Science, Technology and Sanskrit in Ancient India

Presented by:

Dr. M.G. Prasad

Department Of Mechanical Engineering,

Stevens Institute Of Technology

“In recent decades the scholarly study of science and civilization in China has influenced historians concerned with the history of science and technology in India. But, alas, no comprehensive synthesis has yet appeared to match the studies of China”

“Given its technological complexity, India actually underwent an astonishing process of deindustrialization with the coming of formal British rule in the nineteenth century”

James E. McClellan III and Harod Dorn
Science and Technology in World History: An Introduction
The Johns Hopkins University Press, 1999

"…The Hindus have made considerable advances in astronomy, algebra, arithmetic, botany, and medicine, not to mention their superiority in grammar, long before some of these sciences were cultivated by the most ancient nations of Europe. Hence, it has happened that I have been painfully reminded during the progress of this dictionary that a Sanskrit lexicographer ought to aim at a kind of quasi-omniscience.

Sir Monier- Williams in the Introduction in his Sanskrit –English Dictionary, 1899

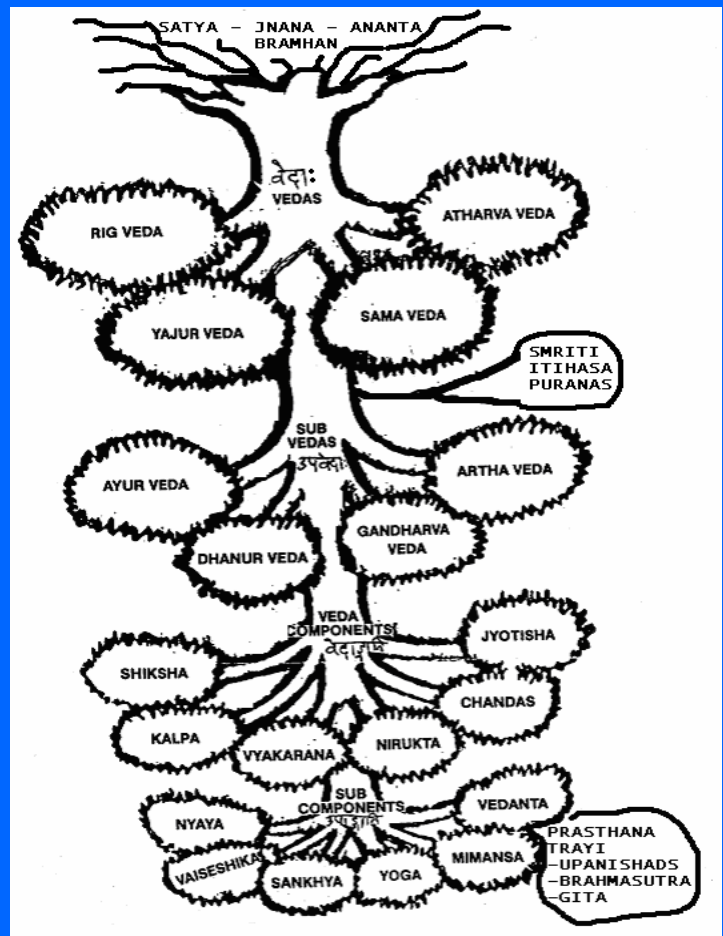
Vedic Scriptural Knowledge represented as an Inverted Tree

- The Roots above refer to the One Source (*Bramhan*).

- The one main body of transcendental (*Apaurusheya)* knowledge - *Vedas* - is classified into 4 major *Vedas*
  - *Rik, Yajus, Sama, Atharva.*

- The Vedic literature deals with all aspects of life including
  - spirituality, philosophy, yoga,
  - religion, rituals, temples,
  - arts and culture, music, dance,
  - grammar, pronunciation, metre
  - astrology, astronomy, logic, law
  - medicine, surgery, technology,
  - martial arts, military strategy, etc.

Integrated knowledge of Spirituality and Science



How to Write the Devanāgarī Characters

The drawings of the Devanāgarī characters are shown below. The order of the strokes is clearly marked by numbers and lines.

