Writing Paper

The word *paper* comes from the ancient Egyptian writing material called papyrus, which was woven from papyrus plants. In China, documents were ordinarily written on bamboo, making them very heavy and awkward to transport. Silk was sometimes used, but was normally too expensive to consider. Indeed, most of the above materials were rare and costly.

While the Chinese court official Cai Lun is widely regarded to have first described the modern method of papermaking (inspired from wasps and bees) from wood pulp in AD 105, the 2006 discovery of specimens bearing written characters in north-west China's Gansu province suggest that paper was in use by the ancient Chinese military more than 100 years before Cai in 8 BCE [1]. Archeologically however, true paper without writing has been excavated in China dating from the 2nd-century BCE. Paper is considered to be one of the Four Great Inventions of Ancient China. It spread slowly outside of China; other East Asian cultures, even after seeing paper, could not figure out how to make it themselves. Instruction in the manufacturing process was required, and the Chinese were reluctant to share their secrets. The technology was first transferred to Korea in 604 and then imported to Japan by a Buddhist priest, Dam Jing from Goguryeo, around 610, where fibres (called *bast*) from the mulberry tree were used.

Some historians speculate that paper was the key element in global cultural advancement. According to this theory, Chinese culture was less developed than the West in ancient times prior to the Han Dynasty because bamboo, while abundant, was a clumsier writing material than papyrus; Chinese culture advanced during the Han Dynasty and preceding centuries due to the invention of paper; and Europe advanced during the Renaissance due to the introduction of paper and the printing press.

Bicycle Chain

A **bicycle chain** is a chain that transfers power from the pedals to the drive-wheel of a bicycle thus propelling it.

It was introduced in China around the year 976 AD, as a way to keep riders from losing control of the rides on steep declines. The bicycle chain did not appear in Europe until 1770.

Originally developed by Chang Ssu-Hsün for mechanical clocks, the inventor later applied the same technology to bicycles, which were originally powered by moving the feet along the ground without the use of pedals or a chain. Chang Ssu-Hsün's application allowed riders to slow or speed their movement based on the difficulty of the terrain. He added pedals to the chain system to achieve this purpose.

Match

A **match** is a consumable artifact for producing fire under controlled circumstances on demand. They are readily available, being sold in tobacconists and other shops. Matches are rarely sold singularly; they are sold in multiples, packaged in either match boxes or in matchbooks. A match is typically a wooden stick (usually sold in match boxes) or stiff paper stick (usually sold in matchbooks) coated at one end with a material, the **match head**, often containing the element phosphorus, that will ignite from the heat of friction if rubbed ("struck") against a suitable surface.

There are two main types of matches: **safety matches**, which can only be struck against a specially-prepared surface, and **strike-anywhere matches**, for which any sufficiently rough surface can be used.

History of the term

Historically, the term *match* referred to lengths of cord, or later cambric, impregnated with chemicals, and allowed to burn continuously.[1] These were used to light fires and set off guns and cannon. Such matches were characterised by their burning speed, e.g. **quick match** and **slow match**; depending on their formulation, they could provide burning rates of between, typically, 4 milliseconds and 15 seconds per centimetre. The modern equivalent of this sort of match is the simple fuse, still used in pyrotechnics to obtain a controlled time delay before ignition. The original meaning of the word still persists in some pyrotechnics terms, e.g. black match, a black powder-impregnated fuse, or **Bengal matches**, a type of firework producing a relatively long-burning, coloured flame. When friction matches were developed, however, they eventually came to be the dominant meaning of the term.

