# Dawn of Science

## 1. The First Tottering Steps

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**In mankind's quest for knowledge, spanning the last four thousand years, certain developments stand out as milestones in the progress of science. This new series, intended for the general reader, will highlight such key events in the growth of mathematics, physics, chemistry, biology and engineering in an approximately chronological manner.**

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You can never really say when science was born – probably when the pre-historic hunter devised the perfect bow – or with the proverbial fire and the wheel. The true beginnings will never be known. Several little acts of logic and imagination are lost to us for lack of recorded history.

Even where some records exist, it is never easy to distinguish true science from mythology, magic and mysticism. Every fable and fairy tale, myth and legend, epic and adventure story contains very imaginative novelties. Did the creators of these works produce science fiction and flights of imagination or did they have first-hand experience with certain magnificent inventions? We believe it is the former and that the ancient literary fables cannot be taken too seriously in determining the early evolution of science.

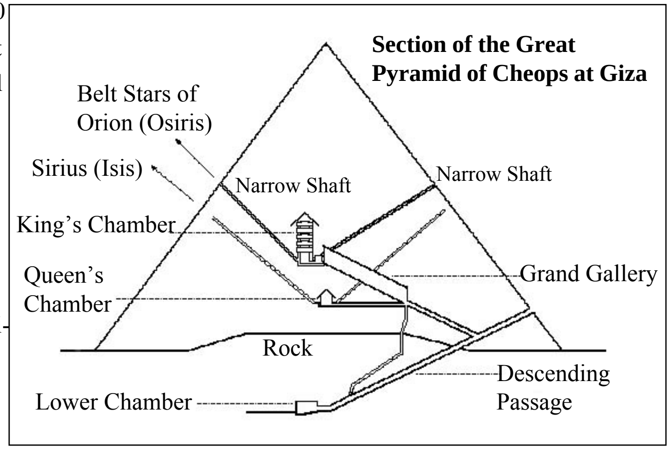
With such a conservative stand, the earliest achievement of humanity requiring mammoth scientific and technological skill is definitely the pyramids in Egypt. (See *Box* 1). These constructions, intended to ensure the safe passage of the rulers or Pharaohs (and certain other privileged ones) to the other world, certainly needed elaborate technical skill. Such a skill could not have been achieved without the understanding of the basics of what we today call 'science'.

**Keywords**
Pyramids, Imhotep, *Moscow Papyrus*, Thales of Miletus.

It is rather difficult to identify 'the scientist' involved with

**Box 1. The Pyramids of Egypt**

The Egyptian pyramids, built around 2500 BC were essentially funeral edifices. But their size, structure, artistic and technical perfection shows the remarkable engineering skills of this ancient civilisation.




The earliest pyramid was the mastaba, a flat-topped rectangular structure of mud-brick or stone with a shaft descending to the burial chamber far below it. The original mastaba, built by Djoser has a base measuring 120 m by 108 m and a height of 60 m. Some of the earlier pyramids have a step-like structure. Usually the builders start with a step pyramid and add packing of stone to form a continuous slope covered with smooth packing of limestone. The biggest of these pyramids is the one at Giza, erected by the Pharaohs Khufu, Khafre and Menkure. It measures a 230 m square base and a towering height of 146 m and is made of 2,300,000 blocks of stone; the King's chamber in this pyramid alone measures 105 m by 5.2 m.

pyramids. Many people must have contributed. All the same, an Egyptian scholar by name Imhotep who lived around 2960 BC has been named the architect of the 'step pyramid' at Saqqara in Egypt; this is said to be the first major Egyptian structure in stone. In addition to being an architect, he was also said to be a good vizier, mathematician and a medical man. There are also some ancient manuscripts, which suggest that Imhotep counseled Zoser (the Pharaoh of step pyramid) on the seven-year famine in the Nile – a story that parallels the legends of Joseph in the Old Testament. Later, the Greeks identified Imhotep, called *Imouthes* in Greek, with Asklepios – the Greek god of medicine. This identification has made several historians doubt whether Imhotep really existed; probably he is no more real than Viswakarma of Indian epics. But the man who designed the pyramids does deserve a mention while describing the dawn of science.

Imhotep, the man who designed the pyramids does deserve a mention while describing the dawn of science.

Moving lightly over a thousand years, we come across the next milestone – the golden age of Egyptian mathematics. There is a

The intuitive leap involved in arriving at the formula in *Box* 2 is considered an important achievement by historians of mathematics.

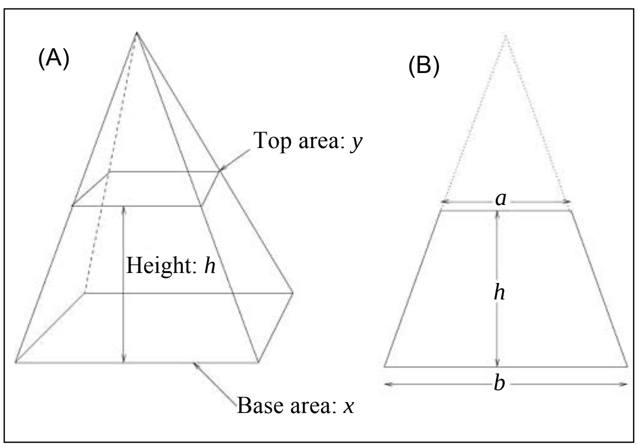
scribe, Ahmose, mentioned in a mathematical treatise of ancient Egypt. He was a copyist who lived around 1000 BC and copied a mathematical treatise dealing with simple equations, fractions and some of the rudimentary mathematical details from the earlier, scattered works of anonymous origin. Though some of the mathematical writings of Egyptians show remarkable ingenuity (see for example, *Box* 2), they never generalised their methods and did not bother to develop mathematics as a scientific and logical discipline.