अ आ इ ई उ ऊ

ऋ ॠ ऌ ॡ ए ऐ

ओ औ अं अः

क ख ग घ ङ

च छ ज झ ञ

ट ठ ड ढ ण

त थ द ध न

प फ ब भ म

य र ल व श ष

स ह क्ष त्र ज्ञ

क का कि की कु

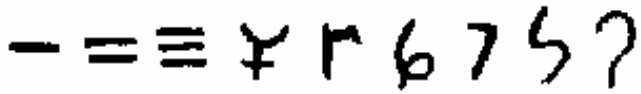
कू कृ कॄ कॢ के कै

को कौ कं कः ।

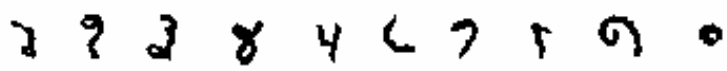
१ २ ३ ४ ५ ६ ७ ८ ९ ०

KEY TO TRANSLITERATION AND PRONUNCIATION

		Sounds like			*Sounds like*
अ	a	o in *s*on	ड्	ḍ	d
आ	ā	a in m*a*ster	ढ्	ḍh	dh in go*dh*ood
इ	i	i in *if*	ण्	ṇ	in u*n*der
ई	ī	ee in *feel*	त्	t	French t
उ	u	u in f*u*ll	थ्	th	th in *th*umb
ऊ	ū	oo in b*oo*t	द्	d	th in *th*em
ऋ	ṛ	somewhat between r and ri	ध्	dh	theh in brea*the* *h*ere
ए	e	a in ev*a*de	न्	n	n
ऐ	ai	y in m*y*	प्	p	p
ओ	o	o in *o*ver	फ्	ph	ph in loo*p*-*h*ole
औ	au	ow in n*ow*	ब्	b	b
क्	k	k	भ्	bh	bh in a*bh*or
ख्	kh	ckh in blo*ckh*ead	म्	m	m
ग्	g	g (hard)	य्	y	
घ्	gh	gh in log-*h*ut	र्	r	r
ङ्	ṅ	ng	ल्	l	l
च्	c	ch (not k)	व्	v	v in *a*vert
छ्	ch	chh in cat*ch* *h*im	श्	ś	sh
ज्	j	j	ष्	ṣ	sh in *sh*ow
झ्	jh	dgeh in he*dgeh*og	स्	s	s
ञ्	ñ	n (somewhat)	ह्	h	h
ट्	ṭ	t	ं	ṃ	m in hu*m*
ठ्	ṭh	th in an*t*-*h*ill	ः	ḥ	half h in hu*h*!

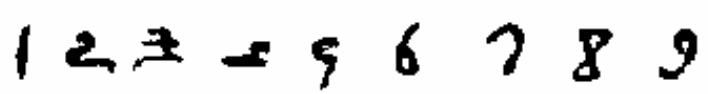


HINDU (Brahmi)– c. 300 B.C.

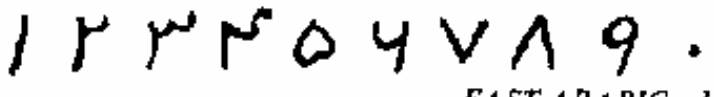


HINDU (Gwalior)– 876 A.D.

HINDU (Devanagari)– 11th century



WEST ARABIC (Ghobar)– 11th century



EAST ARABIC– 1575

EUROPEAN– 15th century

EUROPEAN– 16th century

COMPUTER NUMERALS– 20th century

Place of Articulation

kanta (Throat)	अ		क	ख	ग	घ	ङ	ह	
thalu (Palate)	इ		च	छ	ज	झ	ञ	य	श
murdha (Roof of Mouth)	ऋ		ट	ठ	ड	ढ	ण	र	ष
dhanta (Teeth)	ऌ		त	थ	द	ध	न	ल	स
ostam (Lips)	उ		प	फ	ब	भ	म	×प	
nasika (Nasal)			ञ	म	ङ	ण	न		
kanta,thalu	ए	ऐ							
kanta,ostam	ओ	औ							
dhanta,ostam			व						
jihwamuliya			×क						

अथ प्रथमोऽध्यायः

अथ पाणिनि-सूत्राणि

प्रथमः पादः

१ **वृद्धि**रादैच् ३
२ अदेङ्गुणः ३
३ **इको गुण-वृद्धी** ६
४ न धातु-लोप आर्ध-धातुके ६
५ क्ङिति च
६ दीधी-वेवीटाम्
७ हलोऽनन्तराः संयोगः
८ मुख-नासिका-वचनोऽनुनासिकः
९ तुल्यास्य-प्रयत्नं **सवर्णम्** १०
(वा०)ऋ-ऌ-वर्णयोर्मिथः सावर्ण्यं वाच्यम्
१० नाज्झलौ
११ **ईदूदेद्** द्विवचनं **प्रगृह्यम्** १२,१
१२ अदसो मात्
१३ शे
१४ **निपात** एकाजनाङ्
१५ **ओत्**
१६ संबुद्धौ **शाकल्यस्येतावनार्षे**
१७ **उञः**
१८ ॐ
१९ ईदूतौ च सप्तम्यर्थे "इति प्रगृह्यम्
२० दाधा घ्वदाप् (१
२१ आद्यन्तवदेकस्मिन्
२२ तरप्-तमपौ घः

