Progress of History and Technology

CH 3: Technology Applications in Ancient Countries (~ Ruin of Rome)

Emergence of Ancient Countries and Fight for Superiority

War and Trade

BC 1800

BC1720 Hyksos

For 150 years, ruled Egypt

Battle of Kadesh

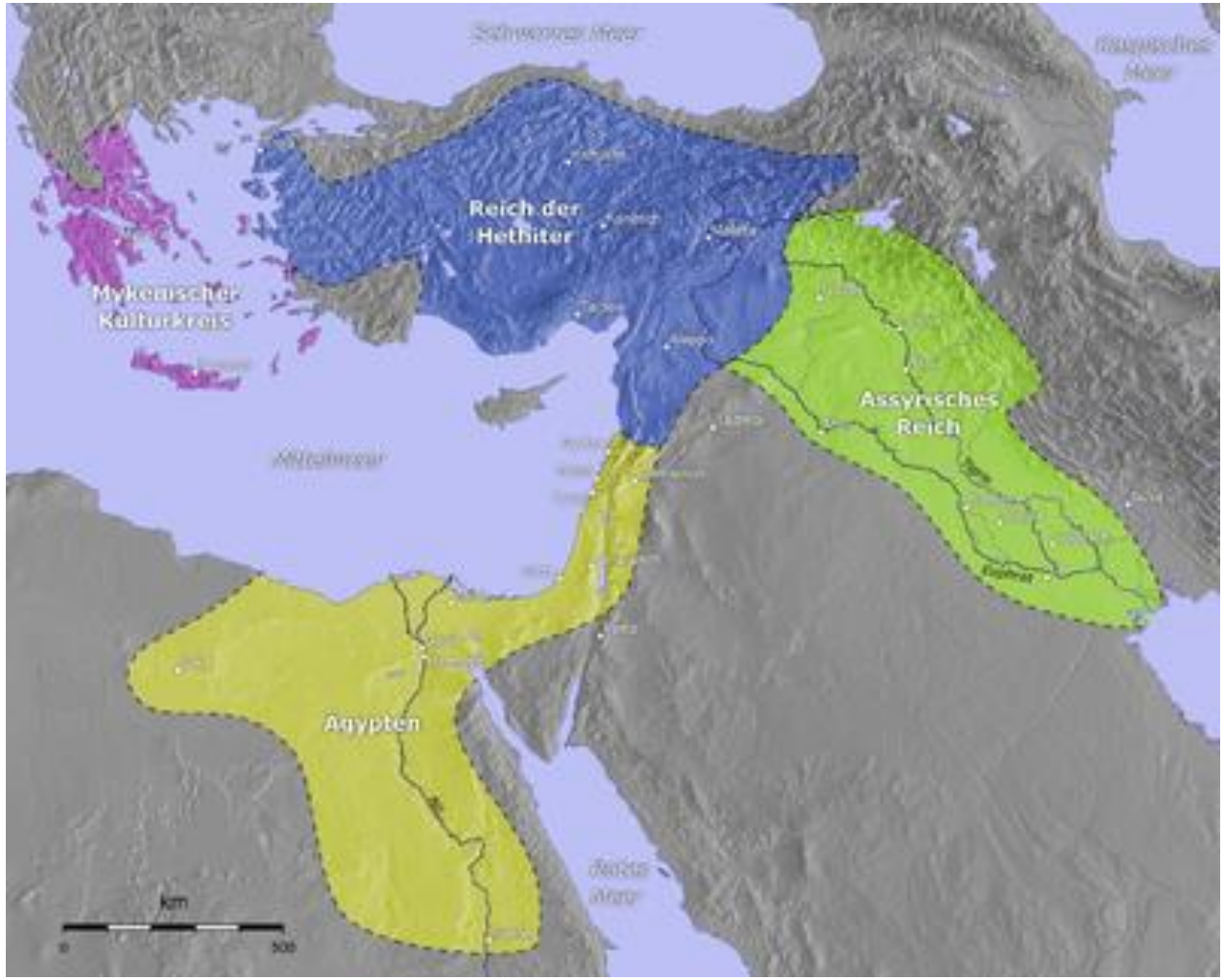
Ramses II vs Muwatallis

BC1200 Assyria took Mesopotamia

BC1180 Hittite extinction

Big fire or Invasion of Sea Tribes

BC 1100



War and Trade

BC 1000

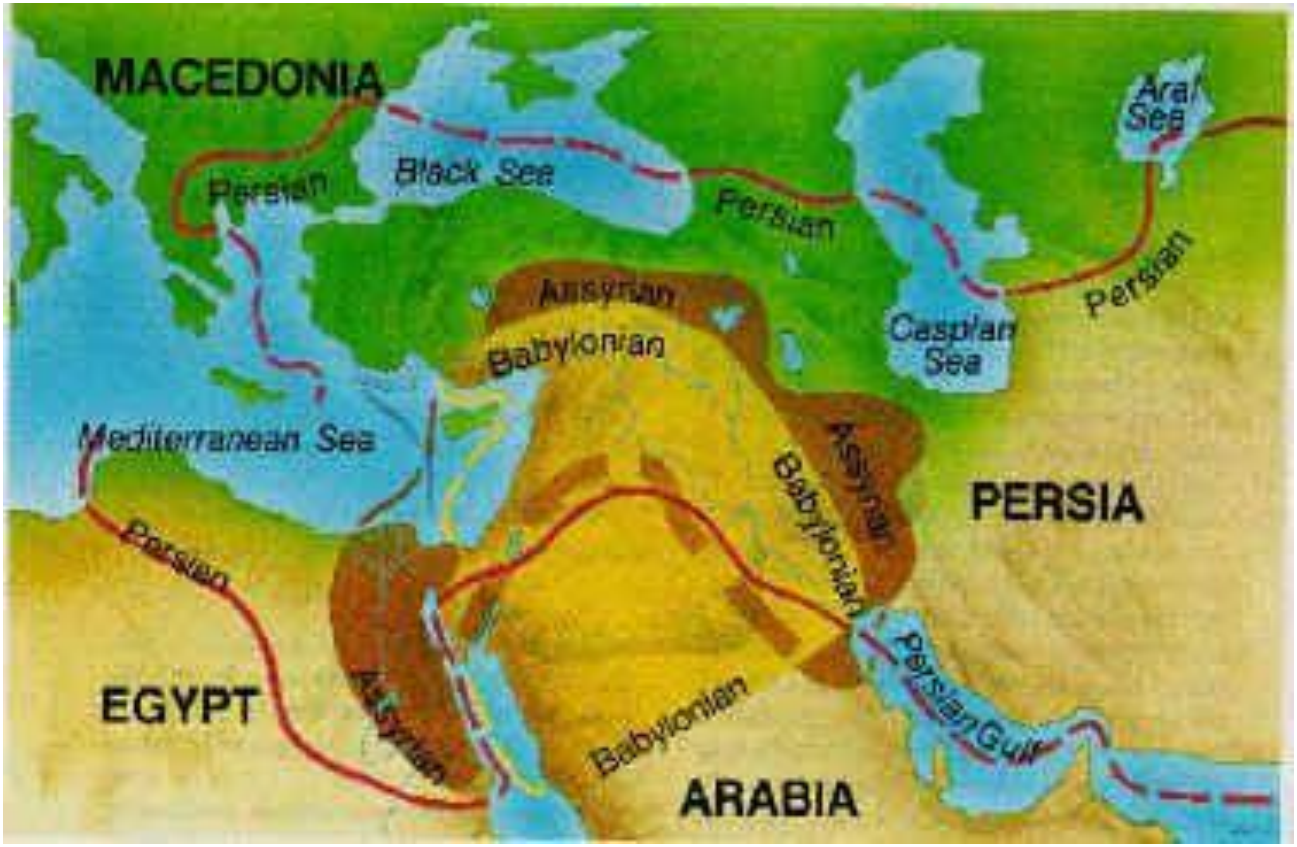
Assyria Dominance

From BC960, dominated the area and occupied Egypt in BC671

BC550 Persia

Civilization unification for 220 years and fought for the Aegean Sea against Greece

