

The Science and Technology of Ancient Mesopotamia

The Wheel

Although archeologists don't know for sure who invented the wheel, the oldest wheel discovered was found in Mesopotamia. It is likely that Sumer first used the wheel in making pottery in 3500BC and then used it for their chariots around 3200 BC.

Mathematics

The Mesopotamians used a number system with the base 60 (like we use base 10). They divided time up by 60s including a 60 second minute and a 60 minute hour, which we still use today. They also divided up the circle into 360 degrees.

They had a wide knowledge of mathematics including addition, subtraction, multiplication, division, quadratic and cubic equations, and fractions. This was important in keeping track of records as well as in some of their large building projects.

The Mesopotamians had formulas for figuring out the circumference and area for different geometric shapes like rectangles, circles, and triangles. Some evidence suggests that they even knew the Pythagorean Theorem long before Pythagoras wrote it down. They may have even discovered the number for pi in figuring the circumference of a circle.

Astronomy

Using their advanced math, the Mesopotamian astronomers were able to follow the movements of the stars, planets, and the Moon. One major achievement was the ability to predict the movements of several planets. This took logic, mathematics, and a scientific process.

By studying the phases of the Moon, the Mesopotamians created the first calendar. It had 12 lunar months and was the predecessor for both the Jewish and Greek calendars.

Medicine

The Babylonians made several advances in medicine. They used logic and recorded medical history to be able to diagnose and treat illnesses with various creams and pills.

Technology

The Mesopotamians made many technological discoveries. They were the first to use the potter's wheel to make better pottery, they used irrigation to get water to their crops, they used bronze metal (and later iron metal) to make strong tools and weapons, and used looms to weave cloth from wool.

The Science and Technology of Egyptian Science

The ancient Egyptians are famous for many scientific achievements:

- metal working, including working with copper and gold;
- glass-blowing;
- knowledge of anatomy and medicine;
- invention of a calendar;
- the standardization of measurement;
- paper-making from papyrus reeds;

Metal working

The ancient Egyptians learned how to heat metal ores in order to extract the metals. They were skilled metal-workers, particularly in copper and in gold. Workmen poured molten metal (gold made liquid through heating) into molds.

Glass-blowing

The ancient Egyptians may have been the first people to learn how to make glass. They learnt how to heat sand in a very hot furnace and then blow the molten sand into glass. They made glass jars and glass beads. Ancient Egyptians created a glass jar, for example, blowing glass in a furnace.

Knowledge of anatomy and medicine

The Egyptians knew about the anatomy of the human body. They were able to remove the organs of the body, such as the heart and liver and intestine after a person had died without needing to cut the body completely open.

There is a papyrus dating from 1600 B.C. in which the different organs of the body are identified. (It is known as the Edwin Smith papyrus after the man who deciphered it (worked out what it meant).) The papyrus also explains that blood is pumped round the body from the heart (this knowledge was lost and not rediscovered for another 2000 years).

The calendar

Egyptian scientists observed the movement of the stars across the sky. They realized that the annual flood of the Nile happened at the same time as a particular pattern of stars. From very detailed records year after year they were able to work out that this constellation of stars was in exactly the same place after 365¼ days. The ancient Egyptians gave us our calendar year. This allowed them to forecast when to expect the flood each year.

The standardization of measurement

The Egyptians were very quick to understand that units of measurement needed to be standardized.

The easiest way to measure something is to compare to some part of your own body. In early civilizations the units of length were defined as parts of the body. The Egyptian cubit, therefore, was the length of the forearm, from the elbow to the fingertips. Other measurements of length could be the hand, the pace or the double pace, the full length of both arms outstretched, or the breadth of the forefinger.

Weight could also be measured in terms of a container. Before measurements were standardized you might buy a basket of corn, or even a boatload.

The Egyptians understood that these measurements could vary. One person's forearm is likely to be shorter or longer than another person's. Also the measurements were not related to each other. A basket of corn is not a 100th part of a boatload of corn. A forearm is not twice the length of a pace.

So the ancient Egyptians 'standardized the units. The Egyptian cubit was now the length of a certain bar of metal, or sometimes wood, which was kept carefully in the royal palace or temple.

Once the Egyptians had standardized the cubit, they based all other measurements on it, so that every measurement was either a fraction or a multiple of a cubit. The Egyptian measurement of area, the 'setat' was defined by a square with sides 100 cubits long.

