

Varahamihira Science Forum

Numbers in Sanskrit

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Numbers in Sanskrit

Early on, words and letters used to represent numbers.
Only later, separate symbols called *NUMERALS*,
were invented for writing numbers

Left to right - Units, tens, hundreds, thousands

Charturdasha Four and ten = 41 (this is fourteen 14)

Ashta sahasram - Eight and thousand = 8001 (today 1008)

Order is different from Dravidian languages

pathinaalu : Ten and four 14

aayiratthu eTTu : 1008

Division of Time – Number names

वर्ष द्वादश मासास्त्रिंशद्विवसो भवेत् स मासस्तु ।

षष्ठिनाड्यो दिवसः षष्ठिश्च विनाडिका नाडी ॥

varsha dvaadasha mAṣA trimshad divasO
bavEd sa mAṣa tu

shashTi naaDyo divasa shashTi ca
vinaaDikaa naaDee

year (varsha) = 12 (dvaadasha) months

month (maasa) = 30 (trimshath) days

day (divasa) = 60 (shashTi) naaDee

naadee = 60 vinaaDee

2 naaDee = 1 muhurtha

चतुरधिकं शतमष्टगुणं द्वाषष्टिस्तथा सहस्राणाम् ।
catur-adhikam shatam-ashTa-guNam dvaashashTi-tathA sahasrANAm
अयुतद्वय विष्कम्भस्यासन्नो वृत्तपरिणाहः ॥

a **104*8 + 62000 = 62832**

p **For Diameter of 20,000 Circumference is
62,832 approximately**

Catur adhikam
shatam
ashTa guNam
dvaashashTi
sahasrANAm
ayuta dvaya
vishkambha-sya
aasannaH
vRtta pariNaaha

Four plus hundred
By eight multiply
 $(2+60) * 1000$
10,000 times 2
Diameter's
Approximately
Circle's Circumference

Number Notations in Sanskrit

Number names - eka, dvi, tri, chatur, pancha...

Bhuta sankhya - Symbolic Words for numbers

kaTapayaadi - Letters to represent numbers

Aryabhatiya - A special system used by Aryabhata

Numerals – What we use today: 1,2,3,4,5....

Bhuta-sankhya system

In the *bhUta-saMkya* system, in place of name of numbers,
objects (and all their synonyms)
universally associated with the numbers
are given.

Here are some examples:

sky (0)

moon, *rUpam* (1)

eyes, ears, *yamam*, nose, *aSvini* (2)

fire, *guNa*, *loka* (3)

veda, ocean (4)

bhUta (5)

seasons, *vedAnga* (6)

muni, **mountains**, *svara* (7)

vasu, serpent, *prakriti*, knowledge (8)

openings in body (9)

avatara, finger (10)

Here are some examples

लोचन-आकाश-गुणं (203 - that is 302)

lochana-aakash-guNam (eye-sky-guNa)

अब्दिवसवैकशरा (4815 – that is 5,184)

abdhi-vasu-eka-sharaa (ocean-vasu-one-arrow)

रामाग्निशरशैलाद्रि (33577 – that is 77,533)

raama-agni-shara-shaila-adri (raama-fire-arrow-hill-mountain)

An example from *Laghu Bhaskariyam*

ते च षट्ट्रिकरामाग्निनवभूतेन्दवो युगे ।
भागहारोऽब्दिवस्वेकशराः स्युरयुताहताः ॥ ५ ॥ लघुभास्करीयम्

षट्ट्रिक राम अग्नि नव भूत इन्दवो (6333951 – that is
15,93,336)

shad trika raama agni nava bhuta indavo

अब्दिवस्वैकशरा (4815 – that is 1,584) अयुता (10,000) हताः
(multiply)

abdhi-vasu-eka-sharaa (ocean-vasu-one-arrow)
That is 1,58,40,000

Astronomy texts using BhutaSankhya

Surya Siddhanta (circa 300 AD)

Paulisa Siddanta (c. 400)

Maha Bhaskariyam, Laghu Bhaskariyam (620)

Braahma Sphuta Siddhaanta (628)

Trishatikaa (c. 750)

Ganita Saara Sangraha (850)

