

Contribution of babylonians in science and technology essay sample

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Babylonia was an ancient cultural region in central-southern Mesopotamia (present-day Iraq), with Babylon as its capital. Babylonia emerged when Hammurabi (fl. ca. 1696 – 1654 BC, short chronology) created an empire out of the territories of the former Akkadian Empire. Babylonia adopted the written Semitic Akkadian language for official use, and retained the Sumerian language for religious use, which by that time was no longer a spoken language. The Akkadian and Sumerian traditions played a major role in later Babylonian culture, and the region would remain an important cultural center, even under outside rule, throughout the Bronze Age and the Early Iron Age. The earliest mention of the city of Babylon can be found in a tablet from the reign of Sargon of Akkad, dating back to the 23rd century BCE. Following the collapse of the last Sumerian “Ur-III” dynasty at the hands of the Elamites (2002 BCE traditional, 1940 BCE short), the Amorites gained control over most of Mesopotamia, where they formed a series of small kingdoms. During the first centuries of what is called the “Amorite period”, the most powerful city states were Isin and Larsa, although Shamshi-Adad I came close to uniting the more northern regions around Assur and Mari.

One of these Amorite dynasties was established in the city-state of Babylon, which would ultimately take over the others and form the first Babylonian empire, during what is also called the Old Babylonian Period. Babylonian mathematics (also known as Assyro-Babylonian mathematics) refers to any mathematics of the people of Mesopotamia, from the days of the early Sumerians to the fall of Babylon in 539 BC. Babylonian mathematical texts are plentiful and well edited. In respect of time they fall in two distinct

groups: one from the Old Babylonian period (1830-1531 BC), the other mainly Seleucid from the last three or four centuries B. C. In respect of content there is scarcely any difference between the two groups of texts.

Thus Babylonian mathematics remained constant, in character and content, for nearly two millennia. In contrast to the scarcity of sources in Egyptian mathematics, our knowledge of Babylonian mathematics is derived from some 400 clay tablets unearthed since the 1850s. Written in Cuneiform script, tablets were inscribed while the clay was moist, and baked hard in an oven or by the heat of the sun. The majority of recovered clay tablets date from 1800 to 1600 BC, and cover topics which include fractions, algebra, quadratic and cubic equations and the Pythagorean theorem. The Babylonian tablet YBC 7289 gives an approximation to accurate to five decimal places.

Babylonian clay tablet YBC 7289 with annotations. The diagonal displays an approximation of the square root of 2 in four sexagesimal figures, which is about six decimal figures. Babylonian numerals were written in cuneiform, using a wedge-tipped reed stylus to make a mark on a soft clay tablet which would be exposed in the sun to harden to create a permanent record. The Babylonians, who were famous for their astronomical observations and calculations (aided by their invention of the abacus), used a sexagesimal (base-60) positional numeral system Sumerian and also Akkadian civilizations. Neither of the predecessors was a positional system (having a convention for which 'e' inherited from the 'nd' of the numeral represented the units).

Babylonian numerals

This system first appeared around 3100 B. C. It is also credited as being the first known positional numeral system, in which the value of a particular digit depends both on the digit itself and its position within the number. This was an extremely important development, because non-place-value systems require unique symbols to represent each power of a base (ten, one hundred, one thousand, and so forth), making calculations difficult. Only two symbols (to count units and to count tens) were used to notate the 59 non-zero digits. These symbols and their values were combined to form a digit in a sign-value notation Roman numerals; for example, the combination represented the digit for 23 (see table of digits below).

