placed in an order that makes sense to the reader. o I have used correct math notation. o I have used correct math vocabulary. o I have used my choice of presentation (slides/paper/poster) effectively.
Reasoning: o I have demonstrated understanding of each part of the project. o My lines of work record each step in the calculations clearly, one step at a time. o My writing (including text/diagrams) is sufficient to demonstrate my understanding.
Technology: o I have used technology effectively as required by the project description. o Non-essential labels/components are hidden. o Blank space is minimised. o Links are provided for any dynamic creation
Reflection: o I have demonstrated understanding of the reflection question/s. o I have written my own paragraph in response the reflection question. o I have given my sources.

Descriptors for Extending: If your work can be described as containing unique ideas, or as creative, insightful, sophisticated in any of the categories it can be graded as 'extending'. E.g:

Communication: Creative and insightful use of the media you use (paper, document, google slides, verbal presentation with slides, poster).
Reasoning: In depth understanding of the math is demonstrated through conversation in the classroom, through your writing (with math notation), connections between ideas.
Technology: Clean, clear diagrams and use of scripting or original ideas to create the technology component of your project.
Reflection: Substantial (in terms of content, not word count) reflection demonstrating in depth learning or knowledge of the topic.

Lesson 7: Mandala art: Construct the cover Mandala

Here are some construction steps to building the cover Mandala

1. Line segment

2. Perpendicular Bisector.

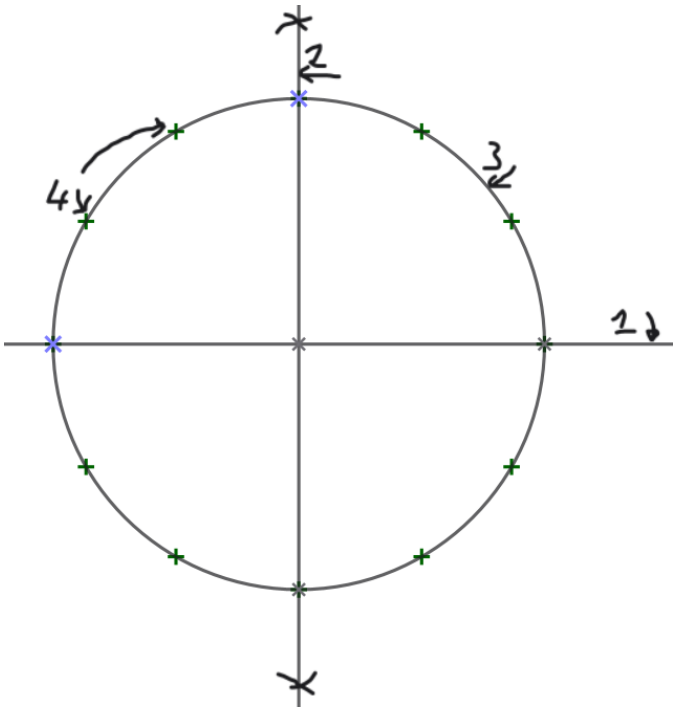
3. Circle.

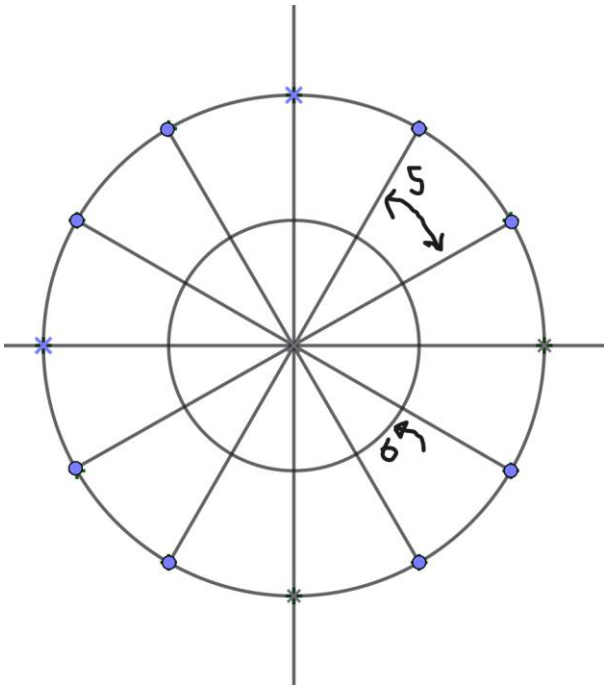
4. Mark 30 degrees using the radius for every 60 from the horizontal, every 60 from the vertical.

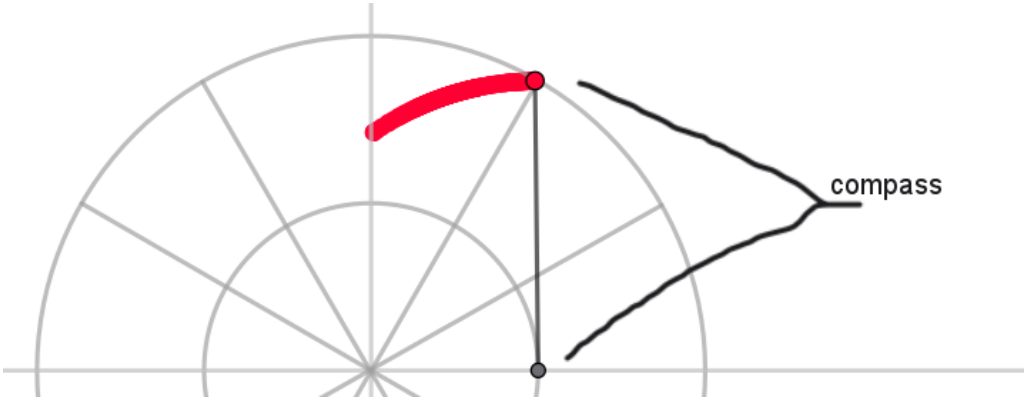
5. Draw the remaining diameters at 1 pm, 2 pm, 4 pm and 5 pm.

6. Inner circle. (smaller radius, flatter curve)

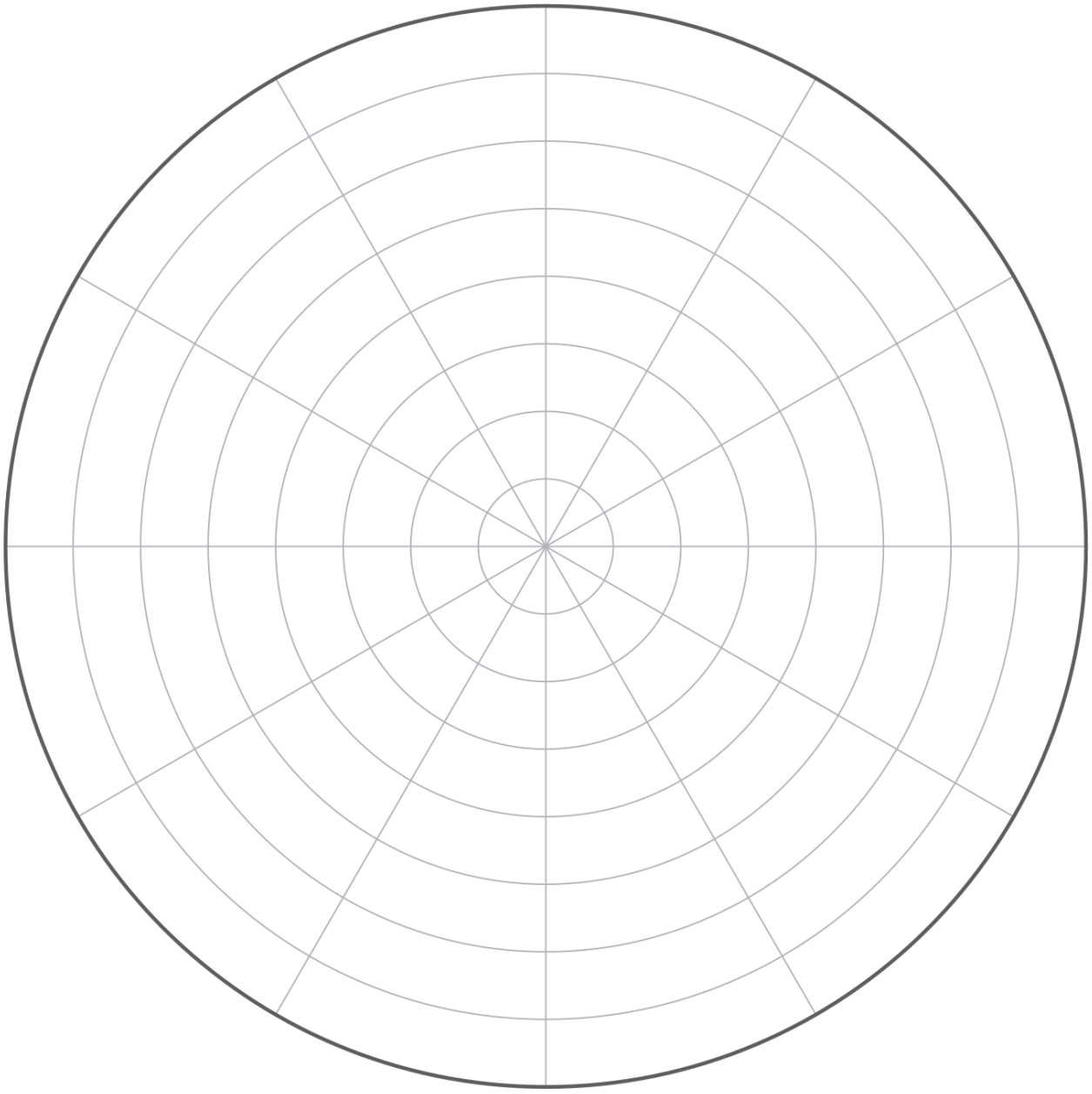
7 Use the main circle radius to draw petal ends, using the point on the inner circle intersection with each of the 12 radius.



