



Ancient Astronomy

Topics: How did Greeks know the SHAPE and SIZE of the Earth, the DISTANCE to the Moon and the DISTANCE to the Sun. Why did the Greeks put the Sun at the centre of the Solar System 1700 years before Copernicus did?

Learning Goals

- **Reproduce experiments of Aristotle and Eratosthenes. Use geometry to explain how these experiments reveal the shape and size of the Earth, Moon and Sun and the distance to the Moon and Sun.**



ANCIENT ASTRONOMY

- *In the British Isles, stones were used to keep track of the Sun and Moon.* Stonehenge



ANCIENT ASTRONOMY

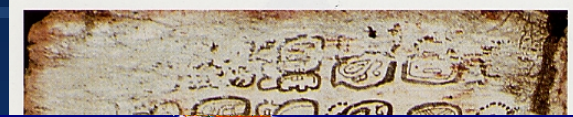
- *The Mayan culture was able to accurately predict solar and lunar eclipses.*

- *The Mayans also developed a very accurate calendar, later adopted by the Aztecs.*

Dresden Codex 11th C copy

of original 3-400 yrs earlier
Oldest known North American book.

This structure, called the Caracol at Chuzen Itza may have been used as a Venus Observatory



ANCIENT ASTRONOMY

- *The Mayan civilization 250 - 900 AD - southern Mexico, Guatemala, El Salvador*
- *Many parts to calendar - long count 52 years (life of a person) - longer running 5126 years began in 3114 BC (-3114 + 5126 = 2012!!)*
- *But Mayan culture not apocalyptic - just start of a new cycle*





