MEASURING THE EARTH

A) The shape of the Earth:
   a) An oblate spheroid (flattened sphere)
   b) Flattened at poles
      1) polar circumference 40,008 km
      2) polar diameter 12,714 km
   c) Bulging at the equator
      1) equatorial circumference 40,076 km
      2) equatorial diameter 12,757 km
   d) From space the Earth appears to be a perfect sphere

B) Evidence for Earth's shape (ROUND vs FLAT)
   a) Photographs of the Earth from space or the moon (this is the best evidence because it’s a direct observation).
   b) Earth's shadow seen on moon during eclipse.
   c) Ships disappear over horizon bottom first.
   d) Altitude of polaris varies with latitude.
   e) Angle of noon sun varies with latitude.

C) Evidence for Earth's shape (OBLATE SPHEROID)
   a) Gravitational measurements:
      1) stronger at poles (closer to center)
      2) weaker at equator (further from center)
   b) Altitude of polaris does not match latitude. Moving 1° north or south on the earth’s surface does not always result in a change of exactly 1° in the altitude of Polaris. If the earth was perfectly round this slight difference would not occur.

D) Determination of circumference
   a) Eratothenes experiment
      1) Get angle of noon sun at 2 locations on the same meridian (N-S line)
      2) Find difference between 2 angles
      3) Get distance between 2 locations
      4) Divide difference into 360
      5) Multiply result by the distance = Circumf.

\[
\text{Circumference} = \frac{360}{(\text{Angle 2}) - (\text{Angle 1})} \times \text{Distance}
\]

E) Diameter of the Earth
   a) \( D = 2r \)
   b) \( D = (2)(6.37 \times 10^3) \)
   c) \( D = 12.74 \times 10^3 \) or \( 1.274 \times 10^4 \)

F) Hydrosphere
a) Water (salt and fresh) covering 70% of the Earth  
  b) Averages 3.5 - 4.0 km in depth  
  c) Oceans represent <1% of thickness of Earth

G) Atmosphere  
  a) Gas envelope surrounding Earth  
  b) 78% nitrogen, 21% oxygen, 1% other  
  c) Extends to approx. 150 km.  
  d) Layers:  
     1) Troposphere (0 to 12 km)  
     2) Stratosphere (12 to 50 km)  
     3) Mesosphere (50 to 82 km)  
     4) Thermosphere (82+ km)  
  e) Interfaces between layers are "pauses"  
     1) Tropopause  
     2) Stratopause  
     3) Mesopause

H) Lithosphere  
  a) Solid, rocky, outer shell of the Earth. (Covered by regolith, the loose rock & soil)  
  b) Averages 20-25 km.  
  c) Thicker under continents - thinner under oceans.

POSITIONS ON THE EARTH

A) Coordinate system (grid)  
  a) Latitude (aka parallels)  
     1) Measured in degrees/minutes  
     2) 60 minutes = 1 degree  
     3) Run east-west  
     4) Change north-south  
     5) Maximum latitude = 90˚E (N or S poles)  
     6) Minimum latitude = 0˚E (equator)  
     7) Size of a degree varies with latitude due to shape of the Earth  
     8) Altitude of Polaris = latitude (N only)  
  b) Determination of latitude  
     1) Draw line to horizon  
     2) Draw line to Polaris  
     3) Angle formed by these lines is the latitude  
     4) Applies to Northern hemisphere only
c) Longitude (aka meridians)
   1) Measured in degrees/minutes
   2) Run North-south connecting poles
   3) Change north-south
   4) Prime meridian (0°E) through Greenwich Eng.
   5) Time changes 1 hour per 15°E long. change
   6) West = earlier / East = later

B) Fields
   a) Region of space w/measureable values
      1) Examples: elevation/temperature/pressure
   b) Scalar fields
      1) Values have magnitude only
      2) Examples: elevation/temperature/pressure
   c) Vector fields
      1) Values have magnitude and direction
      2) Examples: Wind/magnetic fields

C) Gradient (aka slope, rate of change)

\[
\text{gradient} = \frac{\text{change in field value between 2 points}}{\text{change in distance between 2 points}}
\]

D) Isolines
   a) Lines on a map connecting points of equal value
   b) Special isolines:
      1) Isotherms - equal temperature
      2) Isobars - equal atmospheric pressure
      3) Contour lines - equal elevation
         c) Interval - value difference between adjacent lines
         d) Index isoline - marked with its value
         e) Isolines interval small (close) = steep gradient
            Isoline interval large (far apart) = gentle slope
         f) Contour lines seem to point in opposite direction of stream flowing
            across them (point uphill)
         g) Sea level = 0 elevation
         h) Contour lines w/hatch marks = slope downward
         i) Max elevation is a value higher than the highest contour line but less
            than the next WOULD be.

E) Map legend
   a) Gives distance scale (km and/or miles)
   b) Key to symbols of man-made and natural features
   c) Indicates direction