A space was left to indicate a place without value, similar to the modern-day zero. Babylonians later devised a sign to represent this empty place. They lacked a symbol to serve the function of radix point, so the place of the units had to be inferred from context : could have represented 23 or 23×60 or $23 \times 60 \times 60$ or $23/60$, etc. way similar to that of Their system clearly used internal decimal to represent digits, but it was not really a mixed-radix system of bases 10 and 6, since the ten sub-base was used merely to facilitate the representation of the large set of digits needed, while the place-values in a digit string were consistently 60-based and the arithmetic needed to work with these digit strings was correspondingly sexagesimal. Babylonian Philosophy

The origins of Babylonian philosophy can be traced back to early Mesopotamian wisdom, which embodied certain philosophies of life,

particularly ethics. These are reflected in Mesopotamian religion and in a variety of Babylonian literature in the forms of dialectic, dialogs, epic poetry, folklore, hymns, lyrics, prose, and proverbs. These different forms of literature were first classified by the Babylonians, and they had developed forms of reasoning both rationally and empirically. [3] Esagil-kin-apli's medical Diagnostic Handbook written in the 11th century BC was based on a logical set of axioms and assumptions, including the modern view that through the examination and inspection of the symptoms of a patient, it is possible to determine the patient's disease, its aetiology and future development, and the chances of the patient's recovery.[4] During the 8th and 7th centuries BC, Babylonian astronomers began studying philosophy dealing with the ideal nature of the early universe and began employing an internal logic within their predictive planetary systems.

This was an important contribution to the philosophy of science.[5] It is possible that Babylonian philosophy had an influence on Greek, particularly Hellenistic philosophy. The Babylonian text Dialog of Pessimism contains similarities to the agonistic sophists, the Heraclitean doctrine of contrasts, and the dialogs of Plato, as well as a precursor to the maieutic Socratic method developed by Socrates.[6] The Ionian philosopher Thales had also studied in Babylonia. thought of the <http://entertheworldofscience.blogspot.com/2010/07/contribution-of-babylonians-in-science.html>

Babylonian astronomy

From Wikipedia, the free encyclopedia

According to Asger Aaboe, the origins of Western astronomy can be found in

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Mesopotamia, and all Western efforts in the exact sciences are descendants in direct line from the work of the late Babylonian astronomers.

[1] Our knowledge of Sumerian astronomy is indirect, via the earliest Babylonian star catalogues dating from about 1200 BCE. The fact that many star names appear in Sumerian suggests a continuity reaching into the Early Bronze Age. The history of astronomy in Mesopotamia, and the world, begins with the Sumerians who developed the earliest writing system—known as cuneiform—around 3500–3200 BC. The Sumerians developed a form of astronomy that had an important influence on the sophisticated astronomy of the Babylonians. Astrolatry, which gave planetary gods an important role in Mesopotamian mythology and religion, began with the Sumerians. They also used a sexagesimal (base 60) place-value number system, which simplified the task of recording very great and very small numbers.

The modern practice of dividing a circle into 360 degrees, of 60 minutes each hour, began with the Sumerians. During the 8th and 7th centuries BCE, Babylonian astronomers developed a new empirical approach to astronomy. They began studying philosophy dealing with the ideal nature of the universe and began employing an internal logic within their predictive planetary systems. This was an important contribution to astronomy and the philosophy of science, and some scholars have thus referred to this new approach as the first scientific revolution.[2] This new approach to astronomy was adopted and further developed in Greek and Hellenistic astronomy. Classical Greek and Latin sources frequently use the term Chaldeans for the astronomers of Mesopotamia, who were, in reality, priest-scribes specializing in astrology and other forms of divination.

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Only fragments of Babylonian astronomy have survived, consisting largely of contemporary clay tablets with ephemerides and procedure texts, hence current knowledge of Babylonian planetary theory is in a fragmentary state.

[3] Nevertheless, the surviving fragments show that, according to the historian A. Aaboe, Babylonian astronomy was “ the first and highly successful attempt at giving a refined mathematical description of astronomical phenomena” and that “ all subsequent varieties of scientific astronomy, in the Hellenistic world, in India, in Islam, and in the West—if not indeed all subsequent endeavour in the exact sciences—depend upon Babylonian astronomy in decisive and fundamental ways.”[4]

