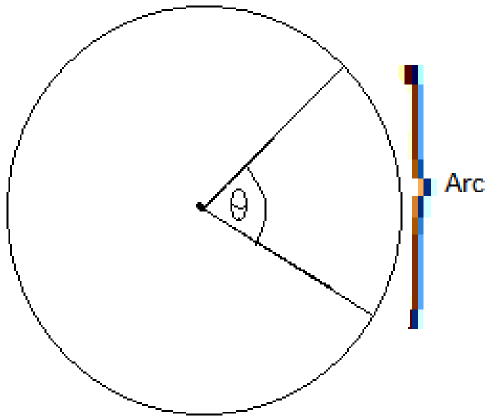
CHAPTER ELEVEN

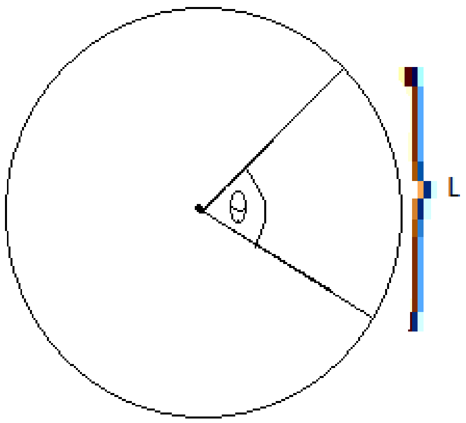
GLOBAL MATHEMATICS



- The figure shows an arc with angle θ at its centre.
- The length of an arc with angle θ at its centre = $\frac{\theta}{360}$ x $2\pi r$, where r = the radius.

(Q1) Find the length of an arc which has an angle of 60^0 at the centre, and a radius of 10cm.

Soln:



Let the length of the arc = L, and $\theta = 60^0$.

Since L = $\frac{\theta}{360}$ x $2\pi r$ => L = $\frac{60}{360}$ x 2 x 3.14 x 10 = 1.04cm.

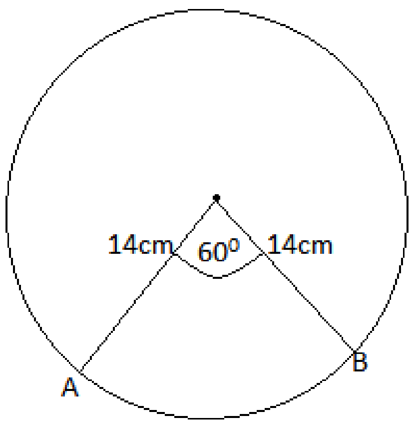
(Q2)An arc AB subtends an angle of 60^0 at the centre of a circle of radius 14cm.

Find (i) the length of the arc AB.

ii) the length of the chord AB. (Take $\pi = 3.142$ or $\frac{22}{7}$).

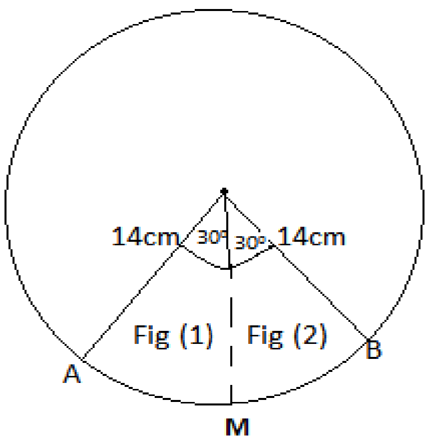
Soln:

(i)



Length of arc AB = $\frac{\theta}{360}$ x $2\pi r$ = $\frac{60}{360}$ x 2 x 3.14 x 14 = 15cm.

(II)



Considering Fig.(1), Sin $30^0 = \frac{AM}{14}$

=> AM = 14 x sin 30^0, => AM = 14 x 0.5 = 7cm.

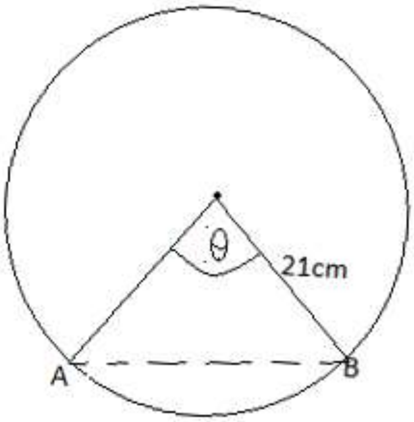
But AB = 2AM = 2(7) = 14cm.

Length of chord AB = AB = 14cm.

(Q3) An arc AB is of length 28.5cm, and the diameter of the circle is 42cm. Find θ the angle subtended at the centre of the circle.

Soln:

Length of arc = 28.5cm. Since diameter = 42cm => radius = 21cm.



Since length of arc AB = $\frac{\theta}{360}$ x $2\pi r$,

=>28.5 = $\frac{\theta}{360}$ x 2 x $\frac{22}{7}$ x 21

=>28.5 = $\frac{132\theta}{360}$

=>132θ = 28.5 x 360,

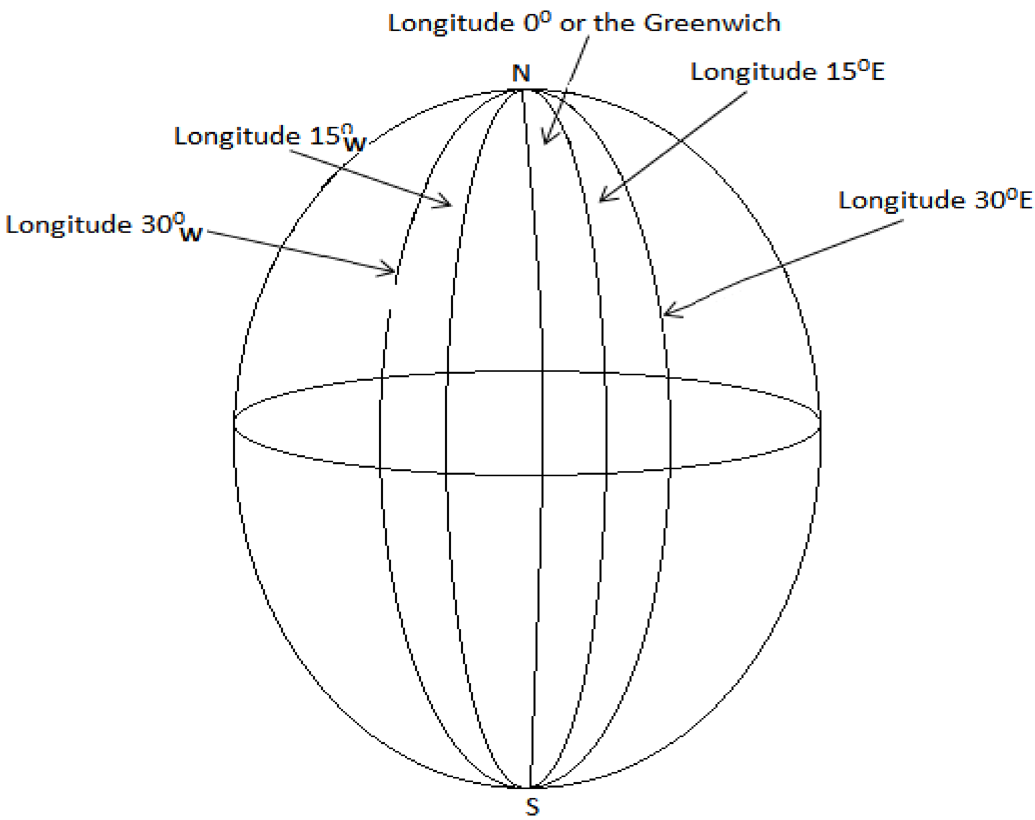
=>132θ = 10260, => θ = $\frac{10260}{132}$, => θ = 78^0

..

:

:

The Earth:



N/B:

- Longitude 180^0W always meets longitude 180^0E.

- When two longitudes have a similar direction, i.e either East or West, then their difference is used in calculation.

- For example longitude 10^0E and longitude 25^0E have a similar direction, which is East.

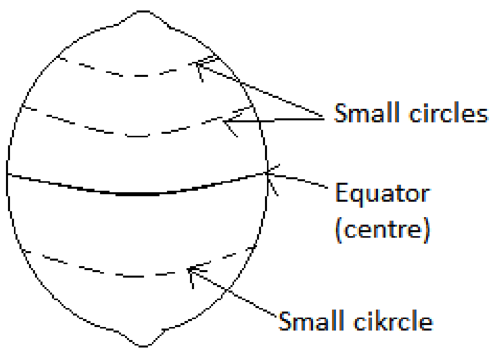
- Therefore their difference i.e $25 – 10 = 15^0$ must be used in calculation.

- When the two longitudes differ in direction, then their sum is used.

- For example, considering longitude 25^0W and longitude 15^0E, their sum i.e. $15 + 25 = 40^0$, must be used in calculation.

Small and great circles:

- A small circle is obtained when the line of longitude or the line of latitude does not through the centre of the earth.



