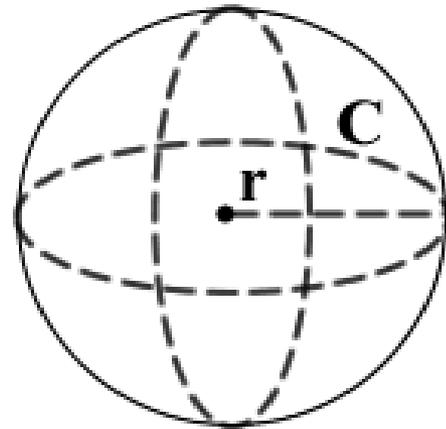


How do we describe a location on
Earth?



Geodetic reference system

How do we define the shape of the earth?



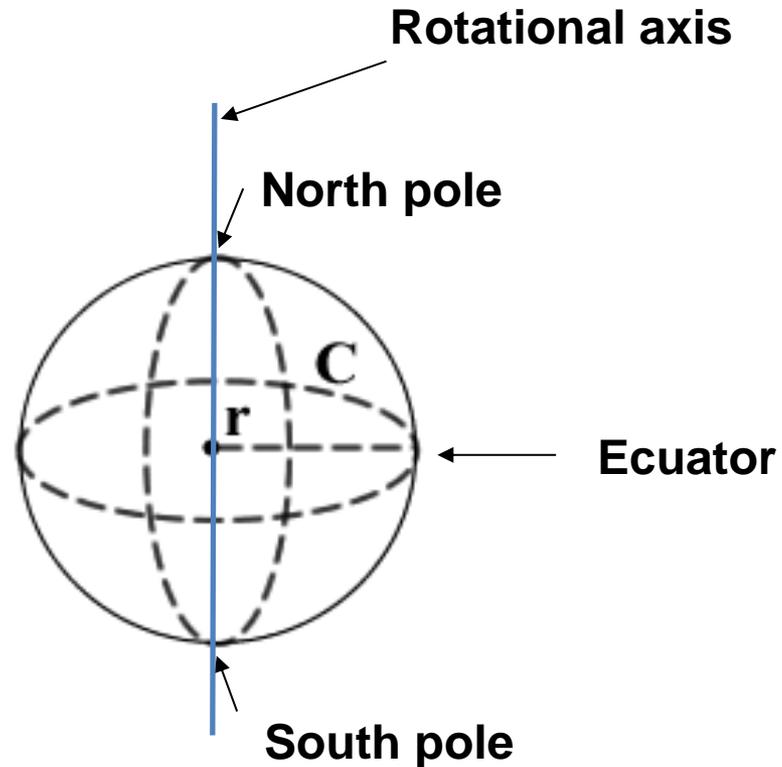
Definition of the sphere:

A three-dimensional surface, all points of which are equidistant from a fixed point.

The Earth as a sphere...

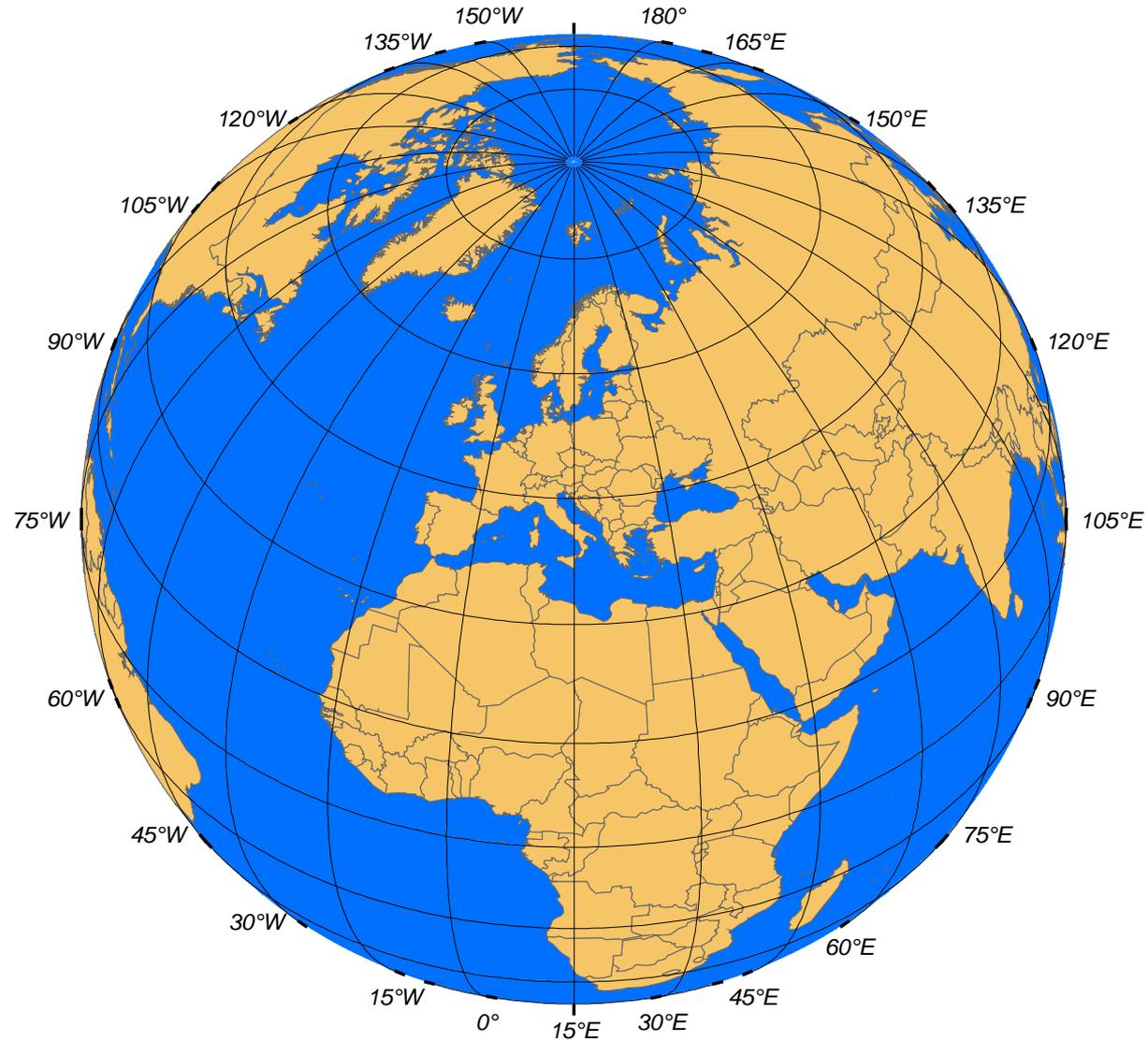
Poles =
ends of the earth's
rotational axis