Old Babylonian astronomy

See also: Babylonian star catalogues

Old Babylonian astronomy refers to the astronomy that was practiced during and after the First Babylonian Dynasty (ca. 1830 BC) and before the Neo-Babylonian Empire (ca. 626 BC). The Babylonians were the first to recognize that astronomical phenomena are periodic and apply mathematics to their predictions. Tablets dating back to the Old Babylonian period document the application of mathematics to the variation in the length of daylight over a solar year. Centuries of Babylonian observations of celestial phenomena are recorded in the series of cuneiform tablets known as the Enûma Anu Enlil—the oldest significant astronomical text that we possess is Tablet 63 of the Enûma Anu Enlil, the Venus tablet of Ammisaduqa, which lists the first and last visible risings of Venus over a period of about 21 years. It is the earliest evidence that planetary phenomena were recognized as periodic.

The MUL.APIN contains catalogues of stars and constellations as well as schemes for predicting heliacal risings and settings of the planets, and lengths of daylight as measured by a water clock, gnomon, shadows, and intercalations. The Babylonian GU text arranges stars in 'strings' that lie along declination circles and thus measure right-ascensions or time intervals, and also employs the stars of the zenith, which are also separated by given right-ascensional differences.[5] There are dozens of cuneiform Mesopotamian texts with real observations of eclipses, mainly from Babylonia. Planetary theory

The Babylonians were the first civilization known to possess a functional theory of the planets. The oldest surviving planetary astronomical text is the Babylonian Venus tablet of Ammisaduqa, a 7th century BC copy of a list of observations of the motions of the planet Venus that probably dates as early as the second millennium BC.[6] The Babylonian astrologers also laid the foundations of what would eventually become Western astrology.[7] The Enuma anu enlil, written during the Neo-Assyrian period in the 7th century BC,[8] comprises a list of omens and their relationships with various celestial phenomena including the motions of the planets.[9] Cosmology

In contrast to the world view presented in Mesopotamian and Assyro-Babylonian literature, particularly in Mesopotamian and Babylonian mythology, very little is known about the cosmology and world view of the ancient Babylonian astrologers and astronomers.[10] This is largely due to the current fragmentary state of Babylonian planetary theory,[3] and also due to Babylonian astronomy being independent from cosmology at the

time.[11] Nevertheless, traces of cosmology can be found in Babylonian literature and mythology. In Babylonian cosmology, the Earth and the heavens were depicted as a “ spatial whole, even one of round shape” with references to “ the circumference of heaven and earth” and “ the totality of heaven and earth”. Their worldview was not exactly geocentric either. The idea of geocentrism, where the center of the Earth is the exact center of the universe, did not yet exist in Babylonian cosmology, but was established later by the Greek philosopher Aristotle’s *On the Heavens*. In contrast, Babylonian cosmology suggested that the cosmos revolved around circularly with the heavens and the earth being equal and joined as a whole.[12] The Babylonians and their predecessors, the Sumerians, also believed in a plurality of heavens and earths. This idea dates back to Sumerian incantations of the 2nd millennium BC, which refers to there being seven heavens and seven earths, linked possibly chronologically to the creation by 7 generations of Gods.[13]

Neo-Babylonian astronomy

Neo-Babylonian astronomy refers to the astronomy developed by Chaldean astronomers during the Neo-Babylonian, Achaemenid, Seleucid, and Parthian periods of Mesopotamian history. A significant increase in the quality and frequency of Babylonian observations appeared during the reign of Nabonassar (747–734 BC), who founded the Neo-Babylonian Empire. The systematic records of ominous phenomena in Babylonian astronomical diaries that began at this time allowed for the discovery of a repeating 18-year Saros cycle of lunar eclipses, for example.[14] The Egyptian astronomer

Ptolemy later used Nabonassar's reign to fix the beginning of an era, since he felt that the earliest usable observations began at this time.

