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Some Applications of Mathematics in other Sciences

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Abstract

Mathematics is involved in all sciences, not just science, but all areas of life. Because mathematics has to do with all areas of life, it is very important which is not limited to proving the various theories in physics and chemistry only, but also in geology and biology and many the other sciences, and mathematics enters our daily lives without feeling, as mathematics is an integral part of our daily work such as business administration and our daily problems. We must mention the history of mathematics as well; it is one of the most important and oldest sciences on which the rest of the other sciences.

Key Words:

Electroencephalography , Biometrics , Interdisciplinary field , Epidemiology

Introduction

Mathematics is the foundation and key to all sciences, which extremely important in teaching other subjects and conducting research. However, this has always been the case, and mathematics has never been more important than it is now.

Science is worthless without mathematics since chemical reactions, scientific theories, and element details can only be created/calculated via maths. Mathematics is also applied in many fields, including work, energy, electricity, motion, gravity, and magnetism.[1]

Carl Friedrich Gauss and Leonard Euler were two of history's most distinguished mathematicians, making significant contributions to a variety of scientific subjects. Gauss, sometimes known as the "Prince of Mathematics" he conducted groundbreaking research in space, analytical geometry, and applied physics. His conducted extensive research in applied mathematics, including statistics, algebra, and mathematical physics. And his most notable works are "Number Theory," "Subjective Space," and "Regional Space."
Euler pioneered various mathematical concepts and procedures that influenced a variety of domains, including physics, engineering, and biology, and he made significant contributions to mathematics, physics, engineering, and computer science. Also, he created concepts like algebra, analysis, and quantum mechanics and he demonstrated numerous fundamental mathematical discoveries in fields such as rational numbers, sequences, and electromagnetic transformations.
Gauss and Euler's contributions to mathematics, as well as their applications in other scientific domains, demonstrate the importance of mathematics as a foundation for understanding and advancement.
In addition, famed physicist Einstein and distinguished chemist Hermann Black were among the scientists who actively used mathematics to construct their theories and produce key discoveries in their respective domains.
Einstein, who created the theories of special and general relativity, relied heavily on mathematics to guide his thoughts and create physical models. His sophisticated mathematical calculations were critical in comprehending unusual physical phenomena such as the curvature of space routes and the link between time and space.
Black's study focused on biochemistry and chemical interactions in living organisms. He employed mathematics to analyse data and predict chemical interactions, resulting in a greater understanding of cellular life processes.
Throughout history, many other scientists have employed mathematics significantly to build their theories and discoveries, including Isaac Newton in physics, Alan Turing in astronomy, George Boyle in chemistry, and many more. The advanced use of mathematics was critical to the growth of science in many domains.[2]

The relationship between mathematics and physics

Mathematics is the language of physics, where physics attempts to find mathematical solutions to explain natural phenomena and formulate them into comprehensive theories. Mathematics is not only a tool for calculation and obtaining final results, but also the main source of concepts and principles in new theories of natural science. Therefore, Einstein's theory of relativity was formulated with the help of geometric laws in quantum mechanics.

Physics and mathematics are closely related. Various laws and principles of physics are expressed mathematically to describe the behaviour of the physical world.

The belief that “numbers rule the world” demonstrates the importance of mathematics.

In 1845 AD, astronomers noticed that Uranus was moving in an unusual way that was inconsistent with Geneva's law of gravity. After doing various calculations with new paper and pen,

Two scientists, Urban Louvre and John Adams, suspected that Uranus' unusual movements were causing the formation of new stars, but no astronomers noticed this. The two scientists then instructed the observatory to point the telescope in a specific direction in the sky to observe this new world. Observing scientists ignored the request as a crime and wanted to know: could he spot the planet with the tip of his pen and tell us where to point the telescope?

Shortly thereafter, Neptune was discovered. This led Hungarian yoga scientist Eugene Wagner to call the phenomenon "the incredible effectiveness of mathematics in nature."[3]

It is obvious that the nature around us follows order and consistency: everything follows certain laws; including nature that follows certain mathematical patterns. For example, if we take Newton's law: the force between two objects in the universe is equal to the product of their masses divided by the square of the distance between them, we see that it involves mathematical operations such as multiplication and division.

For centuries, professional mathematicians developed abstract, intangible ideas, and physicists discovered that after a while, natural phenomena began to behave exactly according to these ideas.

Partial differential equations, along with the Schrödinger equation, are a new state-change filter for physical processing of time, proposed in late 1925 by the Austrian physicist Erwin Schrödinger and published in 1926. They describe the complete state of a time-dependent quantum system. This implication is particularly important in quantum mechanics, which takes happiness into account

Newton's second law is considered the basis of good health.

Time-dependent Schrödinger equation:

$$\hat{H}\Psi = i\,\hbar \left(\frac{\partial \Psi}{\partial t}\right)$$

Ψ = time-dependent wave function

$\hbar$: Planck's constant

i = imaginary unit

$\hat{H}$= Hamiltonian factor [4]

Newton's first law

An object at rest remains at rest and an object in motion remains in motion unless a force acts on it.

The first law states that when the net force (the sum of the directions of the forces acting on an object) is zero, the velocity of an object is constant. consider speed

$$\sum F = 0 \quad , \quad \frac{dv}{dt} = 0$$

Examples of Newton's first law:

The golf ball on the field while it is at rest at the starting point is affected by the external force exerted on it by the player's swinging golf stick when it comes into contact with it, which leads to its state of balance being disrupted and its movement.

Newton's Second Law

The acceleration of an item is immediately proportional to the internet pressure performing upon it and inversely proportional to its mass

$$F = m \times a$$

Where in F is the pressure carried out to the object, m is its mass, and a is its acceleration.

Example of Newton's Second Law:

Below are some questions on Newton's Second Law, and an explanation of the mathematical relationships that represent this law: A car with a mass of 1000 (kg) and moving with an acceleration of 4 m/s^2, what is the amount of force acting on it? By applying Newton's law of motion, which is force = mass × acceleration. Force = 1000 kg × 4 m/s^2, and after doing the math, force = 4000 (Newtons).

Newton's Third Law (**Action and Reaction**):

Every action has an equal and opposite reaction. In other words, if object A exerts a force on item B, object B will respond with an equal magnitude force in the opposite direction on object A.

In classical mechanics, these three principles serve as the foundation for understanding object motion and the effects of forces.[5]

Kepler's laws of planetary motion:

The law of equal areas: It is mathematically expressed by the equation $A = \frac{1}{2}mv^2t$, where A is area, m is mass, v is velocity, and t is time.

