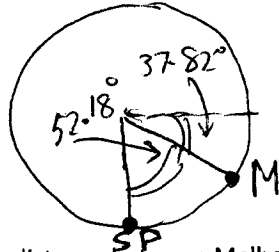


**Question 1**

Melbourne (Victoria) is at  $37.82^\circ$  S and  $144.97^\circ$  E.

- i. Calculate the distance from Melbourne to the South Pole, travelling along the meridian. Give your answer to the nearest kilometre.



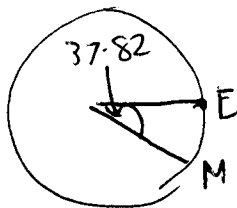
$$90^\circ - 37.82^\circ = 52.18^\circ$$

Distance from Melbourne to South Pole

$$= \frac{\pi R \theta}{180} = \frac{\pi \times 6400 \times 52.18}{180} = 5828.6 \text{ km}$$

$$\approx 5829 \text{ km}$$

- ii. Calculate the distance between Melbourne and the Equator, travelling along the meridian. Give your answer to the nearest km.

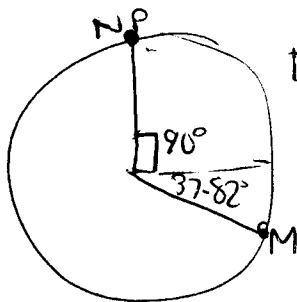


Distance from Melbourne to equator

$$= \frac{\pi R \theta}{180} = \frac{\pi \times 6400 \times 37.82}{180} \approx 4225 \text{ km}$$

2 marks

- iii. Calculate the distance between Melbourne and the North Pole travelling along the meridian. Give your answer correct to the nearest km.



Distance from Melbourne to North Pole

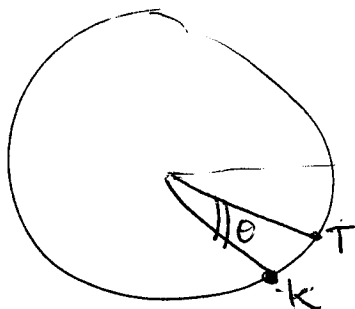
$$= \frac{\pi R \theta}{180}$$

$$= \frac{\pi \times 6400 \times 127.82^\circ}{180} = 14,278 \text{ km}$$

2 marks

**Question 2**

Both Torrens Creek (Queensland) and Kyabram (Victoria) are on the  $145^\circ$  E meridian of longitude, but Torrens Creek is at  $20.77^\circ$  S whereas Kyabram is at  $36.32^\circ$  S. How far is it from Torrens Creek to Kyabram travelling along the  $145^\circ$  E meridian, correct to the nearest km?



$$\theta = 36.32^\circ - 20.77^\circ$$

$$= 15.55^\circ$$

2 marks

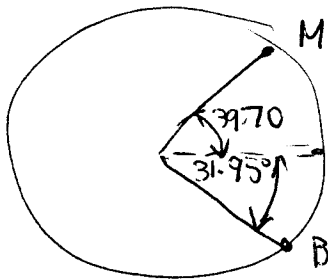
Distance from T to K

$$= \frac{\pi R \theta}{180}$$

$$= \frac{\pi \times 6400 \times 15.55}{180} \approx 1726 \text{ km}$$

**Question 3**

Both Broken Hill (NSW) and Morioka (Japan) are on the 141° E meridian of longitude, but Broken Hill is at 31.95° S whereas Morioka is at 39.70° N. How far is it from Broken Hill to Morioka travelling along the 141° E meridian, correct to the nearest km ?



Distance from B to M

$$= \frac{\pi R \theta}{180}$$

$$\theta = 31.95^\circ + 39.70^\circ = 71.65^\circ$$

2 marks

$$= \frac{\pi \times 6400 \times 71.65}{180}$$

$$\approx 8003 \text{ km}$$

**Question 4**

A ship sailed due east from Cape of Good Hope South Africa (34°S, 18°E) to Cape Leuwin in Western Australia (34°S, 115°E).