EARLY GREEK ASTRONOMY

- *Shape of Earth (Aristotle circa 340 BC)*





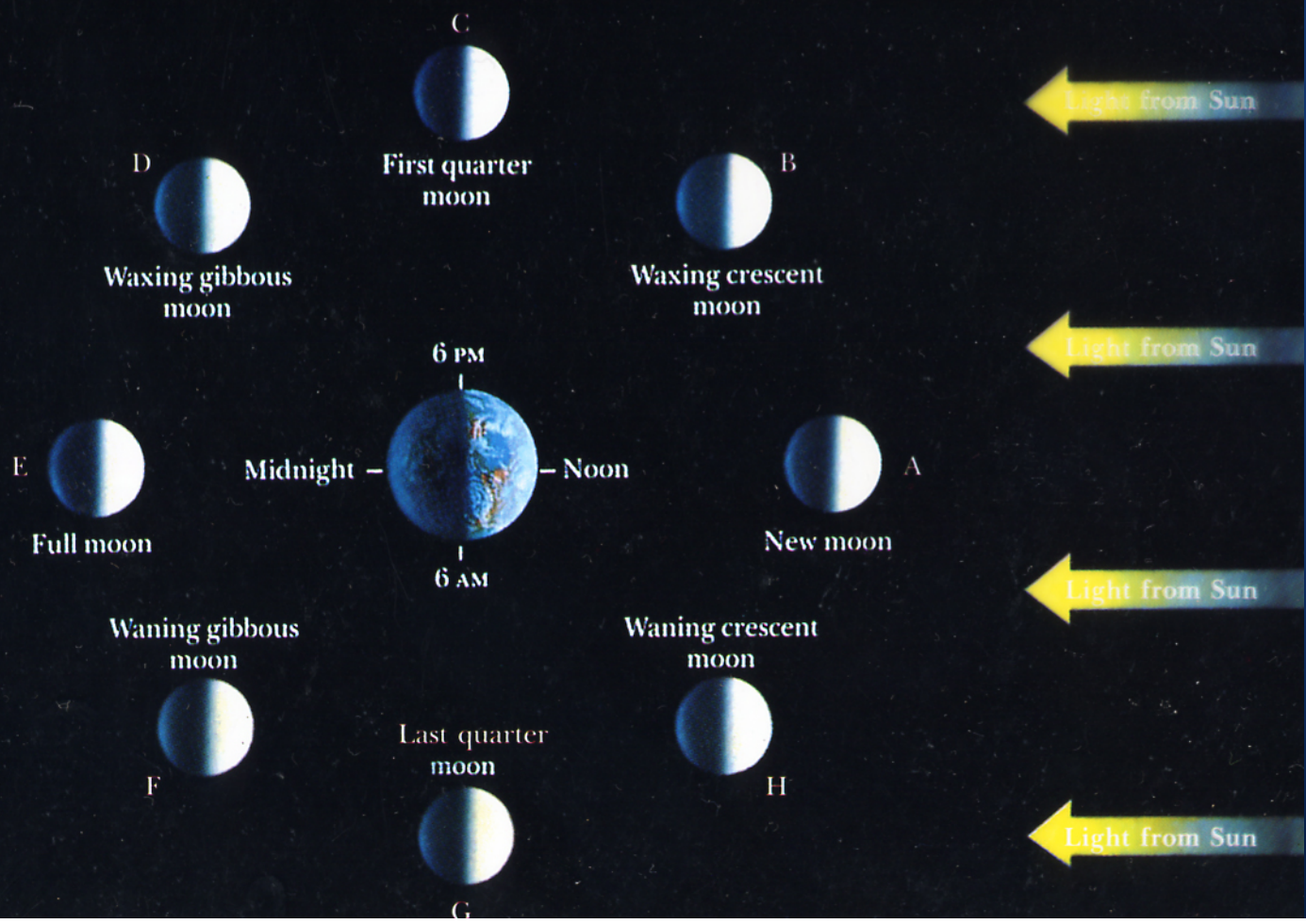
PHASES of the MOON





PHASES of the MOON