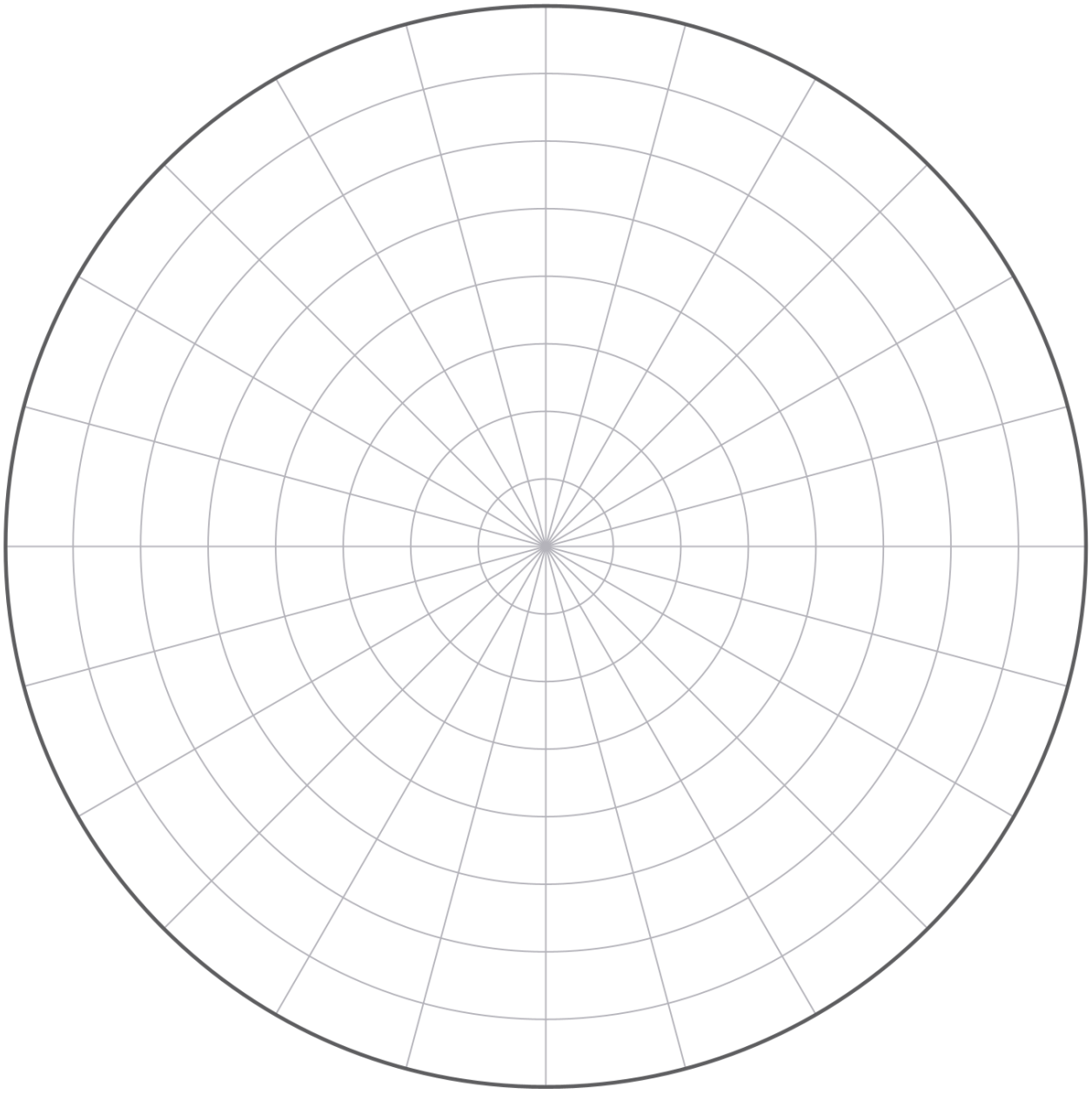




Using increments of 30 degrees:



Using increments of 15 degrees:



Lesson 8: The History, Cultural and Spiritual Significance of the Circle/Mandala from Asia to North America

Create two slides on the shared class slide set on the google classroom. Put your name on both your slides.

As far as possible, use sources written by people raised and living within the cultures they are writing about. Record your sources with a link on your slides.

1. Research the historical, cultural, spiritual significance of the Mandala to Asian cultures.
    Take 10 minutes to choose two webpages. Skim various webpages until you have made your choices.
    Take at least 20 minutes and read the two webpages thoroughly.
2. Choose one or two sentences to quote directly on your slide.
3. Introduce your quote with a sentence of your own. State if your quote teaches us about history, culture, spirituality or a combination of those.
4. Find an image of a Mandala design you like and put it on your slide.
5. Include the sources for both #2 and #4.

Create a second slide beside your first slide and put your name on it.

6. Research the historical, cultural and spiritual significance of the circle to Indigenous Nations, BC Canada
    Take 10 minutes to choose two webpages. Skim read your webpages until you have made your choice.
    Take at least 20 minutes and read at least two webpages thoroughly.
7. Choose one or two sentences to quote directly on your slide.
8. Introduce your quote with a sentence of your own. State if your quote teaches us about history, culture, spirituality or a combination of those.
9. As for #4, but an Indigenous circle design - traditional or modern
10. Include sources for both #7 and #9.

The Sri Yantra:



Suggested web pages:

Class video (Ithaca College, New York): https://www.ithaca.edu/tibetan-buddhist-mandala

Asian Origin

Culturally rooted (often small business) sources:

https://www.prajaya.dk/blogs/posts/mandala-symbol-of-religion-culture

https://asiasociety.org/exploring-mandala

https://www.nehascreations.com/blogs/news/the-deeper-meaning-of-buddhist-mandalas-unlocking-the-sacred-geometry

Academic sources:

https://cswr.hds.harvard.edu/news/2026/08/12/mandala

https://new.artsmia.org/hub/programming-events/tibetan-sand-mandala-history

Indigenous Nations

Search 'Welcome to the Circle' from the University of Waterloo (PDF)