The law of periodic time: It is mathematically expressed by the equation $T^2 = kR^3$, where T is the time period, k is a constant, and R is the radius of the planet's orbit.

In physics, circular motion refers to an object moving at a constant speed and changeable direction around a circle with a constant diameter.

The equation expresses the law of circular motion, which is connected to the speed of the body and the radius.

$$V = \frac{2\pi r}{t}$$

If you have an object moving in a circle with a radius of 2 meters and a rotation period of 4 seconds, you can calculate the speed using the equation $V=2\pi r/t$

Integration can be used to calculate the velocity and acceleration of any object moving in space, for example, if we know the velocity v(t), the acceleration a(t) can be calculated at any moment using the integration.

$$v(t) = \int a(t)dt$$

Einstein developed a theory in which he explained the nature of light called (quantum light theory) and states that light is small amounts of energy called photons and each photon has energy depends on the frequency of light.

$E = h \times f$

For example, if the frequency of light is 5×10^{14} Hz, then to calculate the energy of the photon

$$E = 6.63 \times 10^{-34} \times 5 \times 10^{14} = 3.315 \times 10^{-19}$$

This example illustrates how quantum theory can be used to calculate the properties of light at the particle level

Geometry.

They are used in physics to describe the motion of objects and design devices. Euclidean and non-Euclidean geometry are used in physics to describe spacetime.

Probability theory:

Used in physics to describe random phenomena such as radioactive decay. Mathematics is used to calculate the probability of a particular event occurring.

Statistics:

It is used in physics to analyse data and determine relationships between variables. Mathematics is used to calculate the mean, standard deviation, and probability distribution of data.[6]

The relationship between mathematics and chemistry

Chemistry studies the properties of matter and atoms and the various interactions between materials to create new materials. Therefore, mathematical operations are fundamental to these topics, whether it is determining the number of atoms and masses or determining ratios. Various substances, whether liquids, solids or gases, or finding unknowns in equations or balancing chemical equations. There is no doubt that chemists study mathematics deeply and are able to calculate everything related to chemistry. There is also a branch of chemistry called mathematical chemistry, which is one of the research branches that studies the application of modern mathematics in chemistry. Mathematical chemistry deals primarily with mathematical models of chemical phenomena. Mathematical chemistry is sometimes called computational chemistry, but we should not confuse this term with computational chemistry. But I did. They are verbal expressions and I also converted them into mathematical expressions to make them easier to understand and absorb, and also to understand the atomic masses of the elements. Regarding the application of mathematics in chemistry, you can check the following examples:

Measuring Materials:

When measuring materials, we need to use some tools. These tools have numbers and units that give results for the material being measured, such as: balances and thermometers that measure the weight of the material.

Converting Units in Chemistry:

conversion is done between different units so that an individual can choose the appropriate unit recognized by his or her environment. Kelvin, Fahrenheit or Celsius, it relates them using mathematical expressions.[7]

Mathematical equations in chemistry can be solved by following steps:

1- Understand the chemical reaction inserted into the equation.

2- Analyze the left and right sides of the equation.

3- Assign the number of atoms on the left and right sides Add equilibrium coefficients if necessary.

4- Calculate the reaction Amounts of mass and volume used and available for the reaction.

5- Calculation of moles of liquids and gases used and formed during the interaction based on mass, size and concentration relationships.

6- Use of data determined from spheres obtained in previous steps The required volume and concentration of a substance in a reaction.

The basic mathematical laws and principles of biochemistry include:

1. **Conservation of mass**: The total mass of the reactants in a chemical reaction is equal to the total mass of the products.

2. **Enthalpy**: The change in enthalpy (enthalpy) of the system during a chemical reaction can be calculated using Hess's law.

3. **Entropy**: The change in system entropy (disorder) during a chemical reaction can be calculated using the Gibbs free energy equation.

4. **Kinetics**: Study of reaction rates and mechanisms that can be described using rate laws and the Arrhenius equation.

5. **Equilibrium**: A state in which the forward reaction rate and the reverse reaction rate are equal. It can be described using the equilibrium constant (K) and Le Chatelier's principle.

6. **Thermodynamics**: The study of energy changes in chemical reactions, which can be described using the first and second laws of thermodynamics.

7. **Statistical mechanics**: The study of the behavior of large particle systems and can be used to describe the behavior of biological molecules.

These principles and laws are critical to understanding and predicting the behavior of biological systems at the molecular level.

The principle of mass conservation asserts that the total mass within a closed system remains constant. To illustrate, consider a system comprising a 5 kg iron block and a 3 kg wooden block; the combined mass of the system is 8 kg. If the iron reacts with oxygen to produce iron oxide, the total mass of the system remains 8 kg post-reaction, as the mass is preserved during the conversion process.

Similarly, in the principle of equilibrium, the total sum of quantities remains unchanged within a closed system. For instance, on a balance scale with two blocks, the weight of one block must equal the weight of the other to maintain equilibrium. For instance: Block 1 = 5 kg, Block 2 = 5 kg. In this scenario, both blocks weigh the same, at 5 kg each, thus ensuring equilibrium within the system.[8]

The relationship between mathematics and geology

Geodesy is a discipline of mathematics that permits the shape, movement, and gravitational field of the Earth to be determined, and it also helps to comprehend the underlying principles of making maps and elevation systems.

Measuring the dimensions of an object is considered a simple task. For example, to compute the dimensions of a soccer ball, one must simply establish its radius. However, determining the dimensions of the Earth is a little different affair because the Earth is not perfectly spherical in shape, complicating the challenge of analysing its dimensions.

e.g. The initial clues suggest that the Earth is not spherical, as many think, but rather elliptical in shape. To investigate its dimensions, reference measures must be created. Based on our geodesy research, we concluded that the ground reference system is a collection of landmarks that allow us to establish the location of a point in three dimensions. In this system, the location of a point is given in Cartesian coordinates (X, Y, and Z) or geodesic coordinates. You must operate on an elliptical shape that revolves around itself (like the Earth), and geodesic coordinates are thought to be the best for estimating width, length, and height, all of which can only be explored using mathematics, notably space geometry and elliptic equations.[9]

The relationship between mathematics and biology

Mathematics is involved in biology significantly, mathematics and biology are closely related sciences and biologists are mathematical statisticians as an investigation and explanation of medical data, the electroencephalography, cardiogram and calculation of the number of red and white blood cells, measurement of growth, weight and measurement of blood sugar and there are also many indicators that indicate the entry of mathematics in biology.[10]

Biomathematics: It is a branch of biology that uses theoretical analysis, mathematical models, and abstractions of living organisms to study the principles that control the structure, development, and behaviour of systems, unlike experimental biology, which involves conducting experiments to demonstrate and test scientific theories.

