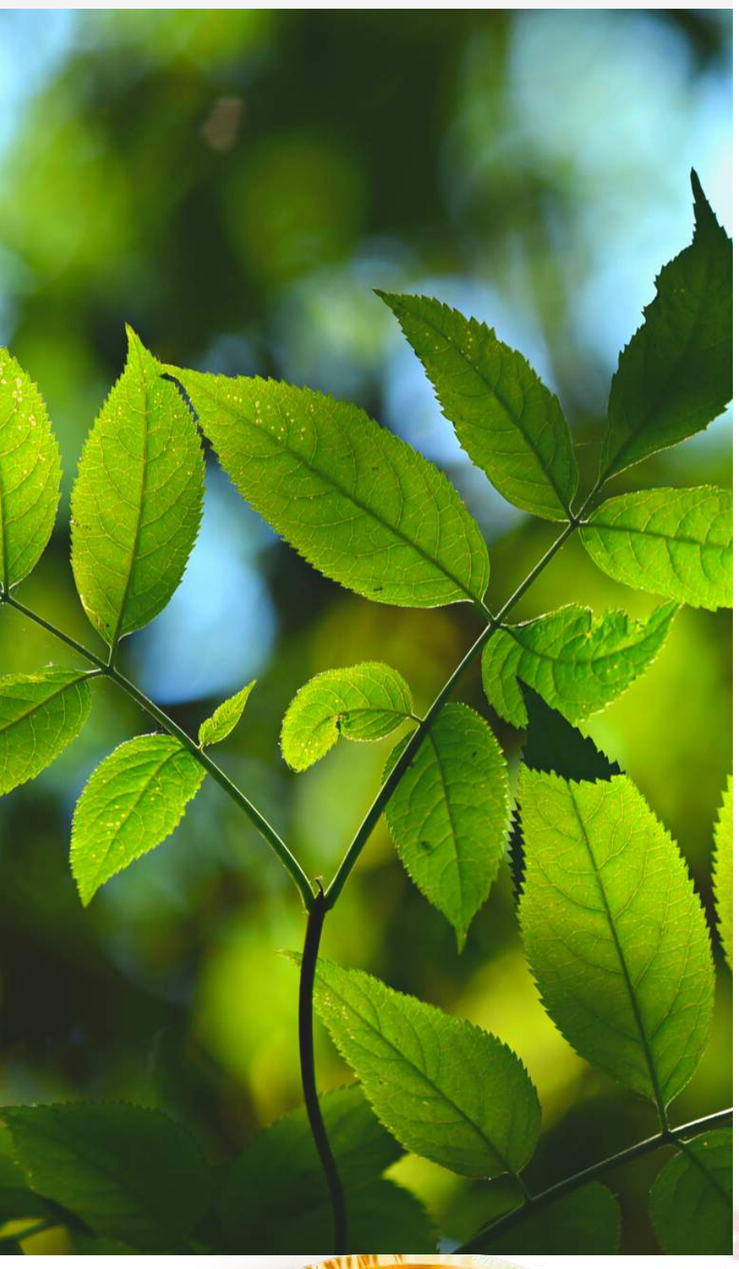
APRIL 2021

QUEST

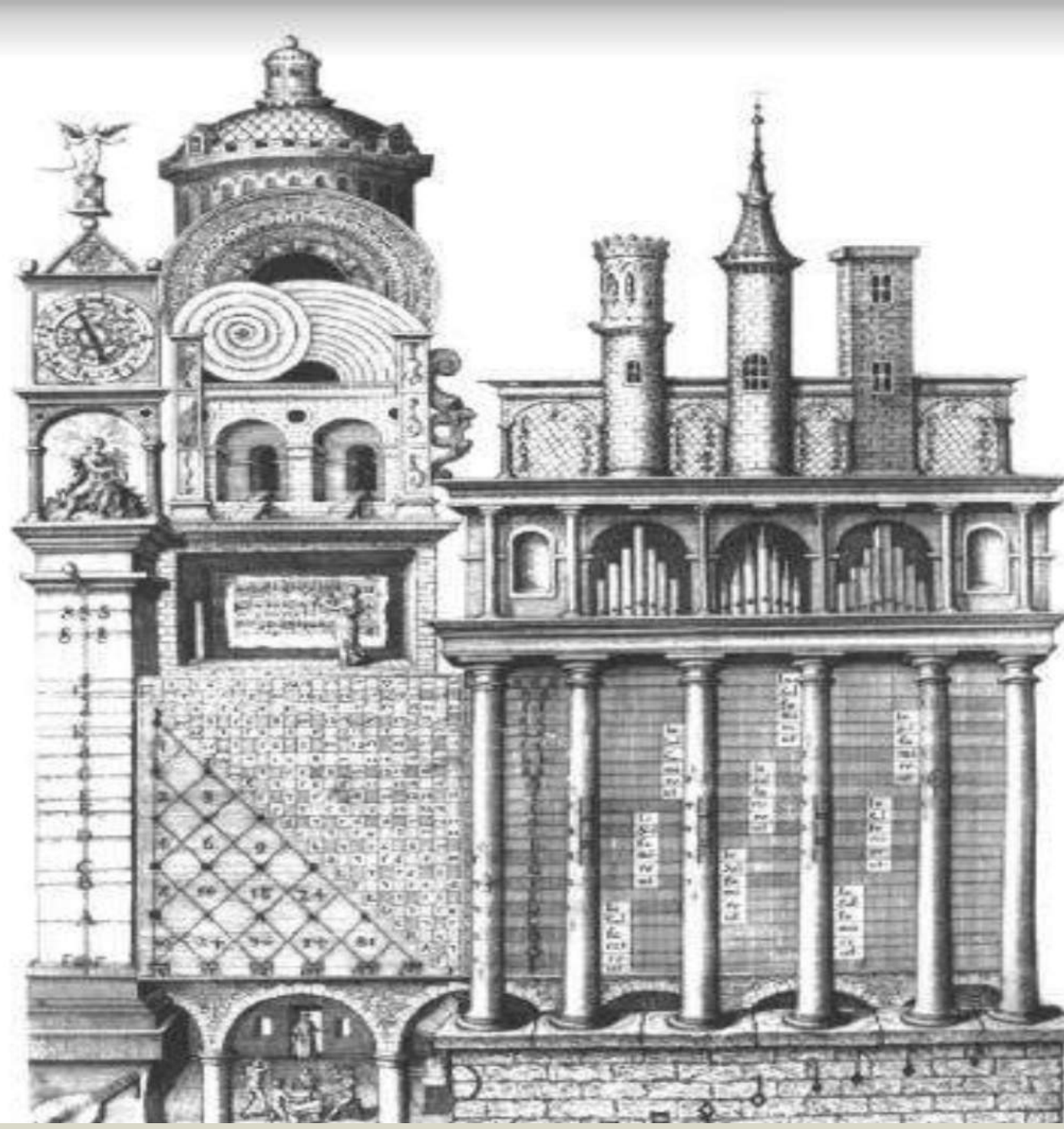
CONTENTS

Quest/April Edition/2021



MAGICAL MATHS OF MUSIC

By :-
V.Aditya
Abdi Gulati
Isshan Marwah



Mathematics and music have traditionally been closely connected. The seventeenth century has been seen by historians as a crucial turning-point, when music was changing from science to art, and science was moving from theoretical to practical. Many connections between science and music can be traced for this period. In the nineteenth and twentieth centuries, the development of the science of music and of mathematical approaches to composition further extended the connections between the two fields. Essentially, the essays in this book share the concern of commentators throughout the ages with the investigation of the power of music.

Musicke I here call that *Science,* which of the Greeks is called Harmonie. Musicke is a Mathematical Science, which teacheth, by sense and reason, perfectly to judge, and order the diversities of sounds high and low.