BC 500

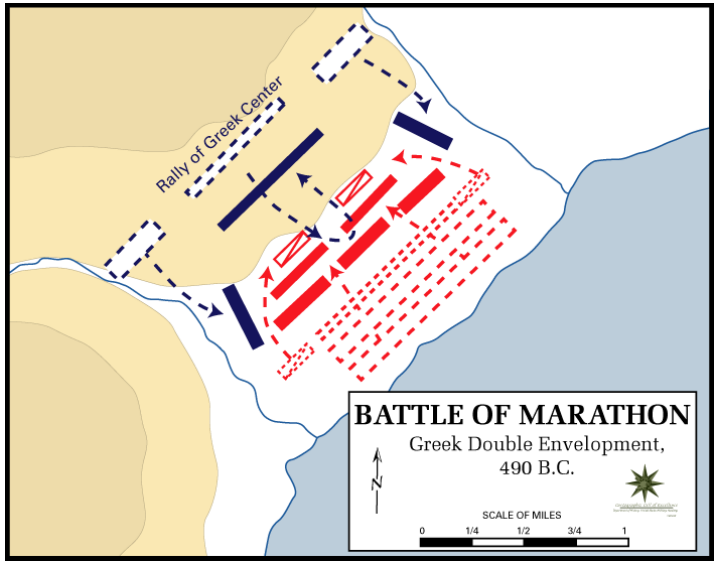


War and Trade

BC 500

BC490 Battle of Marathon

Athene helped Revolt of
Ionia and Persia attacked
Athene in revenge

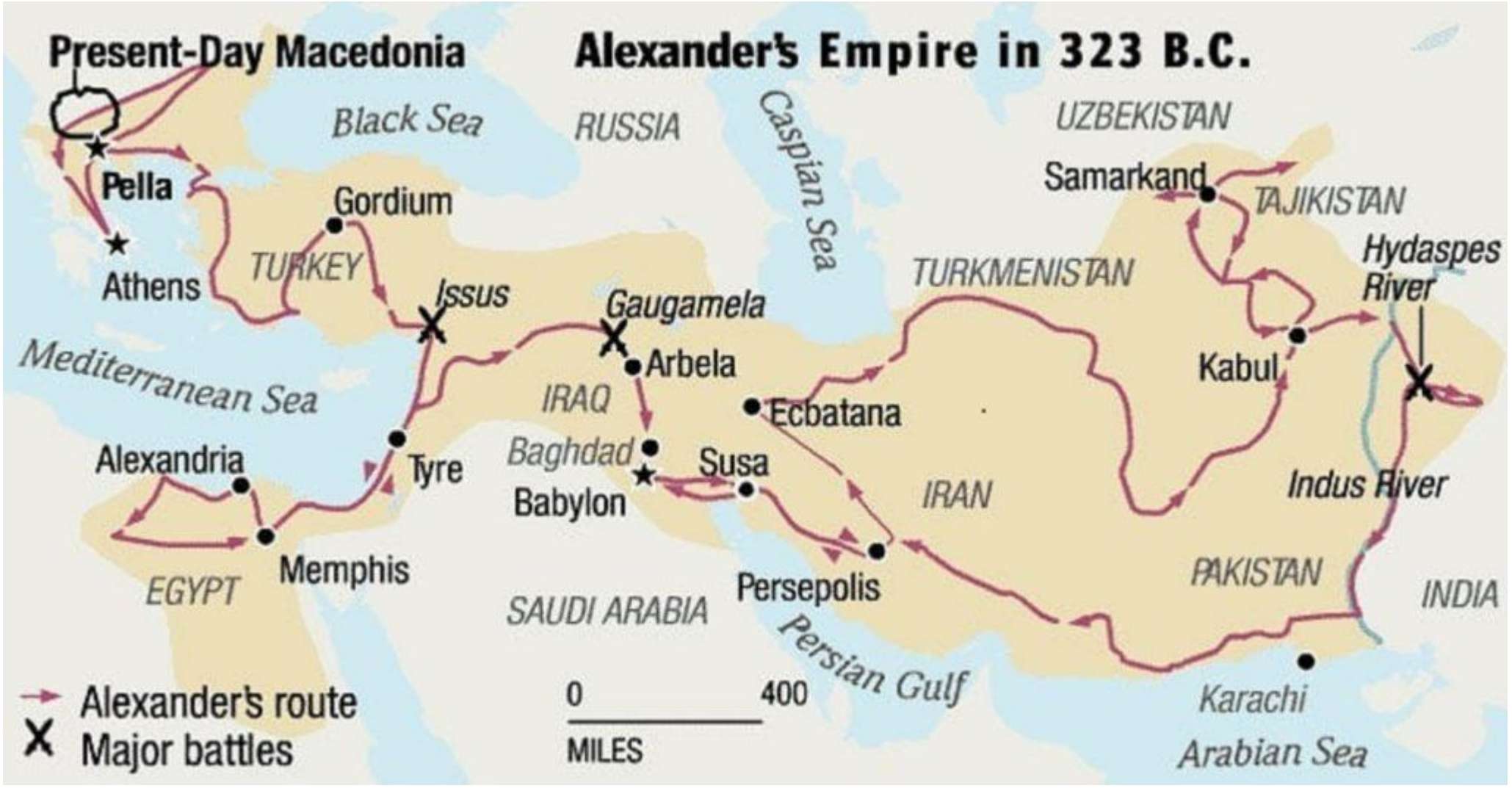


BC431 Peloponnesian War

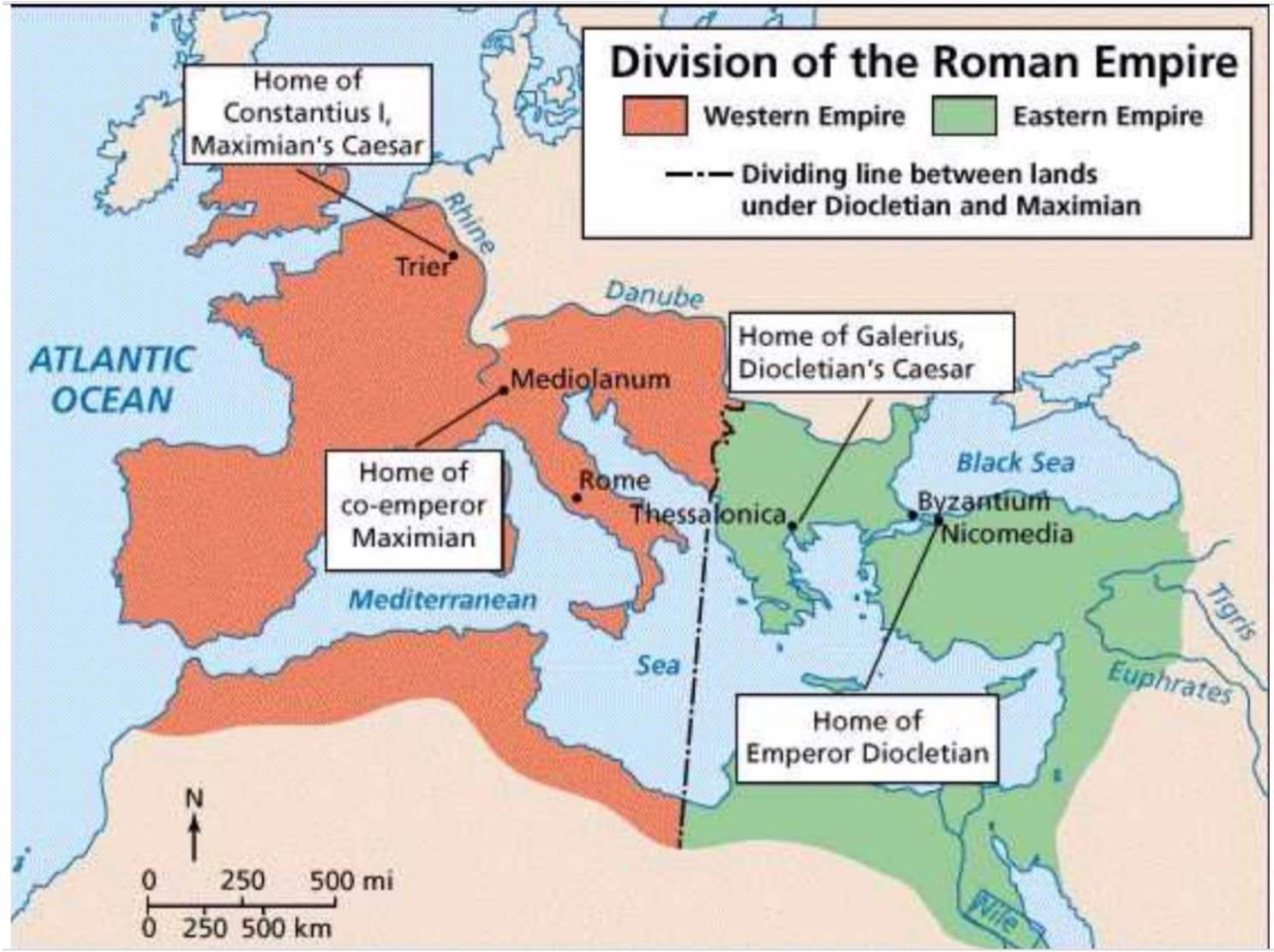
Delian League
VS
Peloponnesian League

BC 400

War and Trade

