Chapter 1 Lesson 4 Technology in the 1500s

Student Objectives:

- Review the invention, design, and uses of the printing press.
- Describe how the printing press works and its importance in history.
- Discuss the astrolabe and its use in navigation in the 1500s.
- Make, use, and test an astrolabe.

Worldview Integration:

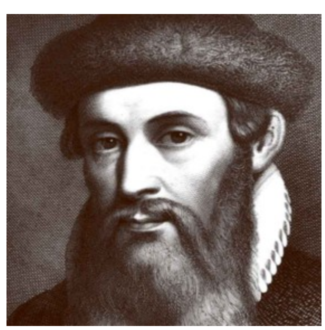
- God wants us to read, circulate, and explain his Word to others. (Acts 8:26-40; letters of Paul)
- God is the maker of the heavens and the Earth. (Genesis 1:1).
- God gave us the stars and constellations to help us navigate here on Earth. (Matthew 2:1-12).

Materials:

- **C1L4 "John Gutenberg and the Invention of the Printing Press" from *Great Inventors and Their Inventions* by Frank P. Bachman**, teacher resource
- **C1L4 Making a Simple Astrolabe**
- **C1L4 An Instrument with a Past and a Future,** teacher resource
- **C1L4 Printing Press Illustrations**, teacher resource
- Potatoes or soft objects that can be formed into letters
- Paper for printing press messages
- Ink or paint to dip letters into to "print" their messages

Introduction:

Two important inventions made possible what we call the Age of Discovery (AD 1400-1799). One was the application of an ancient tool called the *astrolabe—a compact instrument used to* observe sun, moon, stars, and other celestial bodies. The other was the invention of the *printing press* by Johannes (John) Gutenberg. He figured out the use of movable type. Because of the printing press and the travel journals of the explorers, people across Europe were able to read about a new world and its potential for trade and wealth to Europeans.



Johann Gutenberg (1395-1468)

Vocabulary:

movable type: a system or technology that uses movable components (letters) to reproduce the elements of a document

star: a natural luminous body visible in the sky especially at night

luminous: gives off or reflects light

constellation: a group or cluster of stars that often suggest a shape or animal on Earth

navigation: the science and practice of getting naval ships, aircraft, and spacecraft from one point to another

navigate: to steer a naval ship or operate an aircraft

navigator: one who steers a naval vessel or operates an aircraft

astrolabe: a compact instrument used to observe celestial bodies (stars and constellations)

celestial: having to do with the sky, heavens

illuminate: to decorate with gold or silver or brilliant colors or with often elaborate designs or miniature pictures

vellum: smooth material, in medieval times made from the skin of young animals, used for covering books or for writing on

Methods:

(This time ask the students these questions to ponder.)

Day 1:

- Question 1: How might the explorers have kept track of their travels and findings?
- Question 2: How might the news of Columbus and the other explorers' findings have spread through Europe?
- Question 3: What knowledge, technology, tools, and inventions made these trips possible?
- Read or tell the students the story of Johannes (John) Gutenberg, **using C1L4 "John Gutenberg and the Invention of Printing"** as your resource.
- Show students **C1L4 Printing Press Illustrations** and relate it to copiers and printers used today.

Day 2:

- Question 1: How might the explorers know where they are sailing?
- Read **C1L4 An Instrument with a Past and a Future and** share the information with your class.
- Using **C1L4 Build Your Own Astrolabe Kit** and **C1L4 Build Your Own Astrolabe Instructions,** have students make and used their own astrolabes.

Assessment:

- Students will relate the story of Gutenberg's printing press to today's copiers and printers in either a written five-paragraph narrative essay or an equivalent oral presentation using notes.
- Students will tell the story of the astrolabe and its uses in navigation during the Age of Exploration.

Extensions:

- Produce a note or letter on the printing press: Assign each alphabet letter to a different student. For instance, if there are 36 students in a class, two students can make the letter "a." One can make several capital "A's" and the other can make the lower case "a." Another pair of students can focus on the letter "Bb," and so forth through the alphabet.
- Students will enjoy the teamwork and artistry involved as they "print" their messages.
- Short Bible verses are great messages to print.
- Research influential artists and musicians during the time period of the Age of Discovery (AD 1400-1799)

Helpful, though not strictly required:

Modifications:

Students may work in partners to make and test their astrolabes.

C1L4 "John Gutenberg and the Invention of the Printing Press" from *Great Inventors and Their Inventions* by Frank P. Bachman, teacher resource