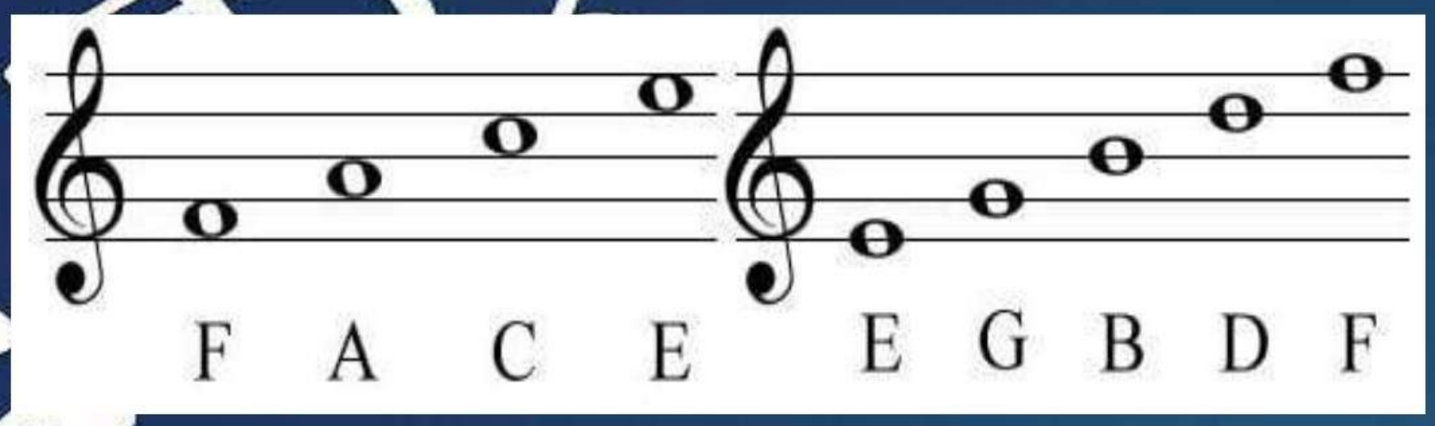
--JOHN DEE

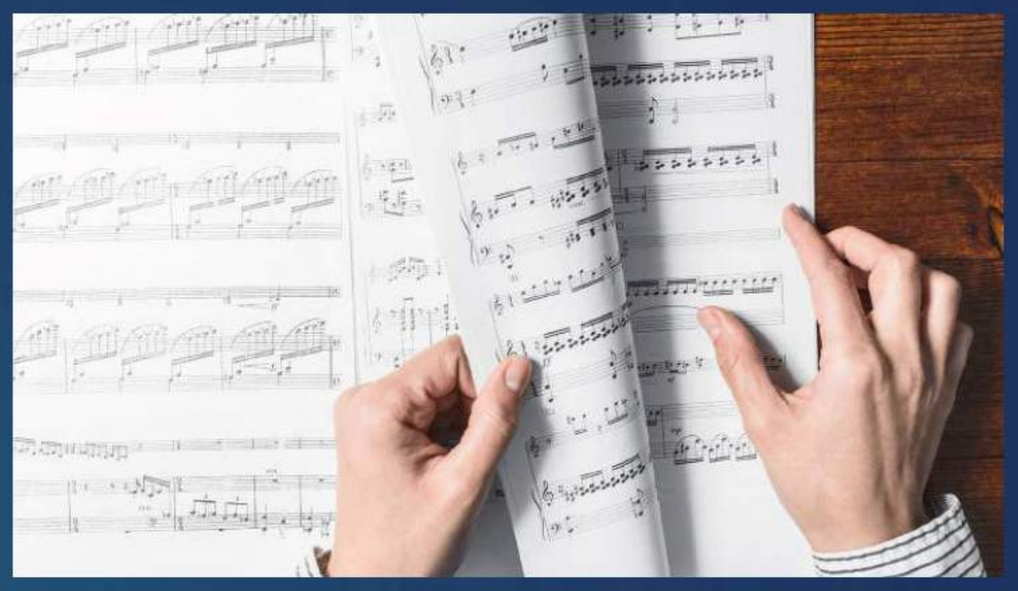
MUSIC COSMOLOGY

The *musica universalis* (literally universal music), also called music of the spheres or harmony of the spheres, is an ancient philosophical concept that regards proportions in the movements of celestial bodies—the Sun, Moon, and planets—as a form of music. This "music" is not thought to be audible, but rather a harmonic, mathematical or religious concept. Further scientific exploration discovered orbital resonance in specific proportions in some orbital motion. Pythagoras first identified that the pitch of a musical note is in inverse proportion to the length of the string that produces it, and that intervals between harmonious sound frequencies form simple numerical ratios. In a theory known as the Harmony of the Spheres, Pythagoras proposed that the Sun, Moon and planets all emit their own unique hum based on their orbital revolution, and that the quality of life on Earth reflects the tenor of celestial sounds which are physically imperceptible to the human ear.

