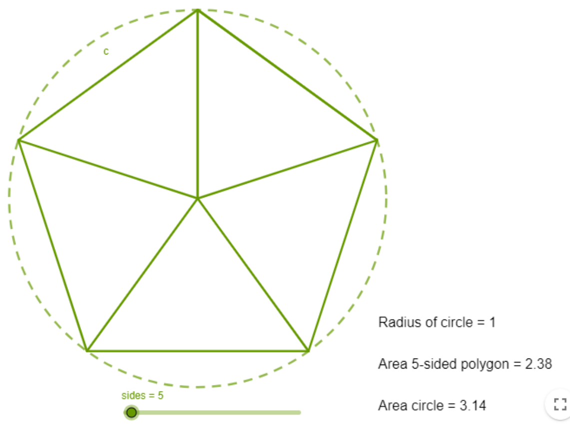
Project #2: Use Triangles to arrive at an estimation for π

The objective of this project is to use trigonometry to calculate the area of regular polygons inscribed in a circle in order to arrive at an approximation for the number π.

App: https://www.geogebra.org/m/bktvqhvk



Optional: do this entire project with a four function calculator and the trig protractor only.

Optional: construct your own diagrams on geogebra.org rather than using the app provided.

Optional: calculate 'circumscribed' *in addition* to inscribed on pages 3, 4, 5, 6.

Page 1: Title page & introduction. This page should have the title of your project, your name & date and perhaps an image. The introduction should describe the objective of the project.

Page 2: Explain why a circle has area more than $2r^2$ and less than $4r^2$. That is, $2 < \pi < 4$. Make relevant diagrams using this applet (or otherwise) to illustrate your writing.

On the next pages use a circle with radius 1. This means that 1 radius square has area 1 unit squared, and that the area of the circle is $A = \pi$.

Page 3: Show calculations (with a GeoGebra diagram) to find the area of triangle inscribed in a circle that has radius 1 unit.

Page 4: Show calculations (with a GeoGebra diagram) to find the area of a square inscribed in a circle that has radius 1 unit.

Page 5: Show calculations (with a GeoGebra diagram) to find the area of a pentagon or hexagon or octagon or nonagon or decagon in a circle that has radius 1 unit.

Page 6: Show calculations (with a GeoGebra diagram) to find the area of an inscribed n-agon. Choose a regular polygon with n sides, where $30 \leq n \leq 60$.

Page 7: Explain the steps required to find the area of any sided regular polygon inscribed in a circle with radius one unit. Draw a flow chart and write the process as a single formula. Verify your flow chart/formula by testing it with any of the values you have already calculated (on page 3, 4, 5 or 6).

Page 8: Conclusion. Give an updated estimate for a value of π based on your calculations.

Project #3: Build your own trigonometry table

In lesson 2 we saw a brief history of trigonometry. The groundbreaking mathematics by Hipparchus in Greece/Egypt and Aryabhata in India (Aryabhata) included constructing a table of chord values (Hipparchus) and half chord (sine) values (Aryabhata).

The objective of this project is to build familiarity with sines and cosines and their history by constructing a table of sines and cosines using measurement and calculations.

Your project can be printed or can be a slide show or can be an in-person presentation with a partner.

Slide 1: Title, name, date & introduction to the slideshow.

Slide 2: Write some biographical notes (in your own words please, no cut and paste and no AI) on either Hipparchus or Aryabhata. Include a relevant image and copy paste the URLs of the webpages where you source your information. (Partner work? Take one each)

Slide 3-16: Photo gallery, construction of each right-angle triangle with acute angle measuring 5° to 85°, increment 5°, using a meter stick and floor markings. You may build this photo gallery with a partner.

Slide 17: Calculation of the sines, cosines (and tangents) of 30° and 60° from an equilateral triangle with side 2 units. (Partner work – take one of slide 17/18 each).