The last stages in the development of Babylonian astronomy took place during the time of the Seleucid Empire (323–60 BC). In the 3rd century BC, astronomers began to use “goal-year texts” to predict the motions of the planets. These texts compiled records of past observations to find repeating occurrences of ominous phenomena for each planet. About the same time, or shortly afterwards, astronomers created mathematical models that allowed them to predict these phenomena directly, without consulting past records. Empirical astronomy

Though there is a lack of surviving material on Babylonian planetary theory, [3] it appears most of the Chaldean astronomers were concerned mainly with ephemerides and not with theory. Most of the predictive Babylonian planetary models that have survived were usually strictly empirical and arithmetical, and usually did not involve geometry, cosmology, or speculative philosophy like that of the later Hellenistic models,[15] though the Babylonian astronomers were concerned with the philosophy dealing with the ideal nature of the early universe.[2] In contrast to Greek astronomy which was dependent upon cosmology, Babylonian astronomy was independent from cosmology.[11] Whereas Greek astronomers expressed “prejudice in favor of circles or spheres rotating with uniform motion”, such a preference did not exist for Babylonian astronomers, for whom uniform circular motion was never a requirement for planetary orbits.[16]

There is no evidence that the celestial bodies moved in uniform circular motion, or along celestial spheres, in Babylonian astronomy.[17]

Contributions made by the Chaldean astronomers during this period include the discovery of eclipse cycles and saros cycles, and many accurate astronomical observations. For example, they observed that the Sun's motion along the ecliptic was not uniform, though they were unaware of why this was; it is today known that this is due to the Earth moving in an elliptic orbit around the Sun, with the Earth moving swifter when it is nearer to the Sun at perihelion and moving slower when it is farther away at aphelion.[18]

Chaldean astronomers known to have followed this model include Naburimannu (fl. 6th–3rd century BC), Kidinnu (d. 330 BC), Berossus (3rd century BCE), and Sudines (fl. 240 BCE). They are known to have had a significant influence on the Greek astronomer Hipparchus and the Egyptian astronomer Ptolemy, as well as other Hellenistic astronomers. Heliocentric astronomy

Main article: Seleucus of Seleucia

The only surviving planetary model from among the Chaldean astronomers is that of Seleucus of Seleucia (b. 190 BC), who supported Aristarchus of Samos' heliocentric model.[19][20][21] Seleucus is known from the writings of Plutarch, Aetius, Strabo, and Muhammad ibn Zakariya al-Razi. Strabo lists Seleucus as one of the four most influential Chaldean/Babylonian astronomers, alongside Kidinnu, Naburianos (Naburimannu), and Sudines. Their works were originally written in the Akkadian language and later translated into Greek.[22] Seleucus, however, was unique among them in that he was the only one known to have supported the heliocentric theory

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of planetary motion proposed by Aristarchus,[23][24][25] where the Earth rotated around its own axis which in turn revolved around the Sun. According to Plutarch, Seleucus even proved the heliocentric system through reasoning, though it is not known what arguments he used.[26]

According to Lucio Russo, his arguments were probably related to the phenomenon of tides.[27] Seleucus correctly theorized that tides were caused by the Moon, although he believed that the interaction was mediated by the Earth's atmosphere. He noted that the tides varied in time and strength in different parts of the world. According to Strabo (1. 1. 9), Seleucus was the first to state that the tides are due to the attraction of the Moon, and that the height of the tides depends on the Moon's position relative to the Sun.[22] According to Bartel Leendert van der Waerden, Seleucus may have proved the heliocentric theory by determining the constants of a geometric model for the heliocentric theory and by developing methods to compute planetary positions using this model. He may have used trigonometric methods that were available in his time, as he was a contemporary of Hipparchus.[28] None of his original writings or Greek translations have survived, though a fragment of his work has survived only in Arabic translation, which was later referred to by the Persian philosopher Muhammad ibn Zakariya al-Razi (865-925).[29]

Babylonian influence on Hellenistic astronomy

This section needs additional citations for verification. Please help improve this article by adding citations to reliable sources. Unsourced material may be challenged and removed. (November 2012)| Many of the works of ancient