TUNING

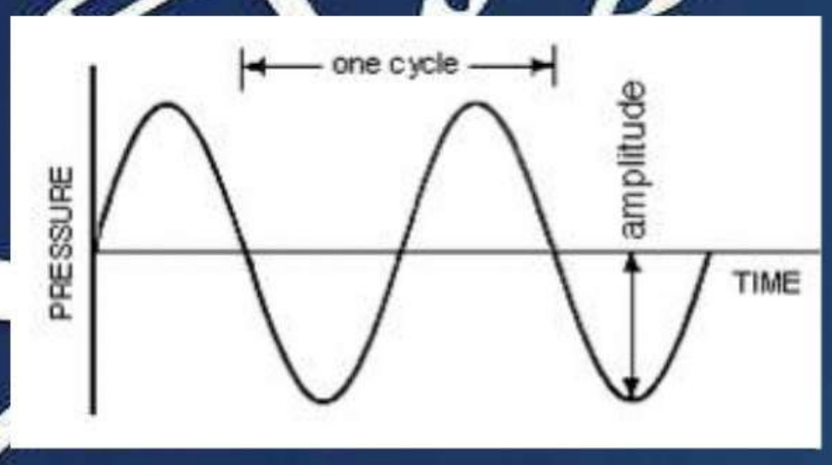
Tuning in the process of adjusting the pitch of one or many tones from musical instruments to establish typical intervals between these tones. Two concepts fundamental to the theory of tuning are those of frequency ratio and of consonance and dissonance. A given musical pitch is determined by the frequency of vibration of the sound wave that produces it, as a′ = 440 cycles per second. An interval, or distance between two pitches, can thus be mathematically described as the ratio of the frequency of the first pitch to the frequency of the second. Various frequency ratios can be reduced to the same basic relationship; for example, 440:220 and 30:15



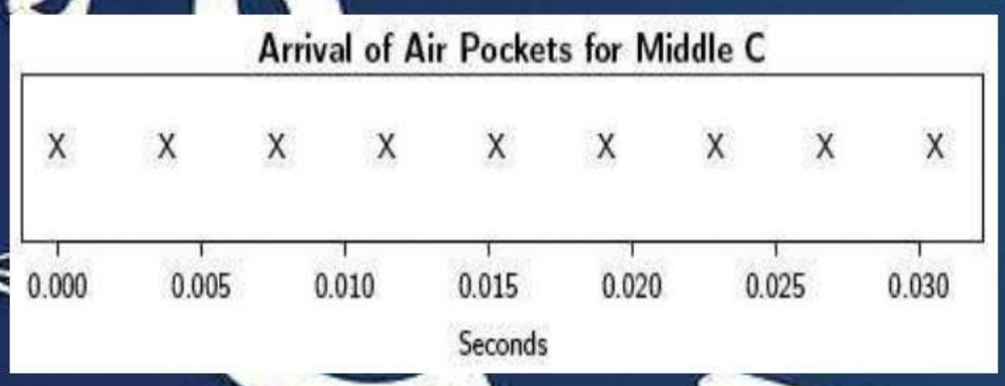


Pythagoras, the Greek philosopher and mathematician, realized that different sounds can be made up with different weights and vibrations. This led to the discovery that the pitch of a vibrating string, such as on a violin, guitar, or piano, can be controlled by it's length.