The field is sometimes called mathematical biology or biomathematics to emphasize the mathematical aspects, and theoretical biology to emphasize the biological aspects. Theoretical biology focuses more on the development of theoretical principles of biology, while mathematical biology

focuses on using mathematical tools to study biological systems, although the two terms are sometimes used interchangeably. Mathematical biology aims at the mathematical representation and modelling of biological processes using applied mathematical techniques and tools.
This is useful in both theoretical and practical research. Quantitative description of systems means that their behaviour can be better modelled and therefore properties that may not be obvious to the experimenter can be predicted. This requires precise mathematical models. Due to the complexity of living systems, theoretical biology covers many areas of mathematics and contributes to the development of new technologies.
Biomathematics or mathematical biology is the field of science that uses mathematical techniques to study biological processes. It involves the use of mathematical tools to address various aspects of biology, medicine, ecology, or environmental science.
According to this line of thinking, biomathematics is an interdisciplinary field of science that applies mathematics to various areas of knowledge related to living organisms and their interactions with their environment. As mathematical biologist José Miguel Pacheco Castillao puts it, he harnesses the power of mathematical tools and methods to explore the world of biology Biochemistry is different from biometrics. Biometrics is the statistical or measurable study of biological phenomena or processes In other words, biometrics is a branch of statistical mathematics that involves the analysis of biological data and covers topics such as population, body measurements, disease treatment, etc. Biometrics is responsible for collecting and measuring data in biological processes, while biomathematics translates these biological problems into mathematical language, allowing you to understand the processes and phenomena of the living world from different scientific methods.
Relationship between Biology and Mathematics Biology is the science of life the study of the structure, development, growth, origin, evolution, and distribution of organisms .[11]
Numerous fields and branches of biology, including molecular biology, genetics, cell biology, plant biology, marine biology, environmental biology, and basic and applied biological sciences, are concerned with living things and the living and non-living factors that influence them and the environment.
Mathematics is a useful tool in the basic biological sciences for interpreting

biological data from tests and experiments, simulating biological processes, and assessing complicated models of biodata. Math is used in molecular biology to comprehend the intricate relationships that exist between biological molecules like DNA, proteins, and other nucleic acids. Complex data pertaining to cellular migration, chemical interactions, and the growth of cells and organs can be analysed mathematically.

Medical science uses mathematical models in medical biology to evaluate medical data, forecast possible side effects, and comprehend the intricate biological processes taking place within the body. Understanding important processes in cells, organs, and vital systems as a whole as well as researching the effects of different therapies, medications, foods, and substances on the body can be accomplished using mathematical modelling.[12]

In addition, the research of diseases, the analysis of intricate medical data, the assessment of health risks, and the forecasting of illnesses and epidemics all make use of mathematical statistics and modelling. In order to comprehend the variables influencing genetic and genetic health, it is also utilized in the analysis of genetic and genetic data.

In cellular and molecular biology, mathematical modelling can also be used to examine complicated data pertaining to biomolecules and their interactions as well as to comprehend biological processes occurring within cells. The evolution of organisms and their changes over time, as well as the generational evolution of genetic features, are also studied mathematically modelled.

Conversely, mathematics is the logical deductive discipline that studies abstract concepts like numbers and symbols in order to derive relationships and properties that aid in our understanding of the outside world. Even if science's methodologies have changed, there are still areas where the two are compatible in some situations. One field where combining science and art produces outstanding outcomes is population dynamics. Multivariate simulation and chaos theory are used to study complicated biological mechanisms. Other examples of the intersection of mathematics and biology include the modelling of complicated networks in epidemiology using graph theory, the control systems in ecology using harmonic algebra, the explanation of DNA's molecular nodes using node theory, etc. Computing was the final factor that promoted the union of mathematics and biology. I was able to run a great deal of simulations with this machine which relies on mathematical logarithms that produced findings in accordance with cutting edge calculating techniques that were previously impractical. Future significance and scientific interest in biomathematics Rather than being a subfield of either biology or mathematics, mathematical biology is an interdisciplinary scientific topic that draws on the conceptual components of both. It is a brand-new field of study with a sparse body of scientific literature, making it difficult to forecast with absolute certainty how far it will develop.[11]

A deeper comprehension of the biological world and the advancement of biology are both greatly aided by mathematics, which is a potent instrument for deciphering and evaluating complex biological processes. Therefore, the link between mathematics and biology is crucial to the ongoing progress of research. [12]

Relationship between math and life application

Linear equation in 2variables:

A key equation in quantum mechanics that characterizes how quantum particles like electrons behave in a physical system is the Schrödinger equation. The relationship between a particle's wave function and energy is represented by a partial differential equation.

The Schrödinger equation has the following form when there are two variables involved:

$$i\hbar\left(\frac{\partial\psi}{\partial t}\right)=\frac{-\hbar^2}{2m}\left(\frac{\partial^2\psi}{\partial x^2}\right)+V(x,y)\psi$$

In this case, ψ stands for the particle's wave function, t for time, x and y for spatial variables, $\hbar$ for the reduced Planck's constant, m for the particle's mass, and $V(x,y)$ for the position dependent potential energy function.

The Schrödinger equation gives details about the energy and spatial distribution of the particle as well as how the wave function changes over time. The permissible wave functions and related energy of the quantum system are obtained by solving the equation.

The wave function ψ that satisfies the Schrödinger equation in two variables under specified boundary conditions and potential energy functions is found by solving the equation. This enables us to ascertain how quantum particles behave in a variety of physical systems, including solid-state materials, molecules, and atoms. The Schrödinger equation has significant ramifications for quantum mechanics and its applications in physics, chemistry, and other scientific and technological domains. It also transformed our understanding of the microscopic universe. It offers a mathematical framework for explaining the probabilistic character of quantum phenomena as well as the wave-particle duality.

A quantum-mechanical system's wave function is determined by the linear partial differential equation known as the Schrödinger equation. An important turning point in the evolution of quantum mechanics was reached with its discovery. It bears Erwin Schrödinger's name, who proposed the equation in 1925 and published it in 1926, providing the foundation for the research that led to his 1933 Nobel Prize in Physics.

