Latitude and longitude

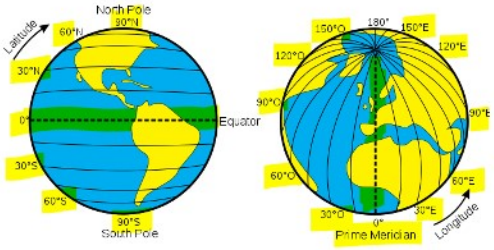
By the end of the lesson I would hope that you have an understanding and be able to apply to questions the following concepts:

- Know what a line of latitude is
- Know what a line of longitude is
- Know what a great circle is
- Know what a small circle is
- Know what a meridian is
- Know what a parallel is

RECAP

The work previously covered on arc lengths has a wonderful practical application.
The large spinning lump of rock we currently call home ... the Earth ... has all of the above and, without which, we wouldn't have GPS.

Now ... we can't see lines of latitude or longitude as they are something we, as humans, have come up with to give sense and order to our existence. But, if we could see them, we might see something like:



Latitude and Longitude: Remembering which is which

I will be honest and say that I struggle to remember which is which.
I'm the same with my left and right hand!

Latitude: Go horizontally around the globe
Longitude: Go vertically around the globe

Isn't a circle just a circle?

Well, not when Barry has been at it ...

In Further Maths and this section of work, we now have **Great Circles** and **Small Circles**.

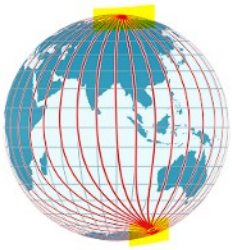
In other words, the equator is an example of a **Great Circle.**
All other lines of latitude are small circles.

A Great Circle is any circle which contains the diameter.

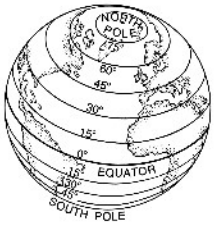
Meridians and Parallels

More language!

The **Meridian of longitude** are circles which pass through the North and South Pole.



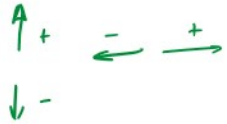
Parallels of latitude are small circles which are parallel to the equator.



Describing Latitude and Longitude

Here is an example of where latitude and longitude might be used:

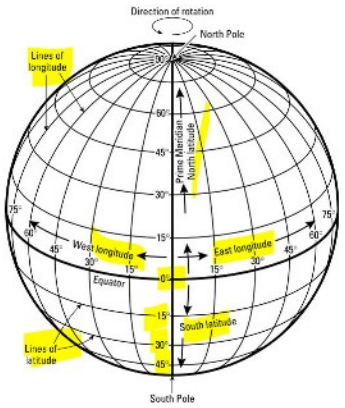
```
> whois -h whois.pwhois.org 4.2.2.1
IP: 4.2.2.1
Origin-AS: 3356
Prefix: 4.0.0.0/9
AS-Path: 3257 3356
AS-Org-Name: Level 3 Communications, LLC
Org-Name: Level 3 Communications, Inc.
Net-Name: LVLT-ORG-4-8
Cache-Date: 1240446962
Latitude: 39.913500
Longitude: -105.093000
City: BROOMFIELD
Region: COLORADO
Country: UNITED STATES
```



Notice that it's given as a decimal number.
What seems to be missing is the degrees sign (°)

Latitudes and longitudes are given as an angle.
The angle is given relative to a fixed point on earth.

Latitudes are given as an angle with respect to the equator.
Longitudes are given as an angle with respect to the Prime Meridian (a line through Greenwich in the UK)



They can be given in two different ways (shown below) but they are always written as **latitude** and then **longitude**.

N E
S W

27.345°S, 60.34°E

27.345°, 60.34°

The first example uses North and South for latitude and East and West for longitude.

The second example uses positive and negative signs to denote being above or below the equator and to the left or right of the prime meridian.