Equator = an imaginary line
on the Earth's surface
equidistant from the north
pole and south pole



Spherical coordinate system

*Coordinates in latitude
and
longitude*



Points of known positions

= “stompunkter”



Coordinates in lat/lon

Elevation (above the ellipsoid)

Go to www.menti.com and use the code 53 95 20

 Mentimeter

What is the min./max. value of a latitude?

0	0	0	0
0 to 365 degrees	-90 to +90 degrees	-180 to + 180 degrees	0 to 90 degrees



Slide is not active

Activate

 0

Go to www.menti.com and use the code 53 95 20

Where is the latitude 0 degrees?

 Mentimeter

0	0	0
At the north pole	At the equator	At the south pole

 0

Go to www.menti.com and use the code 30 03 07

What is the min. /max. value of a longitude?

 Mentimeter

0%

0 to 365
degrees

0%

-90 to +90
degrees

0%

-180 to +180
degrees

0%

0 to 90
degrees



Slide is not active

Activate

 0

Go to www.menti.com and use the code 30 03 07

Where is the longitude 0 degrees?

 Mentimeter

0

At the north
pole

0

Along the
prime meridian

0

At the south
pole

 0

Parallels

= Imaginary lines running around the earth parallel to the Equator. The equator corresponds the great circle perpendicular to the Earth's axis, determining the division of the Earth in two hemispheres: North and South

5 major parallels:

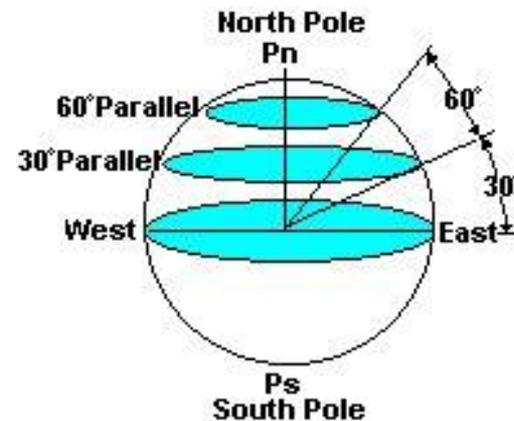
Arctic circle

Tropic of Cancer

The Equator, the 0° parallel →

Tropic of Caprion

Antarctic Circle

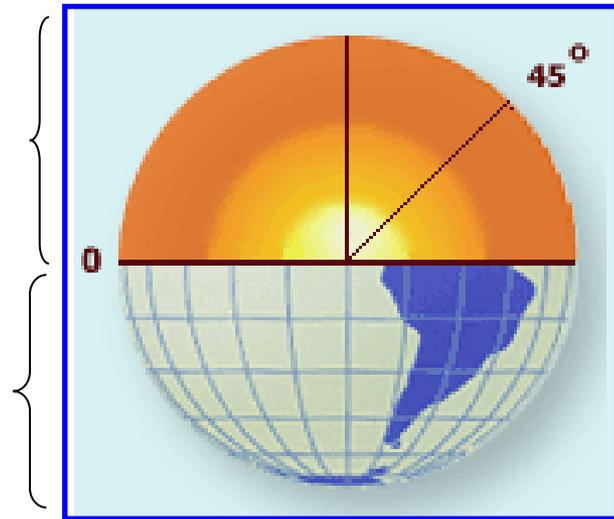


Latitudes

The latitude of a point on the Earth's surface is the angle between the plane of the equator and the straight line segment that joins the point to the center of the globe.