Application of linear equations in variables in each daily life:

Use of linear equations in two variables in daily life: The primary goal of applying linear equations in two variables is to solve a variety of issues where one variable is known and the other is unknown.

Some of those programs of linear equations are:

1) two variables geometry problems.
2) financial issues by combining two elements.
3) two variables distance rate time issues.
4) Using linear equations in economics and business.

Money problems by using two variables:

EX: Essam has 10 bills of L.E.5 and other bills of L.E.20 he bought some goods from a shopping Centre for L.E.65 determine the different possibilities to pay this amount of money. Find the relation and graph it.

Sol: Let X denoted to the number of bills of L.E.5, then its value = 5X

and let Y denoted to the number of bills of L.E.20, then its value = 20Y

therefore, 5X + 20Y = 65 where X and Y are natural numbers.

Therefore X + 4Y = 13 $\rightarrow$ Y= $\frac{13-X}{4}$

Since X $\leq$ 10 , (13 – X) is divisible by 4

i.e. X has the values 9, 5 and 1

, then we can write the different possibilities in the table (No.1) (Fig.1)[13]

Distance and geometry problems by using two variables:

EX:

A cuboid-shaped water tank with dimensions 6 m, 6 m and 12 m and the upper part of it is in the form of half of a right circular cylinder.

Calculate the quantity of the tank in m^3.

Sol:

The volume of the tank = the volume of the cuboid + $\frac{1}{2}$ of the volume of the cylinder = (6 ×6 ×12)+($\frac{1}{2} \times \frac{22}{7} \times (3)^2 \times 12$)

= 432 + 169.71 = 601.714 m^3

Ex: A tree is 3 meters long. Its upper part was broken because of the wind and it made an angle with the surface of the ground. If the length of the left part of the tree is 1 meter, find the distance between the base of the tree and the point of touching of its top with the ground in Fig.(3)

Sol:

Since the length of the tree = 3 m

Therefore, AB + BC = 3 m

,since the length of the left part of the tree = 1 m

Therefore, BC = 3 – 1 = 2 m

Since In Δ ABC : m (∠ A) = 90 °

Therefore,

$(AC)^2 = (BC)^2 - (AB)^2 = 4 - 1 = 3$

Then AC = $\sqrt{3}$ m

Then the distance between the base of the tree and the point of touching of its top with the ground = $\sqrt{3}$ m[14]

Relation between business and mathematics

Business and mathematics are two domains that are thought to be significant because they can be combined to solve a range of problems in novel and inventive ways. The difficulty is in applying mathematical ideas and techniques in a business setting in a way that accomplishes objectives, boosts output, and forecasts market trends Companies and organizations can improve their performance and make more accurate and effective decisions in the current competitive business environment by utilizing mathematics in creative and innovative ways. The integration of mathematics and business is considered a key to achieving improvements and innovations in various aspects of operations Business math is used by commercial companies to record and manage business operations. Math is used in departments of accounting, inventory management, marketing, sales forecasting, and financial analysis. Business math continually offers with earnings or loss. The cost of a product is fixed by taking into consideration its profit, margin, cash discount, trade discount, etc

Ex: Given that a music system was purchased for £10,500 and sold for £9,500, find the profit or loss amount.

Solution: Given that the music system's cost price is £10,500

and its selling price is £9,500,

we can see that there is a loss in this business because C.P. is greater than S.P. Consequently, we ought to decide the quantity of the loss:

Loss = C.P. – S.P.

Loss = 10,500 – 9,500 = 1,000£.[15]

Mathematics is used in business for a variety of reasons. To put it briefly, knowing business mathematics helps people and organizations make better decisions, understand problems in depth, and evaluate the long-term effects of their actions. One particular use of business mathematics is the careful tracking of financial transactions, since accurate recording and maintenance of financial records are essential for businesses of all sizes.

Businesses use mathematics for a variety of purposes, including financial statement preparation, resource allocation strategy, and revenue and expense tracking. Math is also used to help with computations and forecasts, as demonstrated by the following examples of business math problems that highlight its many applications.

Example 2:

After completing its first year of operation, Company XYZ must determine whether to expand by building a new factory or to wait another year. This decision is based on the company's profits for the current year and its projected profits for the following year based on its growth rate; if the projected profits for the following year exceed $200,000, the company will expand; if not, it will wait another year

The following details have been provided by the company's accountant:

- Current year's profits: $100,000;
- Expected growth rate: 20%;
- Projected profits = 100,000 + (100,000 × 0.2)
- Projected profits = $120,000.

The company will wait a year before expanding its operations because the projected profits for the following year are less than $200,000.[16]

The relationship of mathematics to history

The Babylonians practiced writing numbers and calculating interest, especially in commercial business in Babylon, three thousand years ago. Numbers and mathematical operations were written on clay tablets with a pointed reed pen. Then placed in the oven to dry. They knew addition, multiplication, subtraction and division. And why.

They used the currently used decimal system for numbers, which made it more difficult as they used the sexagesimal system, which consists of sixty symbols, to indicate numbers from one to fifty-nine. The sexagesimal system is still used today in measuring angles when calculating triangles and measuring time (an hour is equal to sixty minutes and a minute is equal to sixty seconds). The ancient Egyptians developed this system in surveying lands after every flood to estimate taxes. They also followed the decimal system, which is counting in ones and tens. And hundreds, but they did not know zero, so they used to write 500 by placing five symbols, each symbol crossing a hundred.

The first mathematical sciences that appeared in ancient times were geometry to measure the area of land, and trigonometry to measure angles and inclinations in buildings. The Babylonians used it to predict the dates of solar and lunar eclipses. These appointments were related to their worship. The ancient Egyptians used it to build temples and determine the corners of the pyramids. They used rational numbers and determined the area of the circle by approximation. fig. (3)

The ancient Babylonians - in 2100 BC - developed the sexagesimal system based on the number sixty. This system is still used to this day to tell time, in hours, minutes, and seconds. Historians do not know exactly how the Babylonians developed this system, and they believe that it was the result of using the number sixty as a basis for knowing weight and other measurements. The sexagesimal system has important uses in astronomy due to the ease of dividing the number sixty and the superiority of the Babylonians over the Egyptians in algebra and geometry. Fig. (4)

The Babylonians did not have the number zero, or any concept of zero. However, they were aware of nothing, and did not see it as a number but simply the loss of the number and they used a blank space when writing, and what the Babylonians used was a blank space (and later this symbol was used to remove this ambiguity) to indicate that there was no number somewhere.