FREQUENCY



Frequency is the speed of the vibration, and this determines the pitch of the sound. A sound wave creates minute pockets of higher and lower air pressure, and all the sounds we hear are caused by these pressure changes. With music, the frequency at which these pockets strike your ear controls the pitch that you hear.
For example, consider the note called "Middle C". This note has a frequency of about 262 Hertz. That means that when Middle C is played, 262 pockets of higher air pressure pound against your ear each second.



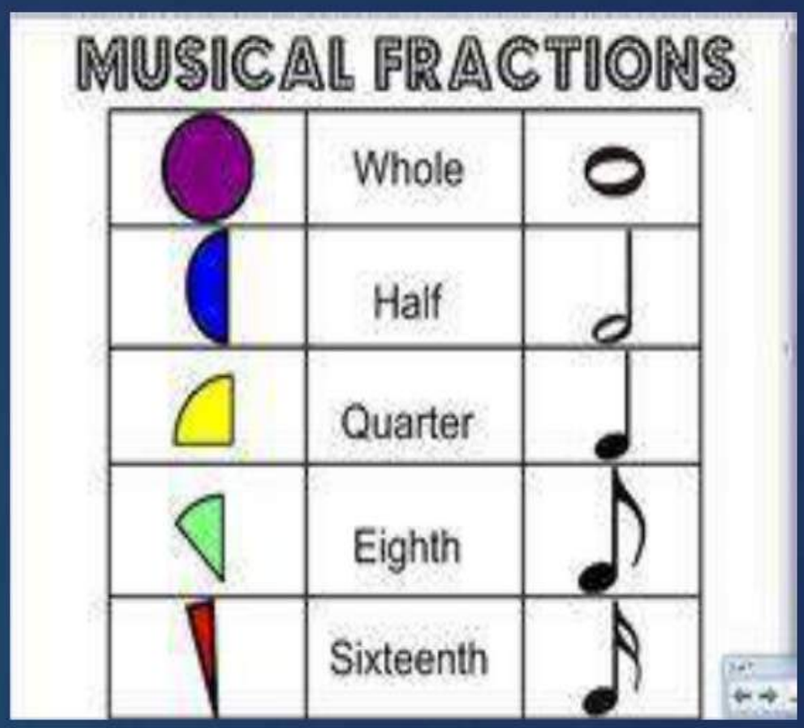
We can draw a graph by putting an X at every time when a pocket of air arrives:

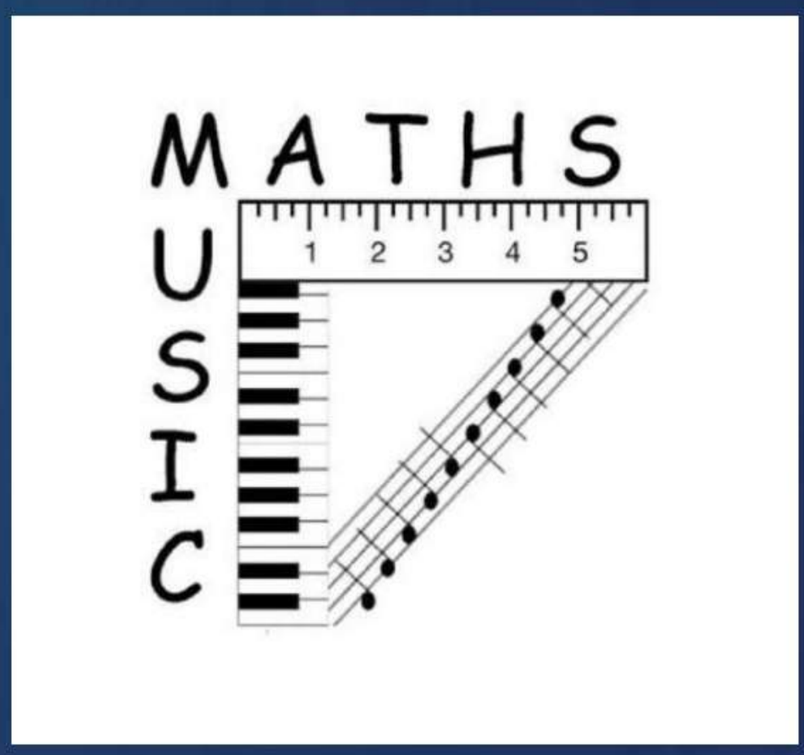
This graph provides a sort of "picture" of Middle C. By itself, it does not tell us much. However, such graphs provide a new perspective on the relationships between different musical notes.

PATTERNS:

PATTERNS ARE USED BOTH IN MUSIC AS WELL AS MATHS....

The closest connection between music and math is that they both use patterns. Music has repeating choruses and sections of songs and in math patterns are used to explain and predict the unknown. Mathematics in the study of patterns, and you can study everything in music from different mathematical perspectives, including geometry, number theory, trigonometry, differential calculus, and signal processing.