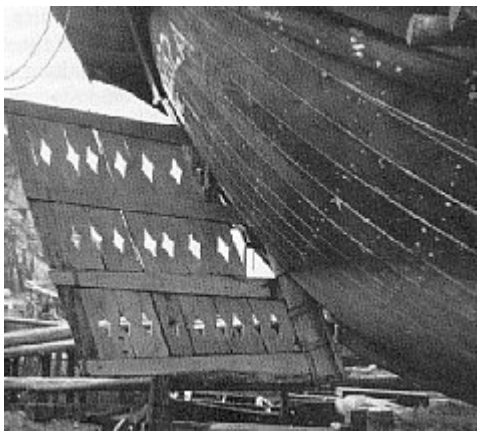
History of the modern match

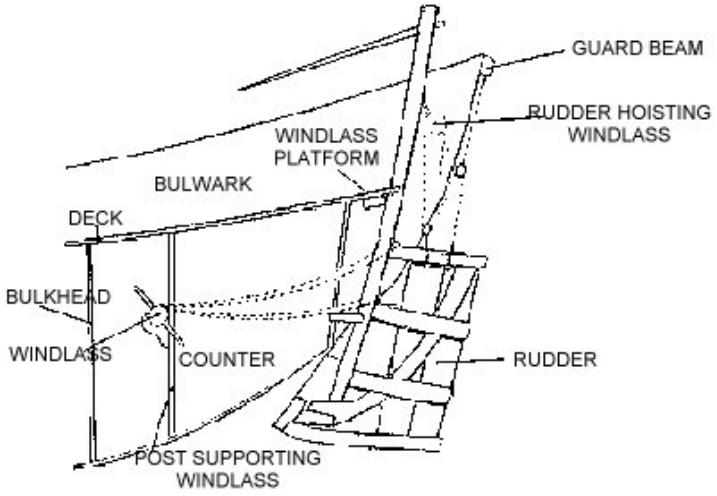
A predecessor of the match, small sticks of pinewood impregnated with sulfur, was developed in China in 577. The first modern, self-igniting match was invented in 1805 by K. Chancel, assistant to Professor L. J. Thénard of Paris. The head of the match consisted of a mixture of potassium chlorate, sulphur, sugar, and rubber. They were ignited by dipping the tip of the match in a small asbestos bottle filled with sulfuric acid. This kind of match was quite expensive and its usage was dangerous, so Chancel's matches never gained much popularity.

Rudder

Until Europeans adopted the rudder from the Chinese, Western ships had to make do with steering oars. This meant that long voyages of discovery by Europeans were impossible. The famous voyages of Christopher Columbus, Vasco da Gama, and others of their time were only made possible by the adoption of Chinese nautical technology. The oldest Western evidence for rudders is found in church carvings of about the year 1180. This is within a few years of the first European evidence for the ship's compass. Rudders and compasses thus seem to have reached Europe at about the same time, which is hardly surprising, since they were so closely associated. The rudder enables one to steer a ship properly, and the compass helped one to decide where to steer it. The world's oldest representation of a rudder may be seen in Plate 136. This is a pottery model of a Chinese ship excavated from a tomb dated to the first century AD. The model is about one foot ten inches long, and its rope slinging tackle has long since rotted away. But a slung axial rudder may clearly be seen. (A slung rudder is one which can be raised and lowered by rope tackle or chains; when entering shallows, it is often desirable to pull the rudder up so that it will not be snapped off.) Chinese seagoing rudders grew to many times the size of a man. Huge ships with enormous rudders were used on the Chinese voyages of discovery which preceded the European ones. The Chinese sailed round the Cape of Good Hope in the opposite direction to that taken by the Europeans and at an earlier time. They were also first to discover Australia, landing at the site now called Port Darwin. Chinese trade with the Philippines and Indonesia was common; and trade with the eastern coast of Africa was so extensive that pieces of broken Chinese porcelain are to be found scattered all up and down the beaches of Tanzania and Mozambique, dating back for centuries. The Chinese also made voyages to the American continents, though it is questionable whether they were return voyages. Many Asian influences have been identified in ancient America by Needham and others. But the Chinese who arrived were quite possibly stranded, unable to return home, owing to the greater difficulty of sailing westwards across the Pacific. Another traditional Chinese invention was the 'fenestrated rudder', which is simply a rudder with holes made in it. The Chinese soon discovered that while easing the task of turning the rudder through the water, the holes did not appreciably diminish its steering function. However, it was not until 1901 that fenestrated rudders were introduced to the West. Until that time, a coal-fired torpedo boat traveling at 30 knots was unable to turn its rudder at speed. Fenestration made this possible.

