

Goals

This week and next week we are going to:



- locate positions on Earth's surface given latitude and longitude using GPS, a globe, an atlas, and digital technologies; find distances between two places on Earth on the same longitude; find distances between two places on Earth using appropriate technology
- understand the link between longitude and time; solve problems involving time zones in Australia and in neighbouring nations, making any necessary allowances for daylight saving; find time differences between two places on Earth
- solve problems associated with time zones; for example, internet and phone usage; solve problems relating to travelling east and west, incorporating time zone changes; solve problems involving Greenwich Mean Time and the International Date Line

Theoretical Components

Resources:

PDF file: Week 7 and 8 Earth Geometry

This clip provides a simple explanation of latitude and longitude.

<https://www.youtube.com/watch?v=swKBi6hHHMA>

This clip provides a more detailed explanation.

<http://www.youtube.com/watch?v=JiA8T-jZwtM>

This clip provides a short introduction to time zones.

<http://www.youtube.com/watch?v=UH3ITIMk2uk>

Knowledge Checklist

- Latitude and longitude
- World locations
- Difference in longitude
- Calculating time
- World time zones
- Calculating differences in time
- Distances along great circles

Order

1. Work through the Week 7 and 8 booklet
2. Complete the Portfolio task
3. Complete the reflection at the end of the booklet
4. Show your teacher the completed booklet

Practical Components

Work through the exercises and show the completed tasks to your teacher.

Week 8 starts at the 'World Time Zones' section.

Do you have a calculator for the test?

Portfolio Task

See the last page of the booklet

Other

Do you have a calculator for the test?

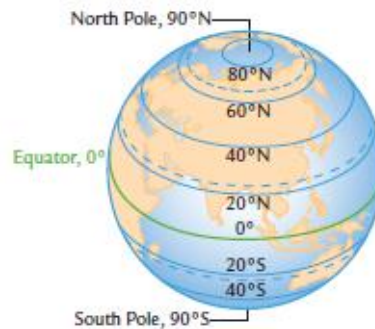
Do you have a calculator and pen for the test?

ESSENTIAL MATHEMATICS 4

WEEK 7 AND 8 – EARTH GEOMETRY

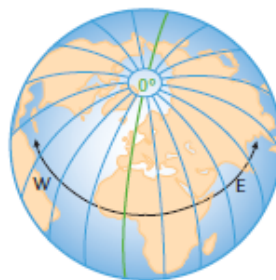
World Locations

Street directories use grid references, such as C5, to locate streets, parks, and other features in the local area. On the world map, or globe, latitude and longitude lines are used as grid references.



Parallels of **latitude** are imaginary lines that are parallel to the Equator.

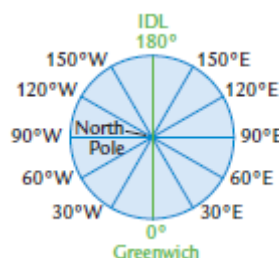
- The latitude of the North Pole is 90° North (90°N)
- The latitude of the equator is 0°
- The latitude of the South Pole is 90° South (90°S)



Meridians of **longitude** are imaginary lines running around the Earth from pole to pole. We measure longitude as degrees East or West of the **Greenwich** meridian.

- The meridian through Greenwich, near London in England, is called the **Prime Meridian**. It has longitude 0°.
- The 180°E and the 180°W meridians are the same line. This line, which runs through the Pacific Ocean, is called the **International Date Line (IDL)**.

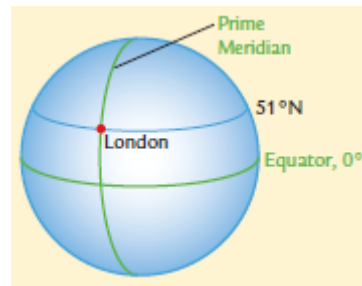
When you travel across the IDL the date changes. The date is one day later west of the line than it is east of the line.



Do you have a calculator and pen for the test?