Paper-making from papyrus reeds

Papyrus is a reed that grows in the swamps of the Nile delta (the delta is where the Nile divides into several channels before joining the Mediterranean). The Egyptians were the first people in the world to understand that this reed could be harvested and made into a material on which people could write.

Surveying

The ancient Egyptians achieved wonders in surveying from building the pyramids (see Egyptian architecture) to accurate measurement of perfectly rectangular fields.

They used:

- a sighting instrument called a merchet, through which the surveyor looked at a fixed vertical line in the distance;
 - a plumb line, which is a line with a heavy weight on the bottom; a plumb line hangs in a perfect vertical line;
 - a measuring rope which was tightly stretched between two points; a new measuring rope was stretched and treated with beeswax and resin so that it kept the same length;
- a groma, an instrument that showed a perfect right-angle, used for laying out fields.

The Science and Technology of Ancient Greek Science

In the Hellenistic Age of Ancient Greece, science became a major topic of study. The Hellenistic Age of Greece was a time when Greek culture spread throughout Persia and North Africa, including Egypt. When the Greek culture spread into a different culture, some parts of both of the cultures mixed together. This was called cross-fertilization. Because of this, a lot of advancements in culture were made in the area of science.

The Greeks had a long tradition of rational inquiry, or using their intelligence to make reason out of things. An example of this is the Greek's rich history of philosophy. East Asia and Persia had an even longer history of rational inquiry, especially in the study of mathematics and science.

When these two cultures cross-cultivated, or mixed, great thinkers were able to join together and advance science. Other things that helped science advance were the use of Greek as an international language: almost everyone in the Hellenistic world spoke Greek. The Museum in Alexandria also helped advance science because it was a meeting point where Greeks and other scientists and thinkers could get together and share their ideas.

This time was called: The Golden Age of Science

Euclid: Living in about 300 BC, Euclid wrote a book that is still used as the basis for the study of plane geometry. This is a type of geometry where math is used to study shapes. The basis of Euclid's geometry was to prove one thing, and then base the rest of the study of shapes off of the basic proof. He used proofs to prove his ideas about geometry, all based off of the proof that the shortest distance between two points is a straight line. Euclid is still the most widely read Greek author.

Archimedes: One of the greatest mathematicians of all time was Archimedes. He calculated the value of pi, which was a geometrical calculation that helped determine the width, or circumference, of a circle. He also developed a system for writing down very large numbers and discovered ratios of volumes of spheres and cylinders.

Archimedes also studied physics, which is a science about energy and the way things move. He discovered new physics laws about the way things sink in water, lever systems, and water screws. In 212 BC, while his city was being attacked by the Romans, he invented engines to help fight them off. He was killed in the same battle when a Roman soldier murdered him as he was drawing a mathematical figure in the sand.

Aristarchus: Both a mathematician and an astronomer, Aristarchus discovered new theories about the way the planets move in their orbits. Aristarchus thought that even though the earth revolved around the sun, it also spun on its own axis, or spin-point, as it followed its orbit around the sun. His theories were not proven right until almost two thousand years later!

Hipparchus and Erasthenes: Two of the major thinkers in the measurement of time and distance were Hipparchus and Erasthenes. The length of the month that Hipparchus discovered is only one second off from the length that we use today. Erasthenes determined that the circumference of (the distance around) the earth was 28,000 miles, which is only three thousand miles more than what we know today.

Greek scientists, mathematicians, and astronomers made great advancements in rational thought in the Hellenistic Age. Not only did their ideas change the ways that people thought thousands of years ago, but many of their ideas form the basis of our scientific and mathematical study today.

The Science and Technology Ancient Rome

The Ancient Romans made much advancement in the field of science. Below are several examples.

- Concrete
- Arch Structures
- Aqueducts
- Plumbing
- Machines
- Sundials
- Tools
- Glassblowing
- Military Technology

One of the greatest scientific feats of Ancient Rome is the concrete road. Nearly 30 military highways, all made of stone, exited the great city. At one point, 372 roads connected 113 provinces. Due to the concrete structure, many of these roads survived more than a thousand years.

