UNIT 2

1	List down the key inferences that one can make about the Indian mathematical tradition based on historical evidence.
Ans	(a) Al-Biruni noted that Indians did not use letters for arithmetic. A legal document from 594 CE and an inscription from 876 CE show the use of the place value format and zero. (b) Based on extensive research, Ifrah presented evidence from Europe and the Arabic world to show that modern number systems indeed originated in India.
2	When was the concept of zero discovered in India? What is its special significance?
Ans	Brahmagupta developed the symbol for zero in 628 CE, enabling its use as an Independent numeral for computation. The real power of zero was evident when the use of zero was beyond a mere placeholder.
3	Note any two incidents of Indian Legacy in Number Systems.
Ans	(a) An episode in the life of Buddha narrated in ancient Indian texts like Lalitavistara mention numbers as large as . (b) The commentary on Yoga-sutra from the 1st Century CE mentions the place value of numbers.
4	What do you understand by the term 'decimal system'? Where did it originate ?
Ans	The universal way of dealing with numbers today, is through the use of 10 as the base. The resulting decimal number system originated in India before the 11th Century BCE.
5	Name the three generic measures used in the ancient Indian system.
Ans	length, weight and time.
6	What is the standardized units for street widths in Indus-Saraswati civilization?
Ans	The Indus-Saraswati civilization used standardized units for street widths, such as Dhanusha and Garhapatya Dhanusha.
7	What is the standardized brick ratio used by Harappa, Mohenjo-Daro civilization ?
Ans	Harappa, Mohenjo-Daro, Dholavira, and Lothal revealed standardized fired bricks with length, width, and depth ratios of 4:2:1.
8	Arthshastra ancient text mentions two types of Dhanush as units for measuring roads and distances, what are they?
Ans	Dhanus = 96 Agulas; Grhapatya-dhanus=108 Agulas used for measurement of roads and distances
9	Give the Sanskrit language names for the numbers 1, 10 and 100.
Ans	1 - ekam, 10- dasa, 100- sata
10	Who used the zero first time and give reference to it?
Ans	The word "nya " was first used to represent zero in Chandasastra by Pingala in the 2nd Century BCE.
11	Indian mathematics is seamlessly linked with literature and poetry. Comment on this statement. Provide some examples to support your arguments.
Ans	The Bhūta-Saṃkhyā system is a unique approach developed in India to represent numbers using words and entities, seamlessly integrating mathematics with literature and poetry. Example **Rama Chandra guna nanda rtiu padah:** This phrase represents the number 2, 69,313.
12	What is **Bhūta and Sankhyā system explain it briefly.**
Ans	The word "Bhūta" refers to entities, beings, or concepts, while "Saṃkhyā" means number. It is **association of numbers with entities.** Each number from 0 to 9 is

	associated with specific entities or concepts. For instance, the number 2 is represented by the word "eye" since humans have two eyes.
13	3. 'vedqa-vedanka-candrah' representation of number in **Bhūta and Sankhyā system.**
Ans	**1944**
14	'Khadri-ramagnayah' representation of number in **Bhūta and Sankhyā system.**
Ans	1733
15	What is the numeral representation for the word 'manu, agni, elephant, Tithi, rudra, Indra, Pandava.
Ans	manu-14, agni-3, elepant-8, tithi-15, rudra-11, Indra-3, Pandava-5.
16	What is the advantage of the Indian numeral system over the Roman numerals explain with examples.
Ans	Roman numerals have varying digits for different numbers, making it difficult to perform mathematical operations and represent large numbers. To represent number 432,000 using the Roman system we need to repeat M 432 times! This is an impractical idea.
17	Differentiate between Bhūta and Sankhyā system and katapayadi system.
Ans	Any three valid differences
18	List and explain the advantages of katapayadi system.
Ans	· Representing long (or large) numbers using a nice and easy-to-remember word, which can be easily remembered. · Particularly very valuable in an oral tradition, where large numbers may have to be remembered and communicated without loss of digits. · Very efficient method of presenting results of complex calculations using number symbols and then codifying and committing to memory effortlessly.
19	Illustrate Bhutasamkhaya system with suitable examples.
Ans	· veda-vedāńka-candräḥ : Let us split the words and associate the numbers to them. Veda (4); Veda (4): Anka(9); Candra(1). Therefore, the number is 1944. · khādri-rāmāgnayaḥ: Kha (0); Adri (7); Râma (3); Agni (3). Therefore, the number is 3370. · bhujanga-nanda-dvi-naga-anga-bana-sat-krita-indavaḥ: bhujanga (8), nanda (9), dvi (2), naga (synonym of adri) (7), anga (6), bâṇa (5), sat(6), krta (4), indu (1). Therefore, the number is 146,567,298.
20	Illustrate Katapayadi system with suitable examples.
Ans	· (bhavati) :Spliting them into separate letters bha-va-ti. After ignoring all the vowels and reading from the table the corresponding numbers, we get 4-4-6. Therefore, the is 644. · (śaktyāloke - śa-ktyā-lo-ke) :In this case, the second group has conjoined consonant 'k' followed by 't' and 'ya We ignore all the preceding ones and take only 'ya' for consideration. The resultant numbers for the string of these alphabets are '5-1-3-1. Therefore, the number is 1315.

