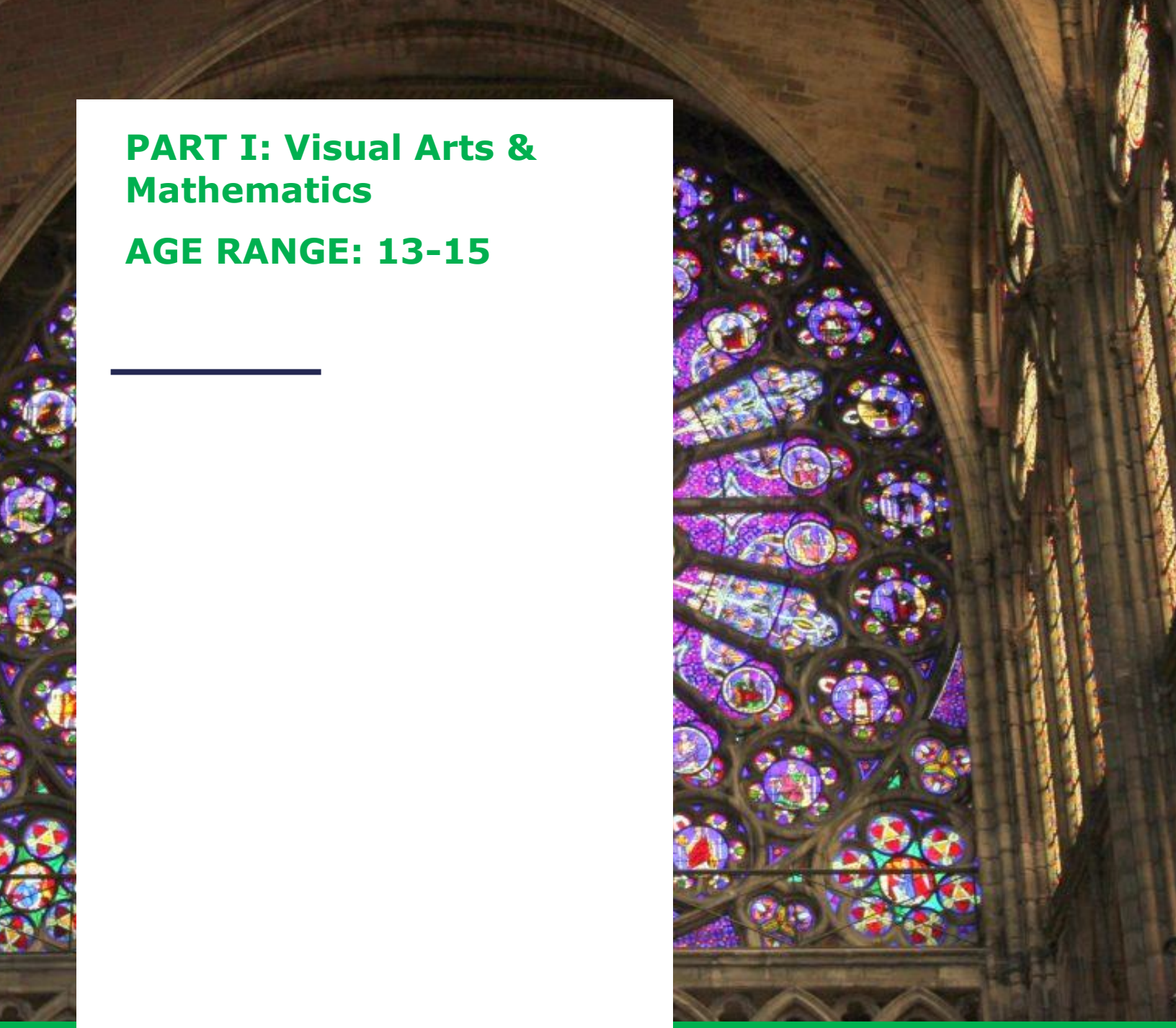

PART I: Visual Arts & Mathematics

AGE RANGE: 13-15

TOOL 1: GOTHIC ART

C.I.P. Citizens In Power

TheArtOf Maths

Co-funded by the Erasmus+ Programme of the European Union

Educator's Guide

Title: Gothic Art

Age Range: 13-15 years old

Duration: 1.5 hours

Mathematical Concepts: equilateral triangle, equiangular, congruent angles, median, centroid of a triangle, circle, radius of a circle, diameter of a circle

Artistic Concepts: gothic art, gothic windows, aisle, flying buttress, groin vault, pointed arch, stained glass.