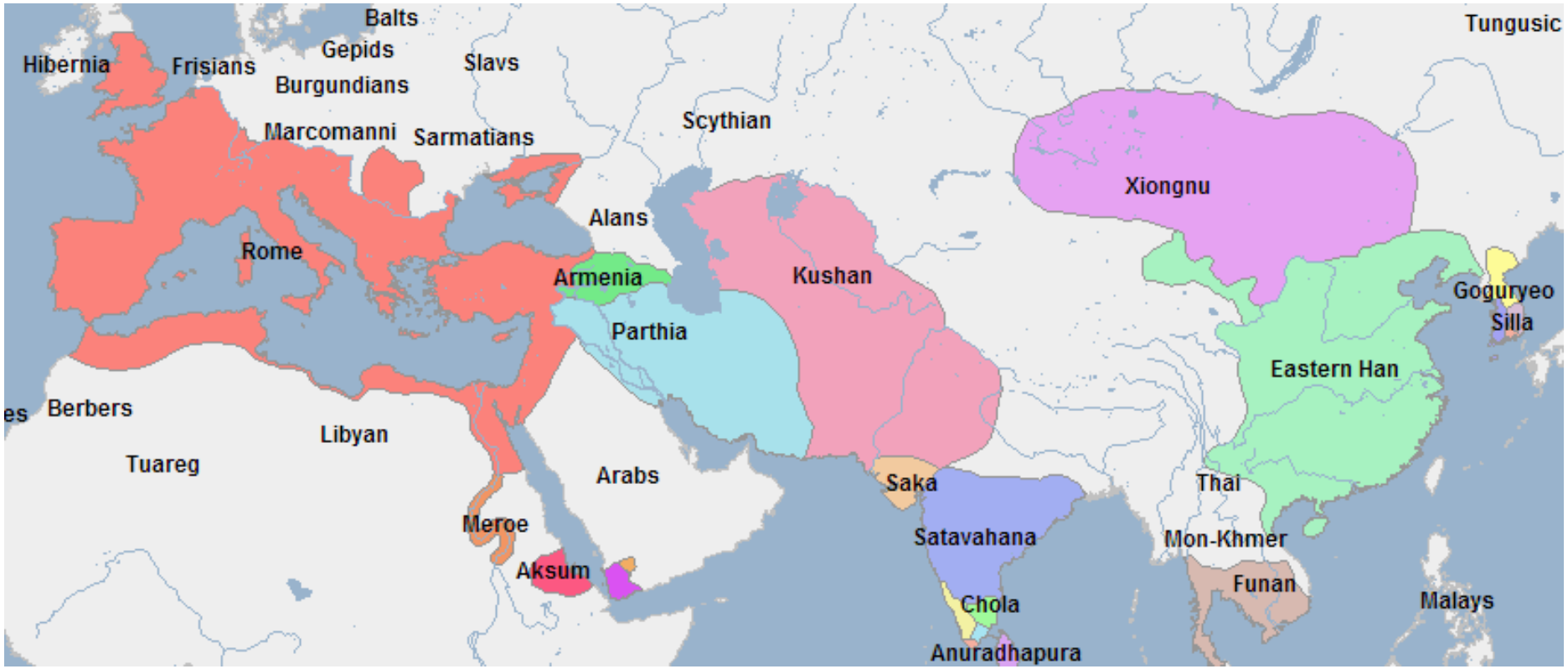


War and Trade



War and Trade

War and Trade



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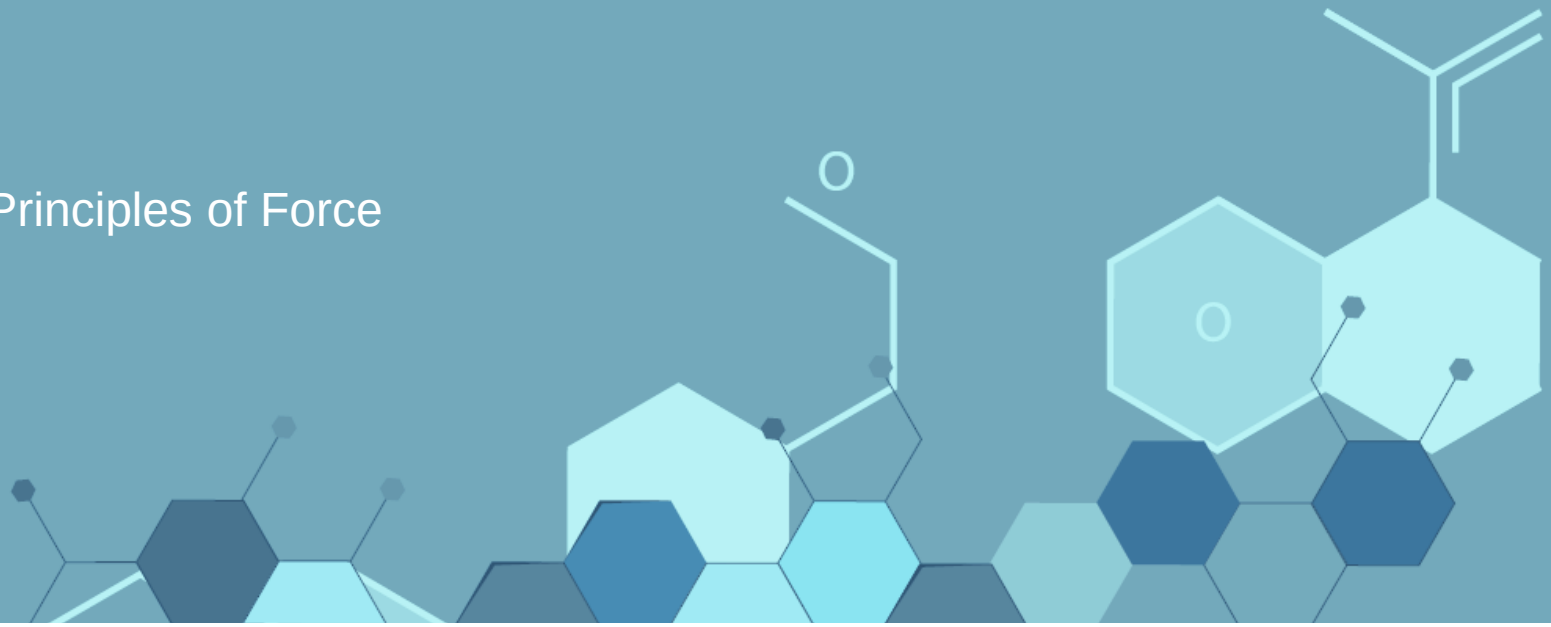
1 Representative Scientific Technologies

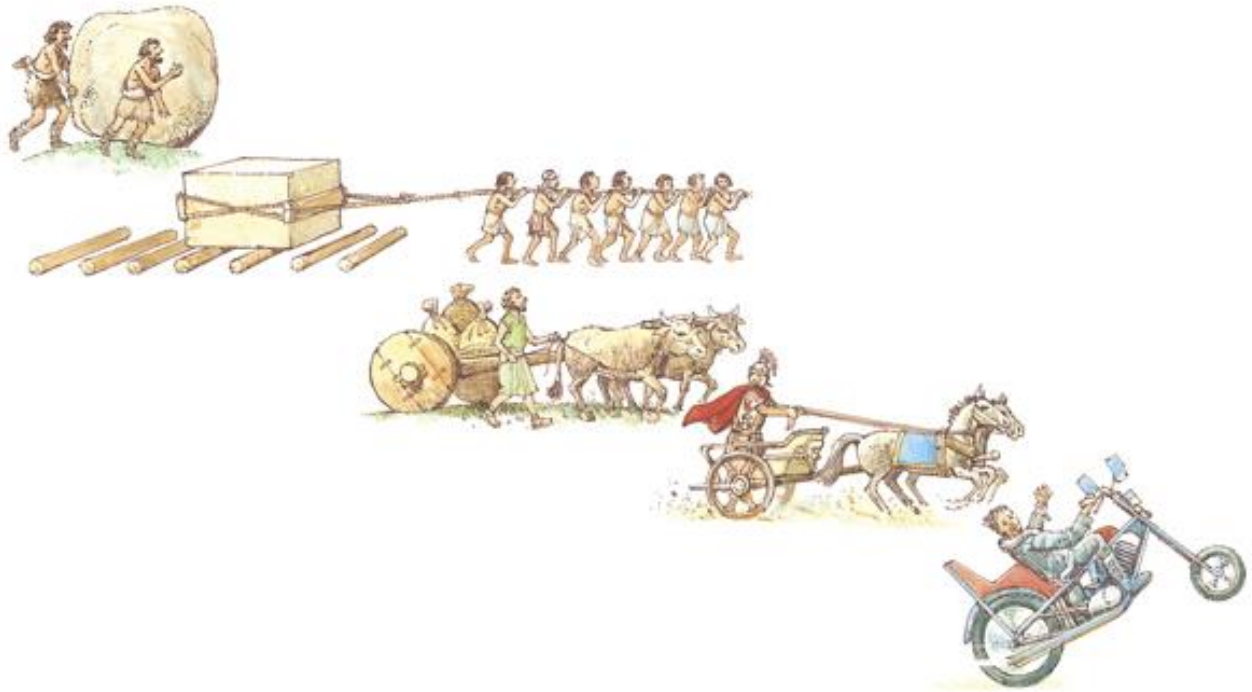
- Wheel
- Technologies using Principles of Force
- Metallurgy
- Weapons



