HSS 201 – History of Science
Second mid-term examination

Part I: Each question carries one mark (20 x 1= 20 marks)

1) Āryabhaṭa's work is called
a) Ārya siddhantha
b) Āryabhaṭīya karna
c) Āryabhaṭīya
d) Āryabhaṭīya sutra

Give 1 mark if the student has selcted 1a OR 1c or BOTH; both are right answer

2)Which is NOT found in Āryabhaṭīya
a) epicycle model of the universe
b) All planets were aligned at the beginning of the Kali Yuga
c) There are 'nava grahas' – nine planets
d) Trigonometry

3) The four sections (or chapters) of Āryabhaṭa's Aryabhatiya are
a) Merupada, Ganitapada, Kalakriyapada, and Golapada
b) Merupada, Ganitapada, Akashapada, and Golapada
c) Gitikapada, Ganitapada, Kalakriyapada, and Golapada
d) Gitikapada, Ganitapada, Akashapada, and Yugapada

4) According to early Purāṇas the Sun goes around ..... to cause day and night
a) Moon
b) Spherical Earth
c) Mt. Meru at the centre of the flat earth
d) Laṅkā

5) According to Āryabhaṭa, Earth is made up of
a) Air, Water, Fire, Earth, and Akash/ Aether – Pañcabhūta
b) Air, Water, Fire, Earth, and Time – Pañcabhūta
c) Air, Water, Fire, Earth – catudhātu-bhūta
d) Air,Water, Earth, viññāṇa (conciseness) – catudhātu-bhūta

6) According to Āryabhaṭa, the shape of the Earth is
a) Flat circular disc
b) Spherical like a Kadamba flower
c) A hemisphere-like bulb of kadamba flowers
d) Flat like the belly of a mirror

7) According to Āryabhaṭa
a) Earth rotates around its axis once a day, and the sky (celestial sphere) is fixed
b) Earth is fixed and the sky(celestial sphere) rotates once a day
c) The sky rotates once a day, making it seem as though the Earth spins. Like in a moving boat, the banks appear to move backward.
d) Earth does not rotate on its axis, however the planets and Sun go around it in epicycle

8) Which of the following is NOT an argument based on naturalistic reasoning?
a) The Earth cannot be rotating because birds are able to return to their nests.
b) The Earth is stationary because it is stated in the sacred texts (Smṛti and Śruti).
c) The Earth does not rotate because if it did, clouds would not be able to rain over the same place.

d) The Earth is not rotating because we do not see flags constantly fluttering in the opposite direction.

9) According to Āryabhaṭa, Eclipses are caused by
a) Shadow of Earth falls on Moon during a lunar eclipse and Moon obstructs the Sun during a Solar eclipse
b) Occasionally, Rāhu and Ketu devour the Sun and Moon, causing Solar and Lunar Eclipses
c) Rāhu takes a circular form equal in shape and size of Earth's shadow and Moon's disc to cause lunar and solar eclipse respectively.
d) Shadow of Earth falls on Moon during lunar eclipse and Moon obstructs Sun during Solar Eclipses; however, Rāhu arrives at that location.

10) According to Āryabhaṭa
a) A mahāyuga consists of four Kali Yugas of equal duration of 4,32,000 years
b) A mahāyuga consists of Satya Yuga, Tretā Yuga, Dvāpara Yuga, and Kali Yuga, each of equal duration (432,000 years).
c) A mahāyuga consists of four yugas: Satya Yuga, Tretā Yuga, Dvāpara Yuga, and Kali Yuga, which have durations in the ratio 4:3:2:1.
d) A mahāyuga consists of Satya Yuga, Tretā Yuga, Dvāpara Yuga, and Kali Yuga of unequal duration in the ratio of 5:3.5:2:1

11) According to Āryabhaṭa he arrived at his theory
a) by penance to Sūrya
b) by penance to Brahmā
c) by penance to Paitāmaha
d) by Svamati – own intellect/intelligence

12) Which is NOT Āryabhaṭa's contribution
a) Mathematical astronomy
b) Trigonometry
c) Naturalism
d) Supernaturalism

13) According to Āryabhaṭa
a) Earth stands in space supportless
b) is held by invisible chords in the hands of deities
c) Supported by Adishesha
d) is at the bottom of the universe, and all other objects are above it

14) In the works of Āryabhaṭa and other astronomers, Laṅkā means
a) Modern-day day Srilanka
b) Old name for Mauritius in Indian ocean
c) An imaginary point on the Equator where the north-south line through Ujjaini (Avanti) meets the Equator.
d) Alexandria

15) According to Āryabhaṭa, the orbits of the planets are around
a) Earth
b) Sun
c) Midpoint between Earth and Sun
d) Mt Meru

16) Zero was discovered by
a) Āryabhaṭa
b) We do not have adequate evidence to emphatically claim, but it was discovered by Āryabhaṭa
c) Āryabhaṭa's disciples
d) Known much before Āryabhaṭa

17) According to Āryabhaṭa, the extent of the cosmos is
a) koti koti koti yojana
b) koti times the height of Mt.Meru
c) the extent to which the Sunlight can illuminate
d) infinite

18) According to Āryabhaṭa
a) People, all creatures terrestrial and aquatic, live on all sides of Earth
b) only people live on all sides of Earth
c) Only people and terrestrial creatures live on all sides of Earth
d) Only people and aquatic life live on all sides of the Earth

