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INDIA'S CIVILIZATION AND SOCIETY FROM ANCIENT TIMES, LEGACY TO THE WORLD

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ABSTRACT

In this article, we are expounding India's incomparable visionary legacy to the world in the following domains: **I. Urban civilization first appeared in ancient India with the Indus Valley civilization in the early third millennium BCE:** Urban civilization first appeared in ancient India with the Indus Valley civilization in the early third millennium BCE, in what is today Pakistan and north-west India. **II. Society and Economy in Ancient India**The Vedic Age was a "dark age" in Indian history, in that it was a time of violent upheaval, and no written records from that period have survived to illuminate it. It was, however, one of the most formative eras of ancient Indian civilization. So far as society is concerned, the coming of Aryans into ancient India, and their establishing themselves as the dominant group, gave rise to the caste system. This divided Indian society into rigid layers, underpinned by religious rules. Originally there were just four castes, the priestly caste, the warrior caste, the farmers and traders, and the menial workers. **III. Government in Ancient India:** The tribal chiefs of early Aryan society were the ancestors of the princes and kings we encounter in later Indian history. The rise of the Mauryan empire to cover most of ancient India involved the creation of a provincial administration which spanned much of the subcontinent. The empire was divided into provinces, and an empire-wide tax-gathering organization was developed. Also created was an extensive espionage system. A network of roads running from south and north and east to west was maintained. Mauryan power rested ultimately on its formidable army, which seems to have been one of the largest in the ancient world. **IV. Ancient Indian Religion:** The civilization of ancient India was an astonishing seedbed of religious innovation. Reconstructing the Indus Valley civilization's religion is impossible, but there are strong clues that it had a major impact on the subsequent religious history of India. In any case, the next period of ancient Indian history, the Vedic age, saw the rise of a belief system that was foundational to all later Indian religions. **V. The emergence of Hinduism:** The teachings and practices of both Jainism and Buddhism had a profound impact on Brahmanism, and helped it evolve into the religion which we know as Hinduism. **VI. Ancient Indian Literature:** Strongly linked to these religious developments, ancient India produced a fantastically rich literature. In the centuries after coming into northern India, during the so-called "Vedic Age", the Aryans developed a great abundance of poems, tales, hymns, spells and so on, in an oral tradition known as the *Vedas*. Another body of oral literature that was composed towards the end of the Vedic age were the *Upanishads*, a collection of works of prose and poetry which explore deep religious and philosophical concepts, including the idea that the material world is an illusion, and the implications of this idea for the individual soul. **VII. Sanskrit and other languages:** Right up until Gupta times and beyond, Sanskrit was the language of high culture – and in fact its use in this way became more prevalent in ancient India as time went on. Sanskrit was the ancient language of the Aryans; it was an Indo-European language distantly related to Persian, Greek, Latin, German and other tongues. The Sanskrit script was based on the Aramaic alphabet, which came to India from the Middle East some time before 500 BCE. **VIII. Ancient Indian Art and Architecture:** Art:Apart from figurines from the Indus Valley civilization, the earliest examples of the art of ancient India which have come down to us are from magnificent cave temples in central India. Architecture: Another Buddhist innovation was the *stupa*, a dome-shaped monument in which religious relics were stored. The earliest of these date from Mauryan times, with the Great Stupa at Sanchi being the most famous. **IX. Ancient Indian Mathematics, Medicine and Science Mathematics:** Indian mathematicians clearly understood the Pythagorean theorem, that the square of the hypotenuse is equal to the sum of the squares of the other two sides. Sometime later, in a step usually accredited to the period of the Gupta empire, Indian thinkers discovered the concept of zero. This was an enormously important advancement in mathematics, even more so for being linked to the development of the decimal number system. **Astronomy:** Aryabhata, the most famous scholar in Gupta times, showed that the Earth is a sphere, and revolves around its axis each day. He believed that it circles round the Sun, not vice versa, and that the stars' motions are caused by the Earth's own movements rather than the sky's. He identified eclipses as the shadow of the moon falling on the Earth. **Medicine:** A medical treatise called the *Sushruta Samhita* (or Sushrita's Compendium, 6th century BCE) describes 1120 illnesses, 700 medicinal plants, a detailed study on anatomy, 64 preparations from mineral sources and 57 preparations based on animal sources. Cataract surgery was known to ancient Indian physicians, and it was performed with a specially designed curved needle to loosen the lens and push the cataract out of the field of vision. **X. The Legacy of Ancient India in World History:** The evolution of a religious culture in ancient India, out of which Hinduism, Jainism and Buddhism emerged as three distinct

religions, was a development of great importance in world history. **XI. India's enduring legacy spans millennia:** India's legacy spans ancient wisdom to modern ideals, offering profound contributions in Spirituality (yoga, dharma), Mathematics (zero, decimal system, algebra), Foundational religions (Hinduism, Buddhism, Jainism), Scientific advancements (astronomy and medicine), Rich arts (epics, architecture), and Philosophies (ahimsa, dharma), influencing global culture, ethics, and intellectual development from the Indus Valley to today's interconnected world. **XII. India's three ancient universities that transformed society by providing new knowledge in academic fields:** India's ancient universities Takshashila, Nalanda, and Vikramshila were pivotal in transforming society by establishing sophisticated centers of learning that offered diverse curricula: from logic and medicine to Vedic studies, astronomy and grammar. The universities drawing scholars globally laid the foundations for modern higher education, fostering intellectual growth, spiritual development and cross-cultural exchange long before the concept of a modern university. **XIII. Essence of India's Legacy:** In essence, India's legacy is a continuous thread of intellectual, spiritual, and cultural innovation that has enriched humanity's understanding of life and the universe, and fostering concepts of interconnectedness, ethical living, and scientific inquiry. From the philosophical insights enshrined in the Vedas and Upanishads to the revolutionary scientific advancements in mathematics, astronomy, and medicine, ancient India emerged as a beacon of intellectual brilliance. Ancient India's culture and achievements have impacted the modern world through medical advances, religions, and scientific discoveries.