Views of the Moon as seen from Earth



Earth goes through phases as seen from Moon





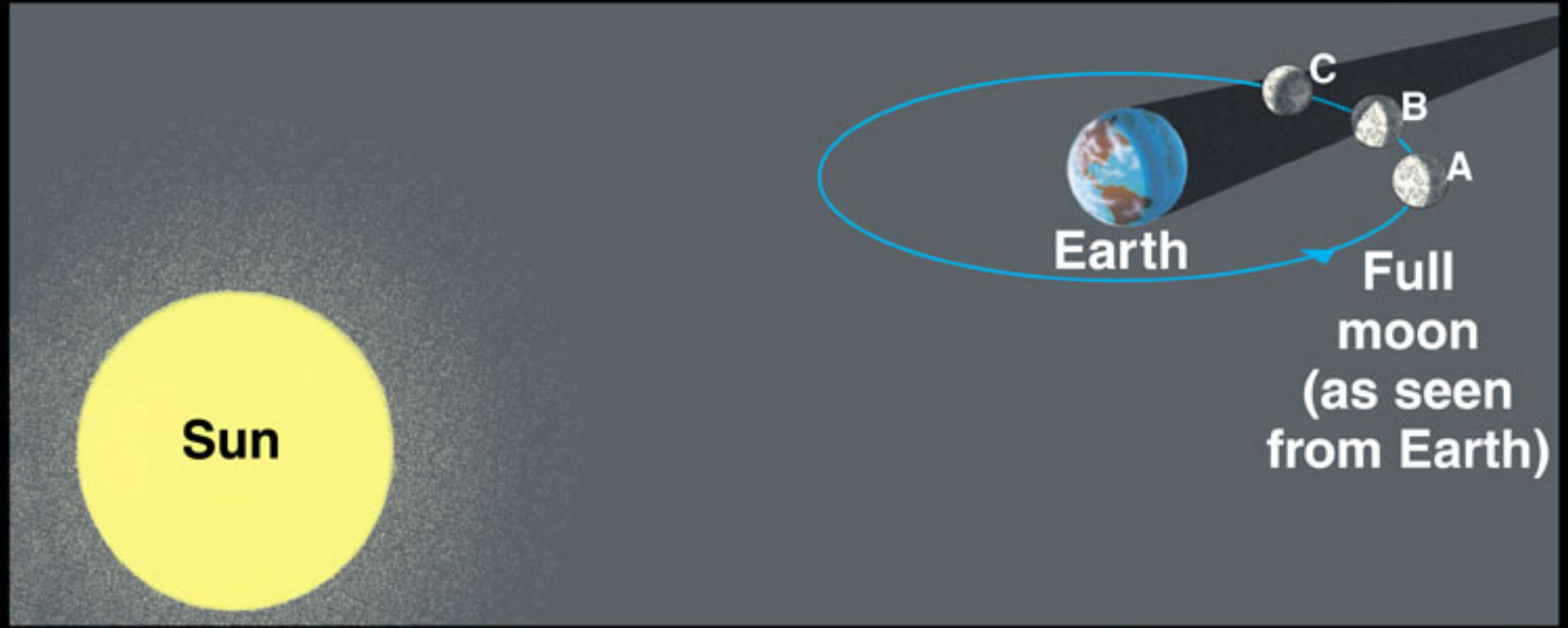
LUNAR ECLIPSE