Example 1

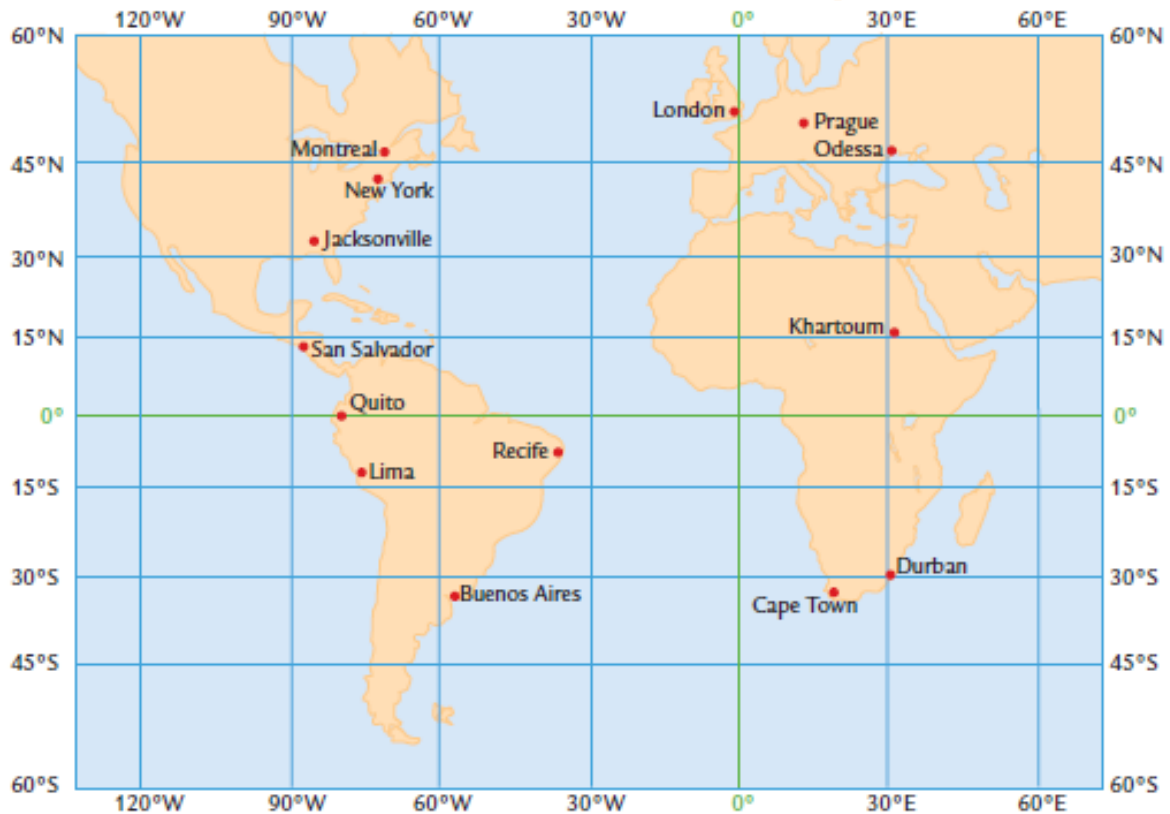
1. What are the position coordinates of London?



Solution

1. London is on the Prime Meridian and on the 51°N parallel of latitude. The latitude is always written first. The position coordinates of London are (51°N, 0°).

Location positions on a world map



Example 2

1. Is the city Odessa north or south of the Equator, and east or west of Greenwich?
2. Which city is located at approximately 35°S and 60°W?

Solution

1. Odessa is **above** the Equator, so Odessa is **north** of the Equator. Odessa is to the **right** of Greenwich, so Odessa is **east** of Greenwich.
2. The position 35°S is below the Equator and 60°W is left of Greenwich. The city is Buenos Aires.

Exercise 1

Use the map above to answer the following 5 questions.

1. Which of these cities, Cape Town, Khartoum, Montreal, New York and Recife, are (there is more than one city for each answer, answer all that applies):
 - a. north of the Equator?
 - b. south of the Equator?
 - c. east of the Prime Meridian?
 - d. west of the Prime Meridian?
2. Write down the names of the two cities with an approximate latitude of 45°N .
3. Write down the names of three cities with an approximate longitude of 30°E .