$0^{\circ} - 90^{\circ}$ N

$0^{\circ} - 90^{\circ}$ S



Note 1:

In computers, North is positive,
South is negative:

lat: $15^{\circ}\text{S} = -15^{\circ}$

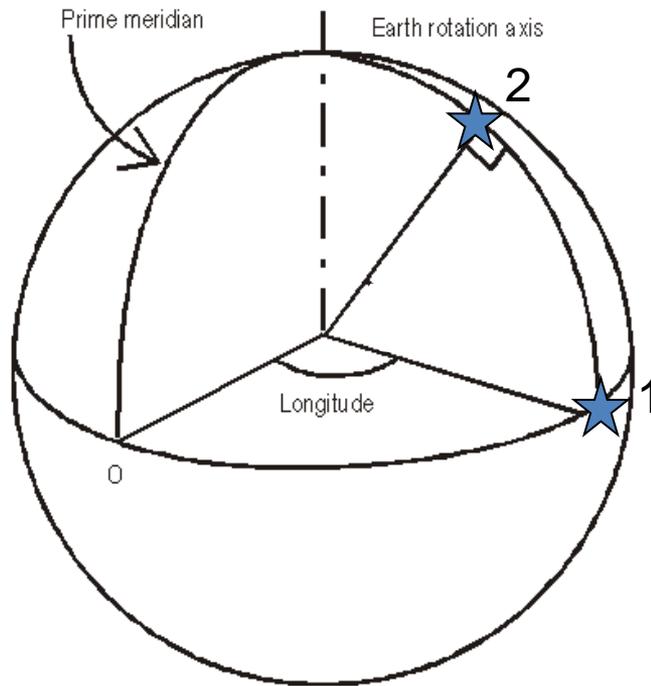
Note 2:

Always use N/S in written form:

lat/ 15°S , not -15°

Latitudes

→ gives the position in N-S direction

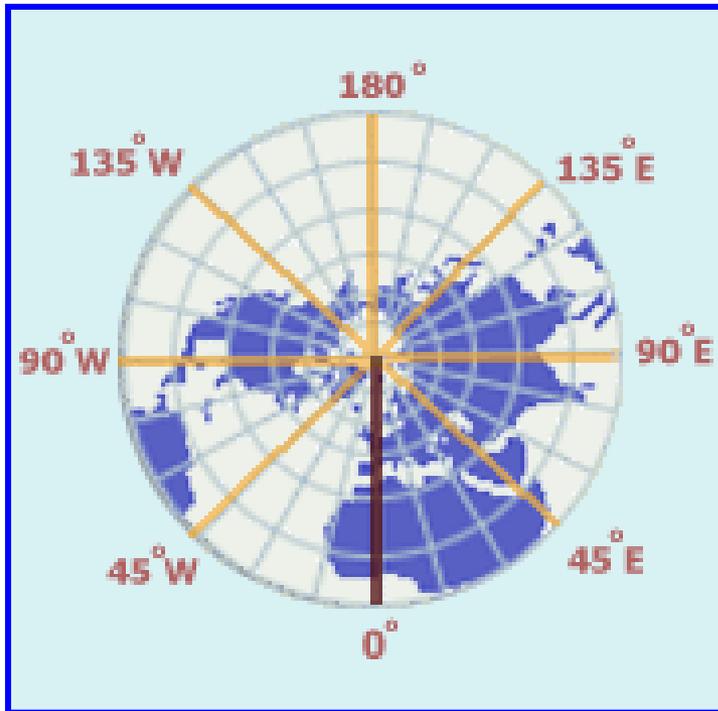


What is the approximate latitude of point 1?

How about point 2?