Mathematics among the ancient Egyptians:

It is likely that prehistoric people first began counting on their fingers. They also had various ways of recording the quantities and numbers of their animals or the number of days starting with the full moon. They used the gravel and the contract for cable and signs of wood and bone to represent numbers. They learned to use regular shapes when making pottery vessels or engraved arrowheads. It was used by athletes in ancient Egypt, about 3000 BC. The decimal system (which is the decimal numbering system) has no place values. The ancient Egyptians were pioneers in geometry, and they developed formulas to find the areas and volumes of some simple solids.

Egyptian mathematics has many applications, ranging from surveying the land after the annual flood to the complex calculations necessary to build the pyramids.
3000 BC The ancient Egyptians used the decimal system. And developed as well as engineering and technology space lands.

Mathematics among the Greeks:

Thales was able in the seventh century BC. To make mathematics purely theoretical, he showed that the diameter of a circle divides it into two halves of equal area, and an equal-sided triangle has two equal angles. After him, Pythagoras concluded that in a triangle, the sum of the square of the two sides of a right angle is equal to the square of the hypotenuse. In Alexandria, Euclid appeared in the third century BC. He laid the foundations of geometry known as Euclidean, whose theories are still followed today. Then appeared in Greece, where he determined the specific density. The Romans did not add anything new to mathematics after the Greeks.
370 BC. Eudoxus Al-Kandusi knew the method of exhaustion, which paved the way for the calculation of integration.
300 BC. Euclid created a geometric system using logical deduction.[17]

Mathematics among Muslims:

In Baghdad, Al-Khwarizmi founded the sciences of algebra and contrast in the early ninth century. During the caliphate of Abu Jaafar Al-Mansur, some works of the ancient Alexandrian scholar Ptolemy Al-Qaludi were translated.
(d. 17 AD), and one of the most important of them is his book known as “Almagest.” The name of this book is in Greek "EMEGAL MATHEMATIKE," fig.(5) meaning the greatest book on arithmetic. The book is an encyclopaedia of knowledge in astronomy and mathematics. Muslim scholars benefited from it and corrected it.
Some of his information they added to it. Regarding the Hindi language, many works were translated, such as the famous Indian book on astronomy and mathematics, Siddhanta, meaning “Knowledge, Science, and Doctrine.” The Arabic translation appeared during the reign of Abu Jaafar Al-Mansur under the title Sindh Hind. With the book “Indus Hind”, Indian arithmetic was introduced with its numbers known in Arabic as Indian numerals, as a result of which the science of numerology developed among the Arabs, and the Muslims added the zero system, which made Arab mathematicians solve many mathematical equations of various degrees. It facilitated its use for all

arithmetic work, and concluded The numbering system is complex, and the use of zero in mathematical operations led to the discovery of the decimal fraction, which was mentioned in the book "Miftah al-Hisb" by the mathematician Jamshid bin Mahmoud Ghiyath al-Din al-Kashi (d. 840 AH, 1436 AD). This discovery was the true introduction to studies and infinitesimal arithmetic operations. Ibrahim Al-Fazari extracted an astronomical calculation table showing the positions of the stars and calculating their movements, which is known as zigzag.

One of the scholars of the House of Wisdom in Baghdad was Muhammad bin Musa Al-Khwarizmi (d. 232 AH 846 AD), whom Al-Ma'mun entrusted with writing a book on the science of algebra. He wrote his brief book on the calculation of algebra and contrast, and this book is what led to the creation of the word algebra and giving it its current meaning. Ibn Khaldun said. The science of algebra and the equation (i.e., equation) is one of the branches of number science, and it is an industry by which the unknown number is extracted from the known number if there is a connection between them that requires it. They meet each other, and the broken ones are repaired until they become whole. Algebra is an Arab science, which the Arabs called using a word from their language, and Al-Khwarizmi was the one who gave it this name, which was passed on to European languages with its Arabic pronunciation ALGEBRA. This book was translated into Latin in the year 1135 AD. He continued studying at universities in Europe until the 16th century. Arabic numerals were also transmitted to Europe through translations of the books of Al-Khwarizmi, who was called "ALGORISMO" in Latin. Then he modified Algorism and ALGORISMO to indicate the number system, arithmetic, algebra, and the method of solving arithmetic problems, and his genius appeared.

"Al-Khwarizmi" in "Al-Zij" or the astronomical table that he made and called it "Sindh Hind Al-Saghir", in which he combined the doctrine of India, the doctrine of the Persians, and the doctrine of Ptolemy (Egypt), so the people of his time approved of it and benefited from it for a long time, so his fame spread and this marriage became It had a great impact on the East and the West. The West transferred mathematical sciences from the Arabs and developed them. Abacus arithmetic was known: Abacus (counting board). It is a frame in which balls were placed for manual counting. This board

was used by the Greeks, Egyptians, Romans, and some European countries before, The arrival of Arabic arithmetic to Europe in the thirteenth century. Addition, subtraction, multiplication and division were carried out through the tally board. Ibn al-Haytham was also the first to extract the general formula for the sum of the arithmetic sequence of the fourth degree (mathematics) in mathematics. fig.(6).
The Arabs worked with algebra and studied it in an organized, scientific way. Kajori even said: "The mind is astonished when it sees what the Arabs have done in algebra..." Among the most famous books written by the Arabs are: "Algebra and Muqabalah" by Al-Khwarizmi, as well as the book Al-Khayyam, which was published by Wopeck in the year 1851 AD; the Arabs divided the equations into six parts and developed solutions for each of them. They used symbols in mathematical works and researched the binomial theorem. They created a law for finding the sum of natural numbers. They dealt with solid roots and paved the way for the discovery of logarithms. In the thirteenth century AD, mathematical sciences began among the Arabs. Others were transmitted to Europe via Andalusia. They translated the Arabs' works on various sciences, including algebra. The monk Jordanian (about 1220 AD) replaced the words in algebraic expressions with symbols. His contemporary Fibonacci did the same thing and wrote a book on arithmetic and the principles of algebra in which he explained his influence on the writings of Al-Khwarizmi and Abu Kamel. The two Arab worlds. In the sixteenth century, scientists reached a solution to third-degree equations.
Fourth, in the seventeenth and eighteenth centuries, they achieved impressive results in their research on power series and their properties.

Among the most prominent achievements of Muslim Arabs in mathematics are:

787 AD Numbers and zero drawn as a dot appeared in Arabic writings before they appeared in Indian books.
830 AD The Arabs gave this call to the technological know-how of algebra for the primary time.
835 AD Al-Khwarizmi used the term al-asam for the first time to refer to a number that has no root.
888 AD Arab mathematicians laid the first building blocks of analytical geometry by using geometry to solve algebraic equations.