Bhuta sankhya

In Bhuta sankhya

A bhuta doesn't always stand for a single digit

Rudra is 11

Aditya is 12

Nakshatra is
27

Tithi is 30

Arhat 24

Buddha 24

Siddha 24

dvija 32

Vishva is 13

Loka is 14

pancha-vishva-veda-nakshatra
is a valid notation for 513427

N bhuta names doesn't mean N digits

Katapayaadi

BhutaSankhya uses WORDS to represent numerals

Katapayaadi uses LETTERS to represent numerals

It takes advantage of the ingenious and logical organization of the Sanskrit alphabet

B C D G P T V
J K
F L M N S
R
H
W
Y
Z

Be Ce De Ge Pe Te Ve
Jay Kay
eF eL eM eN eS
aaR
heicH
W double-u
Y uai
Z zed

கி சி டி தெ பெ றை
இங் இங் இண் ந ம
என்
ய ரு லு வெ ழு ஸி

Origin of Sound	Simple
Throat -	क
Roof of Mouth -	च
Tongue -	ट
Teeth -	त
Lips -	प

କ
ଚ
ଟ
ତ
ପ

ka
cha
ta
tha
pa

Voiceless (*aghoSha*) and is called 'Simple'

Origin of Sound	Unvoiced	
	Simple	Aspirate
Throat -	କ	ଖ
Roof of Mouth -	ଚ	ଛ
Tongue -	ଟ	ଠ
Teeth -	ତ	ଥ
Lips -	ପ	ଫ

କଁ
ଖୁମ୍
ଚଁ
ଛୁମ୍
ଟଁ
ଠୁମ୍
ତଁ
ଥୁମ୍
ପଁ
ଫୁମ୍

kha
chha
Tha
tha
pha

The second letter is also hard,
but, aspirated, that is, the breath is thrown out (*mahA-prAna*).

Origin of Sound	Unvoiced		Voiced		
	Simple	Aspirate	Simple	Aspirate	
Throat -	କ	ଖ	ଗ	ଘ	କ୍ତ୍ତା କ୍ତ୍ତ୍ରା
Roof of Mouth -	ଚ	ଛ	ଜ	ଝ	ଚ୍ଚା ଚ୍ଚ୍ରା
Tongue -	ଟ	ଠ	ଡ	ଢ	ଟ୍ଟା ଟ୍ଟ୍ରା
Teeth -	ତ	ଥ	ଦ	ଧ	ତ୍ତା ତ୍ତ୍ରା
Lips -	ପ	ଫ	ବ	ଭ	ପ୍ତା ପ୍ତ୍ରା

The third are 'light' (*ghoSha*), rich in resonance (voiced), but in the first of this pair the breath is held back (*alpa-prAna*) and in the latter it is thrown out (*mahA-prAna*).

Origin of Sound	- Stopped -				
	Unvoiced		Voiced		Nasal
	Simple	Aspirate	Simple	Aspirate	
Throat -	क	ख	ग	घ	ङ
Roof of Mouth -	च	छ	ज	झ	ञ
Tongue -	ट	ठ	ड	ढ	ण
Teeth -	त	थ	द	ধ	ন
Lips -	প	ফ	ব	ধ	ম

କୁ

ଖୁ

ଗୁଣା

ଘୁ

ଙୁ

ନ୍ଗ

ଅ

ନ୍ୟା

ନା

ମା

Each group ends in a nasal sound (*nAsikA*)
that is soft and resonant.

Origin of Sound	- Stopped -						Semi vowel	Sibilant		
	Unvoiced		Voiced		Nasal					
	Simple	Aspirate	Simple	Aspirate						
Throat -	क	ख	ग	घ	ङ					
Roof of Mouth -	च	छ	ज	झ	ञ	य	श			
Tongue -	ट	ठ	ડ	ଢ	ণ	ର	ଷ			
Teeth -	ତ	ଥ	ଦ	ଧ	ନ	ଲ	ସ			
Lips -	ପ	ଫ	ବ	ଧ	ମ	ବ				

Katapayadi system

Here numbers are assigned to letters as below:

1	2	3	4	5	6	7	8	9	0
କ	ଖ	ଗ	ଘ	ଡ	ଚ	ଛ	ଜ	ଝ	ଙ
କ					ମୁ	ସ			
ଲ	ଶୁ				ଣେ	ତ			
ପ	ନ୍ଦୁ						ମ		
ସ	ର	ଲ	ବ	ଷ୍ଟୁ	/	ଲେ	ହୁ		

As per the *sUtra*:

न जावचश्च शून्यानि सङ्कृत्यः कटपयादयः

मिश्रोचाऽन्त्यहलस्सङ्कृत्या न च चिन्त्या हलस्स्वराः

(from Sankaravarman's SadratnamAlA)

ka
ta
pa
ya

କ
ତ
ପ
ୟ

1	2	3	4	5	6	7	8	9	0
କ	ଖ	ଗ	ଘ	ଡ	ଚ	ଛ	ଜ	ଝ	ଅ
ଟ	ଠ	ଡ	ହ	ଣ	ତ	ଥ	ଦ	ଧ	ନ
ପ	ଫ	ବ	ଭ	ମ					
ୟ	ର	ଲ	ବ	ଶ	ସ	ସ	ହ		

"Zero is denoted by ନ and ଅ,
1 is represented by କ, ଟ, ପ and ଯ and
other successive digits
by successive consonants respectively.

If a mixed consonant is of two consonants
the latter one is to be considered and
if a mixed word is of a consonant and a vowel
then the vowel is to be ignored.

Katapayadi

English transliteration of Sanskrit alphabet

1	2	3	4	5	6	7	8	9
0								
ka	kha	ga	gha	nga	ca	cha	ja	
jha	nya							
Ta	Tha	Da	Dha	Na	ta	tha	da	dha
na								
pa	pha	ba	bha	ma				
ya	ra	la	va	sha	Examples	Sh	sa	ha

203 kha-nya-ba ख-ञ-ब paa-ni-lu पा-नि-लु

4815 gha-ja-pa-Na घजपण vi-ja-ya-me वि-ज-य-मे

33577 bAlamAsItA बालमासीता gu-Daa-maa-sa-the
गु-ढा-मा-स-थे

Melakarta ragas 1 to 72

Katapayaadi order

10	कन	kanakaangi
20	रत्ना	ratnaangi
30	गान	gaanamurti
40	वन	vanaspati
50	मान	maanavati
90	धेनु	dhenuka
01	नाट	naTakapriyA
02	नठ	naThabhairavi

51	माय	mAyamAlavagowla
62	चारु	cArukesi
03	नाग	nAganandini
65	षन्	shanmukhapriyA
36	लता	lataangi
07	नासि	nAsikabhooshaNi

Mixed use of Notation

Word names for numbers, bhuta sankhya words, and numbers in Katapayadi were often homogeniously mixed in Sanskrit books

pancha-chandra-veda-ashta-svara-sapta
is a valid notation

Number names in pink, bhuta sankhya in white

Wordplay

A katapayaadi number can have meaning also

Satyameva jayate सत्यमेव जयते is 7154816

A series of such numbers is an easily memorized table of values, for example

Vaakya panchaangams are made up of such slokas

Sanskrit Numerals

300 BC	Brahmi	०	१	२	३	४	५	६	७	८	९
?	Hindu	०	१	२	३	४	५	६	७	८	९
850 AD	Arabic	٠	١	٢	٣	٤	٥	٦	٧	٨	٩
?	Medieval	०	१	२	३	४	५	६	७	८	९
?	Modern	০	১	২	৩	৪	৫	৬	৭	৮	৯

Numerals were invented at an unknown age in India
Found in Samrat Asoka's inscriptions, third century BC

Numerals in Brahmi and Kharoshti scripts
Evolved over time (Nagari script numerals in 5th century)

Sanskrit numerals adopted by Abbasid Caliphate, Baghdad in 9th century and Italian in 13th century

Adoption of Hindu numerals

Severus Sebokth (sixth century AD)

“I will omit all discussion of the science of the Hindus, a people not the same as Syrians, their subtle discoveries in the science of astronomy, discoveries that are more ingenious than those of the Greeks and the Babylonians; their computing that surpasses description. I wish only to say that this computation is done by means of nine signs. If those who believe because they speak Greek, that they have reached the limits of science should know these things, they should be convinced that there are also others who know something.”