Meridians

= half of great circles that all come together at the North pole and South pole

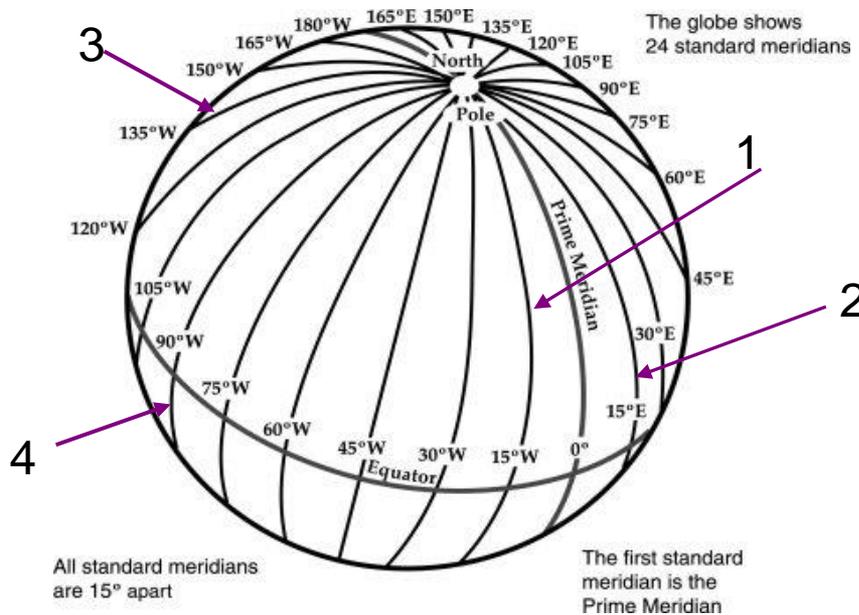


Prime meridian = 0 degrees,
passes through Greenwich

Ranges: 0-180 degrees W
0-180 degrees E

Longitudes

= The angle between the plane of the prime meridian and that of the meridian through a point. East-west direction.



Longitudes 1
= 15°W
2 = 15°E
3 = 135°W
4 = 90°W

Note!

In computers, West has negative values and East has positive values:

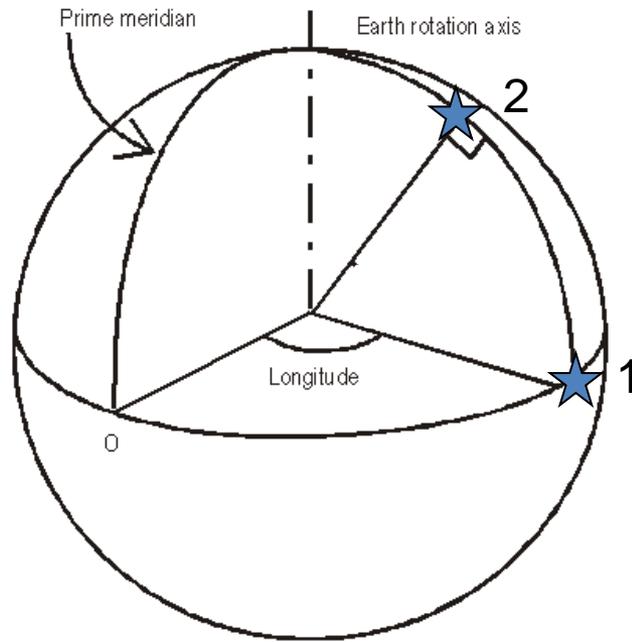
Lon: 15°W = -15°

Note 2:

Always use W/E in written form:

Lon/ 15°W, not ~~-15°~~

Longitudes → the position in E-W direction



What is the approximate longitude of point 1?

How about point 2?

Tachymeter/Tacheometer for distance and topography

= Instrument for fast measurements of distances and heights



Measurement method: Traverse

Traverse

= to estimate the coordinate pair of a point when you know:

- * angle
- * distance

...to a point with known coordinates.

Example:

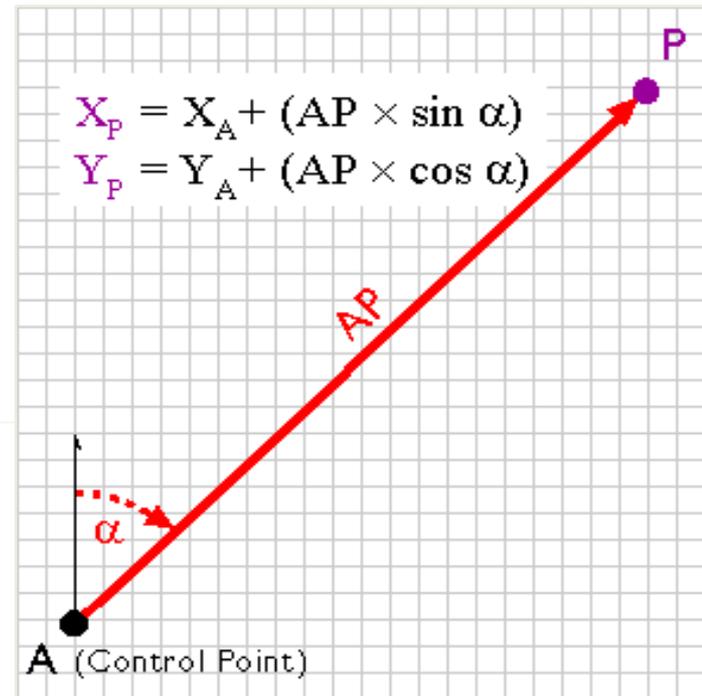
A (x, y) = 385951, 6174851

Distance AP = 2352 meters

$\alpha = 45^\circ$

$\rightarrow X_p = 385951 + (2352 * \sin 45) = 387952$

$\rightarrow Y_p = 6174851 + (2352 * \cos 45) = 6176087$



Measurement method: Traverse

Traverse

= to estimate the coordinate pair of a point when you know:

- * angle
- * distance

...to a point with known coordinates.