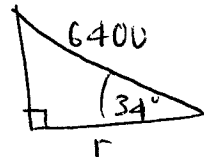
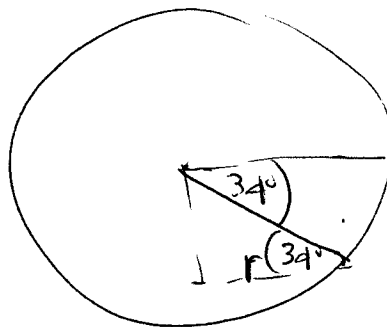
- a. What is the time difference between the Cape of Good Hope and Cape Leuwin?

$$115^\circ - 18^\circ = 97^\circ$$

$$\text{No. of Hours} = \frac{97}{15} \approx 6.47 \approx 6 \text{ hours}$$

1 mark

- b. Calculate the distance in km between the Cape of Good Hope and Cape Leeuwin. Give your answer to the nearest km.



3 marks

$$115^\circ - 18^\circ = 97^\circ$$

i. Distance along circle of latitude

$$\cos(34^\circ) = \frac{r}{6400}$$

$$r = 6400 \cos(34^\circ)$$

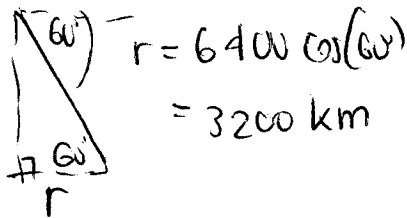
$$r \approx 5305.84 \text{ km}$$

$$= \frac{\pi r \theta}{180} = \frac{\pi \times 5305.84 \times 97}{180} = 8983 \text{ km}$$

**Question 5**

A cruise boat travels from King George Island ( $60^{\circ}\text{S}, 60^{\circ}\text{W}$ ) due west to visit a penguin colony on the South Shetland Island ( $60^{\circ}\text{S}, 64.25^{\circ}\text{W}$ ). Calculate how far the ship travelled, correct to the nearest km.

↑ this means, along the circle of latitude



Distance from King George to South Shetland

$$= \frac{\pi r \theta}{180} \quad \theta = 64.25 - 60 = 4.25^{\circ}$$

$$= \frac{\pi \times 3200 \times 4.25}{180} = 237 \text{ km} \quad \text{3 marks}$$

**Question 6**

The Australian soccer team played against Brazil in the 2006 World Cup in Munich, Germany ( $48^{\circ}\text{N}, 12^{\circ}\text{E}$ ) The game started at 5:00 pm on 18<sup>th</sup> June, Munich time. At what time did the game begin in Melbourne ( $38^{\circ}\text{S}, 145^{\circ}\text{E}$ )?

$$145^{\circ} - 12^{\circ} = 123^{\circ}$$

$$123 \div 15 = 8.2 \approx 8 \text{ hours}$$

$\therefore$  Munich is about 8 hours behind Melbourne

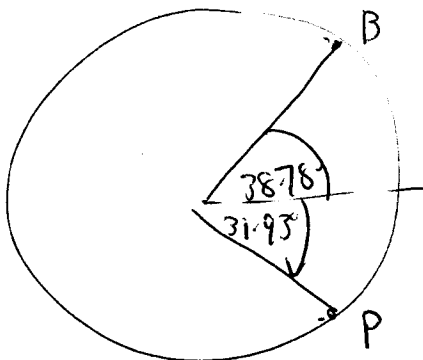
$\therefore$  kick off time in Melbourne

$$= 5:00 \text{ pm} + 8 \text{ hours}$$

$$= 1:00 \text{ AM } 19^{\text{th}} \text{ June} \quad \text{2 marks}$$

**Question 7**

Both Perth (WA) and Baoding (China) are on the  $115^{\circ}\text{E}$  meridian of longitude, but Perth is at  $31.93^{\circ}\text{S}$  whereas Baoding is at  $38.78^{\circ}\text{N}$ . How far is it from Perth to Baoding travelling along the  $115^{\circ}\text{E}$  meridian, correct to the nearest km?



$$\theta = 38.78^{\circ} + 31.93^{\circ} = 70.71^{\circ}$$

Distance

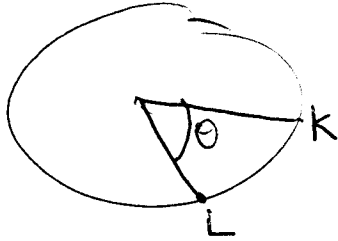
$$= \frac{\pi R \theta}{180}$$

$$= \frac{\pi \times 6400 \times 70.71}{180}$$

$$\approx 7898 \text{ km} \quad \text{2 marks}$$

**Question 8**

Both Libreville (Gabon) and Kismayo (Somalia) are on the Equator on opposite sides of the African continent. Libreville is at  $9.27^\circ$  E and Kismayo is at  $42.32^\circ$  E. How far is it from Libreville to Kismayo travelling along the Equator, correct to the nearest km?



