

# History & Philosophy of Science (Erasmus L2)

# Egyptian arithmetic

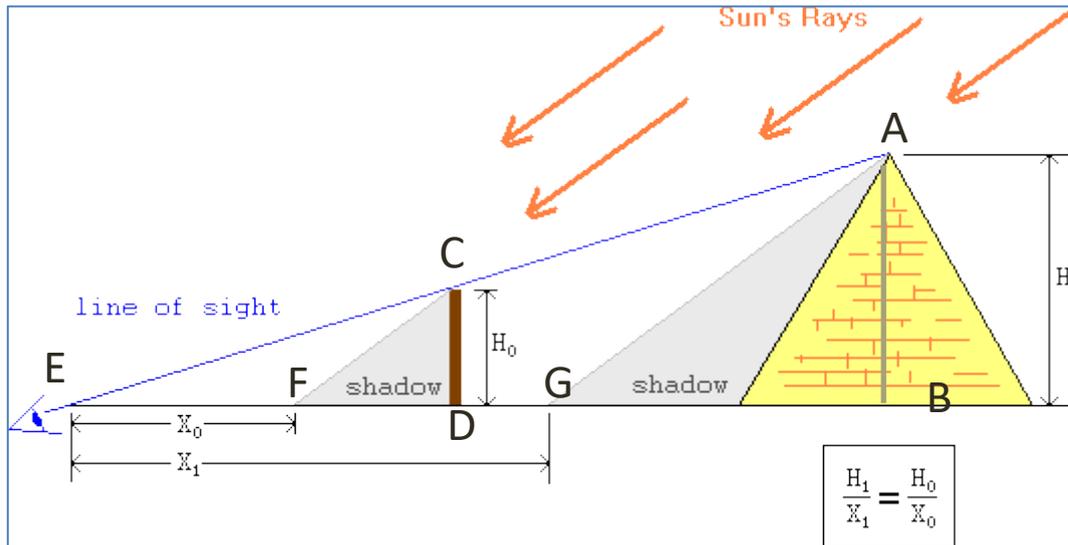
- Multiplication
  - $M = 13 * 25$
  - 1 25
  - 2 50
  - 4 100
  - 8 200
  - $13 = 1 + 4 + 8$
  - $M = 25 + 100 + 200 = 325$

# Egyptian arithmetic (cont.)

- Division
  - $D = 30 / 5$
  - 1 5
  - 2 10
  - 4 20
  - $30 = 20 + 10$
  - $D = 4 + 2 = 6$

# Presocratics

- On the nature of things (suggesting which is the first principle of the world)
  - Thales of Miletus (-624 to -546) : water
  - Anaximander of Miletus (-610 to -546) : infinite
  - Anaximenes of Miletus (-585 to -528) : air
  - Heraclitus of Ephesus (-535 to -475) : fire
  - Parmenides of Elea in Magna Graecia (b.-515) : what is the *being* (a still sphere)
  - Empedocles of Akragas, Sicily (-495 to -444) : earth, water, air, fire
  - Leucippus of Miletus (d.-370) and Democritus of Abdera (-460 to -370) : atoms



## Calculation of the height of the Pyramid by Thales of Miletus

$$AB/CD = BE/DE \quad (1) \quad AB/CD = BG/DF \quad (2)$$

$$(1) \ \& \ (2) \ BE/DE = BG/DF \rightarrow BE/BG = DE/DF \rightarrow BE/BE - BG = DE/DE - DF \rightarrow$$

$$BE/GE = DE/FE \rightarrow BE/DE = GE/FE \rightarrow AB/CD = GE/FE \rightarrow$$

