Eratosthenes

project

bollywood noon

vissanji academy

Mumbai INDIA

2015, May15th

In 205 B.C., the Greek astronomer Eratosthenes, at the time Director of the Great Library of Alexandria in Egypt, proposed a purely geometrical method to measure the length of the Earth's meridian (circle passing through the poles).

He started by using the observation of shadows made at two different places, Alexandria and Syene (now Aswan) distanced approximately 800 km apart (distance estimated in relation to the time taken by a caravan of camels to connect the two towns !) at the time of the Summer solstice and at noon local solar time.

On that date and at that precise time in the northern hemisphere, the Sun reaches its highest position in the year above the horizon. However, Eratosthenes noticed differences from one place to another.

In Syene (approximately situated on the tropic of Cancer) the Sun is at the vertical, so much so that its rays reach the bottom of a well: and the shadows of vertical objects are perfectly centred round them.

Syene

7.2°
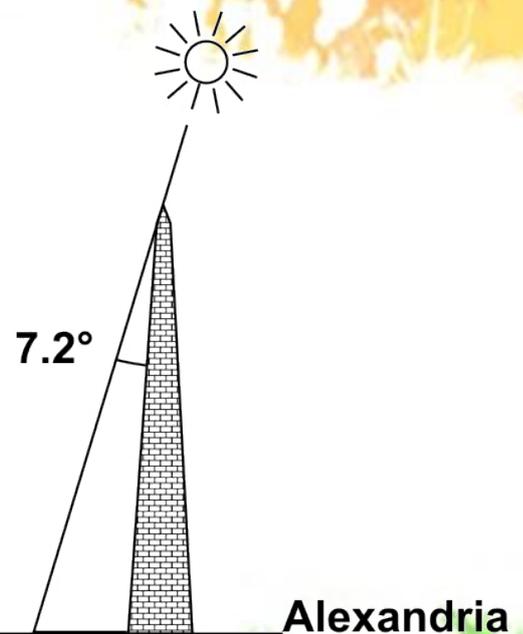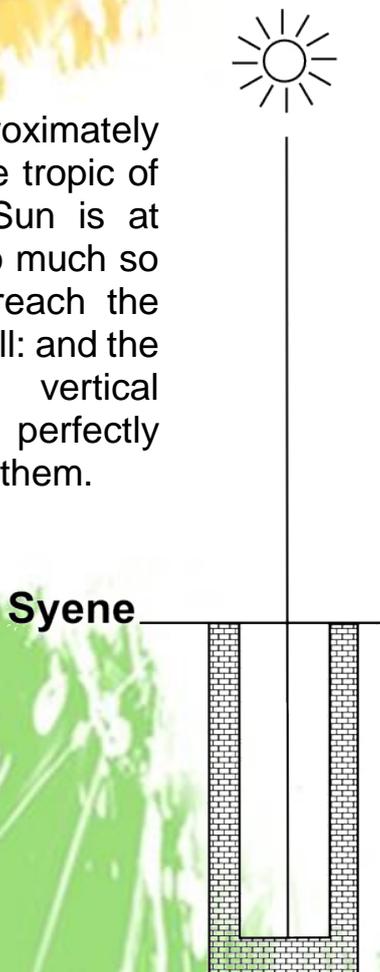
Alexandria

In Alexandria, on the other hand, the Sun is no longer at the vertical, and these same objects have a very shallow offset shadow. Eratosthenes set about measuring the shadow of an obelisk whose height he knew, and used this information to deduce the angle of the sun's rays from the vertical: he found 7.2°

On the basis of these observations, two hypotheses lay before him:

The Earth is flat, but in this case the Sun would be sufficiently close for there to be a significant divergence in its rays reaching distant objects: since objects of identical length have shadows of different length and no shadow at all when vertically underneath the Sun (zero angle).