LUNAR ECLIPSE GEOMETRY





LUNAR ECLIPSE





LUNAR ECLIPSE

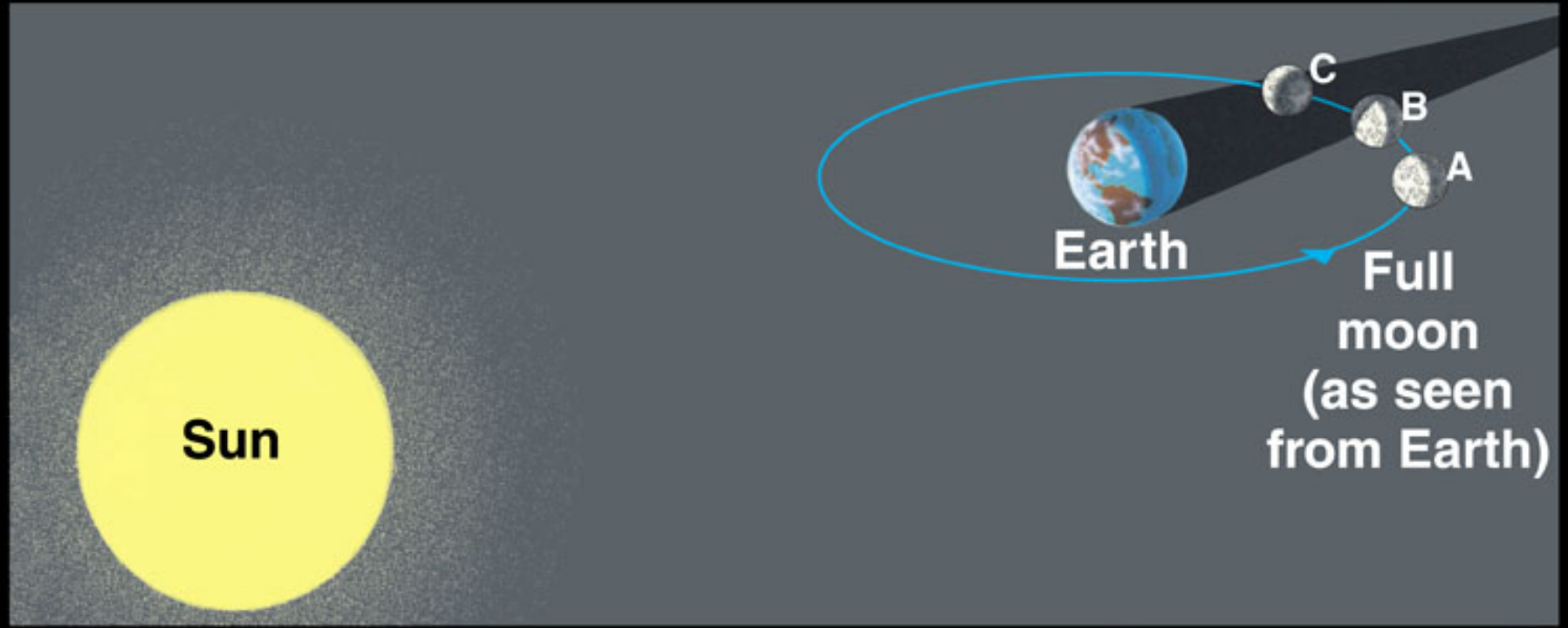
Gives relative size of
Earth and Moon
Earth ~3x size Moon