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I. Urban civilization first appeared in ancient India with the Indus Valley civilization in the early third millennium BCE, in what is today Pakistan and north-west India

This was contemporary with other early civilizations of the ancient world, in Mesopotamia and Ancient Egypt, and is one of the earliest civilizations in world history. It is famous for its large and well-planned cities [Ref.1].

The Indus Valley civilization vanished in the mid-2nd millennium BCE. In the following thousand years, a people known as the Aryans, speaking an Indo-European language, moved into northern India from central Asia. They came into India as pastoral, semi-nomadic tribes led by warrior chieftains. Over time, they settled down as rulers over the native Dravidian populations they found there, and formed tribal kingdoms. This period of ancient Indian history is known as the Vedic age, as it was depicted in the earliest Indian writings, called the Vedas. It is also the formative period in which most of the basic features of traditional Indian civilization were laid down. These include the emergence of early Hinduism as the foundational religion of India, and the social/religious phenomenon known as caste.

A page from the manuscript Seventy-two Specimens of Castes in India. Library of Congress Catalog [Ref.2]

The period lasted from around 1500 BCE through to 500 BCE; that is, from the early days of the Aryan migrations through to the age of the Buddha. The tribal society of the early Aryans gave way to the more complex society of the Classic Age of Ancient India. This period saw the rebirth of urban civilization in the Indian subcontinent, and with it, a literate culture. It was one of the most creative ages in the history of India, and saw the emergence of two new religions, Jainism and Buddhism.

Painting of Indra on his elephant mount, Airavata. The Picture Art Collection.

This period of ancient India ended with the rise of the first great imperial state in ancient India, the Mauryan empire, after 320 BCE. The Maurya empire was in effect an outgrowth of the kingdom of Magadha. Under a line of kings of the Nanda dynasty (reigned c. 424-322 BCE), this kingdom dramatically expanded to cover a large part of northern India; and under the following Maurya dynasty, the empire went on the cover all of north and central India.The most famous of the Maurya emperors, in fact the most famous ruler in ancient India's history and one of the most notable in the entire ancient world, was **Ashoka** (reigned 272-232 BCE). He was a remarkable and attractive ruler: compassionate, tolerant, firm, seeking justice and well-being for all his subjects. Fifty years or so after Ashoka's death the huge Mauryan empire began to crumble. Outlying provinces fell away, and by the mid-2nd century BCE the empire had shrunk to its core areas. Other powerful states had appeared in the wreckage of the empire, the most powerful of which was the Satavahana kingdom.In the north west of the subcontinent, in what is today Afghanistan, there appeared another influential state, the Indo-Greek kingdom of Bactria. This soon fragmented into smaller states, and the area was then conquered by the Scythian people from central Asia – known in Indian history as the Saka. They in turn were driven out of the north west by the Kushana people, who created a powerful empire straddling northern India and parts of central Asia.This succession of states in the north west nourished a distinctive culture who modern scholars call the Gandhara civilization. This was a fusion of Indian, Greek and Persian elements. Buddhism was the predominant religion here, and Gandhara's position astride the Silk Road spread its influence far and wide. Most notably its missionaries carried Buddhism to China.Gandhara also had a deep cultural influence within the Indian subcontinent. The art and architecture of the Gupta empire owed a large debt to it.

II. Society and Economy in Ancient India

The Vedic Age was a "dark age" in Indian history, in that it was a time of violent upheaval, and no written records from that period have survived to illuminate it. It was, however, one of the most formative eras of ancient Indian civilization. So far as society is concerned, the coming of Aryans into ancient India, and their establishing themselves as the dominant group, gave rise to the caste system**.**This divided Indian society into rigid layers, underpinned by religious rules. Originally there were just four castes, the priestly caste, the warrior caste, the farmers and traders, and the menial workers. Outside the caste system altogether, excluded from Aryan-dominated society, were the "Untouchables".As early Aryan society evolved into the more settled and more urban society of ancient India, these caste divisions persisted. New religious movements, the Jains and Buddhists, rebelled against it, preaching that all men are equal. However, caste was never overthrown. As time went on, indeed, it became more complex, and more rigid. It has endured right up to the present day.In the earliest times, many hunter-gatherer groups inhabited much of the Indian sub-continent. However, the economic history of ancient India is one of agricultural advance. The use of iron spread from the Middle East from around 800 BCE, making farming more productive, and populations grew. At first, this occurred on the plains of northern India. However, iron-age farming gradually spread throughout the entire subcontinent. The hunter-gatherers were squeezed more and more into the forests and hills of India, eventually to take up farming themselves and being incorporated into Aryan society as new castes.The spread of iron-age farming was a crucial development in the history of ancient India as it led to the rebirth of urban civilization in the subcontinent. Cities grew up; trade expanded; metal currency appeared, and an alphabetical script came into use [Ref.3].These developments were consolidated under the Mauryan empire and its successors, and urban civilization spread throughout India.

