2026 Volume: 02 Issue: 03 www.ijrpa.com ISSN 2456-9995 Review Article

International Journal Research Publication Analysis

Page: 01-05

MATHEMATICAL PRACTICES OF HINDUS IN ANCIENT INDIA

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Article Received: 18 February 2026
Article Revised: 08 March 2026
Published on: 28 March 2026

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DOI: https://doi-doi.org/101555/ijrpa.9246

Brief introduction of the author:--*Projjwal Mandal a Bio-Science Graduate,Vedic Shastra related topic writer in "Pranab Patrika"(Bharat Sevashram Sangha) and "Viswa Hindu Varta" (VHP Bengal) Magazine.*

The word “Mathematics” means the science related to calculation. It is one of the principal branches of science. It is not possible to give an exact answer to the question of when and where mathematics began. In our ancient India, advanced mathematical practices existed, for which much evidence has been found. Therefore, according to many scholars, India is the birthplace of mathematics.

A question may arise—what is the reasoning behind such a claim? The Indus Civilization is considered the beginning of mathematical development on Indian soil, as no earlier civilization has yet been discovered. The script found in the ruins of the Indus Civilization has not yet been deciphered. Therefore, the true nature of mathematical practices of that era remains unknown. However, from various scattered artifacts, it is easy to infer that the inhabitants of this valley possessed highly developed mathematical knowledge. This civilization emerged between 3500–3300 BCE.

Primarily, mathematical practices in India have existed since the Vedic age. It is believed that the complete practice of mathematics by Vedic scholars helped Indian astronomy reach great heights. In the Vedic period, the foundation of mathematics was embedded in the 16 sutras and 13 subsutras described in the Vedas. Calculations were mainly performed using the decimal system. From numbers mentioned in the Yajurveda Samhita such as “Arbud” (10,000,000), “Narbud” (100,000,000), “Samudra” (1,000,000,000), and “Parardha” (1,000,000,000,000), it is evident that Hindu mathematicians were not unfamiliar with the

concept of extremely large numbers. Contemporary civilizations likely could not imagine such vast numbers.

Let us observe the following number sequences:

1, 3, 5, …, 99

24, 48, 96, 192, …, 393216

The first is called an arithmetic progression and the second a geometric progression. These are mentioned respectively in the Taittiriya Samhita and Panchavimsha Brahmana. So much for arithmetic. The Shatapatha Brahmana also provides evidence of Hindu knowledge in geometry. In Vedic rituals, an important structure was the "Mahavedi," shaped like an isosceles trapezium. Hindus knew the area and relationships between sides and height of this trapezium. They were also aware of negative quantities.

Another important text in Sanskrit is the "Shulba Sutra." The word "Shulba" means rope. These sutras were used in constructing altars after death. It is a type of Vedic knowledge describing various fire altars and their symbolic meanings. For example, those wishing to go to heaven would have an altar shaped like a crane. Those wishing to conquer the world like Brahmins would have a tortoise-shaped altar. Those wishing to be invincible would have rhombus-shaped altars.

Some important sutras obtained from the Vedas are:-----

1.Apastamba 2.Baudhayana 3.Manava 4.Katyayana 5.Maitrayani 6.Varaha 7.Badhula 8.Hiranyakeshi

Most of these were discovered between 800–200 BCE. The oldest among them is Baudhayana. Interestingly, similarities have been observed between the works of Apastamba, Baudhayana, and the Pythagorean theorem. Various geometric shapes like quadrilaterals and squares are mentioned. Methods for transforming the area of one geometric figure into another are also described. Remarkably, a highly accurate method for determining $\sqrt{2}$ is also found in these texts.

After this, for nearly 1000 years, significant contributions in fundamental mathematical research were not observed. Later, great scholars like Aryabhata (476–530), Brahmagupta (588–660 CE), Varahamihira, Bhaskara, Mahaviracharya, Sridhara Acharya, Sripati, and Bhaskaracharya re-established the prominence of Hindu mathematics.

The most notable contributions of Hindu scholars are the decimal place-value system and the invention of zero. However, the use of zero is found earlier in Pingala's Chhanda Sutra (200 BCE). Aryabhata's Aryabhatiya contains solutions to indeterminate equations and an accurate value of π. He also developed methods for extracting square roots.

Brahmagupta discovered the formula for the volume of a frustum of a pyramid. Bhaskara wrote the famous Siddhanta Shiromani, consisting of four parts, including Lilavati and Bijaganita. He stated that multiplying two negative numbers gives a positive number, while multiplying a negative and a positive gives a negative number.

The quadratic formula
$x = (-b \pm \sqrt{(b^2 - 4ac)}) / 2a$
is attributed to Sridhara and is known as "Sridharacharya's theorem."

In trigonometry, Hindu contributions are undeniable. Varahamihira calculated sin30 and sin60. Aryabhata, Bhaskara, and Sridhara contributed to functions, π, and quadratic equations. Ramanujan and P. L. Bhatnagar are modern mathematical luminaries.

Mahaviracharya wrote Ganit Sara Sangraha and developed methods for finding LCM. Brahmagupta discovered the formula for the area of a cyclic quadrilateral.

Sridhara Acharya wrote three important works: Trisatika, Patiganita, and Bijaganita. He developed methods for solving quadratic equations and gave geometric interpretations of algebraic formulas.

Sripati wrote Siddhanta Shekhar and Ganit Tilak.
The decimal system, based on ten fingers, is the most widely used today. Though zero existed in Mesopotamian and Mayan civilizations, it was considered absence or negativity. India is credited with its effective use and integration into the decimal system.

Around 400 BCE, decimal usage appeared in India. Aryabhata wrote:
"sthanam sthanam dasa gunam"
meaning each place is ten times the previous—indicating the place-value system.

If asked about the theorem stating that the square of the hypotenuse equals the sum of squares of the other two sides, most would say it is the Pythagorean theorem. While globally recognized as such, its concept appears in Indian texts much earlier.

Pythagoras was born around 572 BCE in Greece. However, earlier Indian civilization already had advanced knowledge in philosophy and science. The concept appears in Shulba Sutras:

"dirghachaturasrasyakshnaya rajjustriryagmani parshchamani cha yat prithagbhute kurutah, tadubhayam karoti iti kshetrajnanam."
[Baudhayana Shulba 1.48, Katyayana 2.11, Apastamba 1.7]

Meaning: The square formed by the diagonal of a rectangle equals the sum of squares formed on its two sides.

Aryabhata also wrote:
"yashchaiva bhujabargah kotibargashcha karnabargah sah."

Meaning: The sum of the squares of the base and height equals the square of the hypotenuse.

These ancient texts show how advanced India was in knowledge, science, and mathematics. Contributions include zero, algebra, algorithms, square roots, and cube roots.

Algebra developed significantly in India. Around the 5th century, it was used mainly in astronomy due to complex calculations. Trigonometry also originated in India and spread to the Middle East and Europe.

Indian mathematicians like Aryabhata, Brahmagupta, Bhaskara I, and Bhaskara II contributed significantly to trigonometry. Kerala mathematician Madhava discovered infinite series for sine and cosine long before Newton, making him a pioneer of mathematical analysis.

From the above discussion, it is clear that ancient India was highly advanced in mathematics. However, during the medieval period, barbaric Islamic invasions led to the decline of this golden age of mathematical practice.

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