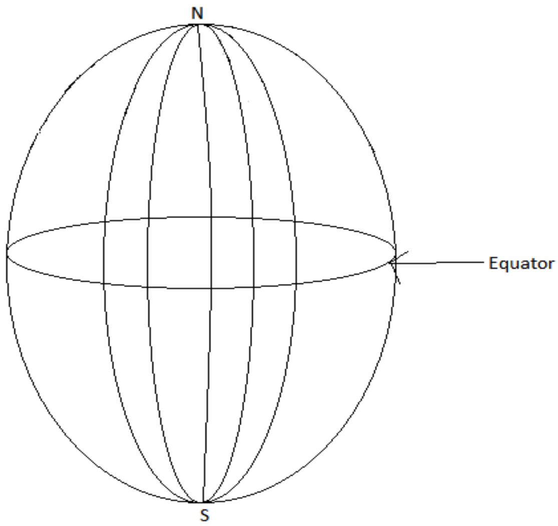
- A great circle is obtained when the line of latitude or the line of longitude passes though the centre of the earth.

- All longitudes are great circles, since they all pass through the centre of the earth.

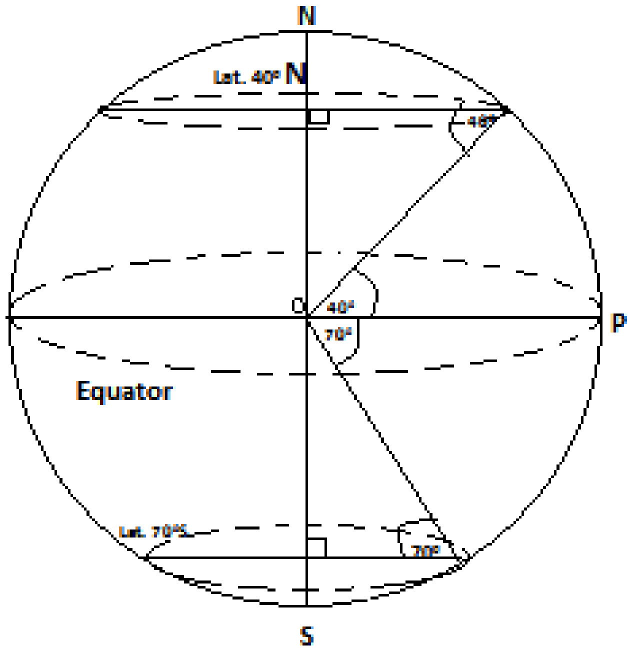
- The equator is the only latitude which passes through the centre of the earth.

- For this reason, it is the only latitude which is a great circle.

- It must be noted that every longitude passes through the north pole and the south pole.



N/B: N is the North pole with S being the south pole.

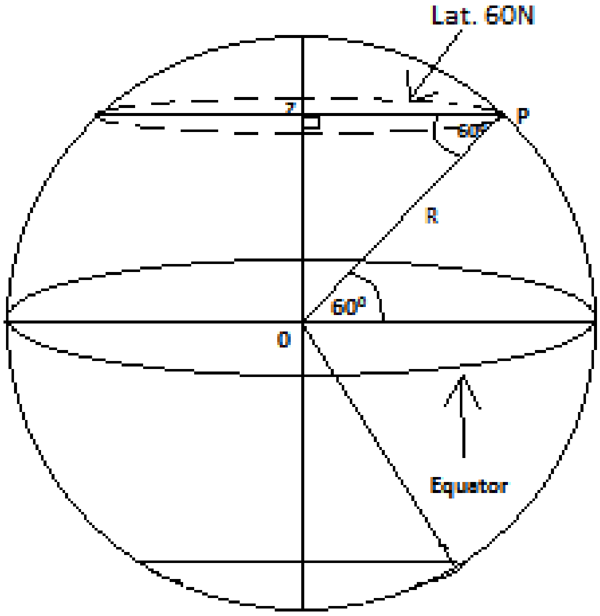


- The above indicates the relationship between Latitude 40^0N and latitude 70^0S, with respect to the equator.

(Q1) Find the radius of a circle of latitude 60^0N, given that the radius of the earth is R, where R = 6400km.

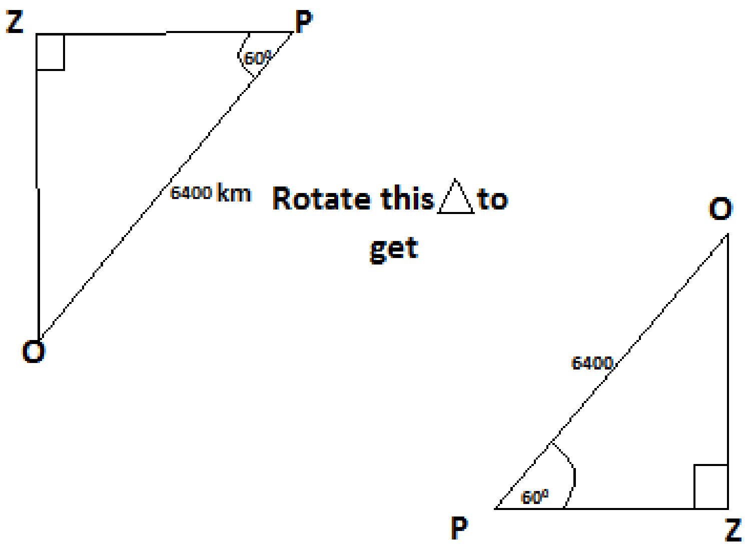
.

Soln:



R = radius of the earth and ZP = radius of Lat. 60^0N.

Consider $\triangle$ PZO i.e.



Cos $60^0 = \frac{P2}{6400}$ => PZ = 6400 Cos 60

= 6400 x 0.5 = 320km.

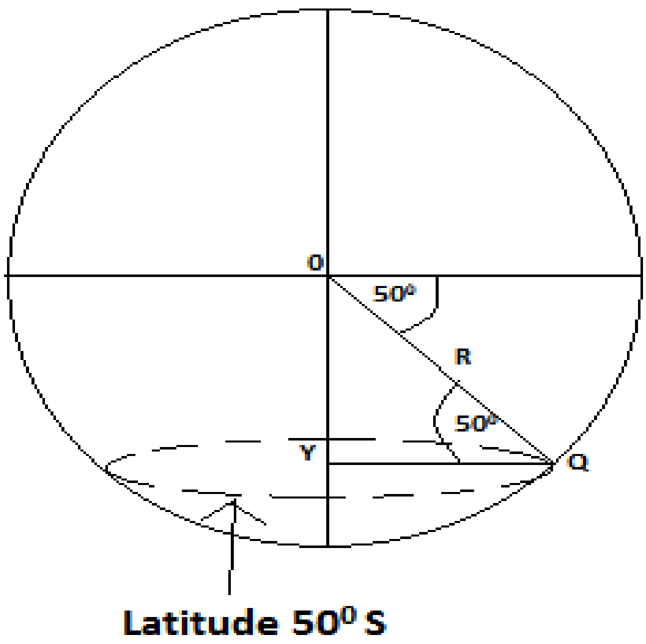
The radius of latitude 60^0N = 320km.

N/B: To find the diameter of the circle of latitude 60^0, first determine the radius and multiply it by 2.

Diametre = 2 x 320 = 640km.

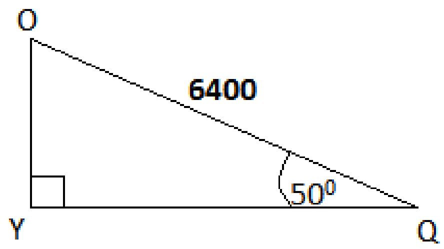
(Q2) Find the radius of latitude 50^0S, if the radius of the earth is 6400km.

Soln:



YQ = the radius of latitude 50^0 S. R = 6400km.

Consider triangle OYQ i.e.



YQ = 6400 Cos 50^0

=>YQ = 6400 x 0.64 = 4114km.

N/B:

- From YQ = 6400 Cos 50^0, YQ = the radius of the latitude 50^0S, 6400 = the radius of the earth and 50^0 = the latitude.

- We can therefore conclude that the radius of a latitude = R Cos L.

- For example, the radius of latitude 30^0 is given by r = 6400 Cos 30^0.

- Also the radius of latitude 10^0 is given by r = 6400 Cos 10^0.

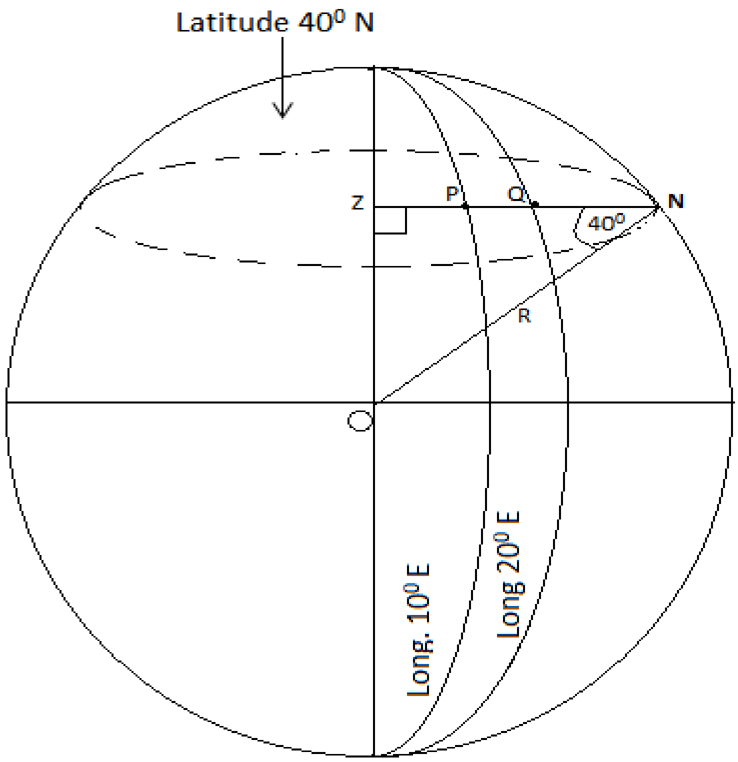
(Q3) P(Latitude 40^0N, longitude 10^0 E) and Q(Latitude 40^0N, longitude 20^0E), are two points on the earth`s surface. Find

- the radius of their common latitude.