That had to wait for yet another thousand years – for Thales of Miletus (640–546 BC). He probably deserves to be called the founder of Greek science, mathematics and philosophy. Thales was born in Miletus, which is on the western coast of Turkey. He definitely traveled around and visited Egypt and Babylonia. He learnt a lot from the Babylonians (who had by then developed a science of astronomy and had worked out detailed rules for

**Box 2. The Moscow Papyrus**

The *MoscowPapyrus* is an ancient Egyptian mathematical text, dating back to about 1850 BC, now kept in the museum in Moscow. It contains a discussion of 25 problems in different areas of mathematics. Of these, the discussion in problem 14 is of special importance. This problem attempts to calculate the volume of a section (frustum) of a square pyramid of base areas $x$ and $y$ and height $h$ (*Figure* A).

Both the Babylonians and the Egyptians knew the answer to the 'corresponding' problem in two dimensions, namely, the area of a section of a triangle with parallel sides $a$ and $b$ and height $h$ (*Figure* B). This is given by the formula $(½)\, h\, (a + b)$. Working by 'analogy', the Babylonians took the volume of the frustum of the pyramid to be $(½)\ h\ (x + y)$ which is wrong. On the other hand, the *Moscow Papyrus* shows that the Egyptians 'guessed' the correct formula: $(1/3)\, h(x + \sqrt{(xy)} + y)$! The intuitive leap involved in arriving at this formula is considered an important achievement by historians of mathematics.



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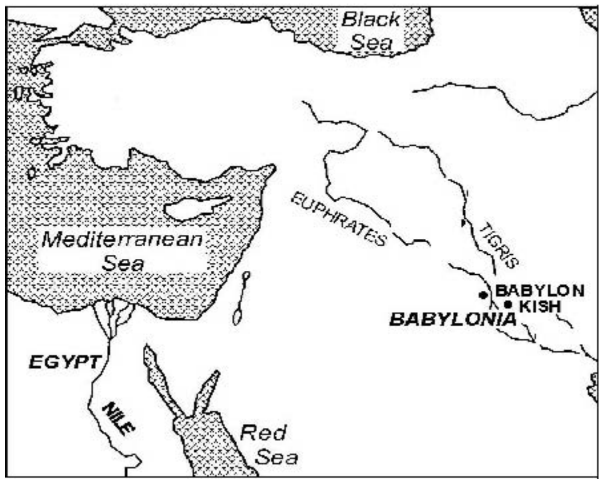


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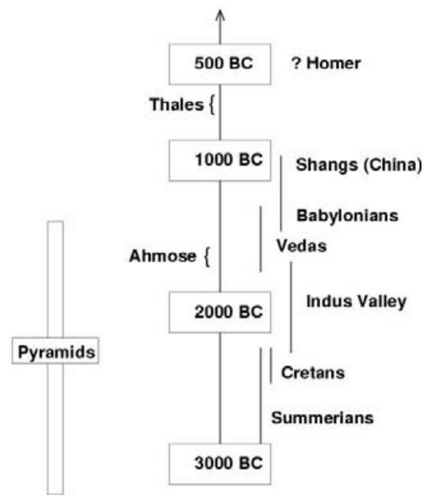


***Figure 1. (left)***
***Figure 2. (right)***

calculating the eclipses and other astronomical phenomena) and put it to good use. There is a story that Thales predicted a solar eclipse which is supposed to have occurred on the day the armies of Medes and Lydians were about to clash. The eclipse scared them into signing a treaty of peace. (Calculating back we can now know that this event must have taken place on 28 May 585 BC!)

Thales also borrowed concepts from Egyptian mathematics but he went ahead and developed it in a rather axiomatic way. He had the vision to see the necessity of proof and had proceeded to develop step-by-step logic leading to conclusions from given premises. This feat is truly incredible because, as far as we know, several other major civilisations like the Egyptians, Babylonians, Indians and the Chinese didn't seem to have worried about the rigours of logical proof, the cornerstones of modern mathematics.

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Thales is credited with the following five elementary theorems: (1) The circle is bisected by the diameter; (2) the base angles of an isosceles triangle are equal; (3) vertically opposite angles of two intersecting straight lines are equal; (4) two triangles are congruent if they have two angles and the corresponding side respectively equal; and (5) an angle inscribed in a semi-circle is a right

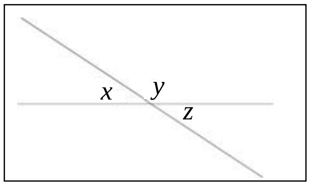


*Figure 3.*

angle. These results were known long before Thales but were accepted as true based on direct, empirical measurement. Thales's genius lies in supporting each of these theorems by logical reasoning, starting from certain basic axioms. For example, he proved (3) in the following manner: "In *Figure* 3, $x$ is the supplementary angle to $y$; but $y$ is also a supplementary angle to $z$. Since things equal to the same thing are equal to one another, $x = z$."

When the Greeks listed the 'seven wise men', Thales was always the first.

Thales also worried about the larger questions of Nature like, "What is the Universe made of?" It is irrelevant that he didn't get the right answer. What is important was that he asked the question and, probably, for the first time in history, attempted to answer it without invoking gods, demons and other mythological objects, which were available in plenty at the time. He influenced his contemporaries and the coming generations in no small measure. So much so that when the Greeks listed the 'seven wise men', Thales was always the first.

## Suggested Reading

**[1] Howard Eves, *Great Moments in Mathematics Before* 1650, (Dolciani Mathematical Expositions No 5), Mathematical Association of America, 1983.**

**[2] Isaac Asimov, *Asimov's Biographical Encyclopedia of Science and Technology*, Doubleday, 1982.**

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