Example:

A (x, y) = 385951, 6174851

Distance AP = 2352 meters

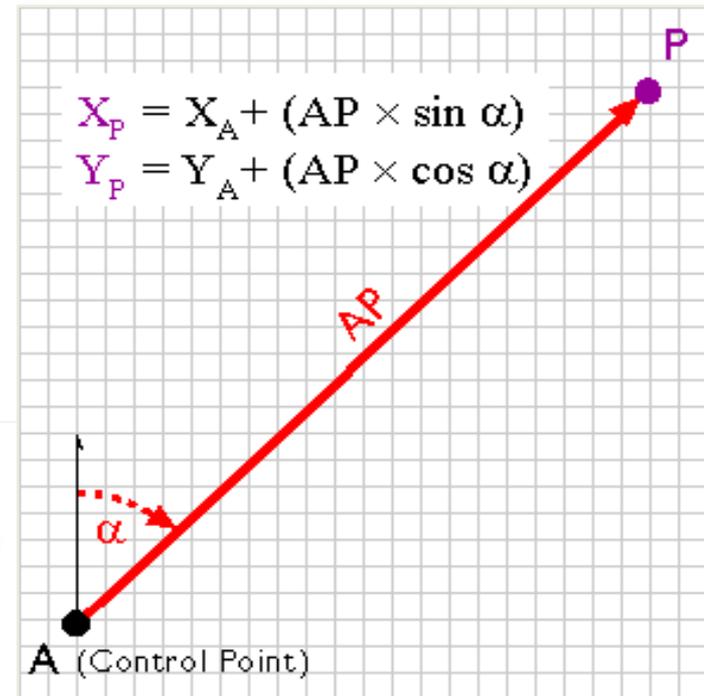
$\alpha = 45^\circ$

What are these numbers?



$$\rightarrow X_p = 385951 + (2352 * \sin 45) = 387952$$

$$\rightarrow Y_p = 6174851 + (2352 * \cos 45) = 6176087$$



Plain coordinate systems

- Unit = meters
- Swedish national reference system = SWEREF99

$X = 385951 \text{ m,}$

$Y = 6174851 \text{ m}$

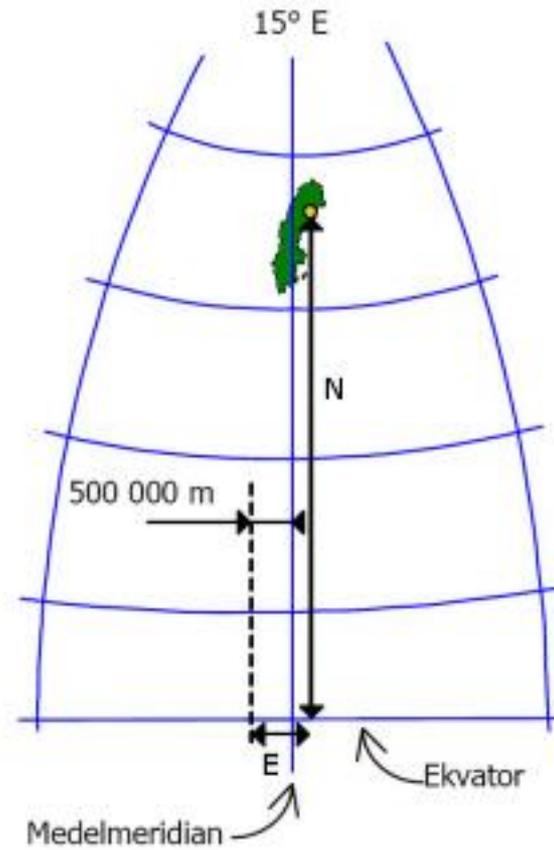


So where is 0 meters then?

What do the values mean?

- $55^{\circ}42' = 617416 \text{ m}$
- $13^{\circ}12' = 386877 \text{ m}$

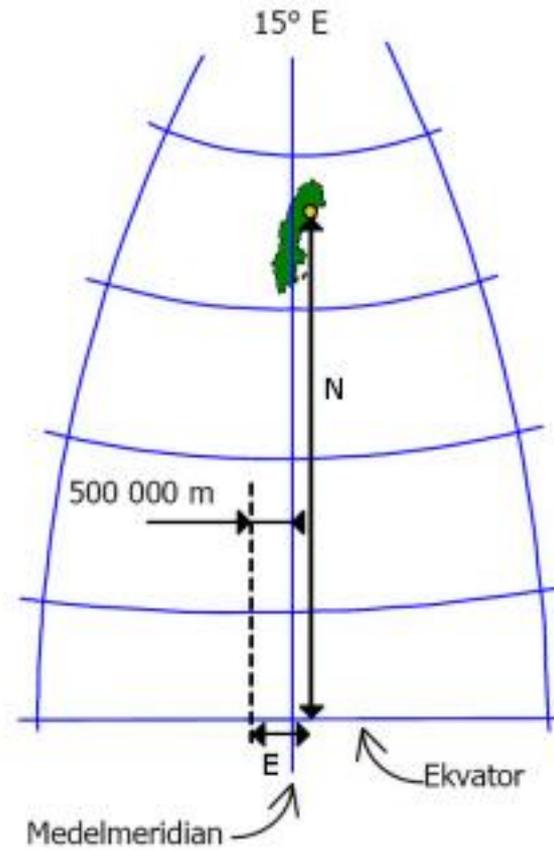
So where is 0 meters then?
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What do the values mean?