912 AD Al-Battani used the sine instead of the bowstring to measure angles for the first time.
1029 AD Arab mathematicians exploited planar and three-dimensional geometry in light research for the first time in history.
1252 AD Nasir al-Din al-Tusi drew attention - for the first time - to Euclid's errors in parallels.
1397 AD Ghiyath al-Din al-Kashi invented decimal fractions.
1465 AD Al-Qalasadi Abu Al-Hasan Al-Qurashi created symbols for algebra for the first time instead of words.

Mathematics in ancient American civilizations:

In the Maya civilization in Mexico, arithmetic was known and was developed. One unit is a point, five units is a rod, and twenty is a crescent. And they were taking human and animal shapes as numerical units.

Mathematics development:

Based on the above, mathematics initially appeared as a need to perform calculations in business, to measure quantities, such as lengths and areas, and to predict astronomical events. These three needs can be considered the beginning of the three broad divisions of mathematics, which are the study of structure, space, and variables.
The study of structures appeared with the emergence of numbers, and it began with natural numbers, integers, and arithmetic operations on them, then in-depth studies on numbers led to the emergence of number theory. The search for ways to solve equations also led to the emergence of abstract or abstract algebra, and the physical idea of the beam was generalized to radial spaces and studied in linear algebra.
The study of space appeared with geometry, and began with Euclidean geometry and trigonometry, in two- and three-dimensional spaces, and this was later generalized to non-Euclidean engineering sciences, to play A function withinside the fashionable idea of relativity.
Understanding and studying change in measurable values is a general phenomenon in the natural sciences. Mathematical analysis appeared as a suitable tool for carrying out these operations, as the general idea is to express value with a function, and then many phenomena can be analysed on the basis of studying the rate of change of this function.
With the advent of computers, many new mathematical concepts emerged, such as computability, computational complexity, information theory, and algorithms. Many of these concepts are currently part of computer science.

Another important field of mathematics is statistics, which uses probability theory to describe, analyse, and predict the behaviour of phenomena in various sciences, while mathematical analysis provides.

Mathematics in Medieval Europe:

1142 AD Adelard of Albethey translated from Arabic the fifteen parts of Euclid's Elements, and as a result Euclid's works became well known in Europe.

Mid-twelfth century AD. The Indo-Arabic number system was introduced to Europe as a result of the translation of Al-Khwarizmi's book on arithmetic.

Mathematics in the Renaissance:

1514 AD The Dutch mathematician Giel Vander Hoecke used the signs of addition (+) and subtraction (-) for the first time in algebraic formulas.

1533 AD The German mathematician Regiomontanus founded trigonometry as a branch independent of astronomy.

1542 AD Girolamo Cardano wrote the first book on modern mathematics.

1557 AD Robert Record introduced the equal sign (=) into mathematics, believing that nothing could be more equal than a pair of parallel lines.

Mathematics during the scientific revolution:

The seventeenth century:

1614 AD John Napier published his discovery of logarithms, which help simplify calculations.

1637 AD René Descartes published his discovery of analytical geometry, establishing that mathematics was the ideal model for reasoning.

The middle of the ninth decade of the seventeenth century AD. Sir Isaac Newton and Gottfried Leibniz independently published their discoveries in calculus.

18th century:

1717 AD Abraham Sharpe calculated the value of the approximate ratio to 72 decimal places.

1742 AD Christian Goldbach established what is known as Goldbach's conjecture: that every even number is the sum of two prime numbers. This conjecture is still open for mathematicians to prove whether it is true or false.

1763 AD Gaspard Monge introduced descriptive geometry. Until 1795 AD, he worked in French military intelligence fig.(7) .[18]

Relationship between math and geography

The geographer needs mathematics, as with all sciences, to assist coordinate those experiences that the qualitative criteria cannot bring to a coherent whole. Because mathematics is the method of choice for implementing a thorough order in the knowledge of several geography-related subjects. In the study of geography, mathematical and statistical ideas and techniques for addressing geographically connected issues are widely applied. The depiction of the formal perspective on space and time is made possible by mathematical models. An abstraction of people's experiences with a place's spatial characteristics is found in Euclidean space, for instance. In the spatial representation, it deals with points, lines, areas, and volumes, all of which have intuitive meanings. Formalized and deductive mathematical knowledge inside the scientific conceptual framework might help with study difficulties that are taken from. Through the use of technology, codified and deductive mathematical knowledge within the conceptual framework of science can aid in the solution of study issues taken from actual scenarios. A phenomenon requires both quantitative and qualitative investigation, as shown by the examination of mathematical models that serve as the foundation for web and mobile applications, particularly those that deal with geographic area.

The most notable accomplishment of Eratosthenes's scientist is that he was the first to determine the circumference of the Earth, a feat he accomplished with remarkable accuracy by using the vast survey findings that the Library provided for him In addition, he was the first to determine Earth's axial tilt, a calculation that has shown to be very accurate.Based on the geographic knowledge available at the time, he created the world's first earth projection map incorporating parallels and meridians.[19]

Some Trends in Geography towards Mathematics

Though the phrase "quantitative geography" was first used in the 1960s, quantitative methods in geography trace at least as far back as Greek attempts to estimate the circumference of the world. The choice of words was intentional; it was meant to elevate the quantitative revolution above more traditional regional geography by positioning it as a new and improved scientific geography. One reason the word "quantitative geography" still has resonance with historical practices is undoubtedly the force of this time in Anglo-American geography, both in terms of its own language and in developing a concern for theory and philosophical foundations that remains with us now. The disciplinary language and worldview underwent significant shift as a result of the quantitative revolution, both of which reinforced one another.

One of the four key turning moments in the history of modern geography, along with environmental determinism, regional geography, and critical geography, was the quantitative revolution (QR). The 1950s and 1960s saw the quantitative revolution, which swiftly transformed geographic research from a regional geography into a spatial science. The primary thesis of the quantitative revolution is that it resulted in a change from idiographic (descriptive) geography to nomothetic (empirical law making) geography. With the backing of statisticians and geographers in both Europe and the US, the European universities saw the start of the Quantitative Revolution.