	· (sarvārthaśīlasthiraḥ - sa-rvă-rtha-śī-la-sthi-rah) : As per the rules and the table, we have (7-4-7-5-3-7-2). Therefore, the number is 2,735,747. · (āyurarogyasaukhyam a-yu-rā-ro-gya-sau-khya-m) : In this case, there is a standalone vowel (a), which will indicate 0. There is a standalone consonant at the end (m), which will have to be ignored. The digits are 0-1-2-2 -1-7-1. Therefore, the number is 1,712,210.
21	_____gave the THEORY OF binary numeral system, arithmetical triangle. a.Pingala b. Aryabhata c. Brahmagupta d. None of these
Ans	a.**Pingala**
22	Who gave the explanation of lunar eclipse and solar eclipse, rotation of Earth on its axis, reflection of light by moon. a.Pingala b. Aryabhata c. Brahmagupta d. None of these
Ans	**b. Aryabhata**
23	Develop a binary cycle of length four and identify all possible binary words of length four.
	a. 0000 b. 0001 c. 0010 d. 0011 e. 0100 f. 0101 g. 0110 h. 0111 i. 1000 j. 1001 k. 1010 l. 1011 m. 1100 n. 1101 o. 1110 p. 1111
Ans	
24	As per Sulba Sutra basic vedic unit of measurement is _____

	a. Angula b. Meter c. Stupi d. None of the above
Ans	a. **Angula**
	_____introduces a formal definition of the word "Sunya" to denote the zero. a. Agam Sashtra b. Chandah Sashtra c. Panchtantra d. None of the above
25	
Ans	b. Chandah Sashtra
	_____is the first famous text on astronomy in India. a. Siddhanta b. Panchratna c. Aryabhatiya d. Rasendramalika
26	
Ans	c. **Aryabhatiya**
27	List the two types of syllables defined by pingala in the Chandah-Sastra.
Ans	Laghu and Guru.
28	List the Eight Ganas and respective binary word as defined by Pingala.
Ans	<table><tr><th>Sl. No.</th><th>Gana Name</th><th>Binary Word</th></tr><tr><td>1</td><td>'Ya' Gana</td><td>100</td></tr><tr><td>2</td><td>'Ma' Gana</td><td>000</td></tr><tr><td>3</td><td>'Ta' Gana</td><td>001</td></tr><tr><td>4</td><td>'Ra' Gana</td><td>010</td></tr><tr><td>5</td><td>'Ja' Gana</td><td>101</td></tr><tr><td>6</td><td>'Bha' Gana</td><td>011</td></tr><tr><td>7</td><td>'Na' Gana</td><td>111</td></tr><tr><td>8</td><td>'Sa' Gana</td><td>110</td></tr></table>
29	List the four varieties of Guru as defined by Pingala.
Ans	(a) Any syllable with a long vowel. (b) Any short syllable followed by conjunction of consonants

	(c) Any short syllable followed by 'm' known as anusvara or visarga denoted by'.' (d) The last syllable in the quarter of a meter