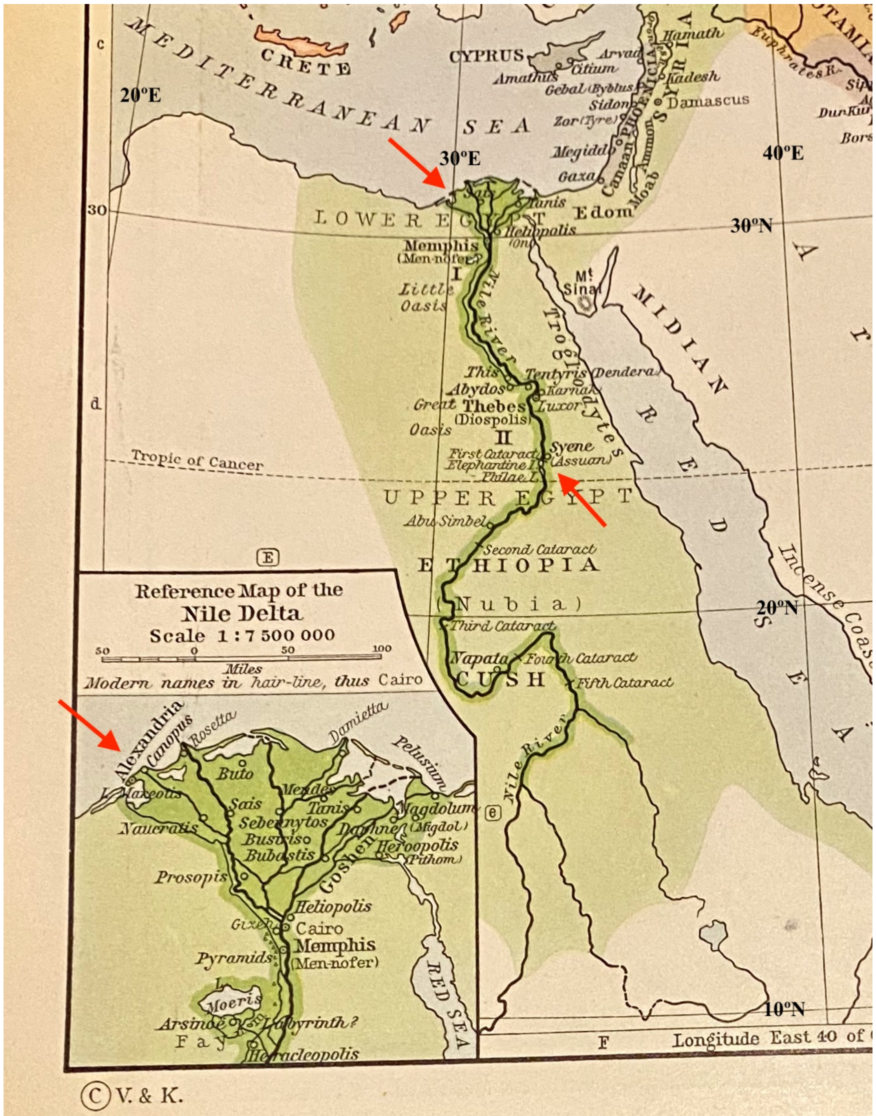
You can estimate the latitude and longitude of Alexandria and Syene to better than 1° using this historical map (of the Mediterranean and Middle East c. 1450 BC):



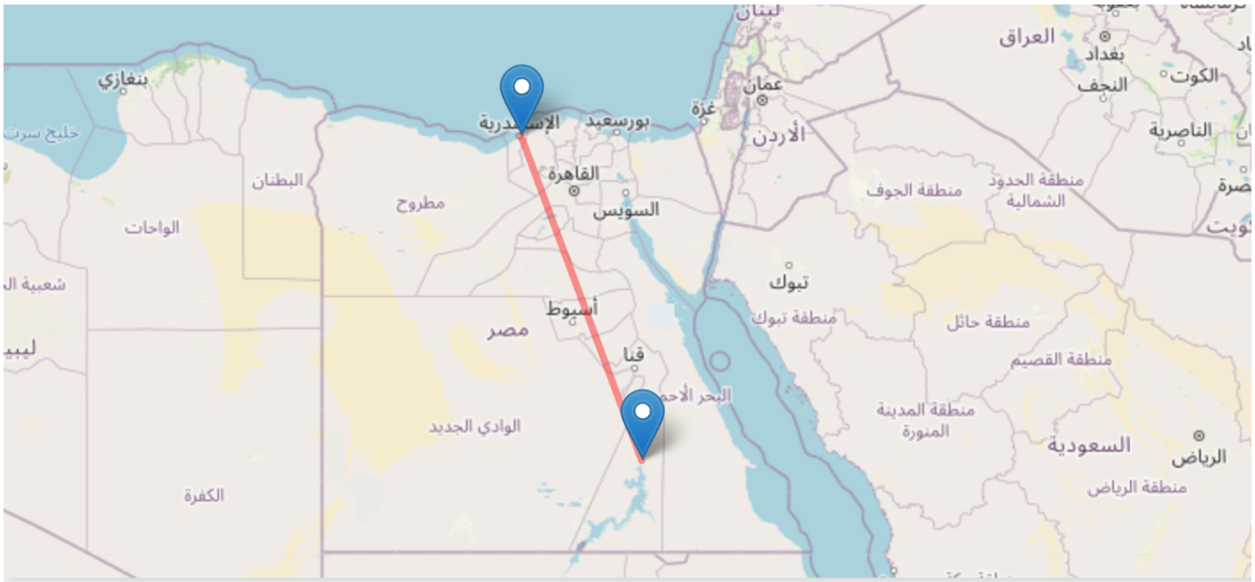
Or you can just look them up. Coordinates of Aswan (Syene):

Lat	24° 5' 20.1768" N
Long	32° 53' 59.3880" E

Coordinates of Alexandria:

Lat	31° 12' 20.7108" N
Long	29° 55' 28.2936" E

We can also look up the as-the-crow-flies distance between Aswan and Alexandria (but by the end of this course we will be able to calculate both the distance and the direction from the coordinates):



The air travel (bird fly) shortest **distance between Aswān and Alexandria is 841 km**

Finally, we need to know the “obliquity of the ecliptic.” That is the angle between the Earth’s axis and the Earth’s orbital plane around the Sun.

In the year 2000, it was 23° 26’ 21”. However it is slowly changing! In the year 0, it was about 23.7º.

What Van Brummelen is asking you to do in Problem 10(b) is to estimate the various sources of error in Eratosthenes’ calculation, and to compare it with the modern measured value.

Modern measured value:

The Earth bulges at the middle. If you measure the circumference at the equator, you get a different answer than if you measure the pole-to-pole distance.

The circumference using the pole-to-pole distance is 40,007.86km. Getting 40,000km for the answer (in other words, being off by only 8km) is incredible!

Estimate the sources of error in the calculation to convince yourself that such accuracy was essentially luck.

As one source of error to start with, compare the latitude of Aswan with the obliquity of the ecliptic. Does the Sun ever shine directly into the well at Aswan? How much is it off by, in degrees?

As a second source of error, what is the angle of the shadow of a gnomon (vertical pole) at Alexandria on the Solstice? Eratosthenes estimated that angle as 1/50 of a circle, which is 7.2º.