ASHTAADHYAEE OF PANINI RISHI (500B.C)

"Sanskrit's potential for scientific use was greatly enhanced as a result of the thorough systemization of its grammar by Panini… On the basis of just under 4000 sutras (rules expressed as aphorisms), he built virtually the whole structure of the Sanskrit language, whose general 'shape' hardly changed for the next two thousand years… An indirect consequence of Panini's efforts to increase the linguistic facility of Sanskrit soon became apparent in the character of scientific and mathematical literature"

G. G. Joseph
The crest of the peacock
Princeton University Press (2000)

FEATURES OF SANSKRIT

COMPOUND LETTERS

क् + त = क्त ; ग् + ध = ग्ध ; प् + ल = प्ल

SANDHI

अ + इ = ए गण + ईशः = गणेशः

SOUND CHANGE

शरत् + चन्द्र = शरच्चन्द्र

ROOTS(about 1900)
(incl. proper noun) विद् : वेद , विद्वान् , विद्या

SYNTAX FREE

रामः फलं खादति = खादिति रामः फलं

SINGULAR - DUAL - PLURAL

रामः (s) रामौ (d) रामाः (p)

KARAKAS : CASES (7)

रामः (प्र) रामम् (द्वि) रामेण (तृ) रामाय (च) ...

FIRST- SECOND- THIRD PERSON

पठामि (उ) पठसि (म) पठति (प्र)

SUTRAS (4000 in grammar)

अदेङ्गुणः इकोयणचि

SINGLE LETTERS (meaning)

अनुज = अनु + ज (to be born) - Younger Brother

RHYTHMIC STRUCTURE
(HELPS TO MEMORIZE)

ACOUSTICAL ASPECTS OF SANSKRIT

SOUND ASSIGNED TO ALPHABET DO NOT CHANGE

THE DESIRED WORDS USUALLY HAVE SOME ACOUSTIC SIMILARITY WITH THE ROOT

LARGE NUMBER OF ALPHABETS (53), HENCE LARGE NUMBER OF BASIC SOUNDS

SOFT ASPIRANT, HARD ASPIRANT, NASALS

VERY GOOD CORRELATION BETWEEN SOUND AND SCRIPT

EASY FOR MEMORISATION (SHRUTHI)

EFFECT OF SANDHI RELATES TO PLACES OF UTTERANCES

ओं शीक्षां व्याख्यास्यामः । वर्णः स्वरः । मात्रा बलम् । साम संतानः । इत्युक्तः शीक्षाध्यायः ॥

[इति द्वितीयोऽनुवाकः]

Om śīkṣām vyākhyāsyāmaḥ. Varṇaḥ svaraḥ. Mātrā balaṁ. Sāma santañaḥ Ityuktaḥ sīkṣādhyāyḥ.

(Iti Dvitīyo Anuvākaḥ)

ॐ-Om, **शीक्षाम्**-the science of pronunciation, **व्याख्यास्यामः**-we shall explain, **वर्णः**-sound, **स्वरः**-accent or pitch. **मात्रा**-measure, **बलम्**-the effort employed in articulation. **साम**-uniformity, **सन्तानः**-continuity (in pronouncing the letters). इति-thus, **उक्तः**-has been explained, **शीक्षाध्यायः**-the chapter on pronunciation.

We shall now explain the science of pronunciation. (It consists of) the sounds, accent or the pitch, quality or measure, the effort put in articulation, uniformity and continuity in pronouncing the letters. Thus has been explained the lesson on pronunciation.