Important points (and references) and information

The following are important points to make a note of:

- The equator has latitude 0°N.
- The North Pole has latitude 90°N.
- The South Pole has latitude 90°S.

- The prime meridian has longitude 0°E.

The radius of the Earth is needed (and is assumed to be constant).

- 6400 Km

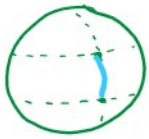
Examples of how this is used

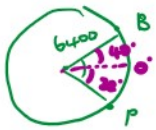
The following examples have been taken, with permission, from the Cambridge Further Mathematics Units 3 and 4 textbook.

L Lo L Lo

Beijing, China and Perth, Australia have coordinates (40°N, 116°E) and (32°S, 116°E) respectively. Calculate the shortest distance between Beijing and Perth, to the nearest kilometre, given that the Earth's radius is 6400 km. Give your answer to the nearest kilometre.

[Hint: Always draw a diagram]





$$\text{Arc} = \frac{72}{360} \times 2.\pi.6400$$

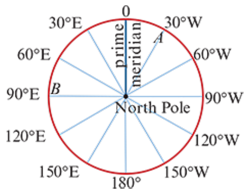
$$= 8042 \text{ KM}$$

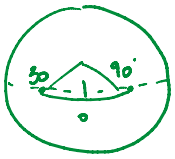
Point A has longitude 30°W and latitude 0°.

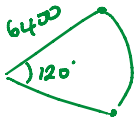
Point B has longitude 90°E and latitude 0°.

Find the distance between the two points.

Give your answer to the nearest kilometre.







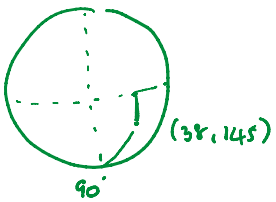
$$\text{Arc} = \frac{120}{360} \times 2.\pi.6400$$

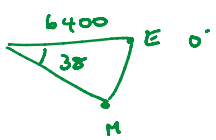
$$= 13\,404 \text{ km}$$

Melbourne has latitude 38°S and longitude 145°E. Find the distance of Melbourne to:

- the equator
- the South Pole
- the North Pole.

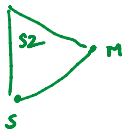
Give your answer to the nearest kilometre.





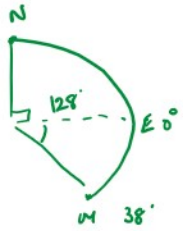
$$\text{Arc length} = \frac{38}{360} \times 2.\pi.6400$$

$$= 4\,245 \text{ km}$$



$$\text{Arc length} = \frac{52}{360} \times 2.\pi.6400$$

$$= 5808 \text{ km}$$



S

= 5808 km

Arc length = $\frac{128}{360} \times 2.\pi.6400$

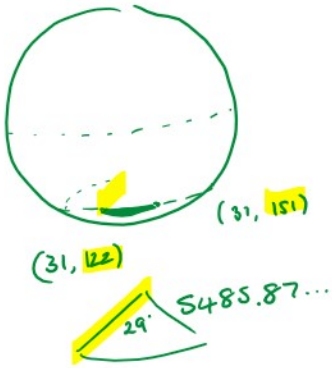
= 14 298 km

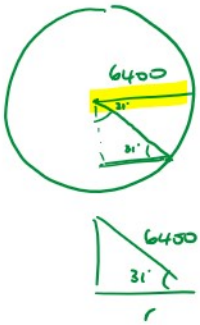
Something a little harder!

Kalgoorlie, WA (K) has latitude 31°S and longitude 122°E.

Tamworth, NSW (T) has latitude 31°S and longitude 151°E.

Find the distance along the parallel of latitude 31°S from Kalgoorlie to Tamworth. Give your answer to the nearest kilometre.





$\cos 31° = \frac{r}{6400}$

$r = \cos 31 \times 6400$

= 5485.87... km

equator

$r = \cos(\text{lat}) \times 6400$

$\therefore$ Arc = $\frac{29}{360} \times 2.\pi.5485.87...$

= 2777 km.