Known to the Greeks
Aristotle 340 BC

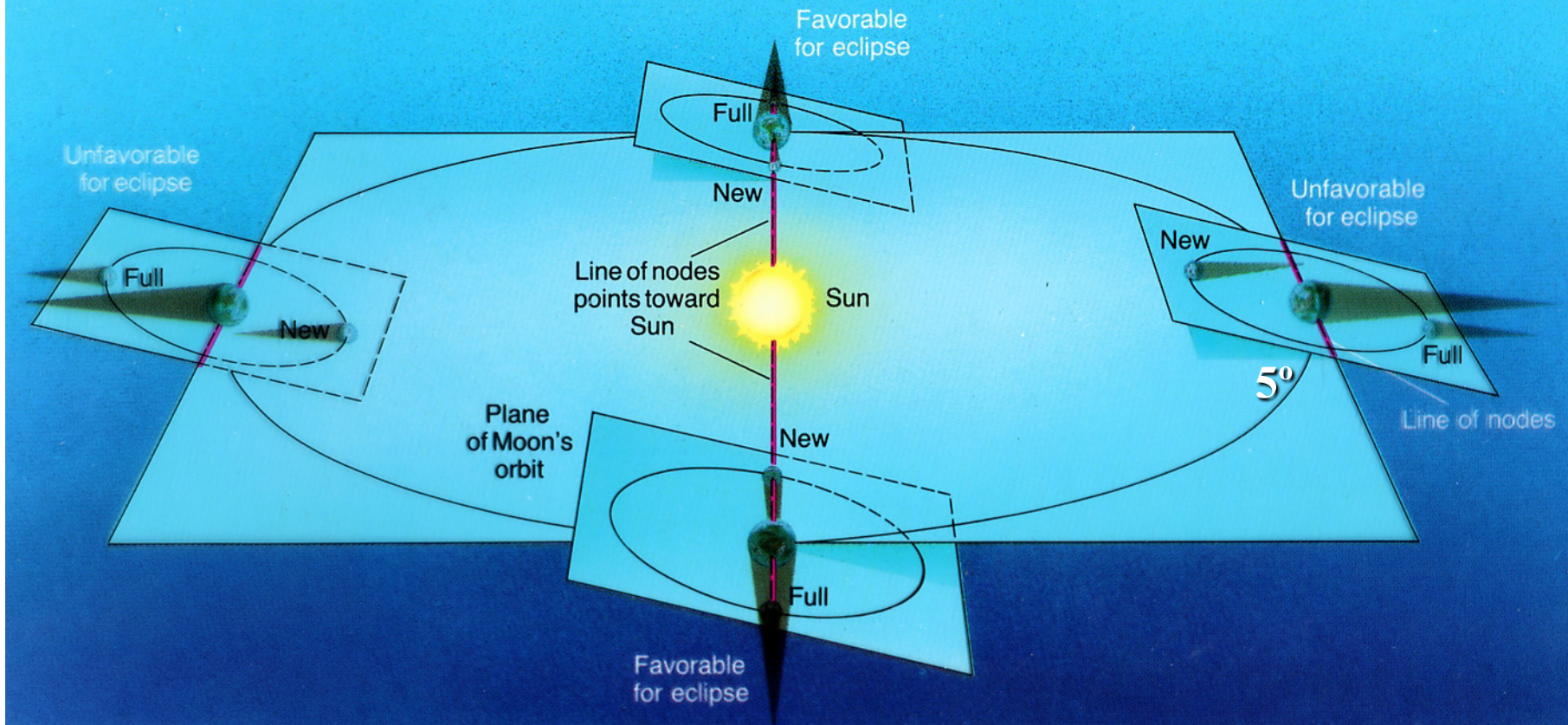




LUNAR ECLIPSE GEOMETRY

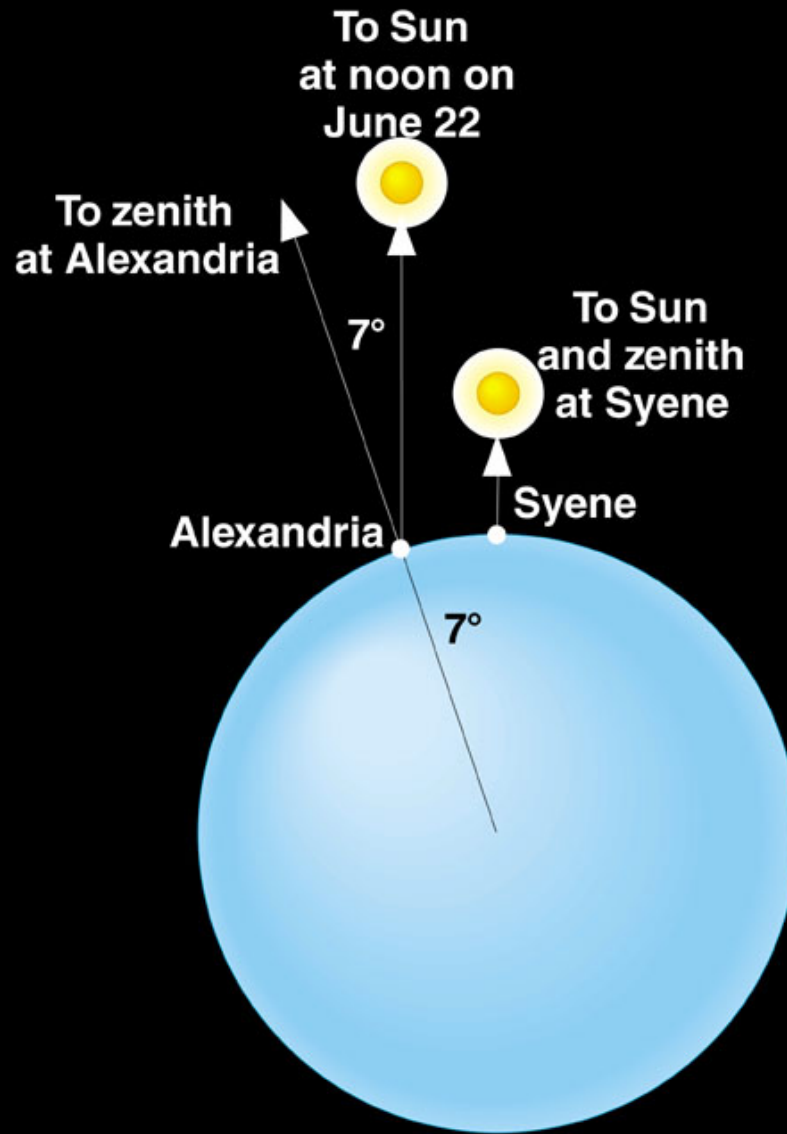


ECLIPSE GEOMETRY



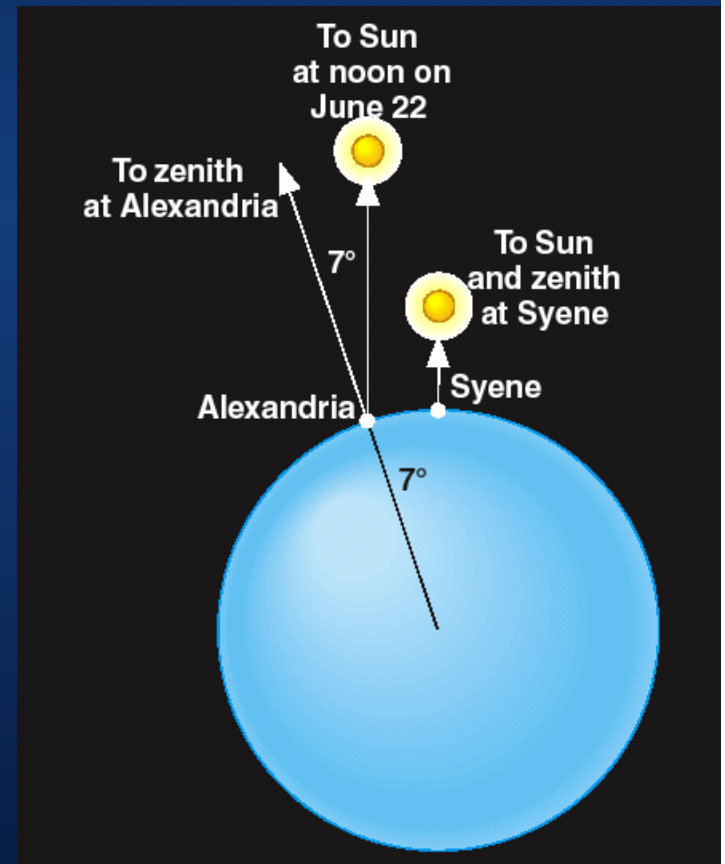


Size Earth: Erastothenes' Method



Size Earth

- *Shape of Earth (circa 340 BC)*
- *Size of Earth (Erastosthenes circa 200 BC)*
- $7/360 = AS/\text{Circumference}$