General Objectives: The students to employ a combination of artistic and mathematical concepts in order to measure and design a gothic window in the end of the tool.

Instructions and Methodologies: This tool is being composed of an introductory part that attempts to link mathematics and visual arts; an artistic part, along with a glossary, entitled as "Gothic Art" within which the student gets acquainted with artistic concepts that fall in gothic art; a mathematical part which provides definitions for all the math concepts and theories behind the construction of a typical window; plus a task within which the student is invited to combine all the aforementioned mathematical and artistic concepts in order to design a gothic window. Accordingly, the educator is recommended to present the entire content of the tool in the classroom by following a linear manner.

Resources: This tool provides pictures and videos for you to use in your classroom. The topics addressed in these resources will help you find other materials to personalize and give nuance to your lesson. The "Learn More" Section that comes in the end provides the educator with extra online sources, for further study and research on the concepts contained within the tool.

Tips for the educator: Learning by doing is very efficient, especially with young learners with learning difficulties. Provide a hands-on experience for a more enjoyable experience and encourage creativity.

Desirable Outcomes and Competences: At the end of this tool, the student will be able to: (i) Understand the different artistic concepts that fall in gothic art; (ii)

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understand how to use and apply simple geometric concepts, such as equilateral triangle, median, centroid of a triangle, circle, radius and diameter in order to re-create particular patterns which are characteristic for gothic art and architecture

Debriefing and Evaluation: As part of reflection and/or formative assessment (=in order to improve the tool for the next time according to the students' background, interest, exact age, country's culture, students' prior knowledge etc) you can use these cards sometimes called EXIT CARDS either by a hard copy made from before or simply by posing these statements on board and the students write the answers on a paper which they will leave preferably anonymously while exiting the room. The specific formative strategy is called 3,2,1. For more strategies you can visit: **https://www.bhamcityschools.org/cms/lib/AL01001646/Centricity/Domain/131/70%20Formative%20Assessments.pdf**

Write 3 aspects you liked about this activity:	1. 2. 3.
Write 2 aspects that you have learned	1. 2.
Write 1 aspect for improvement	1.

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Introduction

It would seem at first sight that there is an absence of one obvious connection between art and mathematics, inasmuch they are seemingly both based on different models of thinking.

However, geometric knowledge could decisively be conceived as theoretical instrument in visual arts. On the other hand, art assimilates elements which they took from both the material and the abstract world of science. In fact, the existence of the geometric instinct is what led the primitive artist in depicting the three-dimensional space.

Many scholars dealing with the history of art, have occasionally noted that the two greatest revolutions in the history of art, namely Renaissance and Modern Art, were made by artists who conceptualized new geometries; the perspective geometry for Renaissance and the multidimensional geometry for Modern Art.

Although, within the first tool of Part I, we will start our journey in the applicability of mathematics in visual art by first investigating mathematics of Middle Ages Art, and particularly Gothic Art.

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Gothic Art

Gothic art is the artistic stream that appeared during the Middle Ages. It was first appeared in France in the beginning of the 12th century, whilst it was mainly related to architecture and sculpture. Over the next few decades and until the end of the 14th century, Gothic art had been spread across Western Europe. Gothic art was succeeded by the Renaissance period, although samples of Gothic creations were recorded up to the end of the 15th century.

Gothic art fundamentally renewed the architecture of Europe, achieving a breakthrough in the way of constructing temples. The enormous dimensions of Gothic temples symbolized the power of the church within bourgeois society and, -in an attempt to annihilate the human diastasis-, aimed at presenting a strict hierarchy and escalation of things (heaven, earthly world, hell).

The structure of the Gothic temple was a stone skeleton with large openings in which big windows were placed, made of colored pieces of glass, joined together with pencil strips (stained glass). The multicolor of the stained glass, combined with the thin stone columns made up of many stone ribs, used to give a sense of exaltation. The need to search for the light along with the search for the feeling of inclination towards the sky required an increasing height. Consequently, the height of the central aisle of a gothic temple was, in many cases, over 30 meters.