$$\theta = 42.32^\circ - 9.27^\circ = 33.05^\circ$$

Distance from L to K

$$= \frac{\pi R \theta}{180}$$

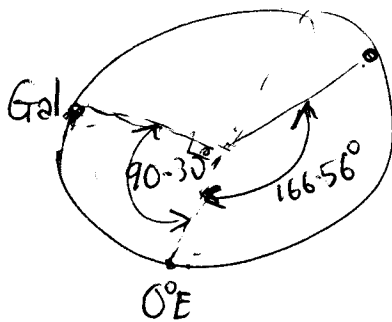
$$= \frac{\pi \times 33.05 \times 6400}{180}$$

$$= 3692 \text{ km}$$

2 marks

**Question 9**

Both the Galapagos Islands and the island of Nauru are on the Equator, but the Galapagos Islands are at  $90.30^\circ$  W whereas the island of Nauru is at  $166.56^\circ$  E. How far is it from the Galapagos Islands to Nauru travelling over the Pacific ocean along the Equator, correct to the nearest km?



The shorter angular distance is:

$$89.70^\circ + 13.44^\circ = 103.14^\circ$$

$$\text{Distance} = \frac{\pi R \theta}{180}$$

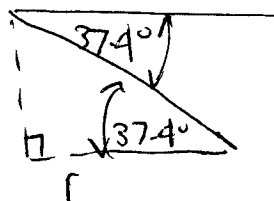
$$= \frac{\pi \times 6400 \times 103.14}{180} = 11,520.85$$

$$\approx 11,521 \text{ km}$$

2 marks

**Question 10**

Both Hamilton (Western Victoria) and Orbost (Gippsland) are on the  $37.4^\circ$  S parallel of latitude, but Hamilton is at  $142.02^\circ$  E whereas Orbost is at  $148.27^\circ$  E. How far is it from Hamilton to Orbost travelling along the  $37.4^\circ$  S parallel, correct to the nearest km?



$$\cos(37.4^\circ) = \frac{r}{6400}$$

$$r = 6400 \cos(37.4^\circ)$$

$$r = 5084.25$$

3 marks

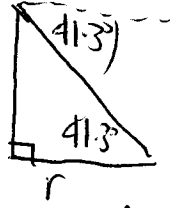
$$\theta = 148.27^\circ - 142.02^\circ = 6.25^\circ$$

$$\text{Distance} = \frac{\pi r \theta}{180} = \frac{\pi \times 5084.25 \times 6.25}{180}$$

$$= 555 \text{ km}$$

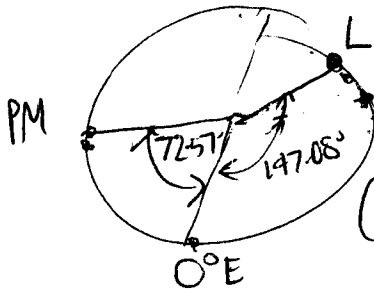
**Question 11**

Both Launceston (Tasmania, Australia) and Puerto Monti (Chile, South America) are on the  $41.3^\circ$  S parallel of latitude, but Launceston is at  $147.08^\circ$  E whereas Puerto Monti is at  $72.57^\circ$  W. How far is it from Launceston to Puerto Monti travelling over the southern Pacific ocean along the  $41.3^\circ$  S parallel, correct to the nearest km?



$$r = 6400 \cos(41.3)$$

$$r = 4808.1 \text{ km}$$



Angular difference

$$= 32.92^\circ + (180^\circ - 72.57^\circ)$$

$$= 140.35^\circ$$

(Or:  $147.08^\circ + 72.57^\circ = 219.65^\circ$   
 $360^\circ - 219.65^\circ = 140.35^\circ$ )

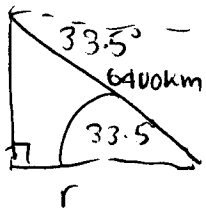
$$\text{Distance} = \frac{\pi r \theta}{180}$$

$$= \frac{\pi \times 4808.1 \times 140.35}{180}$$

$$\approx 11,778 \text{ km}$$

**Question 12**

Both Sydney (New South Wales) and Margaret River (Western Australia) are on the  $33.5^\circ$  S parallel of latitude, but Sydney is at  $151.13^\circ$  E whereas Margaret River is at  $115.04^\circ$  E. How far is it from Sydney to Margaret River travelling along the  $33.5^\circ$  S parallel, correct to the nearest km?