The earliest rudders in China were what is called 'balanced' rudders. This means that part of the blade projected in front of the post. Such rudders are easier to use, but Europeans did not adopt them until the nineteenth century. One of the earliest ships to use such a rudder was the Great Britain of 1843. The British were in the forefront when it came to adopting Chinese inventions for naval use, with this as well as the square-pallet chain pump as a bilge pump and watertight compartments in hulls. It is no exaggeration to say that the superiority of the British Navy was to a large extent due to its readiness to adopt Chinese inventions more rapidly than other European powers.





指南針

Magnetic Compass

The Chinese were using compasses to chart their course at sea almost two centuries before news of the Chinese invention reached Europe. As early as 500 B.C., both the Chinese and the ancient Greeks had discovered that a mineral called lodestone was magnetically attracted to iron. To create a south-pointing compass, the Chinese used a pointer—in the shape of a spoon or ladle—made of magnetic lodestone and a bronze plate with directions on it. The spoon was placed on the center of the plate, where it rotated and pointed south. The device was adapted for navigation as sea, as well as for "geomancy," a way of laying out buildings to conform to the earth's energy. By the ninth century, the spoon of the early compass was replaced by figures in the shape of a fish, or tortoise, and then later by magnetized needles. Eventually, the fish-shaped magnetized needle was placed on the surface of a bowl of water and was an effective navigation technique. The earliest European reference to a magnetic compass similar to the Chinese was in 1187.

火藥

Gunpowder

Gunpowder was invented in China and used to develop weapons like the cannon long before the substance was heard of in Europe. Chinese alchemists (scientists who study chemicals) first discovered gunpowder in the third century by mixing sulphur, saltpeter, and charcoal and then exposing the mixture to intense heat. By the time of the Song Dynasty, which began in A.D. 960, military manuals discussed gunpowder's ingredients and its uses for military purposes. Other documents warned soldiers of fatal accidents caused by the misuse of the weapon. Chinese soldiers used gunpowder to make fire arrows and to make the catapult more dangerous to their enemies. By 1259, the Chinese had made a gun barrel of bamboo with fiber wrappings. Just a few years later, the first metal gun barrel recorded in history was used in China. The Europeans and the Arabs later copied the Chinese model of the gun.

算盤

Abacus

The Chinese developed the abacus, a counting device, during the Song Dynasty. By the fourteenth century, the Chinese *suanpan*, or abacus, was perfected and given the form it still has today. The instrument consisted of a rectangular wooden frame with parallel rods or wires, each of which has strung on it seven flattened beads, or counters. The rods are separated into upper and lower parts by a crossbar. Two beads on each rod are above the bar, and five are below it. On a standard abacus, each bead above the crosspiece us worth five units, and each below is worth one. The rungs from right to left indicate units—tens, hundreds, and so on. With this instrument the Chinese could easily add, subtract, multiply, and divide. Brilliantly simple in design, this instrument makes addition, subtraction, multiplication, and division remarkably fast. The abacus became the basic calculating device in Asia and the Near East, and it is still widely used for commercial purposes.

活字版

Movable-Type Printing

Printing was one of the most significant inventions of the Chinese during the Tang and Song dynasties. Though woodblock printing—a time-consuming process done by hand—had been invented in China in the eighth century, a Chinese commoner named Bi Sheng created a faster way of printing, using movable type, around the year 1045. The movable-type method used reusable blocks of Chinese characters (words) that could be moved around on a page. Bi Sheng made his movable type by carving Chinese characters from clay and then baking the clay forms until they were hard. Each page of a text was printed after the necessary forms of the characters were placed into an iron frame, in which they were held with wax. Bi Sheng's invention and other Chinese developments in printing made printing books faster and easier, making more books available to more people. It wasn't until 200 years later that moveable-type printing was used in Korea, and 400 years later that it was developed in Europe.

紡車

Spinning Wheel

To meet the increasing demand for silk, China's greatest export, the Chinese developed the spinning wheel in A.D. 1035. Processing silk fibers was difficult because silk strands can run for hundreds of yards and can withstand the weight of 65,000 pounds per square inch. Chinese silk winders needed a machine to deal with the tough, long fibers. The answer was the spinning wheel, a simple circular machine—easily operated by one person—for winding fibers of silk into thread. The invention had two rimless wheels that were laced together with a criss-cross pattern of string (cat's cradle). A drive belt made the wheels spin. Italians who traveled to China during the Mongol dynasty brought the clever invention to Europe. The earliest picture of a spinning wheel in Europe dates from the fourteenth century; later, it came to America with early immigrants. The spinning wheel is still in use in China.