Greek and Hellenistic writers (including mathematicians, astronomers, and geographers) have been preserved up to the present time, or some aspects of their work and thought are still known through later references. However, achievements in these fields by earlier ancient Near Eastern civilizations, notably those in Babylonia, were forgotten for a long time. Since the discovery of key archaeological sites in the 19th century, many cuneiform writings on clay tablets have been found, some of them related to astronomy. Most known astronomical tablets have been described by Abraham Sachs and later published by Otto Neugebauer in the *Astronomical Cuneiform Texts* (ACT). Since the rediscovery of the Babylonian civilization, it has become apparent that Hellenistic astronomy was strongly influenced by the Chaldeans. The best documented borrowings are those of Hipparchus (2nd century BCE) and Claudius Ptolemy (2nd century CE). Early influence

Many scholars agree that the Metonic cycle is likely to have been learned by the Greeks from Babylonian scribes. Meton of Athens, a Greek astronomer of the 5th century BCE, developed a lunisolar calendar based on the fact that 19 solar years is about equal to 235 lunar months, a period relation already known to the Babylonians. In the 4th century, Eudoxus of Cnidus wrote a book on the fixed stars. His descriptions of many constellations, especially the twelve signs of the zodiac, are suspiciously similar to Babylonian originals. The following century Aristarchus of Samos used an eclipse cycle of Babylonian origin called the Saros cycle to determine the year length. However, all these examples of early influence must be inferred and the chain of transmission is not known. Influence on Hipparchus and Ptolemy

In 1900, Franz Xaver Kugler demonstrated that Ptolemy had stated in his *Almagest* IV. 2 that Hipparchus improved the values for the Moon's periods known to him from "even more ancient astronomers" by comparing eclipse observations made earlier by "the Chaldeans", and by himself. However Kugler found that the periods that Ptolemy attributes to Hipparchus had already been used in Babylonian ephemerides, specifically the collection of texts nowadays called "System B" (sometimes attributed to Kidinnu). Apparently Hipparchus only confirmed the validity of the periods he learned from the Chaldeans by his newer observations. Later Greek knowledge of this specific Babylonian theory is confirmed by 2nd-century papyrus, which contains 32 lines of a single column of calculations for the Moon using this same "System B", but written in Greek on papyrus rather than in cuneiform on clay tablets.[30] It is clear that Hipparchus (and Ptolemy after him) had an essentially complete list of eclipse observations covering many centuries. Most likely these had been compiled from the "diary" tablets: these are clay tablets recording all relevant observations that the Chaldeans routinely made.

Preserved examples date from 652 BC to AD 130, but probably the records went back as far as the reign of the Babylonian king Nabonassar: Ptolemy starts his chronology with the first day in the Egyptian calendar of the first year of Nabonassar; i. e., 26 February 747 BC. This raw material by itself must have been tough to use, and no doubt the Chaldeans themselves compiled extracts of e. g., all observed eclipses (some tablets with a list of all eclipses in a period of time covering a saros have been found). This allowed them to recognise periodic recurrences of events. Among others

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they used in System B (cf. Almagest IV. 2): * 223 (synodic) months = 239 returns in anomaly (anomalistic month) = 242 returns in latitude (draconic month). This is now known as the saros period which is very useful for predicting eclipses. * 251 (synodic) months = 269 returns in anomaly

* 5458 (synodic) months = 5923 returns in latitude

* 1 synodic month = 29; 31: 50: 08: 20 days (sexagesimal; 29. 53059413... days in decimals = 29 days 12 hours 44 min $3\frac{1}{3}$ s) The Babylonians expressed all periods in synodic months, probably because they used a lunisolar calendar. Various relations with yearly phenomena led to different values for the length of the year. Similarly various relations between the periods of the planets were known. The relations that Ptolemy attributes to Hipparchus in Almagest IX. 3 had all already been used in predictions found on Babylonian clay tablets. Other traces of Babylonian practice in Hipparchus' work are

* first Greek known to divide the circle in 360 degrees of 60 arc minutes. * first consistent use of the sexagesimal number system. * the use of the unit pegasus ("cubit") of about 2° or $2\frac{1}{2}^\circ$. * use of a short period of 248 days = 9 anomalistic months. Means of transmission