Arabic source : Al Hinda

Italian source : *Modus Indorum* (Method of Indians)

Leonardo Fibonacci

Zero and Place Value System

Simon Laplace

It is India that gave us the ingenious method of expressing all numbers by means of ten symbols, each symbol receiving a value of position as well as an absolute value; a profound and important idea which appears so simple to us now that we ignore its true merit. But its very simplicity and the great ease which it has lent to all computations put our arithmetic in the first rank of useful inventions; and we shall appreciate the grandeur of this achievement the more when we remember that it escaped the genius of Archimedes and Apollonius, two of the greatest men produced by antiquity.”

Carl Friedrich Gauss

“To what height would science now have been if Archimedes made that discovery [place value system]!”

Place Value System

यथैका रेखा शतस्थाने शतं दशस्थाने दशैका चैकस्थाने। यथा
चैकत्वेऽपि स्त्री माता चोच्यते दुहिता च स्वसा चेति ॥

Yatha-ekaa rekhaa shata-sthaane shatam dasha-sthaane
dashaas ekaa ca ekaa-sthaane | yathaa ca eka-tu-api
stree **maataa** ca-ucyate **duhitaa** ca **svasaa** ca-iti ||

Source Vasumithra's **Vyaasabhaasha** on **YogaSutra**

As a stroke (rekhaa) means 100 in hundredth place, 10 in tenth place, and 1 in unit place,

So also a woman is a mother, a daughter or a mother-in-law

GuDhalekhya - Cryptography

46th of the 64 arts

KV Sarma (Facets of Indian Astronomy) example

वे-दाङ्-ग-सा-रक्-ष-प-णः:

Ve-daa-ga-saa-rak-sha-pa-NaaH sthaanur

lokahitoh varah

R⁴k-8h³k⁷h²-kl⁶am¹ s⁵-pi-ti

रक् ष क सु खं स्व पि ति

encoded



su-ti-kah pi-sha-sva ra-

kham

ति कि श वा रा ं

ORGANIZE
12 3 4 5 6 7 8

AEGZRION
4 8 3 7 2 6 1 5

Numbers in inscriptions

Palm leaves and bhuj patra deteriorate in a few hundred years

They have to be copied over and over
Copies are in *contemporary* scripts,
numerals

Inscriptions on walls, coins, copper plates
PRESERVE scripts, numerals of their era

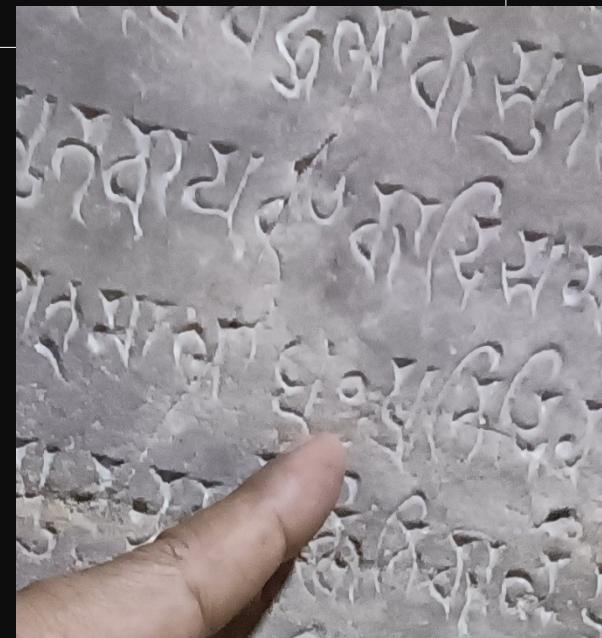
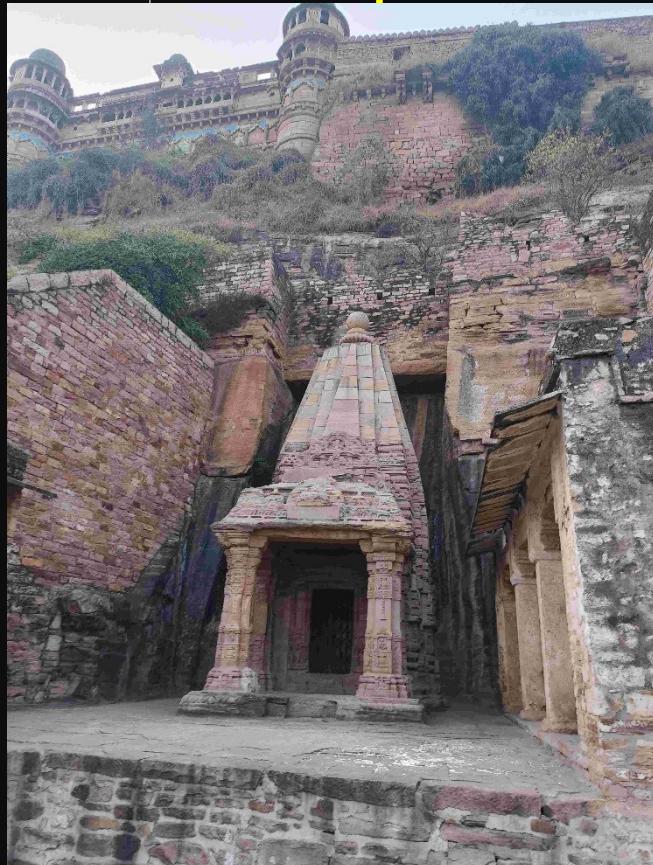
Numbers in inscriptions

