New concepts such as shape properties are accompanied with an application. Example: If two chords intersect inside a circle the product between the 2 segments on one chord is equal to the product of the 2 segments on the other chord: $A M \times M B=M C \times M D$


D

## Application:

An arched bridge is made of a circular arc (AB) and eleven equally distanced vertical supports. The arc is 2.4 m high at its highest point $(x=2.4)$. Determine the radius of the arc.
Hint: extend the arc into a circle and use the intersecting chords property.


## Building application- Foundation Plan

An important aspect of architectural and building design involves quantity take-offs from drawings. Calculations involving both perimeter and area are often involved in quantity take-offs.

## Examples

The dimensions to the outside walls of a house are given here, as well as a cross-section through the footing.
a. Determine the area of the floor slab.
b. Determine the length of perimeter drain tile required for this project.
c. Determine the area of the formwork required to pour the foundation wall, given that the wall height is $2^{\prime} 6^{\prime \prime}$


[^0]Determine the area of roofing required to cover the roof shown here



For the symmetrical cross-gable roof pictured here,
Draw the top view and front view.
Given the dimensions below, determine the total roof area. Note that the building is built on level ground and the ridge beams KC and GM are horizontal.
Dimensions:

| $\mathrm{GH}=\mathrm{GN}=29 \mathrm{ft}$ | $\mathrm{CK}=62 \mathrm{ft}$ |
| :--- | :--- |
| $\mathrm{EH}=\mathrm{NF}=6 \mathrm{ft}$ | $\mathrm{AB}=40 \mathrm{ft}$ |
| $\mathrm{GM}=65 \mathrm{ft}$ | $\mathrm{CD}=\mathrm{CP}=30 \mathrm{ft}$ |
| $\mathrm{EF}=40 \mathrm{ft}$ | $\mathrm{AD}=\mathrm{PB}=3 \mathrm{ft}$ |

Percentages are often used to describe the slope of ramps. Recall that a percentage is a ratio of one number over 100. A slope of $15 \%$ means that the ramp rises 15 units vertically for every 100 units horizontally that it spans.


Photo and question credit: Elizabeth Gray

In the wheelchair ramp shown here, the grade of the ramp is not to exceed $8 \%$. If it must rise $16^{\prime \prime}$, how far before the first step does it need to start? What is the sloped length of the ramp? The stairs are 12 " deep.


## Area of basic shapes- Iran

Area of basic shapes:
A Persian decorative Motif (from Sheikh Lutfullah Mosque-Isfahan) is created as described here:


Determine the area of the blue region:


## Area and Volume of Basic Shapes- Mexico

Pyramid house, designed by Mexican architect Juan Carlos Ramos is in the shape of a right, square based pyramid where the lateral walls are equilateral triangles. One face of the pyramid is completely encased in glass (after applying an inward offset of 0.2 m ). The side length of the base square is 1.98m. Determine:

1) The area of the glass covered surface (shaded region)
2) Volume of the pyramid.


## Perimeter of basic shapes- Brazil

This small pavilion is built to stand as a doorway to the design and architecture exhibition 'Casa Cor MG 2015' in Belo Horizonte, Brazil. The radius of the small circle is 120 cm and the radius of the big circle is 150 cm . The centers of the two circles are 215 cm far apart. The straight lines MK and PN are tangent to the circles. Determine the perimeter of the shape. Express the perimeter in meters correct to four significant figures.

© Bel Diniz from https://www.archdaily.com/775384/pamp-pavilion-joao-diniz-arquitetura

A vertical cross section of the building is pictured here.


## Properties of shapes: Cairo tiles

Cairo tiles: Several streets of Cairo, Egypt are tiled with this particular pentagonal tile known as Cairo tile. What can we deduce about angles and sides of each pentagonal tile? Note how the tiles can be placed next to each other, forming a hexagon.

https://www.dialogueacrossborders.com/en/famous-cairo-tiling-seen-maadi\#slideshow-0

## Estimating the Lateral Area of a Cone, Group Project.



Photo credit: https://www.canadianarchitect.com/qa-douglas-cardinal/
The picture shows the world renowned Anishinaabe architect, Douglas Cardinal in the foyer of the First Nations University of Canada, which he completed in Regina in 2003.
After gaining national fame in the late 1960s for designing St. Mary's Roman Catholic Church in his hometown of Red Deer, Alberta, Cardinal designed several international landmarks, including the 1989 Museum of History in Ottawa and the conceptual design for the National Museum of the American Indian in Washington, D.C., completed in 2004. Through dozens of other projects of every size and genre, Cardinal has embedded his Indigenous values in his work. He is considered one of Canada's most influential contemporary Indigenous architects.

For this group project, measure the dimensions of the glass tent/cone by using the provided ruler. Assume that Douglas Cardinal's height is approximately 178 cm (this is just an assumption, not a fact). Estimate the amount of glass needed for the conic entrance of the building shown in the photo. You may ignore the thickness of the steel bars used to hold the cone in place.

## Resources:

History of Art courses:

## 1)

Age of Cathedrals


## 2)

Art Explora, short art courses for people with no art background:
https://academy.artexplora.org/en/learning-hub/


Islamic Art


American Art


Ancient Greece and Ancient Rome


Contemporary Art


Renaissance and Enlightenment

1) Samira Mian on YouTube:

Beginners Online Islamic Geometry Course with Samira Mian
Samira Mian
37.1 K subscribers

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Subscribed
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2) Online workshops offered by Adam Williamson and Richard Henry at https://artofislamicpattern.com/\#/0

They have a few free lessons online available publicly:
https://www.aramcoworld.com/Articles/January-2022/Art-of-Islamic-Patterns-
Alicatado

https://www.aramcoworld.com/Articles/September-2022/Art-of-Islamic-Patterns-A-Moorish-Star

https://www.aramcoworld.com/Articles/March-2022/Art-of-Islamic-Patterns-Mamluk-Rosette

https://www.aramcoworld.com/Articles/July-2022/Art-of-Islamic-Patterns-Rustem-Pasha-Rosette


On YouTube: Geometric Drawing with Adam Williamson: 4 Fold Pattern



## Paper Folding with Adam Williamson: Stars \& Squares


3) Luci Rose Galvani: https://en.lucierosegalvani.com/


Main Rose from Strasbourg Cathedral

To get inspiration for creating the next new problem:
Archdaily: https://www.archdaily.com/

ArchDaily is a weblog covering architectural news, projects, products, events, interviews and competitions, opinion pieces, among others, catering to architects, designers and other interested parties.


[^0]:    © Problem and drawing created by Liz Gray