https://www.ictinc.ca/blog/what-is-an-indigenous-medicine-wheel

https://www.indigenousbc.com/stories/the-drum/

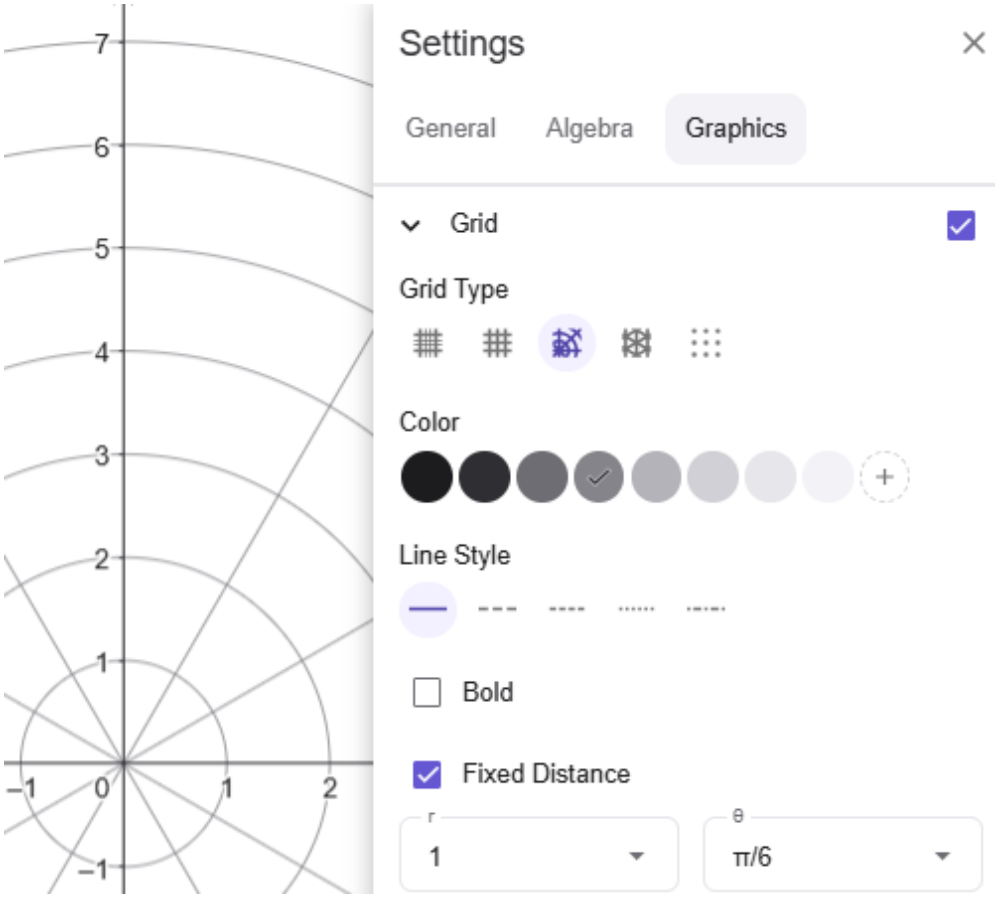
Grid choice:

Choose the regular Cartesian coordinate grid (x, y) or the polar coordinates grid.

Polar Coordinates:

r stands for the increment of radius.

θ stands for the increments of angle on each ray. This measurement is given in radian measure. You can translate this to degrees. The π (radians) represents $180°$. So, $\frac{\pi}{6}$ means grid lines at $\frac{180}{6} = 30°$



Creating circles:

You can use the equation for a circle or the circle tools.

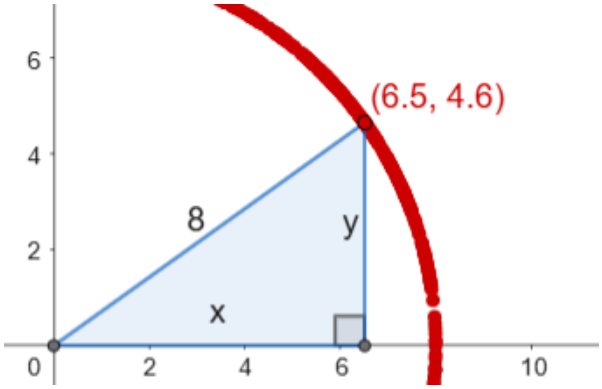
The equation for a circle with its center at $(0,0)$ is:

$$x^2 + y^2 = r^2$$

For example, the locus of

$$x^2 + y^2 = 64$$

is the set of points that make hypotenuse 8 on a right triangle with shorter sides x and y.



Rotate tool:

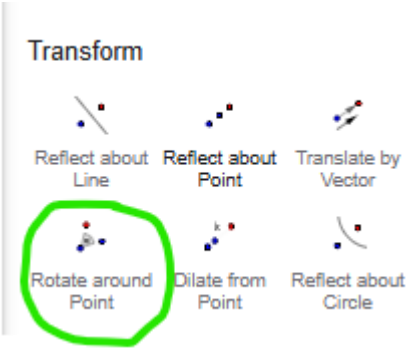
Make sure you have a point at the center of your mandala.

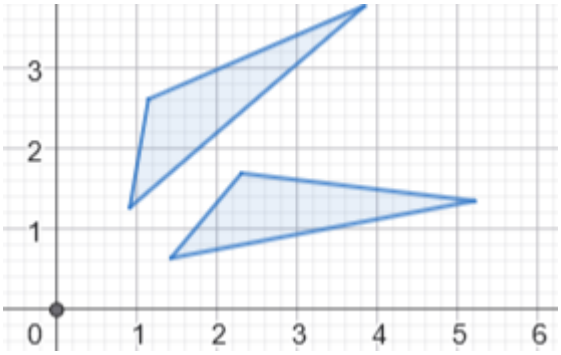
You may rotate any object any angle around any point.

Create an object with the polygon tool. Turn off the points.

Use the 'rotate around center' tool. Click on your polygon. Click on the point at the center of your mandala. Type in the angle you wish to rotate your object.

Repeat this process, either rotating the next shape the same angle, or the original shape with multiples of your angle.





Sequence command:

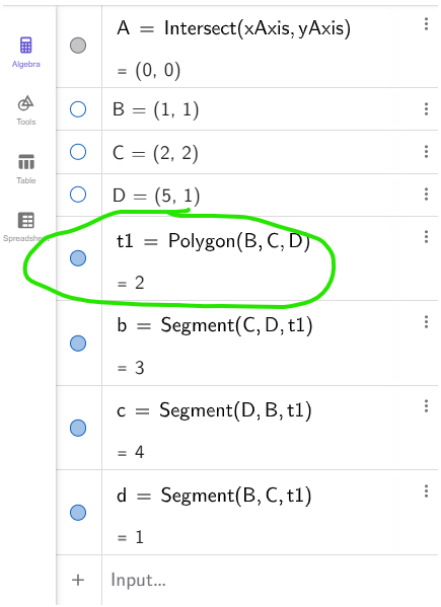
We can repeat a process with the sequence command.

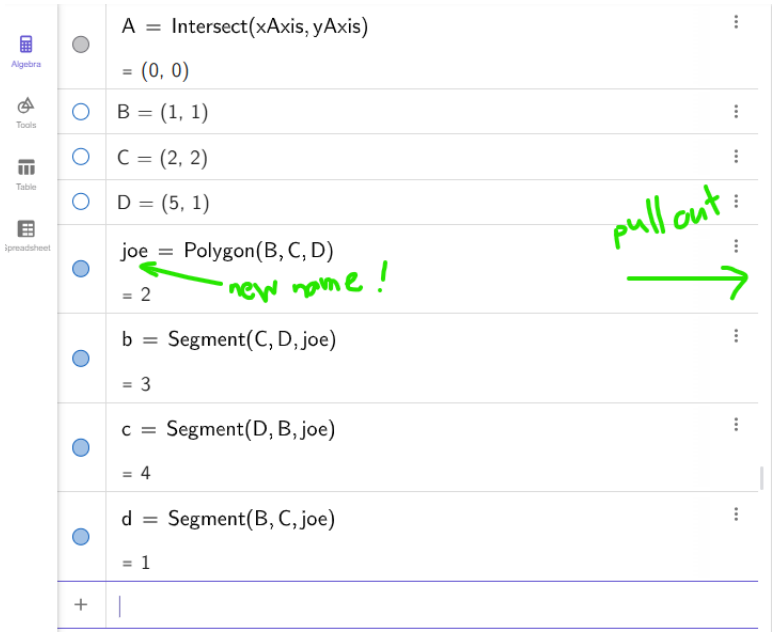
Drag out the algebra window, because the sequence command is long.

The advantage of this command is to have one command to create as many objects as you need.

A disadvantage is that it treats all the objects in the sequence as a single object. You can't colour them different colours.

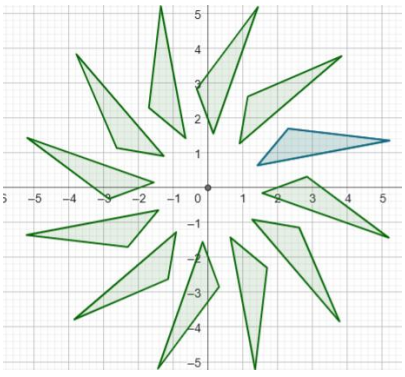
Look on the algebra window to find the name of the object you wish to rotate. My triangle is called 'poly1'. If I want, I can rename this to a name of my choice.