Udayagiri, Madhya pradesh. Fifth century



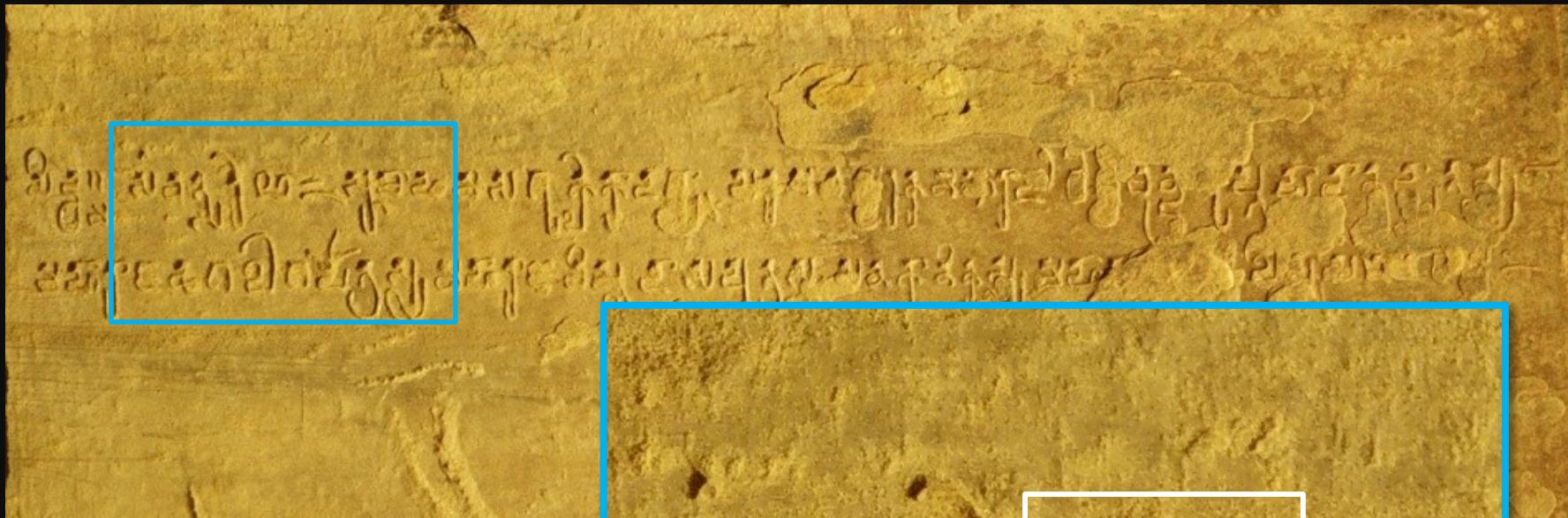
Gwalior Zero – Ashtabhuja temple

Inscription with numbers 270 and 50 in Devanagari numerals – Oldest surviving zero (depicted as a small circle) in an inscription in India.

