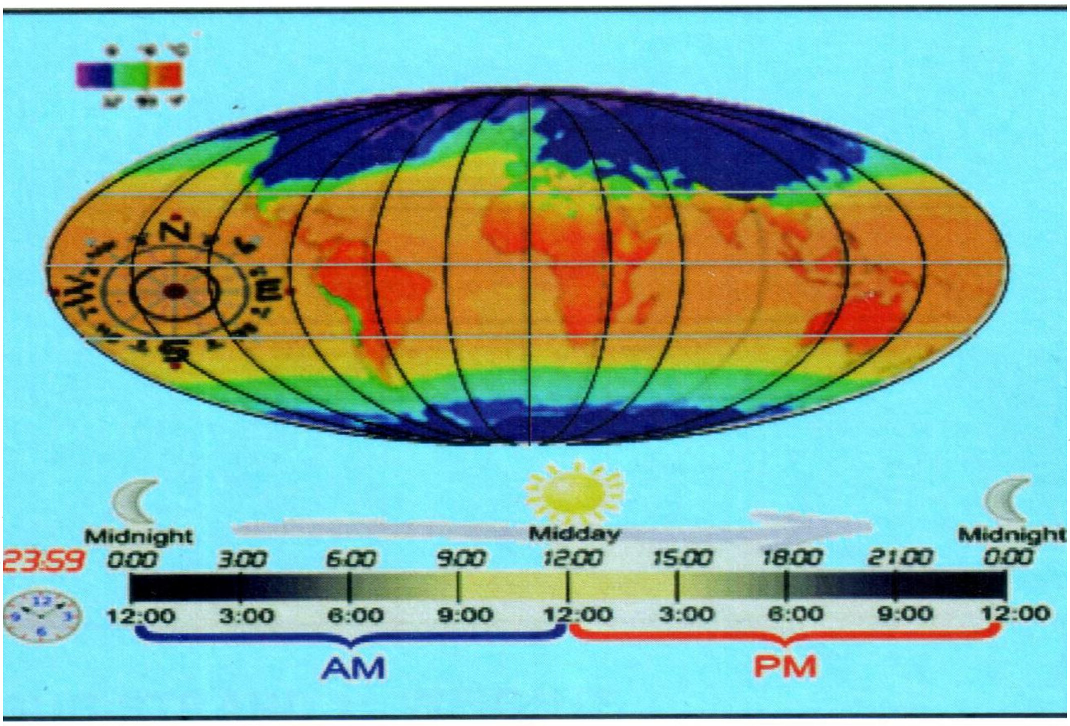
DEPARTMENT OF EDUCATION

GRADE 8

MATHEMATICS

STRAND 4



MEASUREMENTS (2)

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PAPUA NEW GUINEA

GRADE 8

MATHEMATICS

STRAND 4

MEASUREMENT (2)

SUB-STRAND 1: WEIGHTS

SUB-STRAND 2: TEMPERATURE

SUB-STRAND 3: TIME

SUB-STRAND 4: MAPS AND COORDINATES

Acknowledgements

We acknowledge the contributions of all Secondary and Upper Primary Teachers who in one way or another helped to develop this Course.

Special thanks is given to the Staff of the Mathematics Department of FODE who played active role in coordinating writing workshops, outsourcing lesson writing and editing processes, involving selected teachers of NCD.

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MR. DEMAS TONGOGO
Principal- FODE

Written by: Luzviminda B. Fernandez

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CONTENTS

SECRETARY'S MESSAGE

Achieving a better future by individual students and their families, communities or the nation as a whole, depends on the kind of curriculum and the way it is delivered.

This course is part and parcel of the new reformed curriculum. The learning outcomes are student-centered with demonstrations and activities that can be assessed.

It maintains the rationale, goals, aims and principles of the national curriculum and identifies the knowledge, skills, attitudes and values that students should achieve.

This is a provision by Flexible, Open and Distance Education as an alternative pathway of formal education.

The course promotes Papua New Guinea values and beliefs which are found in our Constitution and Government Policies. It is developed in line with the National Education Plans and addresses an increase in the number of school leavers as a result of lack of access to secondary and higher educational institutions.

Flexible, Open and Distance Education curriculum is guided by the Department of Education's Mission which is fivefold:

- to facilitate and promote the integral development of every individual
- to develop and encourage an education system that satisfies the requirements of Papua New Guinea and its people
- to establish, preserve and improve standards of education throughout Papua New Guinea
- to make the benefits of such education available as widely as possible to all of the people
- to make the education accessible to the poor and physically, mentally and socially handicapped as well as to those who are educationally disadvantaged.

The college is enhanced through this course to provide alternative and comparable pathways for students and adults to complete their education through a one system, two pathways and same outcomes.

It is our vision that Papua New Guineans' harness all appropriate and affordable technologies to pursue this program.

I commend all the teachers, curriculum writers and instructional designers who have contributed towards the development of this course.

…………………………………………

DR. UKE KOMBRA, PhD
Acting Secretary for Education

STRAND 4: MEASUREMENTS (2)

Dear student,

This is the Fourth Strand of the Grade 8 Mathematics Course. It is based on the NDOE Upper Primary Mathematics Syllabus and Curriculum framework for Grade 8.

This Strand consists of four Sub-strands:

Sub-strand 1: Weights
Sub-strand 2: Temperature
Sub-strand 3: Time
Sub-strand 4: Maps and Coordinates

Sub-strand 1- **Weight -** You will solve real life weight problems and differentiate between weight and mass.

Sub-strand 2 – **Temperature -** You will read and record temperature using the wet and dry bulb thermometers

Sub-strand 3 – **Time -** You will recognise relationships between location and time and use time rate calculations

Sub-strand 4 – **Maps and Coordinates -** You will use and read maps accurately, locate places on the map using the longitude and latitude, use the number plane to plot and locate points and graph straight lines on a number plane.

You will find that each lesson has reading materials to study, worked examples to help you, and a Practice Exercise. The answers to practice exercises are given at the end of each sub-strand.

All the lessons are written in simple language with comic characters to guide you and many worked examples to help you. The practice exercises are graded to help you to learn the process of working out problems.

We hope you enjoy using this Strand.

All the best!

Mathematics Department
FODE

STUDY GUIDE

Follow the steps given below as you work through the Strand.

Step 1: Start with SUB-STRAND 1 Lesson 1 and work through it.

Step 2: When you complete Lesson 1, do Practice Exercise 1.

Step 3: After you have completed Practice Exercise 1, check your work. The answers are given at the end of SUB-STRAND 1.

Step 4: Then, revise Lesson 1 and correct your mistakes, if any.

Step 5: When you have completed all these steps, tick the check-box for the Lesson, on the Contents Page (page 3) Like this:

√ Lesson 1: Units of Weights

Then go on to the next Lesson. Repeat the process until you complete all of the lessons in Sub-strand 1.

> As you complete each lesson, tick the check-box for that lesson, on the Content‘s page 3, like this √ .This helps you to check on your progress.

Step 6: Revise the Sub-strand using Sub-strand 1 Summary, then do Sub-strand Test 1 in Assignment 4.

Then go on to the next Sub-strand. Repeat the process until you complete all of the four Sub-strands in Strand 4.

Assignment: (Four Sub-strand Tests and a Strand Test)
When you have revised each Sub-strand using the Sub-strand Summary, do the Sub-strand Test for that Sub-strand in your Assignment. The Course book tells you when to do each Sub-strand Test.

When you have completed the four Sub-strand Tests, revise well and do the Strand Test. The Assignment tells you when to do the Strand Test.

> The Sub-strand Tests and the Strand Test in the Assignment will be marked by your Distance Teacher. The marks you score in each Assignment will count towards your final mark. If you score less than 50%, you will repeat that Assignment.

Remember, if you score less than 50% in three Assignments, your enrolment will be cancelled. So, work carefully and make sure that you pass all of the Assignments.

SUB -STRAND 1

WEIGHTS

Lesson 1:	**Units of Weight**
Lesson 2:	**Weight and Age Charts**
Lesson 3:	**Average Weight**
Lesson 4:	**Weight and Mass**
Lesson 5:	**Solving Problems Involving Weight**

SUB-STRAND 1: WEIGHTS

Introduction

In our daily use of the term ‗weight', we often mistakenly use the word in the context of ‗mass'. For instance, someone would say my weight is 69 kg when he actually means his mass is 69 kg.

This Sub-strand is an extension of what you have learnt about weights in your Grade 7 Mathematics Strand 4. As you have learnt, mass and weight are different. Mass is a more fundamental quantity than weight.

Let's revise the definition of these two important terms:

- **The weight of an object is the force which gravity exerts upon it.** It is measured in **newton (N).**
- **The mass of an object is the amount of matter it contains.** The unit of mass is kilogram (kg).

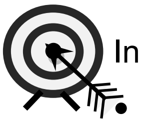
In Grade 7 Strand 4, you differentiated between mass and weight and used appropriate units accordingly to solve problems.

In this sub-strand, you will:

- use a weight-for-age baby weight chart to read and record baby weights and comment as to the health status of a baby based on that.
- use children's weight for age or height chart to determine their own ideal weight and to comment on their actual weight
- use appropriate operations to solve problems involving weight
- recognise that an object keeps its mass but can alter its weight depending on its location.

Lesson 1: Units of Weight

You were introduced to the meaning of weight in your Grade 7 Mathematics Strand 4 Sub-strand 1.



In this lesson, you will:

- define weight
- identify units of weight commonly used.
- convert units of weight from larger to smaller units and vice versa.

As you have learnt, in daily practical usage, mathematically, the word ―**weight**" is often used instead of the word ―**mass**" even though scientifically, they are in fact different concepts.

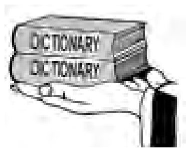
In Mathematics, **weight is the measure of the heaviness of an object**. It uses the same units as mass.

At present, the metric system uses milligrams, grams, kilograms and tonnes to measure weights or mass.

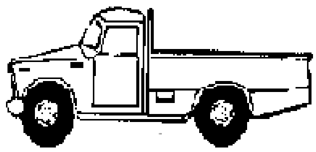
Look at some items and their approximate weights.

About 10 g

About 1 kg



Two pocket dictionaries have a mass of about 2 kg



A Nissan single cab pickup is about 2000 kg or 2 tonnes

You can see that the **smaller or lighter** items are measured in **milligrams** and **grams** while **larger or heavier** quantities are measured in **kilograms** or **tonnes.**

In the metric system, the basic unit of weight is the gram. The prefixes kilo, centi and milli are then added to give the other units.

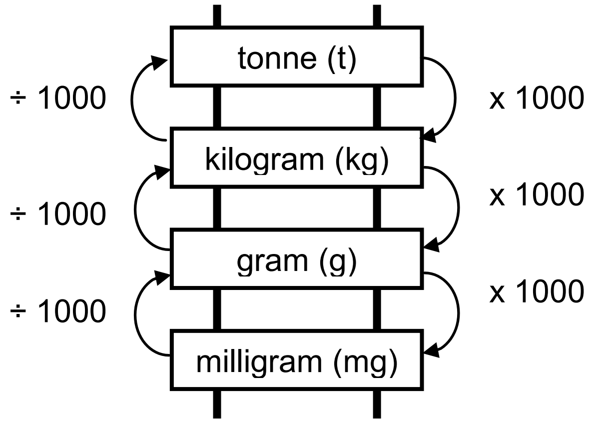
Here again are the units of weight most commonly used and their relationships. Study them to refresh your memory.

TABLE OF UNITS OF WEIGHT

Unit	Symbol	Meaning
milligram	Mg	$\frac{1}{1000}$ g
gram	G	1 g
kilogram	Kg	1000 g
tonne	T	1000 000 g

This means that: 1000 mg = 1 g; 1000 g = 1 kg and 1000 kg = 1 tonne

The relationship between these units is shown by the conversion ladder below:



The units are connected by either multiplication or division using the numbers on the ladder.

- When climbing down the ladder, multiply.
  This means that **in changing larger units to smaller units, multiply the number by the unit equivalence.**
- When climbing up the ladder, divide.
  This means that **in changing smaller units to larger units, divide the number by the unit equivalence.**

Remember to refer to the conversion ladder. This will be your guide in converting units of weight to other units of weight.

Examples

Convert the following:

1. 8 kg = ________ g

Solution: This is converting a larger unit to a smaller unit, so you multiply.

You know that 1 kg = 1000 g,

So, multiplying the given number of kg by 1000

You have 8 kg = 8 x 1000

= 8000

Therefore, **8 kg = 8000 g**

2. 9540 kilograms = __________tonnes

Solution: This is converting a smaller unit to a larger unit so you divide.

You know that 1000 kg =1 tonne (t)

So, dividing the given number of kg by 1000

You have 9540 kilograms = 9540 ÷ 1000 or $\frac{9540}{1000}$

= 9.54

Therefore, **9540 kg = 9.54 t**

3. 120 g = __________ kg

Solution: This is converting a smaller unit to a larger unit so you divide.

You know that 1000 g = 1 kg

So, dividing the given number of kg by 1000

You have 120 kilograms = 120 ÷ 1000 or $\frac{120}{1000}$

= 0.12 kg

Therefore, **120 g = 0.12 kg**

4. 2367 kg = __________ tonnes

Solution: This is converting a smaller unit to a larger unit so you divide.