III. Government in Ancient India

The tribal chiefs of early Aryan society were the ancestors of the princes and kings we encounter in later Indian history. The re-emergence of cities enabled properly organized states to appear. Most of these were kingdoms, but uniquely in the ancient world outside the Mediterranean, some were republics. The rise of the Mauryan empire to cover most of ancient India involved the creation of a provincial administration which spanned much of the subcontinent. The empire was divided into provinces, and an empire-wide tax-gathering organization was developed. Also created was an extensive espionage system. A network of roads running from south and north and east to west was maintained. Mauryan power rested ultimately on its formidable army, which seems to have been one of the largest in the ancient world. The establishment of provinces, with strong centres of state power distributed in key locations throughout much of the subcontinent, set the stage for the next chapter in India's history. As Mauryan power weakened, these provinces became powerful regional kingdoms in their own right, covering a territory far greater than the ancient Aryan homeland of northern India and reaching down into southern India. The pattern of government that emerged in the post-Maurya centuries was a looser form of administration. In fact large Indian states were not so much centralized kingdoms as collections of kingdoms owing obedience to a "king of kings". This is illustrated best in the power structure of the Gupta empire, which also reflected this systems' strengths and weakness well [Ref. 4].

IV. Ancient Indian Religions

The civilization of ancient India was an astonishing seedbed of religious innovation.Reconstructing the Indus Valley civilization's religion is impossible, but there are strong clues that it had a major impact on the subsequent religious history of India. In any case, the next period of ancient Indian history, the Vedic age, saw the rise of a belief system that was foundational to all later Indian religions.

Excavated ruins of Mohenjo-daro, with the Great Bath in the front. Reproduced under Creative Commons license 1.0This is sometimes called the Vedic religion, or Brahmanism. It revolved around a pantheon of gods and goddesses, but also came to include the concept of the "Cycle of Life" – reincarnation of the soul from one creature (including both animals and humans) to another.Later, the idea of the material world being an illusion became widespread. Such ideas were emphasised more strongly in the new teachings of Jainism and Buddhism, which both also had their origins in ancient India, in the years around 500 BCE.

Jainism: Jainism was founded by Mahariva ("The Great Hero", lived c. 540-468 BCE). He emphasised an aspect already present in early Hinduism, non-violence to all living things. He also promoted the renunciation of worldly desires and an ascetic way of life.

Buddhism: Buddhism was founded by Gautama Siddharta, the Buddha ("The Enlightened One", lived c. 565 to 485 BCE). He came to believe that extreme asceticism was not a fruitful basis for a spiritual life. However, like Jains, he believed that the release from worldly desires was the way to salvation. In daily life, Buddhists emphasised the importance of ethical behaviour.

Under the Maurya empire and later: Both Buddhism and Jainism flourished under the Mauryan empire and its successors. Some

scholars believe that it was under Ashoka that Buddhism became established as a major religion within ancient India. in the kingdoms which succeeded the Maurya empire, many kings, in all parts of India, were happy to promote all three religious strands, Brahmanism, Buddhism and Jainism. Indeed, the extent to which they were seen as distinct religions (if such a concept even existed in India at that time) is open to question [Ref.5].

V. The emergence of Hinduism

The teachings and practices of both Jainism and Buddhism had a profound impact on Brahmanism, and helped it evolve into the religion which we know as Hinduism. This was a gradual process which really only becomes apparent towards the end of the period which we have here designated as Ancient India (i.e. up to 500 CE). It was certainly taking place by the time of the Gupta empire, when the worship of Shiva and Vishnu (the cults of Shaiva and Vaishnava respectively) and other deities were gaining in prominence. These new cults were being incorporated into Brahman beliefs and practices, and thereby turning it into an early form of Hinduism. Perhaps the thing which characterized this process most was that the ancient Vedic emphasis on ritual sacrifice was diminishing, and taking its place was a more personal devotion to a deity.

VI. Ancient Indian LiteraturesAn oral tradition

Strongly linked to these religious developments, ancient India produced a fantastically rich literature. In the centuries after coming into northern India, during the so-called "Vedic Age", the Aryans developed a great abundance of poems, tales, hymns, spells and so on, in an oral tradition known as the *Vedas*.Another body of oral literature that was composed towards the end of the Vedic age were the *Upanishads*, a collection of works of prose and poetry which explore deep religious and philosophical concepts, including the idea that the material world is an illusion, and the implications of this idea for the individual soul. Alongside these arose a tradition of elaborate epic poetry, again oral in their original composition. The most famous examples are the *Ramayana* and the *Mahabharata*. These retell famous incidents in semi-mythological history, far back in the Vedic age.

Written works: The earliest example of written texts in ancient India are brief, pithy verses called *sutras,* which express religious and philosophical ideas. The earliest Jain and Buddhist scriptures were formed in this way.It was only towards the end of the ancient period of India's history that the great body of oral works from the Vedic Age, referred to above, began to be written down. Sanskrit was the language in which this was done, using the Brahmic script, the ancestral alphabet for all later Indian literature. The Gupta period was the high-water mark of ancient Indian literature. The greatest of all Indian poets and dramatists, Kalidasa, probably lived and worked at about this time, and so did many others. Works on mathematics, medicine, politics and other subjects were also produced. For example, the *Arthashastra* of the famous statesman Kautilya anticipates Machiavelli by almost 2,000 years [Ref. 6].

