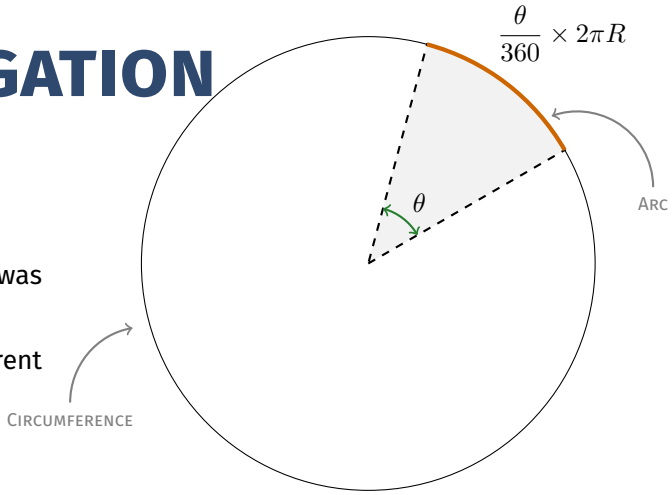
GEH1013

Basic Ocean Navigation



1 Length Along a Circle (Arc Length)

Eratosthenes' estimate of the Earth's circumference was based on:

(a) the length of the shadow cast by the Sun at different locations on the Earth, and

(b) the idea of the circumference of a circle.

So, lets first get to know 'the circle' better…

(1) If the radius of a circle is R how long is its circumference?

(2) A 'whole' circumference corresponds to 360°. What arc lengths corresponds to other angles?

Angle	$360°$	$180°$	$90°$	$45°$	$10°$	$1°$	$x°$
Length of Arc	$2\pi R$	πR		$\frac{1}{4}\pi R$		$\frac{1}{18}\pi R$	

2 The Size of the Earth

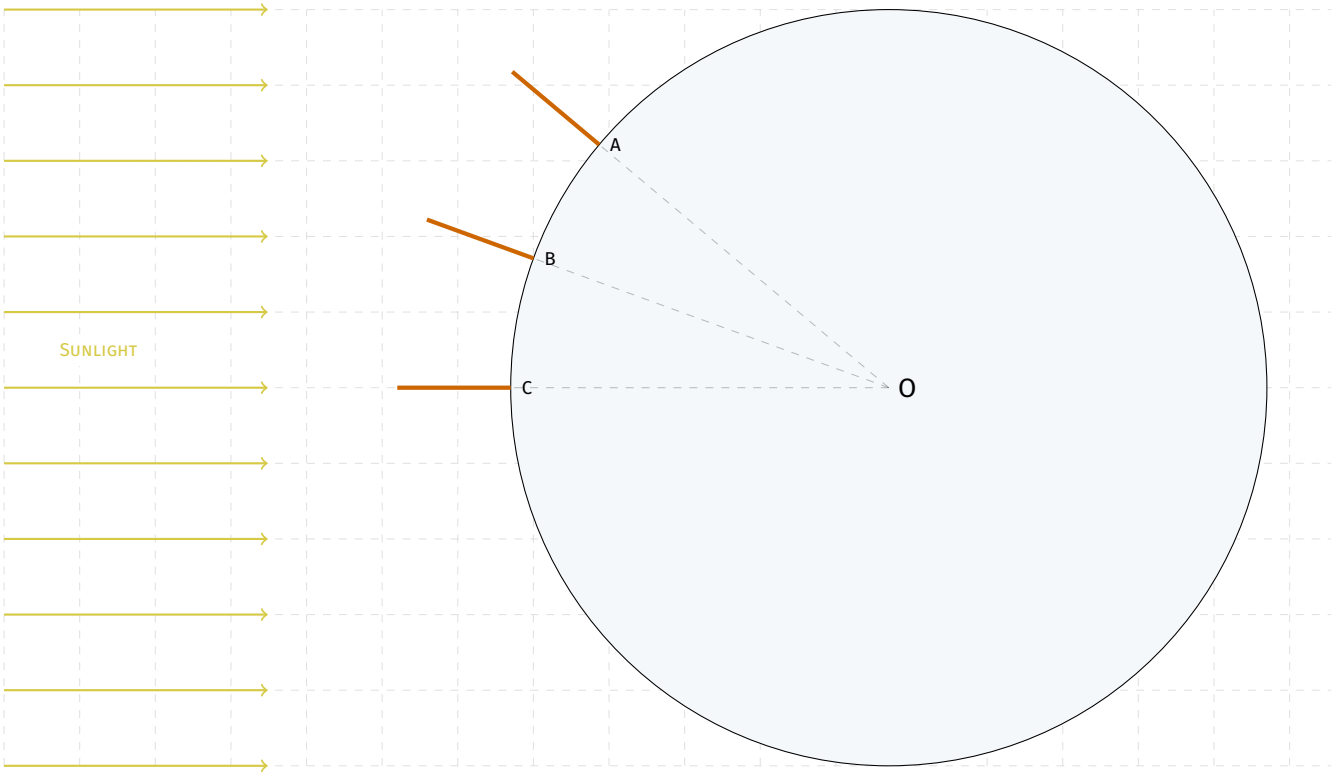
(3) The digram below shows sunlight impinging on the Earth.