Slides 18: Calculation of the sines, cosines (and tangents) of 45° using an isosceles right triangle. (no partner? Just do slide 17 *or* 18).

Slide 19: Your completed trig tables of sines and cosines from 0 to 90 degrees.

Slide 20: Comparison of your completed trig table with calculator values. Your reflection of levels of accuracy/inaccuracies with specific references to your table.

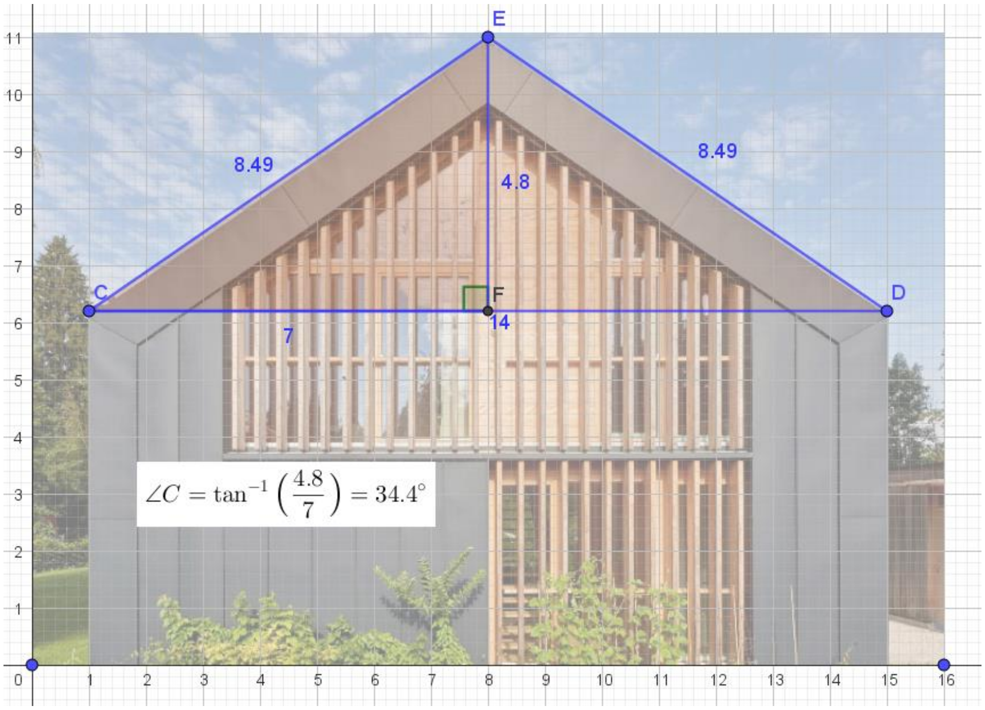
Figure 1: **Hipparchus' Table of Chords (Reconstruction)**

Arcs	Chords	Arcs	Chords
[7, 30]	[7, 30]	[97, 30]	[86, 9]
[15, 0]	[14, 57]	[105, 0]	[90, 55]
[22, 30]	[22, 21]	[112, 30]	[95, 17]
[30, 0]	[29, 40]	[120, 0]	[99, 14]
[37, 30]	[36, 50]	[127, 30]	[102, 46]
[45, 0]	[43, 51]	[135, 0]	[105, 52]
[52, 30]	[50, 41]	[142, 30]	[108, 31]
[60, 0]	[57, 18]	[150, 0]	[110, 41]
[67, 30]	[63, 40]	[157, 30]	[112, 23]
[75, 0]	[69, 46]	[165, 0]	[113, 37]
[82, 30]	[75, 33]	[172, 30]	[114, 21]
[90, 0]	[81, 2]	[180, 0]	[114, 35]

Image:

Project 4: Calculate the roof pitch on three different, local roofs

The objective of this project is to learn about roof pitches and to use trigonometry and technology to analyse different roof pitches in the neighbourhood. To do this project, you need to take photos of three different roofs. You should have permission to take the photos so they can be of your own house, a friends' house, a local business. You also need to take a measurement of part of the photo to be able to scale it correctly on GeoGebra. On one roof, you will need several photos/measurements to be able to calculate the surface area.