$$r = 6400 \cos(33.5)$$

$$r = 5336.87 \text{ km}$$

$$151.13^\circ - 115.04^\circ$$

$$= 36.09^\circ$$

Required distance

$$= \frac{\pi r \theta}{180}$$

$$= \frac{\pi \times 5336.87 \times 36.09}{180}$$

$$= 3362 \text{ km}$$

3 marks

**Question 13**

A direct flight from Melbourne to Perth leaves Melbourne at 5.00 pm local time and arrives in Perth at 7.10 pm local time. If Melbourne is on the  $145^\circ$  E meridian and Perth is on the  $115^\circ$  E meridian, calculate the total journey time.

$$145^\circ - 115^\circ = 30^\circ$$

$$30^\circ \div 15 = 2$$

$\therefore$  Perth is 2 hours behind Melbourne

	Melb Time	Perth Time
Departs Melbourne	5:00pm	3:00pm
Arrives Perth		7:10pm

2 marks

$$\therefore \text{Time of flight} = 7:10\text{pm} - 3:00\text{pm}$$

$$= 4 \text{ hours } 10 \text{ min}$$

**Question 14**

The Australian Cricket team is flying from Perth to Johannesburg (South Africa) for a series of matches. Their flight leaves Perth at 6.05 am (local time) and arrives in Johannesburg at 8.50 pm (local time). If Perth is on the  $115^\circ$  E meridian and Johannesburg is on the  $28^\circ$  E meridian, calculate the total journey time.

$$115^\circ - 28^\circ = 87^\circ$$

$$87^\circ \div 15 = 5.8 \approx 6 \text{ hours}$$

	Perth Time	Johannesburg Time
Departs Perth	6:05 am	12:05 am
Arrives Johannesburg		8:50 pm

2 marks

$$\begin{aligned} \text{Time of flight} &= 8:50 \text{ pm} - 12:05 \text{ am} \\ &= 20 \text{ hours } 45 \text{ min} \end{aligned}$$

**Question 15**

Australian Eastern Standard Time (which includes Melbourne and Sydney) is based on the  $150^\circ$  E meridian and New York (USA) time is based on the  $75^\circ$  W meridian. If a flight leaves Melbourne at 10.30 am and arrives in New York at 10.15 pm on the same day, calculate the total journey time.

$$150^\circ + 75^\circ = 225^\circ \quad 225 \div 15 = 15 \therefore$$

NY is 15 hours behind Melbourne

	Melbourne Time	NY Time
Departs Melbourne	10:30 am	7:30 pm (day before)
Arrives NY		10:15 pm (next day)

$$\text{Time} = 24 + 2 + 45 \text{ min} = 26 \text{ hours } 45 \text{ min}$$

**Question 16**

- a. Ken Gourlay arrived in Devonport in May 2007 after sailing solo around the world. At one point in his voyage, his chronometer showed that it was 9:30 AM GMT and he observed that the sun was at its highest point in the sky. What was Ken's longitude at this moment?

When it was 9:30 am in Greenwich, it was 12:00 pm at Ken's position

$\therefore$  Time difference of  $2\frac{1}{2}$  hours

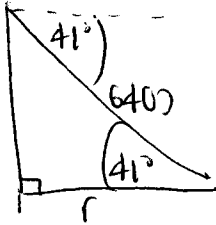
1 mark

$$= 2.5 \times 15^\circ$$

$$= 37.5^\circ \text{ (ahead)}$$

$\therefore$  His longitude was  $37.5^\circ$  E

- b. During the final part of his journey, Ken sailed from the position ( $41^{\circ}\text{S}$ ,  $21^{\circ}\text{E}$ ) (near Cape Town, South Africa) **due east** to the position with co-ordinates: ( $41^{\circ}\text{S}$ ,  $143^{\circ}\text{E}$ ) (near Tasmania). Calculate the distance covered in this part of the journey, to the nearest km.



$$r = 6400 \cos(41^{\circ})$$

$$r = 4830.14 \text{ km}$$

$$143^{\circ} - 21^{\circ} = 122^{\circ}$$

$$d = \frac{\pi r \theta}{180}$$

$$= \frac{\pi \times 4830.14 \times 122}{180}$$

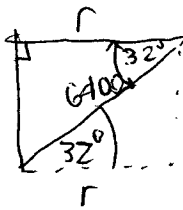
$$= 10,285 \text{ km}$$

3 marks

### Question 17

Neville departs San Diego ( $32^{\circ}\text{N}$ ,  $117^{\circ}\text{W}$ ) at 10:30 am and flies due east to Dallas ( $32^{\circ}\text{N}$ ,  $97^{\circ}\text{W}$ ).