All this knowledge was transferred to the Greeks probably shortly after the conquest by Alexander the Great (331 BC). According to the late classical philosopher Simplicius (early 6th century), Alexander ordered the translation of the historical astronomical records under supervision of his chronicler Callisthenes of Olynthus, who sent it to his uncle Aristotle. It is worth mentioning here that although Simplicius is a very late source, his account

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may be reliable. He spent some time in exile at the Sassanid (Persian) court, and may have accessed sources otherwise lost in the West. It is striking that he mentions the title *tèresis* (Greek: guard) which is an odd name for a historical work, but is in fact an adequate translation of the Babylonian title *massartu* meaning “guarding” but also “observing”. Anyway, Aristotle’s pupil Callippus of Cyzicus introduced his 76-year cycle, which improved upon the 19-year Metonic cycle, about that time. He had the first year of his first cycle start at the summer solstice of 28 June 330 BC (Julian proleptic date), but later he seems to have counted lunar months from the first month after Alexander’s decisive battle at Gaugamela in fall 331 BC.

So Callippus may have obtained his data from Babylonian sources and his calendar may have been anticipated by Kidinnu. Also it is known that the Babylonian priest known as Berossus wrote around 281 BC a book in Greek on the (rather mythological) history of Babylonia, the *Babyloniaca*, for the new ruler Antiochus I; it is said that later he founded a school of astrology on the Greek island of Kos. Another candidate for teaching the Greeks about Babylonian astronomy/astrology was Sudines who was at the court of Attalus I Soter late in the 3rd century BC. In any case, the translation of the astronomical records required profound knowledge of the cuneiform script, the language, and the procedures, so it seems likely that it was done by some unidentified Chaldeans. Now, the Babylonians dated their observations in their lunisolar calendar, in which months and years have varying lengths (29 or 30 days; 12 or 13 months respectively). At the time they did not use a regular calendar (such as based on the Metonic cycle like they did later), but

started a new month based on observations of the New Moon. This made it very tedious to compute the time interval between events.

What Hipparchus may have done is transform these records to the Egyptian calendar, which uses a fixed year of always 365 days (consisting of 12 months of 30 days and 5 extra days): this makes computing time intervals much easier. Ptolemy dated all observations in this calendar. He also writes that “ All that he (= Hipparchus) did was to make a compilation of the planetary observations arranged in a more useful way” (Almagest IX. 2). Pliny states (Naturalis Historia II. IX(53)) on eclipse predictions: “ After their time (= Thales) the courses of both stars (= Sun and Moon) for 600 years were prophesied by Hipparchus, ...”. This seems to imply that Hipparchus predicted eclipses for a period of 600 years, but considering the enormous amount of computation required, this is very unlikely. Rather, Hipparchus would have made a list of all eclipses from Nabonassar’s time to his own.

Later astronomy in Mesopotamia

Sassanid astronomy

The capital of the Sassanid Empire, the city of Ctesiphon, was founded in Mesopotamia. Astronomy was studied by Persians and Babylonians in Ctesiphon and in the Academy of Gundishapur in Persia. Most of the astronomical texts during the Sassanid period were written in the Middle Persian language. The Zīj al-Shah, a collection of astronomical tables compiled in Persia and Mesopotamia over two centuries, was the most famous astronomical text from the Sassanid period, and was later translated into Arabic. Islamic astronomy

Main article: Islamic astronomy

After the Islamic conquest of Persia, the province of Mesopotamia came to be known as Iraq in the Arabic language. During the Abbasid period of the region's history, Baghdad was the capital of the Arab Empire, and for centuries, remained the centre of astronomical activity throughout the Islamic world. Astronomy was also studied in Basra and other Iraqi cities. During the Islamic period, Arabic was adopted as the language of scholarship, and Iraq continued to make numerous contributions to the field of astronomy, up until the 1258 sack of Baghdad, when many libraries were destroyed and scientific activity in Iraq came to a halt. Despite this, the work that did survive had an impact on the subsequent development of astronomy, through the medieval Arabic-Latin translation movement in Europe and Maragheh observatory in Persia. http://en.wikipedia.org/wiki/Babylonian_astronomy