You know that 1000 kg =1 tonne (t)

So, dividing the given number of kg by 1000

You have 2367 kilograms = 2367 ÷ 1000 or $\frac{2367}{1000}$

= 2.367

Therefore, **2367 kg = 2.367 t**

5. Convert 6.3 kilograms to milligrams

Solution: To convert kilograms to milligrams, you need to go through grams.

This is converting a larger unit to a smaller unit so you multiply.

You know that l kg = 1000 g and l g = 1000 mg

So, multiplying the given number of kg by both conversion factors

You have 6.3 kilograms = 6.3 x 1000 x 1000

= 6 300 000 mg

Therefore, **6.3 kg = 6 300 000 mg**

Remember, when you convert units always start with the largest unit on top, then multiply to go down and divide to go up.

NOW DO PRACTICE EXERCISE 1

Practice Exercise 1

1. For each of the following, state whether the mass would be measured in milligrams, grams, kilograms or tonnes. The mass of

   a) an elephant
   b) one hair
   c) an adult
   d) a table spoon of sugar
   e) an orange
   f) a truck
   g) one page of a book
   h) a tennis ball
   i) a sack of potatoes
   j) a new born baby

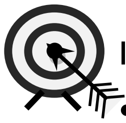
2. Convert the following:

   a) 0.3 kg = __________ g
   b) 12.4 g = __________ mg
   c) 3 t = __________ kg
   d) 8.6 kg = __________ g
   e) 4.5 g = __________ mg
   f) 5.5 t = __________ kg
   g) 300 g = __________ kg
   h) 58 kg = __________ t
   i) 634 mg = __________ g
   j) 3.5 g = __________ kg
   k) 15.25 t = __________ kg
   l) 4.5 kg = __________mg

CHECK YOUR WORK. ANSWERS ARE AT THE END OF SUB-STRAND 4

Lesson 2: Weight for Age Charts

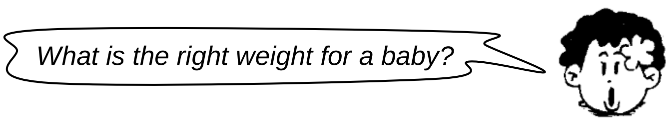
You have learnt how to read and record weights using charts and graph in Strand 4 of your Grade 7 Mathematics.



In this lesson, you will:

- use weight for age charts to read and record baby weights and comment on their health status.
- comment on your own actual weight and determine own ideal weight using weight for age or height charts

A baby's weight is one of the first things communicated to friends and family as soon as a baby is born.



Just like adults, babies come in all shapes and sizes.

The table below shows you the ideal height and weight of a baby from birth to 12 months.

Age	Weight	Height
Birth	2.5 - 4.5 kg	45-55 cm
4-6 months	7 kg	66 cm
7-9 months	8 kg	70 cm
10-12 months	9 kg	73 cm

How much a baby weighs, can be determined by genetics, the health and nutrition throughout pregnancy. However, it is not how much a baby weighs at birth that‘s most important – it‘s the rate at which they gain weight afterwards.

It is common for babies to drop between 5% and 10% of their weight soon after birth. Once they are settled into their feeding pattern most babies are expected to double their birth weight within four to five months, and triple their birth weight by the age of one and are four times their birth weight by the age of 2 years.

So, assuming that the growth rate was normal, we can calculate the expected weight of a child whose birth weight is given.

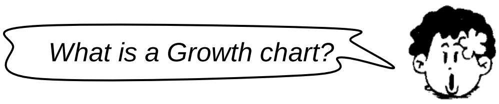
For example:

1) A 1 year old infant whose birth weight was 2650 g is expected to be weighing 7.95 kg.
2) A two year old child who weighed 3200g when born is expected to be weighing 12.8 kg.
3) A 2 year old infant whose birth weight was 3.5 kg would weigh 14 kg.

The figure below illustrates the expected normal rate of growth of a child.

Doctors and nurses use growth charts to decide if a child‘s height and weight is within the normal range for their age. Whether big or small, they‘re expected to put on weight at a steady pace, staying in the same range on the chart. However, just because a baby may be at the top or bottom end of the chart does not mean he/she is overweight or underweight.

One way of measuring a healthy baby is to look at the weight gain. If the baby gains enough weight during his/her first years, then everything is fine.

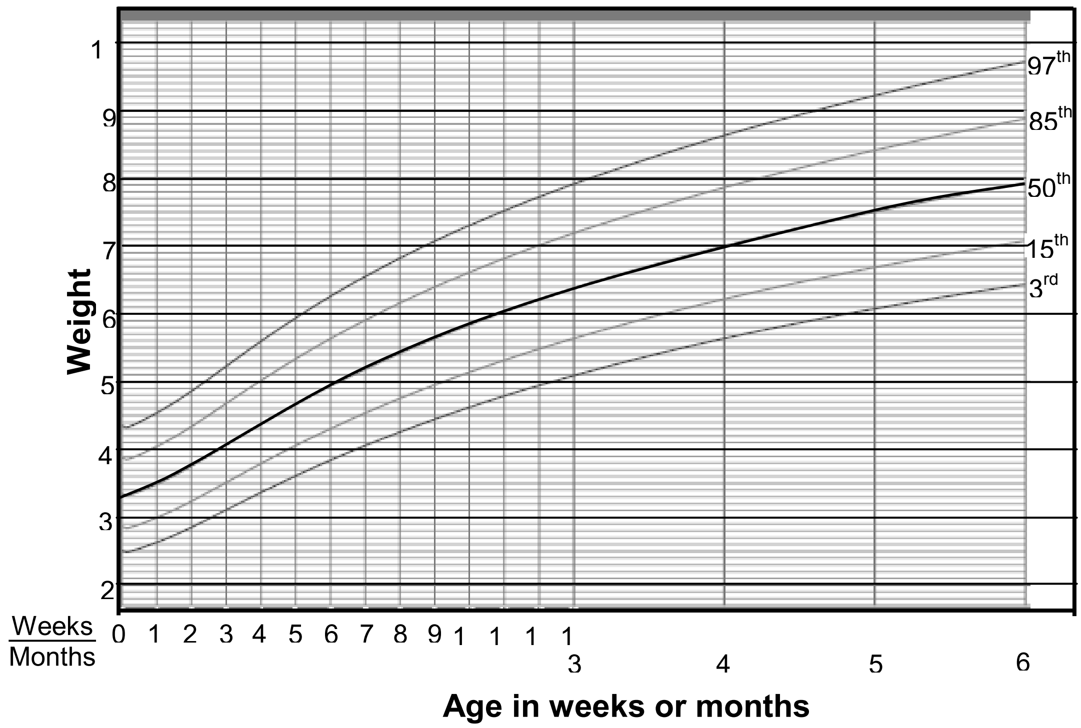


A **Growth Chart** is a fantastic tool designed to keep information and treasured memories about a baby's childhood. The Growth Graph was developed to facilitate the recording of this vital information from the time a baby is newly born.

Growth charts represent data collected from thousands of children. The average height and weight for each age are established and plotted to form a curved line that becomes the 50th percentile curve. This means that in 1000 children, 500 would be above the line and 500 would be below.

Below is a growth chart for boys from birth to 36 months.

BOYS BIRTH TO 6 MONTHS (Percentile)
WEIGHT FOR AGE CHART



Looking at the chart, using the 50th percentile curve line, you will find that the average male birth weight is about 3.3 kg – 3.6 kg.

You can also find that an average boy weighs 7 kg when he is about 4 months old. Also you can see in the chart that an average boy gained about 4.5 kg from birth to 6 months.

Note that the line begins very steeply and then gradually becomes less steep. This indicates rapid weight gain and as the line becomes less steep the weight gain is less rapid.

Now look at the growth chart on the next page for girls from birth to 6 months.

GIRL'S WEIGHT FOR AGE CHART FROM BIRTH TO 6 MONTHS

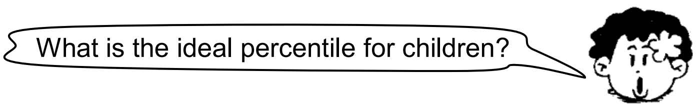
Looking at the chart, using the 50th percentile curve line, you will find that the average female birth weight is about 3.2 kg – 3.4 kg.

You can also find that an average girl weighs 6.5 kg when she is about 4 months old. Also you can see in the chart that an average girl gained about 3.5 kg from birth to 6 months.

While the 50th Percentile line represents the average child, the two graphs also show the 3rd, 15th, 85th and 97th percentiles. Fifteen per cent (150) of one thousand normal children will be at the 15th percentile. In other words, a boy or a girl whose weight was on the 10th percentile would be heavier than 150 and weigh less than 850 boys of the same age.

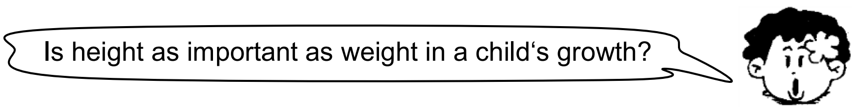
So, if we compare the overall weight gain of a girl whose growth rate remains on the 3^{rd} percentile curve for the first 6 months of her life and that of another girl who remains on the 85^{th} percentile curve for her first 6 months, we can say that, a girl on the 15^{th} percentile would gain 3.1 kg. A girl on the 85^{th} percentile would gain 4.6 kg.

This only tells that being in a higher or a lower percentile does not necessarily mean that a child is healthier or has a growth or weight problem. A child who is in the 3^{rd} or 15^{th} percentile can be just as healthy as a child who is in the 85^{th} or 97^{th} percentile.



There is no one ideal number. Healthy children come in all shapes and sizes, and a baby who is in the 15^{th} percentile can be just as healthy as a baby who is in the 97^{th} percentile.

Ideally, each child will follow along the same growth pattern over time, growing in height and gaining weight at the same rate, with the height and weight in proportion to one another. This means that usually a child stays on a certain percentile line on the growth curve. So if our 6-year-old boy on the 10th percentile line has always been on that line, he is continuing to grow along this pattern, which is a good sign.



Yes, it is very important for a child‘s growth that the weight and height should be in proportion to one another.

Infants usually increase their length by 30% by the first 5 months, and at one year an infant‘s height has increased by 50%.

For instances

a) A new-born measuring 50 cm is expected to be 65 cm tall when the infant reaches 5 months

b) A new-born measuring 40 cm is expected to be 80 cm tall when the infant reaches 12 months.

It is very difficult to predict the adult height of a child; however some health organisations use ‗mid-parent‘ formula to make rough estimates.

For Girls: $$\frac{(\textbf{father's height} - \textbf{13 cm}) + \textbf{mother's height}}{\textbf{2}}$$

For boys: $$\frac{(\textbf{father's height} + \textbf{13 cm}) + \textbf{mother's height}}{\textbf{2}}$$

See examples on the next page.

Example 1

If Mary's father is 175 cm tall and mother is 161 cm, what would be Mary's estimated adult height?

Solution:

Since Mary is a girl use this formula: $\dfrac{(\text{father's height} - 13\text{ cm}) + \text{mother's height}}{2}$

$$\text{So, Mary height} = \frac{(175 - 13) + 161}{2}$$

$$= \frac{162 + 161}{2}$$

$$= \frac{323}{2}$$

$$= 161.5\text{ cm}$$

Therefore, the estimated adult height for Mary is 161.5cm.

Example 2

What is Matthew's predicted adult height when his mother is 155cm and his father is 160cm tall?

Since Matthew is a boy use this formula: $\dfrac{(\text{father's height} + 13\text{ cm}) + \text{mother's height}}{2}$

$$\text{So, Matthew's height} = \frac{(160 + 13) + 155}{2}$$

$$= \frac{173 + 155}{2}$$

$$= \frac{328}{2}$$

$$= 164\text{ cm}$$

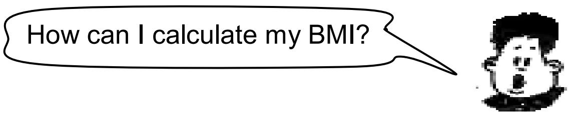
Therefore, the predicted adult height for Matthew is 164 cm.

We have discussed about children's Weight, Height and Age Charts to measure their Health status or growth. However, it is also essential to learn how to determine the health status of adult men and women.

You learnt in Grade 7 that as an adult, the best way to know a healthy weight is to find your body mass index or BMI.

Again, let us define what a Body mass index or (BMI) is.

Body Mass Index or BMI is an approximate measure of a person's body fat based on their weight and height in reference to a table of indices of health risk.



As you have learnt in Grade 7, to calculate your BMI you need to know:

- your weight(mass) in kilograms
- your height in metres.

BMI is determined or found by calculating the weight in kilograms divided by the height in metres squared.