- the distance from P to Q along the common latitude.

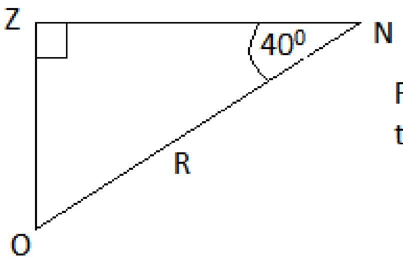
- the distance from P to Q through the earth.[Take R = 6400km and π = $\frac{22}{7}$ or 3.142]

Soln:

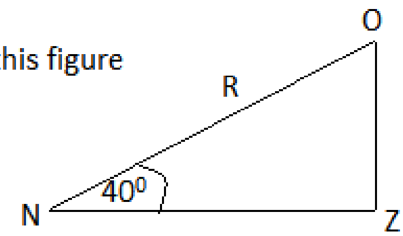


- ZN = the radius of their common latitude.

ConsiderΔ ZON i.e.

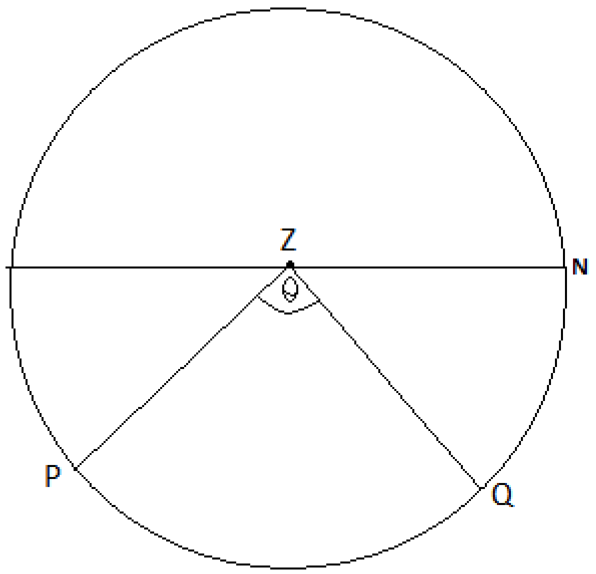


Rotate this figure to get



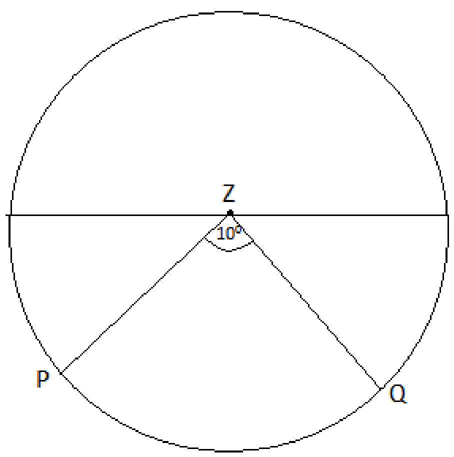
ZN = R Cos 40^0= 6400 Cos 40^0= 4903km.

- For the distance from P to Q along their common latitude, we ,consider the points P and Q, as well as the circle or latitude on which P and Q lies i.e.



Let θ = <PZQ.

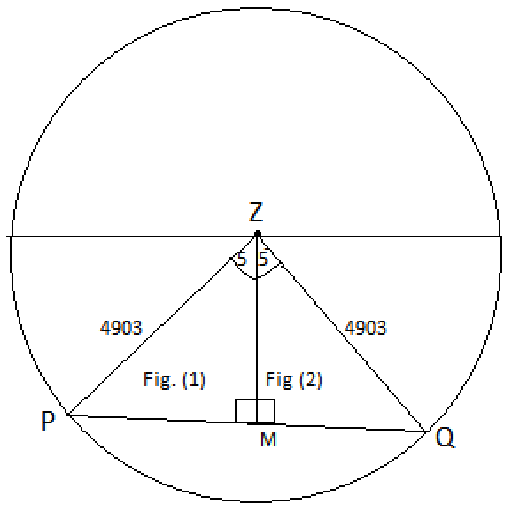
Since the two latitudes share a common direction, then $\theta = 20 - 10 = 10^0$.



The distance from P to Q along their common latitude= the length of the arc PQ.

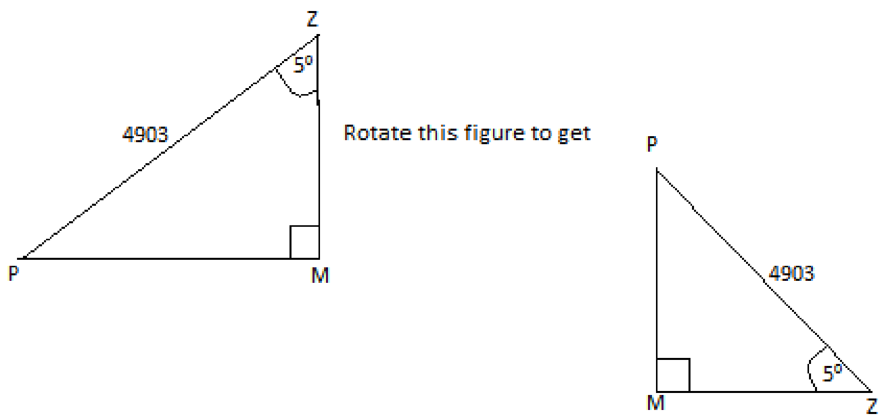
PQ = $\frac{\theta}{360}$ x 2 x π x r => PQ = $\frac{10}{360} \text{x } 2 \text{ x } \frac{22}{7} \text{x } 4903 = 856\text{km}.$

N/B: r which is the same as the radius of their common latitude has already been calculated to be 4903km.



N/B: PZ and ZQ are radii of their common latitude. Therefore PZ = 4903km and ZQ = 4903km. The distance from P to Q through the earth = PQ.

Consider figue (1) i.e



Sin 5^0 = $\frac{PM}{4903}$ => PM = 4903 x Sin 5^0 = 4903 x 0.09

= 441 km.

N/B:

- The shortest distance PQ (or the shortest distance from P to Q, is the same as the shortest distance PQ along the parallel of latitude.

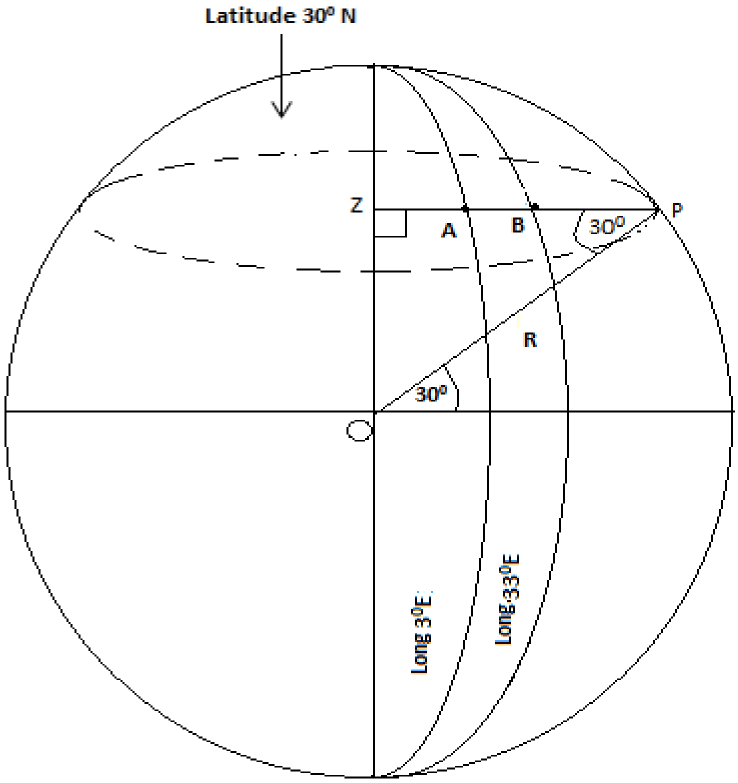
- Also the distance from P to Q through the earth is the same as the shortest distance between P and Q.

(Q4)A (latitude 30^0N, longitude 3^0 E) and B (latitude 30^0N, longitude 33^0E) are two points on the earth`s surface. Assuming the earth to be a sphere of radius 6400km, find

(i) the distance from A to B along the common latitude.

(ii) the distance from A to B through the earth.

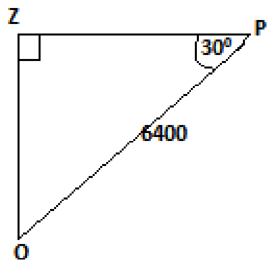
[Take π = 3.142].



