Golden ratio

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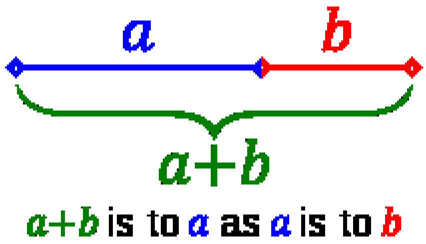


The **golden section** is a line segment divided according to the golden ratio: The total length ***a*** + ***b*** is to the length of the longer segment ***a*** as the length of ***a*** is to the length of the shorter segment ***b***.

a) Answer these questions.

1. **What does it mean when two quantities are in the golden ratio?**
2. **How many synonyms are there of the golden ratio? How would you translate it into Czech (Slovak)?**
3. **How do you distinguish (in notation) the golden ratio and its reciprocal?**
4. **Why was the golden ratio interesting for architects?**
5. **Why were mathematicians interested in it?**

In mathematics and the arts, two quantities are in the **golden ratio** if the ratio of the sum of the quantities to the larger quantity is equal to the ratio of the larger quantity to the smaller one. The golden ratio is an irrational mathematical constant, approximately 1.6180339887. Other names frequently used for the golden ratio are the **golden section** (Latin: *sectio aurea*) and **golden mean**. Other terms encountered include **extreme and mean ratio**, **medial section**, **divine proportion**, **divine section** (Latin: *sectio divina*), **golden proportion**, **golden cut**, **golden number**, and **mean of Phidias**. In this article the golden ratio is denoted by the Greek lowercase letter phi (φ) , while its reciprocal, $1/\varphi$or φ^{-1}, is denoted by the uppercase variant Phi (Φ).

The figure on the right illustrates the geometric relationship that defines this constant. Expressed algebraically:

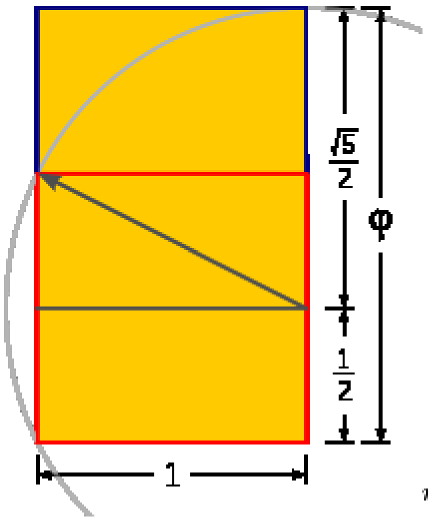
$$\frac{a+b}{a} = \frac{a}{b} \equiv \varphi\,.$$

This equation has one positive solution in the set of algebraic irrational numbers:

$$\varphi = \frac{1+\sqrt{5}}{2} = 1.61803\,39887\ldots$$

At least since the Renaissance, many artists and architects have proportioned their works to approximate the golden ratio—especially in the form of the golden rectangle, in which the ratio of the longer side to the shorter is the golden ratio—believing this proportion to be aesthetically pleasing. Mathematicians have studied the golden ratio because of its unique and interesting properties.

b) Study the drawing of the golden rectangle and try to write instructions for its construction.

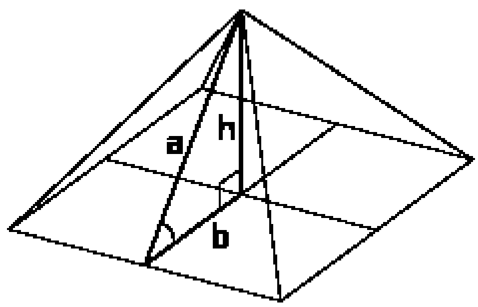


$$\lim_{n\to\infty} \frac{F(n+1)}{F(n)} = \varphi.$$

Construction of a golden rectangle:
1. ……………………………………………………………………………………………………
2. ……………………………………………………………………………………………………
3. …………………………………………………………………………………………………….

c) Pyramids

Study the picture and describe it, using these words: triangle, proportions, golden ratio, edges, height, semi-base, apothem, isosceles, and regular.



d) Mathematical pyramids and triangles. Read the text and try to supply the missing prepositions.