The Romans used the idea of the arch to create architecture that has continued to inspire builders even today. The discovery that the arch shape allowed weight to be distributed evenly allowed the Romans to create amazing buildings and homes. Arches were also used when developing aqueducts to deliver water to citizens all over Rome. Eleven aqueducts measuring nearly 220 total miles carried water across valleys and aided in the area's agriculture.

Citizens of Ancient Rome used sundials to tell time and even created portable versions. They also used tools that were quite advanced, such as measuring tools, manual drills, and metal spikes (used as nails)..

Advanced glassblowing techniques brought new technology to Rome in the form of window glass, hanging glass oil lamps, and other objects made of glass. Pliny the Elder, a key historian from Ancient Rome, also mentioned the use of mirrors in his writings.

Furthermore, Rome's military benefited from technological improvements to weapons, shields, armor, and other items. Combined with the city's ability to build roads and bridges, it is clear that Rome's military success can be partially credited to its ability to excel in scientific fields.

Some of the first flushing toilets and indoor plumbing systems were used in Rome. Some Roman homes contained sewer systems that carried waste to the Tiber River.

Romans used several different machines. For example, olive presses were used frequently. They also used various types of cranes to aid in constructing homes and buildings. Meanwhile, water power was also available through the invention of watermills, which helped grind corn, among other uses.

Throughout history, several Romans have been credited with significant scientific contributions, including:

Galen

was a surgeon and philosopher and once released a piece of writing titled "That the Best Physician is also a Philosopher." Among other notable achievements, he was to discover the difference between dark and bright blood. Galen used animal subjects to learn more about the circulatory, respiratory, and nervous systems, among other parts of the body.

Ptolemy

studied astronomy, geology, astrology, music, and other arts and sciences. He left behind several works, including *Almagest*, which includes a list of 48 constellations and a star catalog. In addition to an asteroid, craters on the Moon and Mars have been named in his honor.

Like the Greeks and other civilizations, the Romans dedicated many resources to the study of astronomy, astrology, geography, and other sciences. Their contributions were crucial to future generations and have helped us to collect the knowledge we have today.

The Science and Technology of Ancient Islam

Medieval Islamic drugs and remedies

As in Ancient Greece, Rome and Egypt, Medieval Islamic medications consisted of natural substances, many of which were plant based. Most of the remedies had also been used in ancient Greek and Roman medicines.

- **Mercuric chloride** was introduced by Muslim scholars to disinfect wounds.
- **Poppy** (*Papaver somniferum Linnaeus*) - this was used to relieve pain. Poppy seeds contain both codeine and morphine. According to literature, poppy was used to relieve the symptoms of pain from gallbladder stones, fever, toothaches, pleurisy, headaches, and eye pain. It was also used to make people "go to sleep before an operation". Ali al-Tabari warned against taking the extract of poppy leaves, saying they could be deadly, and that opium was a poison.

From 800 AD onwards, the use of poppy was restricted to healthcare professionals.

- **Fennel** - commonly used to calm people down.
- **Garlic** - had many uses. It was given to people with heart problems.
- **Willow** - was used as an antiseptic

Did Medieval Islamic doctors perform surgery?

Islamic society built many hospitals, and there was much more surgery going on compared to ancient Greece and Rome. Hospitals were called Bimaristan, which means "house of the sick" in Persian.

As there were no proper anesthetics like we have today, it was not possible to carry out sophisticated surgery deep inside the human body. However, doctors used opium to induce sleep before operations.

Many procedures were learnt from Greek and Roman texts.

Surgery was rarely practiced outside hospitals, because of the very high death rate.

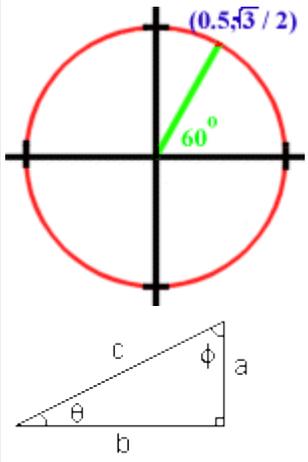
Ophthalmologists made advances in surgeries of the eye, and treated patients with cataracts and trachoma.

Cauterization (when the skin or the flesh of a wound is burnt) was a common procedure to prevent infection and stem the bleeding of wounds. Doctors heated a metal rod and placed the red-hot metal on the skin or flesh of a wound; the blood would immediately clot and the wound would have a chance to heal.