The rising regional geography paradigm gave rise to the Quantitative Revolution, which first appeared in the late 1950s and early 1960s. The quantitative revolution in geographic study resulted in a rise in the application of computerized statistical techniques, particularly multivariate analysis, under the ill-defined umbrella of bringing "scientific Thinking" to the field. The recently adopted methods included a variety of mathematical strategies that increased accuracy. The following are a few methods that personify the quantitative revolution:

. Descriptive statistics;

. Inferential statistics;

. Basic mathematical equations and models, which includes gravity version of social physics, or the Coulomb equation;

. Stochastic fashions the usage of ideas of probability, including spatial diffusion processes;

. Deterministic models, e.g. Von Thune’s and Weber's location model.

The common factors linking the above techniques are a preference for numbers over words, and a belief in the superior scientific pedigree of digital work.

Proponents of quantitative geography tend to describe it as a combination of science and geography. Indeed, a special contribution of the quantitative revolution was the enormous confidence in multivariate analysis, especially in methods related to econometrics. It is also very consistent with empirical science and has proven to be an important source of epistemological debate. Excessive focus on statistical models will ultimately lead to the failure of the quantitative revolution. Many geographers are increasingly concerned that these techniques simply impose complex technical disguises on research methods that lack any underlying theory. Other critics argue that this removes the "human dimension" from a discipline that has always prided itself on looking at humans and the natural world equally.

Fields of geography requiring mathematics:

• The shape and form of the Earth
• The motion of the Earth and its direct gravitational and electromagnetic relationships
• Longitude elements and time determining variables
• Cartography and map interpretation
• Climatology
• Geomorphology

For instance, determining locations' distances, areas' elevations, and the slope of hills. The layout of the areas can be predicted using formulas based on the locations, which are given in degrees. In order to predict and prevent the causes of natural disasters like earthquakes, volcano eruptions, tsunamis, etc., mathematical modelling is helpful. Geographical information is represented using maps and graphs.

How can mathematics be used to analyse geographic patterns and demographic data?

When examining geographic patterns and demographic statistics, mathematics is essential. It offers the methods and resources required to comprehend and analyse the intricate connections and patterns found in populations and their geographic distribution. The following are some ways that mathematics is useful in this analysis:

Statistical Analysis: Patterns and trends are found in population data through the use of mathematics, specifically statistics. By using statistical methods like regression analysis, correlation analysis, and hypothesis testing, geographers can assess the importance of the interactions between various variables.

Spatial Analysis: Population distribution and pattern recognition are two applications of mathematics. Geographers can better comprehend the spatial variation in population density, migration patterns, and other demographic aspects by using techniques like spatial autocorrelation, clustering analysis, and spatial interpolation.

Modelling and Simulation: Statistics are used to develop statistical models and equations that can predict population dynamics. These models include variables such as birth rates, death rates, migration rates, and environmental variables to predict population growth and trends over time. Statistical analysis helps geographers

predict and understand the effects of various factors on population structure.
Geographic Information System (GIS): Statistics are an important part of GIS, a powerful tool used in geography to analyse and display landscape images. GIS uses statistical algorithms and techniques to process and analyse population data, create maps, and identify geographic features. It allows geoscientists to compare different data sets and perform spatial analyses to understand population patterns and their relationships with other regional features.
Data Visualization: Patterns and demographic data are visualized through the application of mathematics. The links and patterns found through mathematical analysis are graphically represented through the use of graphs, charts, and maps.[20] Geographers can more effectively convey their findings and facilitate the interpretation of complex demographic data with the use of these representations.
In conclusion, mathematics offers the analytical methods and instruments required to examine geographic patterns and demographic statistics. It supports the understanding of geographical patterns, forecasting, data visualization, and the interactions between variables by geographers. Geographers can learn a great deal about population dynamics and spatial distribution by using mathematical concepts.
Any formal technique that uses an entity's topological, geometric, or geographic qualities to study it is called spatial analysis. Numerous methods employing various analytical philosophies, particularly spatial statistics, are included in spatial analysis. It can be used in a variety of professions, such as astronomy, which investigates the positions of galaxies in space, or chip fabrication engineering, which uses "place and route" algorithms to construct intricate wiring systems. Spatial analysis is, in a narrower sense, geospatial analysis, which is the method used to analyse human-scale structures, particularly when analysing geographic data. It can also be used with transcriptomics data in genomics in fig.(8).
How to use maths to calculate the climate?
The amount of carbon dioxide in the atmosphere rises annually as a result of human activity releasing more carbon dioxide into the atmosphere than natural processes can absorb. In 2023, the average carbon dioxide concentration worldwide reached a new high of 419.3 parts per million.
The amount of carbon dioxide in the atmosphere has increased by 50% since the beginning of the Industrial Revolution.

Over the past 60 years, the rate of increase in atmospheric carbon dioxide has been approximately 100 times higher than prior natural increases, such as those that happened 11,000–17,000 in the past at the realization of the ultimate ice age. The ocean's pH has dropped by 0.1 units, or 30%, due to the absorption of carbon dioxide in fig. (9).[21]

Cartography

Is regarded as a field of geography that focuses on the creation, examination, and analysis of different maps. It is hard to, engineering plays a number of roles in cartography. To measure lengths, angles, and elevations on the ground, for example, surveyors and engineers use surveying engineering. They also employ the concepts of three-dimensional engineering to create three-dimensional maps in fig.(10). discuss cartography in this setting without bringing up engineering and mathematics. Cartography relies heavily on mathematics since creating maps necessitates the application of numerous mathematical concepts and procedures. For instance, surveyors and engineers must compute areas, lengths, and angles on maps using mathematical formulas. In addition Additionally, a method known as the geographic coordinate system was developed by mathematicians and scientists to help find a point on a three-dimensional sphere. By using this method, you can accurately determine the distance between points because it accounts for the Earth's curvature. This technique uses degrees of latitude and longitude to pinpoint a certain location.[22]

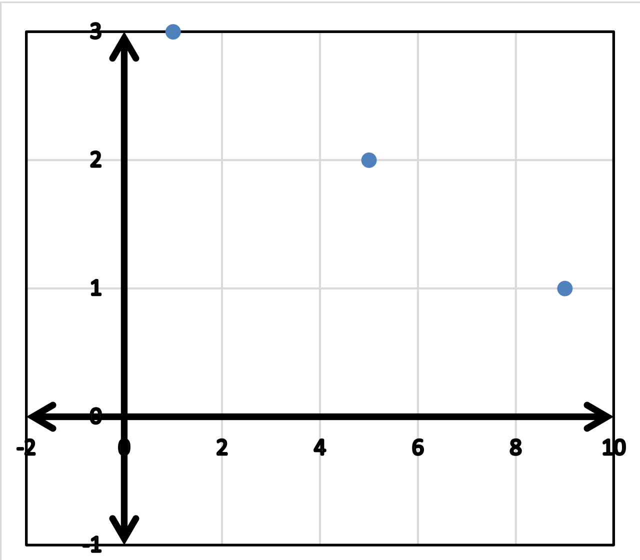


Figure (1): graph that represent the different possibilities to pay the amount of money.