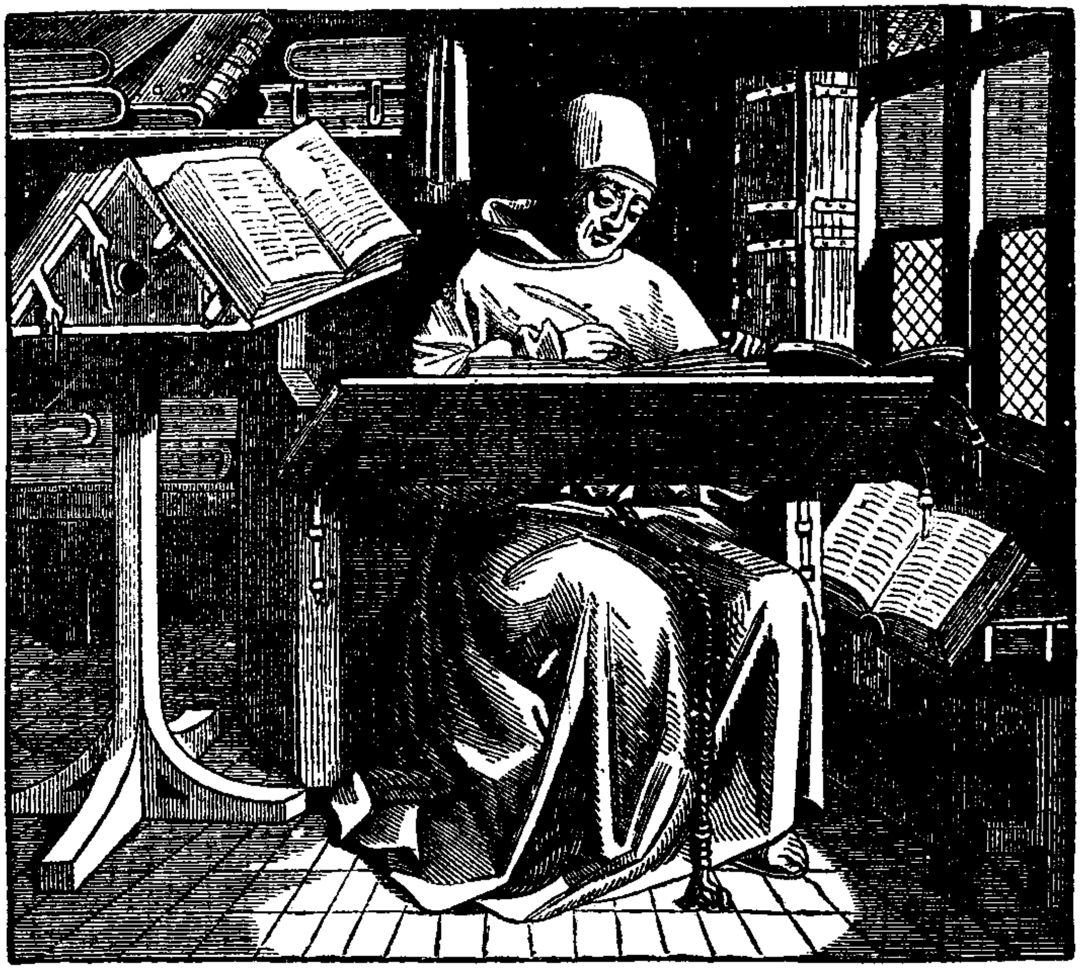
When Christopher Columbus was a boy, there were few books. Those he might have read were of two kinds, manuscript books and block books. Manuscript books were copies of the Bible, or of books of the Greeks and Romans, written out by hand.

Press work and typesetting, 1564.

Persons called copyists made a business of drawing or writing manuscript books. Most of the copyists were monks, who lived in monasteries, where often there was a room set apart for their work, called the writing room. Copying was slow work. To copy a book like the Bible took all of a year, and when this was done well it took two or three years.

Manuscript books were written on parchment or vellum. Parchment is made from the skin of sheep and goats; vellum from the skin of very young lambs and kids. The hair is cut from the skin. The skin is put in a mixture of water and lime, and kept there until the fat is removed. It is then taken out, and stretched and rubbed with pumice stone and lime, until thin and smooth.

The parchment and vellum sheets used in the manuscript books were, as a rule, ten inches [25 cm] wide and fifteen inches [38 cm] long. Broad margins were left on all sides. The first letter of the word beginning the first paragraph on a new page was omitted, as was here and there an important word.



Monk writing on vellum.

When the copyist had finished his work, the separate sheets were turned over to the illuminator or illustrator. The illustrator filled in the margins with a border of flowers or of foliage, interwoven with birds, animals, angels, or saints. The borders were drawn in blue, green, purple, brown, silver, or gold. The important words omitted were written in color, while elaborate initial letters were painted in at the proper places. These decorations gave to the best manuscript books an elegance and beauty beyond anything to be seen in books at the present time.

The illumination or decoration completed, the separate sheets were passed to the book-binder. Books of large size were bound in boards which were sometimes two inches [5 cm] thick. If the binding was not to be ornamented, the board backs were covered with pigskin. If it was to be ornamented, the covering liked best was calf or goatskin. Upon the ornamentation of the bindings of the best books, there worked gilders, jewelers, engravers, and painters. Some of the most famous books were covered with enameled brass, others with ivory, and still others with gold and silver studded with precious stones.

Illuminating pages of a manuscript book by hand.

Because of the work put upon them, manuscript books were sold at a high price, and only the rich could afford to buy them. A Bible, only fairly well written and bound, cost from a hundred and fifty to two hundred dollars. At that time the wages of a laborer were fifteen cents a day, the price of a sheep twenty-five cents, of a cow two dollars, and of a horse five dollars.

Block books, on the other hand, were mostly plain, and made up of a few pictures or of illustrations, interspersed with printed explanations or religious precepts. The *Evangelists*, the first of the block books, had, for example, thirty pages. Fifteen of these were printing, while the other fifteen were full-page pictures. The *Bible of the Poor*, the most famous of the block books, consisted of forty pictures. These were seven and a half inches [9 cm] wide, and ten inches [25 cm] long.

The block books were so named because they were printed from carved or engraved wooden blocks. In making a block book, a piece of oak, ash, cherry, or apple wood was cut two inches [5 cm] thick, and the width and length of the desired page. One side of the block, or the face, was smoothed and polished. On this was placed a drawing of the picture, and of the writing to be printed. The surrounding parts of the block were then cut away, so as to leave the picture and the letters of the writing raised, or in relief, making a sort of stamp. This carving required much skill, and the engraving of a single book consumed weeks and even months.

Page of the *Bible of the Poor*, a block book.

The engraving completed, the rest was easy. The carved block was covered with a coat of thin ink. A sheet of parchment or paper was placed upon it and pressed gently with the flat back of the inking brush. This transferred an impression of the carved picture and writing to the parchment or paper. The different printed sheets were then bound together.

Any number of books could be printed from the same set of blocks; for this reason block books were cheap. The *ABC's* and the *Lord's Prayer* cost two cents, the *Catechism* twenty cents, *Donatus or Boys' Latin Grammar* twelve and a half cents, and the *Bible of the Poor* two dollars. But only small books could be multiplied in this way, for the carving of the blocks was slow work. To prepare the blocks to print the Bible would take at least thirty years, which of course was never done.