4. Abdullah wrote the position coordinates of London as (0°, 51°N). Explain what Abdullah did wrong.

5. What cities are located at these approximate positions (coordinates)?

a. (40°N, 70°W)

b. (50°N, 14°E)

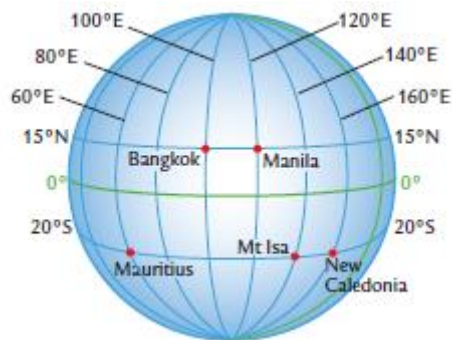
c. (32°S, 55°W)

d. (15°S, 70°W)

e. (32°S, 26°E)

f. (0°, 75°W)

6. What are the coordinates of these locations?



a. New Caledonia

b. Mt Isa

c. Manila

d. Bangkok

7. When Seth was scuba diving, he discovered the wreck of an old Spanish ship at (15°S, 70°E). Is the wreck closest to New Caledonia, Manila, Mauritius or Bangkok?

8. Using the map, what is the latitude and longitude of:



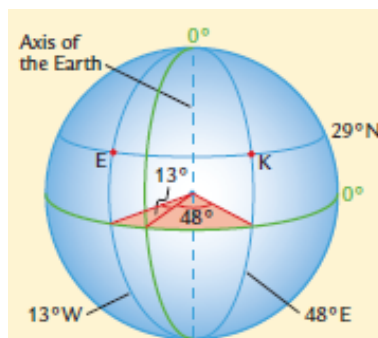
- a. Canberra
- b. Perth
- c. Darwin
- d. Melbourne

The difference in longitude

Real time at locations on the Earth is determined by the place's longitude. You can calculate the time differences between places if you know the difference in the longitude of the places.

Example 3

- Find the difference in longitude between El Ayoun (29°N, 13°W) and Kuwait City (29°N, 48°E).



Do you have a calculator and pen for the test?

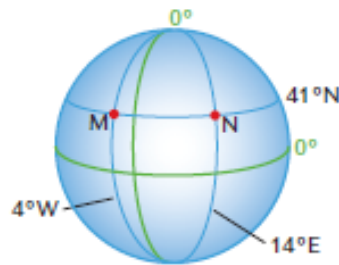
Solution

1. The angle between the meridian through Kuwait City (K) and the Prime Meridian is 48° . The angle between the meridian through El Ayoun (E) and the Prime Meridian is 13° . El Ayoun and Kuwait City are on different sides of the Prime Meridian, so we will add the two angles together.

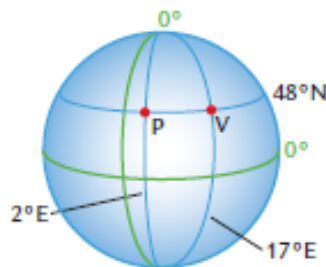
$$\text{Difference in longitude} = 48^\circ + 13^\circ = 61^\circ$$

Exercise 2

1. Madrid in Spain is at (41°N , 4°W) and Naples in Italy is at (41°N , 14°E). Calculate the difference in longitude between Madrid and Naples.

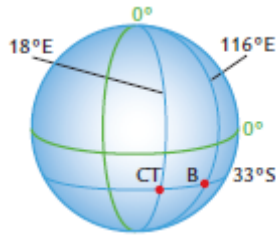


2. The approximate locations of Paris in France and Vienna in Austria are (48°N , 2°E) and (48°N , 17°E).



- a. Are Paris and Vienna on the same or different sides of the Prime Meridian?
- b. Explain why the difference in longitude between Paris and Vienna is 15° .

3. Calculate the difference in longitude between Bunbury in Western Australia (33°S , 116°E) and Cape Town in South Africa (33°S , 18°E).



4. Use the techniques from the previous questions to help you determine the difference in longitude between the following locations.

a. Buenos Aires in Argentina (34°S , 58°W) and Sydney (34°S , 151°E)

b. Natal in Brazil (5°S , 335°W) and Piura in Peru (5°S , 80°W)

c. Rarotonga in the Cook Islands (22°S , 160°W) and Noumea in New Caledonia (22°S , 166°E)

Calculating Time

Two places that have a difference in longitude of 15° have a time difference of 1 hour. Places with a longitude difference of 30° have a time difference of 2 hours.

Places to the east have a later time than places to the west. We say that places to the east are 'ahead' in time and places to the west are 'behind' in time.

Example 4

The longitude of Rockhampton is 150°E and the longitude of Broome in Western Australia is close to 120°E .

- a. What is the time difference between Rockhampton and Broome?
- b. When it is 7 pm in Broome, what time is it in Rockhampton?