The Earth is not flat, but has a curved, and perhaps even a round surface. Only, the same results can be obtained with sun rays which are all parallel: this implies that the Sun is sufficiently far away, very, very far away…
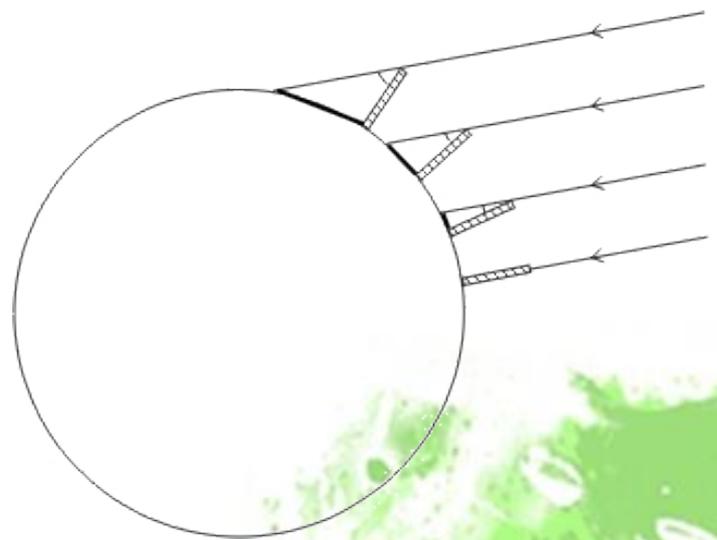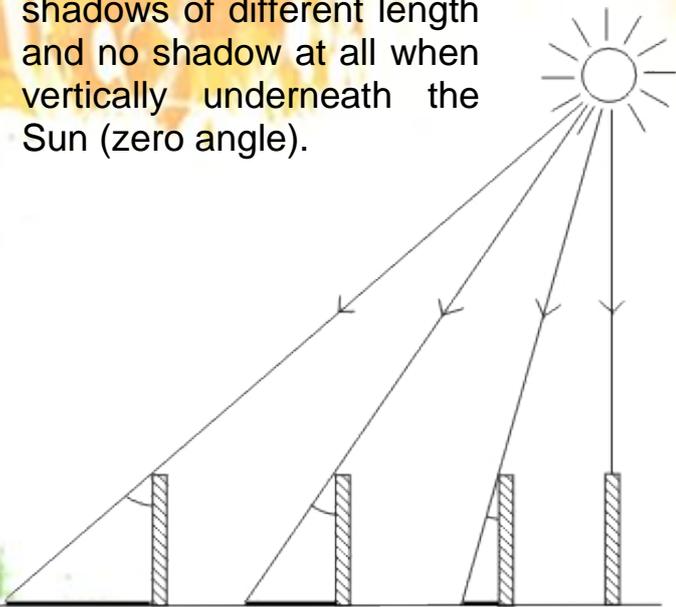
Eratosthenes opted for the second hypothesis. Indeed, the Ancients had already suspected that the Earth was not flat, on the basis of various observations seemingly providing evidence that its surface was somewhat curved: navigators perched on the top of their main mast are the first to perceive the distant coastline; observers on top of a cliff have a longer view of ships moving towards the horizon than observers on the beach; the pole star is not at the same height above the horizon in Greece as in Egypt; finally during eclipses of the Moon, the shadow of the Earth projected onto the Moon shows a circular section.

Convinced that the Earth is round, our genius Eratosthenes set about tracing his famous "amazingly simple" geometrical figure, which he used to calculate with ease the length of the Earth's meridian! Look for yourselves:

7.2°

Alexandria

7.2°
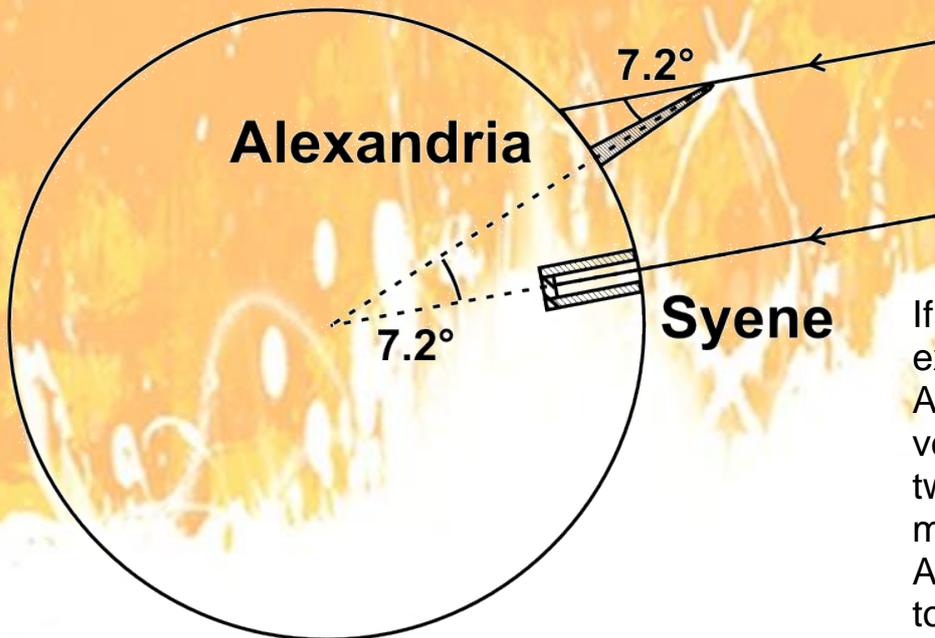
Syene

If the Earth is round, by extending the vertical in Alexandria (the obelisk) and the vertical in Syene (the well), these two verticals should by definition meet at the centre of the Earth. Also, Eratosthenes knew that the town of Syene being situated directly South in relation to Alexandria, the two cities were situated on approximately the same meridian. Since the sun's rays are indeed parallel, the angle formed by the two verticals at the centre of the Earth must therefore be identical to the angle he measured with the shadow of the obelisk (7.2°).

The proportion of this angle in relation to the 360° of a circle is the same as the proportion of the distance separating the two cities (approximately 800 km) relative to the circumference of a circle (in this case the Earth's meridian). The rest you can guess: 360° divided by 7.2° gives 50, and 800 km multiplied by 50 indeed gives 40000 km (a length which was found again later but using other methods).

Angle (°)	Distance (km)
7.2	800
360	circumference

X 50

Circumference=360 x 800 / 7.2 = 40 000

On May 15th, the conditions were the same in Mumbai as in Syene 205 BC.

the Sun is at the vertical at

noon

This experiment was conducted by
Mr Vishal J Sawant
VISSANJI ACADEMY
Dr. S. Radhakrishnan Marg
Andheri (E), Mumbai- 400 069

13 schools
from 9 countries
over 4 continents

participated to this event.

Italy
France
Greece
Spain
Tunisia
India
Malaysia
Brazil
Argentina

And calculated the circumference of the Earth

City	Country	School	Latitude	Longitude	Date	Gnomon height [cm]	Shadow length [cm]	Angle (°)
Pont St Martin	Italy	Istituzione Scolastica Monte Rosa A	45.601	7.795	14 May	100.0	51.0	27.0
Lafrançaise	France	Collège Antonin Perbosc	44.127	1.237	15 May	100.0	47.0	25.2
Ioannina	Greece	Experimental College	39.666	20.845	15 May	100.0	37.1	20.4
Aigio	Greece	1st High School of Aigio	38.252	22.079	15 May	86.0	29.7	19.1
Úbeda	Spain	Colegio Salesiano Santo Domingo Savio	38.017	-3.367	15 May	108.9	37.5	19.0
Petropouli	Greece	4th Junior High School of Petroupoli	38.036	23.674	15 May	100.0	34.0	18.8
Athens A-pro	Greece	Protypo Peiramatiko Gymnasio Agion Anargyron	38.027	23.726	15 May	49.0	16.3	18.4
Tunis	Tunisie	Ecole Primaire 16 Rue de Russie	36.795	10.177	15 May	90.0	28.5	17.6
Yamunanagar	India	Govt. Senior Secondary School, Alahar	30.033	77.2	15 May	50.0	9.6	10.9
Mumbai	India	L.R & S.M Vissanji Academy	19.121	72.851	15 May	249.0	0.0	0.0
Kuantan	Malaysia	SMK Saint Thomas	3.827	103.339	15 May	78.0	-21.3	-15.3
Rio de Janeiro	Brazil	Centro Educacional Nosso Mundo	-22.890	-43.317	15 May	21.0	-18.0	-40.6
Anisacate	Argentina	Fundación Caminos de Anisacate	-31.717	-64.4	14 May	122.0	-147.0	-50.3