(ii) देहे ध्वनेराविर्भावः

आत्मा विवक्षमाणोऽयं मनः प्रेरयते, मनः ।
देहस्थं वह्निमाहन्ति स प्रेरयति मारुतम् ।।३।।
ब्रह्मग्रन्थिस्थितः सोऽथ क्रमादूर्ध्वपथे चरन् ।
नाभिहृत्कण्ठमूर्धास्येष्वाविर्भावयति ध्वनिम् ।।४।।

(ii) The process of the manifestation of sound in the human body. (3-4)

Desirous of speech the individuated being[1] impels the mind, and the mind activates the battery of power[2] stationed in the body, which in its turn stimulates the vital force[3]. The vital force stationed around the root of the navel, rising upwards[4] gradually manifests *nāda*[5] in the navel, the heart, the throat, the cerebrum and the cavity of the mouth as it passes through them. (3-4)

(c. 1150 A.D) SANGITA RATNAKARA by SARANGA DEVA

(vii) सप्तस्वराणामुच्चारयितारः पशुपक्षिणः

मयूरचातकच्छागक्रौञ्चकोकिलदर्दुराः ॥४६॥
गजश्च सप्त षड्जादीन्क्रमादुच्चारयन्त्यमी ।

(vii) Production of *svara-s* (tones) by the birds and animals : 46c-47b

The seven notes commencing with *ṣaḍja* are produced respectively by the peacock, *cātaka*[1], goat[2], heron, cuckoo, frog and the elephant. (46c-47b)

The seven notes of the heptad[3] (*saptaka*) are perceived and utilised not only by the human beings, but also by the rest of the animal kingdom. The notes have been identified with the expressions of particular animals and birds. The author does not elaborate this theme and merely seems to have recorded a popular concept that confirms the fact

प्रत्यक्षानुमानोपमानशब्दाः "प्रमाणानि" ॥१।१।३॥

3. Perception, inference, comparison and word (verbal testimony)—these are the **means of right knowledge.**

[The Câr vâkas admit only one means of right knowledge, *viz.*, perception (pratyakṣa), the Vaiśeṣikas and Bauddhas admit two, *viz.*, perception and inference (anumâna), the Sâṅkhyas admit three, *viz.*, perception, inference and verbal testimony (âgama or śabda) while the Naiyâyikas whose fundamental work is the Nyâya-sûtra admit four, *viz.*, perception, inference, verbal testimony and comparison (upamâna). The Prâbhâkaras admit a fifth means of right knowledge called presumption arthâpatti), the Bhâṭṭas and Vedântins admit a sixth, *viz.*, non-existence (abhâva) and the Paurâṇikas recognise a seventh and eighth means of right knowledge, named probability (sambhava) and rumour (aitihya)].

इन्द्रियार्थसन्निकर्षोत्पन्नं ज्ञानमव्यपदेश्यमव्यभिचारि व्यवसायात्मकं "प्रत्यक्षम्" ॥१।१।४॥

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*हेयं तस्य निवर्त्तकं हानमात्यन्तिकं तस्योपायोऽधिगन्तव्य इत्येतानि चत्वारि अर्थ पदानि सम्यक् बुद्ध्वा निःश्रेयसमधिगच्छति ।

—(Nyâyadarśana, p. 2).

NYAYA SUTRAS

Astronomer	Period	Place	Major work(s)
Lagadha	1500 B.C.		Vedanga Jyotisha
Aryabhata I	476 A.D.	Patna	Aryabhata Siddhanta Aryabhatiya
Varahamihira	505 A.D.	Ujjain	Panchasiddhantika Brihatsamhita
Bhaskara I	600 A.D.	Vallabhi (Gujarat)	Maha Bhaskariyam Laghu Bhaskariyam
Brahmagupta	600 A.D.	Bhillamala (Rajasthan)	Brahma Sphuta Siddhanta
Aryabhata II	953 A.D.		Mahasiddhanta
Bhaskara II	1114 A.D.		Siddhanta Shiromani Leelavati Beeja Ganitam Karana Kutahala
Parameswara	1376 A.D.	Kerala	Drigganita Goladeepika Grahana Mandara

यथा शिखा मयूराणां, नागानां मणयो यथा।
तद्वद् वेदांगशास्त्राणाम् गणितं मूर्धनि स्थितम्॥

—वेदांग ज्योतिष*

"Like the crest of the peacock, like the gem on the head of a snake, so is mathematics at the head of all knowledge."

Vedanga Jyotisha by Lagadha 1500 B.C.

Discovery and use of Zero

While explaining the number and notations mathematics, it is interesting to mention the developmen numeral 0. It is accepted that zero was discovered by Indi Pingalacharya's Chandasastra (200 BC) appears to be the f book in which application of Soonya is given for writing numb as follows:

गायत्रे षड्संख्यामर्धेऽपनीते द्वयङ्के अवशिष्ट स्त्रयस्तेषु
रूपमपनीय द्वयङ्काधः शुन्यं स्थाप्यम् ।।

Gaayathre shadsankhyaamardhe f apaneethe dvayanke avasishtasthrayastheshu roopamapaneeya dvayankaadha: soonyam sthaapy

In gayatri chandas, one pada has six letters. When t number is made half, it becomes three (i.e the pada can be divided into two). Remove one from three and make it half to get one. Remove one from it, thus gets the zero (Soonya).