$$H_1/H_0 = X_1/X_0$$

# Euclid's Elements

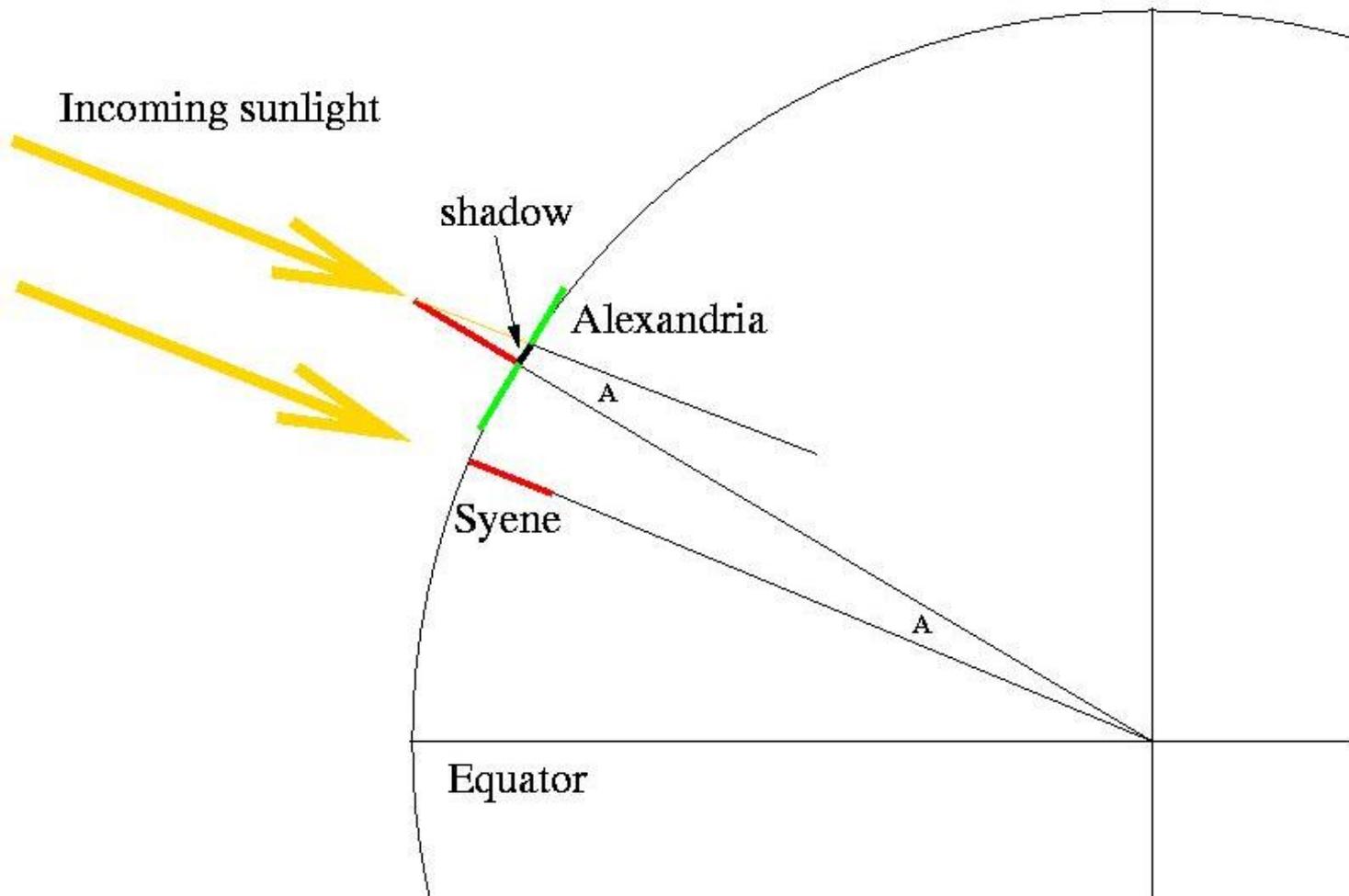
- Euclid (around 300 BC) Greek mathematician, often referred to as the "founder of geometry"
- His *Elements* (13 books) is one of the most influential works in the history of mathematics, serving as the main textbook for teaching mathematics (especially geometry) from the time of its publication until the late 19th or early 20th century.
- There is no mention of Euclid in the earliest remaining copies of the *Elements*. Most of them say they are "from the edition of Theon" or the "lectures of Theon", while the text held by the Vatican, mentions no author. The only reference for Euclid as author of *Elements* was from Proclus, in his *Commentary on the Elements*.

# Euclid's Elements (cont.)

- *Elements* is a collection of definitions, postulates, propositions (theorems and constructions), and mathematical proofs of the propositions.
- The books cover plane and solid Euclidean geometry, elementary number theory, and incommensurable lines.
- *Elements* is the oldest extant deductive treatment of mathematics. It was the main model for the development of Logic and modern science in the 19th century.