N/B: R = 6400km => OP = 6400km.

Soln:

Consider $\triangle$ ZOP i.e.

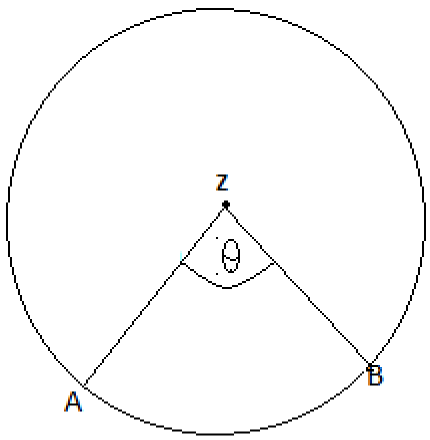


The required radius = ZP.

ZP = OP Cos 30^0.

ZP = 6400 Cos 30.

ZP = 6400 x 0.866 = 5540km.



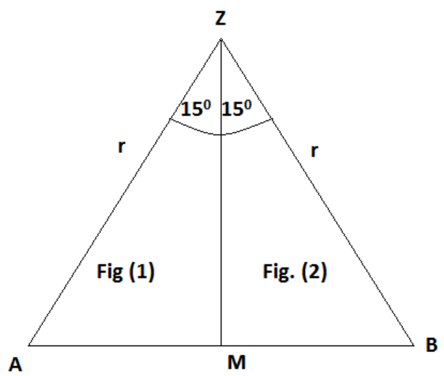
Since the two longitudes have a common direction, then θ = 33 – 3 = 30^0.

The distance from A to B along the common latitude = the length of arc AB

$\frac{\theta}{360}$ x 2 x π x r = $\frac{30}{360}$ x 2 x 3.14 x 5540

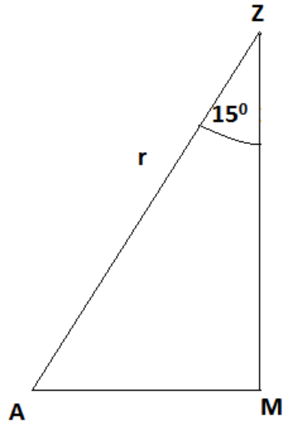
= 2880km.

(ii)

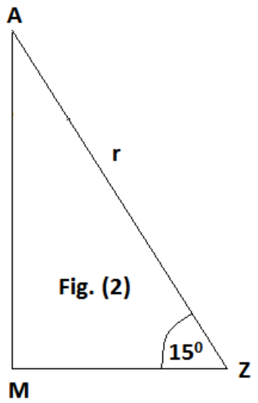


N/B: The 15^0 was had by dividing the 30^0 by 2.

Considering figure (1), i.e.



Rotate to get



AM = r sin 15^0 where r = the common radius.

=> AM = 5540 x 0.26

= 1440.

Since AB = 2AM, then AB = 2(1440) = 2880km.

The required distance = AB = 2880km.

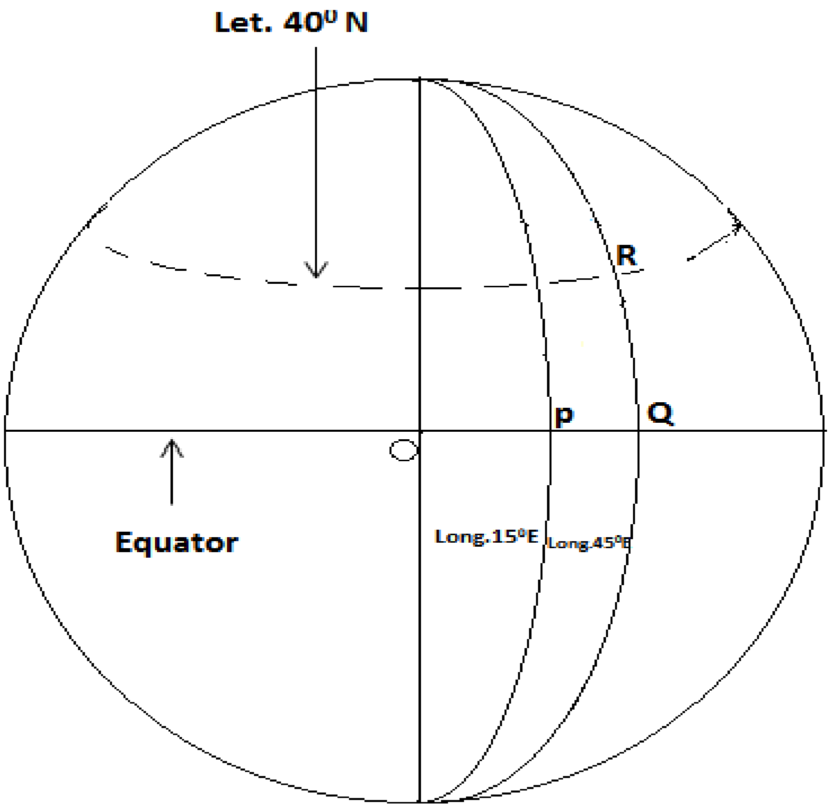
(Q5) P and Q are two points on the equator on longitude 15^0 E and longitude 45^{0}E. R(latitude 40^{0}N, long 45^0 E). A ship sails from P to Q and then from Q to R. Assuming the earth to be a sphere of radius 6400km, find

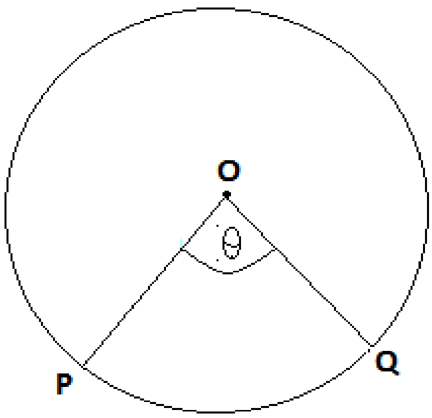
i) the total distance covered by the ship.

(ii)the time taken by the ship to travel from P to Q, if its speed is 15km/h.

[Take the radius of the earth = 6400km].

Soln:





If the ship sailed from P to Q, then it sailed from P to Q along the earth.

$\theta = 45^0 - 15^0 = 30^0$.

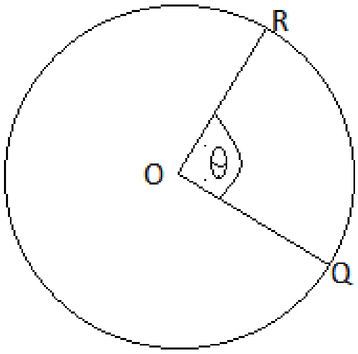
Distance from P to Q along the earth = $\frac{\theta}{360}$ x $2\pi r$

Since these points are located on the equator, then r which is the radius of their common latitude, will be the same as the radius of the earth i.e. 6400km.

Required distance = $\frac{30}{360}$ x 2 x 3.14 x 6400

= 3352km.

For the distance from Q to R, movement is from latitude O^0 or the equator to latitude 40^0N.



$\theta = 40^0 - 0^0 = 40^0$

Distance from Q to R along the earth = $\frac{40}{360}$ x 2 x 3.14 x 6400

= 4480km.

The total distance travelled = 3352 + 4480 = 7832km

(II)Since distance = speed x time, then

Time = $\frac{Distance}{Speed} = \frac{7832}{15}$

= 515.3 mins = 8hrs 36mins.

N/B:

- The shortest distance between any two points along the surface of the earth, is always along a great circle through the two points.

- If the latitude is the equator, then the distance between any two points along it is the shortest distance.

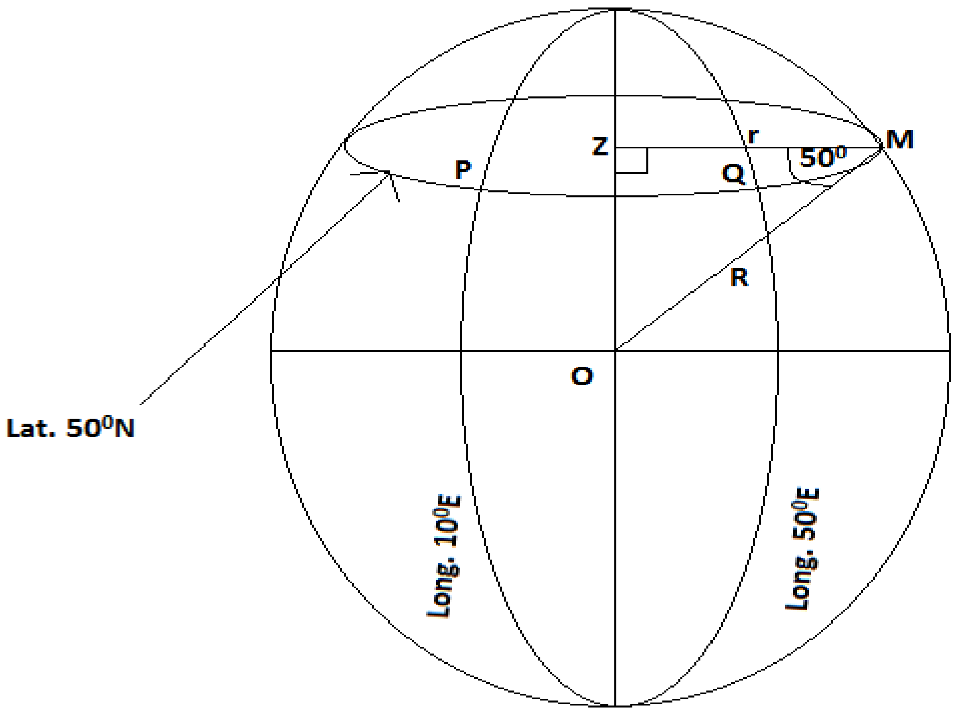
(Q6)P and Q are two points on the same parallel of latitude 50^0N. P lies on longitude 10^0W and Q lies on longitude 50^0E. Taking the radius of the earth to be 6400km and π = 3.142, calculate

(a)the circumference of the line of latitude 50^0N to the nearest kilometer.