Wheels

Wheel Applications

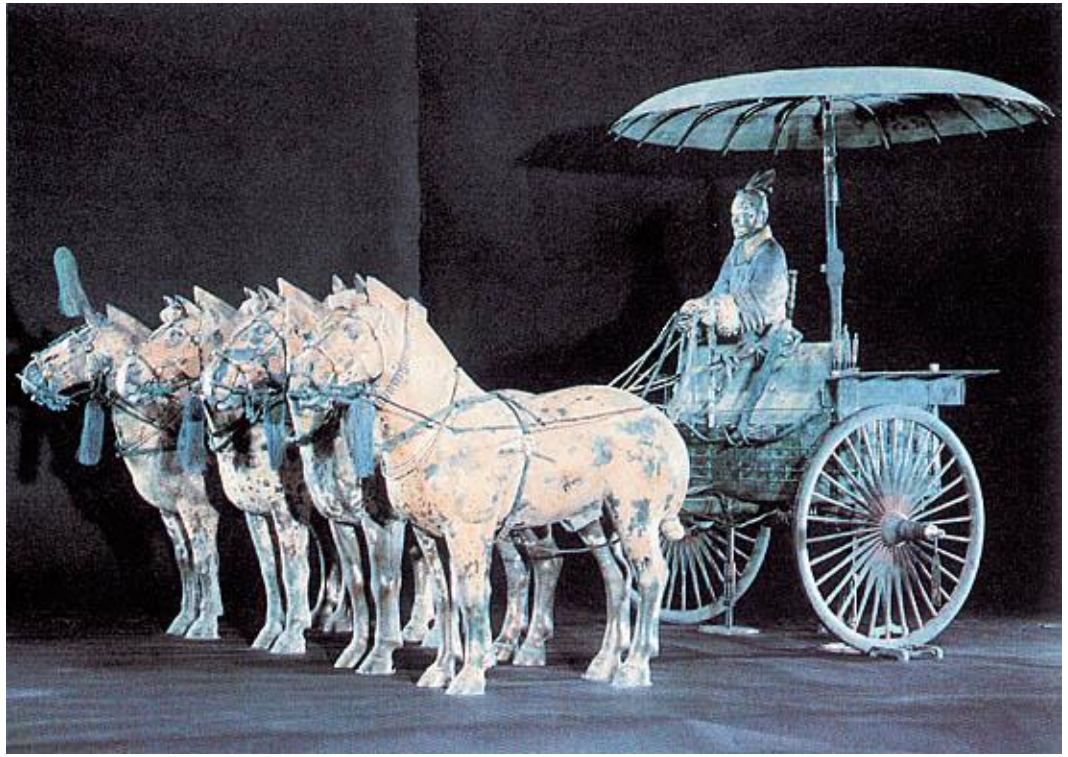
- Use of round axle under the object to move
- To reduce friction, use sledge
- Locating sledge over round axle, wheel was designed to make wagon
- From BC30C~25C, almost all ancient countries starting from Sumerian used wagons that cow or horse draw
- Innovative advance in convenience when moving heavy matters or transferring old and young people
- Successful results in construction and combats



Wheels

Combat Carrier

- In present day, corresponds to armored unit, tank
- Around BC2000, Aryans made a carrier drawn by more than2 horses
- In BC1674, Hyksos invaded Egyptians (who saw the carrier at the first time) ahead the combat carriers and ruled for 107 years
- In ancient China, appeared combat carrier that 4 horses draw



Wheels

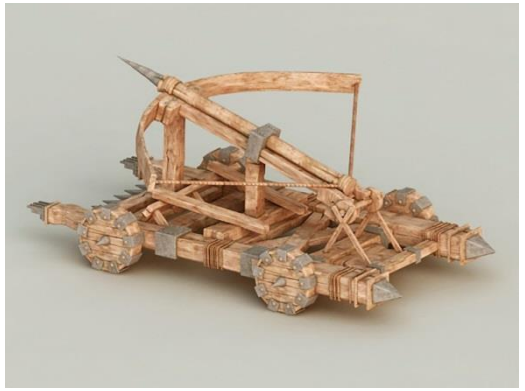
Horseback Riding Techniques

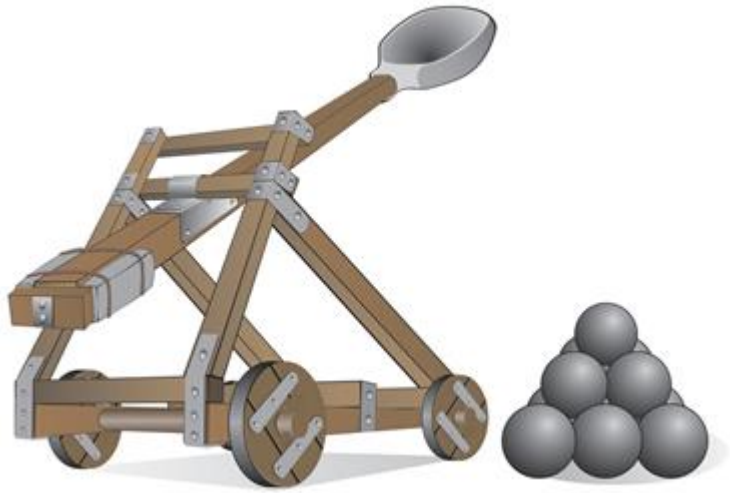
- About BC800, Assyrian improved the bleed of horses so that a man could ride on the horse back
- Cavalrymen expert on horseback riding with long spear were highly valuated more than combat carrier, in about BC330
- In BC330, Alexander developed the tactics that made the carriers useless and thus the combat carriers disappeared in history

Technologies using Principles of Force

Principles of Force

- Bow: Muscle power bowstring changes to potential energy which changes to kinetic energy multiplied by the elasticity of a string when it is released.
  - Length, quality of the material decide the elasticity
- Crossbow: Thick steel arrow cab be shoot, resulting in powerful penetrating power and long distance (made in Qin dynasty)
  - Easy to use, no practice needed
  - About AD200, multiple shots crossbow were invented (1 arrow per sec)
- Ballista: Long and thick iron spear can be shot, a sort of huge cross bow
- Catapult with 6-10 meters height can shoot a stone weighting several tens kg with more than 200km speed

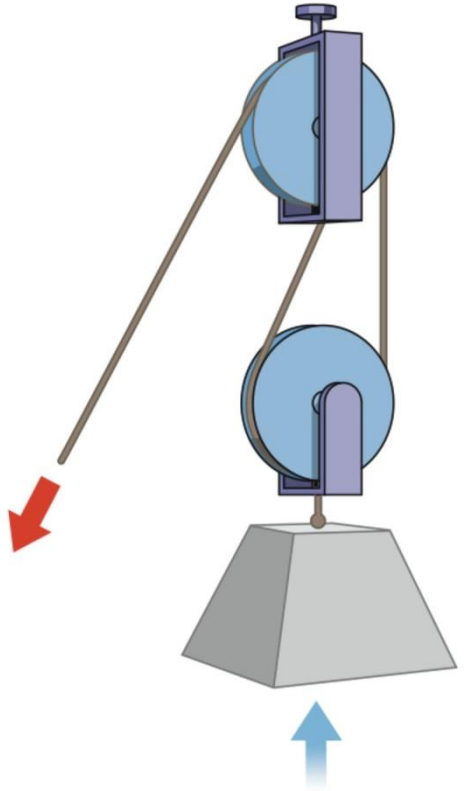


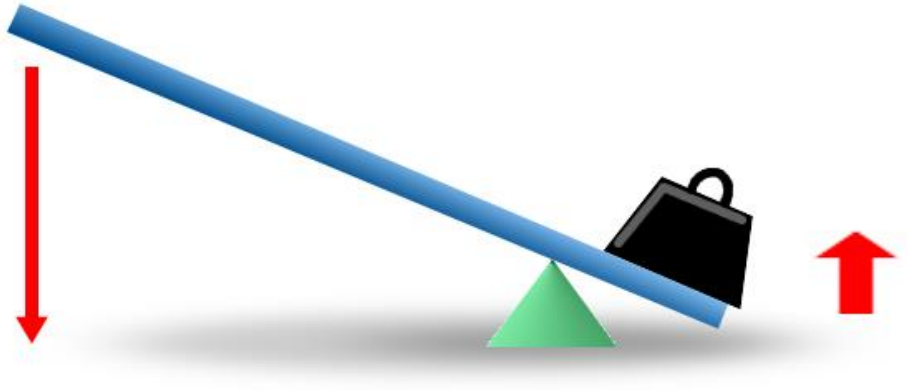


Technologies using Principles of Force

Pulley & Screw

- Around BC260, Archimedes invented
  - a device called pulley lifting an abject with inversely proportional to the number
  - the principle of lever
- Screw is a device changing rotary motion of a large radius cylinder is changed recti-lineal motion





Metallurgy

Smelting Technique

- From BC5~6000, copper was discovered and metal application started
- Bronze was made of mixing soft copper and softer tin with 10:1 ration to produce
  - Weapons such as axe, shield, dagger, armet, wainage, and Farming utensils
  - Household items such as grain bowl, crockery, plate, glass, pot, and Decorations such as mirror, ornament
  - Handwork and related technologies developed
- Iron discovered in BC3000 could not be used until the technique to make high temperature was invented in BC1200
  - Carbon mixing rate determines hardness
  - In China around BC400, the furnace technique of making high temperature up to 1400^{o}C was invented by using bellow and Kaoline soil
  - Applications of iron use became popular