SQUARE AND CUBE NUMBER SEQUENCE

- **Square number sequence** (the **product** of some integer with itself. 9 is a square number, since it can be written as "**3×3**". – Sequence example: **0, 1, 4, 9, 16, 25, 36, 49, 64, 81, …**
- **Cube number sequence** (the **cube** of a number is its third **power**: $1^3=1$, $2^3=8$, $3^3=27$, et cetera – the result of the number multiplied by itself twice. It is also the number multiplied by its **square**. – Sequence example: **1, 8, 27, 64, 125, 216, 343, 512, 729, …**)

MUSIC AFFECTS HOW WE STUDY AND THINK :

Dr. Frances Rauscher of the University of Wisconsin Oshkosh says that "when young children are provided with instruction on musical instruments, they score much higher on tasks measuring spatial-temporal cognition, hand-eye coordination, and arithmetic. Part of this is because of the overlap between math skills and music skills.,.,.,.,.,.,.,.,.,.,.,.,.,.,.,.,.,.,."

ABSTRACT THEORY :

Expanding on the methods of musical set theory, some theorists have used abstract algebra to analyze music. For example, the pitch classes in an equally tempered octave form an abelian group with 12 elements. It is possible to describe just intonation in terms of a free abelian group.

Transformational theory is a branch of music theory developed by David Lewin . The theory allows for great generality because it emphasizes transformations between musical objects, rather than the musical objects themselves.

Theorists have also proposed musical applications of more sophisticated algebraic concepts. The theory of regular temperaments has been extensively developed with a wide range of sophisticated mathematics, for example by associating each regular temperament with a rational point on a Grassmannian.

The chromatic scale has a free and transitive action of the cyclic group , with the action being defined via transposition of notes. So the chromatic scale can be thought of as a torsor for the group

DODECAPHONY ("Twelve-tone technique" or "twelve-note composition")

Dodecaphony is a method of musical composition devised by Austrian composer **Arnold Schoenberg** (1874–1951). The technique is a means of ensuring that all 12 notes of the **chromatic scale** are sounded as often as one another in a piece of music while preventing the emphasis of any one note through the use of **tone rows**, orderings of the 12 **pitch classes**. All 12 notes are thus given more or less equal importance, and the music avoids being in a **key**.

Musicians who are also mathematicians include:

- Brian May (Queen) – PhD in Astrophysics and degrees in mathematics, Imperial College London
- Dan Snaith (Caribou) – PhD Mathematics, Imperial College London
- Art Garfunkel (Simon & Garfunkel) – Masters in Mathematics, Columbia University
- Johnny Buckland (Coldplay) – degree in Mathematics, University College London. Coldplay songs frequently feature math themes, like *Twisted Logic, Square One, Proof, Major Minus and 42.*
- Gregg Turner (Angry Samoans) – Mathematics, Claremont Graduate University (currently teaches at New Mexico Highlands University)
- Ethan Port (Savage Republic) – Mathematics, University of Southern California
- Phil Alvin (The Blasters) – Mathematics, University of California, Los Angeles
- Modern classical composer, Philip Glass, wrote an entire opera based on math: *Einstein on the Beach*. Whole sections of the opera are based on numbers and counting.
- American avant-garde musician Laurie Anderson frequently uses math themes in her work, such as the song "Let X=X" on her album *Big Science*.

VIDEO GALLERY

MUSIC AND MATHEMATICS

BY ABDI GULATI S2D

https://drive.google.com/file/d/1dljCZ4PXq6D-TSPAQTPMuQuvBxLM5HsE/view?usp=drivesdk

VIDEO GALLERY

MUSIC AND MATHEMATICS

BY VOLETI ADITYA S2D

https://drive.google.com/file/d/1m77_ZG2nlqveip483ngFDgrnsEp8ETej/view?usp=drivesdk

INTERNATIONAL DAY OF HUMAN SPACE FLIGHT

Orbiting Earth in the spaceship, I saw how beautiful our planet is. People, let us preserve and increase this beauty, not destroy it!
~ Yuri Gagarin

The International Day of Human Space Flight observed globally on April 12 every year. The UN General Assembly passed a resolution on April 7, 2011, had declared April 12 to be celebrated as International Day of Human Space Flight.

It is to celebrate the beginning of the space era for mankind, the contribution of space science and technology and to ensure the realization to maintain outer space for peaceful purposes.
On April 12, 1961, the first human space flight was carried out by Yuri Gagarin, a Russian pilot and cosmonaut, who became the first person to journey into outer space. The mission opened several pathways for space exploration, which benefited the next generations.

Some of the resolutions undertaken to recognize the achievements are:
• The first resolution related to outer space was adopted by the General Assembly. The resolution was entitled “Question of the Peaceful Use of Outer Space”.
• The “Magna Carta of Space” which was also known as The Treaty on principles governing the activities of states in the exploration and use of outer space, including the moon and other celestial bodies, came into force on October 10, 1967.