# Hellenistic math, engineering & astronomy

- Eratosthenes of Cyrene (-276 to -194) : estimation of the circumference of the Earth
- Archimedes of Syracuse (-287 to -212) : mathematician, engineer, physician, astronomer
  - Archimede's principle for buoyancy (equal to the weight of the fluid it displaces) in his work 'On Floating Bodies'
  - Law of the Lever in his work 'On Equilibrium'
  - (O)stomachion : a dissection puzzle similar to a Tangram
  - The Sand Reckoner : counting the number of grains of sand that will fit inside the universe
  - The Method of Mechanical Theorems (found in Palimpsest): how breaking up a figure into an infinite number of infinitely small parts (infinitesimals) can be used to determine its area or volume.



Estimation of the circumference of the Earth by Eratosthenes

angle/distance = 360/circumference

7.2 degrees / 5000 stadia = 360 degrees / C

→ C = 250000 stadia

→ 1 stadium = 157.7 m → C = 39425 km

→ Real circumference = 40000 km

# Verification of the material of the crown by Archimedes

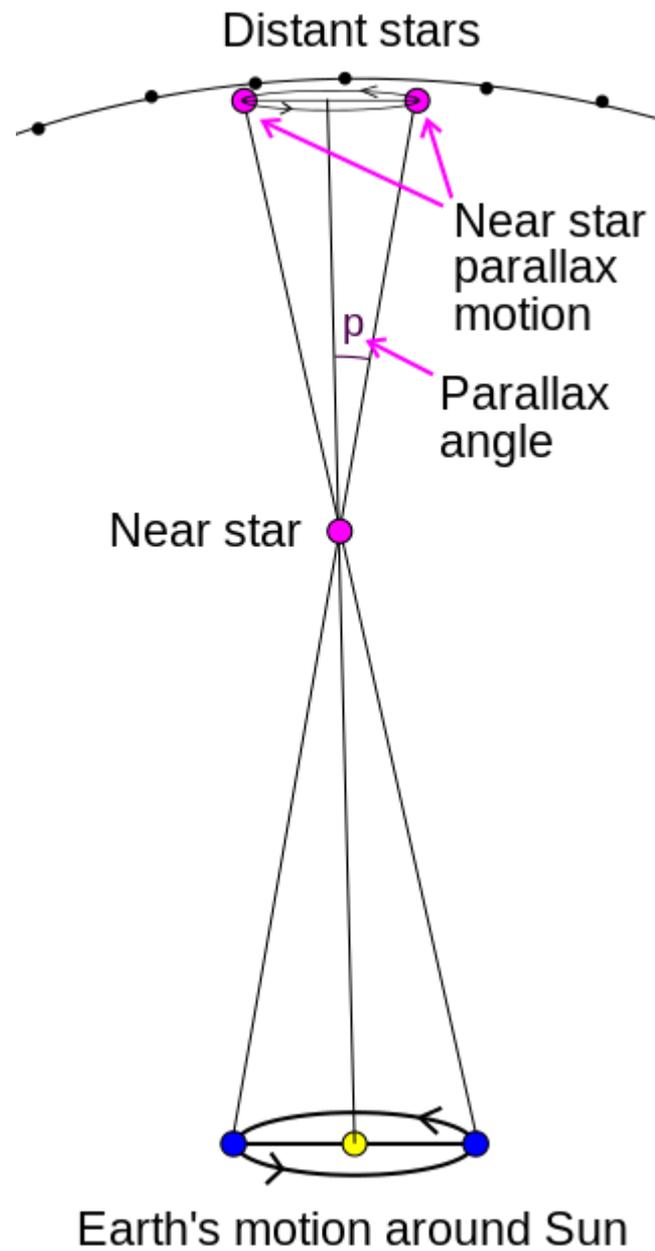
- Out of the water:  $W_{cr} = W_g$ , where  $W_{cr}$  is the weight of the crown and  $W_g$  the equal weight of the golden body
- Within the water:  $W_g - B_g > W_{cr} - B_{cr} \rightarrow B_{cr} > B_g$ , where  $B$  is the buoyant force
- Consequently:  $W_{wat.cr} > W_{wat.g}$ , where  $W_{wat.cr}$  is the weight of the displaced water by the crown and  $W_{wat.g}$  the weight of the displaced water by the golden body ( $W=d.V$ )
- Consequently:  $V_{cr} > V_g$ , where  $V_{cr}$  is the volume of the crown and  $V_g$  the volume of the golden body
- Consequently:  $d_g > d_{cr}$ , where  $d_{cr}$  is the density of the material of the crown and  $d_g$  the density of gold
- **CONCLUSION:** some gold had been substituted for silver by the dishonest goldsmith given to Hiero II of Syracuse