- a. Determine the distance he flies east, to the nearest km.



$$r = 6400 \cos(32^{\circ})$$

$$r = 5427.51 \text{ km}$$

$$117^{\circ} - 97^{\circ} = 20^{\circ}$$

$$d = \frac{\pi r \theta}{180} = \frac{\pi \times 5427.51 \times 20}{180}$$

$$= 1895 \text{ km}$$

- b. If Neville arrives in Dallas at 2:58 pm (Dallas time) on 5 March, how long did his flight take?

	San Diego Time	Dallas Time
Departs San Diego	10:30 am	11:30 am
Arrives Dallas		2:58 pm

$$117^{\circ} - 97^{\circ} = 20^{\circ}$$

$$20 \div 15 \approx 1 \text{ hour}$$

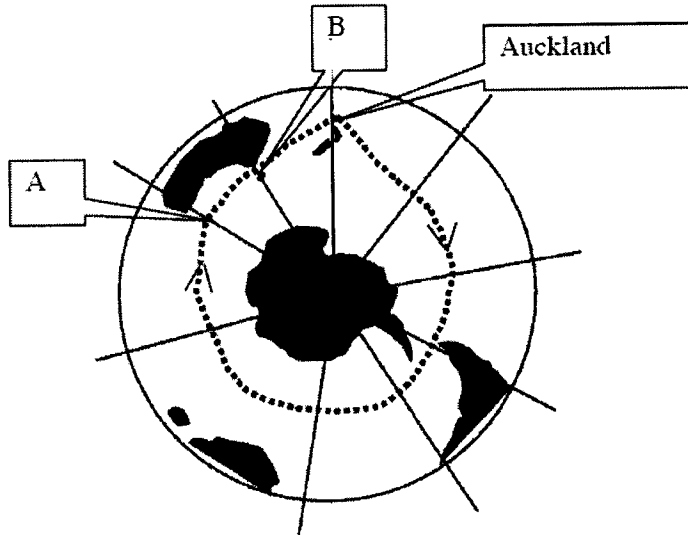
$\therefore$  San Diego is 1 hour behind Dallas

$$\text{Time of flight} = 2:58 \text{ pm} - 11:30 \text{ am}$$

$$= 3 \text{ hours } 28 \text{ min}$$

**Question 18**

The *Antarctica Cup* is an ocean yacht race that involves sailing around the Antarctic continent. The race starts and finishes in Auckland (New Zealand) as shown below.



The last two sections of the race takes the boats from point A ( $40^{\circ}\text{S}$ ,  $116^{\circ}\text{E}$ ) **due east** to point B ( $40^{\circ}\text{S}$ ,  $147^{\circ}\text{E}$ ). From point B the yachts head **directly** to Auckland ( $37^{\circ}\text{S}$ ,  $174^{\circ}\text{E}$ ).

a. Calculate the time difference between:

i. Auckland and point B

$$174^{\circ} - 147^{\circ} = 27^{\circ} \rightarrow \text{Auckland is 2 hours ahead of B.}$$

$$27^{\circ} \div 15 = 1.8 \approx 2$$

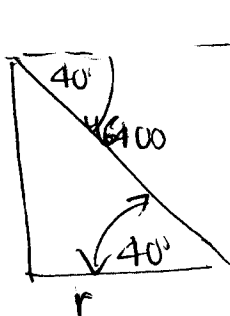
ii. Auckland and point A

$$174^{\circ} - 116^{\circ} = 58^{\circ} \rightarrow \text{Auckland is 4 hours ahead.}$$

$$58^{\circ} \div 15 = 3.87 \approx 4$$

2 marks

b. Calculate the distance in km between point A and B. Give your answer to the nearest km.



$$r = 6400 \cos(40^{\circ})$$

$$r = 4902.68 \text{ km}$$

$$147^{\circ} - 116^{\circ} = 31^{\circ}$$

$$\text{distance} = \frac{\pi r \theta}{180}$$

$$= \frac{\pi \times 4902.68 \times 31}{180}$$

$$\approx 2653 \text{ km}$$

3 marks