Bloodletting was used to restore the balance of humors. Blood would be drained from a vein. Sometimes "wet-cupping" was used to draw blood - a small incision is made on the skin and then a heated cupping glass is placed on it.

Mathematics Advancements by Muslims:

Introduction: Just as with science, the Muslims learned from the Greeks, Egyptians, Indians, and Babylonians. Many translations took place in the House of Wisdom in Baghdad, the capital of the Abbasid Empire. The Muslim scholars there translated the works of the Greeks who loved mathematics and geometry, including Euclid's work on geometry. They borrowed from India a number system that had a zero and rewrote it as their own. They borrowed from the Babylonians whose number system was based on 60 (just like the minutes in an hour), and from the ancient Egyptians who had the math and geometry skills to build incredible pyramids. So from the beginning, "Arabic math" was a mixing of international knowledge. But the Muslims made additional contributions of their own, and through their study and written work, they preserved the knowledge of mathematics that otherwise might have been lost to the world.

<p>Arithmetic: $12 + 10 =$ $14 - 8 =$ $5 \times 4 =$ $6 \div 2 =$</p>	<p>Algebra: $2x = 14$ $x = ?$ $3x + 6 = 18$ $x = ?$ $x^2 + xy = 10$ $x = 5$ $y = ?$</p>	<p>Geometry: $A = \pi r^2$  $a^2 + b^2 = c^2$</p>	<p>Trigonometry:</p>  <p>Top image from Hyperion Cultural Academy.</p>
<p>Arab contributions: - the numbers we use are called Arabic numbers (numerals) which is a system of tens, with place values, and a zero to show an empty place: 1,302,005 - fractions: $\frac{1}{2}$ - decimal fractions: 1.5</p>	<p>Arab contributions: Algebra was first fully developed by Al Khwarism, the "father of algebra".</p>	<p>Arab contributions: The Arabs translated and improved upon the Egyptian, Hebrew, and Greek geometry.</p>	<p>Arab contributions: Al-Tusi, a Muslim, is the "father of trigonometry".</p>

Arabic Numerals

One of the greatest advances was the introduction of "Arabic" numerals. The "Arabic" numerals were influenced by India's mathematics. It is a system based on place values and a decimal system of tens. This system had a zero to hold a place. These numbers were much easier to use for **calculation** than the Roman system which used numbers, like I, V, X, L, C, M, etc. Addition, subtraction, multiplication and division now became easy.



Top: Western Arabic or Hindu-Arabic Numerals

Below: Modern Arabic numerals which developed from them

With Arabic numerals, simple fractions and decimal fractions were also possible. Fractions and decimal fractions were also described by Muslim mathematicians during the Middle Ages.

The Science and Technology of Ancient China

The history of science and technology in China is both long and rich with many contributions to science and technology. Various forms of sciences such as astronomy, physics, chemistry, meteorology, seismology, have originated from China.

Early in 14th century BC, decimal or base ten system was first developed by Chinese. The first recorded observations of comets, solar eclipses, were made in China. The earliest inventions were abacus (this was a calculator that used sliding beads to help compute math problems quickly), flying machines such as kites, Kongming lanterns and clocks.

The clock was first devised for astronomical purposes. The first ever clock had a puppet which would hold up a plate that would tell the time. Also giant water clocks were invented which rang every 15 minutes.

List of inventions that took place in ancient China are as follows:

Compass: This was for religious use. When a new house was being built, people used it to see if the house was faced in perfect harmony with nature. The compass was a wooden circle with markings on it, and a magnetic spoon on top.

Crossbow: A crossbow is a bow set horizontally on a stock. When the shooter releases a mechanism, the crossbow fires arrows or bolts forced by the mechanical energy of previously stretched bowstring. In ancient times, it could be more powerful than the ordinary bow and could fire multiple arrows.

Seismoscope: Zhang Heng invented the earthquake detecting tool called seismoscope. His seismoscope was a giant bronze vessel resembling a kettle almost 6 feet in diameter.

On the outside, the machine had eight dragons facing down marking the primary directions of the compass. In each dragon's mouth was a bronze ball. And beneath the dragons sat eight bronze toads with their broad mouths gaping to receive the balls.

This was invented during the rule of Han dynasty.