a) Indicate the length of the shadows cast by the poles that are positioned at different locations on the Earth.

b) Use a, b and c to indicate the angles between the sunlight and the pole at A, B and C respectively.

c) Indicate and express the angles $\angle COA$ and $\angle COB$ using either a, b or c.

$\angle COA$: $\angle COB$:



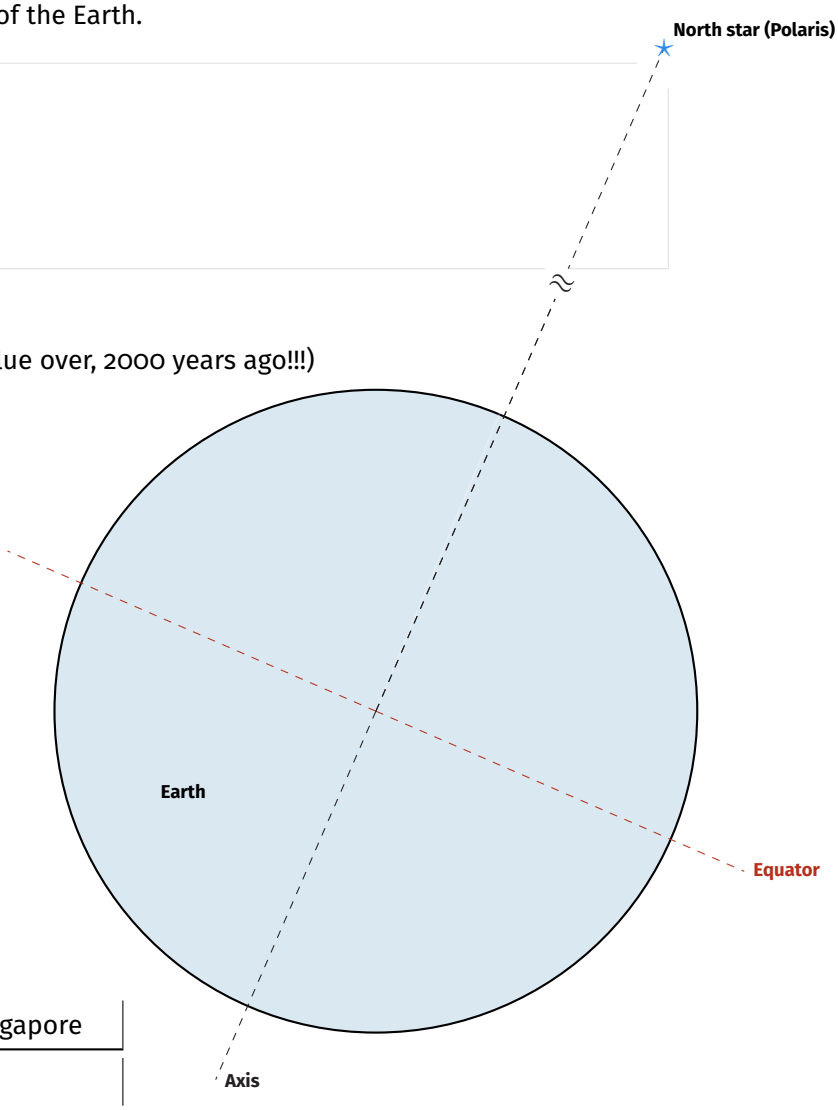
(4) Using $\triangle$'s COB and COA and taking the radius of the Earth as R_E, write down the distances CB and CA.