To rotate 'poly1', 30°, twelve times over, enter this command to the 'input' on algebra:

$$\text{sequence}(\text{Rotate}(\text{joe}, 30n^\circ, A), n, 1, 12)$$



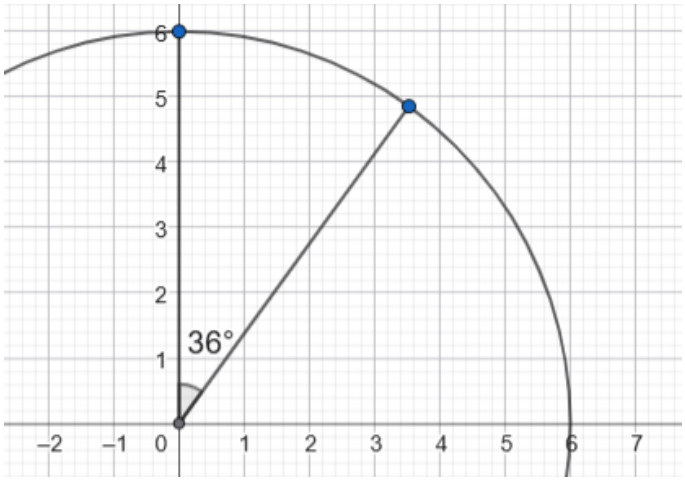
Regular shapes inscribed in a circle:

Mandala's often have inscribed regular polygons.

We can use the 'regular polygon' tool, but we need a minimum of two points.

We can use grade 10 trigonometry to locate these two points.

Let's put a decagon (10 sides) inside a circle radius 6.

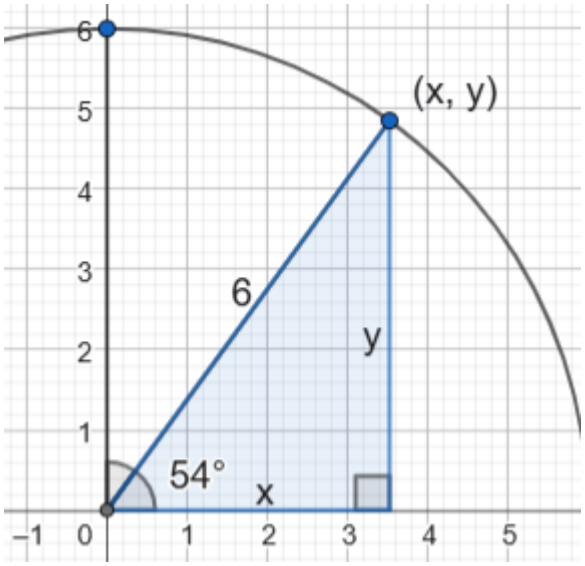


The angle at the center of a decagon is $\frac{360}{10} = 36°$

We can often put one point on either the y axis or the x axis, depending on how you want the shape to look.

We have (0, 6) as one point on this example.

Now we need to use some right-angle trigonometry (or unit circle trigonometry) to calculate the coordinates of the second point. We can see it's approximately at (3.5, 4.8) but let's be more precise.



To get the (x,y) coordinates of the second point, construct a right triangle with the x axis.

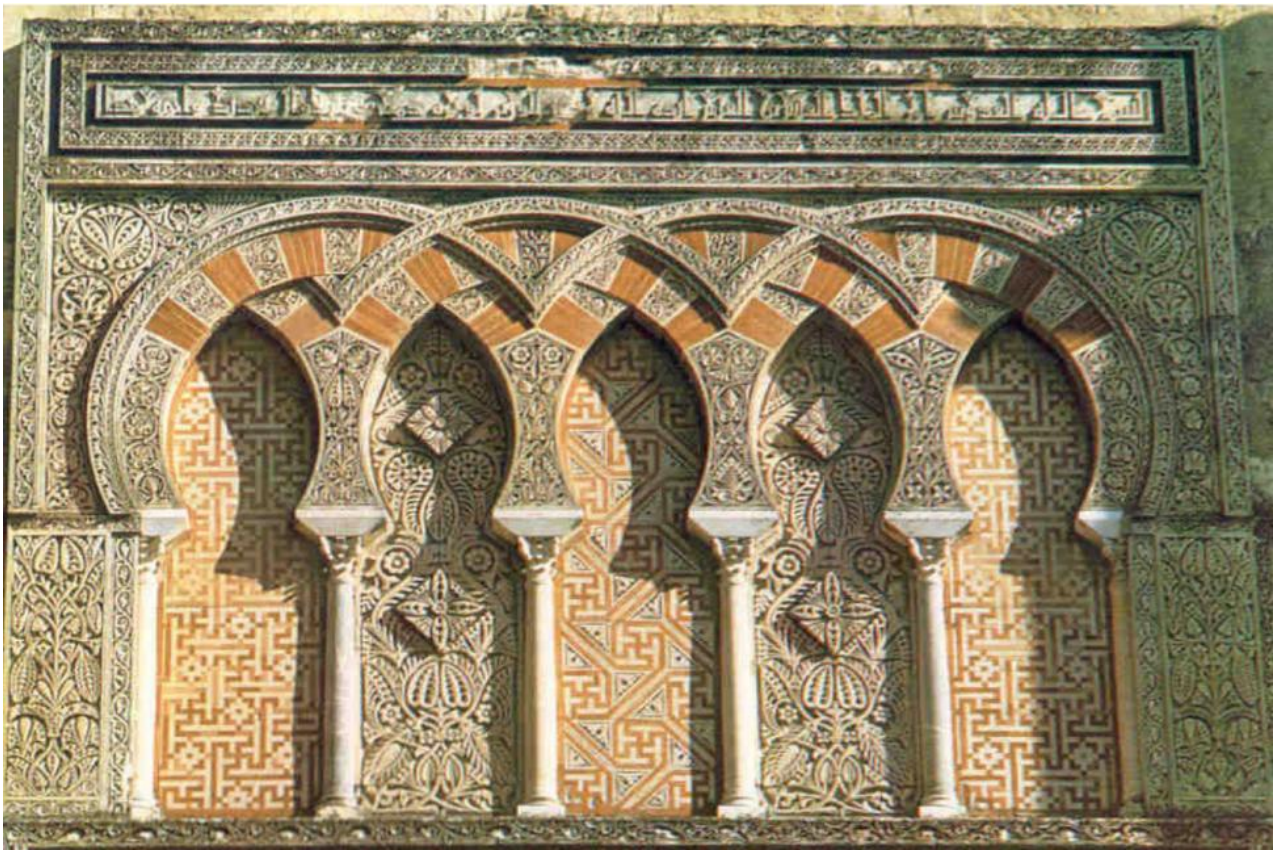
$$\sin 54° = \frac{\text{opp}}{\text{hyp}}$$

$$\sin 54° = \frac{y}{6}$$

With those two points plotted, we can go ahead and use the regular polygon tool.

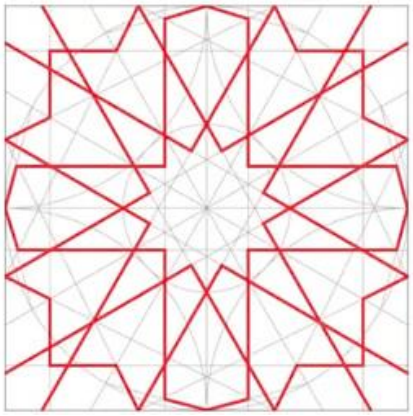
Lesson 10: Islamic art

Islamic art depicts floral, calligraphic and geometric patterns. This image below shows part of the Córdoba Mosque in Córdoba, Spain, built 785CE.



Together with other forms of Islamic art and contemplation, the symmetry, harmony and perfection of geometric patterns; the unity of the structure and the multiplicity of pattern direct the imagination to the divine.