天花

Smallpox Inoculation

The first breakthrough in inoculation (introducing a weak form of a disease to treat or prevent a disease) against the small pox disease was made in China. Smallpox, or *Variola*—a deadly virus disease characterized by skin blisters drying to scab-coated pustules and leaving crater like scars—existed in Europe, Asia, and Africa from the tenth century onward. The technique of inoculation, or variolation, was first publically recognized in China when the eldest son of Prime Minister Wang Dan (A.D. 957–1017) died of smallpox. Hoping to prevent the same thing from happening to other family members, Wang Dan summoned physicians and other specialists from all over China. A Daoist monk brought the technique of inoculation to Wang Dan and introduced it to Chinese physicians in the capital. They continued to experiment with inoculation, and by the sixteenth century it was widely practiced against smallpox in China.

漏

Mechanical Clock

One of the greatest inventions of the medieval world was the mechanical clock, developed in China. Yi Xing, a Buddhist monk and mathematician, made the first model of a mechanical clock in A.D. 725. This clock—really an astronomical instrument that served as a clock—operated by dripping water that powered a wheel that made one full revolution in 24 hours. An iron and bronze system of wheels, shafts, hooks, pins, locks, and interconnected rods made the clock work. This system caused the automatic chiming of a bell on the hour and the beating of a drum every quarter hour. Yi Xing's first clock was called the "Water-driven Spherical Birds'-Eye-View Map of the Heavens." Three centuries later, the inventor Su Song made an even more sophisticated mechanical, or astronomical, clock. This clock, called the Cosmic Empire, included several floors housed in a tower over 35 feet high. It was also made of bronze and powered by water. On top was a platform with a sphere that kept time with the motion of the planets. Su Song developed his clock in 1092, two centuries before the mechanical clock was developed in Europe.

瓷

Porcelain

Ceramics made of porcelain was a Chinese invention that reached perfection during the Song and Ming dynasties. The Chinese had made pottery for centuries, but during the Tang Dynasty Chinese artists learned that a mineral, feldspar, could be added to white clay to make white porcelain. When the special clay, called *kaolin*, is fired at a high temperature it becomes translucent (partially see-through), water resistant, and extremely hard. During the Song and Ming dynasties, porcelain artistry reached new heights as hundreds of thousands of workers crafted the clay into porcelain statues and art objects that were the envy of many foreigners. Some porcelain statues and vases remained white, while others were decorated with patterns or painted. Chinese artists had been making ceramics from porcelain for 1400 years before Europeans finally developed the art in the eighteenth century.

飞钱

Paper Money

The Chinese invented paper money in the ninth century. Paper money was originally called "flying money" because it was so light and could "fly" out of one's hand. In previous centuries, the Chinese had used copper and sometimes iron as currency. However, this metal money was difficult to carry and transport because it was so heavy. When copper became scarce and printing on paper became more widespread, merchants began to issue their own bills of exchange and letters of credit—paper certificates that could be exchanged for cash—to customers and other merchants. In 1024, the Song government took over the printing of paper money and began to issue official certificates, which were used as currency. The idea of paper representing metal money led the Islamic money changers in the marketplaces to develop a checking system. Gradually, paper money and checking systems spread to the rest of the world.

Standard 7.3.5 **CHINESE INVENTIONS & INNOVATIONS** Name: _____

INVENTION/INNOVATION	YEAR	DESCRIPTION	EFFECT ON SOCIETY
The Spinning Wheel			
Smallpox Inoculation			
Paper Money			
Porcelain			
Magnetic Compass			
Mechanical Clock			
Moveable Type Printing			

INVENTION/INNOVATION	YEAR	DESCRIPTION	EFFECT ON SOCIETY
Abacus			
Gunpowder			
Writing paper			
Fishing Reel			
Rudder			
Bicycle			
Matches			
Sea-faring Ships			