19) Who wrote one of the earliest commentaries on Āryabhaṭīya
a) Bhramagupta
b) Varāhamihira
c) Bhaskara-I
d) Pṛthūdhaka

20) According to Āryabhaṭa, when it is sunrise in Laṅkā
a) It is sunset at Romaka , midday at Yavakoti, and midnight at Siddhapura
b) It is sunset at Romaka , midday at Siddhapura, and midnight at Yavakoti
c) It is sunset at Siddhapura, midday at Yavakoti, and midnight at Romaka
d) It is sunset at Yavakoti, midday at Siddhapura, and midnight at Romaka

Part II: Answer any ONE (1 x 5 = 5 marks)

1. How Āryabhaṭa found the spherical shape of Earth using the lunar eclipse
2. Describe how Āryabhaṭa calculated the size of Earth based on the observed change in elevation of the pole star as one travels north.
3. Compare the explanations given by Āryabhaṭa, Varāhamihira, and Brahmagupta for the causes of lunar and solar eclipses, including the role of Rāhu and Ketu, if mentioned by each.

Part II - Keys to short answers

I have not sought exact reproduction, word-for-word, but only the key logic/arguments.

Q1:
Observation 1: At all stages of the eclipse, the shadow is an arc of a circle
Observation 2: At all times, the shadow is about 2.5 times the width of the Moon
Inference 1: Earth should be a circular disc, cylinder, cone, or sphere to produce a circular shadow
Time at a location is the angle between the Sun, the centre of Earth and the location
Observation 3: The shadow of Earth is circular in all lunar eclipses, irrespective of the time of onset of the lunar eclipse
Inference 2: The shadow of Earth is circular from all sides
Observation 4: A cylinder, etc., cannot produce a circular shadow from all sides...
Only a sphere will produce a circular shadow from all sides; therefore, the shape of the Earth must be spherical.

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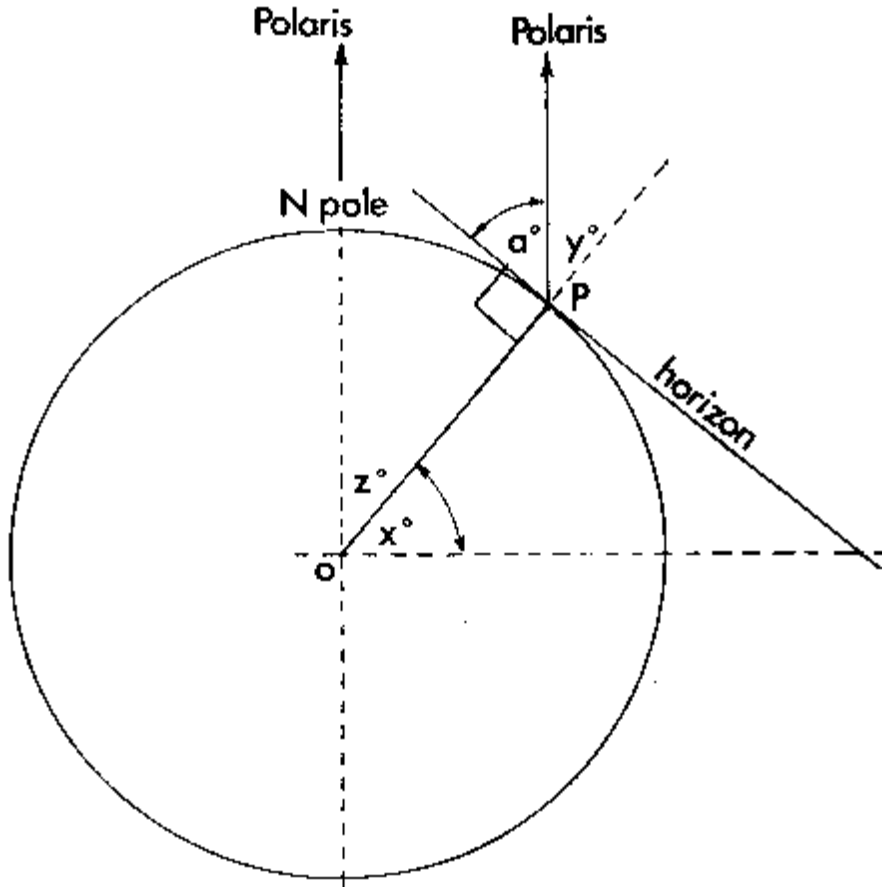
Q2



Āryabhaṭa does not say how he calculated the diameter of the Earth.

Bhaskara I, commenting on Aryabhatiya 1.7, says there are two methods for calculating the diameter of the Earth; one is indirect and shows that the Earth is spherical.

The elevation of the pole method- Akṣonnati

Actual distance between Laṅkā - Kanyakumārī - Ujjayinī (South North line), and their latitude (measured by the elevation of the North Celestial Pole)

For one degree elevation = moving x yojana due north

x 360 deg = circumference
from circumference compute radius

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Q3

Āryabhaṭa,-> pure naturalistic explanation using shadows of Earth and Moon, causing lunar and solar eclipse, respectively
Varāhamihira- > agrees with Āryabhaṭa about cause and says clearly Rahu is not the cause of the eclipse. However, Rahu is present during an eclipse due to Brahma's boon, allowing it to partake of the offerings made by humans during that time.
Brahmagupta -> rejects a naturalistic explanation and insists that Rahu is the cause of the eclipse; Rahu takes on the shape and size of the shadows and causes the eclipse.