Earth's Shape



I. Evidence of Earth's Spherical Shape





A.Two millennia ago Greek mathematicians determined Earth's shape was <u>spherical</u>

1. Aristarchus (310 B.C. to 210 B.C.)



- a. Believed in **Sun-centered** universe.
- b. Attempted to determine the size of the Sun and Moon and distances to them.

2. Eratosthenes (274 B.C. to 195 B.C)

With h and s known.



- a. Calculated Earth's circumference.
- b. Evidence of <u>spherical</u> shape
- you can solve for 8. With Bknown. you can use the equation: (360°/**9** x (s) to measure the circumference of the Earth
- (1) On the summer solstice at noon, the Sun's altitude is <u>not the same</u> at two locations on the same meridian of longitude.
- (2) Can be explained by a <u>round</u> Earth.

Eratosthenes

c. Measurements of <u>shadow angles</u> allowed for a mathematical calculation of circumference using geometric relationships.



B. Ships Sailing out to Sea



- a. Masts of ships are the <u>last</u> to disappear below the horizon.
- b. Caused by Earth's curvature.

Ships Gradually Disappear Below the Horizon



C. Sunlight at Sunset









1. As the Sun sets, the last sunlight is seen on <u>high</u> objects.

D. Lunar Eclipses



Earth's shadow is curved



E. Ferdinand Magellan's ships circumnavigated Earth in 1522.



- Only one of the five ships that set sail in 1519, the Victoria, completed the expedition
- Only 18 of the approximately 270 men returned.
- Magellan was killed in a battle in 1521 on the Philippine island of Cebu.

F. Photographs of Earth from Space



Earthrise from the Moon



Earth from Apollo



Earth and the Moon from the Galileo spacecraft

- 1. The **best** evidence for Earth's shape.
- 2. Clearly shown as being spherical.

II. <u>Earth's Shape is not a Perfect Sphere</u>

A. Earth's true shape is an oblate spheroid.



- 1. A perfect sphere's circumference is <u>the same</u> through the poles and equator.
- 2. Earth's Polar diameter (and circumference) is **slightly smaller** than at the equator.

Earth's "Out of Round" Shape isn't Noticeable



- at the equator which can't 3. As a result, Earth has a be seen by the naked eye.
- This is caused by Earth's 4.

Earth's "Out of Round" Shape isn't Noticeable



- 3. As a result, Earth has a _____at the equator which can't be seen by the naked eye.
- 4. This is caused by Earth's _____

Earth's "Out of Round" Shape isn't Noticeable





On the scale of the actual Earth photo and the drawing, Earth **appears** to be a perfect sphere.

- As a result, Earth has a <u>slight bulge</u> at the equator which can't 3. be seen by the naked eye.
- This is caused by Earth's rotation 4.

B. Evidence of Earth's True Shape

1. Gravity Measurements



- (1) Objects are attracted towards Earth's <u>center of mass</u>.
- (2) The direction of this force would always be <u>vertical</u> at every location on a perfectly spherical Earth.
- (3) Actual measurements show that the direction of the force of gravity is <u>not vertical</u> at every point

b. Magnitude of Gravity Measurements

- The force of gravity should be <u>the same</u> at every location on a perfectly spherical Earth.
- (2) Actual measurements show that the force of gravity is <u>greater</u> at the poles than at the equator (factoring out the effect of elevation).



Gravitometer to measure gravity

- (a) According to Newton's Universal Law of Gravitation, the factor affecting force must be a change in <u>distance</u>.
- (b) As distance decreases, force <u>increases</u>.
- (c) As a result, the greater force at the poles is the result of a <u>shorter</u> distance to Earth's center of mass, indicating a smaller polar diameter





(d) Since weight is the effect of gravity on a mass, a person's weight is slightly <u>less</u> at the equator than at the poles

2. The Altitude of Polaris



Finding Polaris using the Big Dipper's Pointer Stars



a. The altitude to Polaris is equal to the observer's latitude.



b. Precise measurements show that the altitude is slightly different than the latitude because Earth isn't perfectly spherical.