# Mathematics in Dar al-Islam

1. Hindu-Arabic Numerals

The Hindu-Arabic numeral system is the most commonly used number system in the world. Originally developed in India, it included the concept of zero. The system was revolutionary by limiting the number of individual digits to ten. Traditional systems had used different letters of the alphabet to represent numbers or cumbersome Roman numerals, and the new system was far superior, for it allowed people to multiply and divide easily and check their work. Persian mathematician Muhammad ibn Musa al-Khwarizmi's book *On the Calculation with Hindu Numerals*, written about 825, was principally responsible for the diffusion of the Indian system of numeration (Arabic numerals) in the Islamic lands and the West.
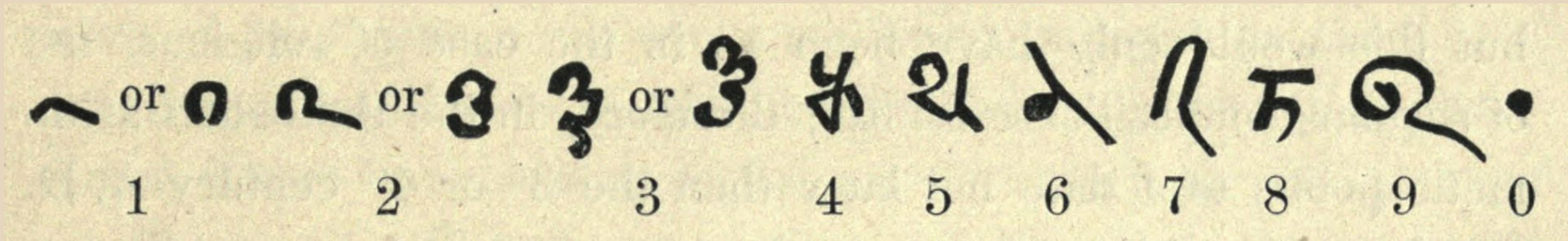
Evolution of the Hindu Numeral System

Brahmi			—	=	≡	+	Ⲡ	Ⲗ	ໆ	Ϛ	ໆ
Hindu		०	१	२	३	४	५	६	७	८	९
Arabic		٠	١	٢	٣	٤	٥	٦	٧	٨	٩
Medieval		O	I	2	3	୪	୨	6	୍	8	9
Modern		0	1	2	3	4	5	6	7	8	9

2. Algebra

Muhammad ibn Musa al-Khwārizmī was head of the House of Wisdom in Baghdad. He introduced the concepts of algebra in his treatise *Book of Algebra* in 820. The development of algebra, according to historian E.F Robertson was "perhaps one of the most significant advances made by Arabic mathematics...It was a revolutionary move away from the Greek concept of mathematics which was essentially geometry. Algebra allowed [for] rational numbers, irrational numbers, geometrical magnitudes, etc...It gave mathematics a whole new development path so much broader in concept to that which had existed before, and provided a vehicle for future development of the subject. Another important aspect of the introduction of algebraic ideas was that it allowed mathematics to be applied to itself in a way which had not happened before."

# Why Does Algebra Matter to a Caliphate? Or any nation, for that matter?

You know what algebra lets you do? Calculate the optimum angle for a cannon to fire when besieging a city, or calculate energy and mass (does $E = mc^2$ look familiar?)

3. Negative Numbers

It sounds weird, but there was a time when negative numbers were considered absurd. Ancient Chinese and Indian mathematicians had written about negative numbers, but Islamic scholars in the Middle Ages furthered the rules of subtracting and multiplying negative numbers and solving problems with negative coefficients. Many ancient Greek scholars had considered negative numbers to be absurd and "false."

4. Trigonometry

Abu Abdallah Mohammad ibn Jabir Al-Battani, aka the "Father of Trigonometry," helped lay the groundwork for trigonometry by computing the first table of cotangents (used to establish the relationship between the three sides of a triangle.) Al-Battani used trig to determine the length of the year and the occurrence of equinoxes. In the 10th century al-Biruni further developed trigonometry and was able to determine earth's circumference and the qibla (direction of the Kaaba in Mecca) from anywhere. Biruni's work introduced triangulation—determining location or distance between locations or objects.
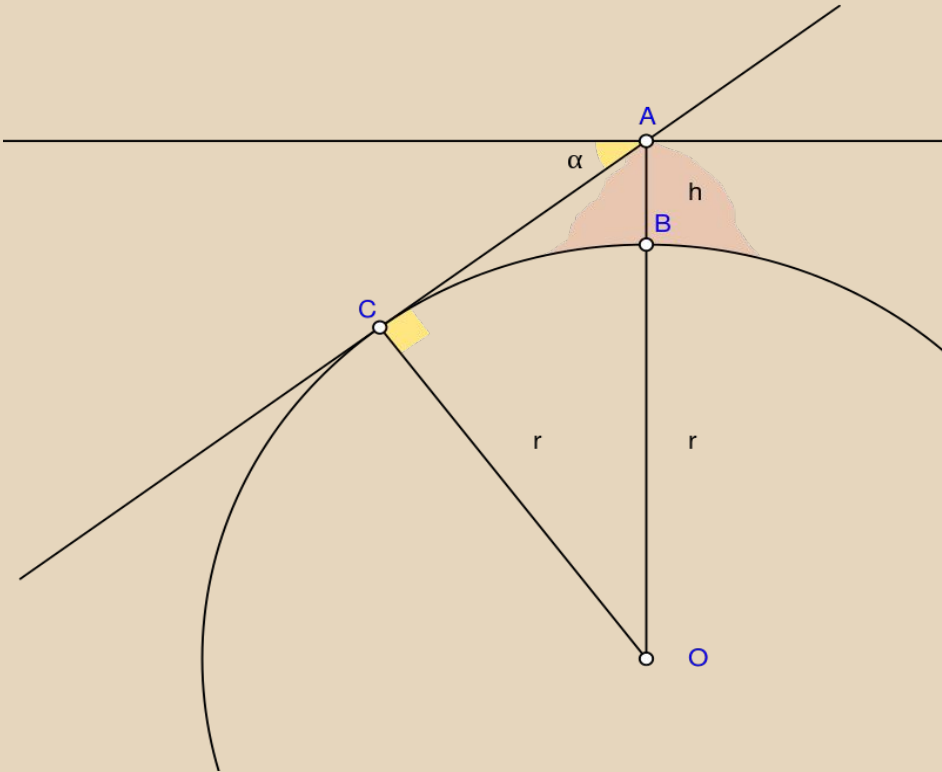
One of Al-Biruni's methods to calculate the Earth's size. Using trigonometry, he calculated the radius of the Earth by using the height of a hill and the dip in the horizon from the top of that hill. He was only off by about 2,000 miles.