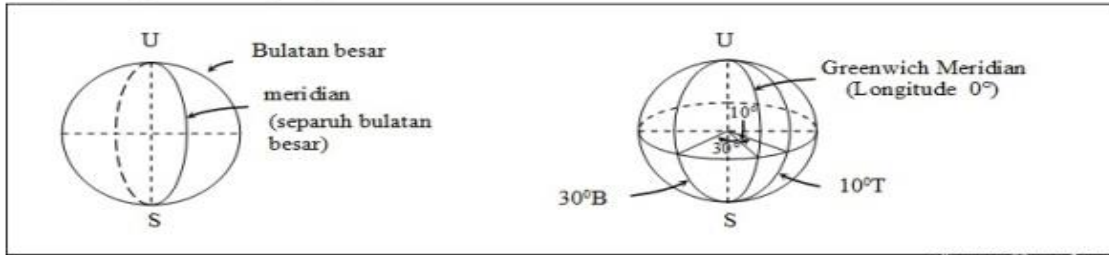


**(30) BUMI SEBAGAI BULATAN  
EARTH AS A SPHERE**

(a) **Longitudes [  $x^{\circ}T$  or  $y^{\circ}B$  ]**      U-Utara S-Selatan T-Timur B-Barat



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(b) **Latitudes [  $x^{\circ}U$  or  $y^{\circ}S$  ]**



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(c) **PERBEZAAN ANTARA DUA LOGITUDE ATAUPUN LATITUDE, Difference between longitudes or latitudes**

Beza dua longitudes, $\theta$	Beza dua latitudes, $\theta$
<ul style="list-style-type: none"> <li><b>sama arah</b> <math>\Rightarrow \theta =</math> cari perbezaan</li> <li><b>Contoh :</b>  <math>20^{\circ}E, 50^{\circ}E \Rightarrow \theta = 50 - 20 = 30</math>  <math>30^{\circ}W, 120^{\circ}W \Rightarrow \theta = 120 - 30 = 90</math> </li> </ul>	<ul style="list-style-type: none"> <li><b>sama arah</b> <math>\Rightarrow \theta =</math> cari perbezaan</li> <li><b>Contoh :</b>  <math>20^{\circ}N, 50^{\circ}N \Rightarrow \theta = 50 - 20 = 30</math>  <math>30^{\circ}S, 120^{\circ}S \Rightarrow \theta = 120 - 30 = 90</math> </li> </ul>
<ul style="list-style-type: none"> <li><b>arah berlainan</b> <math>\Rightarrow \theta =</math> cari jumlah</li> <li><b>Contoh :</b>  <math>10^{\circ}E, 70^{\circ}W \Rightarrow \theta = 10 + 70 = 80</math> </li> <li><b>if the sum of two angles of longitudes <math>&gt; 180</math>,</b>  <math>\Rightarrow \theta = 360 - (\text{the sum})</math></li> <li><b>Example :</b>  <math>120^{\circ}E, 80^{\circ}W \Rightarrow \theta = 360 - (120 + 80) = 160</math> </li> </ul>	<ul style="list-style-type: none"> <li><b>arah berlainan</b> <math>\Rightarrow \theta =</math> cari jumlah</li> <li><b>Contoh :</b>  <math>10^{\circ}N, 70^{\circ}S \Rightarrow \theta = 10 + 70 = 80</math> </li> </ul>

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(d) **Find longitude, latitude**

Find longitude	Find latitude
<ul style="list-style-type: none"> <li>W <math>\leftarrow</math> <math>\ominus</math> E <math>\rightarrow</math> E</li> <li><b>Example :</b>  <math>20^{\circ}W \leftarrow (50) \leftarrow \boxed{30^{\circ}E} \rightarrow (50^{\circ}) \rightarrow 80^{\circ}E</math>                      (difference -if <math>\Rightarrow</math> +if <math>\circ</math>change direction)                 </li> <li>W <math>\leftarrow</math> <math>\oplus</math> W <math>\rightarrow</math> E</li> <li><b>Example :</b>  <math>160^{\circ}E \leftarrow (50) \leftarrow \boxed{150^{\circ}W} \rightarrow (50^{\circ}) \rightarrow 80^{\circ}W</math>                      (sum <math>&gt; 180 \Rightarrow (360 - \text{sum})^{\circ}</math>change direction)                 </li> </ul>	<ul style="list-style-type: none"> <li><b>Example :</b>                      N <math>\uparrow</math> (50°N) <math>\uparrow</math> (40°) <math>\uparrow</math> <math>\boxed{10^{\circ}N}</math> <math>\downarrow</math> (40°) <math>\downarrow</math> (30°S)                      dif. -if, <math>\downarrow</math> +if <math>\circ</math>ch. dir.                 </li> <li><b>Example :</b>                      N <math>\uparrow</math> (30°S) <math>\uparrow</math> (40°) <math>\uparrow</math> <math>\boxed{70^{\circ}S}</math> <math>\downarrow</math> (40°) <math>\downarrow</math> (70°S)                      sum <math>&gt; 90^{\circ}</math>, <math>\downarrow</math> (180-sum)<math>^{\circ}</math> </li> </ul>