| 15 May		Pont St Martin	Lafrançaise	Ioannina	Aigio	Úbeda	Petropouli	Athens A-pro	Tunis	Yamunanagar	Mumbai	Kuantan	Rio de Janeiro	Anisacate	
	Angle >	27.0	25.2	20.4	19.1	19.0	18.8	18.4	17.6	10.9	0.0	-15.3	-40.6	-50.3	
	Latitude V														
Pont St Martin	45.601		32800	35945	37185	37935	36878	35205	37455	38683	39227	39498	40521	40005	C
Lafrançaise	44.127	164		37200	38538	39426	38081	35894	38605	39424	39686	39796	40738	40177	I
Ioannina	39.666	659	496		43477	47057	40725	32760	41014	40547	40288	40155	41016	40384	R
Aigio	38.252	816	653	157		93600	28800	12857	38880	40083	40052	40029	40963	40326	C
Úbeda	38.017	843	679	183	26		-3600	-600	34971	39422	39771	39873	40874	40244	U
Petropouli	38.036	840	677	181	24	-2		900	41400	40511	40232	40128	41024	40376	M
Athens A-pro	38.027	841	678	182	25	-1	1		61650	42624	41087	40593	41296	40606	F
Tunis	36.795	978	815	319	162	136	138	137		40352	40173	40081	41016	40358	E
Yamunanagar	30.033	1730	1566	1070	913	887	889	888	751		40029	39998	41103	40353	R
Mumbai	19.121	2942	2778	2283	2125	2099	2101	2100	1964	1212		39976	41382	40423	E
Kuantan	3.827	4641	4477	3982	3825	3799	3801	3800	3663	2911	1699		42232	40618	N
Rio de Janeiro	-22.890	7609	7446	6950	6793	6767	6769	6768	6631	5880	4667	2968		36408	C
Anisacate	-31.717	8590	8426	7931	7774	7747	7750	7749	7612	6860	5648	3949	981		E
						DISTANCE									

Mumbai India
L.R & S.M Vissanji Academy
19.121N - 72.851E

Ioannina Greece
Experimental College
39.666N -   20.845E

15 May 2015 (Ioannina-GREECE)
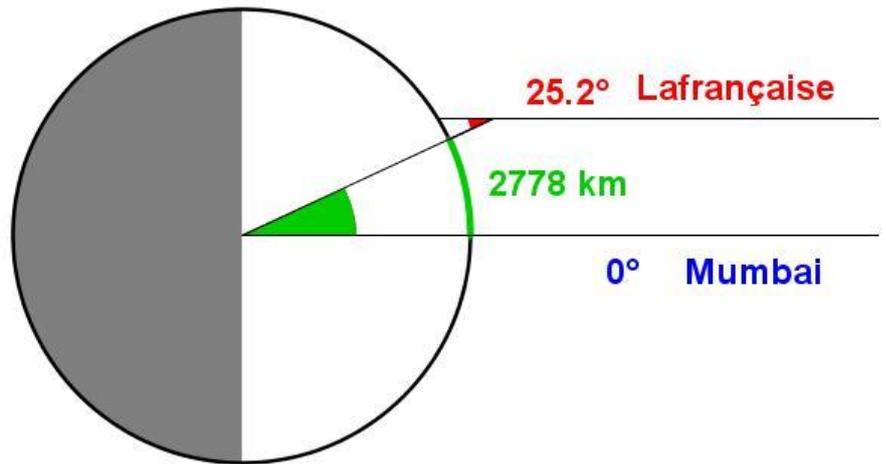15 May 2015 (Mumbai-INDIA)

20.4°   Ioannina
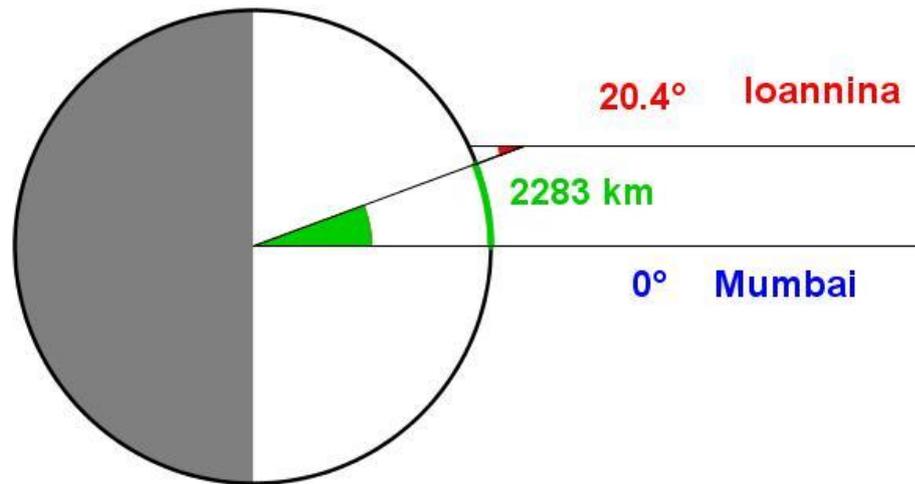
2283 km

0°   Mumbai

$$\text{circumference} = \frac{360° \times 2283 \text{ km}}{20.4° - 0°} = 40288 \text{ km}$$