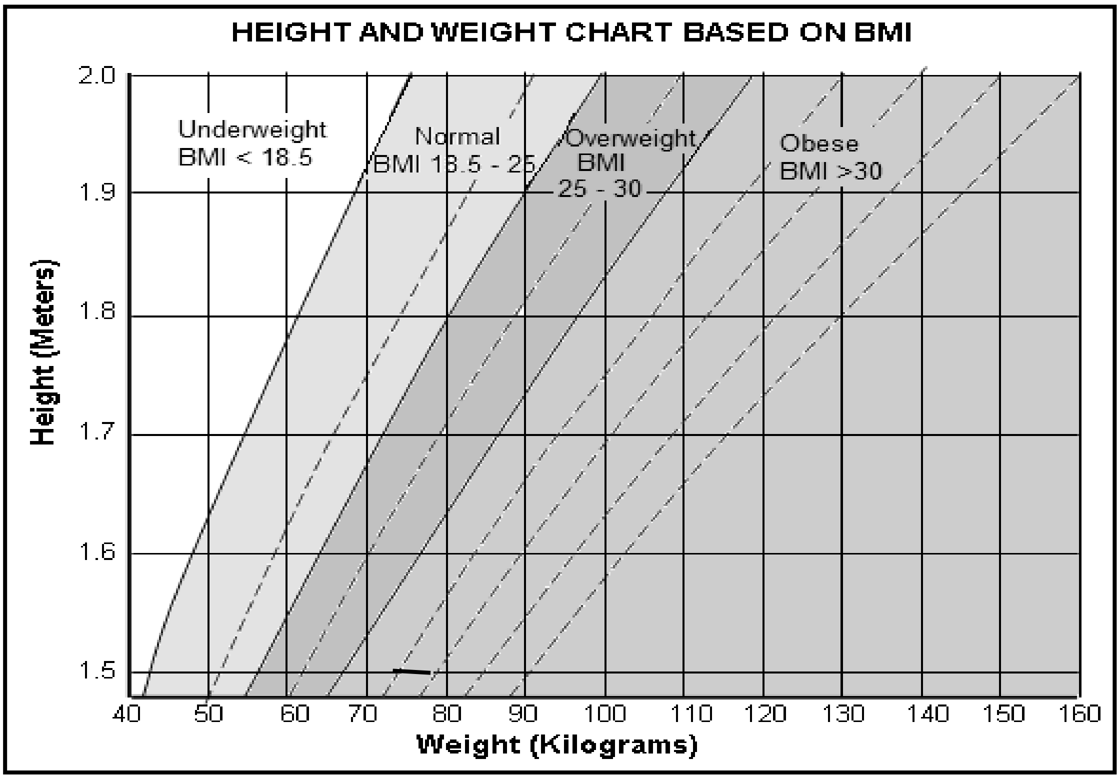
Formula:

$$\textbf{BMI} = \frac{\textbf{weight in kilograms}}{\textbf{height in metres squared}}$$

$$\textbf{BMI} = \frac{\textbf{weight in kg}}{\textbf{height in m}^2}$$

Now study the chart and the table below.

The chart and the table shows the ideal weight for men and women (18 and above) based on height and Body Mass Index (BMI).



BMI <19.9	Underweight
BMI 20.0<24.9	Healthy weight range
BMI 25.0<29.9	Overweight (pre-obese)
BMI 30.0<34.9	Moderately obese
BMI 35.0<39.9	Severely obese
BMI >40.0	Very severely obese

Now study the examples.

Example 1

Andrew weighs 68 kg and has a height of 175 cm. What is Andrew's body mass index?

Solution: $$\text{BMI} = \frac{\text{weight in kg}}{\text{height in m}^2}$$

$$= \frac{68 \text{ kg}}{1.75^2}$$ (remember that 1 m = 100 cm)

$$= \frac{68 \text{ kg}}{3.0625}$$

$$= 22.20$$ (rounded to 2 decimal places))

Therefore, Andrew's BMI is 22.20.

Looking at the chart and table this indicates a healthy BMI. Any figure between 18.5 and 25 would also be considered healthy.

Example 2

Linnet's height is 1.6 m and weighs 65 kilograms. Find Linnet's BMI using the formula.

Solution: $$\text{Body Mass Index(BMI)} = \frac{\text{weight in kg}}{\text{height in m}^2}$$

$$= \frac{65 \text{ kg}}{1.6^2}$$

$$= \frac{65 \text{ kg}}{2.56}$$

$$= 25.39$$ (rounded to 2 decimal places)

Therefore, Linnet's BMI is 25.39

Looking at the chart and table this indicates an unhealthy BMI. Any figure between 25 and 30 would also be considered unhealthy.

Understanding the chart and comparing your height and weight to the standard range will help you know your health status.

For example:

If you are in the **underweight** range, there are a number of possible reasons for this.

If you are in the **normal** range, it means you have a healthy weight for your height. However, to stay in good health, it is still important to eat a balanced diet and do at least 30 minutes of physical activity five days a week.

If you are in any of these **Overweight, obese or very obese** ranges, you are heavier than someone who is healthy for your height. Excess weight puts you at increased risk of heart disease, stroke and diabetes. It is time to take action.

It is essential to maintain height and weight balance to prevent any health risks. Comparing your height and weight to a standard range will help you decide to begin an effective exercise program that will increase your height as well as decrease your weight.

For instance, if you weigh 112 kg and your height is 160 cm or 1.6 m then you will fall into the obese category. This means you are at risk of health problems.

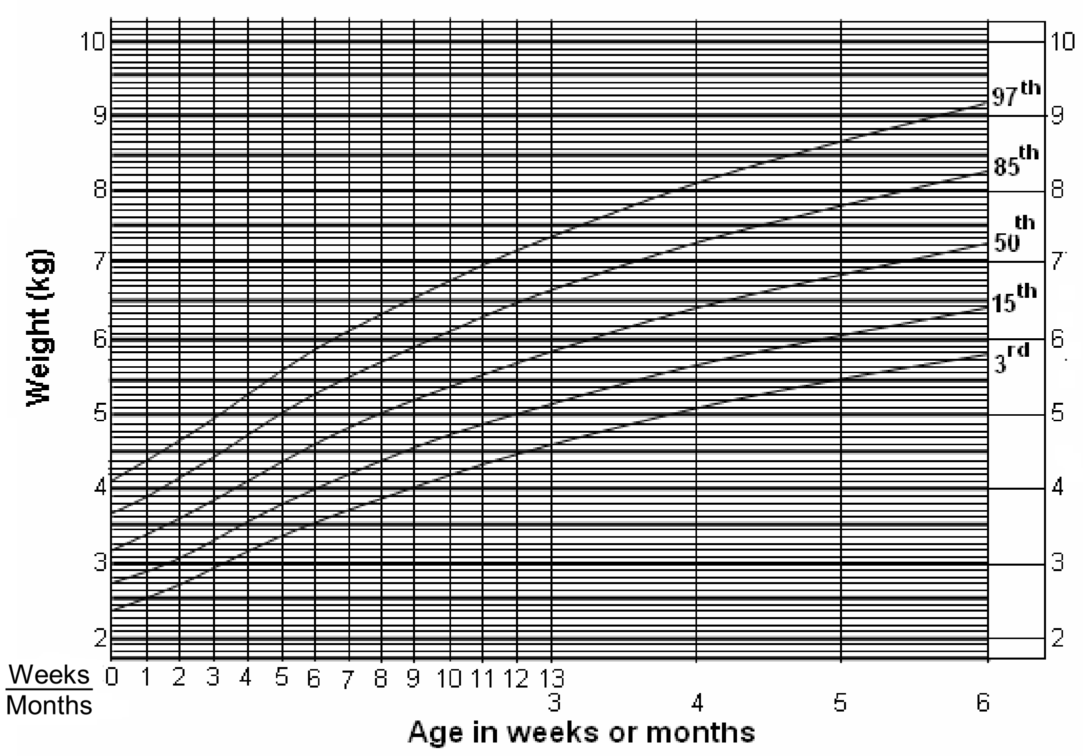
Note: BMI is not a suitable measure for children up to the age of about 20 years, because as children grow the amount of fat changes and so does their BMI. BMI calculations for children should be compared against age and gender graphs.

NOW DO PRACTICE EXERCISE 2

Practice Exercise 2

1. Refer to the weight for age chart below to answer the questions that follow.

GIRL'S WEIGHT FOR AGE CHART FROM BIRTH TO 6 MONTHS



Using the data from the 50% percentile curve for this graph,

a) How many girls are below the average weight?

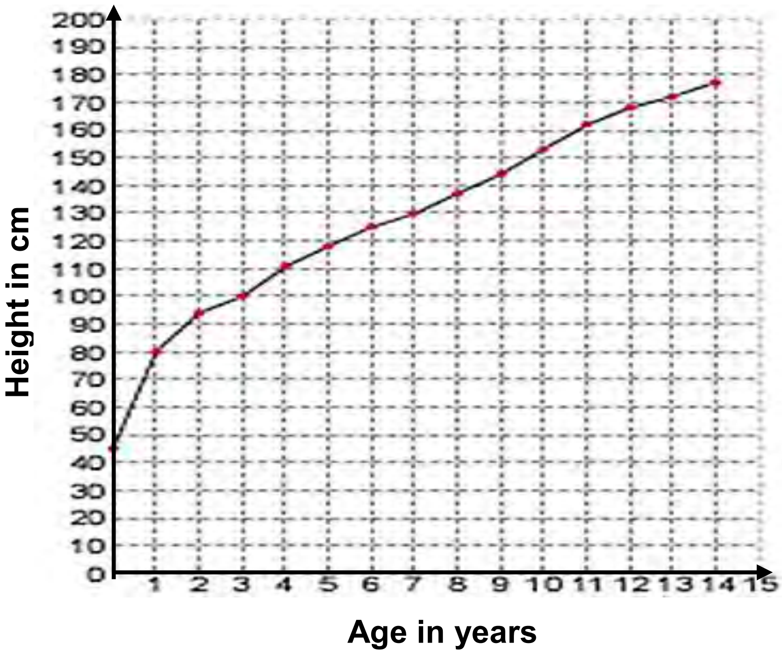
b) What is the average weight for girls at birth in kilograms?

c) If Anna's weight falls in the average weight category for females at birth, how old will she be if she weighs 9 kg?

d) From the graph, when is the line very steep and why?

Refer to the graph to answer Question 2.

ANDY'S GROWTH FROM BIRTH TO 14 YEARS



2. Complete the table by filling in the empty spaces on the table.

Age(yrs)	0	1		5		9	10		12	
Height (cm)		80	100		125	144		162		178

3. Calculate and complete the table to show the expected length of each child at both ages.

Birth length	43 cm	44 cm	46 cm	49 cm	52 cm	55 cm
Expected length at 5 months						
Expected length at 12 months						

4. Use the correct formula to predict each child's adult height.

a) Girl's

Name	Betty	Martina
Father's height	173 cm	1.7 m
Mother's height	156 cm	1.6 m
Predicted adult height		

b) Boy's

Name	Daniel	Samuel
Father's height	173 cm	1.7 m
Mother's height	156 cm	1.6 m
Predicted adult height		

---

5. Refer to the information below to answer questions that follow.

Five students from Goroka Secondary School wanted to check their health status. They recorded their weight and height as follow.

NAME	Weight (kg)	Height (cm)	BMI	Health status
Mathew Wai	45	156		
Linnet Wali	112	170		
Mary Ross	89	159		
David Wama	89	190		
Lily Simo	60	161		

(a) Find the BMI from the data and determine if they are Underweight, Normal, Overweight or Obese. Write your answers in the space provided on the table.

Working Out:

(b) From the 5 students, who is at a high risk of having Health Problems?

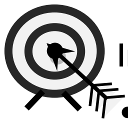
(c) How many are Normal or Healthy?

(d) Is anyone underweight? If yes then who?

CHECK YOUR WORK. ANSWERS ARE AT THE END OF SUB-STRAND 1

Lesson 3: Average Weight

You learnt to work out, read and record weights using the weight and age charts and were able to comment on the health status of people on the basis of these charts.



In this lesson you will:

- define the term average weight
- determine average weight
- calculate cash crop yield given the average weight per hectare.

In the previous lessons, you dealt with the weight for babies and grown people. In this lesson, you will deal with more weights. You will be able to find the average weight for certain sets or groups of people and the average weight for various quantities.

Firstly, let's define the term average weight.

The average weight is the result obtained by adding all the weights of members of groups or sets of samples (people or things) and dividing the total (sum) by the number of members in the group or the set.

Below is the word equation or formula used to calculate average weight.

$$\textbf{Average weight} = \frac{\textbf{total weight}}{\textbf{number of weights}}$$

Example 1

Find the average of the following weights:

12 g, 14 g, 12 g, 11 g, 11 g

Solution:

$$\text{Average weight} = \frac{\text{total weight}}{\text{number of weights}}$$

$$\text{Average weight} = \frac{12\,g + 14\,g + 12\,g + 11\,g + 11\,g}{5}$$

$$= \frac{60}{5}$$

$$= 12\text{ g}$$

Therefore the average weight is 12 g.

Example 2

Find the average of the following weights.

8 kg,1 kg, 2 kg, 3 kg, 2 kg, 5 kg, 7 kg

Solution:

As you can see, for Example 1 the units are the SAME so you can calculate right away**.**

Using the formula: Average weight = $\frac{\text{total weight}}{\text{number of weights}}$

$$\text{Average weight} = \frac{8\text{ kg} + 1\text{ kg} + 2\text{ kg} + 3\text{ kg} + 2\text{ kg} + 5\text{ kg} + 7\text{ kg}}{7}$$

$$= \frac{28}{7}$$

$$= 4\text{ kg}$$

Therefore, the average weight is 4 kg.