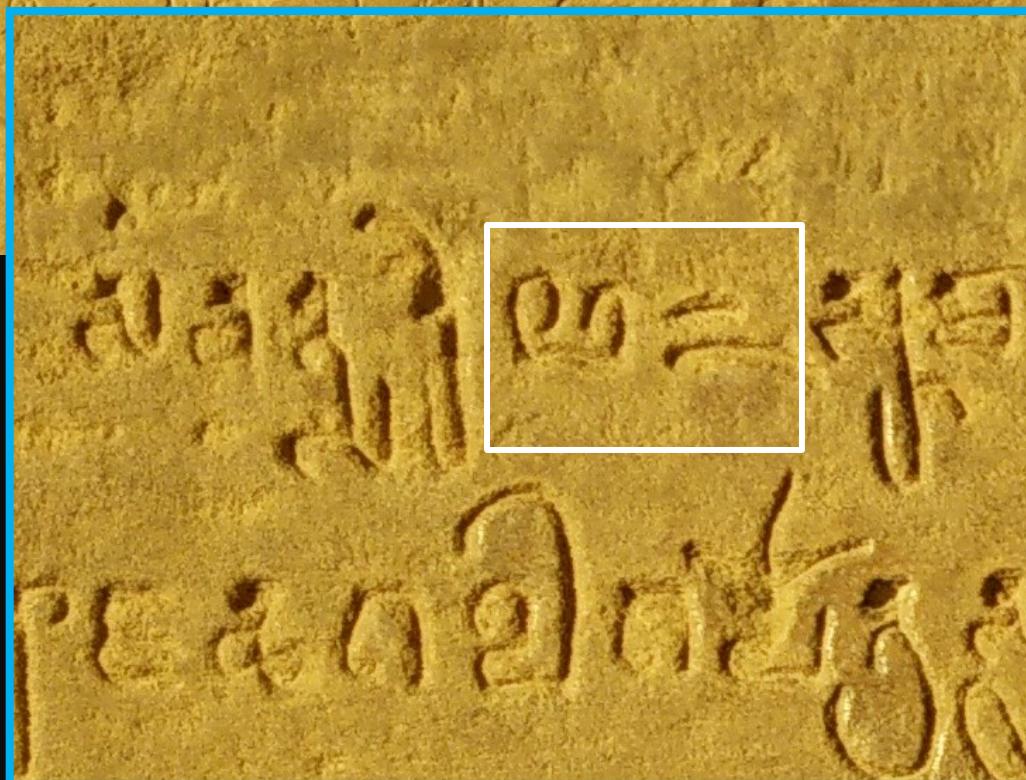


Numbers in inscriptions

Udayagiri, Madhya pradesh. Fifth century



samvatsare 82



Fraction - $\frac{1}{2}$ denoted by || Kodigehalli

ಶಾಸನ
Inscription Stones of Bangalore



०. ಶ್ರೀ ಗಣಾಧಿಪತಯೇ ನಮಃ ನಮಸ್ತಂಗ ಶಿರಜ್ಞಂಬಿ ಚಂದ್ರ
१. ಜಾಮುರ ಜಾರವೇ ತ್ಯಾಗೋಕ್ತ ನಗರಾರಂಭ ಮೂಲ
२. ಸ್ತಂಭಾ [ಯ ಶಂಭವೇ] ಸ್ತಂಭಾ ಶ್ರೀ ಜೆಯಾಭ್ಯಾದಯ ಶಕ ವರುಷ ಗಣಜಾ ನೆಯ
३. ಸಂದ ವರ್ತಮಾನ ವಿರೋಧಿತ್ಯಾತ್ಮ ಸಂವತ್ಸರದ ಭಾದ್ರಪದ
४. ಸು ಗ ಗು ಲು ಶ್ರೀಮನ್ಹಾರಾಜ ರಾಜ ಪರಮೇಶ್ವರ ಶ್ರೀ ವೀರ
५. ವಿಜಯ ಭೂಪತಿರಾಯ ಮಹಾರಾಯರ ಕುಮಾರರು ದೇವ ರಾಯ ಮ
६. ಕಾರಾಯರು ವಿಜಯನಗರಿಯ ಸಿಂಹಾಸನದಲು ಸುಕ ಸಂಕ
७. ತಾ ವಿನೋದದಿಂದ ಫ್ರಿತಿವೀ ರಾಜ್ಯಂ ಗಮಿಣತಯಿದಲ್ಲಿ ಆ ದೇವ ರಾ
८. ಯ ಮಹಾರಾಯರ ಸಮುಕದ ನಿರೂಪದಿಂದ ಸಕನ ಸಮುದ್ರ
९. ದ ವೋಳಗಣ ಉರಮುಂದಣ ಸೋಮೀ ದೇವರ ನಯಿವೇದ್ಯ ಅಂ
१०. ಗ ರಂಗ ಭೋಗಕ್ಕೆ ಶ್ರೀಮಂಮಹಾ ವ್ರಧಾನ ಮಂಗಳ್ಯ ದಂಜಾಯ