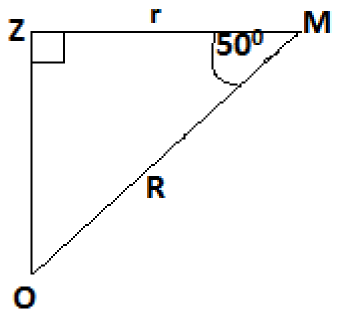
(b)the shortest distance PQ measured along the line of latitude 50^0N.

(c)the latitude at which the circumference of the circle is equal to one quarter the length of the equator.

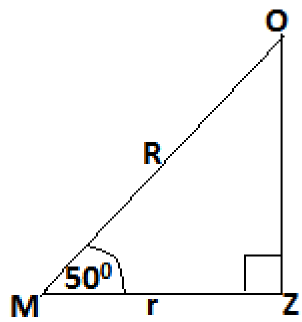
Soln:



Consider $\triangle$ZOM i.e.



rotate it to get



ZM = r = R Cos 50^0 => r = 6400 Cos 50,

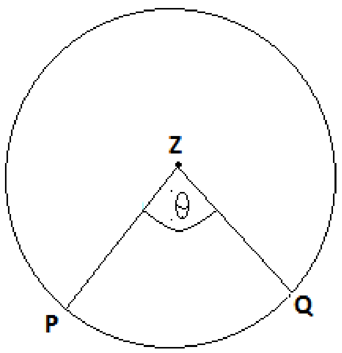
=> r = 4114km.

The radius of circle of latitude 50^0 = 4114km.

The circumference of circle of latitude 50^0 = $2\pi r$

= 2 x 3.142 x 4114 = 25860km.

(b)



Since the two given latitudes have different directions, then their sum must be used,
=> $\theta = 10^0 + 50^0 = 60^0$.

The shortest distance from P to Q along latitude 50^0

= 60/360 x 2 x 3.142 x 4114

= 4310km.

(c)

Let θ = the angle of the latitude.

The length of the latitude = $2\pi R\text{Cos}\,\theta$.

Also the length of the equator = $2\pi R$.

Since the length of the latitude = $2\pi R\text{Cos}\,\theta$

$= \frac{1}{4}$ (length of the equator),

=> $2\pi R\cos\theta = \frac{1}{4}(2\pi R)$ => 2Cos = $0.5\pi R$

=> $2\pi R\cos\theta = \frac{1}{4} \times 2\pi R$

=> $2\cos\theta = 0.5\pi R$

=> $\cos\theta = \frac{0.5\pi R}{2\pi R}$s

=> $\cos\theta = 0.25$ => $\theta = 76$ North or South.

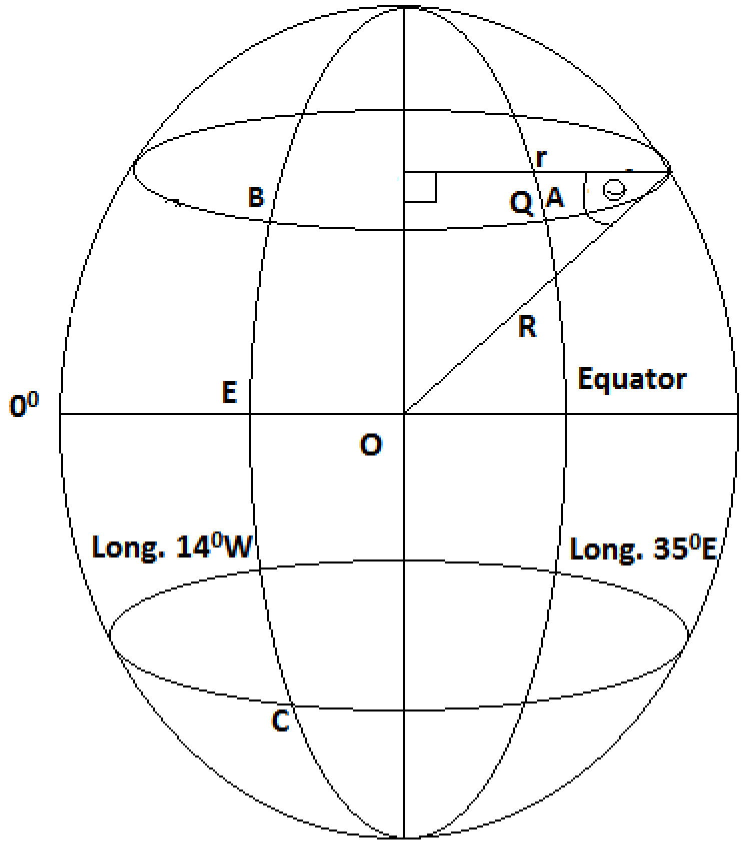
(Q7)A and B are two points on the earth`s surface in the northern hemisphere. They both lie on the same circle of latitude of radius 4900km. A is 35^0E and B is 14^0W. Assuming that the earth is a sphere of radius 6400km and π = 3.14, calculate

a) (i) the latitude of A and B.

(ii) the shortest distance between A and B along their parallel latitude.

(b) C is a point on the earth`s surface along a great circle, and the distance from B to C IS 11200km. Calculate the latitude of C.

Soln:



(a)Let the radius of latitude on which A and B lie be r and let R be the radius of the earth.

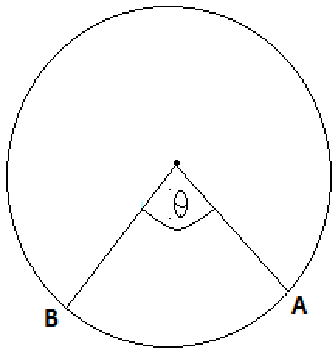
Since r = R Cos θ , then 4900 = 6400 Cos , where θ = the latitude on which A and B lie.

From 4900 = 6400 Cos θ

=> Cos $\theta = \frac{4900}{6400}$

=> $\theta = \text{Cos}^{-1}\, 0.77 = 40^0$.

(II)



The shortest distance between A and B along their parallel latitude = Arc BA (or arc AB).

Arc BA = $\frac{\theta}{360}$ x 2πr,

where r is the radius of the latitude on which A and B lie (i.e. r = 4900km).

Also the angle $\theta = 35^0 + 14^0 = 49^0$

Arc BA = $\frac{49}{360}$ x 2 x 3.142 x 4900

= 42000km.

N/B:

(b)-The distance BC is given as 11200km.

First, we must determine the distance BE, and make use of the fact that BE + EC = BC.

=> EC = 11200 – BE.

From the diagram, B lies on latitude 40^0E and E lies on the equator or latitude 0^0E.

in this case, $\theta = 40 - 0 = 40^0$.

Since E lies on the equator, then arc BE= $\frac{\theta}{360}$ x 2πR, where R = the radius of the earth.

Arc BE = $\frac{40}{360}$ x 2 x 3.142 x 6400

= 4469km.

Since BE + EC = 11200,

=> 4469 + EC = 11200,

=> EC = 11200 – 4469,

=> EC = 6731km.

Let B^0 = the latitude on which C lies. Since E lies on latitude 0^0, and both E and C have the same direction, then $\theta = B^0 - 0^0 = B^0$.

Since arc EC = $\frac{\theta}{360}$ x 2Πr,

=> $6731 = \frac{\theta}{360} \times 2 \times 3.14 \times 6400$,

=> $6731 = \frac{B^0}{360} \times 2 \times 3.14 \times 6400$, => 6731 = 112B => $B^0 = \frac{6731}{112}$

=> $B^0 = 60^0$.