Lafrançaise France
Collège Antonin Perbosc
44.127N - 1.237E

15 May 2015 (Lafrançaise -FRANCE)

15 May 2015 (Mumbai-INDIA)

25.2° Lafrançaise

2778 km

0°   Mumbai

$$circumference = \frac{360° \times 2778\ km}{25.2° - 0°} = 39686\ km$$

Petropouli   Greece
4th Junior High School of Petroupoli
38.036N - 23.674E

15 May 2015 (Petroupoli-GREECE)
15 May 2015 (Mumbai-INDIA)

18.8° Petroupoli
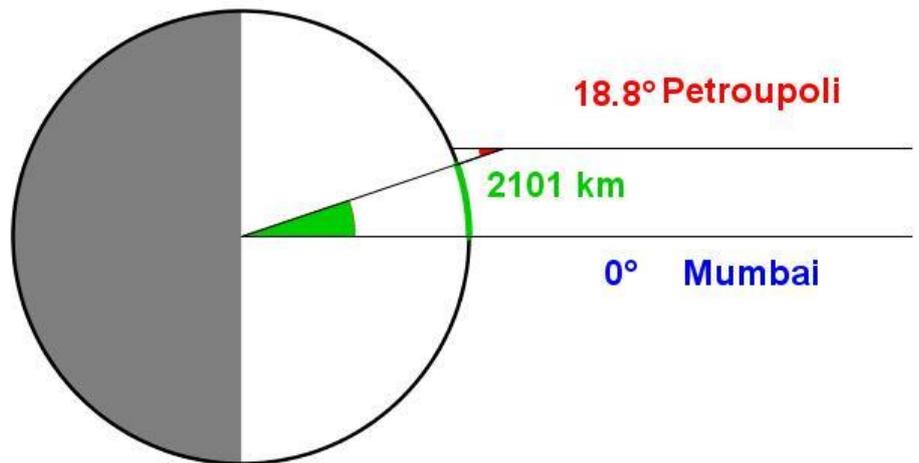
2101 km

0°   Mumbai

$$\text{circumference} = \frac{360° \times 2101 \text{ km}}{18.8° - 0°} = 40232 \text{ km}$$

Khor Got Hun

HELLO INDIA

Greetings from
4th Junior High School of Petroupoli

4ο Πετρούπολης

Time
13.00   35.4
13.05   35.0
13.10   34.
13.15   34.3

Rio de Janeiro Brazil
Centro Educacional Nosso Mundo   -
22.890S - 43.317W

15 May 2015 (Mumbai-INDIA)
15 May 2015 (Rio de Janeiro-BRASIL)

0° Mumbai

4667 km

40.6° Rio de Janeiro
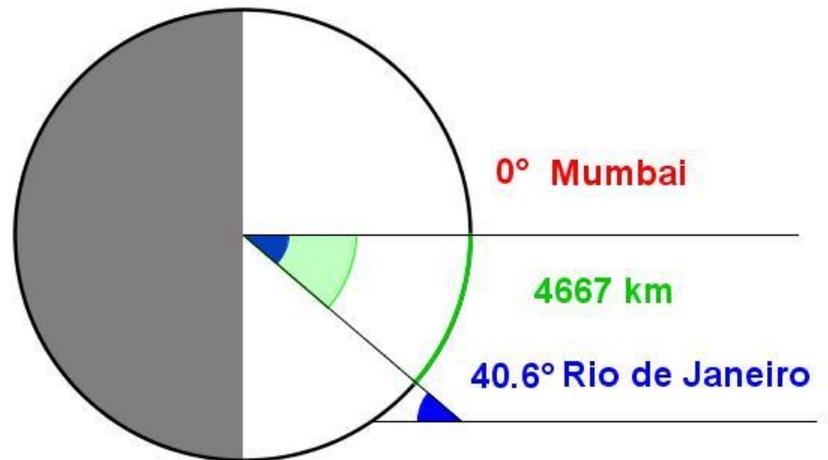
$$circumference = \frac{360° \times 4667\ km}{0° + 40.6°} = 41382\ km$$