John Gutenberg changed all this. He did it by inventing the art of printing from movable type

Gutenberg was born about the year 1400, at Mainz, a German city on the Rhine, near Frankfort [Frankfurt]. His parents were of noble blood, and people of means, who took a prominent part in the affairs of the city. Nothing is known of Gutenberg's boyhood days, other than that they were passed amid scenes of strife between the common people and the nobility.

When John Gutenberg was a boy, it was thought beneath the dignity of one of noble birth to do any ordinary labor, or to learn a **trade.** Despite this belief, he learned not one, but two trades. He learned the art of cutting and polishing precious stones, and of mirror making.

It is not an easy task today to learn a trade. It was even more difficult when John Gutenberg was a boy. The trades at that time were in the hands of guilds, or, as we would say, trade unions. Of those in a trade, only the master workmen were allowed to teach it. The number of boys a master workman might take to teach was limited. The boy while learning the trade, which took from five to seven years, received no wages. Instead, he often had to pay a considerable sum for his instruction.

A boy on undertaking to learn a trade became an **apprentice**. As an apprentice, he ran errands, brought tools and materials, took care of the shop, and assisted in other ways. After two years or more, he rose to be a **journeyman** and served a second two years. In this period, he learned how to handle and to use tools, and how to do simple kinds of work. In the last two or three years of his service, the journeyman conquered the more difficult parts of the trade. As a kind of final examination he made what was called a **masterpiece**. This was examined by a committee of master workmen. If they were satisfied with his workmanship, he was admitted to the guild at a great banquet held at his expense and given the right to set up in business for himself.

A long time to learn a trade? Yes. But John Gutenberg learned two, and at thirty-five was well established at Strasbourg with a good paying business. He was also sought out by young men wishing to become cutters of precious stones or makers of mirrors, and was paid for teaching them these arts.

The idea came to Gutenberg, that all words, all writings, all languages are expressed in a small number of different letters. Our language has, for example, only twenty-six letters. With a large number of letters properly set together, a whole page of text could be printed at once. By resetting the different letters, and by repeating the process of printing, large books could be swiftly multiplied. This idea took possession of him, and after 1436, to the neglect of everything else, he gave his time, his energy, and his fortune to working out the process.

Should you go into a newspaper office and see a printing press print, cut, paste, fold, and deliver in sixty minutes forty-eight thousand newspapers of sixteen pages each, it would be natural to think that the most important part of printing is the press. The most important part, in printing, however, is the type, or the little movable metal letters. For this reason, the key to inventing printing lay in finding the right kind of metal, and in finding an easy way of making type.

Knowing that block books were printed from carved blocks, Gutenberg first tried to make type from wood. It would seem easy to do this. Yet it proved difficult to carve a good letter upon the end of a small wooden stick. It proved equally hard to cut the sticks of such width that there would be equal spaces between the letters. Even when Gutenberg succeeded in doing this, for he was an expert carver, the ink so softened the wooden type that after a few impressions the printed letters became blurred. As the printed letters must be clear and distinct, Gutenberg was forced, much against his will, to give up trying to make movable type from wood.

It now occurred to him that lead would serve. From his work in making mirrors he knew how easy it was to mold it. With a simple mold he cast a number of small lead sticks of uniform width and height, and then with no great difficulty he carved a letter on the end of each stick. He seemed to be on the direct road to success, but when he came to print from lead type, he found that it took more pressure than with wooden blocks, and when the pressure was sufficient to transfer the impression to the paper, the lead letters were flattened out.

Since lead was too soft, Gutenberg thought that iron might do. It proved difficult to mold small iron sticks. The iron stuck to the mold, and the sides of the little sticks were so rough that they would not fit closely together. Expert as Gutenberg was, it was slow work to cut the letters. Worse yet, when the letters were cut, so much pressure had to be used in printing that the hard iron type cut into the paper.

These attempts at making type from wood, lead, and iron took weeks and months. Thus a great deal of time and labor seemed lost. Yet this was not all true; for Gutenberg learned from these trials that a metal would have to be found, out of which to make type that could be easily cast. He learned that this metal would have to be harder than lead, but softer than iron. He also learned, from trying to cut metal letters, that a mold would have to be invented in which the type could be cast.

As lead could be easily molded, and was at that time one of the cheapest metals, Gutenberg set about finding a metal to mix with lead, to give it the needed hardness and toughness. Many are the mixtures he must have tried. On one day, this and that combination of lead and copper was tested. On another, lead and brass were combined, now in this and now in that way; and so on, week after week, month after month. Some of the combinations were fairly good, but Gutenberg was never satisfied with half success. He worked on and on, until he hit upon combining five parts of **lead,** four parts of **antimony**, and one part of **tin**. The lead supplied the bulk of the type, the antimony the hardness, and the tin the needed toughness. This mixture of metals proved satisfactory. Strange as it may seem, it is about the one used today. No better combination of metal for type has ever been found. It is known as **type metal,** and is only one of the great discoveries of Gutenberg.

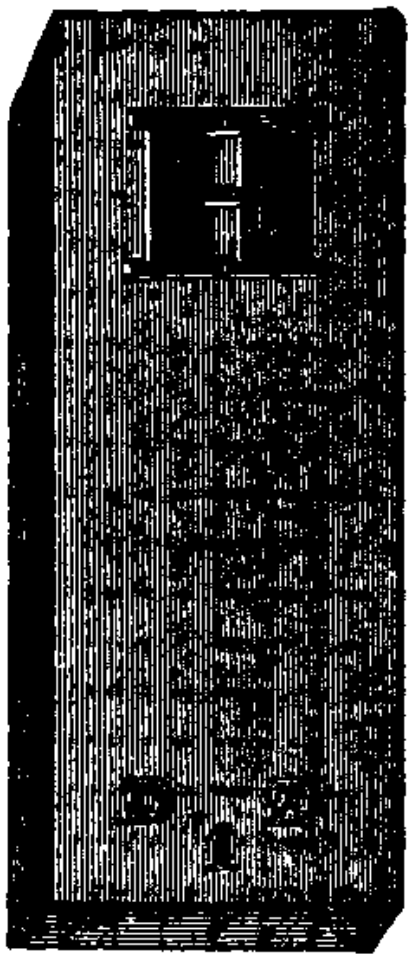
While Gutenberg was trying to find a metal suitable for type, he was at the same time working upon a mold. Unless an easy way of casting metal type could be found, printing from movable letters could never be made a success.