Metallurgy

Precious Metal

- Gold (Au) used with Copper from around BC5000
  - Can be 0.0001mm thin, 3000m line with 1 gram
  - No oxidation so very scare, thus used as money and accessory over he whole world
- Alchemy (by Aristotle): by changing Aristotle's 4 elements of an object with proper mixing ratio, the characteristic of the object can be changed
  - Assertion that Gold can be made by fusing mercury and sulfur and Medicina (stone of a wise man)
  - No artificial gold produced
- Silver (Argentum) appeared in the literature of Yin dynasty about BC2500 and used as a money with gold
  - Weakness of color changing by foreign element so less valuable than gold
  - Used for industrial purpose and for health use because of its sterilization effect on 650 kind of virus

Weapons

Ironware weapon

- Egypt around BC3000 used ironware such as iron mace so that may keep dominant position
- Around BC1500, bronze axe and sickle were the strongest weapon
- Hittite produced iron whip armor and shield in around BC1200
- Sword production: Competition of making harder, longer, sharper

Weapons

China

- In China around BC400, furnace was invented so that massive production of ironware weapon (cast technology started), such as stirrup and crossbow was possible
- Sword: Sharp knife was produced by chromium plating on iron using metallurgy in Qin dynasty
- Catapult: launched a big size of arrow with 1 kg up to 270m using trigger
  - Large Catapult: sot a 50kg stone up to 500m
- Nest Wagon: A kind of lift observing far distance

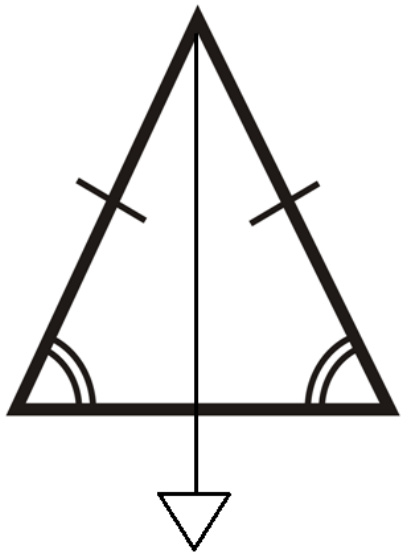
2 Technologies for Architecture and Civil Engineering

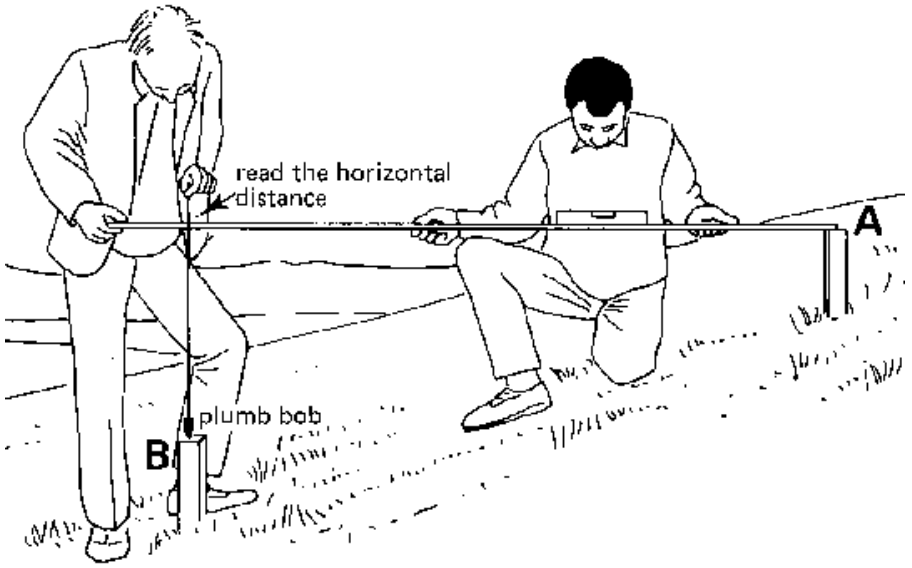
- Land Survey and Measurement Technologies
- Large Size Construction
- Art of Building

Survey and Measurement Technologies

Measurement Standard (Western)

- Scientific measurement started from ancient civilization for tax impose
  - Around BC2350, Egypt left the record of water level measurement with the length unit of cubits, hands, fingers
  - Area was defined with 1kht(aroura) equal to 10cubits in length and width
- Measurement of altitude difference for irrigation and water supply, horizontality measurement for standing wall vertically, vertical line measurement for land planning
- Length measurement using string, Right angle measurement using square ruler, Horizontality measurement using isosceles triangle

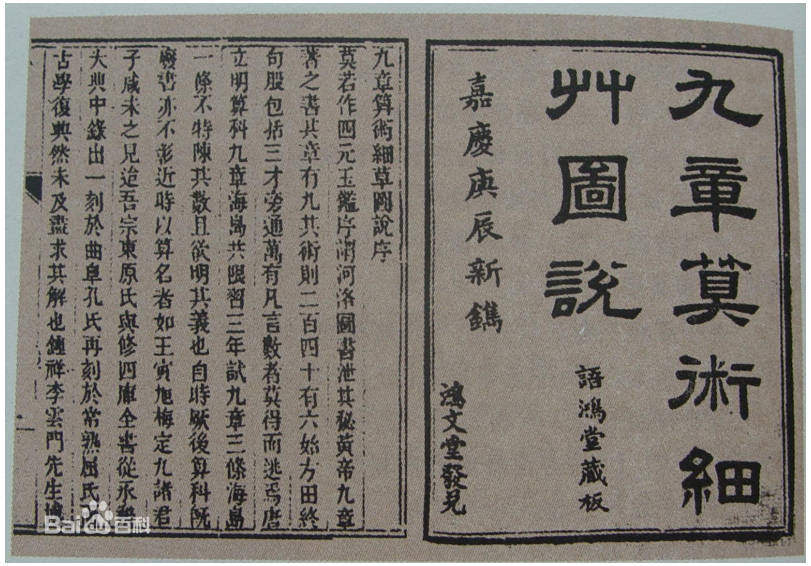




Survey and Measurement Technologies

Measurement Standard (China)

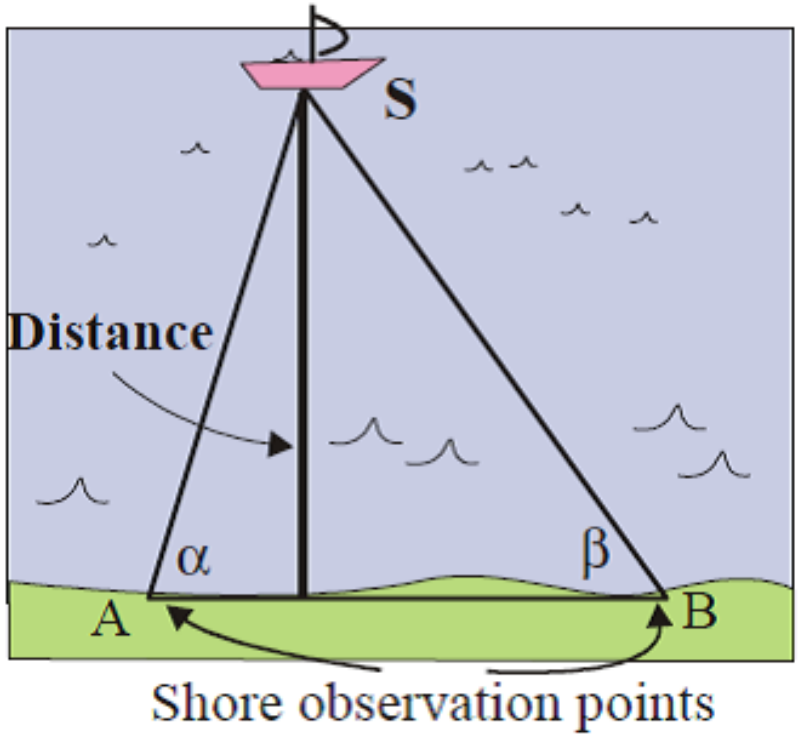
- China left the records related to measurement system around BC2000
- Qin Dynasty BC300 standardized the weights and measure
  - Length: 1 Zhang = 10 Chuck, 1 Chuck = 10 Chon, 4 Chon = 1 Phu
    (1 Chuck = 15.8cm, later in Han Dynasty changed to 25.1cm)
  - Volume: Ryang
  - Weight: 1 Hyung = 15 Keuk (used balance scale)
- Hay Dynasty in AD179, 'The nine chapters on the mathematical art' was written explaining how to measure the extent of a figure, volume of an object, etc.