# About the rotation and the revolution of the Earth

- Pythagoreans (Philolaus) supported that the center of the Universe is a fire around which all the planets are revolved
- Heraclidis Ponticus is the first who proposed the rotation of the Earth from west to east, every 24 hours. He is also considered by some as the originator of the heliocentric theory, although this is doubted by the most.
- Aristarchus is the first astronomer who proposed the heliocentric system. The original text has been lost, but a reference in Archimedes's book *The Sand Reckoner*, describes a work by Aristarchus in which he presented the heliocentric model as an alternative hypothesis to the geocentric.

# About the rotation and the revolution of the Earth (cont.)

- Aristarchus suspected the stars are other suns very far away, and that was the reason that there was no observable parallax, that is, a movement of the stars relative to each other as the Earth moves around the Sun.
- Since no stellar parallax was observed, Plato, Aristotle, and Ptolemy preferred the geocentric model, which was held as true throughout the Middle Ages.



# Diophantus, the father of algebra

- Diophantus (201/215 to 285/299) was a Hellenistic Greek mathematician who lived in Alexandria during the 3rd Century CE. He is sometimes called ‘the father of algebra’, and wrote an influential series of books called ‘Arithmetica’, a collection of algebraic problems which greatly influenced the subsequent development of number theory.
- He also proposed mathematical notation (symbolism into algebra), using an abridged notation for frequently occurring operations, and an abbreviation for the unknown and for the powers of the unknown.
- *Arithmetica* was originally written in 13 books, but the Greek manuscripts that survived to the present contain only the 6 books. In 1968, Fuat Sezgin found 4 previously unknown books of *Arithmetica* at the shrine of Imam Rezā in Mashhad in northeastern Iran, translated from Greek to Arabic by Qusta ibn Luqa (820–912)

# Diophantus, the father of algebra (cont.)

- Diophantus' epitaph:
- “Here lies Diophantus.
- God gave him his boyhood one-sixth of his life;
- One twelfth more as youth while whiskers grew rife;
- One-seventh more and then marriage began.
- In five years there came a bouncing new son;
- Alas, the dear child of master and sage, after attaining half the measure of his father's life, chill fate took him.
- After consoling his fate by the science of numbers for four years, he ended his life.”

# Hypatia (350/370 – 415 AD)

- The last great Greek mathematician, astronomer and philosopher in Hellenistic Alexandria, daughter of mathematician Theon.
- Commentary on Apollonius of Perga's work on *conic sections*, Commentary on Diophantus' *Arithmetica*, *Astronomical Canon* a commentary on Ptolemy's *Almagest*
- Constructor of astrolabes.
- Platonic School with a lot of students, Synesius, a Greek bishop of Ptolemais in ancient Libya, was one of her most famous students: Astrolabe and hymns to the ancient gods
- Conflict of Hypatia with Cyril, bishop of Alexandria
- Her tragic end of life (cut into pieces by the fanatic Christian monks and scattered to Nile) → the end of the ancient world

## Exercise 2. Part a. A presentation about a scientist in ancient Greece.

- Thales (Loran) / Pythagoras (Luciana) / Archimedes (Bianca) / Apollonius of Perga (Apolonia) / Eratosthenes (Nicolo) / Hipparchus (Cecilia) / Aristarchus (Leva) / Hero or Heron of Alexandria (Gabija) / Claudius Ptolemy (Paula) / Diophantus (Maxime) / Pappus of Alexandria (Sarah) / Hypatia (Antonina)

## Exercise 2. Part b.

### Egyptian multiplication - division

- Find the multiplication
- $1x * 15$  ( $x=2$  for Loran, 3 for Luciana, 4 for Bianca, 5 for Antonina, 7 for Apolonia, 8 for Nicolo, 9 for Cecilia)
- $2x * 15$  ( $x=0$  for Leva, 1 for Gabija, 2 for Paula, 3 for Maxime, 4 for Sarah)
- Find the division
- $x0 / 5$  ( $x=5$  for Loran, 6 for Luciana, 7 for Bianca, 9 for Antonina),
- $1x0 / 5$  (0 for Apolonia, 1 for Nicolo, 2 for Cecilia, 3 for Leva, 4 for Gabija, 5 for Paula, 7 for Maxime, 8 for Sarah)