To understand what he really invented, let us see what tools are now used in making type. The most important of these tools are the punch or master type, the matrix or mold for the face of the letter, and the mold in which the body of the type is cast.

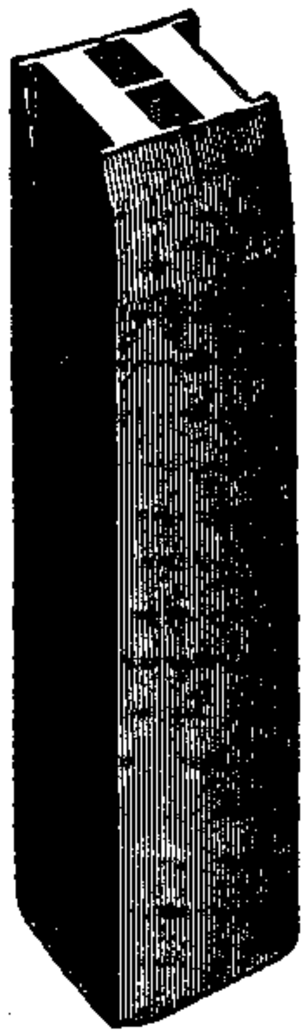
The **punch** is made by taking a bar of steel about six inches [15 cm] long, and of the width of a printed letter, and three or four times its thickness. Upon one end of this bar is drawn, say, an *H*. The surrounding parts of steel are then cut away until the letter stands out in bold relief. Each separate letter, both small and capital, requires a separate punch.

The **matrix,** or mold for the face of the letter, is made by taking a bar of copper half an inch [1.2 cm] thick, and about twice the width and four times the length of a printed letter. A punch is driven into this with a sharp blow. The result is the sunken imprint in the copper of the letter on the punch. This sunken letter becomes a mold for the face of the letter.

The **mold** consists of two halves. When these halves are put together, their inner sides face each other and form an opening. On the lower side of the mold, and just under the opening, is a place for fastening the matrix. On the upper side, the opening is left open for the inflow of the molten type metal. A dozen or more molds are needed for each set of type.



a

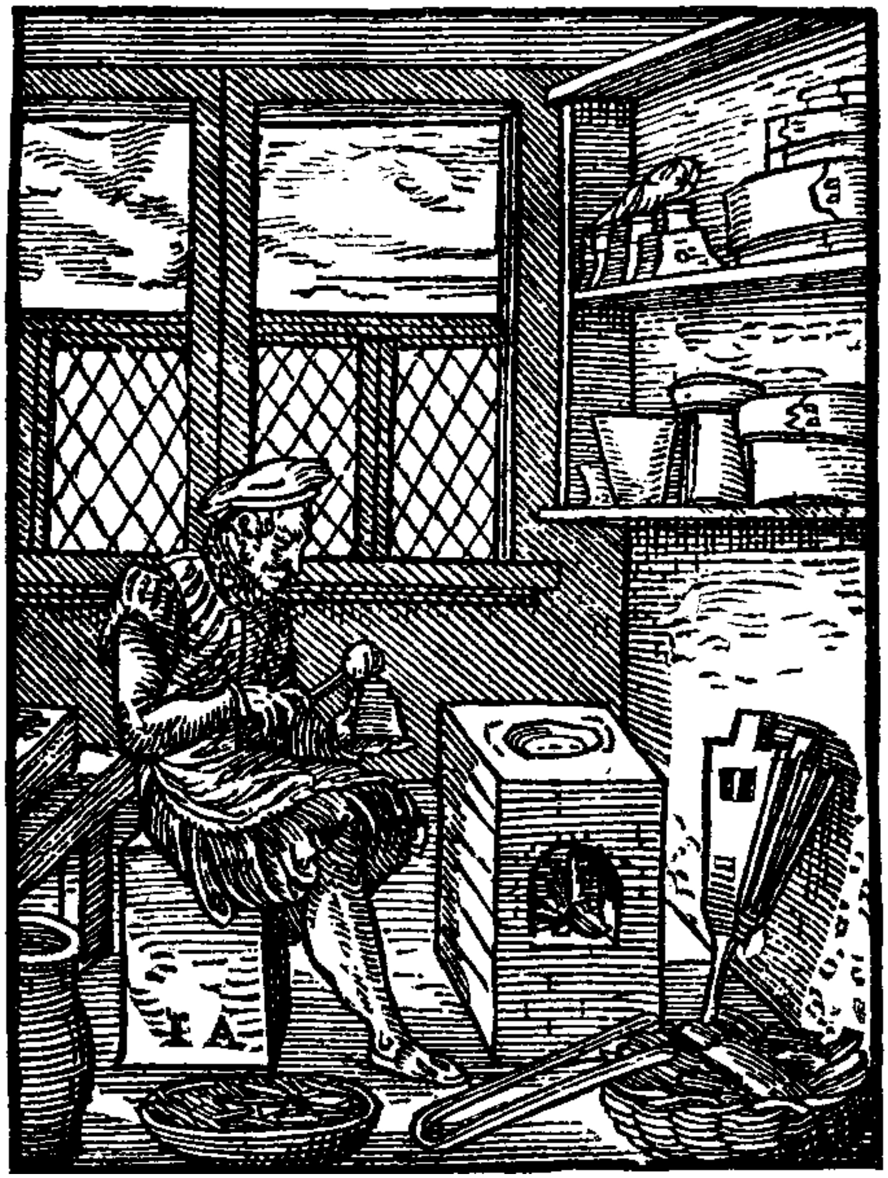


b

***A*, Matrix, AND *B*, Punch of the Letter *H*.**

(The barely visible characters *D, 1, E*, are private marks of the type founder.)