- *Stadium Roman Unit 158 m*
- $AS = (5000 \text{ Stadia}) 790 \text{ km}$
- *Circumference = 40,600 km*
- *Knowing π (Circumf / Diam.)*
- *Radius = 6470 (6370) km*



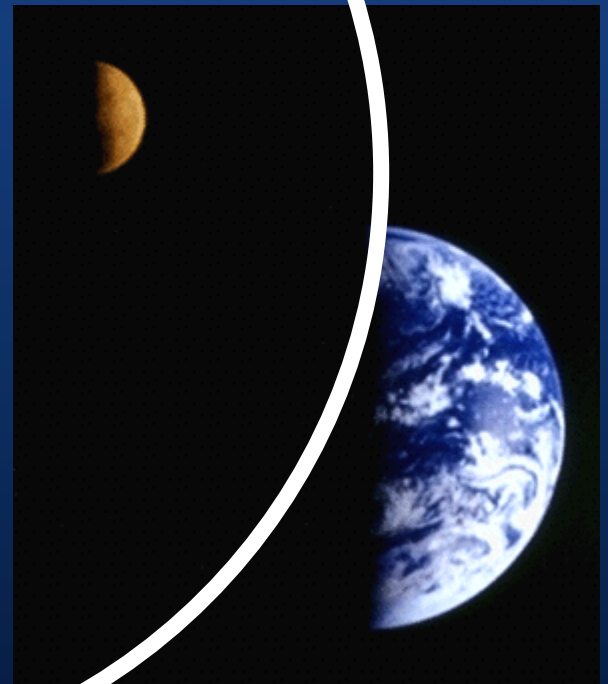
Discussion Question

Why is it important that the experiment be done simultaneously at two sites that are more or less north-south?