Solution

- a. The difference in longitude between Rockhampton and Broome is $150^\circ - 120^\circ = 30^\circ$. For every 15° difference in longitude the time difference is 1 hour. $30^\circ \div 15^\circ = 2$ hours. The time difference is 2 hours.
- b. Rockhampton is east of Broome. The time in Rockhampton is 2 hours later than the time in Broome. In Rockhampton, it is 7 pm + 2 hours. The time in Rockhampton is 9 pm.

Exercise 3

1. Two cities have a time difference of 3 hours. Explain how you know that the difference in their longitude is 45° .

2. Two places have a difference in longitude of 60° . What is the time difference between the places?

3. The longitude of Canberra is close to 150°E and the longitude of Taiwan is 120°E .
 - a. What is the difference in longitude between Canberra and Taiwan?

- b. What is the time difference between Canberra and Taiwan?
 - c. Which location, Canberra or Taiwan, is further east?
 - d. What time is it in Canberra when it is 12 noon in Taiwan?
 - e. What time is it in Taiwan when it is 7 pm in Canberra?
4. The time in Sri Lanka is based on the 80°E meridian of longitude and the time in Vietnam is based on the 110°E .
- a. What is the difference in longitude?
 - b. Calculate the time difference between Sri Lanka and Vietnam.
 - c. Is the time later in Sri Lanka or in Vietnam? Why?
 - d. When it is 9 pm in Vietnam, what time is it in Sri Lanka?
5. Kiev in the Ukraine is at (50°N , 30°E) and Shanghai in China is at (30°N , 120°E).
- a. Explain how you know that the time difference between Kiev and Shanghai is 6 hours.
 - b. When it is 12 noon in Shanghai, what time is it in Kiev?

World Time Zones

It would be very inconvenient if places used the exact time determined by their longitude. Imagine the chaos if you had to change your watch by a few minutes when you travelled 100 km west.

To avoid this problem, the world is divided into 24 time zones. The 12th time zone east (+12) and the 12th time zone west (-12) meet at the International Date Line.



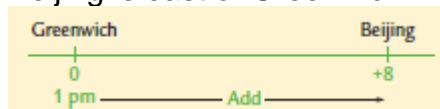
Example 5

1. When it is 1 pm in Greenwich, what time is it in Beijing?
2. When it is 9 am on Tuesday in Beijing, what time and day is it in New York?

Solution

The easiest way to determine local time is to use a timeline.

1. Beijing is east of Greenwich.



We add the time difference to the time in Greenwich.
Time in Beijing = 1 pm + 8 hours = 9 pm

2. New York is west of Beijing.

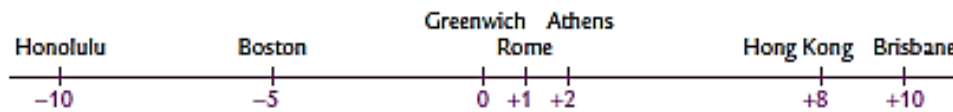
The time difference is $8 + 5 = 13$, we add because they are on different sides of the Prime Meridian.

We subtract the time difference from the time in Beijing.

Time on New York = 9 am Tuesday – 13 hours = 8 pm Monday

Exercise 4

This timeline shows the world time zones for seven cities. Use the timeline to answer these questions. You may need to look up some other time zones.



1. What is the time difference between Boston and Hong Kong?
2. When Charlie was in Hong Kong, he phoned his mother in Boston. The time in Hong Kong was 9 am. What time was it in Boston?
3. Isabel was in Rome enjoying her first overseas holiday. At 7:30 am, after she finished breakfast in the café, she phoned her father in Brisbane. What time was it in Brisbane?
4. Zoe is in Honolulu and wants to video call her friend, George, in Athens. What time should Zoe call George if George finishes work at 6 pm in Athens?
5. Elka caught a non-stop flight from Brisbane to Athens. The flight left Brisbane at 1130 Brisbane time.
 - a. What time was it in Athens when Elka's flight left Brisbane? Express your answer in 24-hour time.
 - b. The flight landed in Athens at 2330 local time. How long did the flight take?

6. Lachlan's flight from London to Hong Kong left London at 1300 London time. The flight took 11 hours and 30 minutes.
 - a. What time was it in London when Lachlan's flight landed in Hong Kong?

 - b. What was the local time in Hong Kong when Lachlan's plane landed?