VII. Sanskrit and other languages

Right up until Gupta times and beyond, Sanskrit was the language of high culture – and in fact its use in this way became more prevalent in ancient India as time went on. Sanskrit was the ancient language of the Aryans; it was an Indo-European language distantly related to Persian, Greek, Latin, German and other tongues. The Sanskrit script was based on the Aramaic alphabet, which came to India from the Middle East sometime before 500 BCE. One of the greatest linguists in world history flourished sometime in the following centuries. This was Panini. He set out highly logical rules of grammar, which formed the basis of classical Sanskrit. His underlying idea was that words should express meaning as efficiently as possible – the brief *sutras* in ancient Indian scriptures embody this principle. The influence of Panini's work on the history of Indian high culture is incalculable. Much Indian education came to be based on its principles, even if not in Sanskrit; they trained Indian scholars in a rigorous logic which acted as a major stimulus to intellectual thought and debate.Despite Sanskrit's near-monopoly of learned literature, an increasing number of popular works were being written in regional languages throughout India. During the ancient period these experienced a slow evolution towards becoming literary languages, which would bear fruit in medieval times and beyond.

VIII. Ancient Indian Art and Architecture Art

Apart from figurines from the Indus Valley civilization, the earliest examples of the art of ancient India which have come down to us are from magnificent cave temples in central India. The spread of such temples – either located in natural caves which have been shaped to create a religious space, or entirely carved from rock – was originally a Buddhist innovation, which Hindus later adopted. Here, stone carvings and painted frescoes dating from ancient times have come down to us, the earliest dating from the Mauryan empire, or just after. The most famous early cave-temples are found at Ellora, in central India.Separate developments were taking place in northwest India. Here, Greek and Persian styles of art were mingling with Indian elements to give rise to the Gandhara culture. This rich fusion of traditions would have a major impact on art far beyond India's borders, as far afield as China; but it would also feed into the ongoing evolution of Indian styles in painting and sculpture.

Architecture: Another Buddhist innovation was the *stupa*, a dome-shaped monument in which religious relics were stored. The earliest of these date from Mauryan times, with the Great Stupa at Sanchi being the most famous.Apart from cave temples, ancient Indian buildings – secular and religious – were largely made of wood and bricks. Unfortunately, none have survived from this period of India's history. Apparently, they incorporated rounded arches atop their windows and doors – in which case they preceded arched architecture in the West by several centuries [Ref. 7].

IX. Ancient Indian Mathematics, Medicine and Science

Some of the most important achievements of ancient India lay in the fields of mathematics and science. In fact Indian mathematics was probably the most advanced in the ancient world.

Mathematics: Indian mathematicians clearly understood the Pythagorean theorem, that the square of the hypotenuse (the side opposite the right angle) is equal to the sum of the squares of the other two sides. The religious texts of the Vedic period contain examples of simple Pythagorean triples, such as, "the rope stretched along the length of the diagonal of a rectangle makes an area which the vertical and horizontal sides make together." Sometime later, in a step usually accredited to the period of the Gupta empire or a little earlier, Indian thinkers discovered the concept ofzero. This was an enormously important advancement in mathematics, all the more so for being linked to the development of the decimal number system.This achievement would spread westward to the Islamic Caliphate in the 8th and 9th centuries, and from there reach Europe a couple of centuries later. Here, it freed mathematicians from the limitations of the clumsy Roman numerical system, and would become a critical factor in the rise of Western mathematics and science.

Astronomy: Aryabhata, the most famous scholar in Gupta times, showed that the Earth is a sphere, and revolves around its axis each day. He believed that it circles round the Sun, not vice versa, and that the stars' motions are caused by the Earth's own movements rather than the sky's. He identified eclipses as the shadow of the moon falling on the Earth.Gupta scholars calculated the length of the solar year with a precision not matched by any other ancient civilization, including the Greeks.

Medicine: A medical treatise called the *Sushruta Samhita* (or Sushrita's Compendium, 6th century BCE) describes 1120 illnesses,

700 medicinal plants, a detailed study on anatomy, 64 preparations from mineral sources and 57 preparations based on animal sources. Cataract surgery was known to ancient Indian physicians, and it was performed with a specially designed curved needle to loosen the lens and push the cataract out of the field of vision.

A statue dedicated to Sushruta at the Patanjali Yogpeeth institute in Haridwar.Reproduced under Creative Commons 3.0 [Ref.8].

X. The Legacy of Ancient India in World History

The evolution of a religious culture in ancient India, out of which Hinduism, Jainism and Buddhism emerged as three distinct religions, was a development of great importance in world history. Between them, these religions today have the allegiance of billions of people. Buddhism has spread far and wide outside the Indian subcontinent (where, curiously, it has become a minority religion), and has had a deep impact upon societies in China, Japan, Korea, Tibet and South East Asia. It is now spreading fast amongst people in the West, where by some counts it is the fastest growing religion.The interaction between three rival but closely related belief systems, coupled with the rigorous logic arising from the well-defined grammatical rules of Sanskrit, produced a rich and tolerant intellectual environment. This would give rise to achievements of world significance. Indian developments in mathematics helped lay the foundations for modern Western mathematics, and therefore for modern Western science.