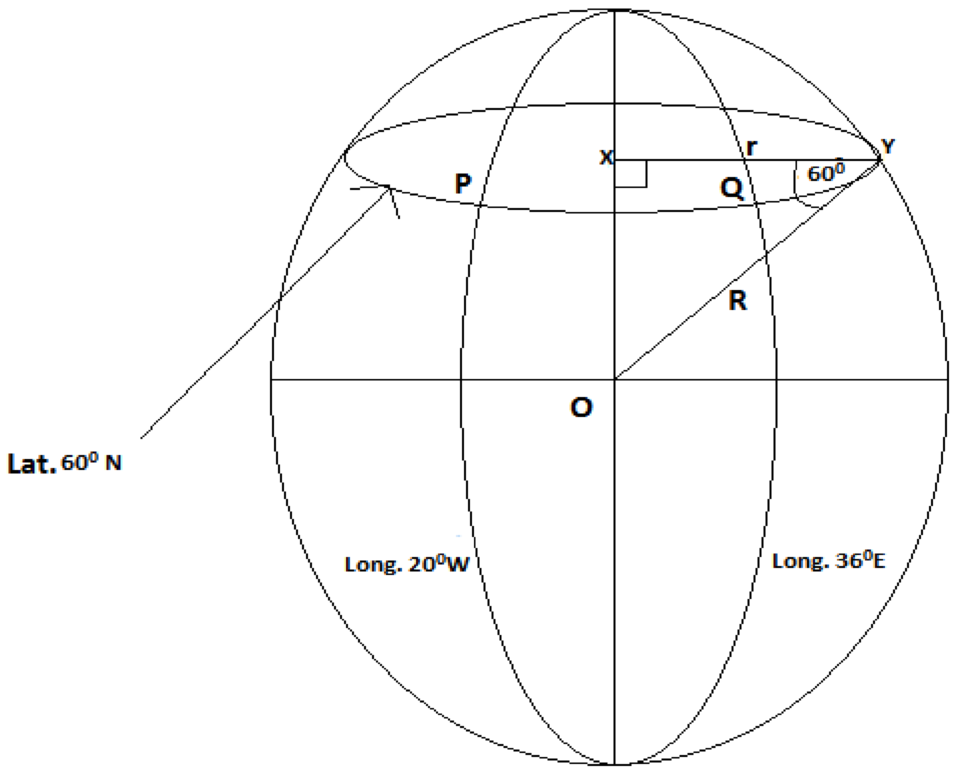
C lies on latitude 60^0.

(Q8) P(Latitude 60^0N, longitude 20^0W) and Q(Latitude 60^0, longitude 36^0E) are two points on the earth`s surface. Assuming that the earth is a sphere of radius 6400km, calculate

i) the time taken for an aircraft to fly from P to Q at an average speed of $540kmh^{-1}$. Take π = 4.142

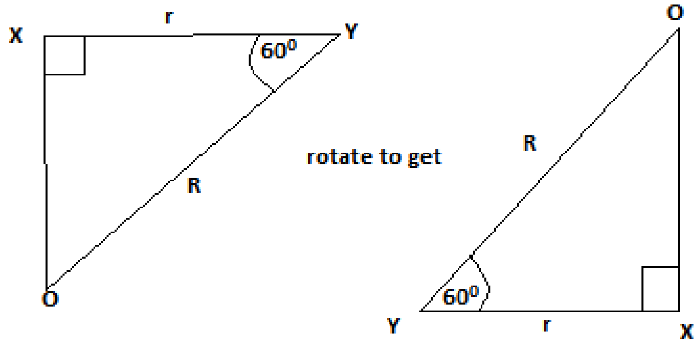
(ii) the shortest distance through the earth.

Soln;



(i)Let r = the radius of latitude 60^0N or the common radius.

Consider $\triangle$ OXY i.e.



r = R Cos 60^0 => r = 6400 x 0.766

= 4900 , => r = 4900km.

N/B: Also, r = R Cos θ , where θ = the latitude.

$\theta = 20^0 + 36^0 = 56^0$.

Distance from P to Q along their common latitude = length of arc PQ.

PQ = $\frac{\theta}{360}$ x 2πr

=> PQ =$\frac{56}{360}$ x 2 x 3.14 x 4900,

=> PQ = 4786.

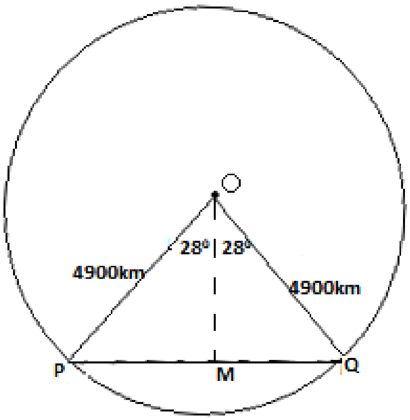
Therefore distance travelled by aircraft = 4786km.

Speed of aircraft = 540km^{-}h.

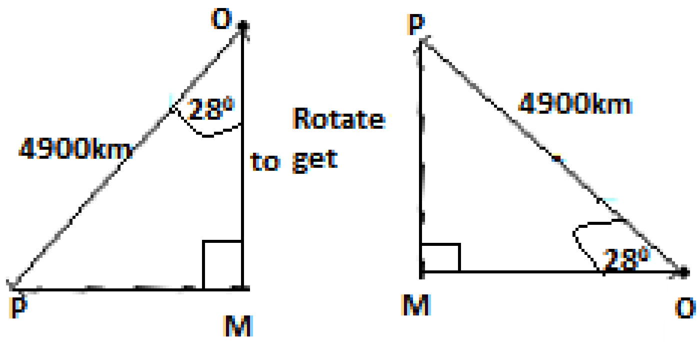
Time taken = $\frac{Distance}{Speed} = \frac{4786}{540}$

= 9hrs.

(II)



The shortest distance = PQ = 2(PM), consider figure (1), i.e.



PM = 4900 Sin 28^0

= 4900 x 0.47

= 2303km.

The shortest distance = 2PM

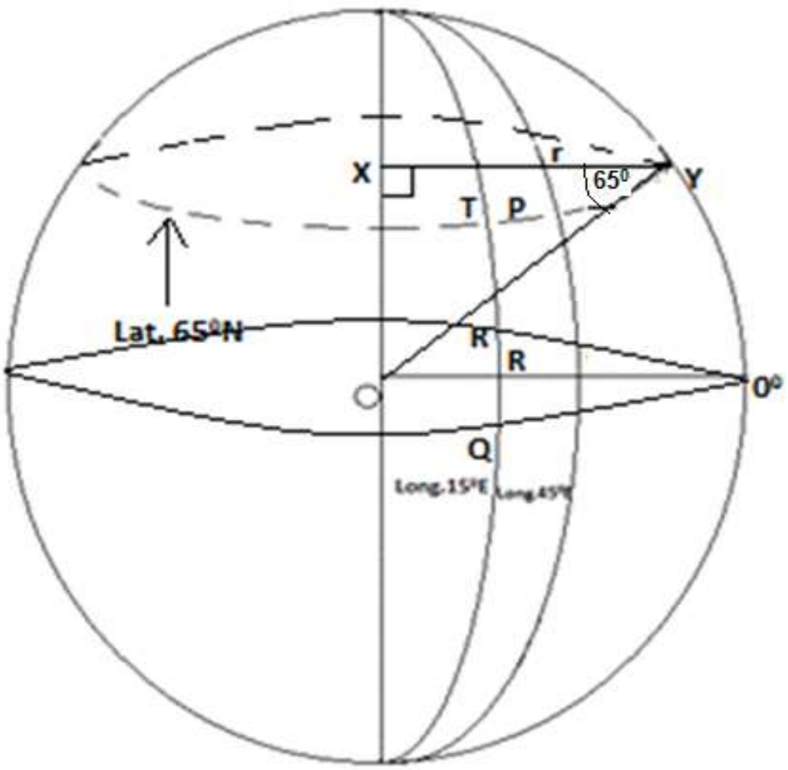
= 2(2303) = 4606km.

(Q9)An aircraft took 2 hours to fly from town P (latitude 65^0N, longitude 45^0E) to another town T(latitude 65^0N, longitude 15^0E). The aircraft then changed its course and 9 hours after leaving T, arrived at a third town Q(latitude 0^0, longitude 15^0E). If the flight from P to T was along the line of latitude and that from T to Q along the meridian, calculate

(a) the total length of the journey.

(b) the average speed of the aircraft.[Take π = 3.142 and radius of earth = 6400km].

(a)



From r = R Cos 65^0 => r = 6400 Cos 65^0

=> r = 6400 x 0.4226 = 2705km, where r = the radius of their common latitude.

Distance travelled from P to T= length of arc TP.

θ = 45 – 15 = 30^0

Length of arc TP = $\frac{\theta}{360}$ x 2πr $= \frac{30}{360}$ x 2 x 3.142 x 2705

= 1417km.

∴ Distance travelled from P to T = 1417km.

The distance from T to Q = length of arc TQ. Since Q lies on the equator, then its latitude = 0^0

θ = $65^0 - 0^0 = 65^0$.

Length of arc TQ = $\frac{\theta}{360}$ x 2πR, where R = the radius of the earth, (since Q lies on the equator).

Length of arc TQ = distance travelled from T to Q = $\frac{65}{360}$ x 2 x 3.142 x 6400 = 7262km.

The total length of journey = Distance travelled from P to T + distance travelled from T to Q = 1417 + 7262 = 8679km.

c) total distance travelled = 8679km

Total time taken = 2 + 9 = 11hrs.

