History and Philosophy of Science

Attempt any 6 (six) questions.
All questions carry equal marks.

1. (a) What are primary, secondary, and tertiary sources?

   (b) Classify the following as primary, secondary or tertiary sources. Briefly explain the reasons for your classification.
   (i) a Bollywood film on Mohenjodaro, (ii) a newspaper article on the floods in India, (iii) a Wikipedia article, (iv) a handwritten letter by Matteo Ricci.

2. (a) What is the stock model of the history of science? Elaborate with reference to the stock history of mathematics.

   (b) How is the terminology "Pythagorean theorem" justified by reference to the philosophy of mathematics? Is that philosophy of mathematics universal or is it just declared superior? Is it the philosophy on which math is taught today? Where can you find a reasoned comparison of the two philosophies to decide which philosophy of math is better?

3. (a) The evidence for Euclid (supposedly from -4th c. CE) is said to be a passage from Proclus (5th c. CE). However, the actual manuscript attributed to Proclus is written on paper. Paper factories started in Europe only in the 13th c. On this data, give your assessment of the value of this passage as evidence for Euclid.

   (b) Is the very first proposition of the Elements proved formally or empirically? Briefly discuss the relative advantages of empirical proof versus pure deductive proof.

4. (a) According to Plato's *Apology*, both Socrates and Anaxagoras were condemned to death for impiety, for not believing that the sun and moon are gods. What would you infer from this about about Greek astronomy in Plato's time?

   (b) Could the Greeks and Romans have done astronomy without a good system of arithmetic? Calculate xvii times iv the way Romans would have done it using an abacus instead of algorithms.

5. (a) What is non-textual evidence? Give an example to explain how it can be more reliable than textual evidence.

   (b) The length of the (tropical) year on the Julian calendar is 365¼ days. By approximately how much is this incorrect? How would the correct length be stated in Roman numerals? In how much time would this wrong length of the year cause the calculated date of spring equinox to disagree with observations. What was the consequence of a bad calendar for European navigation?

6. (a) Why did Arabs and Europeans seek out Indian arithmetic?

   (b) Explain European difficulties in understanding Indian arithmetic in relation to (i) Gerbert's abacus vs alogrithms (ii) Florentine merchants and zero.

7. (a) How did Aryabhata calculate his 24 trigonometric values? Did he use geometry or a numerical approach? Did this amount to the beginning of calculus?

   (b) How accurate were Aryabhata's values? How accurate were Madhava's values? Why were such accurate trigonometric values regarded as important in India?

8. (a) Briefly explain what is the evidence for the transmission of calculus from India to Europe in the 16^{th} c, in terms of (i) opportunity, (ii) motivation, and (iii) circumstantial evidence.

   (b) An infinite series with no pattern cannot be summed exactly. Explain briefly how early Indians handled this situation with regard to $\sqrt{2}$.

9. (a) What is Popper's criterion of falsifiability or refutability? Discuss the refutability of the astrological prediction “you will have a romantic day today”.

   (b) “All crows are black”. Is this statement refuted by genetically engineering a crow which is albinoid (white)? Explain how you can still “save the story” to avoid refutation of the statement “all crows are black” against this empirical evidence.

10. (a) Are Newton's laws of motion refutable? Is Newton's law of gravitation refutable? What refutable conclusions can one draw from Newtonian physics by putting the two together to eliminate time?

    (b) Does Newtonian gravitation hold or fail for the rotation of stars in the galaxy? Discuss Dark Matter as “accumulation of hypothesis” to save Newtonian gravitation from empirical refutation.