It was easy enough for Gutenberg to make a mold with which he could cast metal sticks of the same thickness. The difficult problem was to make one which would cast metal sticks of different widths, and at the same time form a letter on the end. He tried many ways of doing this. Months passed before the idea of a separate mold for the face of the letter occurred to him. Matrices [plural for matrix] were then made of lead, of iron, and of brass. In some, the impress of the letter was cast; in others it was cut or engraved. But no sooner was one made, than it was put aside. Still other months went by before he thought of the punch. Molds for the body of the type were made first in one way, then in another. Some were of iron, others of lead, and still others of copper, but not one would do. How many years he toiled, in hope and in despair, no one knows. We only know that by trying again and again, and never giving up, he learned that the mold should be of two like, adjustable parts and that the punch should be of steel, and the matrix of copper.



Beginnings of Type Casting.

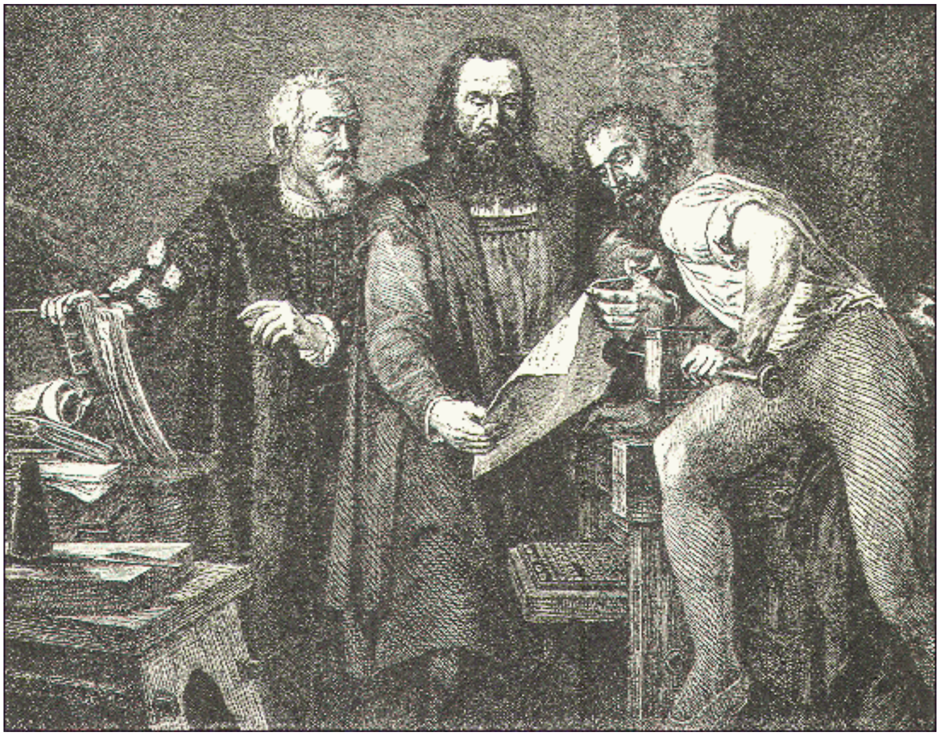
Thus by patient toil, Gutenberg invented the tools needed in casting type. With them he could easily cast two or three thousand letters a day. So well did he do his work that more than four hundred years have made [few] changes in these tools, or in the metal from which they are made. Although type-casting machines are now employed, which cast a hundred type a minute, the punch, the matrix, and the mold invented by Gutenberg are in all important points like those in use at the present time.

No press was needed in making either manuscript or block books. But when Gutenberg came to print from metal type, he discovered that considerable pressure was required to transfer the likeness of the letters to the parchment or paper. That this pressure might be quickly given and be uniform over the face of all the type, it became necessary to invent a **press**.

Gutenberg modeled his printing press after the wine press then in use. It had two upright posts of great strength. These were placed four feet [1.2 m] apart, fastened at the bottom to a solid wooden base, and joined together at the top by a heavy crossbeam. The middle of this crossbeam held an iron screw worked by a lever. On the lower end of the screw hung a heavy block of wood called the **plate**, the underside of which was flat and smooth. By turning the screw, the plate could be forced up or down. Between the two upright posts, and upon the base of the press, stood a strong, four-legged stool, which served to support a heavy wooden platform, four feet wide [1.2 m] and six feet [1.8 m] long. Upon this was laid the form, or the wooden frame in which the type was locked. Crude as this printing press was, it served Gutenberg well, and presses like it were the only kind used for more than a hundred and fifty years.

The only **ink** at the time was the writing fluid of the copyists. Gutenberg found that when this was employed in printing, instead of forming a thin black coat over the type, it collected in drops and blotted the paper. Another kind of ink had to be made, if printing from metal type was to be a success. The Italian painters had lately invented a new paint composed of lampblack [made from soot] and linseed oil. It was probably from them that Gutenberg got a suggestion which turned him in the right direction. At any rate, he hit upon mixing lampblack and boiled linseed oil, and this mixture proved satisfactory. Printer's ink is still made in the same way.

Gutenberg seemed to be standing upon the threshold of success, but events intervened to rob him of his reward. For a number of years he had worked night and day, upon different parts of his invention. Into it went, little by little, all the money he had saved, and all he had inherited. To be able to support himself and to continue his work he took three men into partnership. These men paid him a considerable sum of money for their part, and were to share in the profits of the enterprise. As was then the custom, they were sworn to secrecy. Their plan was to complete the invention and print a small religious book. Though Gutenberg and his partners worked steadily for two years, the invention was not complete before the Christmas of 1439.



Gutenberg examining proof.

The cost of the enterprise, the faith of these men, and the will with which they worked are shown in a talk between Andrew Dritzehen, one of the partners, and a Frau von Zabern:

“But will you not stop work, so that you can get some sleep?”

“It is necessary that I first finish this work.”

“But what a great sum of money you are spending. That has, at least, cost you ten guilders.”