XI. India's enduring legacy spans millennia

India's legacy spans ancient wisdom to modern ideals, offering profound contributions in Spirituality (yoga, dharma), Mathematics (zero, decimal system, algebra), Foundational religions (Hinduism, Buddhism, Jainism), Scientific advancements (astronomy and medicine), Rich arts (epics, architecture), and Philosophies (ahimsa, dharma), influencing global culture, ethics, and intellectual development from the Indus Valley to today's interconnected world.

1. Ancient and Classical Era (c. 3000 BCE - 1200 CE)

- **Mathematics & Astronomy**: Developed zero, the decimal system, algebra, and precise astronomical calculations, fundamentally impacting global mathematics.
- **Spirituality & Philosophy**: Birthplace of Hinduism, Buddhism, and Jainism, introducing concepts like Karma, Dharma, reincarnation, and meditation, influencing Asian and global thought.
- **Science & Medicine**: Ayurveda (holistic medicine), advanced metallurgy (Wootz steel), and sophisticated urban planning (Indus Valley).
- **Arts & Literature**: Epics like the Mahabharata, Sanskrit drama (Kalidasa), and Iconic art (Ajanta, Ellora caves).
- **Trade**: Key player in ancient trade routes, exporting spices, cotton, and textiles.
- **Lord Krishna's pivotal contribution to the Mahabharata** , acting as Arjuna's divine charioteer and spiritual guide, delivering the profound teachings of the Bhagavad Gita on duty and righteousness (*dharma*), while also attempting diplomacy to prevent war and ultimately supporting the Pandavas' just cause to re-establish cosmic order against unrighteousness (*adharma*).

Discovery of the Number Zero and its significance: Around the 5th century CE, the Indian mathematician and astronomer Aryabhata used a symbol for zero in his astronomical calculations. Then it was Brahmagupta, another Indian mathematician, who formalized the use of zero in 628 CE. In his seminal work, Brahmasphutasiddhanta, Brahmagupta described zero as a number and laid out rules for arithmetic operations involving zero, such as addition, subtraction, and multiplication.Brahmagupta's insights were groundbreaking. For the first time, zero was recognized as a distinct entity that could be used in calculations, transforming mathematics into a more robust and universal tool.

Brahmagupta's book Brahmasphutasiddhanta: Writtenaround 628 CE in Sanskrit, it contains ideas including a good understanding of the mathematical role of zero, rules for manipulating both negative and positive numbers. It also contains a method for computing square roots, methods of solving linear and some quadratic equations, and rules for summing series, Brahmagupta's identity, and the Brahmagupta's theorem. The book was written completely in verse. The number zero, initially a placeholder, evolved into a fundamental mathematical concept with profound significance. Its discovery, largely attributed to Indian mathematicians like Aryabhataand Brahmaguptain ancient India, revolutionized mathematics and paved the way for modern systems. Zero's impact extends from basic arithmetic to complex fields like computer science, representing a pivotal moment in human intellectual history.

Early Usage: Zero initially appeared as a placeholder in various ancient civilizations (Babylonians, Mayans) to indicate the absence of a digit in a number's place.

Indian Breakthrough: Indian mathematicians in the 5th-7th centuries CE, like Aryabhata and Brahmagupta, formalized zero as a number with its own properties, not just a placeholder.

Brahmagupta's Contributions: Brahmagupta, in the 7th century, established rules for operations involving zero (addition, subtraction, multiplication, etc.) and also showed that a number subtracted from itself results in zero.

Global Impact and Significance: The concept of zero, along with the Hindu-Arabic numeral system, spread to the Islamic world and eventually to Europe through trade and cultural exchange.

Revolutionizing Mathematics: Zero's acceptance enabled the development of more sophisticated mathematical systems, including algebra, calculus, and computer science**.**

Foundation of Modern Computing: Zero is the basis of binary code, the language of computers, making it crucial for the digital age.

Philosophical Implications: Zero also holds philosophical significance, representing both nothingness and the concept of infinity.

Indispensable in Various Fields: Zero is essential in various fields, including mathematics, physics, and computer science, demonstrating its widespread impact. In essence, the discovery of zero was not a singular event but a gradual process of evolution and acceptance. Its journey from a simple placeholder to a fundamental number has fundamentally changed the way we understand and interact with the world.

The Spread of Zero: From India, the concept of zero spread to the Islamic world during the 8th and 9th centuries CE. Scholars like Al-

Khwarizmi and Al-Kindi translated Indian mathematical texts into Arabic, incorporating zero into their studies. Al-Khwarizmi, often regarded as the father of algebra, helped popularize the decimal system, which relied heavily on the use of zero. The introduction of zero to Europe came through these Islamic scholars. By the 12th century, the Italian mathematician Fibonacci included zero in his book Liber Abaci, which introduced Arabic numerals to the Western world. This development paved the way for modern mathematics and commerce.

The Power of Zero: Today, zero is indispensable. It serves as the foundation for algebra, calculus, and computer science. It enables us to understand the concept of nothingness and infinity. Zero also plays a critical role in binary code, the language of computers, making it a cornerstone of the digital age.The invention of zero was not a singular event but a journey across cultures and centuries. From its elevation as a number in ancient India, zero has shaped the way we think, calculate, and innovate. It is a testament to humanity's quest for knowledge and our ability to find meaning even in the void.