$$CB: \qquad CA:$$

(5) Lets assume A to be Alexandria and C to be Syene.
Eratosthenes figured out that the angle formed by the shadow at Alexandria (i.e. a) is 7° and that the distance (CA) between the cities is 785 km.

Use this information to determine the radius R_E of the Earth.

(6) Google the value of the Earth's radius. R_E km.
(Notice how close Eratosthenes got to the real value over, 2000 years ago!!!)



3 In the Northern Hemisphere

(7) What is special about Polaris (North star)?

(8) Use the diagram to show how we can use Polaris to determine latitude.

4 Time & Longitude

(9) Google the longitudes of the following locations and indicate in the table. Also note down the order in which the 'new' Sun is observed.

	London	San Francisco	Singapore
Longitude			
Order			

(10) Approximately how long will it take 'noon' to reach London after Singapore?

(answer: 6.9 h)

(11) Approximately how long will it take 'noon' to reach San Francisco after Singapore?

(answer: 15.1 h)

(12) Mr Bond; Mr James Bond, is in trouble. He just woke up to find himself floating in the middle of the ocean (lucky for him the fancy tuxedo that Q had given him is keeping him warm and afloat). All he remembers is going out to drinks with his 'friends' in London, and he is now wondering where he is. He notices that the Sun is not casting a shadow and therefore figures out it should be time for lunch. However, when he looks at his watch, it shows 2 pm! What is 007's present longitude?

5 Travelling the World

5.1 Issues of Time

(13) Do you go 'back' or 'forward' in time if you travel East or West from your current location

a) East: b) West:

(14) If the time now is 10:00, what is the time at a location:

a) 15° East: b) 15° West:

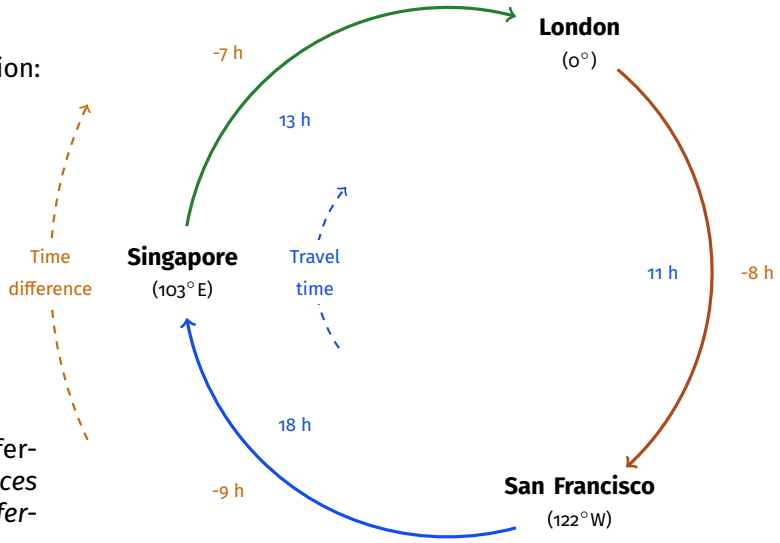
5.2 Round-the-World Trip!

(15) Marvin is going on a round-the-world trip and Susan will stay put in Singapore.

Marvin will be moving in quick succession from **Singapore** to **London** to **San Francisco** and back to **Singapore** .