When you calculate the average weight, make sure that the units are the same.

Study the next examples.

Example 3 Find the average of the following weights.

12 g, 11.5 g, 14.1 g, 12.2 g, 112 mg

Solution:

This question is slightly different from the first two examples. As you can see from the set of weights, the unit for one of the members of the set is **mg**.

12 g, 11.5 g, 14.1 g, 12.2 g, **112 mg**

First, convert 112 mg to g.

You know that 1000 mg = 1 gram, therefore, 112 mg ÷1000 mg = 0.112 g

Now you can calculate the average weight**.** Use the formula.

$$\text{Average weight} = \frac{\text{total weight}}{\text{number of weights}}$$

$$= \frac{12\text{ g} + 11.5\text{ g} + 14.1\text{ g} + 12.2\text{ g} + 0.112\text{ g}}{5}$$

$$= \frac{49.912\text{ g}}{5}$$

$$= 9.9824\text{ g}$$

Therefore the average weight is 9.9824 g.

Example 4

Find the average for the following weights.

12 kg, 1220 mg, 125 g, 1.5 kg

Solution:

This question is similar to Example 3. However, you would have to decide which unit of mass to convert to so that all the units are uniform. For this case we will convert all the units of weight to kg. That means you will need to convert 1220 mg and 125 g to kg.

12 kg, 1220 mg, 125 g, 1.5 kg

First, convert 125 g to kg. This is converting a smaller unit to a larger unit. Division is required.

You know that 1000 g = 1 kg

So, dividing the given number of g by 1000

You have 125 ÷ 1000 = 0.125

Therefore, 125 g = 0.125 kg

Next convert 1220 mg to kg. Again this is converting a smaller unit to a larger unit. Division is required.

You know that 1000 mg = 1 gram and 1000 grams = 1 kg

So, dividing the given number of kg by both conversion factors

You have 1220 ÷ 1000 ÷ 1000 = 0.00122

Therefore, 1220 mg = 0.00122 kg

Now that the units are the same you can calculate the average weight.

$$\text{Average weight} = \frac{\text{total weight}}{\text{numberof weight}}$$

$$= \frac{12\text{ kg} + 0.00122\text{ kg} + 0.125\text{ kg} + 1.5\text{ kg}}{4}$$

$$= \frac{13.62622\text{kg}}{4}$$

$$= 3.406555\text{ kg}$$

Therefore, the average weight is 3.406555 kg.

On the next page you will work out examples of practical problems relating to average weight.

Study the example carefully.

Example 1

Five boxes weigh 500 g in total. One box weighing 140 g was taken away. What is the average weight of the remaining four boxes?

Solution:

You know that

i. 500 g is the total weight of 5 five boxes
ii. 140 g is one box that was taken away

Given these two facts; we can work out the total weight of the remaining 4 boxes by subtracting the 140 g from 500 g.

Hence, the total weight of 4 remaining boxes = 500 g – 140 g = 360 g

However, the question requires you to find the average weight of the 4 remaining boxes. Therefore, using the formula

$$\text{Average weight} = \frac{\text{Total weight}}{\text{number of boxes}}$$

Substitute, 360 g as total weight and 4 as number of boxes, you have

$$\text{Average weight} = \frac{360\text{ g}}{4\ \text{boxes}} = 90\text{ g}$$

Therefore, the average weight for each box is 90 g.

Example 2

Calculate the yield for taro if the average weight of taro is 40 tonnes per hectare and the land is 35 hectares.

Solution:

Using the formula for average weight, let us formulate the equation based on the given statement. Thus we have,

$$\text{Average weight of taro yield per hectare} = \frac{\text{total weight of taro}}{\text{number of hectares of land}}$$

However, the problem asked for the total weight of taro yielded. So let us represent this unknown by x.

You know that

i. the average weight of taro yielded is 40 tonnes per hectare
ii. the total number of hectares of land is 35 hectares

Given these two facts; we can work out the total weight of taro produced by substituting the two given values to the formula.

Average weight of taro yielded per hectare = $\frac{\text{total weight of taro}}{\text{number of hectares of land}}$

Hence, we have the equation: $40\,\text{tonne} = \frac{x}{35}$

Solve for the value of x, by solving the equation using multiplication property of equality.

x = 40 tonne per hectare x 35 hectares of land

x = 1400 tonnes of taro produced

Therefore, 1400 tonnes of taro was produced in the 35 hectares of land.

Example 3

The average weight of the 30 boys in 9A class is 45 kg, and the average weight of the 10 girls is 41 kg.

i. What is the total weight of all the students in the class?
ii. What is the average weight of all the students in the class?

Solutions:

Let‘s outline the data given.

Average weight of 30 boys= 45 kg

Average weight of 10 girls = 41 kg

Number of boys = 30

Number of girls = 10

Total weight for boys= unknown

Total weight for girls = unknown

As you can see there are 2 unknowns we have to find aside from what the problem is asking for.

We need to work out the two total weights before we can work out what the problem was asking for. So, from the general formula for average weight,

Average weight = $\frac{\text{total weight}}{\text{number of weights}}$

We derive: (a) Total weight for boys = average weight of boys x number of boys

= 45 kg x 30

= 1350 kg

Therefore, the total weight for the boys is 1350 kg.

(b) Total weight for the girls = average weight of girls x number of girls

= 41 kg x 10

= 410 Kg

Therefore the total weight for the girls is 410 kg.

Now, we can answer questions i and ii.

i. What is the total weight of all the students in the class?

Total weight of all the students = total weight of boys + total weight of girls
= 1350 kg + 410 kg
= 1760 kg

Therefore, the total weight of all the students in the 9A class is 1760 kg.

ii. What is the average weight of all the students in the class?

$$\text{Average weight of all the students in 9A class} = \frac{\text{total weight}}{\text{number of students}}$$

$$= \frac{1760\,\text{kg}}{40\,\text{students}}$$

$$= 44\text{ kg}$$

Therefore, the average weight of all the students in 9A class is 44 kg

---

NOW DO PRACTICE EXERCISE 3

Practice Exercise 3

---

1. Find the average weight of the following.

   a) 128 mg, 243 mg, 230 mg, 122 mg, 247 mg

   Answer:__________

   b) 7.3 kg, 2.1 kg, 3.4 kg, 5.2 kg, 6.5 kg

   Answer:__________

   c) 38 g, 46 g, 89 g, 43 g, 54 g, 55 g

   Answer:__________

   d) 1120 mg, 1220 mg, 3450 mg, 2 g

   Answer:__________

   e) 14 kg, 15 kg, 10 000 g, 20 kg, 1 000 000 mg

   Answer:__________

---

2. Solve the following problems.

a) Tau has twelve oranges. A quarter of them are 120g each, another quarter of them weigh 150g each, while five weigh 75g each and one weighs 60g.

   i) What is their total weight?

   Answer:__________

   ii) What is the average weight?

   Answer:__________

---

b) Wilma dug 6 taros weighing 2.1 kg, 3.4 kg, 3 kg, 1.4 kg, 2.1 kg. What is the average weight for the taros?

Answer:__________

c) Ronda filled 5 bags of dried coffee beans. Each bag weighed 110.5 kg. One kilogram of dried coffee beans cost K2.50.

i. What is the average weight of each bag?

Answer:__________

ii. How much money will Ronda get from her coffee?

Answer:__________

---

d) The average weight of the 35 boys in a class is 40 kg, and the average weight of the 15 girls is 30 kg.

i. What is the total weight of all the students in the class?

Answer:__________

ii. What is the average weight of all the students in the class?

Answer:__________

---

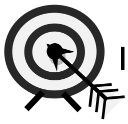
3. Find the total weight of pawpaw produced when the average weight of pawpaw produced per hectare is 48 tonnes on 38 hectares of land.

Answer:__________

CHECK YOUR WORK. ANSWERS ARE AT THE END OF SUB-STRAND 4

Lesson 4: Weight and Mass

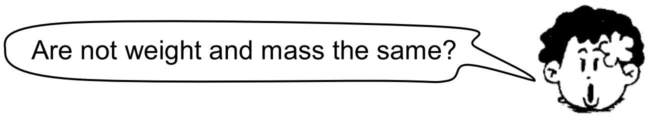
You now know the meaning of the term average weight from the previous lesson. You also learnt to solve problems involving average weight by performing the fundamental operations indicated.



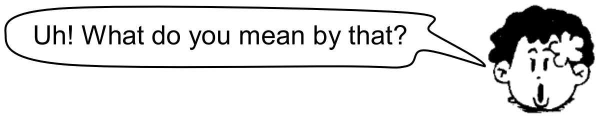
In this lesson, you will:

- define the term mass
- differentiate between weight and mass.

Most people do not think that there is a difference between the terms ―weight ―and ―mass” and it was not until mankind started to explore space that it was possible for humans to experience, even indirectly, what it must mean to be ―weightless”.



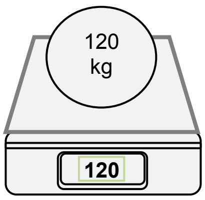
People often use weight instead of mass and vice versa. Because gravity is pretty much the same everywhere on earth, we don‘t notice the difference. As long as you stay on earth, the difference is more philosophical than practical.



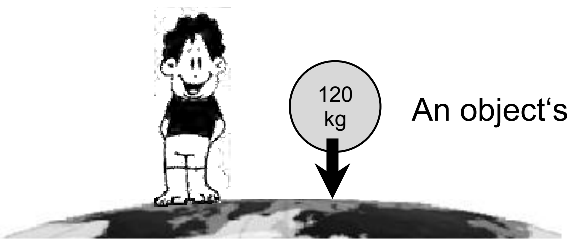
Well, let us define mass and weight.

> **Mass** is a measurement of how much matter is in an object.
>
> **Weight** is a measurement of how hard gravity is pulling on that object.

Look at the diagrams.



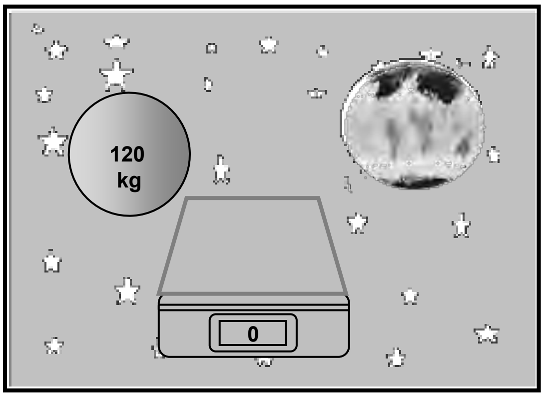
An object has **mass**, let say 120 kg. This makes it heavy enough to **weigh** 120 kg.



An object‘s **weight** is how hard gravity is pulling on it.

We think that weight is the same everywhere, because we live on the surface of the earth.

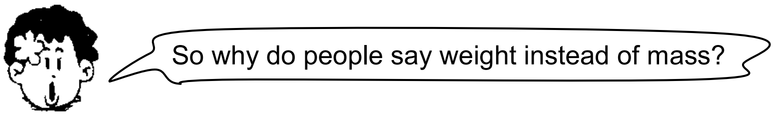
But if the object were far out in the space it would just float around, exerting no force on the scale.



The scale would show 0 kg… but the mass is still 120 kg.

The mass of an object is the same on Earth, floating in the space or on the moon because the stuff it is made of does not change.

The weight depends on how much gravity is acting on it. An object would weigh less on the moon than on Earth, and in space it would weigh nothing at all. But if it stays on Earth, gravity is always the same, so it really does not matter whether you talk about weight or mass.

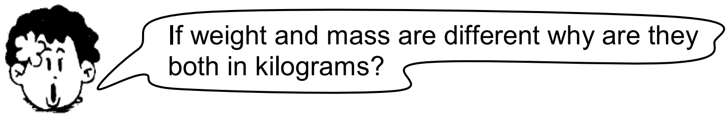


Since gravity is pretty much the same everywhere on Earth, we do not notice a difference. That is why, people often use —weight— to mean —mass”, and vice versa.

But remember, they do not mean the same thing, and they can have different measurements.

Here are some conditions where the weight might change.

a) In space an object can be weightless.
b) On the moon, 100 kg mass would weigh 16.6 kg.
c) You can even get very slight differences in weight in different locations on earth

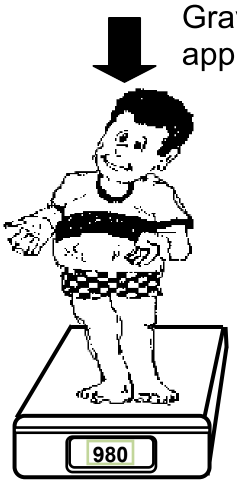


Well, scientifically, weight should not be in kilograms. We have used kilogram so far because practically that is what we see on a pair of scales, but it is technically wrong to talk about weight in kilogram.

Sometimes people say —kilogram force” (kgf) or —pound force” (lbf) to show that they are talking about the **force that the mass exerts** because gravity is pulling it.

Thus, we say **weight is a force.**

Weight is the amount of **force** that the mass exerts because gravity is pulling down on it. It is measured in **Newtons** ($\mathbf{\frac{kg}{s^2}}$). It is the correct unit for **force** and is abbreviated **N**.