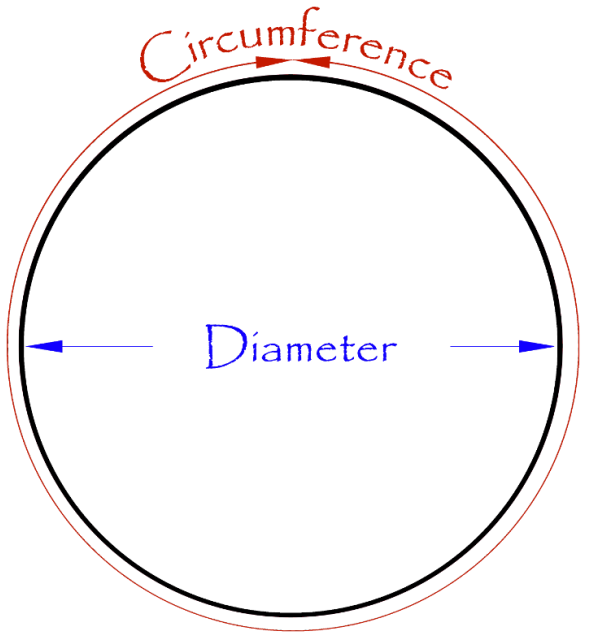
Survey and Measurement Technologies

Advance of Geometry

- In Greece around BC600, Thales measured the height of high object using triangulation method
- To calculate area of a circle (AOC), the ratio if the circumstance of a circle to its diameter was measured
  - Ancient Egyptian: AOC = [(diameter) x 8/9]^2 (Same as current standard)
  - Ancient Babylonia and China: AOC = 3 x (radius)^2



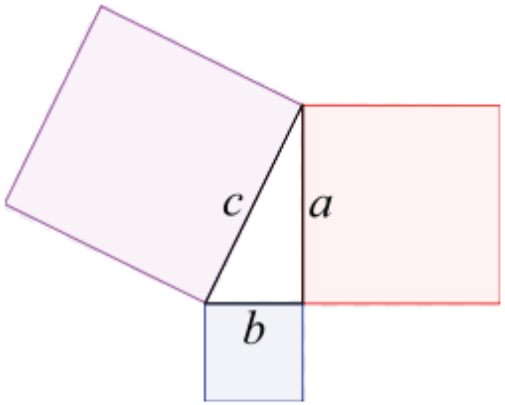
$$\pi = \frac{\text{Circumference}}{\text{Diameter}}$$



Survey and Measurement Technologies

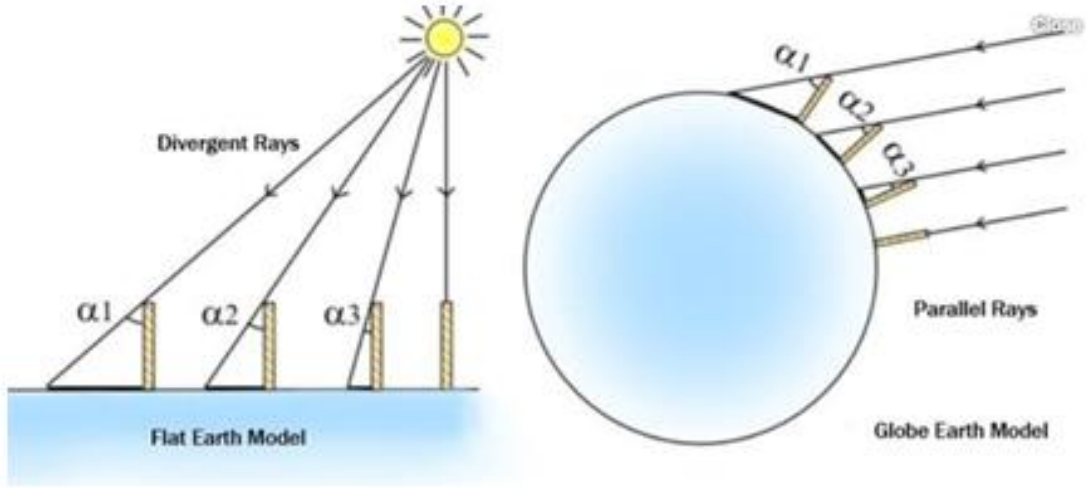
Advance of Geometry

- Legacy of Pythagoras around BC569
  - Established concepts of trigonometry as well as odd number, even number, prime number, perfect number
  - Explained the sound scale with analyzing the relationship between chord length and frequency
- Eratosthenes around BC200, based on the fact that arc length and its central angle are proportional, calculated the circumference of the earth as 45,000km from the difference of position angles measured at two cities separated from each other



$$a^2 + b^2 = c^2$$
$$c = \sqrt{a^2 + b^2}.$$

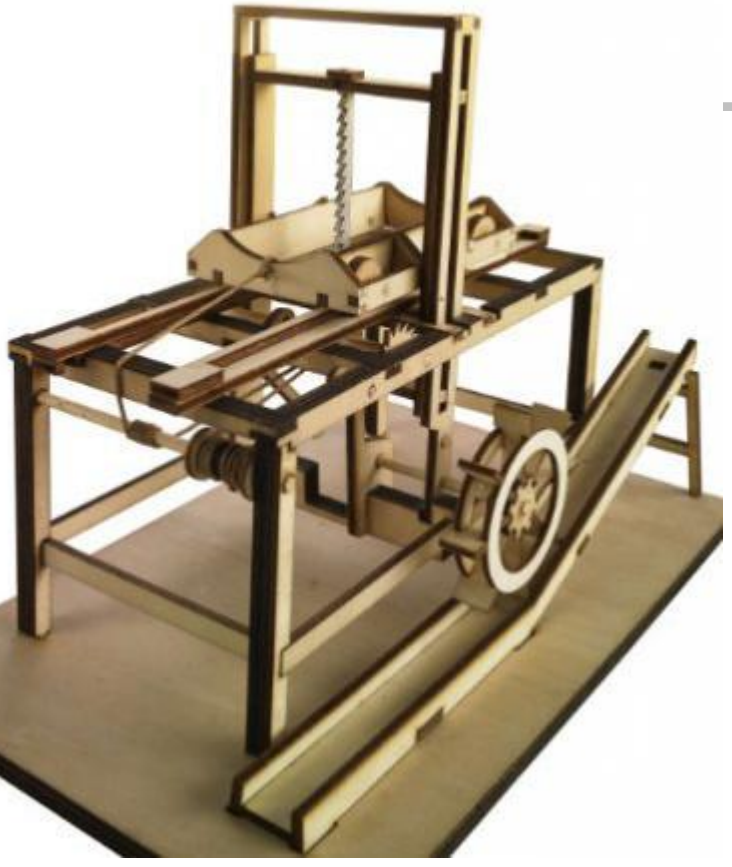
Pythagorean theorem



Survey and Measurement Technologies

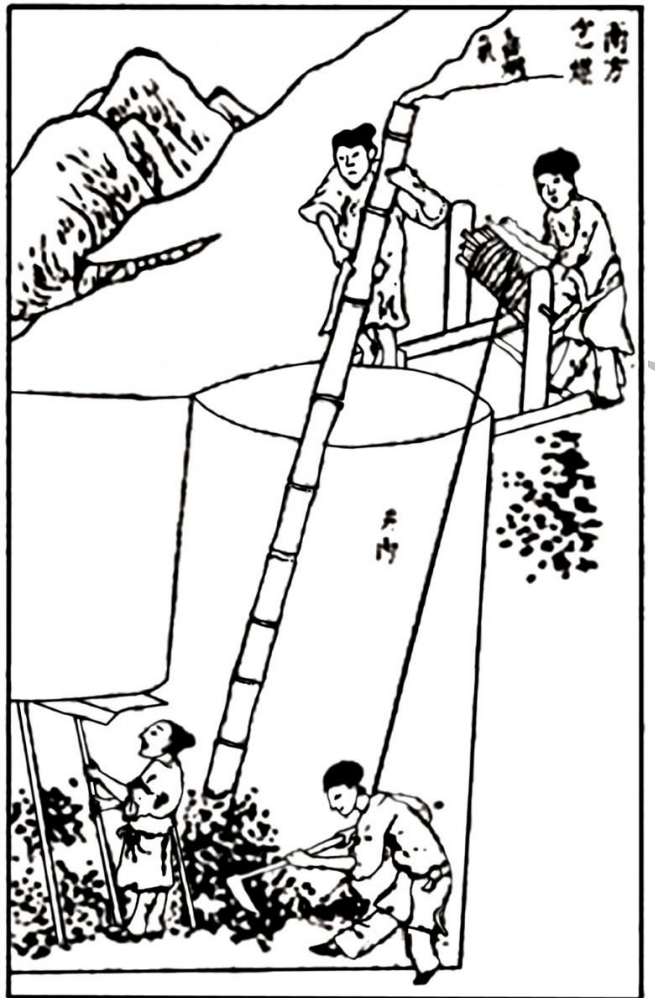
Large Scale Equipment

- Crane with cable: Used from BC2000 to move several tons of stone or heavy objects
  - Breakwater of Cyprus harbor was built with 5000 rocks weighting 3tons
  - Pyramid in Egypt was constructed with 2.5M several tons rocks
  - Greek temple was built by heaping 40ton stones
  - Romans developed a quintuplex pulley to lift several ten tons objects
- Automatic saw: Using mechanical saw to clip a giant stone
  - Rotary motion of waterwheel can be transformed to recti-lineal reciprocating motion
  - Instead of water, cows moved front and back to cut obelisk of 1000 tons