“You are a goose; you think this cost but ten guilders. Look here! If you had the money which this has cost, over and above three hundred guilders, you would have enough for all your life; this has cost me at least five hundred guilders. It is but a trifle to what I shall have to spend. It is for this that I have mortgaged my goods and my inheritance.”

“But if this does not succeed, what will you do then?”

“It is not possible that we can fail. Before another year is over, we shall have recovered our capital and shall be prosperous.”

Dritzehen died a few days later. His death left Gutenberg in a bad plight. The two remaining partners became discouraged and were ready to give up. Frau von Zabern told of her conversation with Dritzehen, and the circumstances of his death caused other people to talk. Gutenberg grew fearful that others would learn of the new art. He sent to Dritzehen’s home, and warned the people there to let no one see the press. The molds and type he melted. George, the brother of Andrew, now demanded that he be let into the secret, or that the money Andrew had spent on the enterprise be paid back. Gutenberg refused to tell him of the nature of the undertaking, and claimed that instead of being in debt to Andrew, Dritzehen died in debt to him. The dispute was taken to court, where, after a year of delay, it was settled in favor of Gutenberg.

During the trial, witnesses spoke of the “secret work” Gutenberg was carrying on; they spoke of the “beautiful things,” of the “costly things” he was making. No one knew just what he was doing. There was a lot of mystery about the whole enterprise. People began to say: “He doesn’t want anyone to know.” “He is not willing anyone should see.” “Something is wrong.” “He is practicing the Black Art.”

So great was the prejudice against him, and he was now so poor, that it was impossible for him to go on. He went back to polishing precious stones and making mirrors.

Gutenberg was not long content, however, to work at his trade only. After a year or two, he began to think again of his invention, and to spend his evenings upon punches, matrices, and molds. He finally decided to return to Mainz, and set up a printing press.

For four or five years after returning to Mainz, he did what we should call job printing. His success was so marked that a rich money lender became interested. Their plan was to print the complete Bible. It was to be printed in Latin, and was to look in every way like the best of the manuscript books.

The pages were printed in two columns of forty-two lines each. These columns, with the space between of five eighths of an inch [1.9 cm], made a page eleven and a half inches [29 cm] long and seven and three fourths inches [19.7 cm] wide. Great spaces were left for initial letters, and a wide margin was allowed for a border. It often happened that the space for the initial letter and for the border was not filled in. Yet some of the early printed books rival in beauty of decoration the most famous manuscript books.

The entire Bible, when printed in this way, covered twelve hundred and eighty-two pages, and was bound in two large volumes. It is known as Gutenberg’s first Bible, and was the first great work to come from the printing press. An undecorated copy on paper could be had then for four dollars. A decorated copy on vellum was lately sold in London for seventeen thousand dollars.

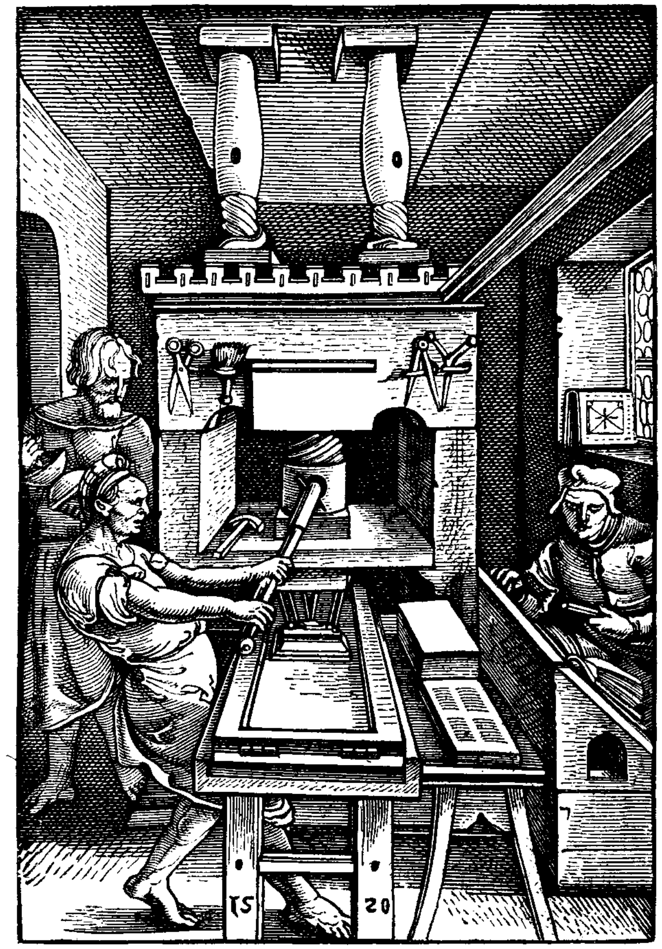
When Gutenberg entered upon the bold plan of printing the entire Bible, he thought he could have it ready for sale within three years. Plan and toil as he might, three years passed, four years went by, and it was late in the fifth, or towards the end of 1455, before the printed pages were ready to be bound. Yet at last, after five years of disappointment, hard work, and trials, the task was done, and the printed Bible was ready for sale.

But Fust, the money lender, did not go into partnership with Gutenberg to help him perfect a great invention and to aid him in printing the greatest of all books. He thought that he saw in the new art a means of making money. He had invested a large sum in the enterprise. After five years, not one cent of this had been returned, nor had he received one penny of profit. This was too much for the money-greedy Fust.

[<https://dart120nvc.wordpress.com/2014/09/02/gutenberg-bible/>accessed 11.29.2017.2:33p.ab]

Part of a page of Gutenberg's Bible.

With the Bible printed and ready for sale, he saw his opportunity. He would seize the molds, the type, the presses, and all the printed Bibles. In this way he could get back all, and even more than he had invested. To do this, he brought suit in the court for the return of all the money he had spent on the undertaking. An unjust judge decided in his favor. As Gutenberg had no way of paying such a large sum, Fust seized everything, and turned Gutenberg out.