Gravity makes a 1 Kilogram mass exert about 9.8 Newtons or approximately 10 Newtons of force.

So, a 100 kg mass really weighs about 980 N.

Scales shows kilogram because that is what people understand best…

… but it is really just an estimate of the mass above them.

Scales should really show Newtons, but that might confuse people.

> Note: To find out how much force your body is exerting on the scales, **multiply by 9.8 to convert Kilogram to Newton** and **divide by 9.8 to convert Newtons to kilogram.**

Now look at the following examples.

Example 1

Find out how much force the following masses are exerting on the scale.

(a) 56 kg
(b) 73 kg
(c) 120 kg
(d) 0.5 kg

Solutions: You know that gravity makes a 1 kg mass exert 9.8 N of force.

Since the conversion required is kilogram to Newton, you multiply by 9.8 N.

Then, (a) 56 kg = 56 x 9.8
= 548.8 N

Therefore, a 56 kg mass exerts **548.8 N** of force on the scale.

(b) 73 kg = 73 x 9.8
n = 715.4 N

Therefore, a 73 kg mass exerts **715.4 N** of force on the scale.

(c) 120 kg = 120 x 9.8
= 1176 N

Therefore, a 120 kg mass exerts **1176 N** of force on the scale.

(d) 0.5 kg = 0.5 x 9.8
= 4.9 N

Therefore, a 56 kg mass exerts **4.9 N** of force on the scale

Example 2

Convert the following force in Newtons to mass in kilograms. Round off answer to the nearest whole number.

(a) 50 N
(b) 110 N
(c) 86 N
(d) 1250 N

Solution: The conversion required is Newtons to kilogram, so you divide by 9.8 N.

(a) 50 N $= \frac{50}{9.8}$

≈ 5.10 kg $\approx$ **5 kg** (rounded to the nearest whole number)

(b) 110 N $= \frac{110}{9.8}$

≈ 11.22 kg $\approx$ **11 kg** (rounded to the nearest whole number)

(c) 86 N $= \frac{86}{9.8}$

≈ 8.77 kg $\approx$ **9 kg** (rounded to the nearest whole number)

(d) 1250 N $= \frac{1250}{9.8}$

≈ 127.55 kg $\approx$ **128 kg** (rounded to the nearest whole number)

Example 3

How many Newtons should the scales show when a 69 kg man stands on it?

Solution: Since a 1 kg mass exerts a 9.8 N force

Weight = 69 kg x 9.8

= 676.2 N

Example 4

The gravitational force on the moon is $\frac{1}{6}$ of the gravitational force on Earth. What would be the weight of an astronaut on the moon if his mass is 81 kg?

Solution: Since weight on moon = $\frac{1}{6}$ of the weight on Earth,

Then, the weight of the astronaut is found by multiplying his weight on Earth by $\frac{1}{6}$.

Hence, we have: Weight = 81 kg x $\frac{1}{6}$

= 13.5 N

Example 5

What is the mass of an astronaut on earth if he weighs 15 N on the moon?

Solution: To find the mass of an astronaut on earth divide his weight on the moon by $\frac{1}{6}$.

Hence, Weight on earth = 15 N ÷ $\frac{1}{6}$

= 15 N x 6

= 90 kg

Base on the discussions and examples let us summarize what we have learnt.

- Mass is a measure of how much matter something contains.
- Weight is a measure of how strongly gravity pulls downwards on an object. It is a Force measured in Newtons, not kilograms.(1 newton = 1 kg x m/s^2
- Gravity is constant at 9.8 m/s^2
- When scales show ―kg‖ it is just an estimate of the mass above it.

You are now expected to understand clearly the difference between weight and mass.

NOW DO PRACTICE EXERCISE 4

Practice Exercise 4

1. Find out how much force is each of the following masses exerting on the scales.

   a) 96 kg __________N

   b) 103 kg __________N

   c) 220 kg __________N

   d) 0.75 kg __________N

   e) 370 kg __________N

---

2. Convert the following Newtons to kilogram mass. Round off the answer to the nearest whole number.

   (a) 70 N __________kg

   (b) 180 N __________kg

   (c) 126 N __________kg

   (d) 2250 N __________kg

   (e) 100 N __________kg

---

3. The mass of an astronaut is 112 kg on Earth. What would his weight be on the moon if the gravitational force of the moon is $\frac{1}{6}$ of that on earth?

Refer to the table below to answer Questions 4 and 5.

GRAVITATIONAL FORCE OF SOME PLANETS COMPARED TO EARTH

Planet	Gravitational Force (m/s^2)
Mars	0.38
Mercury	0.284
Jupiter	2.34
Venus	0.88
Saturn	0.925
Uranus	0.795

4. What would be the weight of an object on Jupiter if its mass is 3000 kg on Earth?

Answer:__________

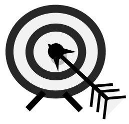
5. If a rock weighs 54 N on Mars, what is its mass on Earth?

Answer:__________

CORRECT YOUR WORK. ANSWERS ARE AT THE END OF SUB-STRAND 1

Lesson 5: Solving Problems Involving Weight

You learnt in the previous lessons the meaning of mass and weight.



In this lesson, you will:

- solve problems involving weight and mass using appropriate operations.

Whether you are in the house, at the market, at school, in the workplace or wherever, there are plenty of problems in real life situations involving weights. To solve these problems, your acquired skills and knowledge in the concepts of weight and mass will be applied. Using the appropriate operations like addition, subtraction, multiplication and division you can solve these problems.

Look at the following examples of word problems. Study these examples carefully and take note of the steps taken to solve them.

Example 1

Mai's pig weighs 1340 g more than Cathy's pig. Mai's pig weighs 5 kg. What is the mass of Cathy's pig in kg?

Solution: Using a table let us outline the information

Mai's pig's weight	5 kg = 5000 g
Cathy's pig's weight	x
Mai's pig weighs 1340 g more than Cathy's pig	x + 1340

The problem states that Mai's pig weighs 1340 g more than Cathy's pig, we can also say that Cathy's pig + 1340 g is equal to Mai's pig.

Thus forming the word equation: Cathy's pig + 1340 g = Mai's pig

Since Cathy's pig weighs x kg, and Mai's pig weighs 5 kg or 5000 g, substituting these into the word equation,

We have $x + 1340\text{ g} = 5000\text{ g}$ ◄---------- equation

Find x, by solving the equation.

$x + 1340 = 5000\text{ g}$

$x = 5000\text{ g} - 1340\text{ g}$ ◄---Subtraction Property of Equality

$x = 3660\text{ g}$

Convert 3660 g to kg by dividing 3660 g by 1000 and the answer is 3.66 kg

Therefore, Cathy's pig weighs **3.66 kg**.

Example 2

Daniel went to the supermarket and bought 5 apples with the following masses: 320 g, 50 000 mg, 350 g, 400 g and 0.08 kg.

(a) Convert all units to grams.

(b) Convert the sum of the mass of the apples to kilograms.

(c) What is the average mass of the apples in kg?

(d) If 1 kg of apples cost K15.65, how much did it cost Daniel to buy 5 apples?
.

Solutions:

(a) Convert all the units to grams

Firstly, outline the units that are needed to be changed. These are 50 000 mg and 0.08 kg.

Convert 50 000 mg to grams: $\frac{50\,000}{1000}$ = **50 grams**

Convert 0.08 kg to grams: 0.08 × 1000 = **80 grams**

(b) Convert the sum of the mass of the apples to kilograms.

Total mass of apples = 320 g + 50 g + 350 g + 400 g + 80 g =1200 g

Convert 1200 g to kg: $\frac{1200}{1000}$ = 1.2 kg

Therefore, the total mass of the apples in kg is 1.2 kg.

(c) What is the average mass of the apples in kg?

$$\text{Average Mass} = \frac{\text{Total mass of apples}}{\text{Total number of apples}}$$

$$= \frac{1.2\text{ kg}}{5}$$

$$= 0.24\text{ kg}$$

Therefore, the average mass is 0.24 kg

(d) If 1 kg of apples cost K15.65, how much did it cost Daniel to buy 5 apples?

Since the weight of 5 apples is 1.2 kg, to find the cost to Daniel, multiply this by K15.65. Hence,

The cost of 5 apples = K15.65 per kg × 1.2 kg = K18.78

Therefore, it cost Daniel K18.78 for the 5 apples.

Example 3

A truck weighs 2.568 tonnes. When it is loaded with sand it weighs 7.280 tonnes. Find the weight of the sand in tonnes and then in kilograms.

Solution:

As you can see, the problem gives the following:

- Weight of the truck when not loaded with sand = 2.568 t
- Weight of the truck when loaded with sand = 7.280 t

You are asked to find the weight of the sand in tonnes and then in kilograms.

To do this, first you have to find the weight of the sand by subtracting the two given weights. Hence, we have

Wt. of sand = Wt. of truck when loaded – Wt. of truck when not loaded

= 7.280 t – 2.568 t

= **4.712 t** ⟵ weight of sand in tonnes

Therefore the weight of the sand in tonnes is 4.712 tonnes.

You know that 1 t = 1000 kg, so you can convert the weight into kilograms.

Thus, by multiplying the weight in tonnes by 1000,

we have: weight in sand in kg = 4.712 x 1000

= 4712 kg

Therefore the weight of the sand in kilograms is 4712 kg.

NOW DO PRACTICE EXERCISE 5

Practice Exercise 5

1. If a jar of honey weighs 800 g, how much will 15 jars weigh in kilograms?

2. A truck weighs 3 t 685 kg. When it is loaded with sand it weighs 9 t 802 kg.

   Find the weight of the sand in tonnes and then in kilograms.

3. A balloon filled with air weighed 0.785 kg. If the weight of air inside the balloon is 30 g, how much does the balloon weigh?

4. An astronauts from the United States collected rocks that weighed 3 pounds, 9 pounds and 15 pounds on the moon. Pounds are imperial measurement. The conversion from pounds to kilograms can be estimated using the formula :

$$\textbf{Kilograms} = \frac{\textbf{weight in pounds}}{\textbf{2.2}}$$

   Use this formula to calculate:

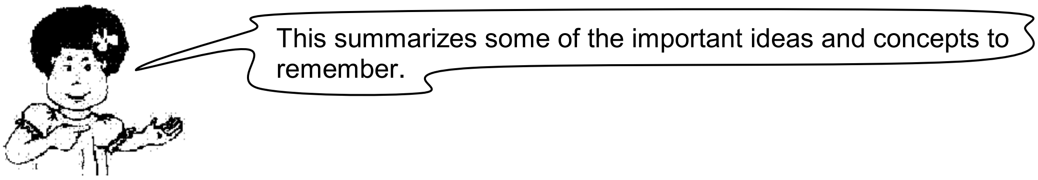
   a) The total weight of the rocks on the moon.

   b) The total mass of the rocks in kg.

   c) The average mass of the rocks in kg.

CORRECT YOUR WORK. ANSWERS ARE AT THE END OF SUB-STRAND 1

SUB-STRAND 1: SUMMARY



- In Mathematics weight is the measure of the heaviness of an object. It uses the same units as mass such as grams and kilograms
- **The Growth Chart** is a tool designed to keep record of important information such as the weight and the height of a baby from the time it is newly born. This information helps health workers to monitor or assess the development process of a child.
- It is important for a child's growth that the weight and height should be in proportion to one another. The formula used to predict the adult height of a child is as follows:

$$\text{For girls} = \frac{(\text{father's height} - 13\text{ cm}) + \text{mother's height}}{2}$$

$$\text{For boys} = \frac{(\text{father's height} + 13\text{ cm}) + \text{mother's height}}{2}$$

- The Body Mass Index (BMI) is an approximate measure of a person's body fat based on their height and with reference to the indices of health risk.

  The formula is: $\text{Body Mass Index(BMI)} = \dfrac{\text{weight in kg}}{\text{height in m}^2}$

- **The Average Weight is the result obtained by adding all the weights of members of groups or sets of samples (people or things) and dividing the total (sum) by the number of members in the group or set.**

  The formula is: **Average weight =** $\dfrac{\text{total weight}}{\text{number of weight}}$

- In practical and commercial usage, we used the word **weight** instead of **mass** even though scientifically they are not quite the same concepts.
- **Mass** is the measure of the amount of matter in an object.
  It is measured in grams, kilograms and tonnes.
- **Weight** is the measure of the force of gravity on a given object.
  It is measured in newtons.
- The mass of an object will remain the same from one location to another. The weight of an object will change from place to place depending on changes in the gravitational attraction.
- Gravity makes 1 kg = 9.8 Newtons of force.

REVISE LESSONS 1 TO 5. THEN DO SUB-STRAND TEST 1 IN ASSIGNMENT 4.

ANSWERS TO PRACTICE EXERCISES 1-5

Practice Exercise 1

1. (a) tonne (f) tonne
   (b) milligram (g) milligram
   (c) kilogram (h) gram
   (d) gram (i) kilogram
   (e) gram (j) kilogram

2. (a) 300 g (g) 0.3 kg
   (b) 12 400 mg (h) 0.058 t
   (c) 3000 kg (i) 0.634 g
   (d) 8 600 g (j) 0.0035 kg
   (e) 4 500 mg (k) 15 250 kg
   (f) 5 500 kg (l) 4 500 000 mg

Practice Exercise 2

1. (a) 500 girls
   (b) 3.2 kg - 3.4 kg
   (c) 12 months
   (d) The line is very steep from birth and then gradually becomes less steep. This indicates rapid weight gain and as the line becomes less steep the weight gain is less rapid.

