

Mathematics Scrapbook.



with Helen Prochazka

Pythagoras' music

Pythagoras believed that music and mathematics were linked — that everything in the universe was a series of harmonies and regulated by music.

For him music had spiritual and healing properties. He played his lyre to infuse his soul with its divine quality. He used music to promote a sense of well being among his followers and to help those who were ill.

Every performance by a jazz pianist, rock band or opera singer owes something to Pythagoras. Experimenting with stretched strings of equal tension he discovered the underlying mathematics of the musical scale.

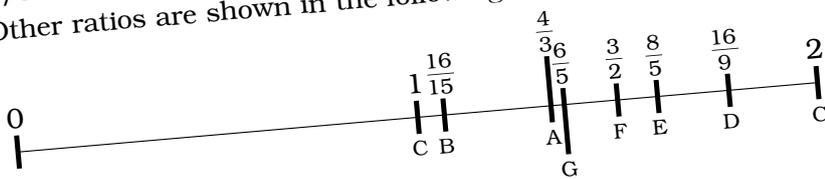
A string that is twice the length of a string that produced a C will also produce a C, but one that was an octave lower. In other words, a lower C is produced by increasing the length of the string in the ratio 2:1.

Other notes can be obtained by taking simple fractions of the string. For example:

$3/2:1 = 3:2$ produces an F

$4/3:1 = 4:3$ produces a G

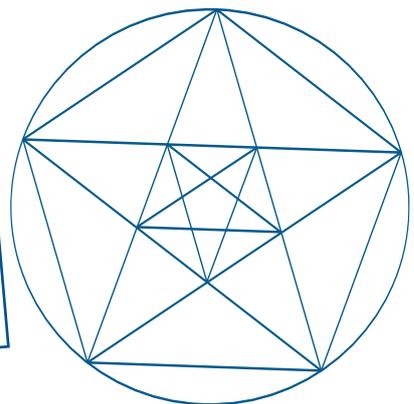
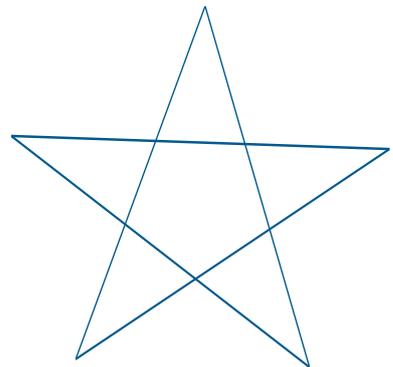
Other ratios are shown in the following diagram.



So the relationship between numbers could be used to describe musical harmonies. The tones they produce are harmonious if the lengths are in the ratio of certain whole numbers.

A mystical polygon

The pentagram or pentacle was the mystical logo of the Pythagoreans. Many centuries later it became the sign of the alchemists.



A divine error?

'Black holes are where God divided by zero.'
— Steven Wright

Mathematics and the fairer sex

Pythagoras encouraged women to learn mathematical and mystical truths. At least twenty-eight women were involved in his school either as students or as teachers. Pythagoras' wife wrote books on mathematics and she and two of their daughters ran the school after Pythagoras died. Plato, too, believed that women should have the opportunity to learn and they came to his academy in large numbers.

Several centuries later it was a woman who was regarded as the greatest mathematician of the time. Hypatia (370–415) was a much admired teacher at the University of Alexandria. A determined celibate, her beauty and talents were famous. She edited books on geometry, algebra and astronomy and students travelled thousands of kilometres to hear her lectures. Hypatia was a liberated woman but this was anathema to the creators of the new moral order in Alexandria. Her brilliant life was cut short by a murderous crowd of Christian zealots.

The 18th and 19th centuries

For a long period after Hypatia women had little access to formal education and only a few were able to leave their mark in the world of mathematics. One who did was an attractive fun-loving French aristocrat with a passion for expensive clothes. Emilie du Chatelet (1706–1749) was Voltaire's mistress and led a busy social life but she never let this interfere with her mathematical work.

Another accomplished French mathematician was the Parisienne Sophie Germain (1776–1831). She had to battle her parents to be able to learn mathematics. They believed that such study would be a dangerous strain on the mind of a young woman. Banned because of her sex from attending university, she eventually achieved success after submitting papers under a man's name.

In Italy Maria Agnesi (1718–1799), the eldest of 21 children, was encouraged to study mathematics by her wealthy mathematics professor father. Her achievements included a highly acclaimed book on algebra and calculus.

In Russia, as a young girl Sonya Kovalevskaya (1850–1891) was inspired by her father's mathematics lecture notes which had been used to wallpaper her bedroom. She was not permitted to study at a Russian university and she married so she could study abroad. Sonya later became a political activist and an enthusiastic feminist.

The 20th & 21st centuries

After women had access to a university education they still had trouble obtaining academic posts or being paid if they did secure one. And even as late as the 20th century women were still letting men take credit for their mathematical achievements.

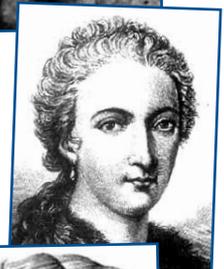
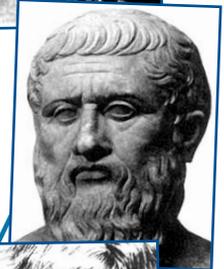
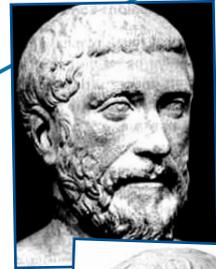
The eminent German mathematician Emmy Noether (1882–1935) became an associate professor at the University of Gottingen but received no salary for her work. In 1933 she was dismissed because she was a Jew. She went on to teach at Princeton. Here, when almost at the end of her life, she finally received a salary.

Today large numbers of women teach mathematics in universities. In many of these institutions female mathematics students outnumber the male ones.

'Sophie Germain proved to the world that even a woman can accomplish something in the most rigorous and abstract of sciences.' – *Karl Gauss*

'To understand the things at our door is the best preparation for understanding the things that lie beyond.' – *Hypatia*

'It is impossible to be a mathematician without being a poet in soul.'
– *Sophia Kovalevskaya*



Portraits in order: Pythagoras, Plato, Hypatia, Emilie du Chatelet, Sophie Germain, Maria Agnesi, Sonya Kovalevskaya, Emmy Noether.