Northeastern University
College of Engineering

Weekly STEM Newsletter 13 (July 17 - July 24, 2020)

Mathematics

Introduction

Did you know that “four” is the only number in English that has the same number of letters as the number itself? Mathematics, or as you might be used to calling it -- Math, actually has no generally accepted definition, and is definitely not boring! Aristotle, one of the world’s earliest and greatest mathematicians described it as the science of quantity. Others described it as the science that draws necessary conclusions. It can also be described as the study of pattern. Nevertheless, Mathematics is a science that consists of the study of numbers, quantity, and space. It is also widely applied to other fields such as engineering and physics.

There are many fields of math that you might have heard of, such as algebra, calculus, geometry, trigonometry, and statistics. Algebra actually comes from an arabic word, “al-jabr”, meaning the reunion of broken parts. It is the study of mathematical symbols and the manipulation of them. It involves using variables, letters that stand for unknown numbers, and you can work towards solving what these numbers are. In calculus, you study the changes of values. This is related to functions, an expression involving one or more variables. Calculus is used in physics, engineering, economics, medicine, and much more. It can be used to predict radioactive decay!

Geometry, on the other hand, is the branch of mathematics that deals with the study of properties and the relations of lines, points, solids, surfaces, and more. It takes a look at shapes, positions, sizes, and dimensions of squares, circles, triangles, cubes and more. Geometry is very important in fields such as architecture, physics, design, and engineering. Trigonometry is a subset of geometry but deals with triangles exclusively. It can be used to calculate the heights of buildings, waves, mountains, and can even be used in satellite systems. The last branch of Mathematics we’ll be exploring is Statistics. Statistics is the practice of collecting numerical data then analyzing it, usually for learning about a population. Samples, only parts of populations, can be surveyed. Or censuses, which include every member of a population, can be done. This is extremely useful in sociology, where we collect data about population growth. It can also be used in psychology, if we want to learn more about the IQ of individuals.

Northeastern Connections

Faculty Connection

Valerio Toledano Laredo has been at Northeastern for over 13 years and is an expert in Mathematical Physics and Representation Theory. As you might guess, mathematical physics is the application of mathematical methods to problems in physics. But what is representation theory? Well, for starters it is another branch of mathematics -- one that we haven't looked at. Representation theory looks at algebraic structures in relation to objects. It is important because it can help us understand more about a particular group, or a collection of groups. Representation theory can help you predict things that you might have otherwise not seen. It can help you understand the differences and chaos in everyday life. Professor Toledano Laredo is an expert in this and says the secret for learning about something you can't see is "Symmetry". They are transformations that allow you to see objects in different ways without actually changing it, hence seeing all the "representations". Professor Toledano Laredo says that representation theory can help scientists and mathematicians understand the behavior of particles such as electrons.

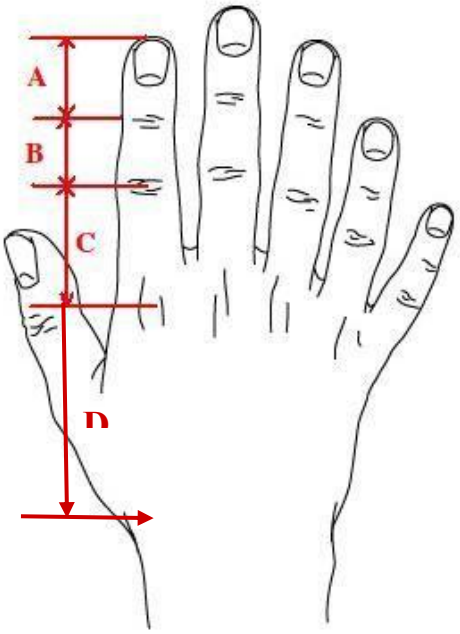
Professor Toledano Laredo is also part of a research team that is funded by the National Science Foundation. He works on preparing students to excel in STEM areas -- Science, Technology, Engineering, and Mathematics. He works with "Bridge to Calculus" to help Boston students in their Math classes. Professor Toledano Loredo was elected Fellow American's Mathematical Society, a program that recognizes individuals with outstanding advancements in Mathematics. He believes that training the next generation of mathematicians will really help expand our understanding of the universe.

Student Connection

Max Daniels is a combined Mathematics and Computer Science major at Northeastern University. He has a fascination for problem solving and spends a lot of time with his friends trying to solve different ones, the more complex the better. He is a self taught programmer- through hacking his video games! He spends hours using online resources for math and programming. He yearns to understand and discover the structures hidden within complex systems.

Max has several research projects at Northeastern, including projects on an audio deep decoder, classification algorithms, and GANS (General Adversarial Networks). These all relate to machine learning, a very useful field that involves many useful math concepts. It is a field that explores having machines learn on their own, instead of having to program every single possibility. He has earned several awards from Northeastern to support these projects. He plans to pursue a PhD in applied mathematics in the future, to continue to conduct research.