The diagram shows (real) flight times and time differences between the cities. *Note that the time differences have been (naively) determined using only the differences in longitude.*

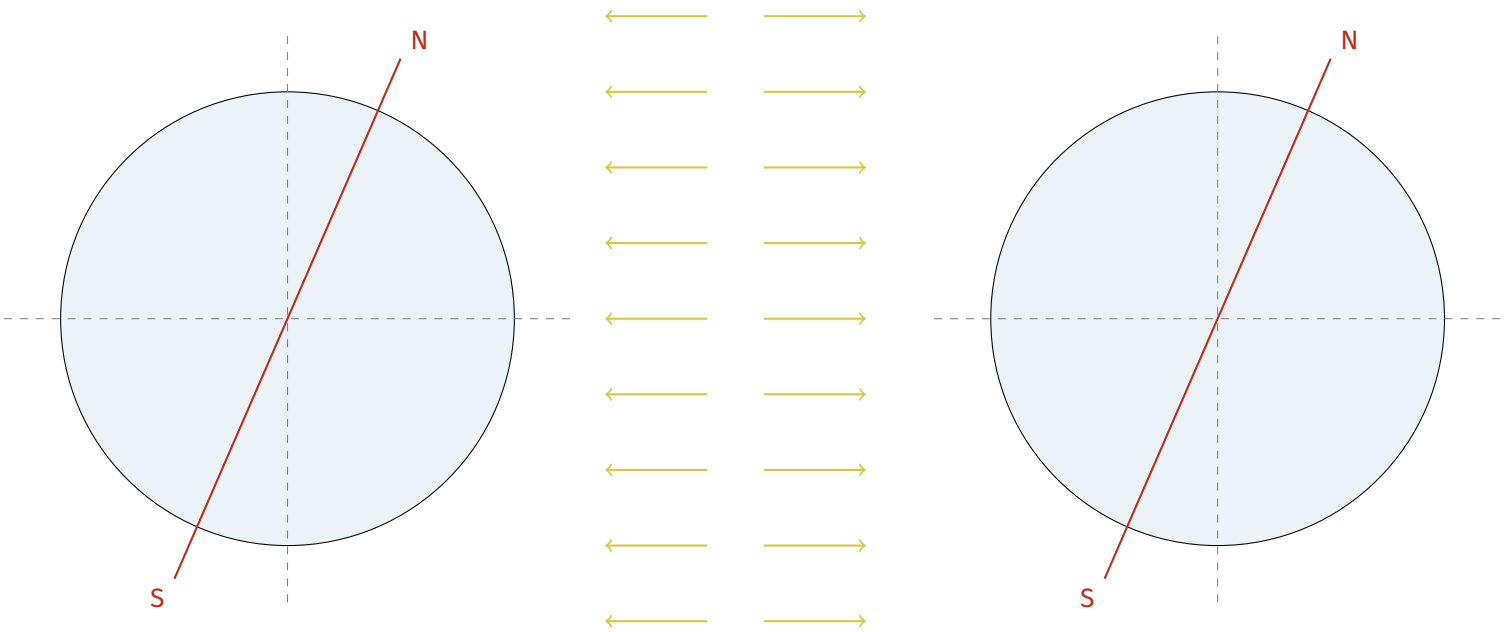
Use the table below to keep track of Marvin's and Susan's dates & times during this journey.



	Marvin			Susan
Location	**Travel Time to next destination**	**Time Difference from previous origin**	Date-Time on arrival	**Date-Time in Singapore**
Singapore	-	-	16:00 on 11-Oct	16:00 on 11-Oct
London				
San Francisco				
Singapore				

Do you now see why you should be conscious of how you cross the international date line.

6 $23\frac{1}{2}^\circ$ Tilt



(16) The two diagrams show how sunlight hits the Earth in the months of June and December. Identify which diagram corresponds to which month.

(17) Indicate the locations of the Sun and the North Star (Polaris).

(18) Indicate the positions of the Equator, the Tropic of Capricorn and the Tropic of Cancer.

(19) Indicate the angles at which sunlight falls on the above three locations.