चतुरधिकं शतमष्टगुणं द्वाषष्टिस्तथा सहस्राणाम्
अयुतद्वय विष्कम्मस्य आसन्नो वृत्तपरिणाहः

Meaning: Add four to one hundred, multiply by eight and then add sixty two thousand; the result is approximately the circumference of a circle of diameter of twenty thousand (Aryabhata, called it an approximate (Aasanna) value!)

VALUE OF π

π

VALUE OF ...

$$\pi = \frac{\text{Circumference}}{\text{Diameter}} = \frac{62832}{20000} = 3.1416$$

Modern Value 3.1415926

Aryabhata I 476 A.D.

1.6 Algebra in Śulvasūtras

It is interesting to learn that in the ancient texts of *Śulvasūtras* we are remarkably introduced to "surds" of the type $\sqrt{2}$, $\sqrt{3}$ etc. In fact, for example, while $\sqrt{2}$ is irrational, the *Baudhāyana* and *Āpastamba sūtras* give a very good rational approximation in the following form:

समस्य द्विकरणी। प्रमाणं तृतीयेन वर्धयेत्
तच्चतुर्थेनात्म चतुस्त्रिंशोनेन सविशेष : ।।

- (*Bau.* i, 61-2, Ap. i, 6)

$$\text{i.e. } \sqrt{2} = 1 + \frac{1}{3} + \frac{1}{3 \cdot 4} - \frac{1}{3 \cdot 4 \cdot 34}$$

In fact, the above rational approximation to the irrational number $\sqrt{2}$ is correct to 5 decimal places !

Sulvasutras ~800 B.C.

सङ्क्रमणे करणसूत्रं वृत्तार्धम् । योगोऽन्तरेणोनयुतोऽर्धितस्तौ राशी स्मृतौ सङ्क्रमणाख्यमेतत् ॥ ५५ ॥

अत्रोद्देशकः । ययोर्योगः शतं सैकं वियोगः पञ्चविंशतिः । तौ राशी वद मे वत्से वेत्सि सङ्क्रमणं यदि ॥ ५६ ॥

न्यासः । योगः । १०१ । अन्तरम् । २५ । जातौ राशी । ३८ । ६३ ।

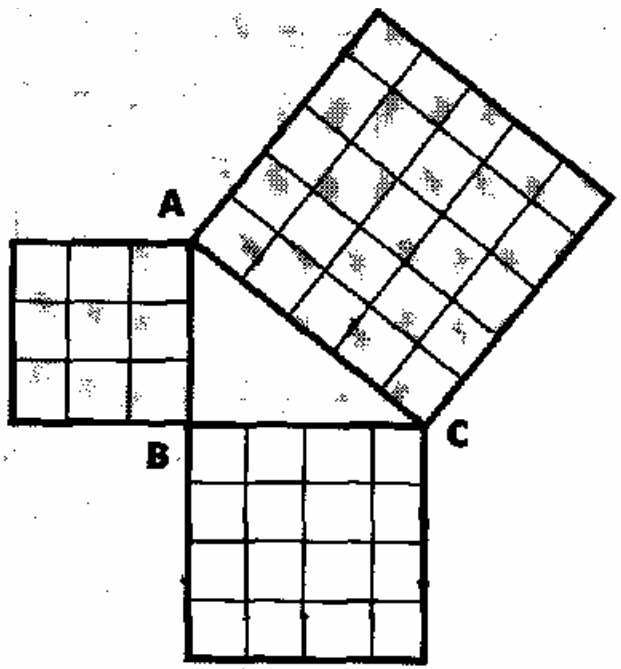
4. बाले मरालकुलमूलदलानि सप्त
तीरे विलासभरमन्थरगाण्यपश्यम् ।
कुर्वच्चकेलिकलहं कलहंसयुग्मम्
शेषंजले वद मरालकुलप्रमाणम् ॥

"O girl, out of a group of swans, seven times half of the square-root were seen going away on the bank of the river and one pair remained sporting in the water. Tell me the number of swans in the group".

Baudhāyana Theorem:

"The diagonal of a rectangle produces both areas which its length and breadth produce separately."