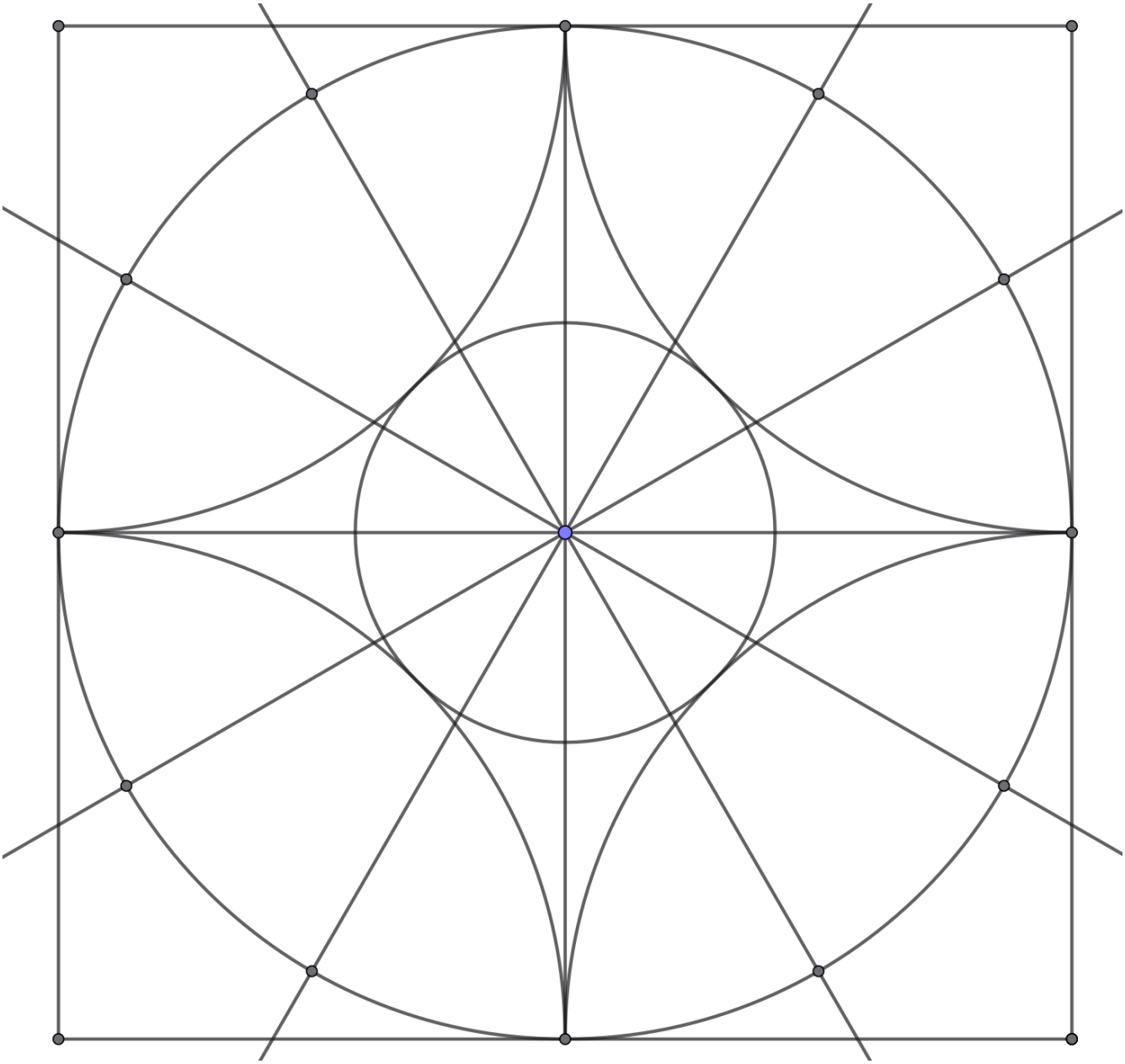
We will use a pen on a grid to create this tile:



This design has both reflection and rotational symmetry.

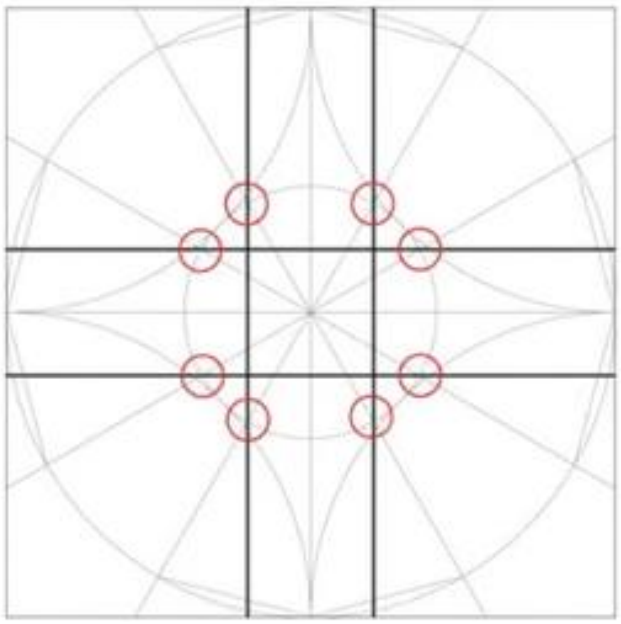
To construct the base of the grid:

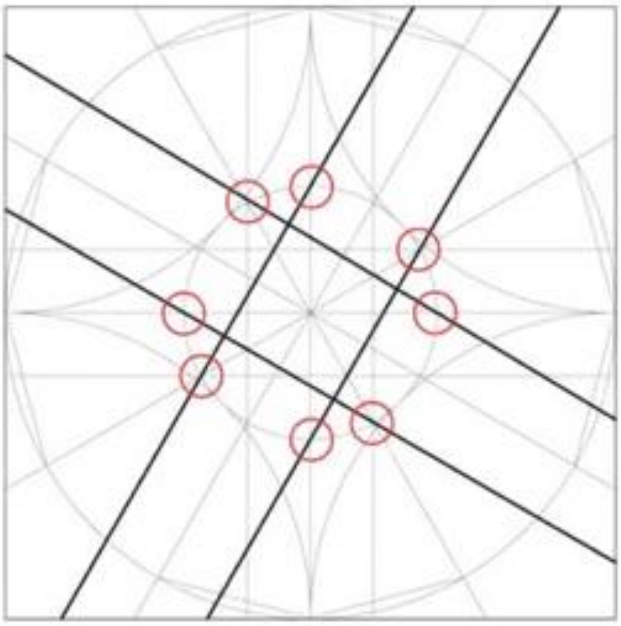
I. Line segment, Perpendicular Bisector, Large Circle,
II. Outer square (4 semi circles to locate the corners)
III. 4 quarter arcs
IV. Midpoint on the quarter arc in one corner, using the corner of the square and the center.
V. Smaller circle with the radius from center to the midpoint created in (iv).

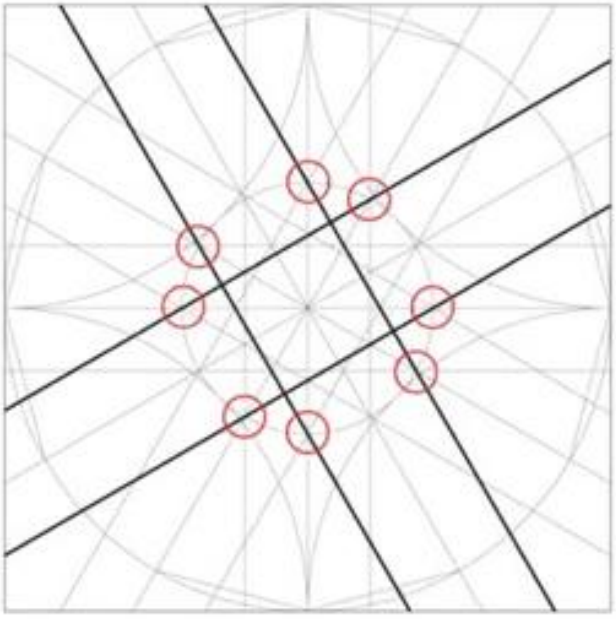


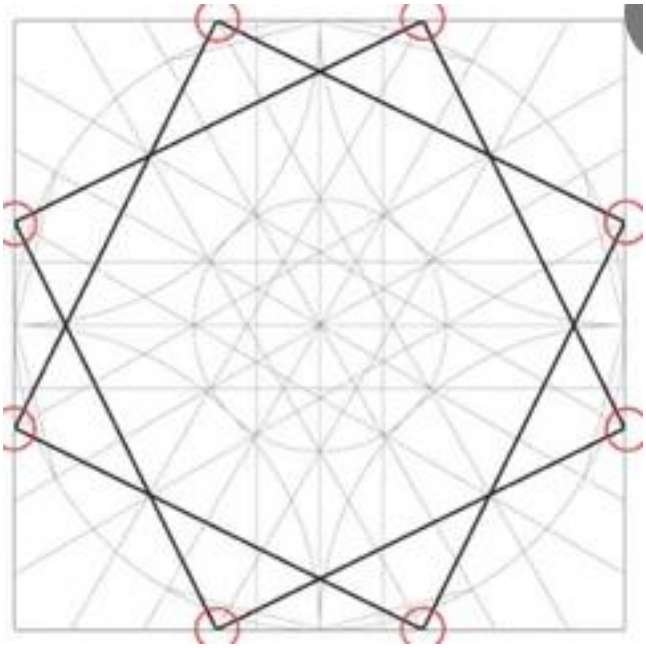
Once the grid opposite has been constructed, draw 8 lines.