BY AKANSHA IVY LAKRA [SS2-A]

SPIRALS

SPIRALS

A long curved line that moves round away from central point

Archimedean Spiral

AS A SYMBOL

It was used as symbols

IN LABORATORY

It can be made in laboratory when k2so4 heated in water

Golden Spiral

Square root Spiral

IN NATURE

It is present in some flowers, branches of some trees and some animals

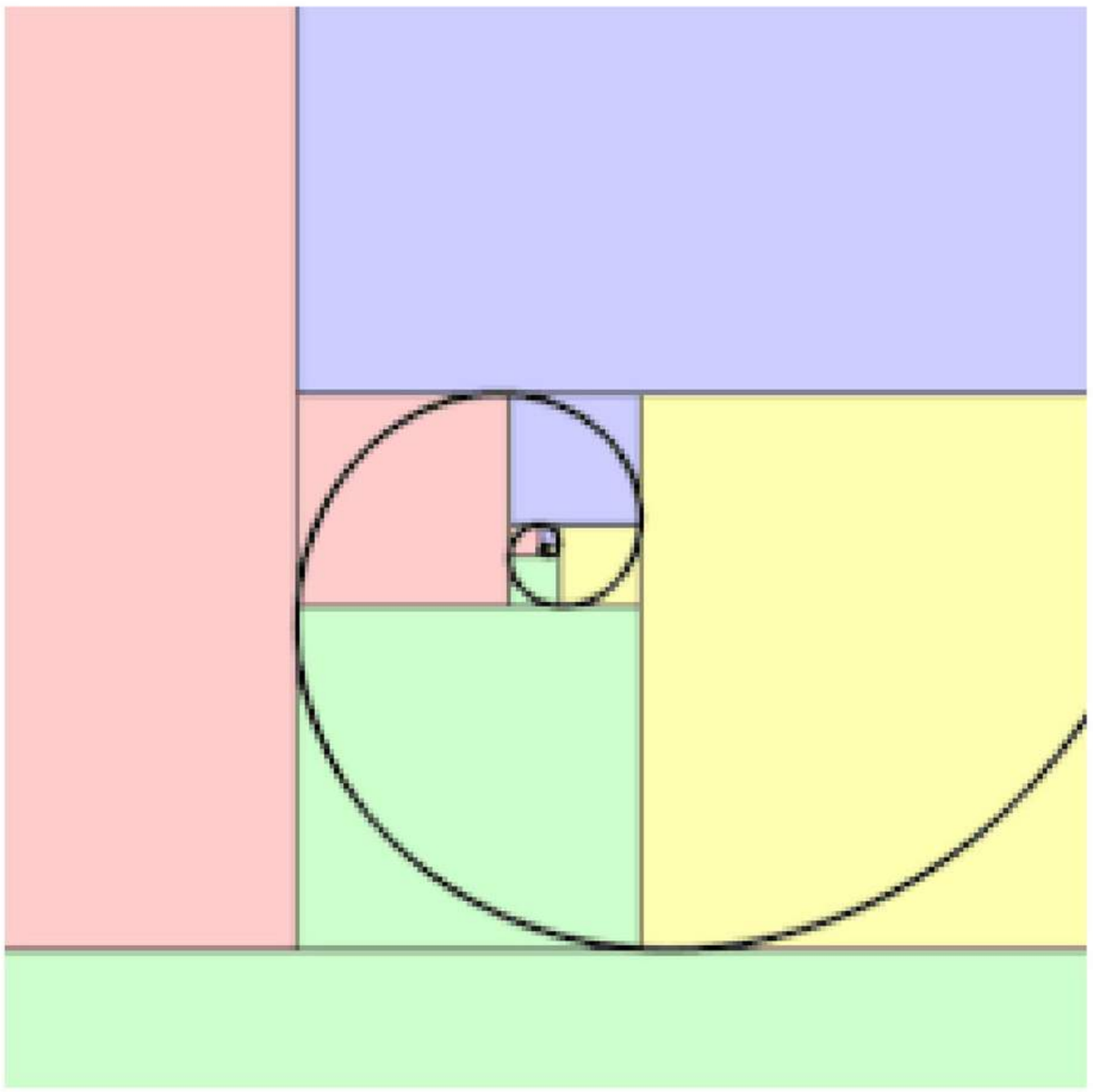
SPIRALS IN ART

It is an art which tells us the way of life

By Parth Bhatia
Arnav Singh
Shaurya Negi
Daksh Choudhary

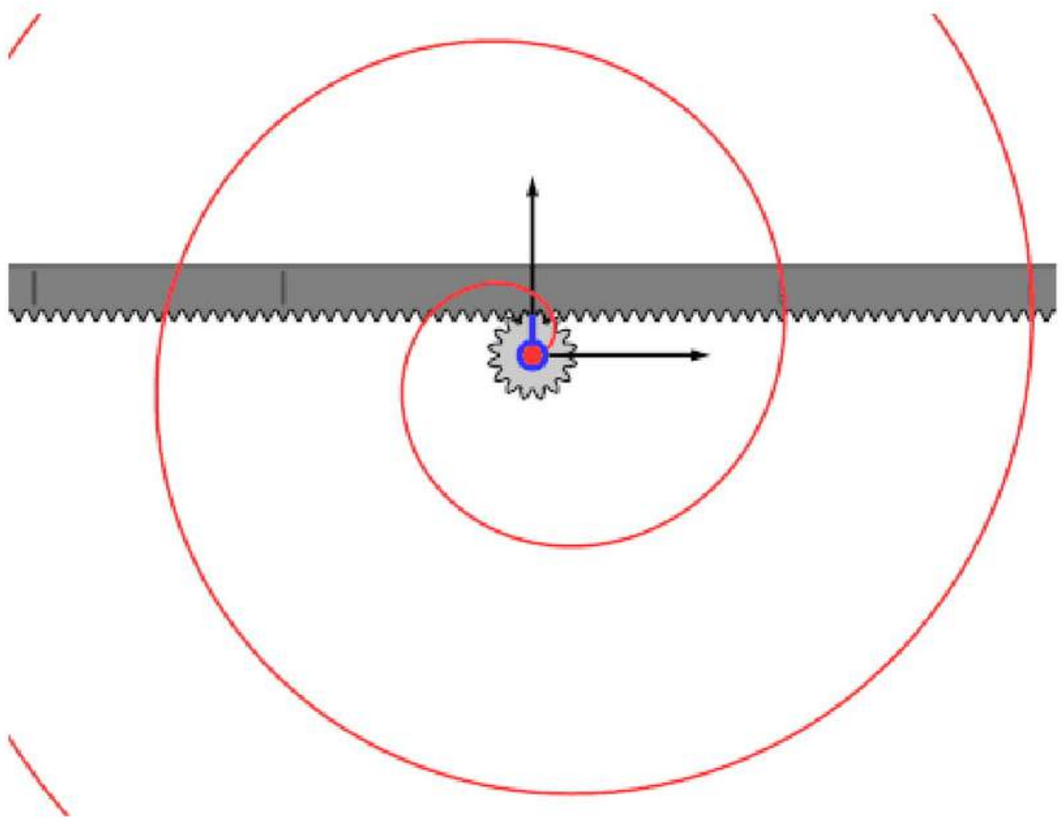
GOLDEN SPIRAL

- In geometry, a **golden spiral** is a logarithmic spiral whose growth factor is φ, the golden ratio. That is, a golden spiral gets wider (or further from its origin) by a factor of φ for every quarter turn it makes.
- There are several comparable spirals that approximate a golden spiral but do not exactly equal.



ARCHIMEDEAN SPIRAL

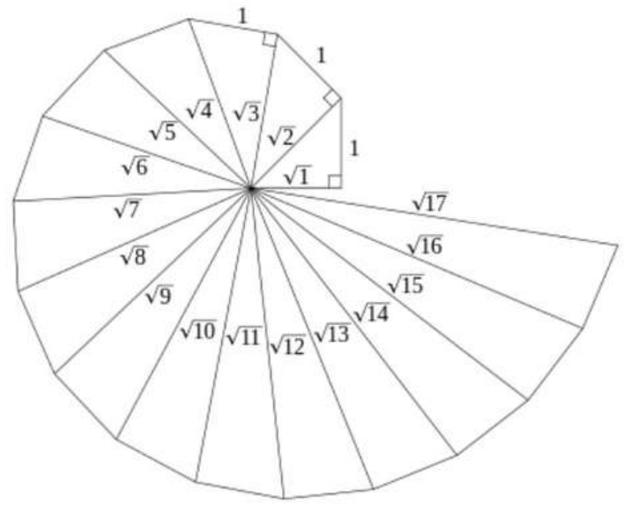
- The **Archimedean spiral** (also known as the **arithmetic spiral**) is a spiral named after the 3rd-century BC Greek mathematician Archimedes. It is the locus of points corresponding to the locations over time of a point moving away from a fixed point with a constant speed along a line that rotates with constant angular velocity.
- The Archimedean spiral has the property that any ray from the origin intersects successive turnings of the spiral in points with a constant separation distance (equal to $2\pi b$ if θ is measured in radians), hence the name "arithmetic spiral".



SQUARE ROOT SPIRAL

- In geometry, the square root spiral is a spiral composed of right triangles, placed edge-to-edge.
- Construction:

The spiral is started with an isosceles right triangle, with each leg having unit length. Another right triangle is formed, an **automedian right triangle** with one leg being the hypotenuse of the prior triangle (with length $\sqrt{2}$) and the other leg having length of 1; the length of the hypotenuse of this second triangle is $\sqrt{3}$.



In some shell such as *Nautilus* and *ammonites* the generating curve revolves in a plane perpendicular to the axis and the shell will form a planer discoid shape. In others it follows a skew path forming a helico-spiral pattern.