दीर्घस्याक्ष्णया रज्जुः पार्श्वमानी तिर्यङ्मानी
च यत् पृथग्भूते कुरुतस्तदुभयं करोति ।।



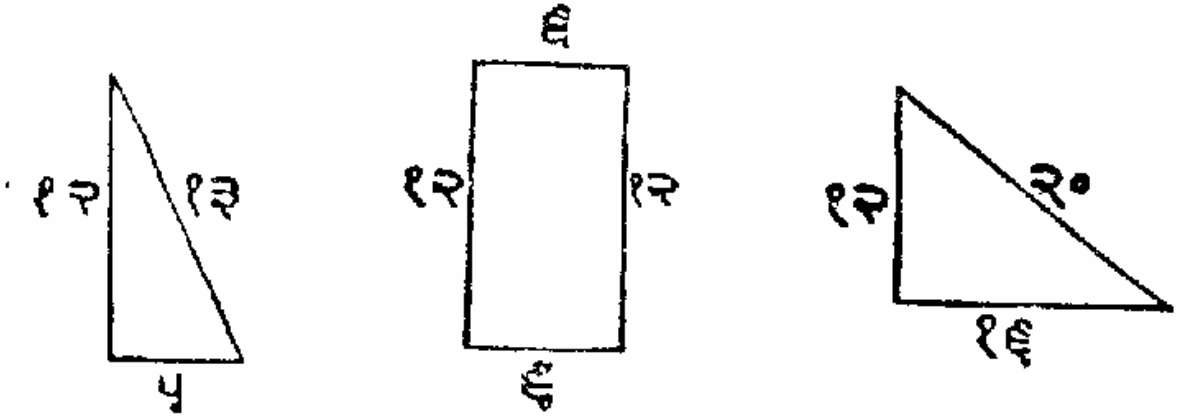
$AC^2 = AB^2 + BC^2$

Boudhayana Theorem

Baudhayana in Sulvasutras ~800 B.C.

Pythagoras ~540 B.C.

खण्डत्रयदर्शनम् ।



प्रथमस्य भुजकोटिकर्णाः । ५ । १२ । १३ । द्वितीयस्यायतस्य विस्तृतिः । ६ । दैर्घ्यम् । १२ । तृतीयस्य भुजकोटिकर्णाः । १६ । १२ । २० ।

अत्र त्रिभुजयोः क्षेत्रयोर्भुजकोटिघातार्धं फलं आयते चतुरस्रे क्षेत्रे तद्भुजकोटिघातः फलं यथा प्रथमक्षेत्रे फलम् । ३० । द्वितीये । ७२ । तृतीये । ९६ । एषामैक्यं सर्वक्षेत्रफलम् । १९८ ।

Leelavati
by Bhaskara II
1114 A.D.

Sulva Sutras of Vedic Mathematics

एकाधिकेन पूर्वेण (by one more than the previous one)

1 So $75^2 = \underline{56/25}$ where $56 = 7\times 8$, $25 = 5^2$.

2 Similarly $65^2 = \underline{4225}$ $42 = 6\times 7$, $25 = 5^2$.

3 And $25^2 = \underline{625}$ where $6 = 2\times 3$.

4 Also since $4\frac{1}{2} = 4.5$, the same method applies to squaring numbers ending in ½. So $4\frac{1}{2}^2 = 20\frac{1}{4}$, where $20 = 4\times 5$ and $\frac{1}{4} = \frac{1}{2}^2$.

The method can be applied to numbers of any size:

5 $305^2 = \underline{93025}$ where $930 = 30\times 31$

Even for large numbers like, say, 635^2, it is still easier to multiply 63 by 64 and put 25 on the end than to multiply 635 by 635.

Vedic Mathematics by H.H.Bharati Krishna Tirtha 1884-1960

Finally Bharati Krishna Teertha expresses π in this verse in the Katapayadi numerical code as :

गोपी भाग्य मधुव्रात श्रृङ्गिशो दधिसन्धिग

खलजीवित खाताव गलहालारसंधर

Which gives :
π=3.1415 9265 3589 7932 3846 2643 3832 792 to 31 decimal places. This verse can also be interpreted as a hymn to God Krishna and also to God Siva. Coincidentally a four line verse in the French language gives an identical value of π by counting the number of letters in each of the 32 words of the verse.

ORBITING PLANETS
Concept of Gravitation

आकृष्टि शक्तिश्च मही यत् स्वस्थम् गुरू स्वाभिमुखम् स्वशक्त्या ।
आकृष्यते तत् पततीव भाति समे समन्तात् क्व पतत्वयं खे ।।

Massive celestial bodies are attracted powerfully towards the earth by her own (gravitational) force, and they appear to fall as a result of such attraction, but when equal forces act on a body in space from all sides how can it fall?