2. Medieval and Early Modern Era (c. 1200 - 1800 CE)

During the Medieval & Early Modern Era (c. 1200-1800 CE), India significantly contributed through Mathematics (zero, calculus), Astronomy, Advanced metallurgy (Mysorean rockets, Wootz steel), Textiles (charkha, calico), and Rich cultural synthesis, fostering trade, urbanism, vernacular literature, and devotional movements (Bhakti, Sufism), making it a global economic and intellectual powerhouse.

Science & Technology

- **Mathematics:** Kerala School advanced calculus, infinite series; concept of zero, base-ten system, algebra spread globally. The work of mathematicians of the Kerala School, founded by Madhava of Sangamagrama, predated the development of calculus in Europe by Isaac Newton and Gottfried Leibniz by over 200 years.
- **Astronomy:** Significant developments in understanding celestial mechanics. Celestial mechanics is the branch of astronomy using physics and math to study the motion and interactions of celestial bodies like planets, stars, and moons, primarily driven by gravity, to predict their orbits and movements, crucial for space exploration and understanding the universe
- **Metallurgy:** Wootz steel (Damascus steel) renowned; iron-cased rockets (Mysorean rockets- Indian military weapon,) developed by Mysore kingdom, used against British.
- **Textiles:** Invention of the spinning wheel (charkha), carding devices, and development of calico and chintz.
- **Engineering:** Flush toilets, planned cities with sewer systems.

Culture & Society

- **Art & Architecture:** Blending of Indian and Islamic styles (Indo-Islamic), exquisite miniature paintings (Mughal, Rajput), grand temples (Cholas), and sophisticated bronze casting.
- **Literature:** Flourishing of vernacular languages, promoting devotional poetry (Kabir, Nanak) and regional epics.
- **Religion & Philosophy:** Rise of Bhakti and Sufi movements, fostering interfaith dialogue and syncretism, leading to Sikhism's founding.
- **Games:** Chess (from Chaturanga) originated in India.

Economy & Trade

- **Global Hub:** Major producer of textiles, spices, and industrial goods, meeting global demand.
- **Urbanization:** Significant urban growth, with large cities like Agra and Dhaka.
- **Infrastructure:** Mughals built extensive roads and standardized currency (Rupee).

Governance & Administration

- **Imperial Systems:** Cholas built maritime empires; Mughals established centralized rule, uniform currency, and tax systems.
- **Intellectual Centers:** Universities like Nalanda and Takshashila became important, attracting scholars worldwide.

3. Modern Era (1800s - Present)

India's modern contributions (1800s-present) span Science (J.C. Bose's radio waves, Bose-Einstein statistics), Technology (ISRO, IT boom), Medicine (Ayurveda, modern pharma), Economics (service/tech sector rise), and Socio-politics (non-alignment, democracy), shaping global science, tech, culture, and governance through research, development, and democratic ideals.

Science & Technology

- Physics: J.C. Bose pioneered microwave optics (1895), S.N. Bose worked on Bose-Einstein statistics (1920s), C.V. Raman discovered Raman scattering (Nobel Prize).
- Space: ISRO (1969) led to achievements like Chandrayaan missions and Mars Orbiter.
- IT: India became a global IT hub post-1990s liberalization, excelling in software and services.
- Innovation: Contributions in optics, metallurgy, and communication technologies, plus modern advances in auto, pharma, and polar research.

Medicine & Health

- Ancient Roots: Continued use of Ayurveda, with historical texts detailing complex medical knowledge.
- Modern Pharma: Emergence as a major producer of generic medicines and vaccines.

Economy & Industry

- Colonial Era: Creating manufacturing hubs, Growth in railways, irrigation, and small-scale industries (proto industrialization).
- Post-Independence: Shift from agrarian to service-led economy (IT, finance) post-1991 reforms, major growth in manufacturing (textiles, chemicals, engineering).

Mathematics & Foundational Concepts

- Number System: The modern decimal system and the concept of zero as a number originated in ancient India, with mathematicians like Aryabhata and Brahmagupta formalizing its use by the 6th-7th centuries, providing the foundation for algebra, calculus, and the digital age. This revolutionary place-value system, which uses a dot or circle for zero (Shunya), allowed for efficient calculation and was later transmitted to the Islamic world and then Europe, becoming essential for modern mathematics and technology.

Astonishing Legacy of Mathematician Srinivasa Ramanujan (22 December 1887 to 26 April 1920)

He developed around 4,000 formulas, many proving to be far ahead of their time, touching on areas like modular forms, partitions, and infinite series, which later found crucial applications in string theory and black hole physics, among other modern fields. His intuitive genius, without extensive formal training, led to discoveries that took decades to be fully understood and verified by the mathematical community, establishing him as one of history's greatest mathematicians.

Key Aspects of Ramanujan's Work:

- Prolific Discoveries: He compiled nearly 3,900 results, including identities and equations, often arriving at them through deep intuition.
- Foreshadowing Modern Concepts: His notebooks contained ideas related to mock theta functions (used in string theory), number theory, and partitions that later became foundational.
- Impact on Physics: His work on modular forms and infinite series has proven vital in understanding phenomena in string theory, black hole physics, and quantum mechanics.
- Unconventional Genius: Despite lacking formal knowledge of many advanced concepts, he produced profound results, famously describing his insights as divine inspiration.
- He went to Cambridge University in April 1914 and worked at Cambridge for nearly five years, until 1919. When he came to Cambridge and showed his notebook of genius. They said, “where are the proofs?” He said, “oh you need me to prove them too?” So, he spent years proving his equations to the Cambridge Dons. Most of them they never understood.
- Legacy: Ramanujan's work continues to inspire and be explored, with many of his formulas still being proven and applied today, decades after his death in 1920.