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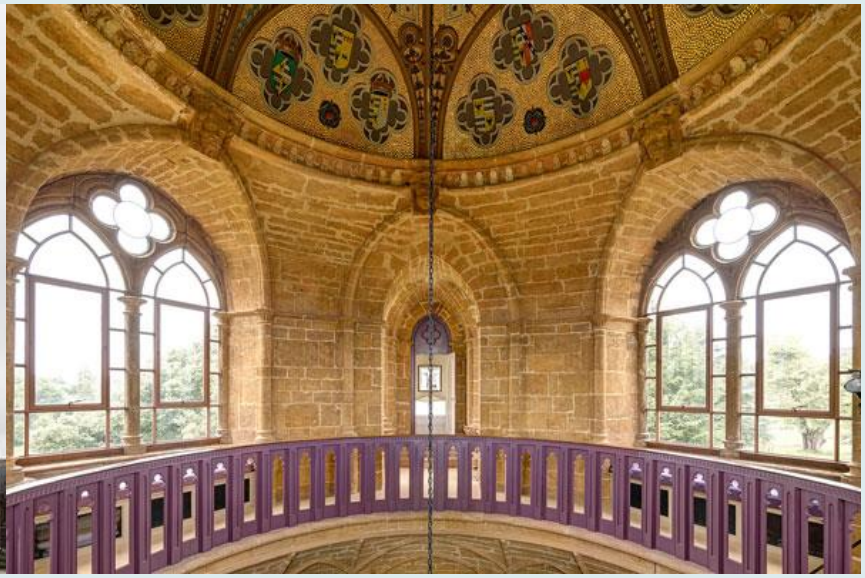
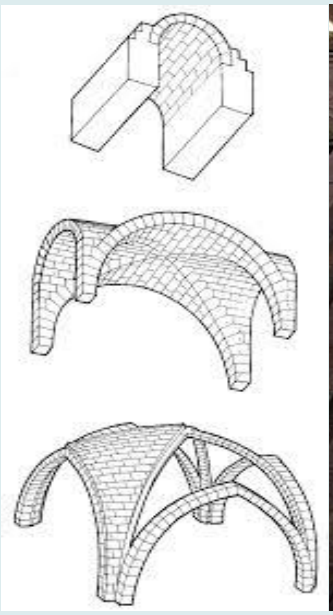


Picture 1: Notre Dame, Paris; **Picture 2: inside of a gothic temple**

(Pictures 1-2: Retrieved from: https://www.landmarktrust.org.uk/search-and-book/properties/gothic-temple-8075)

Due to the great height of the gothic temple, **arcs** and **crosses** began to require external support, which led to another innovation, the **flying buttress**. **Flying buttresses**, **pointed arches** and **groin vaults** composed a completely new construction system that characterizes Gothic architecture.



Picture 3: Groin Vaults

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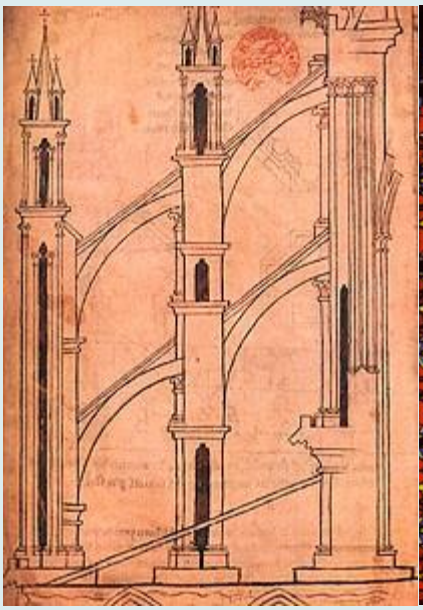

Picture 4: Flying buttresses; **Picture 5: Stained glass, Notre Dame**

(Pictures 3-5: Retrieved from: http://www.all-art.org/history194-2.html)