Each line intersects the inner circle and the ‘clock’ lines.









https://www.theguardian.com/science/alexs-adventures-in-numberland/2015/feb/10/muslim-rule-and-compass-the-magic-of-islamic-geometric-design

Explore Collections of Islamic Art:

https://www.samiramian.uk/gallery

https://www.drawingislamicgeometricdesigns.com/

https://artofislamicpattern.com/

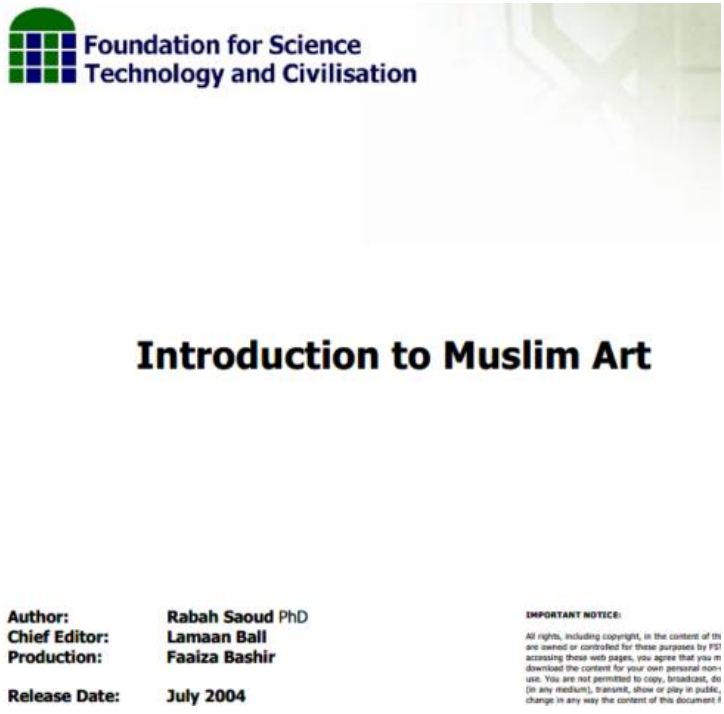
https://patterninislamicart.com/s/collections

Explore: Religion and religious ideas expressed through art

https://asiasociety.org/education/islamic-belief-made-visual

https://renovatio.zaytuna.edu/article/the-silent-theology-of-islamic-art

https://patterninislamicart.com/the-religious-dimension



Lesson 11: Fractals (i)

5 things to know about fractals:

1
2
3
4
5

Videos:

Fractal definition	4 ways fractals changed tech forever
10 most beautiful fractals	Drawing the Mandelbrot Set on GeoGebra

From the University of Waterloo, Top five applications of fractals.

1. **Fractal cities**. Some cities tend to grow in fractal patterns over time and are called fractal cities. As a large fractal city absorbs its neighbouring towns and villages, the pattern developed resembles a self-similar structure that seems random at first but is a dynamic network that may prove to be more efficient than modern "pre-planned" cities.
2. **Fractal medicine**. Knowledge of fractals is especially useful in medical diagnoses, including for cancer. Since healthy human blood vessel cells typically grow in an orderly fractal pattern, cancerous cells, which grow in an abnormal fashion, become easier to detect. This form of fractal analysis makes distinguishing between healthy cells and signs of concern much easier.
3. **Image compression and resolution**. Since fractals allow us to convey seemingly random patterns with little data, working with image resolution and even 3D model creation becomes hugely data-efficient using fractal image coding (FIC) and other applications.
4. **Antennas**. The typically self-similar nature of fractals is also helpful in creating and operating antennas. Curves like the Hilbert curve can be used to design high-performance and low-profile antennas. When they are combined with EM radiation concepts, multi-band antennas can also be operated. Read more here.
5. **Art**. The simplistic to the complex range of rules that govern fractal creation are downright alluring for artists. For example, the Mandelbrot set is well known for providing different "scenes" based on the colour scheme used for its display.

Drawing: The Sierpinsky Triangle

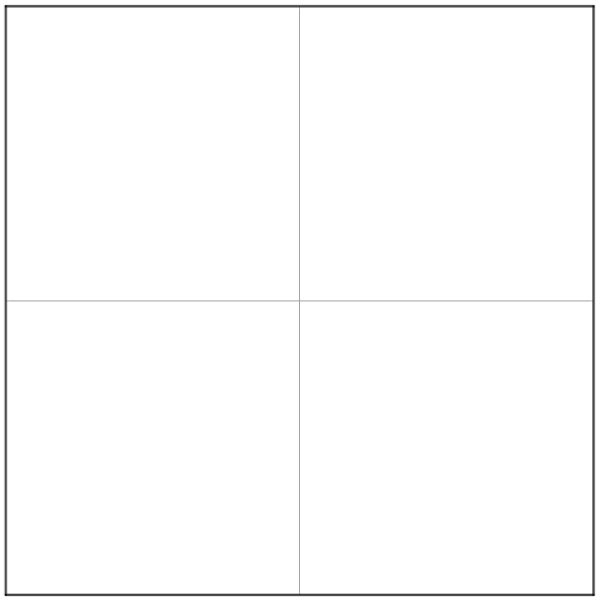
Begin by constructing an equilateral triangle on a line segment that is 16 cm long. Use a ruler and a protractor.

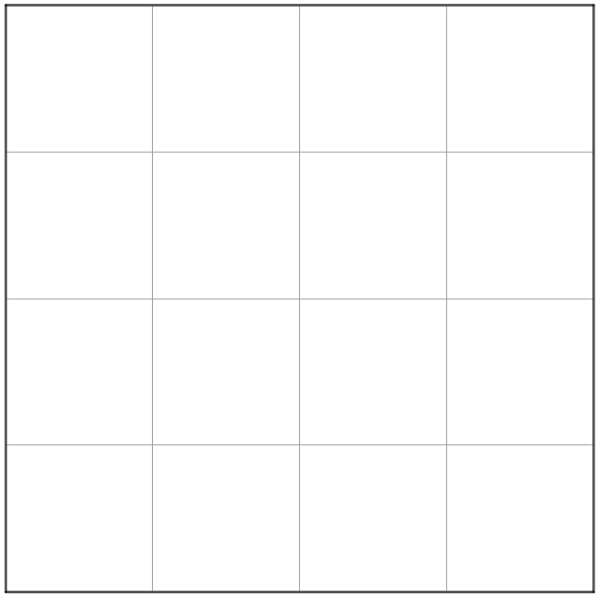
Drawing: The Koch Snowflake

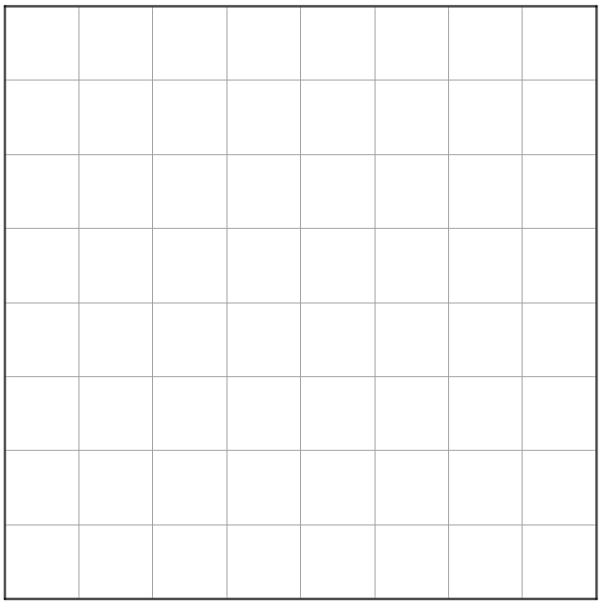
Begin by constructing an equilateral triangle on a line segment that is 18 cm long. Use a ruler and a protractor.

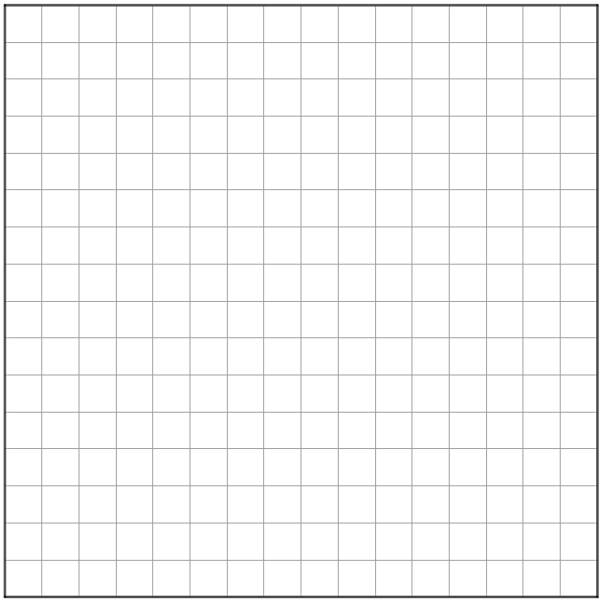
Drawing: The Hilbert Curve

Draw the first four iterations. Each iteration should start in the bottom left square and finish in the bottom right.