7. The Brisbane Broncos are going to play a football match in Auckland, New Zealand. The local time in Auckland is 2 hours ahead of the time in Brisbane. The live TV coverage of the match is going to start in Auckland at 7 pm local time. At what time will the live match start on Brisbane TV?

8. Aaliah caught a flight from Canberra to London, stopping at Perth. The duration of the flight from Canberra to Perth is 5 hours and the duration of the flight from Perth to London is 17 hours. Aaliah had a layover time of 2 hours. The flight left Canberra at 2:35 pm Wednesday. What time does the flight land in London? Hint: Find the time difference for each city.

World distances

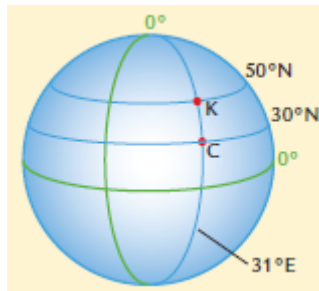
The imaginary parallels of latitude and meridians of longitude make two different types of circles on the Earth's surface. **Great circles** are the biggest circles on the Earth. The Equator and all the meridians of longitude are great circles. The radius of all great circles is the same as the radius of the Earth, about 6400 km. The Tropic of Capricorn and all other parallels of latitude, with the exception of the **Equator**, are different sized **small circles**. The radii of small circles are less than 6400 km.

Distances on great circles

On the surface of the Earth, a difference of 1° along a great circle is the same as 60 nautical miles. A speed of 1 nautical mile per hour is **1 knot**. A distance of 1 nautical mile is about **1.852 kilometres**. Nautical miles are often used to measure distances over water or in the air.

Example 6

Find the distance between Kiev in Ukraine (50°N , 31°E) and Cairo in Egypt (30°N , 31°E).



Solution

Kiev and Cairo lie on the **same** meridian of longitude. They are on the same great circle. There is 20° along the great circle between the locations. Each degree represents 60 nautical miles.

Distance between Kiev and Cairo:

$$\text{Distance} = 20 \times 60 \text{ nautical miles}$$

$$\text{Distance} = 1200 \text{ nautical miles}$$

To convert nautical miles to kilometres, just multiply by 1.852.

$$\text{Distance} = 1200 \times 1.852 \text{ km}$$

$$\text{Distance} = 2222.4 \text{ km}$$

Exercise 5

1. Use the conversion factor, 1 nautical mile (M) = 1.852 km, to convert the following distances to kilometres.

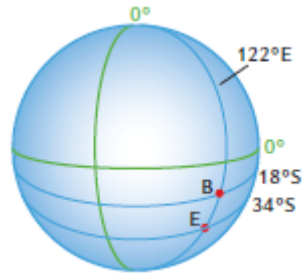
a. 700 M

b. 1550 M

c. 3600 M

d. 46.5 M

2. Calculate the distance in nautical miles along the 122°E meridian of longitude from Esperance (34°S , 122°E) to Broome (18°S , 122°E), both in Western Australia.



3. Pontianak in Borneo and Mbandaka in Zaire both lie on the Equator. Their position coordinates are Pontianak (0° , 109°E) and Mbandaka (0° , 18°E).
- a. How many degrees is it between Pontianak and Mbandaka?

b. Calculate the distance between Pontianak and Mbandaka in nautical miles.