Printing books in 1520.

Gutenberg was not, however, to be neglected in his old age. As a reward for his services to the church and to the world, the Archbishop of Mainz made him, in 1465, a gentleman at court, and gave him a pension for life. The pension supplied him with a home, with food, and also with clothing, for the quaint document reads: “We will clothe him every year, always like our noblemen, and give him our court dress.”

Gutenberg was not to enjoy his leisure or the honors of a nobleman long. In February, 1468, he became sick and died. He was laid to rest at Mainz.

Though he died loaded down with debts, and with but few friends by his side, great honors were to come to him as the inventor of the greatest of the modern arts. On one of the first tablets erected to his memory is this inscription: “To John Gutenberg, of Mainz, who, first of all, invented molding letters in brass, and by this art has deserved honor from the whole world.” Monuments honoring him are now to be found in many places. His greatest monument will survive them all. It is the printed book.

[<http://www.mainlesson.com/display.php?author=bachman&book=inventors&story=gutenberg&PHPSESSID=0a3d5ca6ff8522fef4de610fef6ebc44>accessed09.20.2016.10:03a.adb.]

C1L4 Making a Simple Astrolabe

History of the Astrolabe

The astrolabe was invented in Greece either by Hipparchus, a second century BC astronomer, or Apollonius of Perga, a third century BC mathematician. For many centuries, it was used by both astronomers and navigators, and especially by the 15th century explorers who used it to determine latitude, longitude, and time of day.

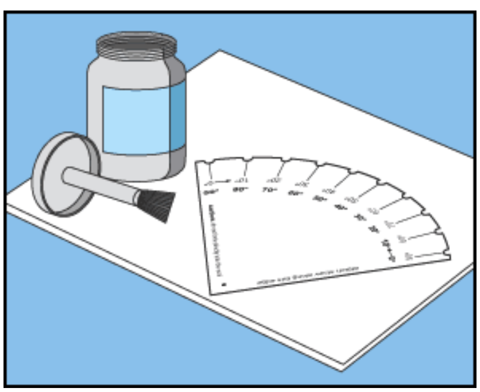
About this Activity

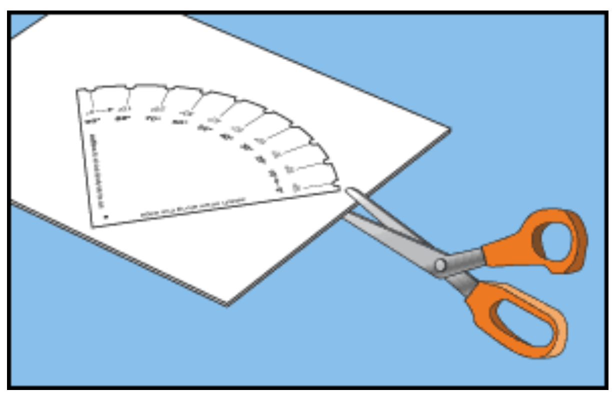
An astrolabe /AS troh Layb/ is a device used for measuring altitude, including the height of objects in the sky. This activity covers the construction of the astrolabe.

Supplies:

- 1 copy of 07 Astrolabe Drawing
- 1 piece of cardboard, manila file folder, or other stiff paper.
- 1 piece of dark thread or string 30 cm long
- 1 small weight such as a metal washer or small nail
- 1 plastic drinking straw
- 1 container of glue or paste
- 1 pair of scissors
- 1 roll of tape
- 1 paper hole puncher

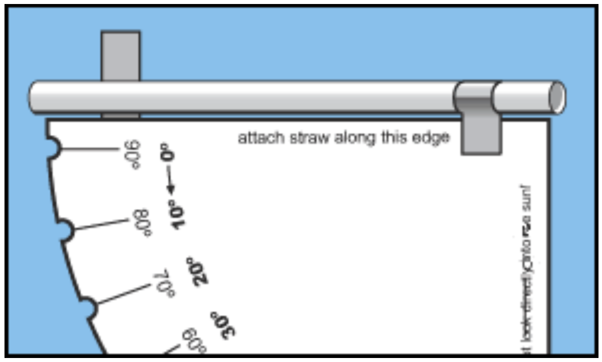
1. Make a copy of 07 Astrolabe Drawing for each student.
2. Glue the copy of the astrolabe drawing to a piece of cardboard or file folder. Cut the astrolabe out with scissors.