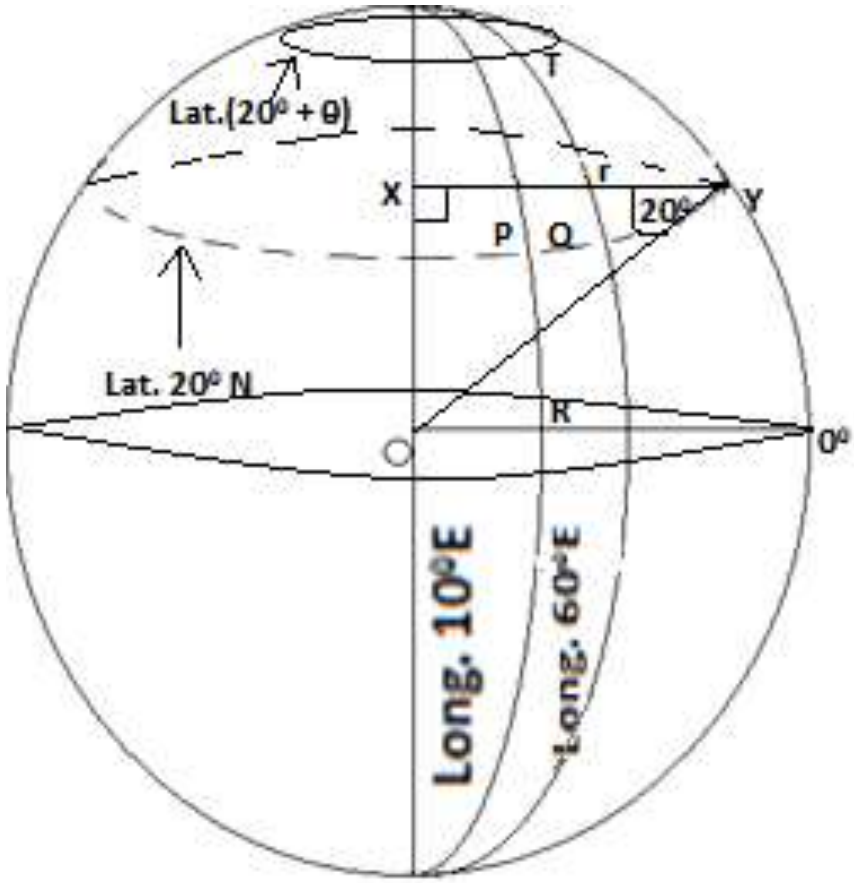
Average speed = $\frac{total\ distance}{total\ time\ taken}\frac{8679}{11} = \frac{8679}{11} = 789kmh^{-1}$.

(Q10) An aeroplane flies from P(latitude 20^0N, longitude 10^0E) due east to Q(latitude, 20^0N, longitude 60^0E).

i) If the journey takes $6\frac{1}{4}$ hours, calculate the average speed of the aeroplane.

(ii) If the pilot then flies due north from Q to T, 400km away from Q, calculate the latitude of T. [Assume the earth to be a sphere of radius 6400km and take π = 3.142].

Soln:



(i) The radius of the latitude on which PQ lies is given by r = R Cos θ => r = 6400 Cos 20^0

=> r = 6014Km.

θ = 60 – 10 = 50^0.

Distance travelled from P to Q = length of arc PQ.

Length of arc PQ = $\frac{\theta}{360}$ x 2πr = $\frac{50}{360}$ x 2 x 3.14 x 6014

= 5249.

Distance travelled from P to Q = 5249km.

Time taken for this journey = $6\frac{1}{4}$ hrs.

Average speed = $\frac{Distance\ travelled}{Time\ Taken} = \frac{5249}{6\frac{1}{4}} = \frac{5249}{6.25}$ = 840kmh^{-1}.

(ii) The distance travelled from Q to T = the length of arc QT.

Length of arc QT = $\frac{\theta}{360}$ x 2πr, where R = the radius of the earth, (since in this case, movement was along a longitude).

Length of arc QT = $\frac{\theta}{360}$ x 2 x 3.142 x 6400

But since the distance travelled from Q to T = 400km, then length of arc QT = 400km, => 400 = $\frac{\theta}{360}$ x 2 x 3.142 x 6400,

=> 400 = 112θ, => $\theta = \frac{400}{112} = 3.6^0$

The latitude of T = $20^0 + \theta = 20 + 3.6^0 = 23.6^0$.

N/B:

- When movement from one point to another is made along a longitude or a meridian, then R(i.e. radius of the earth) is the radius of the latitude concerned.

- From the diagram drawn, it will be noticed that the radius of the latitude on which T lies = $20^0 + \theta$.

(Q11) An aeroplane flies from point P(Lat. 60^0N, Long 35^0 E) due west of P on the same latitude. If the distance PR along the parallel of latitude is 5000km,

(a) find the longitude of R.

(b) If the aeroplane flies due north from R for 8hours to point Q on latitude 30^0 north, find the speed of the plane correct to 2 significant figure.

N/B:

- Since the plane flew due west of P from P, before arriving at R, then P and R have different directions.

- While P is in the east, R is in the west. P(Lat. 60^0 N, long 30^0E) and R(Lat 60^0 N, long B^0W)

Let B = the longitude on which R lies.

Soln:

- Since the longitude of P is 30^0E and that of R is B^0W, then in this case θ = 30 + B^0

PR = 500 km. Since PR = $\frac{\theta}{360}$ x $2\pi r$, where r = R Cos 60^0

PR = $\frac{\theta}{360}$ x $2\pi R$ Cos 60^0

=> PR = $\frac{\theta}{360}$ x 2 x 3.142 x 6400 x 0.5,

=> PR = 56θ.

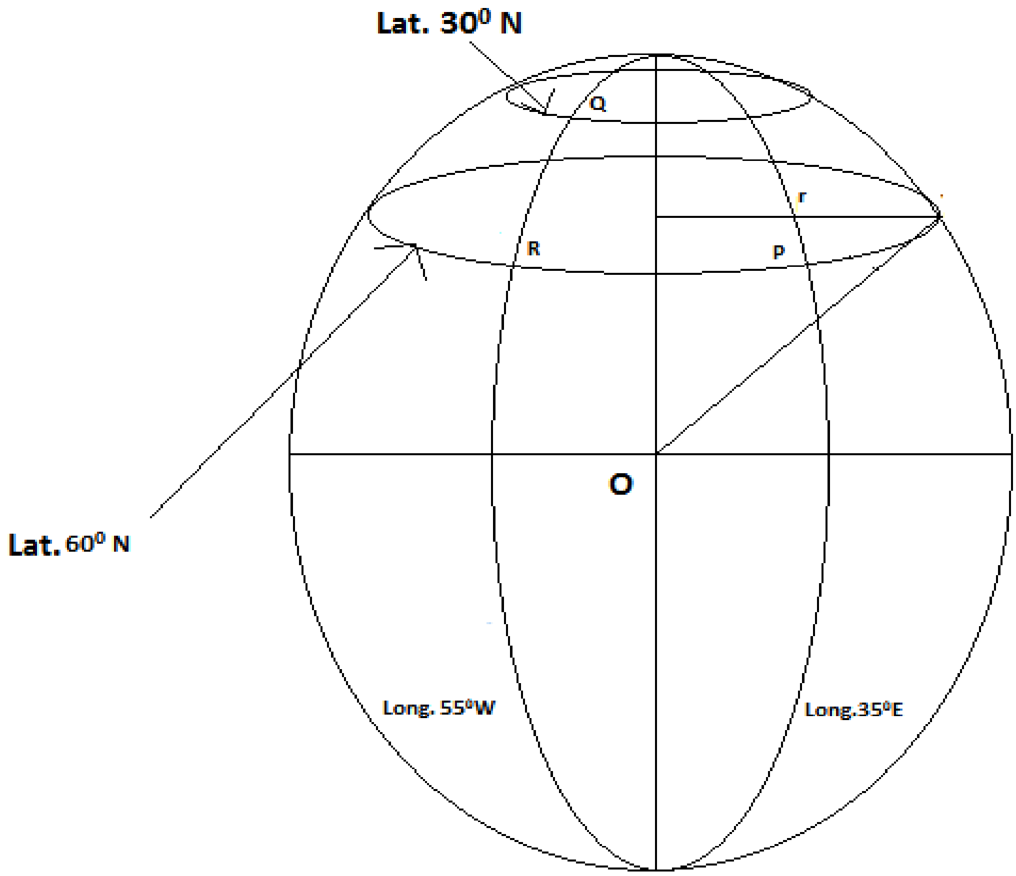
But since PR = 5000km and θ = 35 + B, then 5000 = 56(35 + B),

=> 5000 = 1960 + 56B,

=> 56B = 5000 – 1960 = 3040,

=> B = $\frac{3040}{56} = 55^0$

R lies on longitude 55^0



a) Since the plane flies north from the point R to point Q on latitude 30^0N, then P and Q will have a common longitude of 55^0.

R(Lat. 60^0N, long 55^0W) and Q(Lat. 30^0N, long. 55^0W).

$\theta = 60^0 - 30^0 = 30^0$, since both R and Q are in the west.

The distance QR travelled by the plane = $\frac{\theta}{360}$ x $2\pi R$,

=> QR = $\frac{30}{360}$ x 2 x 3.142 x 6400,

=> QR = 3351km.

Time taken to cover this distance = 8hrs.

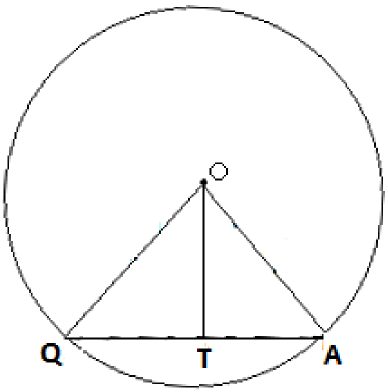
Speed = $\frac{Distance\ travelled}{Time\ taken} = \frac{3351}{8}$

= 420km/h.