Project structure:

Page 1: Title page & introduction. This page should have the title of your project, your name & date and perhaps an image. The introduction should describe the objective of the project. You should state on the title page whether you are using feet and inches or meters and cm as your unit of length.

Page 2: Roof #1 Photo and analysis. Measure run, rise and calculate the angle of elevation.

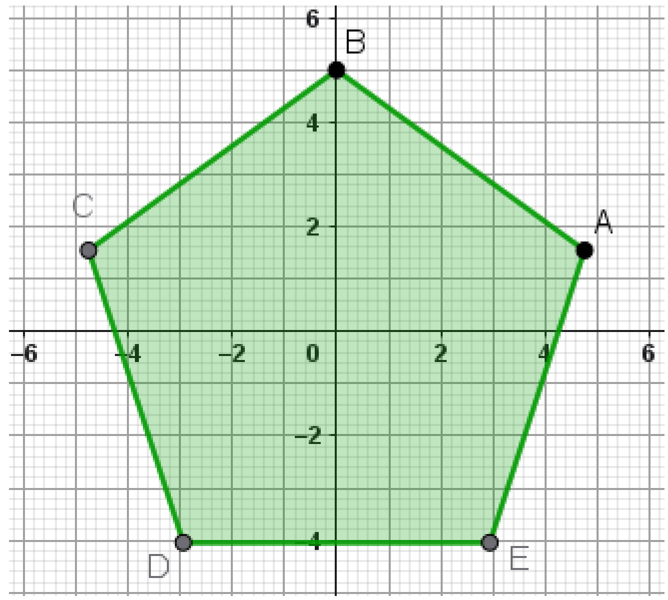
Page 3: Roof #2 Photo and analysis. Measure run, rise and calculate the angle of elevation.

Page 4: Roof #3 Photo and analysis. Measure run, rise and calculate the angle of elevation.

Page 5: Surface area calculation. Choose one of the roofs you have already studied. Calculate the total surface area of the roof. Draw diagrams and explain your calculations. Calculate the cost of materials if the roof is replaced with a metal roof at $12 per square foot ($130 per square meter).

Project 5: Build a regular polygon on GeoGebra using trigonometry and plotting points

The objective of this project is to create a accurate mathematical diagrams by combining knowledge of angles, polygons, graphing and trigonometry.



In the image above, each point is 5 units distant from the origin. The coordinates of point B are (0,5). The coordinates of point A are approximately (4.7, 1.6). In this task you are to calculate the coordinates of each point precisely, correct to 2 decimal places.

Project structure:

Page 1: Title page & introduction. This page should have the title of your project, your name & date and perhaps an image. The introduction should describe the objective of the project.

Page 2: Calculate the coordinates of the point B. Use diagrams to explain your calculation.

Page 3: Calculate the coordinates of points C, D and E. Use diagrams.

Page 4: Plot all five calculated points on GeoGebra. Take a screenshot and discuss your image. Visually predict whether or not your think that they are calculated correctly. Revise your calculations if one or more points seem to be out of place.

Page 5: Use the 'regular polygon tool'. Click on your point A, followed by your point B. Enter the number of vertices (a pentagon has 5 vertices).

Page 6: Use the applet to choose a radius and a number of points between 6 and 12. Perhaps don't choose 7 or 11, but, you do you. Screenshot the image. Repeat the study (pages 2- 5) for your shape.

> *Optional:* Create a formula for calculating each of the coordinates x and y for the point A for any radius r and any number of sides n. Test out your formula on GeoGebra.
>
> *Optional:* Create a formula for calculating the perimeter of a regular polygon constructed with n sides inscribed in a circle with radius r. Use the app to test and verify your formula.