Babylonian mathematics

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Babylonian clay tablet YBC 7289 with annotations. The diagonal displays an approximation of the square root of 2 in foursexagesimal figures, which is about six decimalfigures. $1 + 24/60 + 51/60^2 + 10/60^3 = 1.41421296\dots$

Babylonian mathematics (also known as Assyro-Babylonian mathematics[1][2][3][4][5][6]) was any mathematics developed or practiced by the people of Mesopotamia, from the days of the early Sumerians to the fall of Babylon in 539 BC. Babylonian mathematical texts are plentiful and well edited.[7] In respect of time they fall in two distinct groups: one from the Old Babylonian <https://assignbuster.com/contribution-of-babylonians-in-science-and-technology-essay-sample/>

period (1830-1531 BC), the other mainly Seleucid from the last three or four centuries BC.

In respect of content there is scarcely any difference between the two groups of texts. Thus Babylonian mathematics remained constant, in character and content, for nearly two millennia.[7] In contrast to the scarcity of sources in Egyptian mathematics, our knowledge of Babylonian mathematics is derived from some 400 clay tablets unearthed since the 1850s. Written in Cuneiform script, tablets were inscribed while the clay was moist, and baked hard in an oven or by the heat of the sun. The majority of recovered clay tablets date from 1800 to 1600 BC, and cover topics that include fractions, algebra, quadratic and cubic equations and the Pythagorean theorem. The Babylonian tablet YBC 7289 gives an approximation to accurate to five decimal places.

Origins of Babylonian mathematics

Babylonian mathematics is a range of numeric and more advanced mathematical practices in the ancient Near East, written in cuneiform script. Study has historically focused on the Old Babylonian period in the early second millennium BC due to the wealth of data available. There has been debate over the earliest appearance of Babylonian mathematics, with historians suggesting a range of dates between the 5th and 3rd millennia BC. [citation needed] Babylonian mathematics was primarily written on clay tablets in cuneiform script in the Akkadian or Sumerian languages. “ Babylonian mathematics” is perhaps an unhelpful term since the earliest

suggested origins date to the use of accounting devices, such as bullae and tokens, in the 5th millennium BC.

Babylonian numerals

Main article: Babylonian numerals

The Babylonian system of mathematics was sexagesimal (base 60) numeral system. From this we derive the modern day usage of 60 seconds in a minute, 60 minutes in an hour, and 360 degrees in a circle. The Babylonians were able to make great advances in mathematics for two reasons. Firstly, the number 60 is a superior highly composite number, having divisors of 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30, 60 (including those that are themselves composite), facilitating calculations with fractions. Additionally, unlike the Egyptians and Romans, the Babylonians and Indians had a true place-value system, where digits written in the left column represented larger values (much as in our base ten system: $734 = 7 \times 100 + 3 \times 10 + 4 \times 1$). The Sumerians and Babylonians were pioneers in this respect.

Sumerian mathematics (2000 — 2300 BC)

The ancient Sumerians of Mesopotamia developed a complex system of metrology from 3000 BC. From 2600 BC onwards, the Sumerians wrote multiplication tables on clay tablets and dealt with geometrical exercises and division problems. The earliest traces of the Babylonian numerals also date back to this period.[8]

Old Babylonian mathematics (2000–1600 BC)

Most clay tablets that describe Babylonian mathematics belong to the Old Babylonian, which is why the mathematics of Mesopotamia is commonly

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known as Babylonian mathematics. Some clay tablets contain mathematical lists and tables, others contain problems and worked solutions. Arithmetic

The Babylonians used pre-calculated tables to assist with arithmetic. For example, two tablets found at Senkerah on the Euphrates in 1854, dating from 2000 BC, give lists of the squares of numbers up to 59 and the cubes of numbers up to 32. The Babylonians used the lists of squares together with the formulas

to simplify multiplication.