Picture 6: Pointed Arch in Gothic Architecture

(Picture 6: Retrieved from: http://karaelvars.com/gothic-architecture-pointed-arch.html/gothic-architecture-pointed-arch-81-arches-cathedral-place-of-worship-old-town-cozy-640x480)

One of the basic patterns in Gothic Architecture constitutes the so-called **pointed arch**. In order to construct a geometric representation of the pointed arch, we need to work on the intersection of two circles with the same radius; the circles are tangent to the top of the vertical sides of a window:

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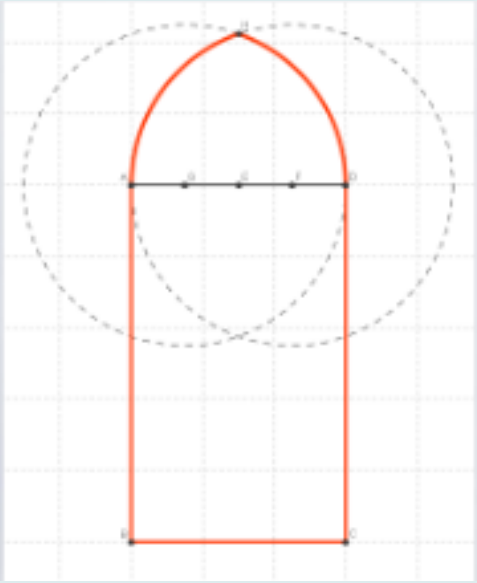

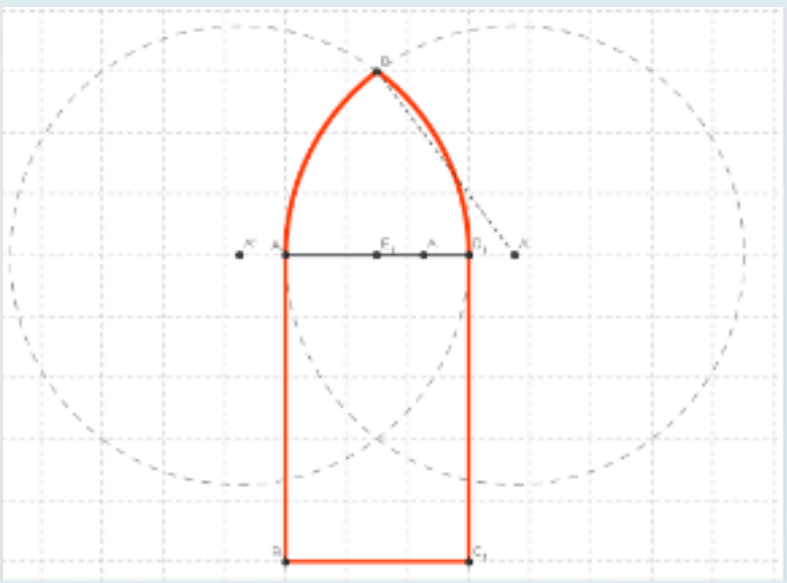

Glossary

Aisle: (in a church) a lower part parallel to the nave, choir, or transept, from which it is divided by pillars

Flying Buttress: a buttress slanting from a separate column, typically forming an arch with the wall it supports

Groin Vault: a vault produced by the intersection at right angles of two-barrel (tunnel) vaults. Sometimes the arches of groin vaults may be pointed instead of round.

Pointed Arch: an arch with a pointed crown, characteristic of Gothic architecture

Stained glass: colored glass used to form decorative or pictorial designs, typically by setting contrasting pieces in a lead framework like a mosaic and used for church windows

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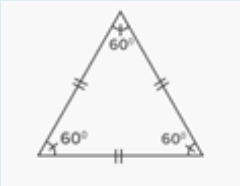
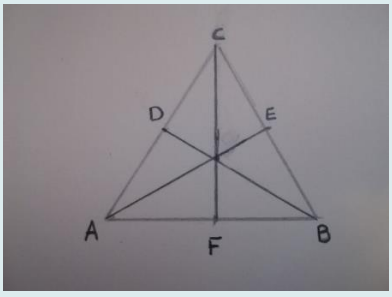
1. Equilateral triangle