Pont St Martin Italy
Istituzione Scolastica Monte Rosa
A 45.601N - 7.795E

14 MAY 2015 (Pont Saint Martin-ITALY)
15 MAY 2015 (Mumbai-INDIA)

27°   Pont Saint Martin
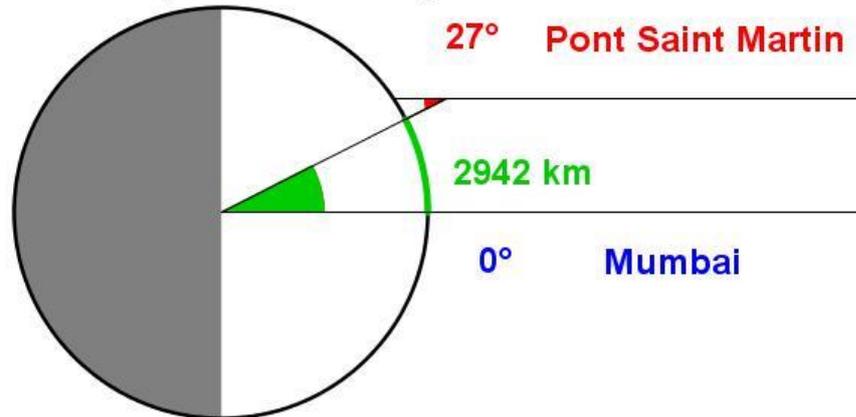
2942 km

0°   Mumbai

$$circumference = \frac{360° \times 2942 \ km}{27° - 0°} = 39227 \ km$$

Aigio Greece
1st High School of Aigio
38.252N - 22.079E

15 May 2015 (Aigio-GREECE)

15 May 2015 (Mumbai-INDIA)

19.1° Aigio
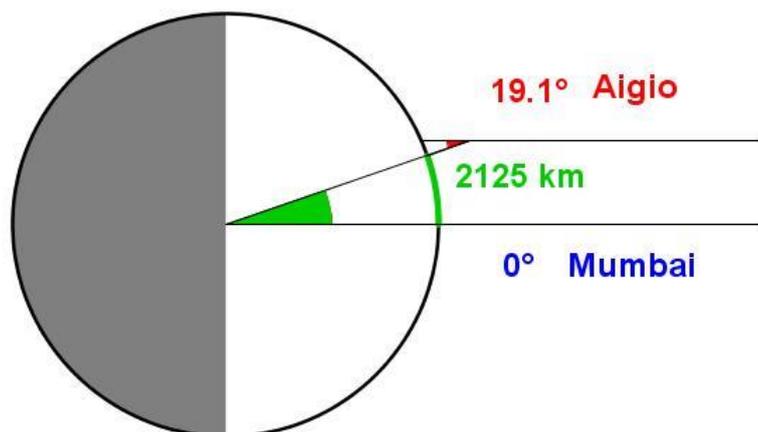
2125 km

0° Mumbai

$$circumference = \frac{360° \times 2125\ km}{19.1° - 0°} = 40052\ km$$

Úbeda   Spain
Colegio Salesiano Santo Domingo Savio
38.017N - 3.367W
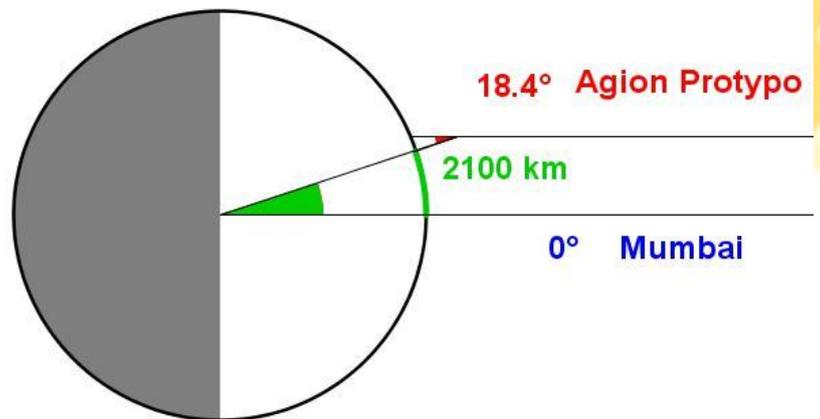
15 May 2015 (Úbeda-SPAIN)
15 May 2015 (Mumbai-INDIA)