A pyramid 1…. which the apothem (slant height along the bisector of a face) is equal 2…. φ times the semi-base (half the base width) is sometimes called a *golden pyramid*. The isosceles triangle that is the face of such a pyramid can be constructed 3……… the two halves of a diagonally split golden rectangle (of size semi-base by apothem), joining the medium-length edges to make the apothem. The height of this pyramid is $\sqrt{\varphi}$ times the semi-base (that is, the slope of the face is $\sqrt{\varphi}$); the square of the height is equal to the area 4…….. a face, φ times the square of the semi-base.

The medial right triangle of this "golden" pyramid , with sides $1 : \sqrt{\varphi} : \varphi$ is interesting 5……. its own right, demonstrating via the Pythagorean theorem the relationship $\sqrt{\varphi} = \sqrt{\varphi^2 - 1}$ or $\varphi = \sqrt{1 + \varphi}$. This "Kepler triangle" is the only right triangle proportion 6………. edge lengths in geometric progression, just as the 3–4–5 triangle is the only right triangle proportion with edge lengths 7………… arithmetic progression. The angle with tangent $\sqrt{\varphi}$ corresponds 8………. the angle that the side of the pyramid makes 9……… respect to the ground, 51.827… degrees (51° 49' 38").

A nearly similar pyramid shape, but with rational proportions, is described in the Rhind Mathematical Papyrus (the source of a large part of modern knowledge of ancient Egyptian mathematics), based 10…….. the 3:4:5 triangle; the face slope corresponding to the angle with tangent 4/3 is 53.13 degrees (53 degrees and 8 minutes). The slant height or apothem is 5/3 or 1.666… times the semi-base. Egyptian mathematics did not include the notion of irrational numbers, and the rational inverse slope (run/rise, multiplied by a factor of 7 to convert to their conventional units of palms per cubit) was used 11……… the building of pyramids.

Another mathematical pyramid with proportions almost identical 12…….. the "golden" one is the one with perimeter equal to 2π times the height, or h:b = 4:π. This triangle has a face angle of 51.854° (51°51'), very close to the 51.827° of the Kepler triangle. This pyramid relationship corresponds to the coincidental relationship $\sqrt{\varphi} \approx 4/\pi$.

e) Word study: **When do we say "gold"?** (© Robert E. Jones, 2004)

Generally, we use *gold* before a noun when we are talking about something that is made from the metal we call gold (chemical symbol - Au). For example, we can use it when we talk about **gold jewellery**: an Olympic gold medal, a gold necklace, a gold ring. We also use *gold* in these expressions: a gold card: a very special type of credit card, which buys more goods and services than a normal credit card; a gold mine: a place where you can dig gold from under the ground; a goldsmith: a person who makes things from gold.

When do we say "golden"?

<u>MEANING ONE: the colour of gold</u>. She has beautiful long golden hair.
<u>MEANING TWO: (something) very special.</u>
The Golden Age: the most important time in the history of a country or cultural movement (e.g. The 1950s and 60s were the golden age of rock and roll); golden handshake: a large sum of money which is given to someone when they leave their job; golden boy / girl: a person who has been very successful at something and become very popular (e.g. It seems that Wayne Rooney might replace David Beckham as the new golden boy of British soccer).

Use some of the above golden + noun expressions to fill in the blanks below:

1. You've been offered a job by the BBC! Well, don't turn it down. It's a _______.
2. My parents have been married for 49 years, so next year will be their _______.
3. Ai Fukuhara could be called the ________ of Japanese table tennis.
4. My uncle had to retire early through ill health. His company gave him a ________ of £100,000.
5. The Momoyama period (1576-1600) was when a lot of Japanese arts such as noh drama, kabuki and the tea ceremony were developed. Some people call it Japan's _________.
6. Constant practice is one of the ________ of language learning.

Golden ratio – listening

http://www.youtube.com/watch?v=085KSyQVb-U

Pre-listening

a) Where can you find the golden ratio?

b) What is an angstrom?

Listening – fill in the missing information

1. The golden ratio can be found in ....
2. Each number in the Fibonacci sequence is ………… ……….............................
3. When you divide one number in the F.S. by the number before it, you obtain ....
4. Da Vinci and Le Corbusier used the golden ratio ....
5. t/s ratio is always ....to the golden ratio.
6. The golden ratio applies to an .... human body.
7. List some examples of the golden ratio in human body.
   a) ....
   b) ....
   c) ....
   d) ....
   e) ....

   List some examples of the golden ratio on human face.
   a) ....
   b) ....
   c) ....

8. The study of American physicists revealed the golden ratio in ....
9. The cochlea serves to ....
10. DNA consists of two intertwined ....