- Equilateral triangle is a triangle in which all the **three sides** are **equal**. We should also note that when it comes to Euclidean geometry, the equilateral triangle is additionally **equiangular,** that is, all its three internal angles are **congruent** to each other, whilst they are **60 degrees** each



2. Median of a triangle

- A **median** of a triangle is a line segment drawn from a **vertex** to the **midpoint** of the opposite side of the vertex.
- In the picture below vertex of the triangle are the points A, B and C, whilst the midpoints of the opposite side are the points E, D and F, respectively



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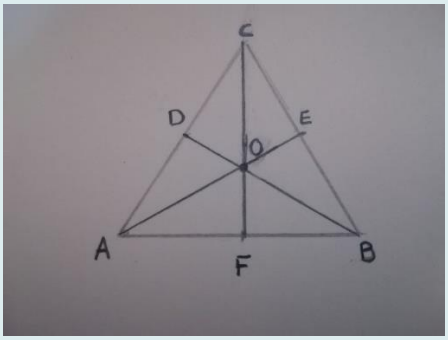
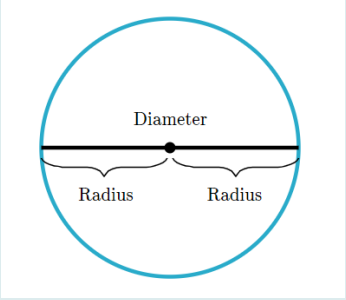
3. Centroid of a triangle

- The medians of a triangle are **intersect** at a point. The point of concurrency (**point of intersection**, O) is called the **centroid**



4. Circle

- **Radius** of a circle is any straight line from the center to the circumference of a circle
- **Diameter** of a circle is any straight line that passes through the center of the circle and whose endpoints lie on the circle



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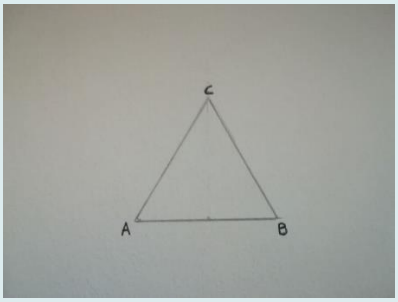
TASK

This task will enable you to comprehend the ways in which Euclidean geometric constructions had been employed during the process of designing and constructing gothic temples.

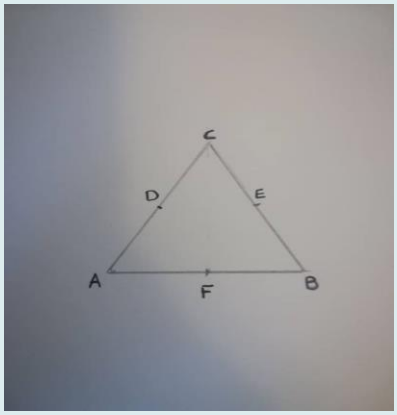
I. By using a pencil, set out an equilateral triangle (triangle side: 4cm)



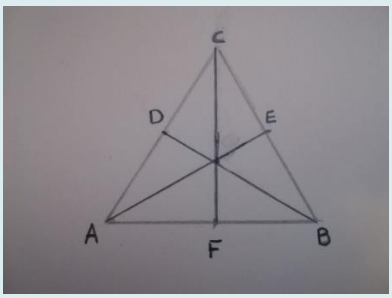
II. Measure half the length between point A and point C to find point D