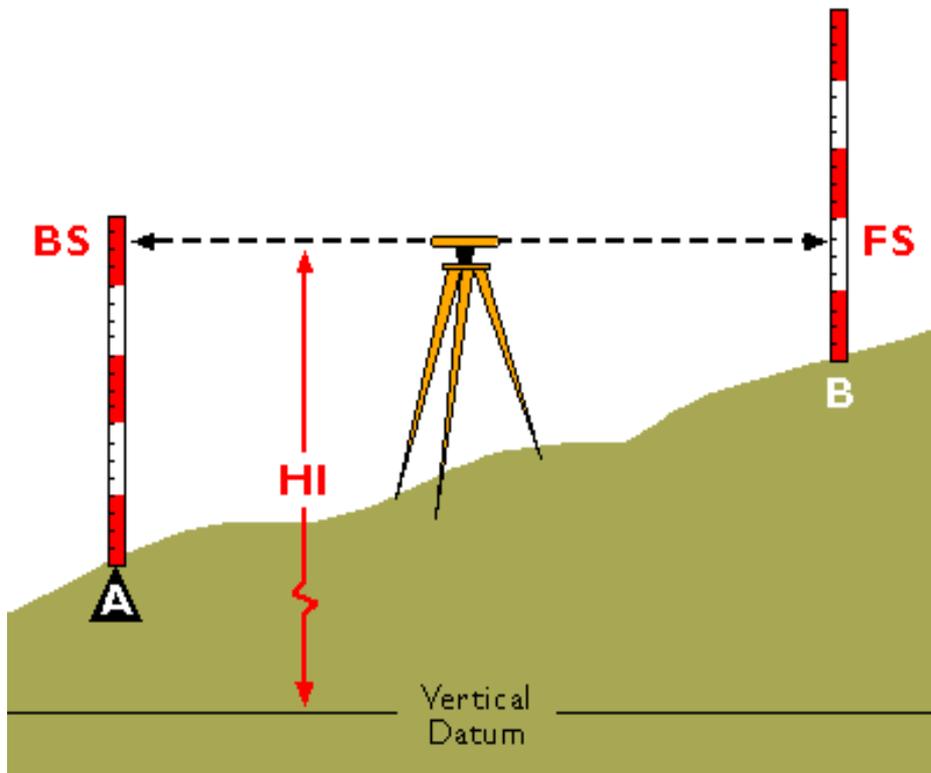
- $55^{\circ}42' = 617416 \text{ m}$
- $13^{\circ}12' = 386877 \text{ m}$

0 m (x) = meridian
in the Atlantic
= m (y) = the
equator



Ground meas. - Heights

Differential leveling



Point A = known height.
Point B = unknown.
Leveling instrument is placed between A and B.

1. Back sight measurement (BS) off of a leveling rod on A.

→ HI ($BS + \text{height at A}$)

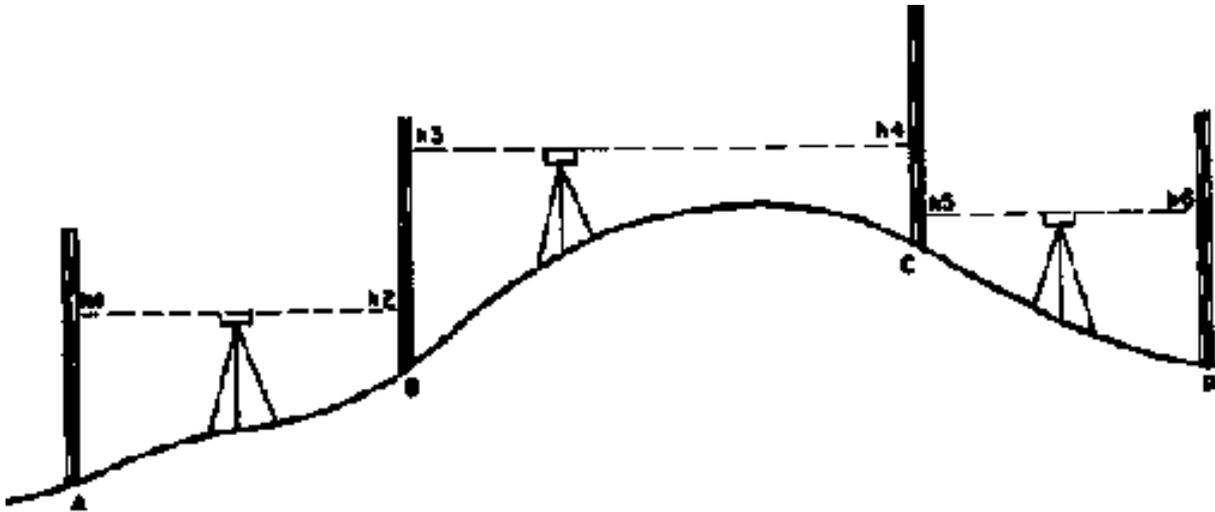
3. Rod is turned to point B.