११. ಕರ ಮಕ್ಕಳ ಪ್ರಥಾವ ರಾಯರು ಕೊಟ್ಟ ಧರ್ಮ ಸಾಸನ ಶ್ರೀ ಸೋವೆಯ
१२. ದೇವರ ನಯಿವೇದ್ಯ ಅಂಗ ರಂಗ ಭೋಗಕ್ಕೆ ಮಾಡಿದ ಕಟ್ಟಳೆ ನಂ
१३. ಮ ನಾಯಿಕತನಕ ಕೊಟ್ಟಿಹ ಶಿವನಸಮುದ್ರದ ಕೆಳಗೆ ಸಲು
१४. ದ ಯೆಲಹಂಕನಾಡಲ್ಲಿ ತರಣೆಯವೈನ ಬಾಗಿಯೋಳಗಣ ದೇವನ
१५. ಮುದ್ರದ ಗ್ರಾಮದ ಕಾಲುವಳಿ ವಿರುಪಾಕ್ಷಪುರ ಗ್ರಾಮ ಕೆ
१६. ಪಾಕು ಗುತ್ತಿಗೆಯ ವ್ರಮಾಣ ಕಾಣಿಕ ಸಹಕರ್ಮಣ್ಯವೈ ಗ १६ || ಆ
१७. ಗ್ರಾಮಕ್ಕೆ ಅಂದಿನಾದಾಯ ಆವೂರ್ವ ಆದಾಯಕ್ಕಾಗಿ ಬ
१८. ಟ್ಯಾ ಕೊಟ್ಟಿಯ ಗ २ || ಉಭಯಂವರಹ ಗ १० ವರಕ ಯಿವೈತ್ತು
१९. ಹೊಂನಿನ ಗ್ರಾಮವಾಗಿ ಯಿರಲಾಗಿ ಆ ಗ್ರಾಮವನು ವಿಜಯ ದೇ
२०. ವ ರಾಯ ಪುರ ವೆಂಬ ಗ್ರಾಮವನು ಮಾಡಿ ಆದೇವರಾಯವು
२१. ರಯಂಬ ಗ್ರಾಮವನು ದೇವನಸಮುದ್ರದ ಹಿರಿಯಕೆಳೆಯ ಕೆ
२२. ಖಗೆ ಬೀಜವರಿಯ ಗದ್ದೆ ಬ ಇ ಬೀಜವರಿ ಗದ್ದೆ ಅಯಿ
२३. ಗಂಡುಗವನು ಶಾವಣ ಬ 30 ಸೂರಿಯ ಪರಾಗ ಪುಣ್ಯ ಕಾ
२४. ಲದಲು ಆ ದೇವರಾಯ ಮಹಾರಾಯರಿಗೆ ಆಯುರಾರೋಗ್ಯ
२५. ಯಿಸ್ವರಿಯ ವೃದ್ಧಿಅಹಂತಾರಿ ಶ್ರೀ ಪರಮೇಶ್ವರ ಪ್ರೀತಿಯಾಗಿ

Next
Vedic Period