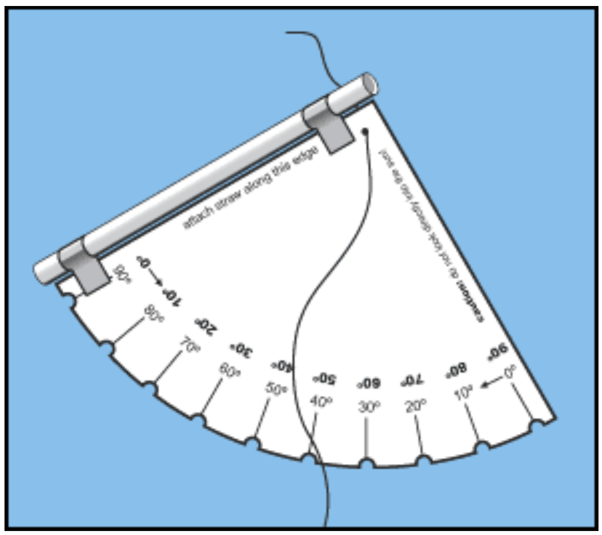


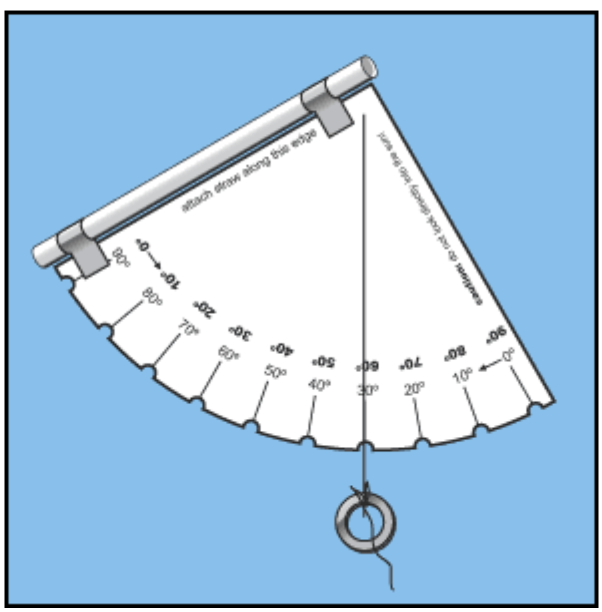
3. Using scissors or a paper hole-puncher, carefully make a small notch at each of the lines marked along the curved edge of the astrolabe. These notches will come in handy when you're measuring the angle between two celestial objects and you have to hold the astrolabe horizontally.
4. Cut a drinking straw to the same length as the sides of the astrolabe.

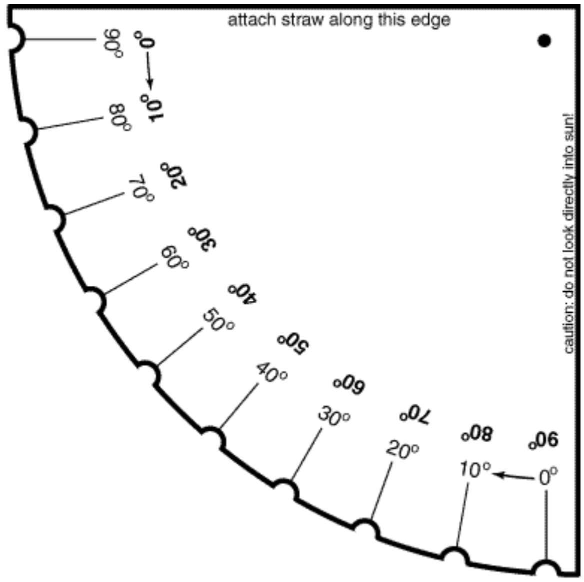
5. Tape the drinking straw to the edge of the astrolabe marked “Attach straw to this edge.” Be careful to not tape the straw on the astrolabe, but just on the edge.



6. Carefully poke a small hole through the astrolabe where the “X” is marked, pass the string through it, and either knot the string at the back of the cardboard or tape it there.







07 Astrolabe Drawing

7. Tie the small weight to the opposite (front) end of the string as shown.

You have now constructed an astrolabe!

[<http://cse.ssl.berkeley.edu/AtHomeAstronomy/act07_astrolabe.html>accessed09.20.2017.3:30p.adb]

C1L4 An Instrument with a Past and a Future

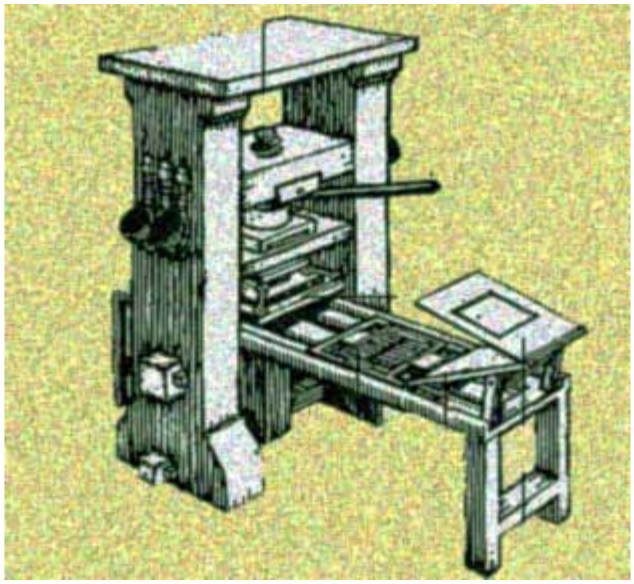
The astrolabe is a very ancient astronomical computer for solving problems relating to time and the position of the sun and stars in the sky. Several types of astrolabes have been made. By far the most popular type is the *planispheric astrolabe*, on which the celestial sphere is projected onto the plane of the equator. A typical old astrolabe was made of brass and was about 6 inches (15 cm) in diameter, although much larger and smaller ones were made.

Astrolabes are used to show how the sky looks at a specific place at a given time. This is done by drawing the sky on the face of the astrolabe and marking it so positions in the sky are easy to find. To use an astrolabe, you adjust the moveable components to a specific date and time. Once set, much of the sky, both visible and invisible, is represented on the face of the instrument. This allows a great many astronomical problems to be solved in a very visual way. Typical uses of the astrolabe include finding the time during the day or night, finding the time of a celestial event such as sunrise or sunset and as a handy reference of celestial positions. Astrolabes were also one of the basic astronomy education tools in the late Middle Ages. Old instruments were also used for astrological purposes. The typical astrolabe was not a navigational instrument although an instrument called the *mariner's astrolabe* was widely used in the Renaissance. The mariner's astrolabe is simply a ring marked in degrees for measuring celestial altitudes.

The history of the astrolabe begins more than two thousand years ago. The principles of the astrolabe projection were known before 150 BC, and true astrolabes were made before AD 400. The astrolabe was highly developed in the Islamic world by 800 and was introduced to Europe from Islamic Spain in the early twelfth century. It was the most popular astronomical instrument until about AD 1650, when it was replaced by more specialized and accurate instruments. Astrolabes are still appreciated for their unique capabilities and their value for astronomy education.

[<http://www.astrolabes.org/>accessed09.20.2016.4:36p.adb.]

C1L4 Printing Press Illustrations



Printing Press

Letters used for a printing press. Notice that the letters are backward. Can you pick out any words?

[<https://carnivalofsorts.files.wordpress.com/2010/06/dsc04445.jpg>accessedo3.01.2019.2:36p.ab]