The universal law of gravitation was propounded by Issac Newton (1642-1727 A.D.)

Siddhanta Shiromani by Bhaskara II – 1114 A.D.

Force causes Motion : The following Vaisheshika sutras describe the action of force. Vega Samskara (वेग संस्कार) is mechanical force.

	Sutra	Meaning
(1)	वेगः निमित्तविशेषात कर्मणो जायते	Change of motion is due to impressed force.
(2)	वेगः निमित्तापेक्षात कर्मणो जायते नियतदिक् क्रियाप्रबन्धहेतुः ।	Change of motion is proportional to the impressed force and is in the direction of the Force.
(3)	वेगः संयोगविशेषविरोधी	Action and reaction are equal and opposite.

In *Vaisheshika* philosophy force is inferred by the change of motion it produces.

मर्माणि मांससिरास्नायवास्थिसन्धिसन्निपाताः, तेषु स्वभावत एव विशेषेण प्राणस्तिष्ठन्ति, तस्मान्मर्मस्वभिहतास्तांस्तान् भावानापद्यन्ते

Susruta Sharirathan 6.15.

The areas where muscles, vessels, ligaments, bones, and joints meet together are known as the vital spots *(marmas)* which, by virtue of their vulnerability to damage are known as the seats of life. An injury to any of these spots may be dangerous to health/life, temporily or permanently.

Susruta ~200 B.C.

SVASTHAVRITTA -- KEEPING GOOD HEALTH

Charaka gives characteristics of healthy body i.e. *Swastha Sharir.*

समसंहननो नरः ।
समसंहननो नरः ।
इन्द्रिय विकाराणां न बलेनाभिभूयते ।।
क्षुत्पिपासातपसहः शीतव्यायामसाहसः ।
समपक्ता समजरः सममांससचयो मतः ।।

Charak Samhita (Ch.Ca.18-19)

1. Proportionate musculature
2. Compactness of body
3. Strong sensory and motor organs
4. Not overcome by onslought of diseases
5. Withstands hunger, thirst, heat of sun, cold and physical exertion
6. Digest and assimilate food properly

Charaka ~200 B.C.

Metallurgy

Period	Item	Location
2500-1800 BC	Copper-Bronze Technology Cire-perdue process Copper mines found	North West India Rajasthan Many parts of India
4th Century BC.	King Purushottam presents Indian made steel to Alexander	Taxila
370-375 AD.	(Delhi) Iron pillar fabricated it was shifted to Delhi in 1050 AD.	Mathura-UP.
8th Century AD Onwards	Wootz steel for making high quality swords	Export to Damascus, Syria
13th-18th Century AD	Large scale production of Zinc.	Zawar - Rajasthan

DELHI IRON PILLAR

"The Iron Pillar of Delhi opens our eyes to an unsuspected state of affairs to find Hindus at that age capable of forge-welding a pillar of iron larger than any that have been forged even in Europe up to a very late age, and not frequently even now. It is almost equally startling to find that after exposure to wind and rain for centuries, it has remained unrusted and the capital and inscriptions are as clear and as sharp now as when put up fifteen centuries ago."..... James Ferguson in his book 'A History of Indian and Eastern Architecture II, ' 208, 1910.

Pillar Fabrication ~375 A.D.