Large Size Construction Technologies

Construction & Civil Engineering

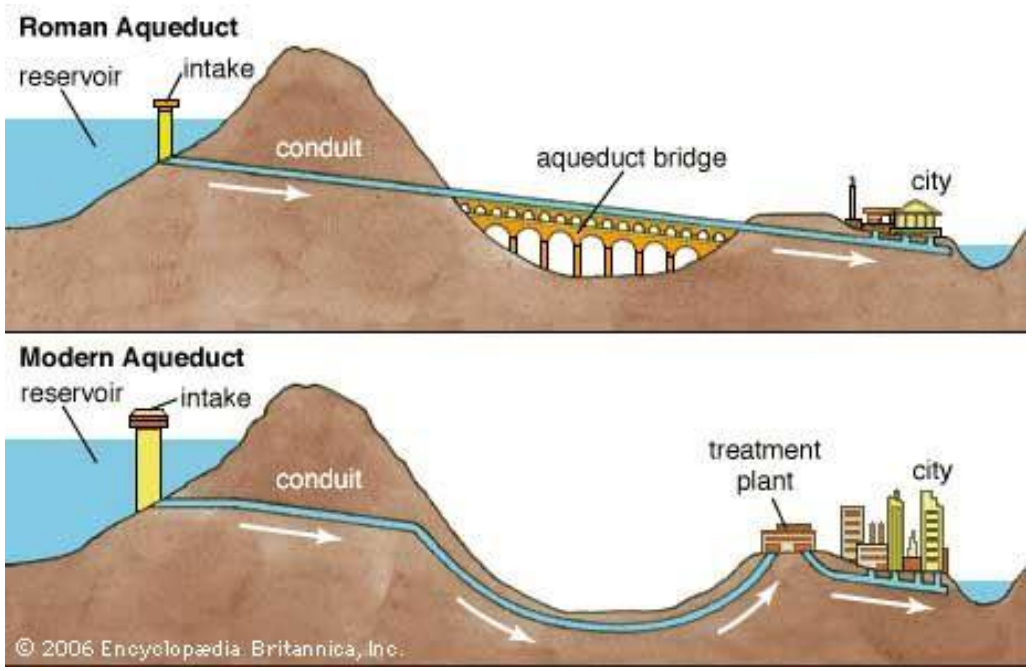


- Pantheon temple reconstructed in AD125
  - Original one had been constructed in BC3000 in Memphis, Egypt by King Menes with 15m high
- Canals in Egypt and China took a role of highway connecting major regions
  - In China around BC300, canals connecting major cities were started to be built and the total length in AD600 became 1600km
- Chinese drilling and mining technologies
  - To collect salt, used bamboo pipe to dig 600m under ground
  - Around BC1000, the largest copper mine was in China

Large Size Construction Technologies

Construction & Civil Engineering

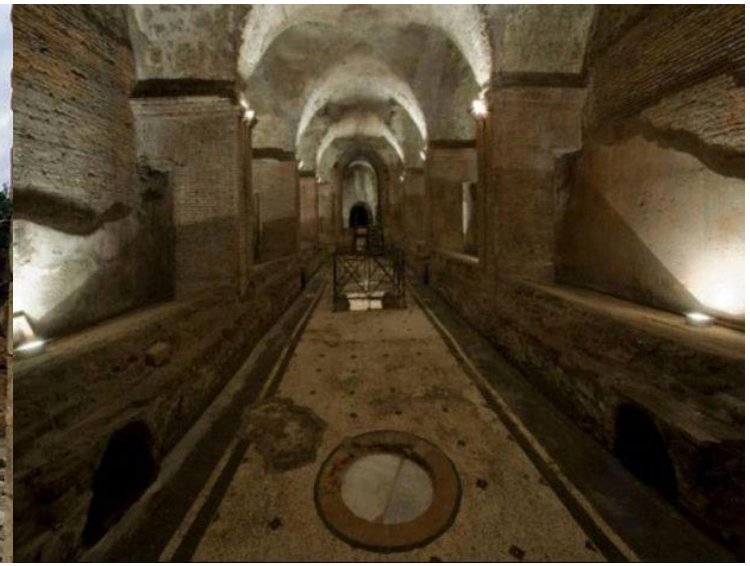
- 11 Waterways in Rome constructed from BC312
  - Pont du gard : in France Avignon occupied territory of Rome before AD100, waterworks whose length was total 50km and height was 48m (3 story way) and the height difference from the start and the end was only 20cm were built
  - To pass valley, adjusted the heights of both ends



Large Size Construction Technologies

Construction & Civil Engineering

- Road building
  - Total length of stone paved main road was 80K km (15K km including pebbles)
  - Appian way constructed in BC312 had the longest straight course of 42km.
  - Considering water supply, pebbles paved 1m depth; Overcoming wetland, bank was constructed first: To pass river and valley, made bridges; To pass mountains, dig tunnels
- Emperor Qin in BC212, constructed the 700km long road from Hamyang to Podu



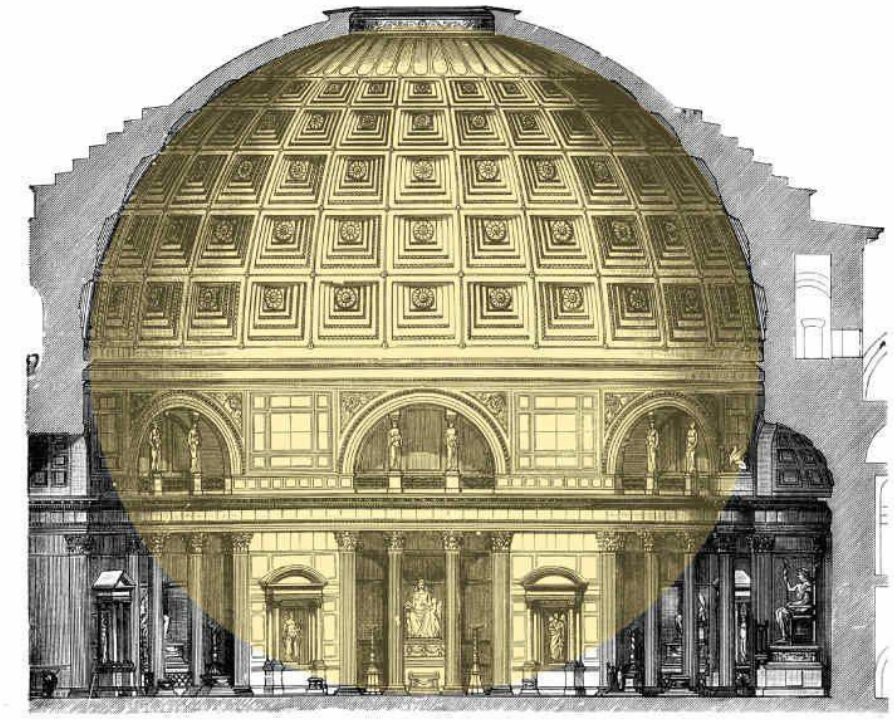
Large Size Construction Technologies

Castle

- The Great Wall of China: During BC222~212, Qin Dynasty had started after universal unification and ended in Ming Dynasty, whose distance is total 6000km and the longest part is 2,700km

Large Size Construction Technologies

Temple



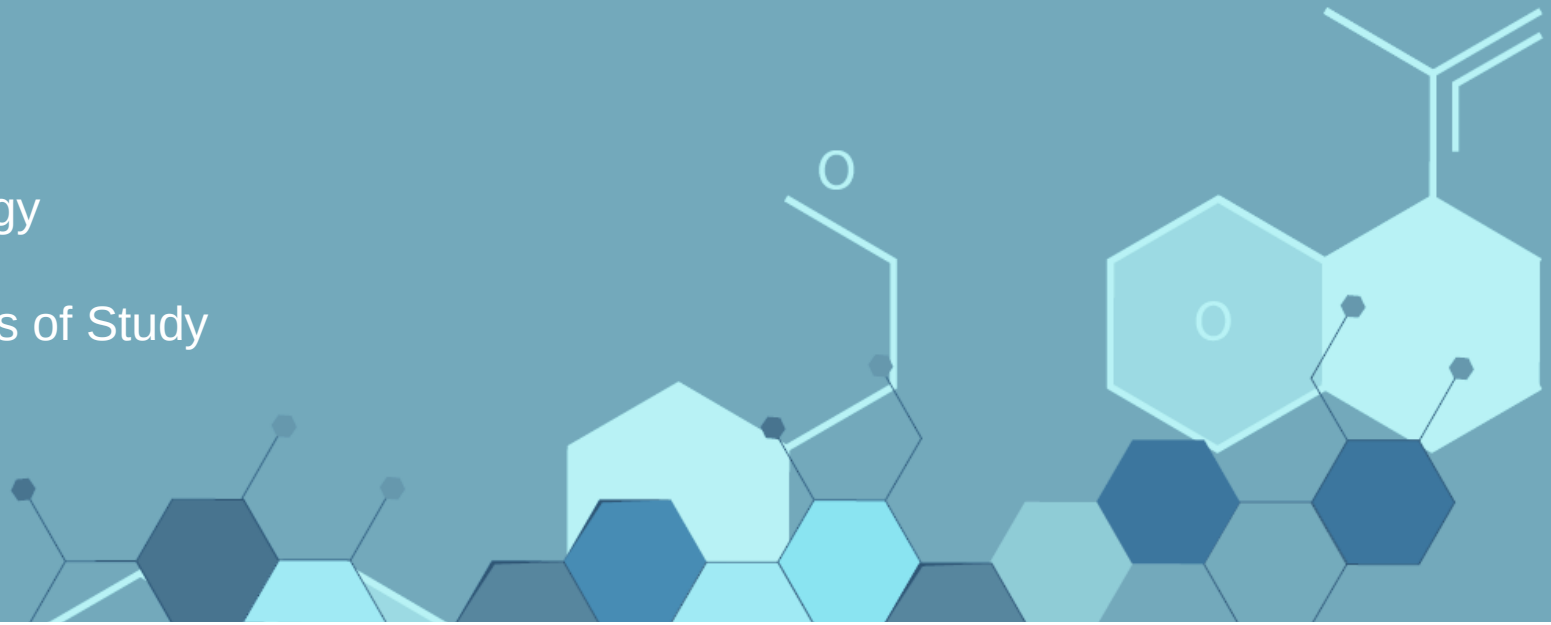
- The Pantheon Temple: The weight of concrete to build the dome is 4,535 tons, The dome diameter is 43.3m, the thickness of upper and lower part of the dome is 1.2m and 6.4m.