The Babylonians did not have an algorithm for long division. Instead they based their method on the fact that

together with a table of reciprocals. Numbers whose only prime factors are 2, 3 or 5 (known as 5-smooth or regular numbers) have finite reciprocals in sexagesimal notation, and tables with extensive lists of these reciprocals have been found. Reciprocals such as $1/7$, $1/11$, $1/13$, etc. do not have finite representations in sexagesimal notation. To compute $1/13$ or to divide a number by 13 the Babylonians would use an approximation such as

Algebra

As well as arithmetical calculations, Babylonian mathematicians also developed algebraic methods of solving equations. Once again, these were based on pre-calculated tables. To solve a quadratic equation, the Babylonians essentially used the standard quadratic formula. They considered quadratic equations of the form where here b and c were not necessarily integers, but c was always positive. They knew that a solution to

this form of equation is and they would use their tables of squares in reverse to find square roots. They always used the positive root because this made sense when solving “ real” problems. Problems of this type included finding the dimensions of a rectangle given its area and the amount by which the length exceeds the width. Tables of values of $n^3 + n^2$ were used to solve certain cubic equations. For example, consider the equation

Multiplying the equation by a^2 and dividing by b^3 gives

Substituting $y = ax/b$ gives which could now be solved by looking up the $n^3 + n^2$ table to find the value closest to the right hand side. The Babylonians accomplished this without algebraic notation, showing a remarkable depth of understanding. However, they did not have a method for solving the general cubic equation. Growth

Babylonians modeled exponential growth, constrained growth (via a form of sigmoid functions), and doubling time, the latter in the context of interest on loans. Clay tablets from c. 2000 BCE include the exercise “ Given an interest rate of $1/60$ per month (no compounding), compute the doubling time.” This yields an annual interest rate of $12/60 = 20\%$, and hence a doubling time of $100\% \text{ growth} / 20\% \text{ growth per year} = 5 \text{ years}$. [9][10] Plimpton 322

The Plimpton 322 tablet contains a list of “ Pythagorean triples”, i. e., integers such that . The triples are too many and too large to have been obtained by brute force. Much has been written on the subject, including some speculation (perhaps anachronistic) as to whether the tablet could have served as an early trigonometrical table. Care must be exercised to see

the tablet in terms of methods familiar or accessible to scribes at the time. [...] the question “ how was the tablet calculated?” does not have to have the same answer as the question “ what problems does the tablet set?” The first can be answered most satisfactorily by reciprocal pairs, as first suggested half a century ago, and the second by some sort of right-triangle problems. (E. Robson, “ Neither Sherlock Holmes nor Babylon: a reassessment of Plimpton 322”, *Historia Math.* 28 (3), p. 202). Geometry

Babylonians knew the common rules for measuring volumes and areas. They measured the circumference of a circle as three times the diameter and the area as one-twelfth the square of the circumference, which would be correct if π is estimated as 3. The volume of a cylinder was taken as the product of the base and the height, however, the volume of the frustum of a cone or a square pyramid was incorrectly taken as the product of the height and half the sum of the bases. The Pythagorean theorem was also known to the Babylonians. Also, there was a recent discovery in which a tablet used π as 3 and $1/8$. The Babylonians are also known for the Babylonian mile, which was a measure of distance equal to about seven miles (or 11.3 kilometers) today.

This measurement for distances eventually was converted to a time-mile used for measuring the travel of the Sun, therefore, representing time.[11] The ancient Babylonians had known of theorems on the ratios of the sides of similar triangles for many centuries, but they lacked the concept of an angle measure and consequently, studied the sides of triangles instead.[12] The Babylonian astronomers kept detailed records on the rising and setting of

stars, the motion of the planets, and the solar and lunar eclipses, all of which required familiarity with angular distances measured on the celestial sphere.

[13] They also used a form of Fourier analysis to compute ephemeris (tables of astronomical positions), which was discovered in the 1950s by Otto Neugebauer.