Do Now



Measure your hand as seen in the diagram.
Record the lengths below in the units of your choice:

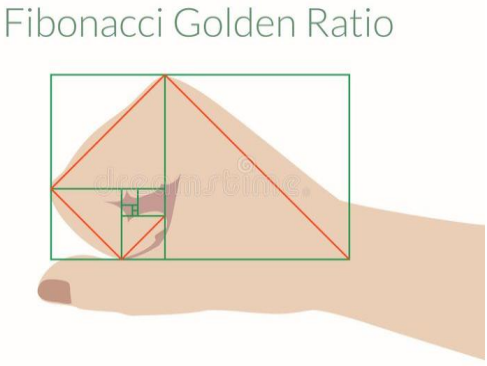
A: _____

B: _____

C: _____

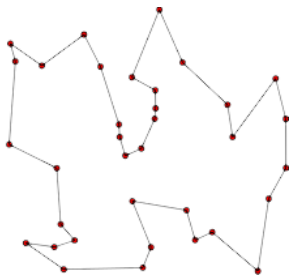
D: _____

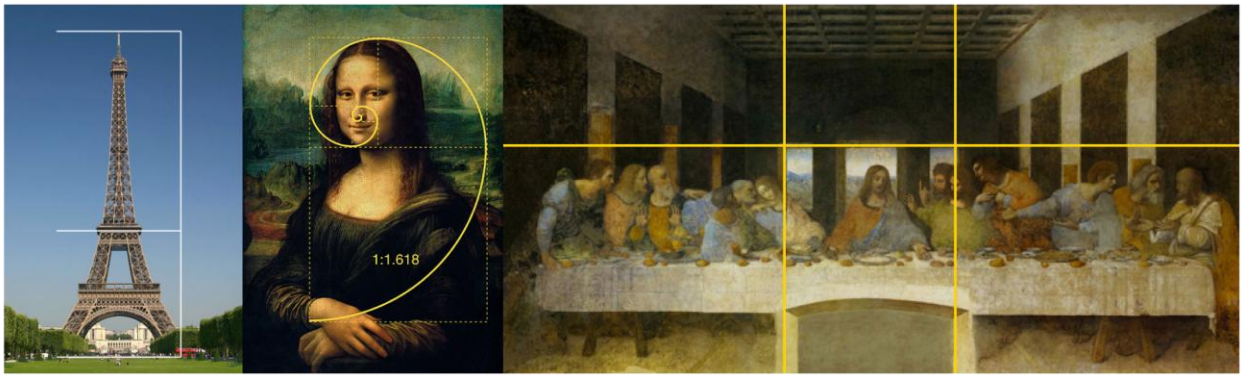
Find the ratio between the 4 measurements:
A : B : C : D
___ : ___ : ___ : ___



Our hands, like many other things in nature, follow the golden ratio. Think of the Fibonacci sequence: 1 1 2 3 5 8 ... Starting with 1, the next number is always the sum of the previous two numbers (0 + 1 = 1, 1 + 1 = 2, 1 +2 = 3 ...). The Fibonacci sequence is the mathematical source for the golden ratio, also known as Phi.

This is found all over nature, from snail shells, pineapples, flowers, and even our faces. It can be found in famous artwork and architecture such as the following:





Eiffel Tower, “Mona Lisa” and “The Last Supper” both by Leonardo da Vinci

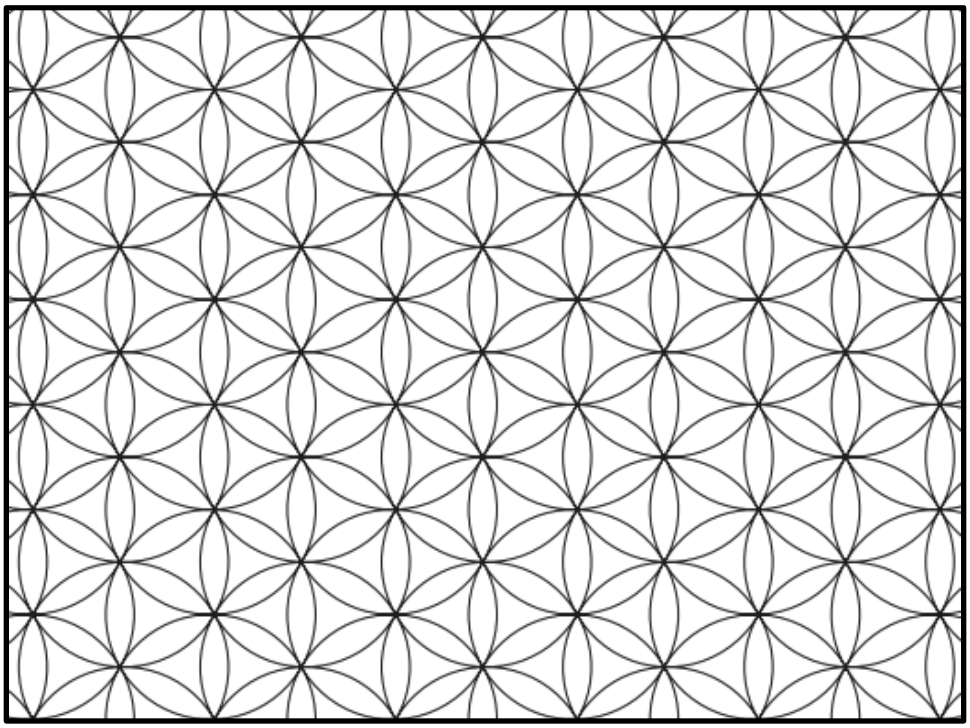
Activity

Islamic Art uses many different geometric patterns and can be found on items such as rugs, ceramics, and buildings. This is a mathematically-based decoration that usually consists of different combinations of repeated circles and squares that overlap or interlace. Stars are often represented using squares on top of each other to form an 8-pointed star.

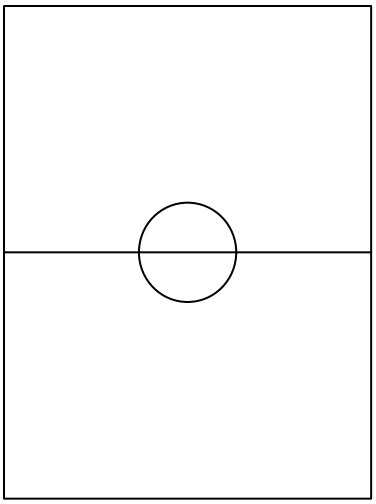
Materials Needed:

You can use any materials you want but here are some suggestions:

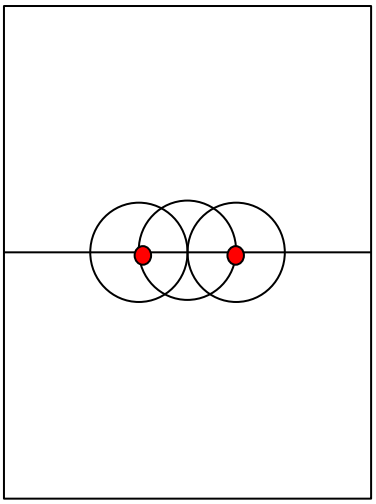
- Paper
- Pencil
- Compass
- Ruler
- Scissors
- Pen (Optional)
- Colored Markers (Optional)
- Colored pencils (Optional)



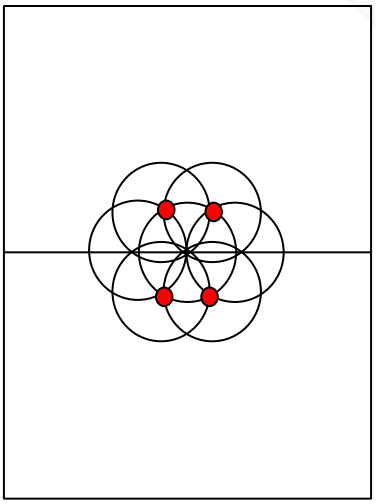
Steps:



1. Using your ruler, draw a horizontal line in the center of your paper using a pencil (to be able to erase it later). Draw a circle in the center.



2. Keeping the compass open at the same width, place your compass point on the intersection between the circle and the line, draw two more circles this way (the red dots are the center of your circles.)



3. Add four more circles using your compass, using the new intersection points (red dots), as the center for the circle. Make sure all the circles have

For more patterns check out: https://www.metmuseum.org/-/media/files/learn/for-educators/publications-for-educators/islamic_art_and_geometric_design.pdf

Discussion Questions:

- Can you locate any hexagons in your pattern?
- Can you draw any equilateral triangles using your pattern?
- Can you find any stars?
- What other shapes can you make out of your pattern?

Share Your Results

We'd love to know how the activity and/or the "do now" turned out! What worked and what didn't work? Please share with us something you learned and/or send us pictures! Email us at stem@northeastern.edu.

Related links/Extensions

- Crash Course: Statistics
- FunBrain: Math Zone
- KhanAcademy: Math
- MET: Islamic Art and Geometric Design
- Cool Math Games
- Mr. Nussbaum's Math Games and Math Activities
- Online Scientific Calculator
- Learn math through a game: Prodigy