An Ammonite shell

A Nautilus shell

SPIRALS IN NATURE

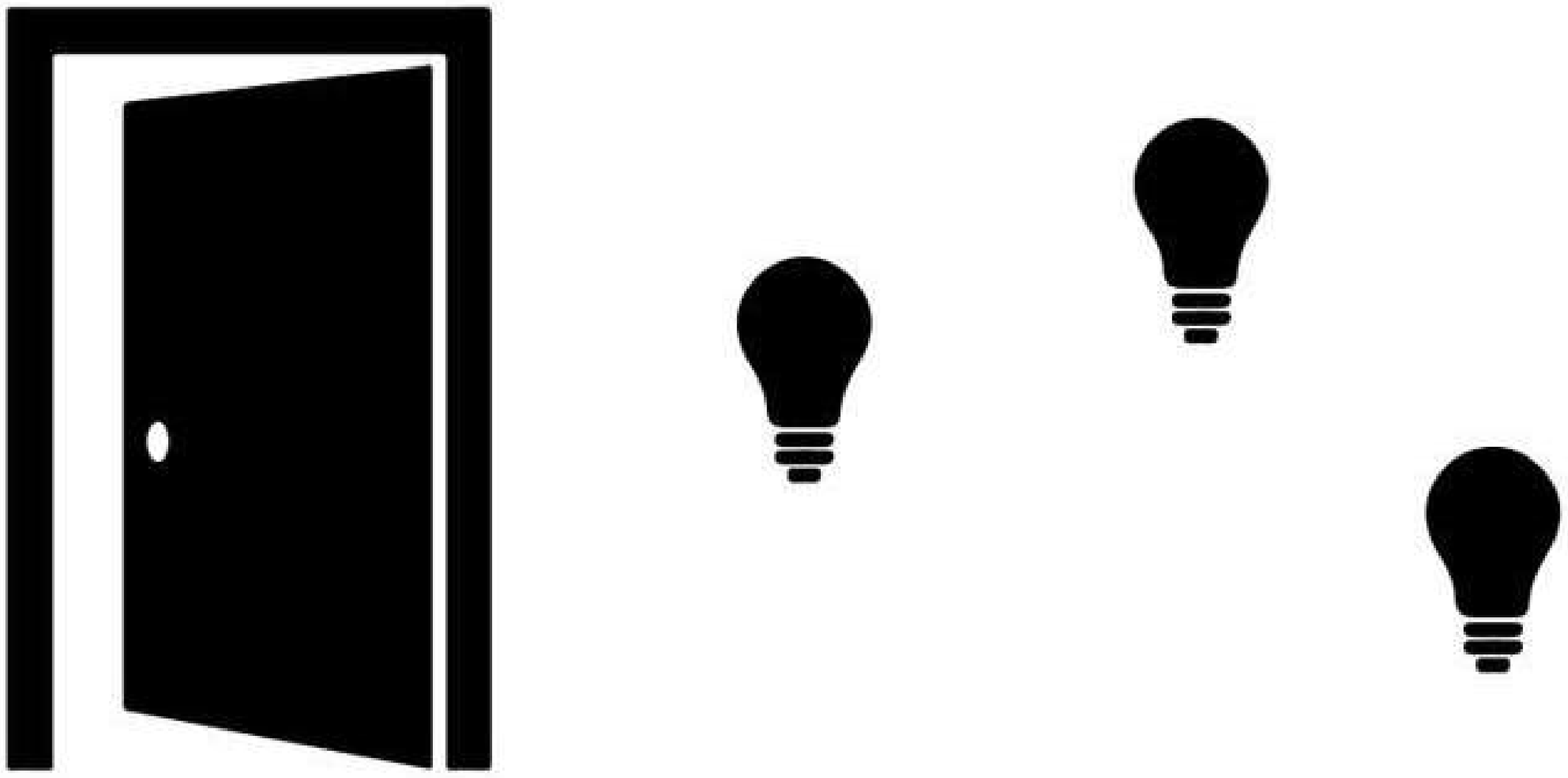
- The study of spirals in nature have a long history. Christopher Wren found out that many shells form a logarithmic spiral.
- Jan Swammerdam observed the common mathematical characteristics of a wide range of shells from *Helix* to *Spirula* and Henry Nottidge Moseley described the mathematics of univalve shells.
- D'Arcy Wentworth Thompson's *On Growth and Form* gives extensive treatment to these spirals. He describes how shells are formed by rotating a closed curve around a fixed axis, the shape of the curve remains fixed but its size grows in a geometric progression.
- The spiral also represents infinity. Starting at a single point, and revolving outwardly until the end of the universe. Because of this, some civilizations believe that the Spiral is a pathway to the afterlife.

SPIRALS IN ART

- The spiral has inspired artists throughout the ages. Among the most famous of spiral-inspired art is Robert Smithson's earthwork, "Spiral Jetty", at the Great Salt Lake in Utah. The spiral theme is also present in David Wood's Spiral Resonance Field at the Balloon Museum in Albuquerque, as well as in the critically acclaimed Nine Inch Nails 1994 concept album *The Downward Spiral*. The Spiral is also a prominent theme in the anime Gurren Lagann, where it represents a philosophy and way of life. It also central in Mario Merz and Andy Goldsworthy's work. The spiral is the central theme of the horror manga *Uzumaki* by Junji Ito, where a small coastal town is afflicted by a curse involving spirals. *2012 A Piece of Mind By Wayne A Beale* also depicts a large spiral in this book of dreams and images.

SUDOKU

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



BRAIN TEASERS

YOU ARE IN A ROOM THAT HAS THREE SWITCHES AND A CLOSED DOOR. THE SWITCHES CONTROL THREE LIGHT BULBS ON THE OTHER SIDE OF THE DOOR. ONCE YOU OPEN THE DOOR, YOU MAY NEVER TOUCH THE SWITCHES AGAIN. HOW CAN YOU DEFINITIVELY TELL WHICH SWITCH IS CONNECTED TO EACH OF THE LIGHT BULBS?

BRAIN TEASERS

A MAN STANDS ON ONE SIDE OF A RIVER, HIS DOG ON THE OTHER. THE MAN CALLS HIS DOG, WHO IMMEDIATELY CROSSES THE RIVER WITHOUT GETTING WET AND WITHOUT USING A BRIDGE OR A BOAT. HOW DID THE DOG DO IT? ONLY 2 PERCENT OF PEOPLE CAN SOLVE EINSTEIN'S RIDDLE. CAN YOU DO IT?

APRIL 2021

Somewhere, something incredible is waiting to be known.

Carl Sagan