Space Mission

India, through ISRO, has also made significant space contributions, including the first discovery of lunar water (Chandrayaan-1), the first nation to reach Mars' orbit on its first attempt (MOM), the first soft landing near the Moon's south pole (Chandrayaan-3), pioneering low-cost satellite launches, developing key technologies like space docking (SPADEX), and achieving major commercial successes, establishing itself as a leading space power with ambitious human spaceflight goals.

XII. India's three ancient universities that transformed society by providing new knowledge in academic fields

India's ancient universities Takshashila, Nalanda, and Vikramshila were pivotal in transforming society by establishing sophisticated centers of learning that offered diverse curricula: from logic and medicine to Vedic studies, astronomy and grammar. The universities drawing scholars globally laid the foundations for modern higher education, fostering intellectual growth, spiritual development and cross-cultural exchange long before the concept of a modern university.

1. Takshashila University (Ancient Gandhara, ~6th Century BCE - 5th Century CE)

Known For: World’s oldest university, famous for its broad curriculum and influential teachers like Chanakya.

Knowledge Areas: Vedic studies, Ayurveda, medicine, Arthashastra (statecraft), archery, and astronomy.

Impact: Shaped governance, healthcare, and philosophy, influencing rulers and scholars across the ancient world.

Takshashila (Taxila) was unique as the world's first international university, a merit-based center for advanced studies in 60+ subjects (medicine, warfare, philosophy, grammar) from 700 BCE to 5th Century CE, attracting global students and producing influential figures like Chanakya & Panini; its key contributions include pioneering higher education, fostering intellectual exchange, shaping statecraft (Arthashastra), and advancing medicine (Charaka Samhita), leaving a lasting legacy despite its destruction by Huns.

Uniqueness

- **First International University:** Attracted students from Greece, Syria, China, and beyond, long before European universities.
- **Comprehensive Curriculum:** Taught over 60 diverse subjects, including Vedas, astronomy, surgery, politics, military science, music, and logic.
- **Advanced & Specialized:** Included separate schools for law, medicine, and military science, with labs, libraries, and astronomical centers.
- **Merit-Based Admission:** Students, typically starting at age 16, entered through rigorous exams.

Significant Contributions & Alumni

- **Chanakya (Kautilya):** Political philosopher and advisor, authored the *Arthashastra*, a treatise on statecraft, from Takshashila.
- **Panini:** Famous Sanskrit grammarian who codified the language.
- **Charaka:** Father of Indian medicine, author of the *Charaka Samhita*, a foundational Ayurvedic text.
- **Jivaka Komarabhacca:** Renowned physician who treated Buddha.
- **Foundation of Knowledge:** Served as a bridge for Buddhist philosophy and a hub for Vedic learning, influencing later institutions like Nalanda.

Legacy

- **Intellectual Hub:** A global center for academic freedom and cultural exchange for centuries.

- **Archaeological Significance:** Ruins are a UNESCO World Heritage Site, revealing ancient urban and educational systems.
- **Enduring Impact:** Its educational model and scholarly output shaped South Asian and global intellectual traditions.

2. Nalanda University (Bihar, 5th-12th Century CE)

Known For: The world's first residential university, a massive monastic complex, attracting students from China, Korea, Tibet, and beyond.

Knowledge Areas: Buddhist philosophy, logic, medicine, astronomy, mathematics, grammar, and metaphysics.

Impact: Became a legendary hub for spiritual and intellectual development, leaving a vast legacy in Buddhist thought and Asian scholarship.

Nalanda University was unique as the world's first residential university, a vast center of systematic learning attracting 10,000 students from across Asia, fostering critical thinking, interdisciplinary study (science & spirituality), and free education, significantly contributing to Buddhist philosophy, medicine (Ayurveda), logic, mathematics, and influencing Asian art/culture through its scholars like Xuanzang. Its legacy lies in its advanced curriculum, global reach, and role in disseminating knowledge before its destruction in the 12th century, with a modern revival aiming to restore its vision.

Uniqueness: The World's First Residential University

- **Residential & Comprehensive:** A massive, organized complex with dorms, temples, libraries (9 million books), gardens, and hostels, operating like a medieval Ivy League institution.
- **Free Education:** Provided free education, food, and lodging, funded by state-donated villages, removing financial barriers.
- **Rigorous Admissions:** Featured a difficult entrance exam, ensuring only the brightest students gained admission.
- **Self-Governance:** Students had unions and elected representatives, similar to modern universities.

Significant Contributions & Legacy

- **Intellectual Hub:** A center for critical inquiry, debate, and holistic learning, merging science and spirituality.
- **Global Reach:** Drew scholars and students from China, Korea, Indonesia, Persia, Tibet, Sri Lanka, and Southeast Asia.
- **Dissemination of Knowledge:** Scholars like Xuanzang and Yijing documented its curriculum (logic, medicine, math, Buddhist texts) for future generations.