19°   Úbeda
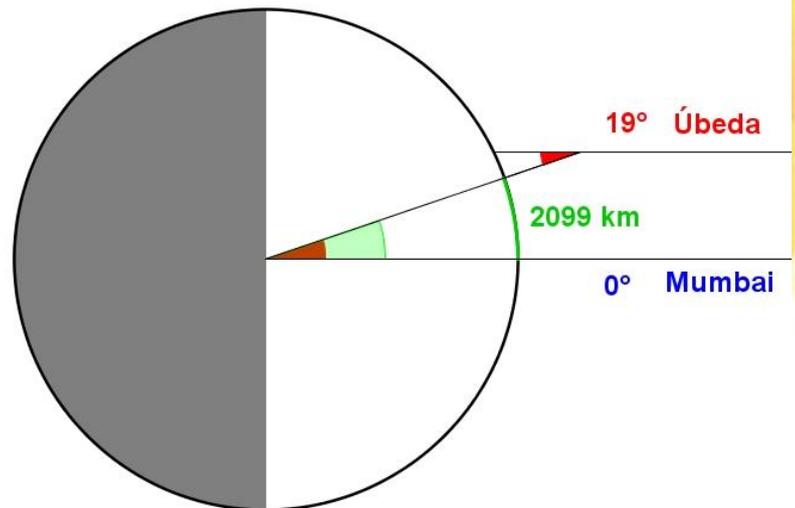
2099 km

0°   Mumbai

circumference = $\dfrac{360° \times 2099 \text{ km}}{19° + 0°}$ = 39771 km

Athens Greece
Protypo Peiramatiko Gymnasio
Agion Anargyron
38.027N - 23.726E

15 May 2015 (Agion Protypo-GREECE)
15 May 2015 (Mumbai-INDIA)

18.4° Agion Protypo

2100 km

0°   Mumbai

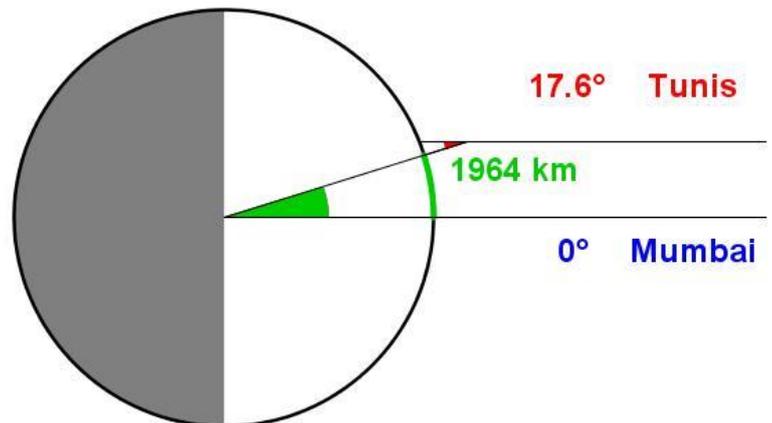$$circumference = \frac{360° \times 2100 \text{ km}}{18.4° - 0°} = 41087 \text{ km}$$

Tunis Tunisie
Ecole Primaire 16 Rue de Russie
36.795N - 10.177E
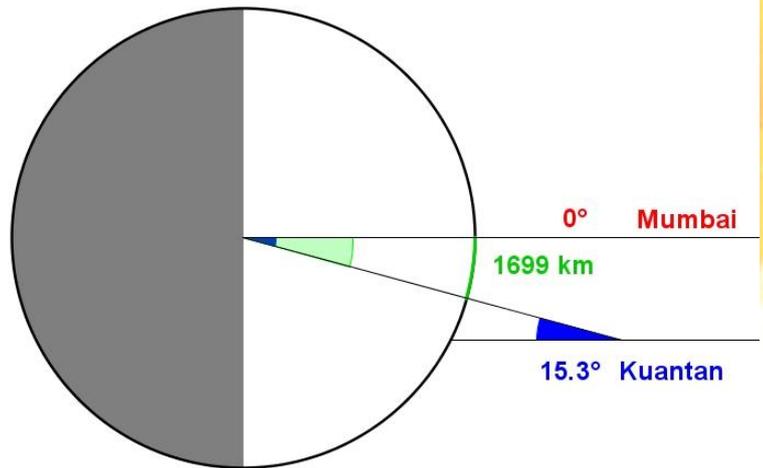