EARLY GREEK ASTRONOMY

- *Shape of Earth (circa 340 BC)*
- *Size of Earth (Erasthones circa 200 BC)*
- *Relative Size of Earth and the Moon from eclipse (Aristarchus circa 280 BC) – M/E measured 0.38*
- *Correct answer M/E = 0.27*





Aristarchus' Calculations on Relative Sizes Sun, Earth, Moon (10th C Greek copy)

ἄβρι φ βρά αὐτὸν ἡλιὸν καὶ τὸν φ βρῆται τα αἰρω τῆσδε ἀμῆρου τοῦ
διορίζουτος βυτῆ σφαιρῆ τὸ π σίμ βρογ καὶ τὸ λαμπροῦ τῆσδε
ἀμῆρου τῆσ σφαιρῆσ βλαστωρ μβρ βίτη η β μά ζορ αὐδθρογορ ἄδ
ἡ ὄρ ται π η πρὸ σ με: ρ

ὁρ αὐτωρ ὑποκῆ μβρ αὐ μχθασ αππο το υ ἄ τ η α β πρὸ σ ορ θασ ἡ
π ἄρ μάσοσ τῆ ζ η τῆσ διαμέτρου τὸν ἡλιὸν βλαστωρ μβρ βίτη η θ
μβροσ μά ζορ αὐδθρογορ ἄδ πρὸ σ αὐτῆ ἡ ὄρ ται ι ε πρὸ σ αὐτῆσ.



EARLY GREEK ASTRONOMY

- *Shape of Earth (circa 340 BC)*
- *Size of Earth (Erastheneas circa 200 BC)*
- *Relative Size of Earth and the Moon (Aristarchus circa 280 BC)*
- *Size of the Moon, Distance to the Moon*
- *Radius = 1730 km (modern number 0.27 Earth)*
- *Distance = 380,000 km – from size and angular size*
- *(angular size = true size / distance)*

Earth



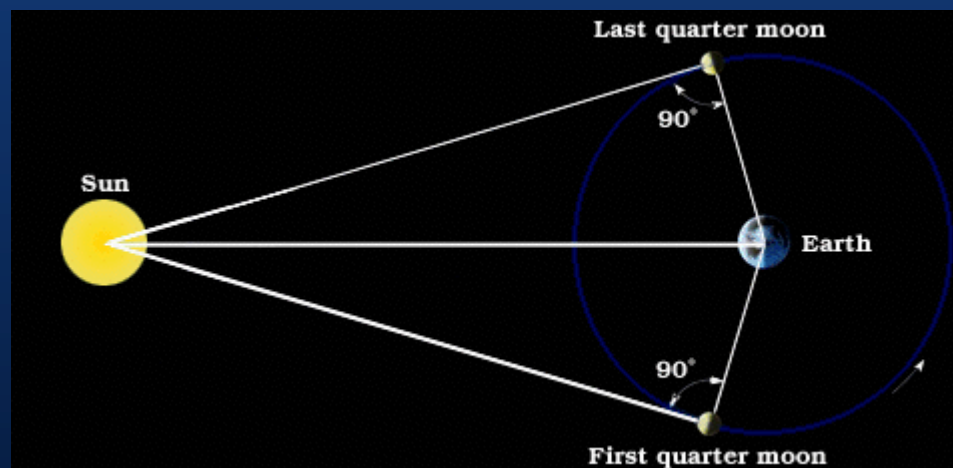
Moon





EARLY GREEK ASTRONOMY

- *Shape of Earth (circa 340 BC)*
- *Size of Earth (Erasthones circa 200 BC)*
- *Relative Size of Earth and the Moon (Aristarchus circa 280 BC)*
- *Size of the Moon, Distance to the Moon*
- *Distance to the Sun*





HELIOCENTRIC SOLAR SYSTEM

- *Greek Argument that the Sun is at the Centre of the Solar System*
 - *Sun is much farther from Earth than the Moon*
 - *Since the Sun and Moon have the same angular size, diameter Sun much larger than Moon*
 - *Earth is only 3 times larger than the Moon, thus the Sun is much larger than Earth*
 - *Thus, the Sun is much more massive than Earth (assumes both made of same material)*
 - *∴ Greeks concluded Sun is at centre of the system (circa 200 BC) - 1700 years before Copernicus.*