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(e) Diameter of the earth, Diameter of the parallel of latitude

	<p style="text-align: center;"><math>a + b = 180</math></p>	<p><b>Example :</b></p> <p>P (30°N, 130°E), Q (30°S, 130°E)</p>
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(f) Location of a place

<p><b>Example 1 :</b></p> <p>∴ R (40°N, 110°E)</p>	<p><b>Example 2 :</b></p> <p>latitude of P = 30°N - 45 = 15°S          longitude of P = 80°E + 60 = 140°E          ∴ P (15°S, 140°E)</p>
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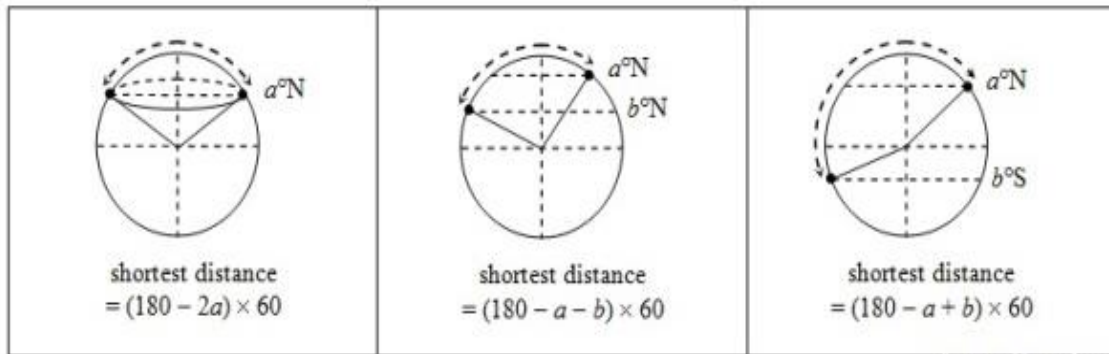
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(g) Distance on the surface of the earth

along a meridian	along the equator	along the parallel of latitude, $y^\circ\text{N} / \text{S}$
<p>distance = <math>\theta \times 60</math>,  <math>\theta</math> = different in latitude</p> <p>∴ <math>\theta = \frac{\text{dis tance}}{60}</math></p>	<p>distance = <math>\theta \times 60</math>,  <math>\theta</math> = different in longitude</p> <p>∴ <math>\theta = \frac{\text{dis tance}}{60}</math></p>	<p>distance = <math>\theta \times 60 \times \cos y</math>,  <math>\theta</math> = different in longitude</p> <p>∴ <math>\theta = \frac{\text{dis tance}}{60 \cos y}</math></p>

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(h) Shortest distance ( distance along a great circle : ----- )



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**Remark :**

⇒ **knot** = unit of speed

⇒ **nautical mile** = unit of distance

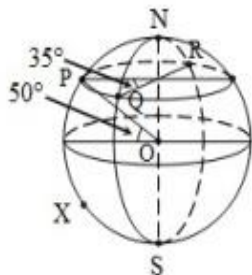
⇒  $\text{speed} = \frac{\text{distance}}{\text{time}}$

⇒  $\text{time} = \frac{\text{distance}}{\text{speed}}$

⇒  $\text{distance} = \text{speed} \times \text{time}$

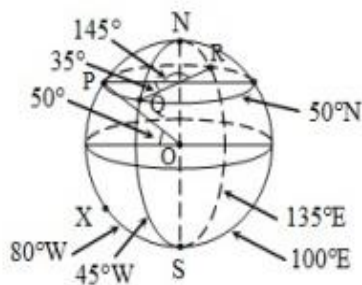
**Example 1 :**

The diagram shows four points, P, Q, R and X, on the surface of the earth. P lies on longitude of  $80^\circ\text{W}$ . QR is the diameter of the parallel of latitude of  $50^\circ\text{N}$ . X lies 5820 nautical miles due south of P.



- (a) Find the position of R.
- (b) Calculate the shortest distance, in nautical miles, from Q to R, measured along the surface of the earth.
- (c) Find the latitude of X.
- (d) An aeroplane took off from P and flew due west to R along the parallel of latitude with an average speed of 600 knots. Calculate the time, in hours, taken for the flight.

**Solution :**



(a) longitude of Q =  $80^\circ\text{W} - 35 = 45^\circ\text{W}$   
 $\therefore R (50^\circ\text{N}, 135^\circ\text{E})$

(b) different in longitude of QR =  $180^\circ$   
 $\therefore QR = 180 \times 60 \times \cos 50 = 10421.63$

(c) different in latitude of PX =  $\frac{5820}{60} = 97^\circ$   
 $\therefore \text{latitude of X} = 50^\circ\text{N} - 97 = 47^\circ\text{S}$

(d) different in longitude of PR =  $145^\circ$   
 $PR = 145 \times 60 = 8700$

$\therefore \text{time} = \frac{8700}{600} = 14.5 \text{ hours}$