Fan: Fans were made of bamboo spines that stick out in the shape of a semicircle with silk wrapped around it. Fans were mostly used by women and soldiers.

Fireworks: Fireworks were actually bamboo cases filled with gunpowder with a fuse on the side. Fireworks were initially used only for shows. Later on they were used to scare off the enemies during the war. This invention took place during the rule of Tang dynasty.

Glider: Kite which was invented in the 4th century B.C. by the Chinese had many practical uses. But it wasn't until the sixth century A.D. that the Chinese put the kites to use as hang gliders, cutting the cord, as it were. The gliders were strong enough to sustain the weight of a man. The Chinese hang gliders initially were used for the amusement of emperors, who strapped captured enemies and criminals onto the gliders, forcing them to jump off cliff in terror.

Seed Drill: Seed drills were used by farmers to plant seeds into the soil at uniform depth. Without this tool,

farmers otherwise would toss the seeds with hands over the ground resulting in wastage and uneven growth.

Iron Plough: This was one of the major developments in ancient Chinese agriculture. It was first developed in 4th century BC. Later on it was more popular and used commonly during the Han dynasty.

Harness for horses: Harness is a set of straps by which a horse can be fastened to the cart. Throat harness was first invented. The drawback of the throat harness was that it presses the back on the neck, thus limiting the full strength of the animals. Later horse collar was invented. With this invention the horse could run faster than ox.

Kites: Kites were first invented in China during Chou dynasty. Kites were first made of bamboo and silk. Chinese people flew kites for fun and also during war to carry messages to signal people and also to carry explosives in besieged cities.

Gunpowder: By 300 AD, a Chin dynasty scientist named Ge Hong had written down the ingredients of gunpowder and described the explosion. Scientists made gunpowder by mixing sulphur, charcoal and potassium nitrate.

The reason gunpowder explodes is that it burns very fast, and when it burns it releases gases that are bigger in volume than the original powder. Gunpowder was used much later on during the reign of Tang dynasty. Chinese army used gunpowder in the form of rockets.

They put small stone cannonballs inside bamboo tubes and shot the cannonballs out by lighting gunpowder at one end.

Paper: China also was first in inventing paper and printing. Their early script contained 80,000 different characters. They went on to invent books and had book shops in every city by the end of the Tang dynasty. There were 3 different kinds of paper, the first being silk rags.

The cheap kinds were the wooden strips, and the most expensive was silk cloth. Although most of the kinds of paper were made from over 50%bamboo, some of the other things they were made of were silk, cloth, hemp, mulberry bark, and plant fibres. Paper and ink were invented during Han dynasty. During Tang dynasty, the first printer was invented

Porcelain: This is made of special white clay which has lot of kaolin in it. The clay is put on fire at very high temperature. The temperature is kept so high that some of the clay melts and becomes shiny and translucent like glass. Porcelain was invented during the Sui Dynasty and perfected during the Tang Dynasty, most notably by Tao-Yue.

Boat Rudder - The rudder was invented to help steer large ships. This enabled the Chinese to build huge ships as early as 200 AD, well before they were ever built in Europe.

Silk: Silk was made from the cocoons of silkworms. The Chinese managed to keep the process for making silk a secret for hundreds of years. Silk was a soft and light material much desired by the wealthy throughout the world. It became such a valuable export that the trade route running from Europe to China became known as the Silk Road.

Wheelbarrow: Wheelbarrows are basically hand driven vehicles with two handles on the rear side for a person to push ahead. It is mostly used in the Construction Industry. Wheelbarrows were in use in China right from

the Ancient times during the Han dynasty. Chuko Liang is the inventor of wheelbarrow. Liang was a general who used the wheelbarrows to transport supplies and injured soldiers. The Chinese wheelbarrows had two wheels and required two men to drive and steer.

Other inventions included umbrella, iron casting, hot air balloon, matches, stirrups for riding horses, and acupuncture. A clear coating called lacquer was also made to protect and enhance certain works of art and furniture. Paper money was first developed and used in China during the Tang dynasty (7th century).

Mayan Science

The Mayans became excellent scientists in many different fields, including medicine, astronomy and mathematics. They tracked the movement of the stars and planets across the sky, and were able to accurately predict celestial events such as eclipses.

They also developed an accurate calendar of 360 days, which they used to plan their harvests and religious ceremonies.