4. Telescope rotated to measure fore sight height (FS).

5. Height at B = $HI - FS$.



Levelling work on long distances...

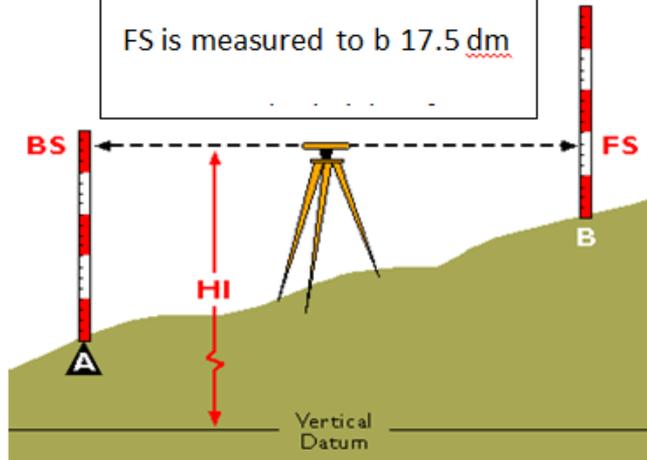


Quiz

The height at A = 57 m

BS is measured to be 45 dm

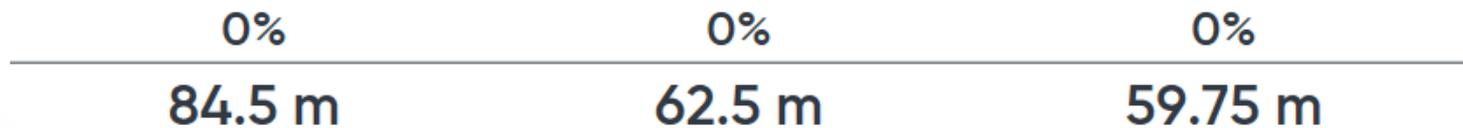
FS is measured to be 17.5 dm



Go to www.menti.com and use the code **11 81 44**

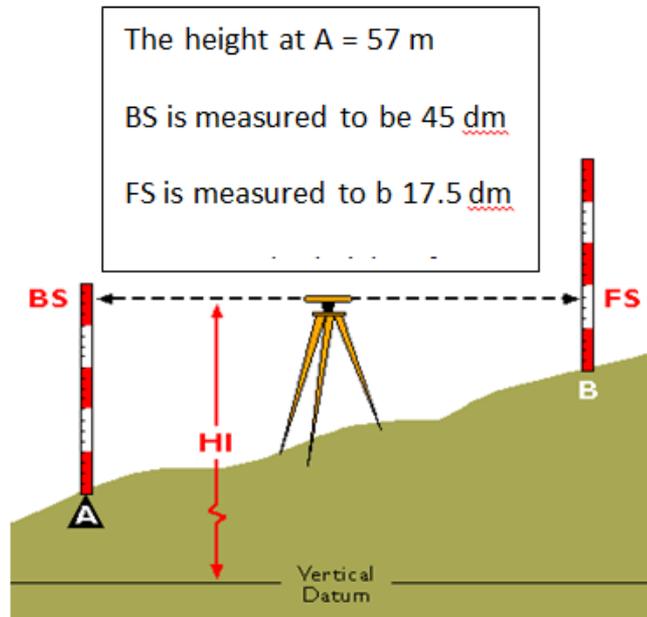
What is the height at B?

 Mentimeter



 0

Solution to question 2



Solution:

$$\text{HI (height of instrument)} = A + \text{BS} \rightarrow 57 + 4.5 = 61.5$$

$$\text{FS} = 1.75$$

$$B = \text{HI} - \text{FS} \rightarrow B = 61.5 - 1.75 \rightarrow B = 59.75$$

Determine position from satellites

Navigation Satellite System

- GPS = Global Positioning System (USA)

Start: 1973/1978 (American defense dep.+ air force),

Officially: 1995.

Selective availability (SA) until: 2000. → 70 – 100 m error

Name: **Navigation Signal Timing and Ranging GPS (NAVSTAR)**

More at: <http://GPS.gov>.