Lesson 12: Fractals (ii)

Geometric Sequences, the Koch Snowflake Analysis and the Coastline Paradox

A geometric sequence has a common ratio. Continue these geometric sequences:

$$3, \quad 12, \quad 48, \qquad \ldots$$

$$162, 54, 18, \qquad \ldots$$

In general:

$$a, ar, ar^2, \qquad \ldots$$

A geometric sequence that has five terms can be added together like this:

Any geometric sequence that has five terms can be added together in a similar way:

In general, a geometric sequence that has n terms can be added together with this formula:

Without the formula, add: $3 + 6 + 12 + 24 + 48 + 96 + 192 =$

Now use the formula: $S_7 =$

When the ratio $r < 1$ (between -1 and 1), the sum converges as $n \to \infty$.

Consider the sequence

$$10, 3, 0.9, 0.27, \ldots \ (r = 0.3)$$

Use the formula to add the first five terms: $S_5 =$

Use the formula to add the first ten terms: $S_{10} =$

Use the formula to add the first twenty terms: $S_{20} =$

Use the formula to add the first fifty terms: $S_{50} =$

Video: The Coastline Paradox

Let's calculate the perimeter of the Koch snowflake at each iteration:

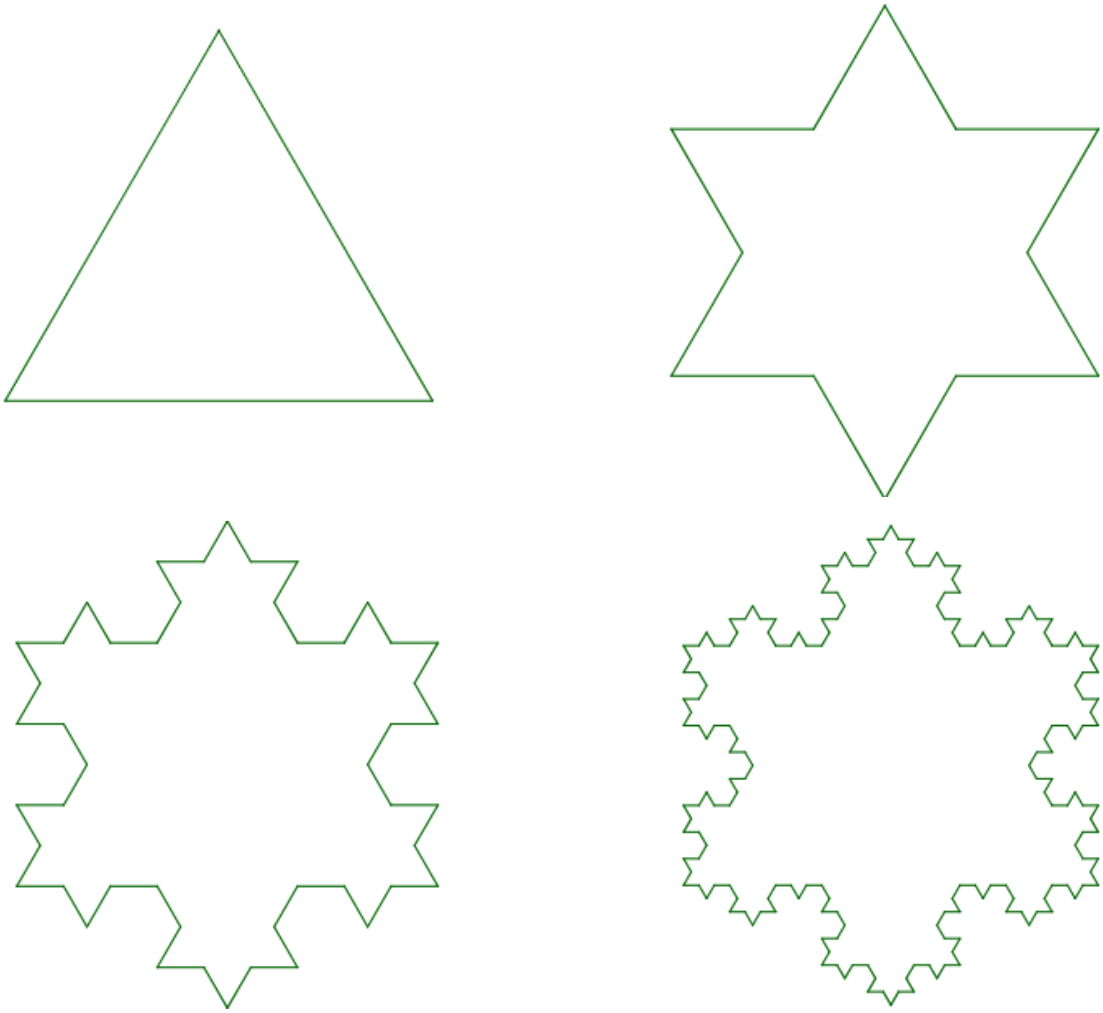
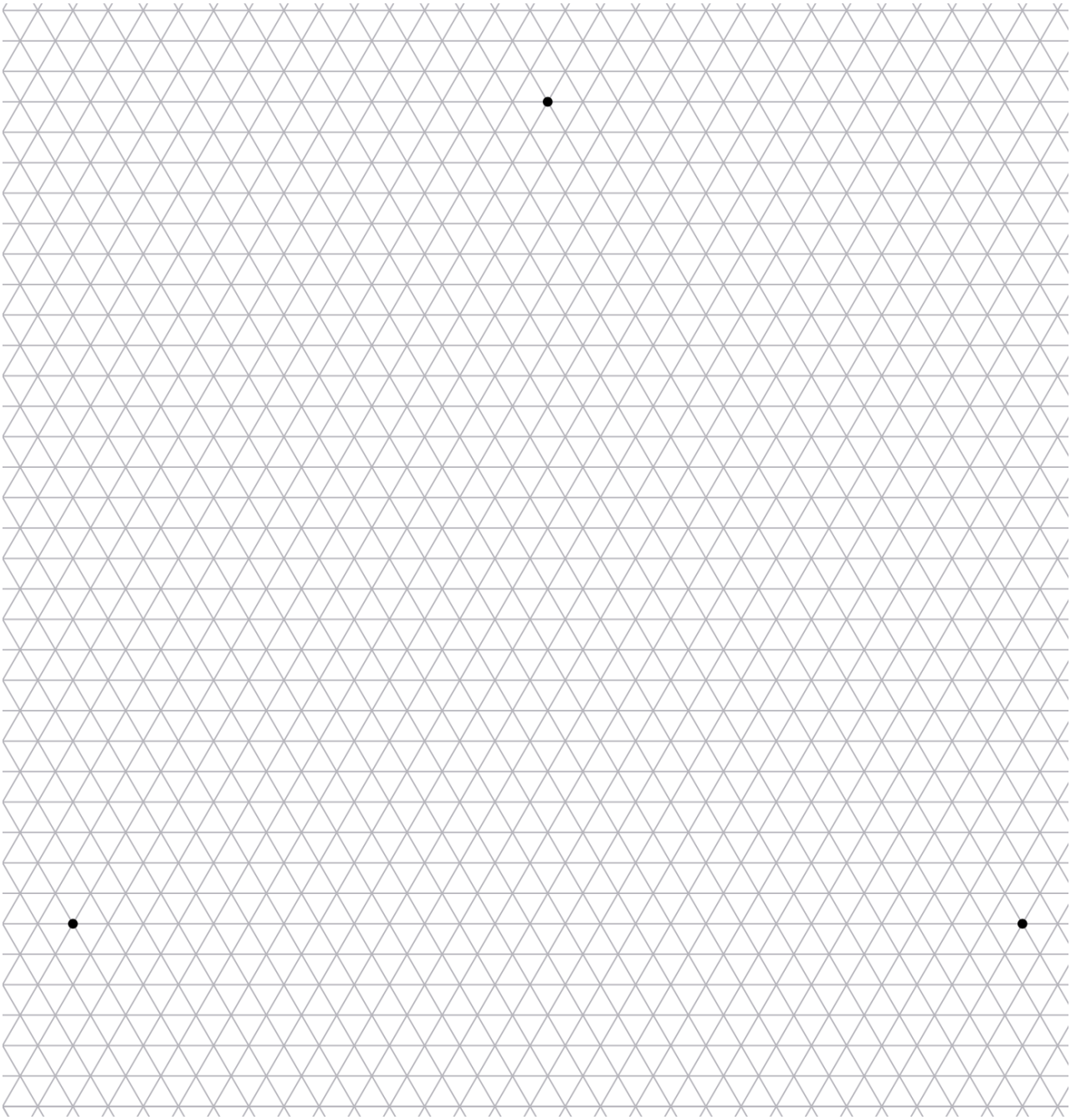