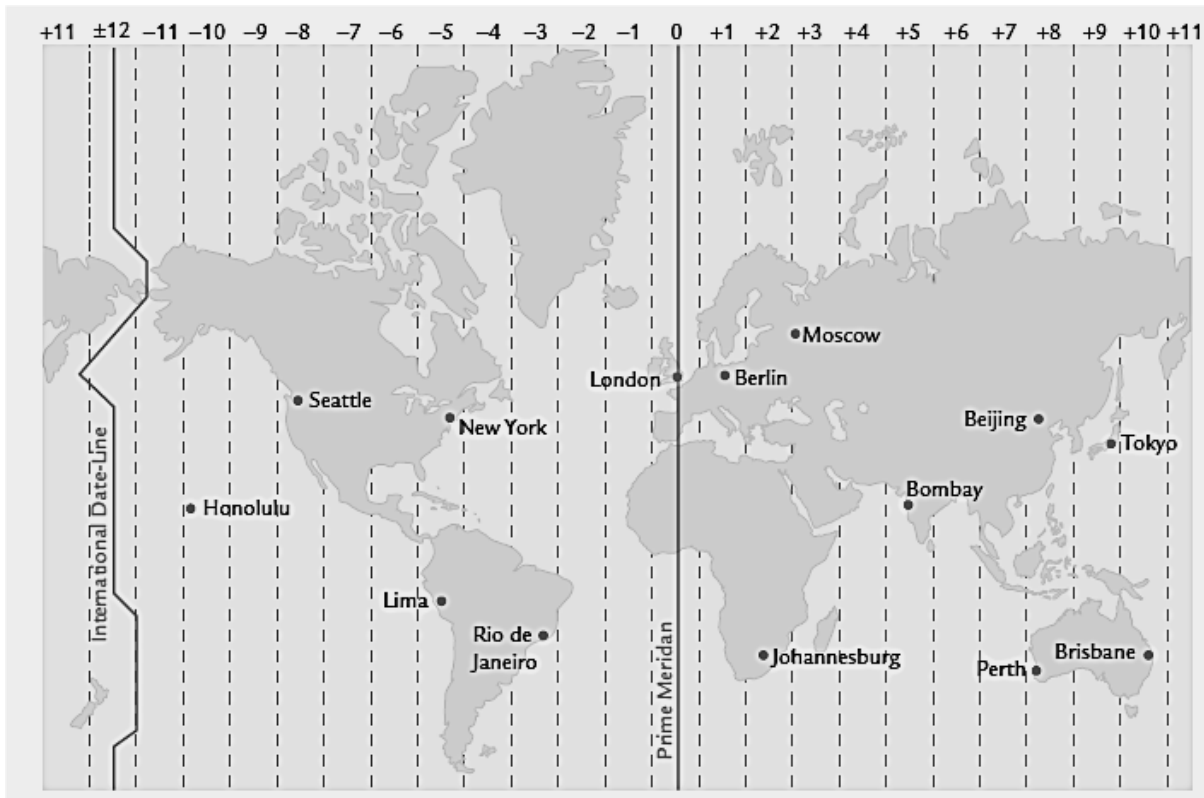
c. Convert the distance between the two places to kilometres.

4. Calculate the distance in km along the Equator from (0° , 30°E) to (0° , 10°W).

5. Alif sailed along a great circle from Cuba (22°N , 80°W) to Miami (26°N , 80°W).
- How many nautical miles is it from Cuba to Miami?
 - Alif's boat averaged 6 knots for the trip. How many hours did it take him to sail from Cuba to Miami?
 - He left Cuba at 3 am on Monday. What was the day and time when he arrived in Miami?
6. A plane flies due South, from Canberra (35°S , 148°E) to Hobart (42°S , 148°E).
- What is the distance the plane has travelled to the nearest kilometre?
 - The plane averaged 750 km/hr for the trip. How long was the flight?
 - The plane leaves Canberra at 3:15 pm on Monday. What time will it land in Hobart?

Portfolio Task Week 7 and 8

Canberra is in the same time zone as Brisbane while Los Angeles is in the same time zone as Seattle.



1. Use the map to draw a timeline showing Canberra and Los Angeles.
2. How many hours difference between the two cities? Which city is 'ahead' in time?
3. A flight from Canberra to Los Angeles leaves at 1:00 pm on Saturday. What time is it in Los Angeles?

4. The flight takes 16 hours. What time will the plane land in Los Angeles?

5. If you have done this calculation correctly, you will get an interesting result. What is the result?

MARKING RUBRIC

CRITERIA	EXPECTATIONS	POSS	MULT	GIVEN	TOTAL
Practical	Student completes practical work, including exercises of the brief to an acceptable standard set by the teacher.	2	3		/6
Portfolio Task	Student completes the portfolio task of the week to an acceptable standard set by the teacher.	2	2		/4
Reasoning and Communications	Student responses are accurate and appropriate in presentation of mathematical ideas, with clear and logical working out shown.	4	-		/4
Concepts and Techniques	Student submitted work selects and applies appropriate mathematical techniques to solve practical problems and demonstrates proficiency in the use of mathematical facts, techniques and formulae.	4	-		/4
	Submission Guidelines				
Timeliness	Student submits the exercises and portfolio tasks by the set deadline. See scoring guidelines for specific details.	2	-		/2
				FINAL	/20

Student Reflection:

How did you go with this week's work? What was interesting? What did you find easy? What do you need to work on?