III. Measure half the length between point B and point C to find point E

IV. Measure half the length between point A and point B to find point F



V. By using a pencil, draw the medians of the triangle (BD, AE, CF)



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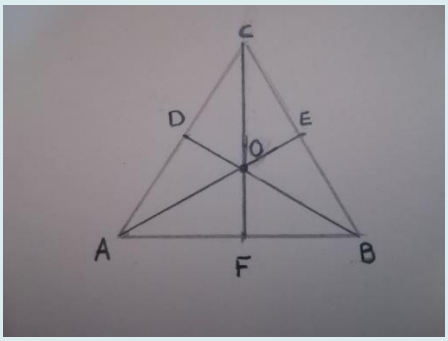
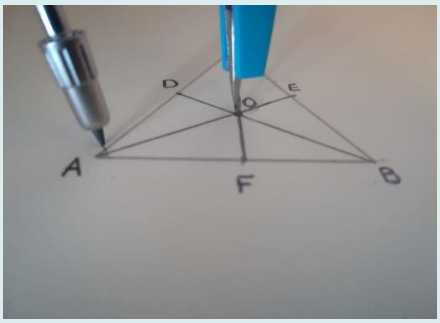
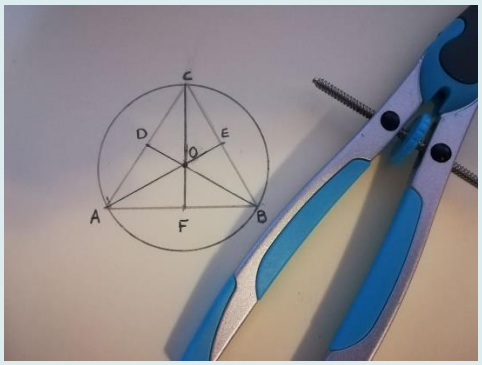
VI. Name as O the point of intersection of the three medians of the triangle



VII. With the help of a compass, measure a **radius** of a circle equal to OA length.



VIII. From centre O, extend your compass to point A. Swing around and return to point A to complete the circumscribed (outer) circle.



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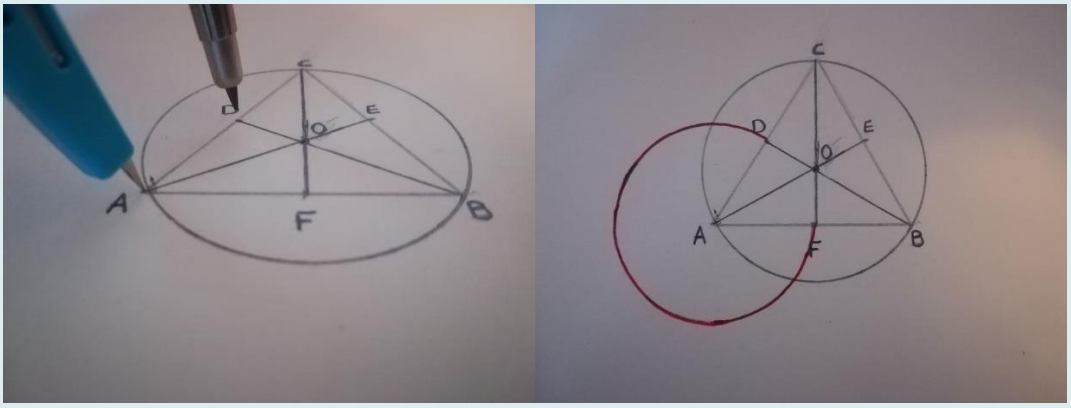
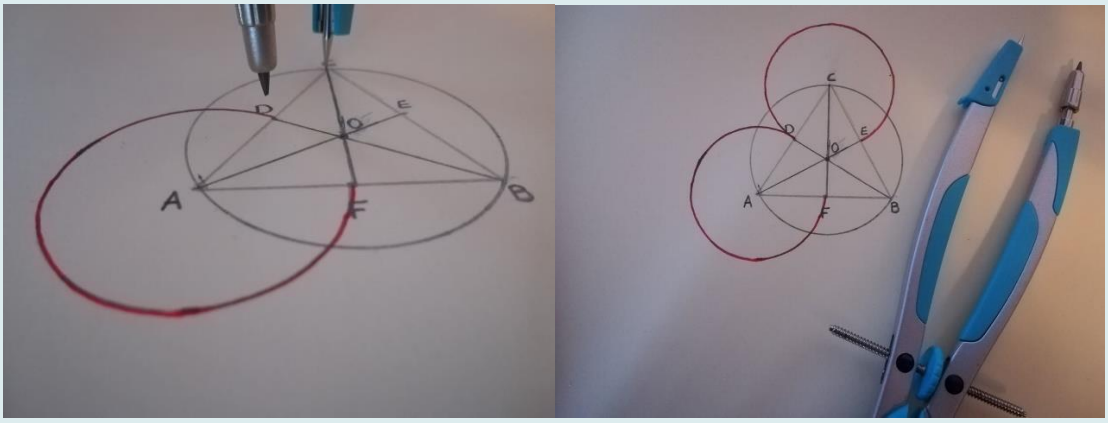
IX. From point A extend your compass to point D (middle of AC). By keeping stable your compass at point A, swing around and return to point F to complete the outer circle in such a way that the arc DF would not be visible.