Cultural Influence:

- **Art:** Stucco and metalwork techniques spread to Thailand, Tibet, and the Malayan Peninsula
- **Science:** Taught Ayurveda, which then spread throughout Asia
- **Philosophy:** A crucial center for Mahayana and Tantric Buddhist philosophy, influencing Tibetan Buddhism.
- **Architectural Inspiration:** Its design of open courtyards influenced other Buddhist monasteries.

Destruction & Revival

- **Devastation:** Destroyed by Turkic invaders under Bakhtiyar Khilji in 1193 CE, burning vast libraries and killing thousands of monks.
- **Modern Revival:** Re-established in 2014 as a new Nalanda University, aiming to recapture the ancient institution's spirit of academic excellence and global vision.

3. Vikramshila University (Bihar, 8th-12th Century CE)
Known For: A powerful duo with Nalanda, founded by King Dharmapala, with six colleges specializing in different fields.

Knowledge Areas: Buddhist Tantra, logic, metaphysics, philosophy, and Sanskrit grammar, also pioneering degree systems (Mahapandit/Pandit).

Impact: Its graduates spread Buddhist teachings globally, fostering spiritual and intellectual growth.

Vikramshila University's uniqueness lay in its specialization as a major center for Tantric and Vajrayana Buddhism, distinguishing it from Nalanda, with significant contributions in esoteric studies, logic, and philosophy, producing scholars like Atisha Dipankara who spread Buddhism abroad, and featuring unique architectural elements like a central stupa with monastic cells. It flourished under the Pala Dynasty as a premier institution, teaching diverse subjects and attracting scholars from across Asia before its destruction around 1203 CE.

Uniqueness & Specialization

- Tantric Buddhism and occult studies, making it a distinct center for esoteric knowledge.
- Pala Dynasty Foundation: Established by King Dharmapala, it became a cornerstone of learning during the Pala Empire.

- Architectural Design: Featured a large central stupa surrounded by 208 cells for monks and a library with a unique cooling system.

Significant Contributions

- **Scholarly Output:** Produced eminent scholars, including Atisha Dipankara, who significantly influenced Tibetan Buddhism's Sarma traditions.
- **Broad Curriculum:** Taught theology, philosophy, grammar, logic, metaphysics, and tantras, alongside Mahayana and Hinayana texts.
- **Dissemination of Buddhism:** Scholars from Vikramshila were invited to foreign lands to spread Buddhist learning, culture, and religion.
- **Major Educational Center:** Attracted thousands of monks and scholars, serving as a leading institution for over 400 years, rivaling Nalanda.

For more information refer to Ref.9.

XIII. Essence of India's Legacy

In essence, India's legacy is a continuous thread of intellectual, spiritual, and cultural innovation that has enriched humanity's understanding of life and the universe, and fostering concepts of interconnectedness, ethical living, and scientific inquiry. From the philosophical insights enshrined in the Vedas and Upanishads to the revolutionary scientific advancements in mathematics, astronomy, and medicine, ancient India emerged as a beacon of intellectual brilliance.Ancient India's culture and achievements have impacted the modern world through medical advances, religions, and scientific discoveries. The medical advances of Ancient India have impacted the world today because certain techniques have been passed down and are still used in modern times. From the largest Hindu temple in the world at Angkor Wat to the Buddhism of China, from the trade that helped fund the Roman Empire to the creation of the numerals we use today (including zero), India transformed the culture and technology of its ancient world – and our world today as we know it.

Contributions of Vedas and Upanishads

India's Vedas and Upanishads offer profound insights into Brahman (Ultimate Reality) and Atman (the Self), revealing their essential unity (non-dualism), the cyclical nature of existence (samsara), the law of karma (action and consequence), and the ultimate goal of liberation (moksha) through self-realization, guiding towards interconnectedness, ethical living (dharma), and spiritual discipline (yoga). They introduce concepts like pure consciousness (Turya), challenging fragmented views of reality and establishing a foundational spiritual framework for all subsequent Indian philosophy.

Key Philosophical Concepts:

- **Brahman & Atman:** The Upanishads teach that the individual soul (Atman) is identical to the universal, infinite Brahman, the sole underlying reality, challenging dualistic thinking.
- **Non-Dualism (Advaita):** A radical monism where all existence is one, and the separation between subject and object, or spirit and matter, is illusory.
- **Karma & Samsara:** Actions (karma) in this life determine future experiences, leading to rebirth (samsara) until true knowledge liberates one.
- **Moksha (Liberation):** The ultimate aim is release from the cycle of rebirth and suffering, achieved through realizing the Atman-Brahman unity, often through paths like Jnana Yoga (knowledge).
- **Dharma:** Moral duty and cosmic order, providing ethical guidance for life.
- **Om (Aum):** Considered the primordial sound, symbolizing the entire universe and the essence of Brahman.
- **Turya (Pure Consciousness):** The unchanging, witness consciousness that underlies the waking, dreaming, and deep sleep states, as described in the Mandukya Upanishad.

Unique Contributions:

- **Holistic Worldview:** A unified vision where the cosmos, nature, mind, and self are interconnected aspects of Brahman.
- **Focus on Inner Experience:** Shift from external rituals (Vedas) to internal realization (Upanishads) for ultimate truth.
- **Foundational for Vedanta:** The Upanishads form the basis (Vedanta, "end of the Vedas") for diverse schools of Indian philosophy.
- **Universal Spirituality:** Concepts like karma, yoga, and the search for self-realization have become globally influential spiritual disciplines.

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