2.

Age(yrs)	0	1	**3**	5	**6**	9	10	**11**	12	**14**
Height (cm)	**4.5**	80	100	**118**	125	144	**152**	162	**168**	178

3.

Birth length	43 cm	44 cm	46 cm	49 cm	52 cm	55 cm
Expected length at 5 months	**55.9 cm**	**57.2 cm**	**59.8 cm**	**63.7 cm**	**67.6 cm**	**71.5 cm**
Expected length at 12 months	**86 cm**	**88 cm**	**92 cm**	**98 cm**	**104 cm**	**105 cm**

4. (a) Girl's

Name	Betty	Martina
Father's height	173 cm	1.7 m
Mother's height	156 cm	1.6 m
Predicted adult height	**158 cm**	**1.585 m**

   (b) Boy's

Name	Daniel	Samuel
Father's height	173 cm	1.7 m
Mother's height	156 cm	1.6 m
Predicted adult height	**171 cm**	**1.715 m**

5. (a)

NAME	Weight (kg)	Height (cm)	BMI	Health status
Mathew Wai	45	156	**18.5**	**Underweight**
Linnet Wali	112	170	**38.75**	**Severely Obese**
Mary Ross	89	159	**35.21**	**Severely Obese**
David Wama	89	190	**24.65**	**Normal**
Lily Simo	60	161	**23.15**	**Normal**

(b) Linnet Wali and Mary Ross

(c) Two (David Wama and Lily Simo

(d) Yes, Mathew wai

Practice Exercise 3

1. (a) 194 mg
   (b) 4.9 kg
   (c) 54.17 g
   (d) 1947.5 mg
   (e) 30 kg

2. (a) i. 1465 g ii. 122.08 g

   (b) 2 kg

   (c) i. 22.10 kg ii. K276.25

   (d) i. 1850 kg ii. 37 kg

3. 1824 tonnes

Practice Exercise 4

1. (a) 940.8 N
   (b) 1009.4 N
   (c) 2156 N
   (d) 1.35 N
   (e) 3626 N

2. (a) 7 kg
   (b) 18 kg
   (c) 13 kg
   (d) 230 kg
   (e) 10 kg

3. 18.7 N
4. 1282.05 N
5. 20.54 kg

Practice Exercise 5

1. 12 kg
2. 6117 kg, 6.117 tonnes
3. 755 g or .755 kg

    (a) 27 pounds
    (b) 12.28 kg
    (c) 4.09 kg

END OF SUB-STRAND 1

SUB-STRAND 2

TEMPERATURE

SUB-STRAND 2: TEMPERATURE

Introduction

This Sub-strand is an extension of what you have studied in your Grade 7 Mathematics about temperature.

The concept of temperature stems from the idea of measuring relative hotness and coldness and from the observation that the addition of heat to a body leads to an increase in temperature as long as no freezing or boiling occurs.

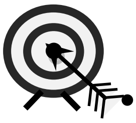
Temperature is probably the first thing that comes to mind when we talk about the weather. Prevailing wind, latitude, altitude, distance from the sea, and seasons are factors that affect temperature in general.

In this Sub-strand, you will:

- record daily maximum and minimum temperatures using a maximum and minimum thermometer and use these to establish long term temperature records
- record temperatures from wet and dry bulb thermometers and use these to determine humidity from a chart
- record body temperatures to the nearest tenth of a degree using clinical thermometer and compare this to normal body temperature.

Lesson 6: Measures of Temperature

You have learnt something about temperature in Grade 7.



In this lesson you will:

- revise temperature
- explain the measures of temperature
- compare temperature readings
- define freezing and boiling points.

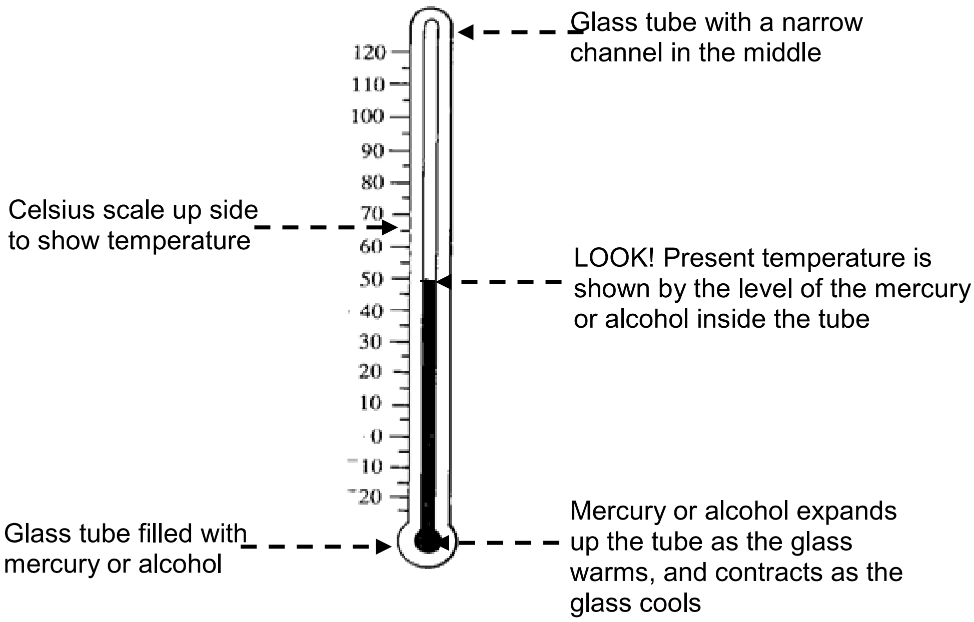
In Grade 7 Strand 4, you learnt that temperature plays an important role in determining the conditions in which living things can exist. You also learnt the meaning of Temperature. Again, let us define what temperature is.

Temperature is the degree of hotness or coldness of a body or environment. It is the measurement of how hot or cold something is.

Do not be confused with temperature and heat, they are two different terms and have different conceptual meanings however, they are interrelated. The concept of temperature stems from the idea of measuring relative hotness and coldness and from the observation that the addition of heat to a certain object leads to an increase in temperature.

As you have learnt in Grade 7, a Thermometer is used in measuring temperature. The units used in expressing temperature are the **Fahrenheit degrees** and the **Celsius** or **Centigrade degrees**). Often times, it is the **Celsius degrees or Centigrade degrees** that we read, see or hear on newspapers, television and radio broadcasts. In Papua New Guinea the temperature is measured in degrees Celsius.

The diagram shows the general features of a typical thermometer.



There are different types of thermometers that measure temperature for different things.

For examples

- The clinical thermometer is used to measure the body temperature of patients.
- The Food thermometer is used to measure the temperature for food.
- The Outdoor or Bulb thermometer is for measuring the temperature of the surrounding air.

We can use the following words to describe temperature:

TEMPERATURE (°C).	WORD
Over 35	**Very hot**
25 to 35	**Hot**
15 to 25	**Cool/warm**
5 to 15	**Cold**
-5 to 5	**Very cold**
Below -5	**freezing**

For example,

1. It is very cold in the morning hours of the night at around 3 to 4 o"clock in the morning.
2. It is very hot towards midday, at around 11 am to 1 pm during the day.
3. You feel warm wearing a jacket during cold nights, especially in the Highlands.
4. It is generally warm during the nights down on the coast than up in the Highlands where it is very cold.

The temperature in Port Moresby on Monday is described in the table below.

TIME	TEMPERATURE(°C)	WORD
9.00 a.m.	20	Cool
10.00 a.m.	25	Warm
11.00 a.m.	28	Hot
12.00 p.m.	31	Hot
1.00 p.m.	34	Hot
2.00 p.m.	29	Hot
3.00 p.m.	25	warm

There are also other key phrases used to describe temperature.

TEMPERATURE (°C).	PHRASE
100	**Boiling Point of Water**
37	**Normal Body temperature**
20	**Room temperature**
0	**Freezing point for water**

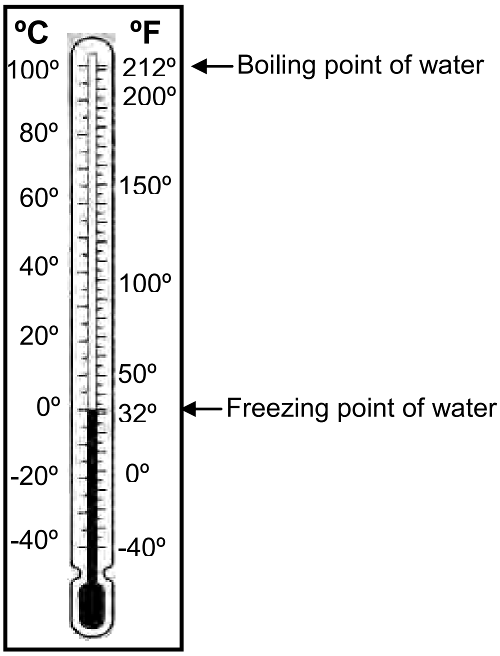
Did you know that water boils at 100˚C and freezes at 0˚C?

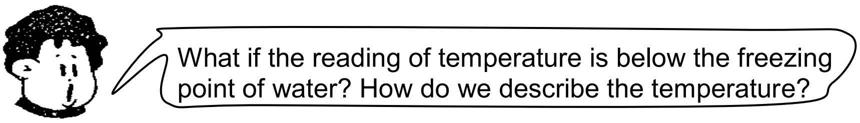
Here are some important terms you should know.

- **The Boiling Point** is the temperature at which liquid boils: the temperature at which a heated liquid turns to gas, e.g. 100 or 212 for water at sea level.

- **The Freezing Point** is the temperature at which something freezes: the temperature at which a liquid solidifies, e.g. the temperature at which water turns to ice.

The diagram below shows a comparison between the Celsius and Fahrenheit Temperature Scales. How many divisions are there between the Boiling point and the Freezing point of water on the Celsius Scale? How many divisions are there between the same temperature limits on the Fahrenheit Scale? Notice that both scales have 100 divisions between the freezing and boiling point.





In Grade seven, you learnt about numbers below zero and the use of negative numbers.

Notice that in the diagram above, if the reading is below the freezing point, we use the negative numbers to describe the temperature.

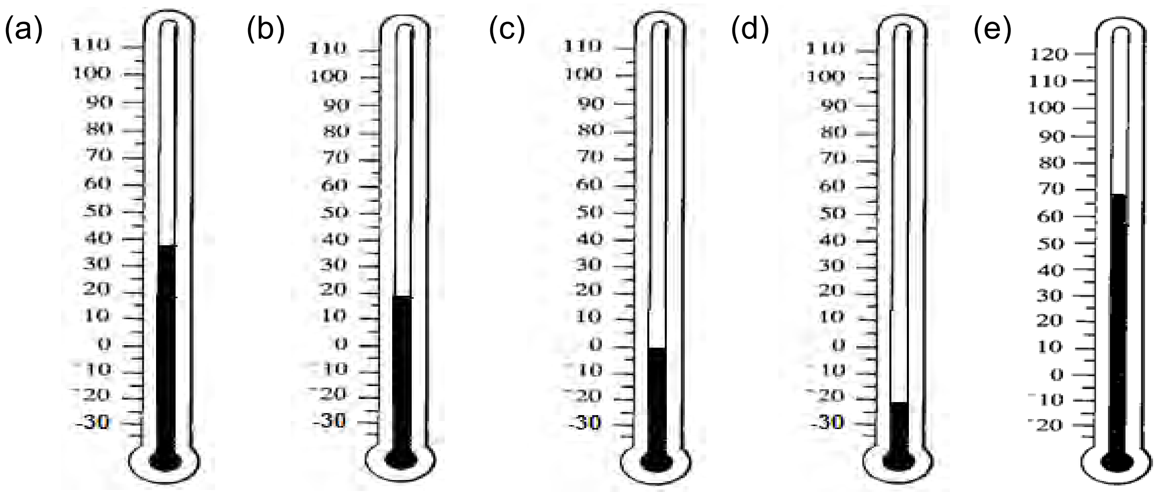
Examples

1. 20º below zero is -20º
2. 40º below zero is -40º

NOW DO PRACTICE EXERCISE 6

Practice Exercise 6

1. Fill in the table below by reading the correct temperature on each thermometer and from the readings describe the temperature using the most appropriate term.



NO	Temperature (˚C)	Describe temperature
a		
b		
c		
d		
e		

2. Mt Wilhelm is the highest mountain in Papua New Guinea. It is located in the in Simbu province of the highlands region. It experiences daily temperature on average from a low of 4˚C to a high of 11˚C.

   What type of temperature will you experience at Mt Wilhelm?

3. At 11.39 a.m. David drove via Markham valley and experienced a high temperature of 28˚C on a certain day. As he arrived in Lae City at 1.40 p.m., the temperature was 12˚C less.

   What was the temperature in Lae when he arrived? ____________________

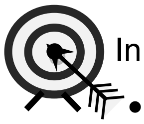
4. Write the directed number to describe each of these temperatures.