15 May 2015 (Tunis-Tunisia)
15 May 2015 (Mumbai-INDIA)

17.6°   Tunis

1964 km

0°   Mumbai

$$\text{circumference} = \frac{360° \times 1964 \text{ km}}{17.6° - 0°} = 40173 \text{ km}$$

Kuantan Malaysia
SMK Saint Thomas
3.827N - 103.339E
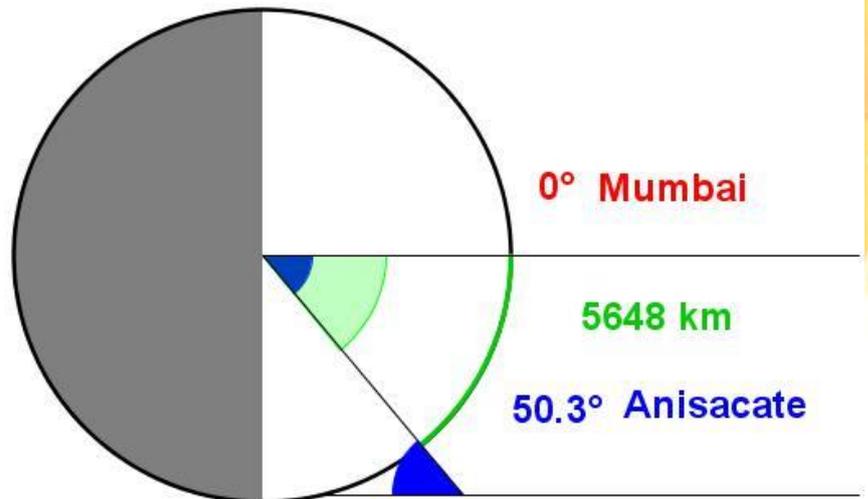
15 May 2015 (Mumbai-INDIA)
15 May 2015 (Kuantan-MALAYSIA)

0°   Mumbai

1699 km

15.3° Kuantan

$$\text{circumference} = \frac{360° \times 1699 \text{ km}}{0° + 15.3°} = 39976 \text{ km}$$

Anisacate   Argentina
Fundación Caminos de Anisacate
31.717S - 64.4W

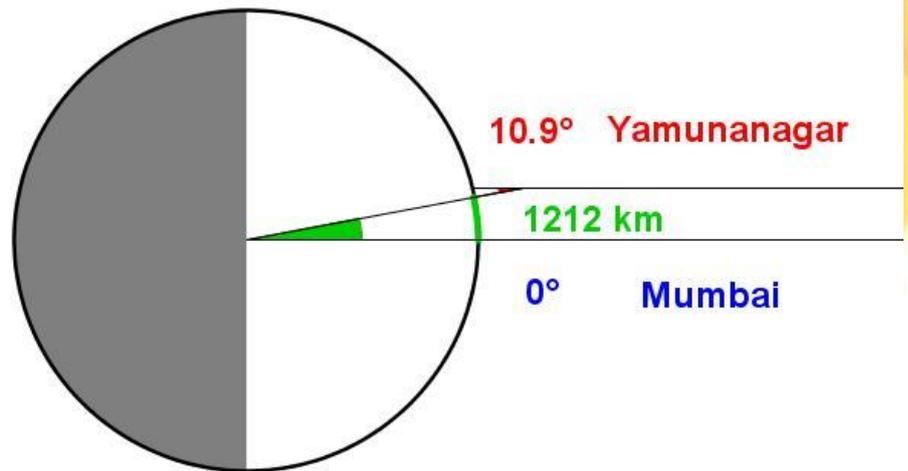15 May 2015 (Mumbai-INDIA)
14 May 2015 (Anisacate-ARGENTINA)

0° Mumbai

5648 km

50.3° Anisacate

$$circumference = \frac{360° \times 5648\ km}{0° + 50.3°} = 40423\ km$$

Yamunanagar India
Govt. Senior Secondary School, Alahar
30.033N - 77.2E

15 May 2015 (Yamunanagar-INDIA)
15 May 2015 (Mumbai-INDIA)

10.9°   Yamunanagar

1212 km

0°   Mumbai

$$circumference = \frac{360° \times 1212 \text{ km}}{10.9° - 0°} = 40029 \text{ km}$$

eTwinning

http://twinspace.etwinning.net/5691/   http://www.fondation-lamap.org/eratos

http://etwinning.net   http://www.fondation-lamap.org/

la main
à la pâte