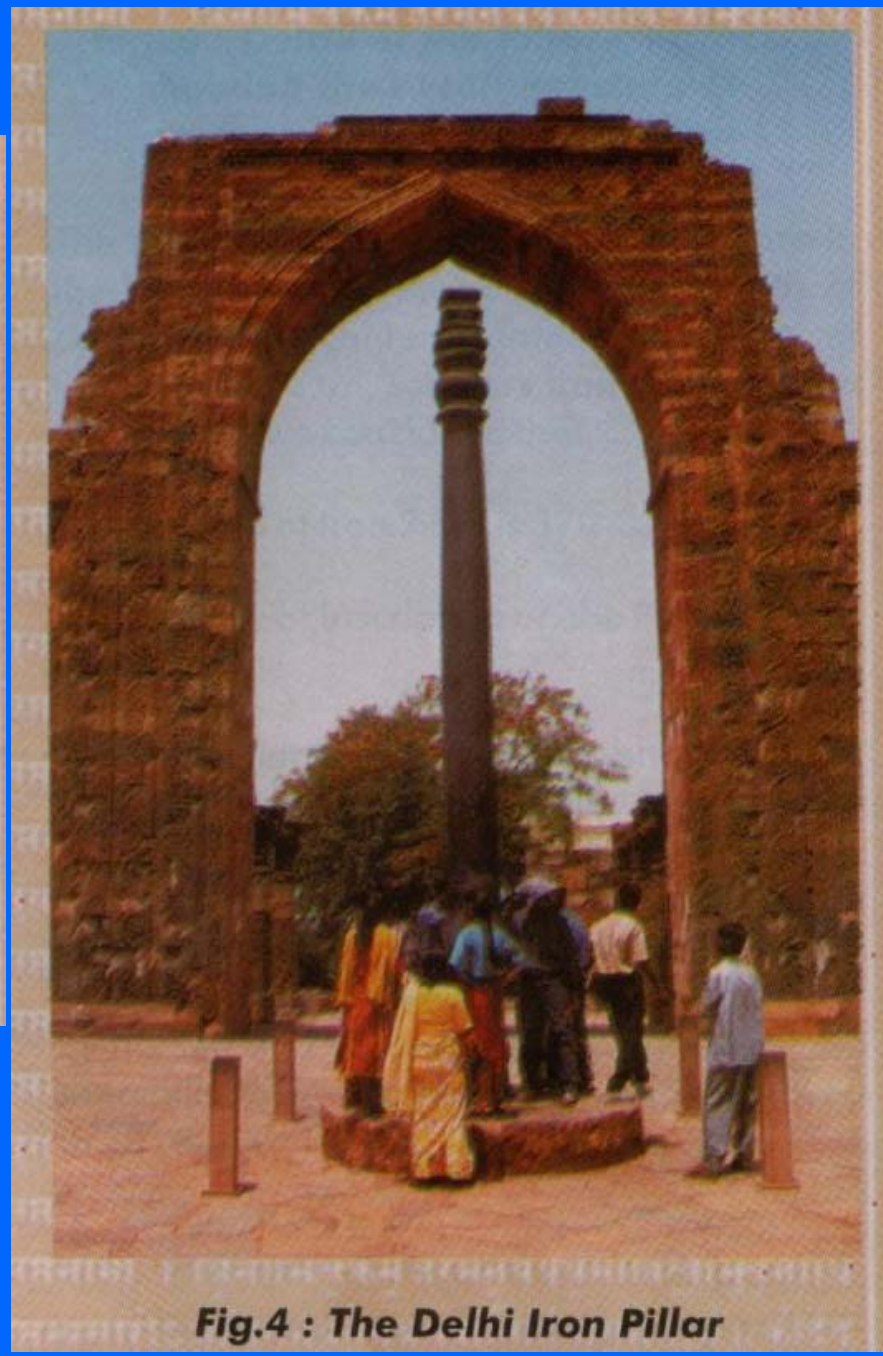


Fig.4 : The Delhi Iron Pillar

“Whatever sphere of human mind you may select for your special study, whether it be language, or religion, or mythology or philosophy, whether it be laws or customs, primitive art or primitive science, every where you have to go to India. Whether you like it or not because some of the most valuable and most instructive materials in the history of man are treasured up in India and in India only”

Max Muller

(ref: A short History of Sanskrit Literatrure)

T. K. Ramachandra Iyer, R.S. Vadhyar & sons, 1984

Summary

The concept of zero, the place value system of numeration, square roots, cube roots and the powers of ten were known to the ancient Indians. Brahmagupta's solution of second degree algebraic equations in two variables, and his work on cyclic quadrilaterals, predated the work of European mathematicians by a few centuries.

Constellations of stars were known, and basic aspects of the motion of the moon and the planets, as well as the occurrence and duration of the lunar and solar eclipses were understood. The heliocentric concept of our world was known in India centuries before it was accepted in Europe.

Classical works of the Indian medical system Ayurveda, like the Charaka Samhita and the Ashtanga Hridaya on medicine, and Sushruta Samhita on surgery, are consulted even today by Indian medical practitioners. Ayurveda is actively practised in India and Sri Lanka, and there is a recent spurt of interest in Ayurveda in the West.

The contributions of ancient Indians in the metallurgy of iron, zinc, copper and its alloys are acknowledged the world over. A blend of aesthetics and technical skill is reflected in the objet d'art made from brass and bronze.

Superb temple architecture, town planning including drainage systems, and the architecture associated with the construction of roads, bridges, forts and ports was well developed.

Sound practices in irrigation and agriculture have been mentioned in our ancient texts. Good expertise existed in the areas of ship building and navigation and there was active maritime trade with countries in south-east Asia, as well as countries to our west. Ancient Indian expertise and supremacy in cotton and silk textiles is well recognized in the world.

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