   (a) 19º above zero (b) 15º below zero
   (c) 5º below zero (d) 6º above zero
   (e) 39º above zero (f) 43º below zero

CHECK YOUR WORK. ANSWERS ARE AT THE END OF SUB-STRAND 2

Lesson 7: Conversion of Temperature

You learnt in the previous lesson how to use appropriately the words hot, warm and cold to describe temperatures. You also learnt the different measures of temperature and to read and compare temperature readings on a given thermometer scale.



In this lesson, you will:

- revise the formulae for converting temperature from degree Celsius to degree Fahrenheit
- convert temperature readings from degree Fahrenheit to degree Celsius.

The Celsius scale is used worldwide today. You will read from the newspapers, hear from radio and even see on television that the daily temperatures are read in degree Celsius. However, the Fahrenheit scale is also important because scientists use this scale to read temperatures for their special experiments or exhibitions. Therefore, it is very important that you know how to convert degree Celsius to degree Fahrenheit and vice versa.

As you have learnt in Grade 7, the formulae for converting these two scales are listed below.

- To convert Fahrenheit readings to Celsius, we use the formula

$$\boxed{\mathbf{{}^{o}C = \frac{5}{9}({}^{o}F - 32)}}$$

- To convert Celsius readings to Fahrenheit, we use the formula

$$\boxed{\mathbf{{}^{o}F = \frac{9}{5}\,{}^{o}C + 32}}$$

Example 1

Convert the following readings from the Fahrenheit scale to the Celsius scale. Round off the decimals to two decimal places.

(a) 45ºF (b) 82ºF (c) -3ºF (d) -20ºF

Solution: Use the formula: $\mathbf{{}^{o}C = \frac{5}{9}\left({}^{o}F - 32\right)}$

(a) Substitute 45 in place of ˚F: $^{o}C = \frac{5}{9}(45 - 32)$

$$^{o}C = \frac{5}{9}(13)$$

$$^{o}C = \frac{65}{9}$$

$$C = 7.22^{o}$$

Therefore, 45ºF = 7.22ºC

(b) Use the formula $°\mathbf{C} = \frac{5}{9}(°\mathbf{F} - 32)$

Substitute 82 in place of ˚F: $°C = \frac{5}{9}(82 - 32)$

$$°C = \frac{5}{9}(50)$$

$$°C = \frac{250}{9}$$

$$C = 27.78°$$

Therefore, 82ºF = 27.78ºC

(c) Use the formula $°\mathbf{C} = \frac{5}{9}(°\mathbf{F} - 32)$

Substitute -3 in place of ˚F: $°C = \frac{5}{9}(-3 - 32)$

$$°C = \frac{5}{9}(-35)$$

$$°C = -\frac{175}{9}$$

$$C = -19.44°$$

Therefore, -3ºF = -19.44ºC

(d) Use the formula $°\mathbf{C} = \frac{5}{9}(°\mathbf{F} - 32)$

Substitute -20 in place of ˚F: $°C = \frac{5}{9}(-20 - 32)$

$$°C = \frac{5}{9}(-52)$$

$$°C = -\frac{260}{9}$$

$$C = -28.89°$$

Therefore, -20ºF = -28.89º

Example 2:

Convert the following readings from the Celsius scale to the Fahrenheit scale.

(a) 100ºC (b) 20ºC (c) 0ºC (d) -30ºC

Solutions:

(a) Use the formula: $\mathbf{°F = \frac{9}{5}C + 32°}$

Substitute 100°C: $°F = \frac{9}{5}(100°) + 32°$

$°F = \frac{900}{5} + 32°$ (9 x 100 = 900)

$°F = 180 + 32°$ (900 ÷ 5 = 180)

$°F = 212°$

Therefore, 100ºC = 212ºF

(b) Use the formula: $\mathbf{°F = \frac{9}{5}°C + 32°}$

Substitute 20°C: $°F = \frac{9}{5}(20°) + 32°$

$°F = \frac{180}{5} + 32°$ (9 x 20 = 180)

$°F = 36 + 32°$ (180 ÷ 5 = 36)

$°F = 68°$

Therefore, 20ºC = 68ºF

(c) Use the formula: $\mathbf{°F = \frac{9}{5}°C + 32°}$

Substitute 0°C $°F = \frac{9}{5}(0°) + 32°$

$°F = 0 + 32°$

$°F = 32°$

Therefore, 0ºC = 32ºF.

(d) Use the formula: $\mathbf{°F = \frac{9}{5}°C + 32°}$

Substitute –30°C: $°F = \frac{9}{5}(-30°) + 32°$

$°F = \frac{-270}{5} + 32°$

$°F = -54° + 32°$

$°F = -22°$

Therefore, –30ºC = –22ºF

Example 3

Normal body temperature is 98.6°F. What is this value on the Celsius scale?

Solution: To solve this problem, replace the value of temperature given in the problem with the matching value in the conversion equation that solves for the units of temperature required in the problem.

Use the formula: $\mathbf{°C = \frac{5}{9}\left(°F - 32\right)}$

Substitute 98.6 in place of ˚F: $°C = \frac{5}{9}(98.6 - 32)$

$$°C = \frac{5}{9}(66.6)$$

$$°C = \frac{333}{9}$$

$$C = 37°$$

Therefore, 98.6° Fahrenheit is equal to 37° Celsius.

Example 4

Today's high temperature will be 40°C. What is today‘s temperature in degrees Fahrenheit?

Solution: To solve this problem, replace the value of temperature given in the problem with the matching value in the conversion equation that solves for the units of temperature required in the problem.

Use the formula: $\mathbf{°F = \frac{9}{5}°C + 32°}$

Substitute 30°C: $°F = \frac{9}{5}(40°) + 32°$

$$°F = \frac{360}{5} + 32°$$

$$°F = 72° + 32°$$

$$°F = 104°$$

Therefore, 40 ºCelsius is equal to 104 ºFahrenheit.

It is very important that you memorize the formulae for converting Celsius to Fahrenheit or vice versa so that it would be easy for you to work out problems involving the conversion of temperature.

NOW DO PRACTICE EXERCISE 7

Practice Exercise 7

a) Find the corresponding Celsius reading for each of the Fahrenheit readings.

(a) 48ºF (b) 110ºF

(c) 240ºF (d) 55ºF

(e) 400ºF (f) 505ºF

2. Express each Celsius reading in degrees Fahrenheit.

(b) 6ºC (b) 110ºC

(c) 48ºC (d) 155ºC

(e) 90ºC (f) 139ºC

3. Calculate the temperature in degrees Celsius for the following.

   (a) A cold day of 50ºF

   (b) an oven operating at 450ºF

   (c) a kettle of water about to boil at 200ºF

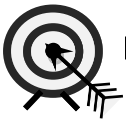
   (d) a hot summers day of 98ºF

   (e) a fever of 101ºF

CHECK YOUR WORK. ANSWERS ARE AT THE END OF SUB-STRAND 2

Lesson 8: Maximum and Minimum Temperatures

In the previous lesson, you learnt to convert temperatures from the Celsius scale to the Fahrenheit scale and vice versa. Furthermore, you learnt the meaning of freezing and boiling points.



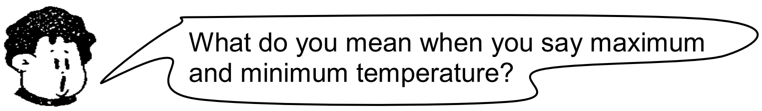
In this lesson you will:

- define maximum and minimum temperatures
- find the maximum and minimum temperatures at a given altitude.

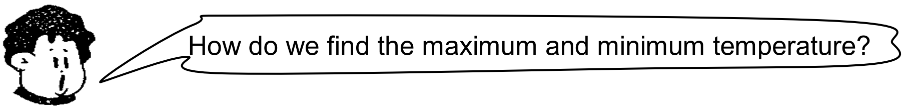
Look at the following pictures carefully. What do they remind you off?

Crack! With a flash and a bang, a bolt of lightning splits a tree in half. Hurricanes bring the ocean onto the land and carry houses away. Tornadoes pick up cars and throw them through brick walls. Floods turn roads into rivers. What do all these extreme events have in common? They‘re all examples of weather.

Maybe you listen to the weather forecast in the morning. You want to know whether it will be cold enough to wear a sweater or jacket, or warm enough to wear shorts. In other words, Meteorologists forecast or predict the maximum or minimum temperature of the day.



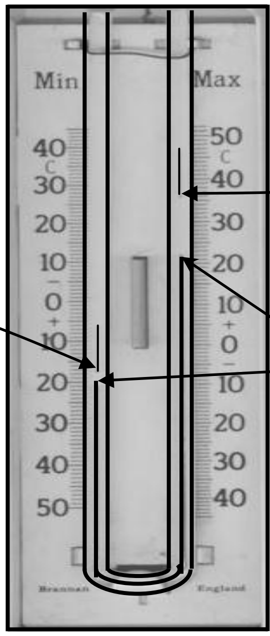
- **Maximum temperature** means the highest or hottest temperature reached during a period of time.
- **Minimum temperature** means the lowest or coldest temperature reached during a period of time.



Maximum (Highest or Hottest) and minimum (Lowest or Coldest) temperatures reached during a period of time can be recorded or measured using the **maximum and minimum thermometer**. This is commonly known as the **Six’s Thermometer** after the name of its inventor a man called James Six.

.
This type of thermometer uses a U-shaped tube. Both sides should measure the same temperature. However, the scale is inverted. There are also needles inside the tube. As the temperature drops, the mercury pushes the left hand side needle upwards. This then, measures the minimum temperature because a magnet at the back holds the needle in position. As the temperature increases to a maximum, the right hand side needle is pushed upwards to record a maximum when it stops. To reset it, the red center button is pushed and the needles drop.

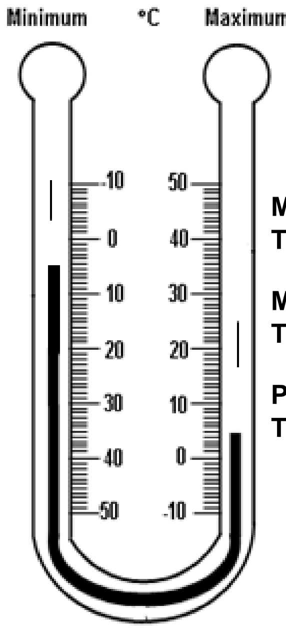
The figure below shows a minimum and maximum thermometer and its features.



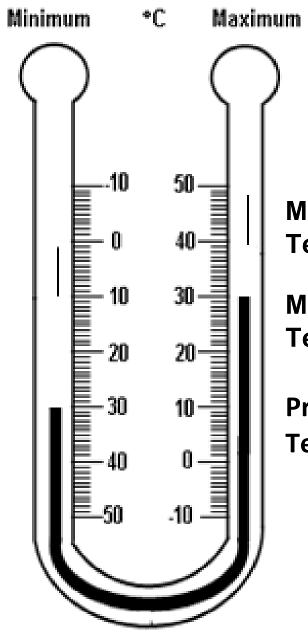
MAXIMUM AND MINIMUM THERMOMETER

Below are examples of maximum and minimum temperature readings on the thermometer scale.

A.

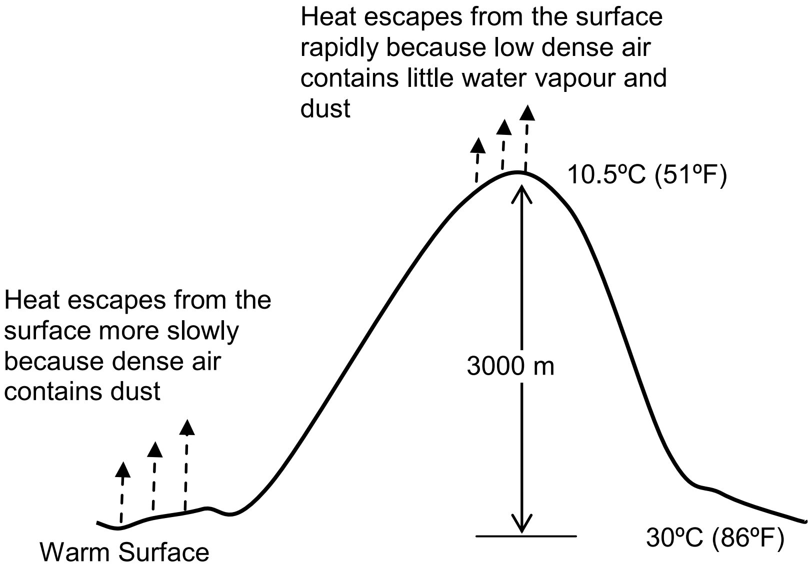


B.



Temperature varies at various locations depending on their distance above sea level. This means that altitude affects temperature. Temperature changes with increase or decrease in altitude. On average, temperature drops 1ºC for every 100 meters or 10ºC for every 1000 meters because air at higher altitudes is thinner and less dense.

The diagram below explains why temperatures are low in the Highlands than the Coastal Regions.



In Papua New Guinea, temperatures are fairly constant although the temperature gets cooler the higher you go above sea level because it lies in the equator.

Study the Table 8.1 below.