N/B:

- The shortest distance through the earth, is also referred to as the shortest distance.

Example:



The shortest distance = QA = 2QT (or 2TA).

Also the shortest distance QA along the parallel of latitude = the length of chord QA = $\frac{\theta}{360}$ x $2\pi r$

- Now consider A(Lat 30^0N, long 15^0E) and B(Lat 30^0N, long 45^0W).

- Since these two points share a common latitude of 30^0N, then for the angle θ, we consider their longitudes which are long 15^0E and long 45^0W.

- Since they have different directions, then $\theta = 15^0 + 45^0 = 60^0$.

- Consider B(Lat 70^0N, long 20^0E) and C(Lat. 70^0N, Long 70^0E).

- These two points share common latitude of 70^0N and as such for the angle θ, we consider only their longitudes i.e. long. 20^0E and Long. 70^0E => $\theta = 70^0 - 20^0 = 50^0$, since they have a common direction.

- In this case, θ = the difference in their longitudes. Consider now B(Lat. 30^0N,Long. 45^0W) and C(Lat 18^0 S, Long. 45^0W).

- Since they have a common longitude of 45^0W, then for angle θ we consider their latitudes which are latitude 30^0N and latitude 18^0S.

- Because they are of different directions, then $\theta = 30 + 18 = 48^0$.

- Lastly, consider A (Lat 10^0N, long 20^0W) and B(Lat 40^0 N, long 20^0W).

- They share a common longitude of 20^0W, and for the angle θ, we consider latitude 10^0N and latitude 40^0N.

- Because they have a common direction, then $\theta = 40 - 10 = 30^0$.

- In this case, θ = the difference in their latitudes.

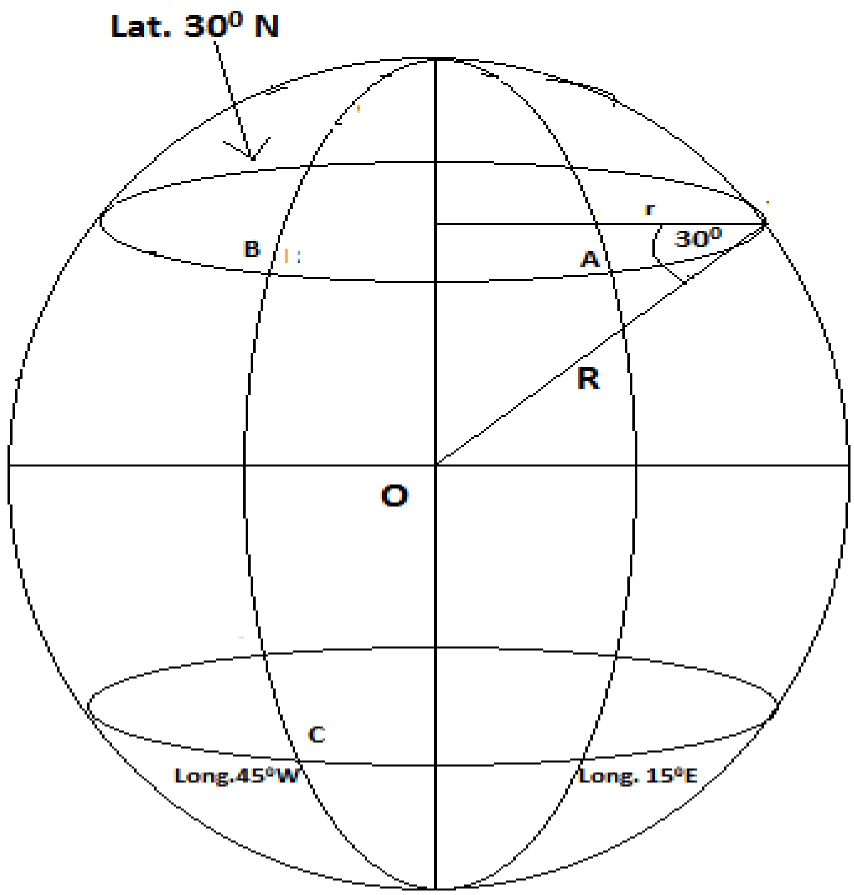
(Q12) If A (Lat. 30^0N, Long 15^0E), B(Lat. 30^0N, Long 45^0W) and C(Lat.18^0S, Longitude 45^0W) are three towns on the earth`s surface. Calculate correct to 3 significant figures;

i) the distance AB measured along the latitude.

(ii) the distance BC measured along the meridian.

Iii) the time taken by an aircraft to cover the distance AB and BC.

Soln:



(i) Since r = R Cos 30^0 => r = 6400 x 0.866,

=> r = 55442km. Towns A and B share or have a common latitude of 30^0N, we consider only their longitudes.

Since the longitudes of A and B have different directions, then θ = 45^0 + 15^0 = 60^0

AB = $\frac{\theta}{360}$ x 2πr = $\frac{60}{360}$ x 2 x 3.142 x 5542

= 5800km.

(ii)Given B(Lat 30^0N, long 45^0W) and C(Lat 18^0S, Long 45^0W). B and C are on the same longitude of 45^0W, and since movement from B to C is along a longitude, then the radius = R = 6400km. Also because towns B and C share a common longitude of 45^0, we consider only their latitudes which are Lat. 30^0N and lat. 18^0S, and this => θ = 30^0 + 18^0 = 48^0.

The distance BC along the meridian = $\frac{\theta}{360}$ x 2πR = $\frac{48}{360}$ x 2 x 3.142 x 6400

= 5365.32 = 5,360km to 3 s.f.

(iii)Time taken by aircraft = $\frac{total\ distance\ travelled\ (km)}{average\ speed\ (km/\text{h})} = \frac{AB\ +\ BC}{average\ speed}$

= $\frac{5800\ +\ 5360}{560}$ = 17.2 hrs (to 3. S.F.)

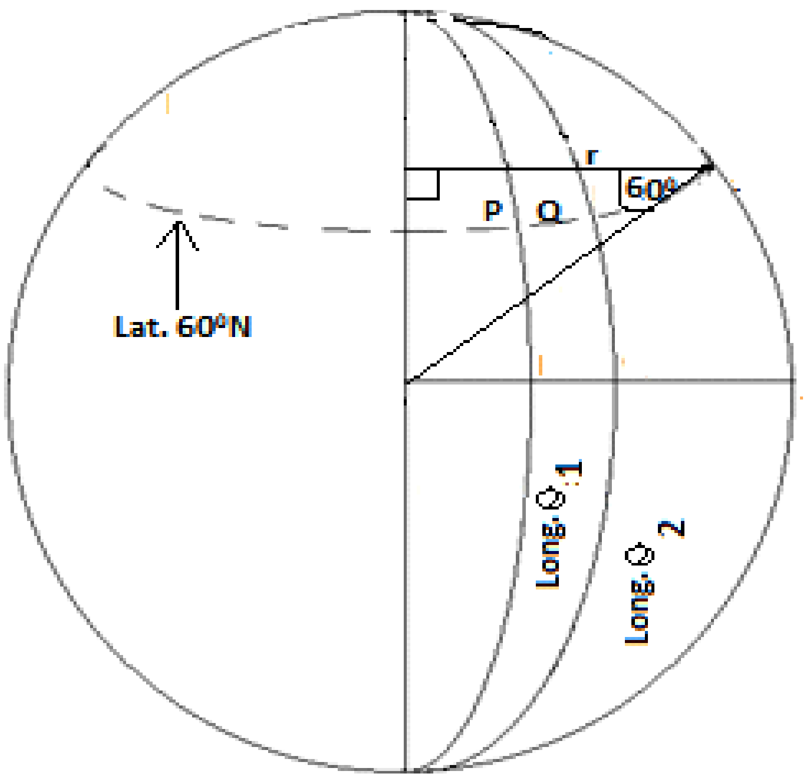
N/B:

- In the formula length of arc = $\frac{\theta}{360}$ x 2πr, θ = the difference in the latitudes concerned.

- Apart from that, θ can also be equal to the difference in the longitudes concerned.

(Q13)An aeroplane files from P to Q in 1 hour at a speed of 120km/min, where P and Q are on the parallel of latitude 60^0N. If the aeroplane flies along this parallel of latitude, calculate correct to three significant figures, the difference in the longitudes of P and Q. [Take π = $\frac{22}{7}$ $and\ the$ radius of the earth = 6400km.].

Soln:



Let P lie on Long. θ_1 and Q lie on Long. θ_2.

Since a difference in their longitudes is made mentioned of, then one longitude must be subtracted from the other, => the two longitudes share a common direction.

In this case, the difference in the longitudes = $\theta = \theta_2 - \theta_1$.

From r = R Cos θ => r = 6400Cos 60^0

=> r = 6400 x 0.5 = 3200.

The radius of their common latitude = 3200km.

Time taken by plane to fly from P to Q = 1hr (60 minutes).

Speed of plane = 120km/min.

If 1 min. = 120km

then 60 mins. =7200.

The total distance travelled by plane from P to Q = 7200km.

Since from the diagram, the distance travelled by plane = the length of arc

PQ, $then\, 7200 = \frac{\theta}{360} \times 2 \times \frac{22}{7} \times 3200$,

=>$7200 = 56\theta$ => $\theta = 129$.

The difference in the longitudes = 129^0.

*