X	1	5	9
Y	3	2	1

Table (1): the different possibilities to pay the amount of money

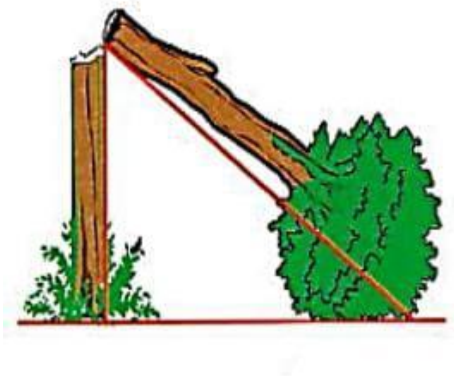


Figure (2): **distance and geometry problems by using two variables**

Figure (3): **A Babylonian tablet containing mathematical tables, dating back to approximately one thousand and eight hundred years BC, called Plympton 322**

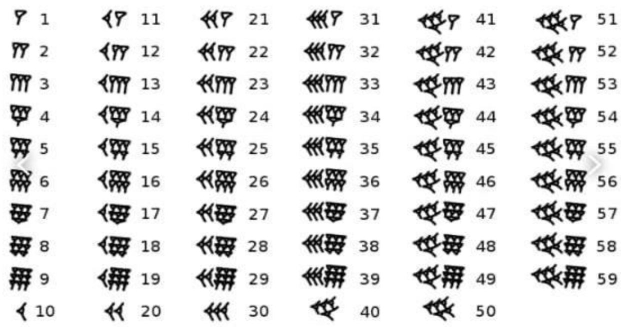
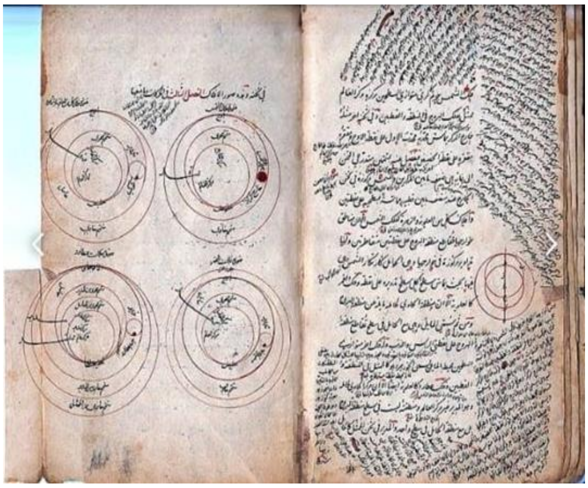


Figure (4): **Babylonian numbers**

Figure (5): **EMEGAL MATHEMATIKE**



Figure(6): An ancient Arabic manuscript dating back to the seventeenth century on geometry and astronomy

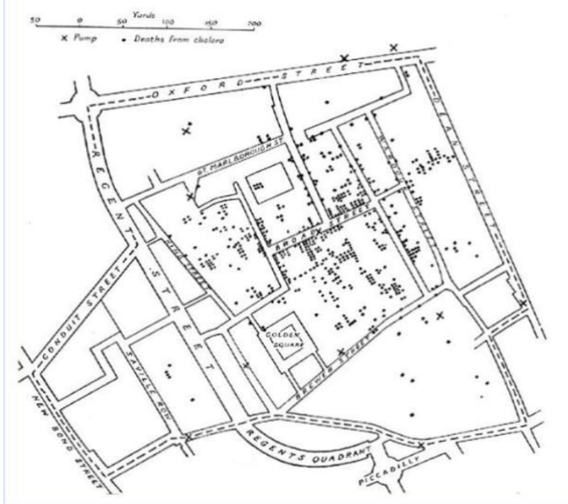


Figure (8):

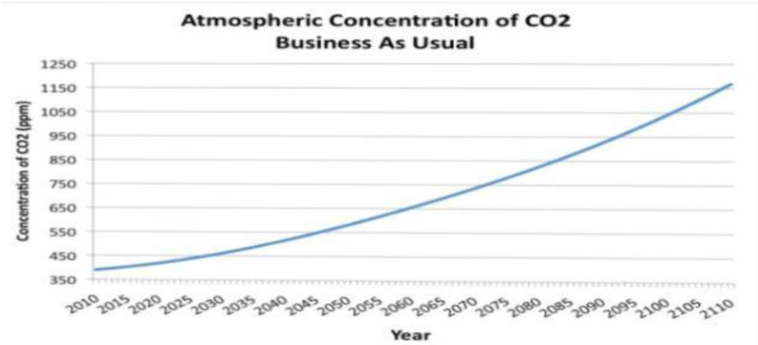


Figure (9)

figure (7): He most influential mathematician of the eighteenth century was without a doubt Leonhard Euler

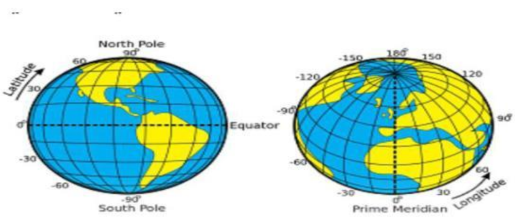


Figure (10) : three dimensional maps

Conclusion

At the end of the research, we concluded that… The integration of mathematics with social studies, history, practical life, and scientific subjects represents a vital intersection that opens up new horizons for understanding and innovation. By utilizing mathematical methods and concepts in various contexts, they can be applied to a wide range of life, social, historical, and scientific challenges. In social studies and history, mathematics can contribute to understanding social phenomena and quantitative analysis of historical data, aiding in the discovery of trends, patterns, and identification of influential factors in social and historical developments. Moreover, mathematics can provide solutions to life challenges, such as personal data analysis, resource planning, and time management, which are fundamental skills in daily and practical life. In scientific subjects, mathematics contributes to the development of accurate models and predictions, enabling researchers to better understand and analyse natural phenomena. Thus, the integration of mathematics with these fields becomes an exciting challenge for creativity and an opportunity to explore and understand the world more deeply and comprehensively.

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This would not have been possible without the efforts of all our family members and their psychological and financial support for us.

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