Grave

- Pyramid in Egypt constructed from BC3000 as King's tomb
- The great pyramid of Khufu built in BC2560 has a height of 147m, the bottom side of a polygon of 230m, total 230M stones weighting several tens tons

3 The Art of Living

- Soil and Fire
- Machinery Technology
- Four Precious Things of Study



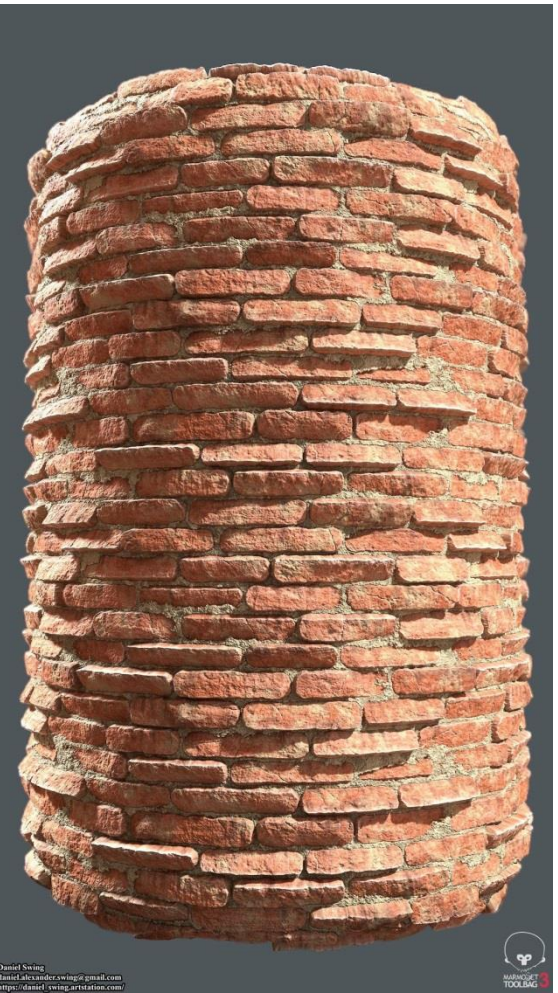
Soil and Fire

Pottery & Porcelain

- Earthenware: Shaping clay and Burn it with 600^{o}~800^{o}C high temperature
  - Easily disintegrated by water
  - Started to make after managing fire since around BC5000
  - Remained trace of coloring and painting
- Pottery: Earthenware burnt with 800^{o}~1000^{o} high temperature in kiln, still weak against water so that could not keep wine long
  - Appeared in both Eastern and Western world
- Porcelain: Earthenware burnt with 1100~1400도 high temperature in kiln
  - The technology raising the temperature of a kin higher than 1300도 was developed in China around BC400
  - Around BC200, could produce celadon porcelain by melting cobalt to use as enamel
  - By advance of enamel technology, white porcelain and celadon having high value could be produced

Soil and Fire

Brick



- Around BC5000 in Mesopotamia, clay brick was made of blending clay or mud with straw or vegetable material and drying and airing under the Sun, having a weakness of melting in water
- Around BC3000 in Egypt and Mesopotamia, burnt clay brick with fire to produce burned brick
- In China around BC500, bricks were produced
- Around BC300 in Mesopotamia, enameled bricks were used for decoration
- Cray bricks burned over 1000^{o}C have a strength superior to concrete

Soil and Fire

Glass

- Transparent glass was make in Egypt around BC1500
- Among BC30~70 in Rome, Hand blown method was invented to make bottles, and the bottoms of bottles were cut and fitted to the cast(mold) of window
- Around AD3~400 in Rome, Gerome spread melted glass over a flat cast to make of plate glass
- Around AD900~1000 in Sicily, stained glass was made to use for decoration

Machinery Technology

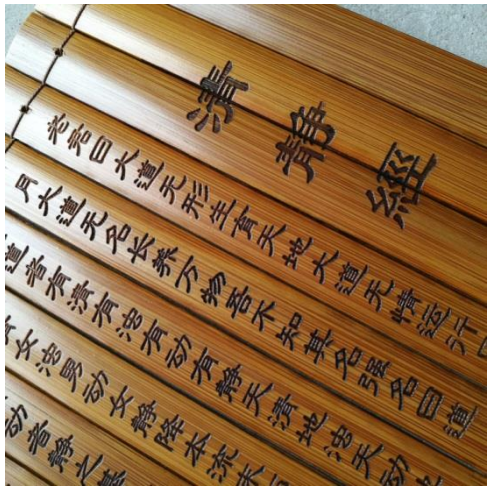
Automatic Machine

- Homeros described that Hephaistos (metal master craftsman) made tripod robot
- Heron in Alexandria around BC300 made a fully automatic door and a consecutive motion of a doll using programmable mechanical equipment and aerodynamics
- Philon in Byzantium made a vending machine selling soap and water in temples
- Directivity wagon made in China where the statue on the wagon maintain the same direction by using difference gear even when the wagon changes its direction
- Around BC3000, water clock and sundial appeared
  - Measure the amount of water passing a small hole in a bowl

Four Precious Things for Study

Paper

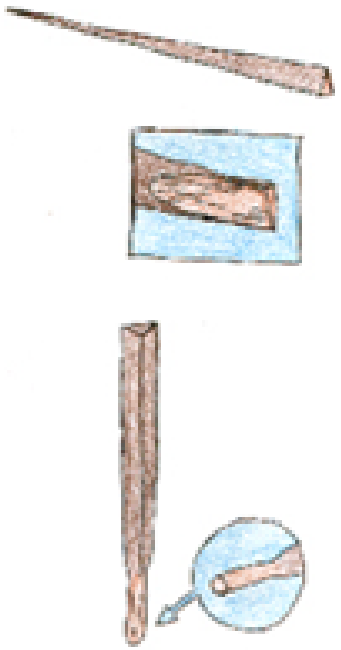
- Started to draw and write on stone, rock, animal skin, clay tablet, parchment
- In Egypt around BC2500, wrote on bark of papyrus
- In ancient China, wrote on a series of weaved bamboo pole
  - In around BC300, award (primitive paper) was produced using cloth and rope and rags as raw material
  - In BC105, ChaeLyun in Han Dynasty made paper
- Technology of paper production spread to western world around AD700, through Samarkand, Egypt, Morocco, and Spain

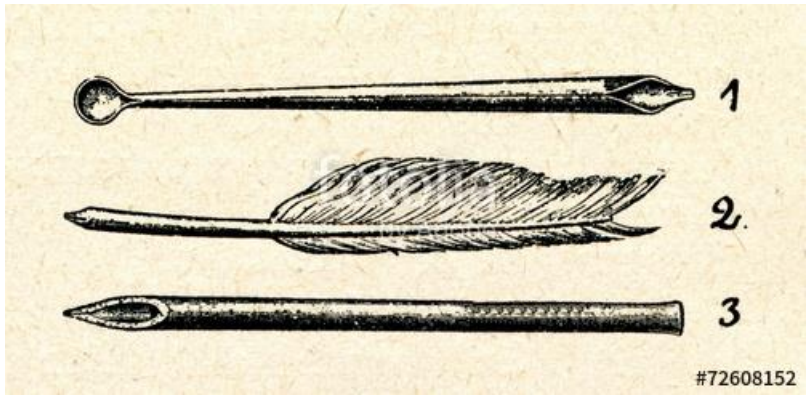


Four Precious Things for Study

Writing Supplies

- Used stylus whose end was sharpened to write and drew on stone, rock, wood
- Thin reed or bamboo with sharpened end were used to write on parchment
- Feather with ink (or colored dye) was used to write on paper
- In China about BC200, Meng Tian used a writing brush which was made of binding a bundle of animal hair
  - At that time, dissolved ink made of melting charcoal or black lead
  - In the Later Han, ink stick appeared





4 Discussion Topics

- Evaluate the influence of ancient Phoenicia’s trade and commerce and finance technology to modern times
- Survey the town planning technology in ancient Hittite and Assyria
- Find the technical factors that Rome could control such a wide occupied territory
- Survey what technologies of Qin Dynasty contributed the unification of whole China?
- Find at least 3 ancient technologies which are applicable to what in the modern times