

## 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

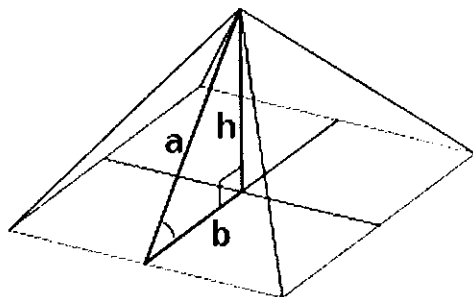
1. The golden ratio can be found in .....
2. Each number in the Fibonacci sequence is .....
3. When you divide one number in the F.S. by the number before it, you obtain  
.....
4. Da Vinci and Le Corbusier used the golden ratio .....
5.  $t/s$  ratio is always .....to the golden ratio.
6. The golden 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 .....

## e) Pyramids

Study the picture and description of this pyramid and state its properties, i.e. edges, vertices, proportions.



A regular square pyramid is determined by its medial right triangle, whose edges are the pyramid's apothem (a), semi-base (b), and height (h); the face inclination angle is also marked. Mathematical proportions b:h:a of  $1 : \sqrt{\varphi} : \varphi$  and  $3 : 4 : 5$  and  $1 : 4/\pi : 1.61899$  are of particular interest in relation to Egyptian pyramids.

## f) 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....  $\varphi$  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,  $\varphi$  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 to the "golden" one is the one with perimeter equal to  $2\pi$  times the height, or  $h:b = 4:\pi$ . This triangle has a face angle of  $51.854^\circ$  ( $51^\circ 51'$ ), very close to the  $51.827^\circ$  of the Kepler triangle. This pyramid relationship corresponds to the coincidental relationship  $\sqrt{\varphi} \approx 4/\pi$ .

Egyptian pyramids very close in proportion to these mathematical pyramids are known.

**g) Answer Qs about the text f.**

- 1. Which pyramid can be called golden?**
- 2. What is special about the "Kepler triangle"?**
- 3. What is the Rhind Mathematical Papyrus?**
- 4. Which measure was used in the construction of pyramids?**
- 5. Is there any mathematical pyramid identical to the "golden" pyramid?**

**h) 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.
- a gold rush: when gold is discovered in a certain place and thousands of people rush there, hoping to get rich (e.g. the California Gold Rush of 1849).

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## When do we say "golden"?

*Golden* has two basic meanings.

MEANING ONE: the colour of gold.

- She has beautiful long golden hair.
- My uncle's dog is a golden retriever.
- There are miles of golden beaches along this coast.

MEANING TWO: (something) very special.

Golden can collocate with certain nouns to mean something very special.

Typical examples include:

- 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).
- The Golden Rule: this is the basic rule of many religions. It is the rule that says "you should treat other people in the same way you would want them to treat you."
- the golden rule of... : this refers to important principles which you should follow if you want to be successful in something (e.g. Alexander Graham Bell's golden rule of learning was "observe, compare and remember").
- golden opportunity: a very special and rare chance to do something wonderful.
- golden wedding: a couple's 50th wedding anniversary.
- golden jubilee: the 50th anniversary of a special event.
- 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).
- golden oldie: a movie or a song which is quite old but still popular (e.g. *White Christmas*).

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## Exercise

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.