X. From point C, extend your compass to point E (or D). Subsequently, swing around and return to point D (or E) to complete the outer circle, in such a way that the arc DE of the circle would not be visible.



XI. From point B, extend your compass to point E (or F). Subsequently swing around and return to point F to complete the outer circle, in such a way that the arc FE would not be visible.

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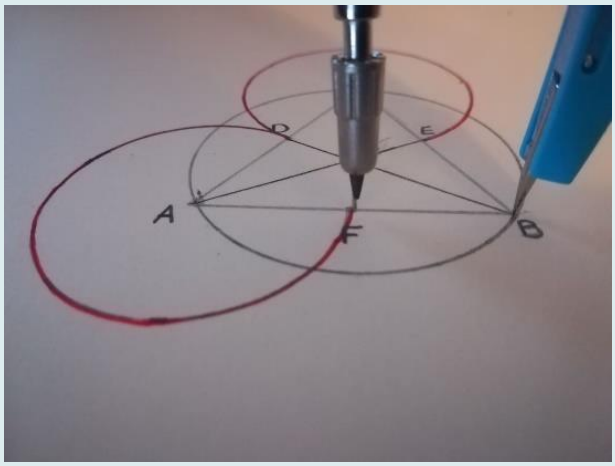
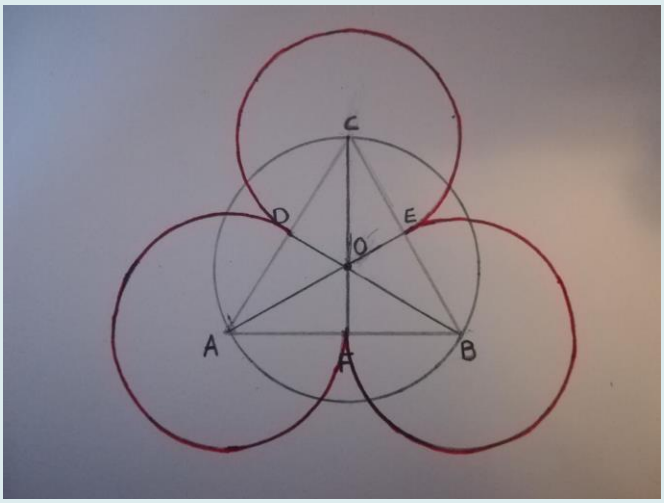
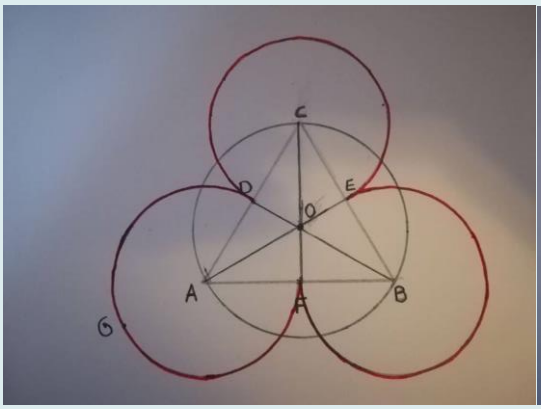
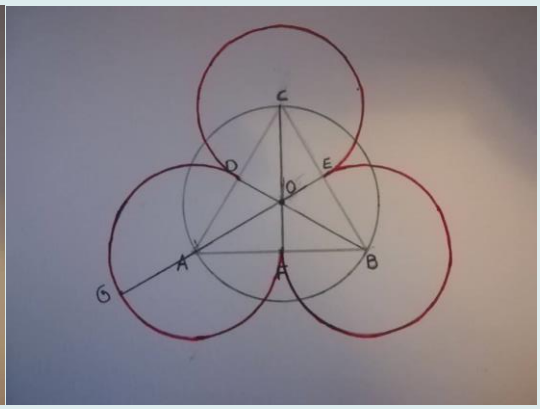