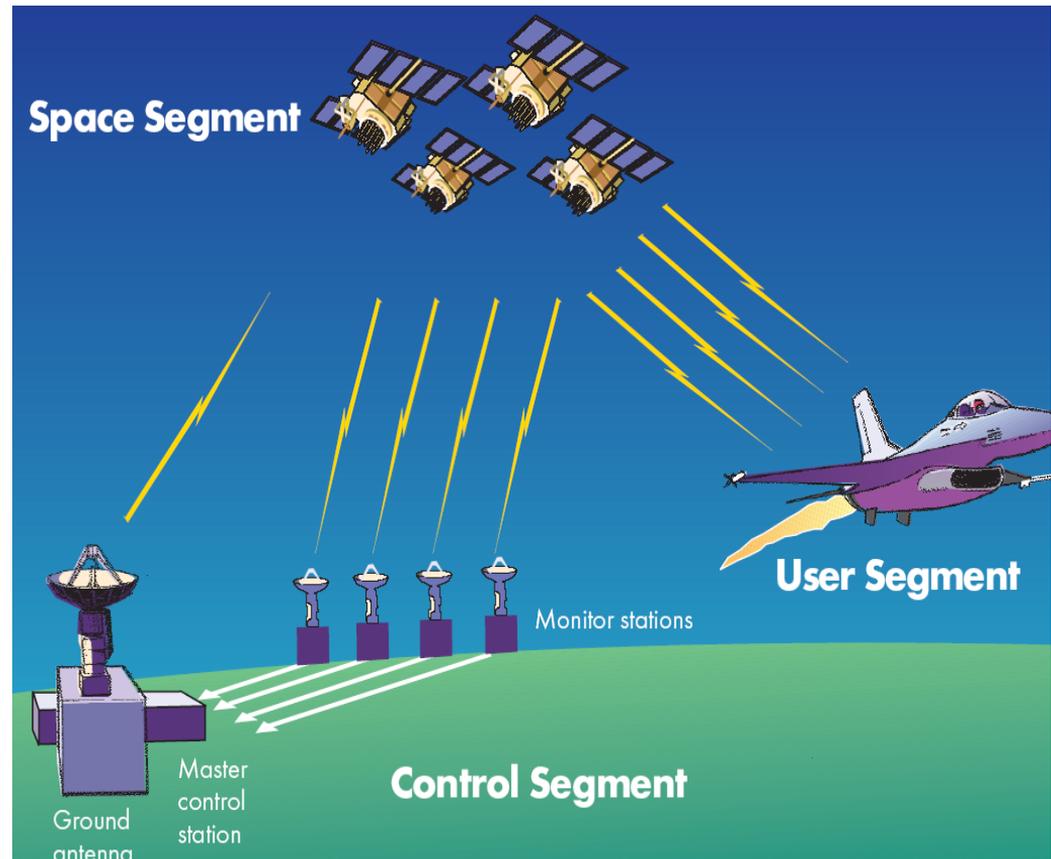
GPS

3 main segments:

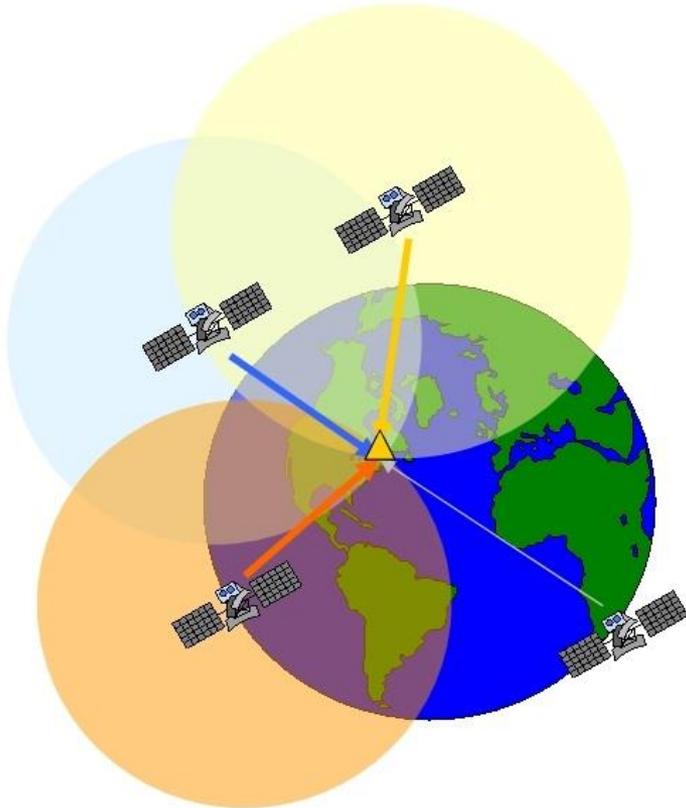
Space Segment
= constellation of satellites

Control Segment
= ground receivers

User segment
= the receivers



HOW DOES IT WORK?



Trilateration:

... the angles of a triangle can be determined if the lengths of all sides are known.

GPS extends this principle in 3 dimensions.

GPS receivers calculate distance as a function of time from satellite to receiver.

Distance = velocity * time