Table of values:

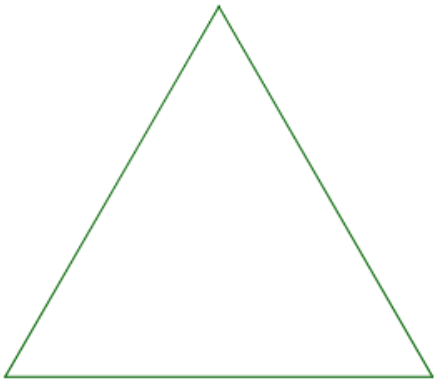
Iteration	#sides	Length of each side	Total perimeter

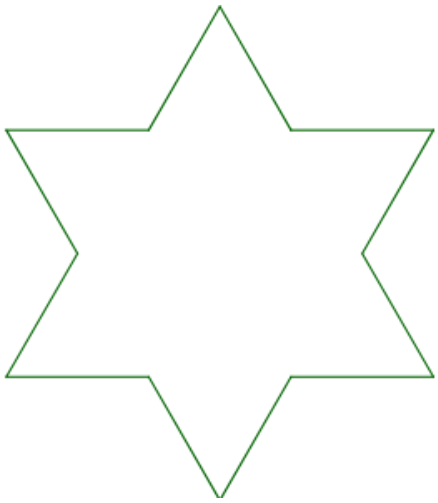
Area analysis. Let one grid triangle = 1 unit of area.

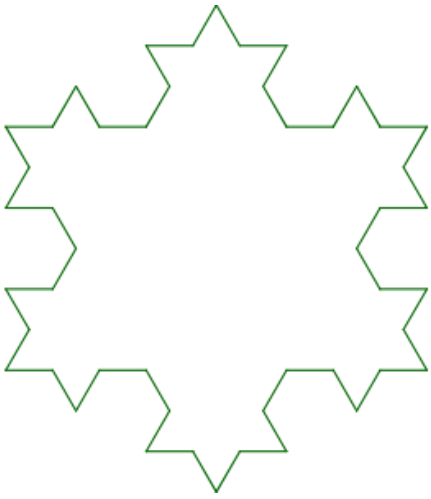
Joining the three dots gives a triangle with 729 units of area.



Let's calculate the area of the Koch snowflake at each iteration:







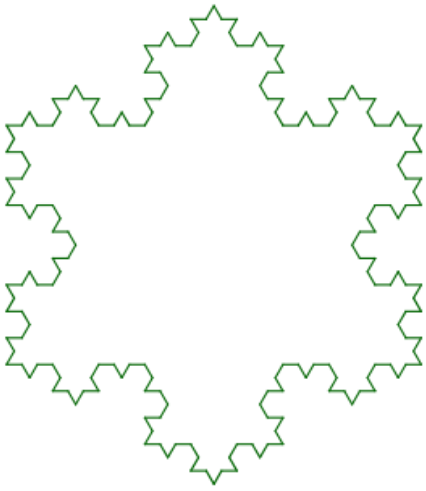


Table of values:

Iteration	#new triangles added	area of each new triangle
1	1	729
2	3	81
3		
4		

Area of the Koch Snowflake as a calculation:

Iteration 1: Area = 729

Iteration 2: Area = $729 + 3\left(\frac{729}{9}\right)$

Iteration 3: Area =$729 + 3\left(\frac{729}{9}\right) +$

Iteration 4: Area =

Continuing the pattern:

Iteration 5: Area =

Analysing and calculating:

Projects #6 - #10

Project #6: Mandala

Page 1: Title page, name, date, course. An image and/or your quote from page 6.

Page 2: Straight edge and compass construction of a Mandala template. Include concentric rings, evenly positioned rays (at least 6, possibly 24), repeated arcs and your own ideas. Explain how you have constructed your template.

Page 3: Your Mandala design on your template, completed. (photocopy the template is ok).

Page 4: Paper and pencil planning of a Mandala using GeoGebra sequences of rotations. Include design details such has number of rotations, angle of rotations, the sequence commands you will need to use.

Page 5: Your GeoGebra construction with a link to your design.

Page 6: Reflect. Use one of the quotes that you or a class member put on our collaborative slideset on the historical, cultural and spiritual significance of the Mandala. Quote directly, provide the source (the quote must be findable at the link). Write a few sentences on how the quote about the Mandala (or First Nations' use of the circle) helps us to understand ourselves and the world around us. (Eg, daily activities, local and traditional practices, popular media, social justice, cross curricular integration- from bc curriculum)

Project #7: Islamic Art

Page 1: Title page, name, date, course. The quote you chose for page 5, cited.

Page 2: Browse the collection: https://patterninislamicart.com/s/collections/main-archive Choose one pattern to dissect. Paste a screenshot and state the details of where the photo was taken.

Page 3: Find (possibly upload to GeoGebra to help you find) a section that can be tiled on the plane. Tile your tile using a screenshot, reduced so you can fit many on a page.

Page 4: Watch, follow and construct the twelvefold Islamic Geometric Rosette. https://youtu.be/YcqakkAKvFI?si=4RtmKOM9DTb342Nn

Page 5: Reflect. Read and choose one or two sentences that are interesting or informative to you from The-silent-theology-of-islamic-art , and cite the source of the sentence. Write a few sentences on how the quote helps us to understand ourselves and the world around us. (Eg, daily activities, local and traditional practices, popular media, social justice, cross curricular integration- from bc curriculum)

Project #8: Mandelbrot Set

Page 1: Title page, name, date, course. An image or perhaps your quote from page 6.

Page 2: Explain what a complex number is and give an example of the first five iterations of your choice of complex number and a complex constant, for the function $f(z) = z^2 + c$.

Page 3: Recreate the Mandelbrot set using GeoGebra following Lee Stemkosky's method:

part 1: https://www.youtube.com/watch?v=954urFVfc_w and

part 2 https://youtu.be/iyKLTIcpn9c?si=eO0JY1LLaAMEd_OW

Put a screenshot of your result on page 3 and a link to your file.

Page 4: Reflect on the value of the explanations given in the videos. Refer to time stamp on the videos provided, and give a couple of examples where you thought Lee Stemkosky's explanations were thoughtful for someone who is new to GeoGebra, to fractals, to spreadsheets and/or to complex numbers. What specifically did he say or do with the tools he was using (voice, GeoGebra, arrow, highlighter, time) to help you follow the instructions.

Project #9: Mathematically Analyse the Koch Snowflake curve

Page 1: Title page, name, date, course and an image of the Koch Snowflake.

Page 2: Describe the coastline paradox in your own words. Cite any sources you use for information or for images.

Page 3 and 4: Using diagrams, text and a geometric sequence, demonstrate that the perimeter of the Koch curve 'diverges' (tends to infinity as $n \to \infty$)

Pages 5 and 6: Using diagrams, text and the sum of a geometric sequence, demonstrate that the area of the Koch curve 'converges' (tends to a limit as $n \to \infty$)

Page 7: Reflect How does the concepts of infinity referred to in this project influence how you think of the idea of 'infinitely large', 'infinitely small', 'tending to infinity'? What is paradoxical about the coastline paradox?

Project #10 Your own idea based on lessons 8-13, developed with the teacher following a format similar to the other projects.

Project #6 -#10 Grading: 3 equally weighted grades.

Descriptors for Proficient:

Communication: o I have completed all parts of this project. o My project has a title page with my name, a title for the project, a sentence describing the objective of the project and perhaps a relevant image. o My project can be read independently of the instructions. o My project has 'flow' from start to finish, through subtitles and sufficient explanatory text. o It is evident that have thought of the reader when structuring each page. That is, the elements (text, diagrams) of each page are placed in an order that makes sense to the reader. o I have used text, diagrams and space to effectively communicate the calculations o I have used correct math notation. o I have used correct math vocabulary. o I have used my choice of presentation (slides/paper/poster) effectively.
Reasoning: o I have demonstrated understanding of each part of the project. o My lines of work record each step in the calculations clearly, one step at a time. o My writing (including text/diagrams) is sufficient to demonstrate my understanding.
Reflection: o I have demonstrated understanding of the reflection question/s. o I have written my own paragraph in response the reflection question. o I have given my sources.

Descriptors for 'Extending': If your work can be described as containing unique ideas, or as creative, insightful, sophisticated in any of the categories it can be graded as 'extending'. E.g:

Communication: Creative and insightful use of the media you use (paper, document, google slides, verbal presentation with slides, poster).
Reasoning: In depth understanding of the math is demonstrated through conversation in the classroom, through your writing (with math notation), connections between ideas.
Reflection: Substantial (in terms of content, not word count) reflection demonstrating in depth learning or knowledge of the topic.