XII. The resulting shape (in red) will be as follows:



XIII. Extend the line segment OA towards A, to reach point G.





XIV. From centre O, extend your compass to point G.

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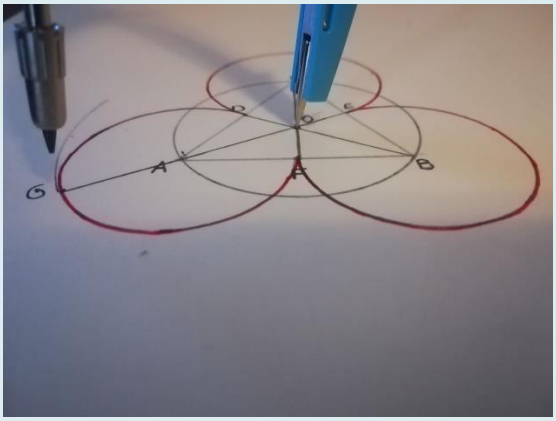
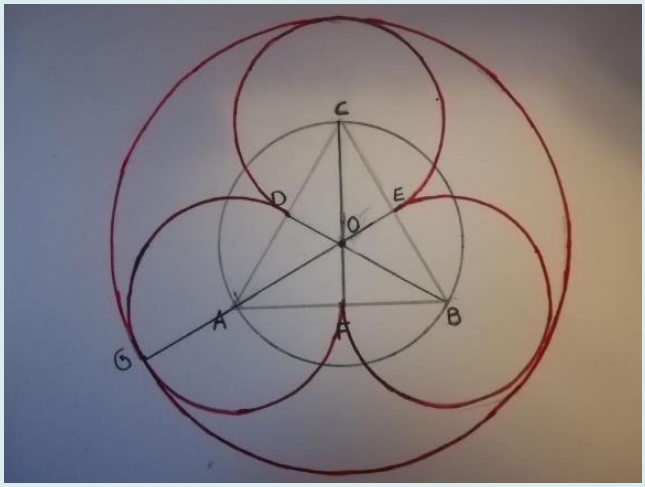
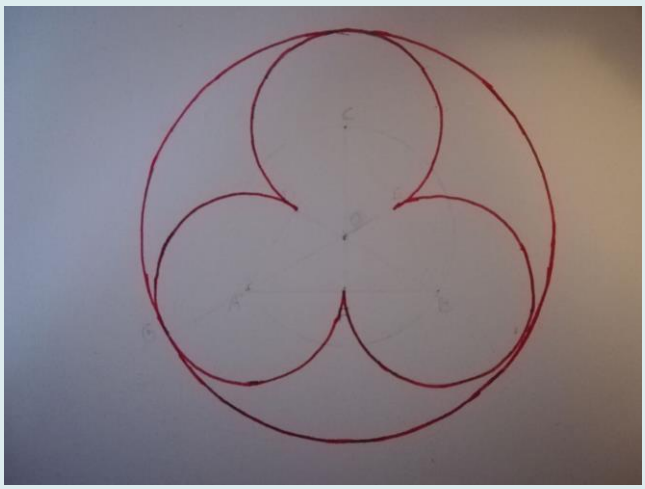


XV. Subsequently swing around and return to point G to complete a circumscribed circle to the resulting red shape of the previous picture.





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XVI. The method you have used in this task is quite similar to the method used by the architects of Gothic times for the construction of window traceries in gothic temples (Picture 5)

Picture 7: window tracery in gothic temple

(Picture 7: Retrieved from: http://www.canterbury-archaeology.org.uk/geometric-tracery/4592908321)

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LEARN MORE...

Mathematical models of gothic structure:

https://archive.bridgesmathart.org/2005/bridges2005-385.pdf

Geometry in gothic windows:
https://prezi.com/onrt-ajwx_nr/maths-and-art-geometry-and-gothic-windows/

A video related with gothic windows:
https://www.youtube.com/watch?v=HgSGWoVusfc

The geometry of gothic architecture:
https://www.ministryofstone.com/the-geometry-of-gothic-architecture

The story of mathematics:
https://www.storyofmathematics.com/islamic.html

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