Table 8.1

AVERAGE DAILY MAXIMUM AND MINIMUM TEMPERATURE FOR DIFFERENT ALTITUDES IN PAPUA NEW GUINEA

Altitude (in metres)	Average Maximum Temperature	Average Minimum Temperature
Sea level	32ºC	23ºC
600	30ºC	19ºC
1200	27ºC	16ºC
1800	23ºC	12ºC
2100	21ºC	11ºC
2400	19ºC	9ºC
2800	16ºC	7ºC
Higher	lower	Lower

By looking at the table, we found that:

1. The difference between the average maximum and minimum temperatures at sea level is 9ºC.
2. The average maximum temperature of a place 2400 above sea level is 19ºC and the average minimum temperature is 9ºC.
3. The difference between the average maximum and minimum temperature at sea level and at 2800 is 16ºC.

Basing our observation on the table, you can say that Port Moresby which is at sea level has higher temperatures than that at Mt. Wilhelm which is at a higher altitude (4509 m) above sea level. By the way, Mt. Wilhelm is the highest peak in Papua New Guinea therefore it has the coldest temperatures.

Remember**, if the altitude increases, the temperature decreases.** This means that the higher the location is, the cooler its temperature will be.

So if you are asked why is the highlands region cooler than the coastal region? It is because of this reason.

NOW DO PRACTICE EXERCISE 8

Practice Exercise 8

1. Refer to the table to answer the Questions that follows.

AVERAGE DAILY MAXIMUM AND MINIMUM TEMPERATUREs
FOR DIFFERENT ALTITUDES IN PAPUA NEW GUINEA
iii.

Altitude (in metres)	**Average Maximum Temperature**	**Average Minimum Temperature**
Sea level	32ºC	23ºC
600	30ºC	19ºC
1200	27ºC	16ºC
1800	23ºC	12ºC
2100	21ºC	11ºC
2400	19ºC	9ºC
2800	16ºC	7ºC
Higher	lower	Lower

(a) What is the difference between the average daily maximum and minimum temperatures of a place at 1800 m above sea level?

Answer:__________

(b) What is the average daily maximum temperature of a place at 2100 m above sea level?

Answer:__________

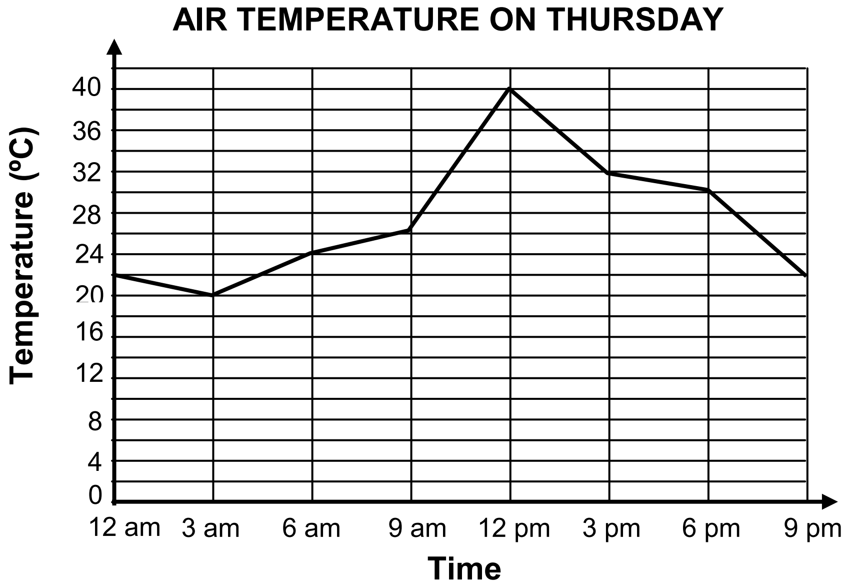
(c) What is the difference between the average daily maximum temperatures at sea level and at 2400 m above sea level?

Answer:__________

(d) Mt. Hagen is 3818 m above sea level while Mt. Kare is 3658 m above sea level. Using the table, which has warmer temperatures, Mt. Hagen or Mt Kare?

Answer:__________

2. Refer to the graph below to answer the Questions that follow.



By looking at the graph,

a) What is the maximum temperature on Thursday?

Answer:__________

b) What is the minimum temperature on Thursday?

Answer:__________

c) What was the air temperature at noon on Thursday?

Answer:__________

d) What was the air temperature at 6pm on Thursday?

Answer:__________

e) Did the air temperature rise or fall between 6 am and 9 am?

Answer:__________

f) What is the difference in air temperature between midnight and noon?

Answer:__________

g) Was it warmer at 9 am or 9 pm?

Answer:__________

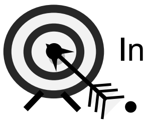
h) At what time was the air temperature the warmest?

Answer:__________

CHECK YOUR WORK. ANSWERS ARE AT THE END OF SUB-STRAND 2

Lesson 9: Body Temperature

You learnt the meaning of maximum and minimum temperatures in the previous lesson. You also learnt that the height or altitude of a place above sea level affects temperature conditions.



In this lesson, you will:

- solve problems on body temperature.

Earlier in your study of temperature, you learnt to measure temperatures using the thermometer scales. Now in this lesson, you will work out problems involving body temperatures of humans and the ideal environmental and body temperature for animals.

In human beings, body temperature at different parts of the body varies. These include

1. **Oral temperatures**, which are the most convenient type of temperatures to measure. Measurement is done by inserting the tip of a thermometer either in the mouth or under the tongue.
2. **Axillary temperatures** are an external measurement taken in the armpit or between two folds of skin on the body. This takes the longest to measure and is the most inaccurate way of measuring body temperature.
3. **Rectal temperatures** are an internal measurement taken in the rectum via the anus. It is the least time consuming and most accurate type of body temperature measurement, being an internal measurement. But it is definitely, by far, not the most comfortable method to measure the body temperature of an individual.

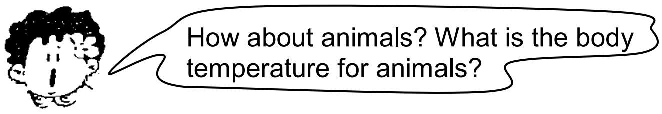
The temperature reading depends on which part of the body is being measured. The typical daytime temperatures among healthy human beings are as follows:

1. The temperature in the anus (rectal/rectum), vagina, or in the ear (otic) is about 37.5ºC or 99.5ºF.
2. The temperature in the mouth (oral) is about 37ºC or 98.6ºF. This is accepted to be the standard normal body temperature.
3. The temperature under the arm (axillary) is about 36.5ºC or 97.7ºF.

Normal human body temperature varies slightly from person to person and also by the time of day. Consequently, each type of temperature has a range of normal temperatures. The range for normal body temperatures, taken orally, is 37ºC ± 0.5ºC or 98.6ºF ± 0.9ºF.

This means that any oral temperature between 36.5ºC and 37.5ºC or 97.7ºF and 98.5 ºF is considered to be normal. Anything below 36.5ºC or above 37.5ºC is worth a call to the doctor for a check.

The human body can normally endure a temperature of 40.6ºC or 105ºF but for a short period of time only otherwise there will be permanent damage to the brain and other vital organs.



Like humans, the normal body temperature of domestic animals also vary greatly from animal to animal.

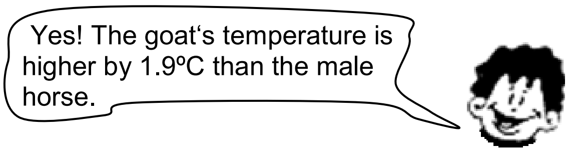
For example

1. Dogs and cats body temperatures range from 38ºC to 39.2ºC (100.5ºF to 102.5ºF)
2. Rabbits body temperature is 103.1ºF or 39.5ºF
3. Male horse‘s body temperature is 37.6ºC or 99.7ºF while a female horse body temperature is 37.7ºC or 100ºF.
4. A healthy goat‘s body temperature is 39.5ºC or 103.1ºF
5. A nesting chicken‘s temperature is 37.5ºC or 99.5ºF
6. A small rodent has similar body temperatures as human which is 37ºC.

Anything below 99ºF (37.2ºC) or above 102.5ºF (39.5ºC) is worth a call to the veterinarian.

Now if we compare the body temperatures among the animals given in the above examples, the goat has the highest body temperature.

Can you tell how much higher the temperature of the goat is compared to the male horse?



Very good!

NOW DO PRACTICE EXERCISE 9

Practice Exercise 9

1. Refer to the table. Write the symbol < or > to make each statement correct. The first one has been done for you.

26,5ºC	<	38.4ºC
38.5ºC		37.5ºC
21ºC		26.5ºC
12ºC		-14ºC
15ºC		-15ºC
-6ºC		2ºC

Refer to the information and the table below to answer Questions 2 and 3.

Healthy chickens breed healthy chickens. Most chicken eggs will hatch after 21 days at the correct temperature of 37.5ºC which is the temperature found under a nesting or sitting hen. A baby chicken needs to be kept at a temperature above 26.5ºC to protect its lungs from the cold. If a young chicklet gets cold, it can easily die.

AVERAGE DAILY MAXIMUM AND MINIMUM TEMPERATURE FOR DIFFERENT ALTITUDES IN PAPUA NEW GUINEA

Altitude (in metres)	Average Maximum Temperature	Average Minimum Temperature
Sea level	32ºC	23ºC
600	30ºC	19ºC
1200	27ºC	16ºC
1800	23ºC	12ºC
2100	21ºC	11ºC
2400	19ºC	9ºC
2800	16ºC	7ºC
Higher	lower	Lower

Using the table:

2. At what height above sea level should newborn chickens be kept indoors when the temperature drops to its minimum?

Answer:__________

3. At what height above sea level should newborn chickens be kept indoors even when the temperature outside is at its maximum?

Answer:__________

4. Matthew's body temperature recorded at 2 p.m. was 100.3ºF. At 5 p.m. his temperature was 98.6ºF. At what time did Matthew have a slight fever?

Answer:__________

---

5. The body temperature of a healthy cat is 39.2ºC. How much higher is the temperature of a cat to the

(a) The ideal environmental temperature for a baby chicken?

Answer:__________

(b) The body temperature of a healthy person at 37ºC?

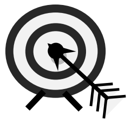
Answer:__________

(c) The body temperature of a female horse at 37.7ºC?

CHECK YOUR WORK. ANSWERS ARE AT THE END OF SUB-STRAND 2.

Lesson 10: Solving Problems involving Temperatures

You learnt to solve problems on body temperature in the last lesson.



In this lesson, you will:

- solve problems involving temperature by applying the concepts learnt in the topic on temperature.

Temperature calculations have real-life applications for everyone. Proper calculation of temperature and understanding how to solve temperature problems are important in everyday life, in science and in business.

To solve problems involving temperature, you need to apply the previous skills, knowledge and concepts learnt, like the four operations, conversion of units, conversion formula, reading scales, and drawing graphs and tables.

Study the following examples.

Example 1

John gets a bit chilly in the locker room when the thermostat is set to 68ºF. He would much prefer that the thermostat be set to 73ºF.

a) What is the difference in the actual locker room temperature and the temperature John would prefer?

b) Draw a thermometer showing the difference in temperature.

Before working out this problem let us define what a thermostat is.

> A **thermostat** may be a control unit for a heating or cooling system or a component part of a heater or air conditioner.

Now, let us work out the problem.

Solution: (a) To find the difference between the actual temperature and the temperature John would prefer, subtract the two given temperatures.

Difference = Temperature John prefer – Actual room temperature

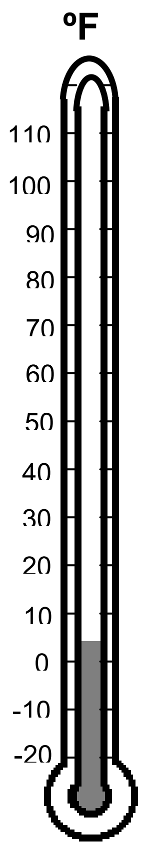
= 73ºF - 68ºF

= 5ºF

Therefore, the difference in the actual locker temperature and the temperature John would prefer is 5ºF.

Now let us show the difference on the thermometer.

(b)



Thermometer showing the difference between the actual locker temperature and the temperature John would prefer.

Example 2

Sea ice is frozen ocean water which freezes at a temperature of about -1.8ºC. What is this temperature in degrees Fahrenheit?

Solution: This problem requires conversion of temperature from ºC to ºF.

So, use the formula: $\mathbf{{}^\circ F = \frac{9}{5}\ {}^\circ C + 32}$

Substitute -1.8°C: $^\circ F = \frac{9}{5}(-1.8^\circ) + 32^\circ$

$^\circ F = \frac{-16.2}{5} + 32^\circ$ (9 x -1.8 = -16.2)

$^\circ F = -3.24^\circ + 32^\circ$ (-16.2 ÷ 5 = -3.24)

$^\circ F = 28.76^\circ$ (-3.24 +32 = 28.76)

Therefore, -1.8ºC = 28.76ºF

Example 3

The temperature of the water in the hot and cold water dispenser begins at 5ºC. It increases by 7ºC every hour for the next 12 hours.

(d) What is the temperature of the water after 12 hours?
(e) Draw a graph showing the increase in water temperature for the 12 hours.

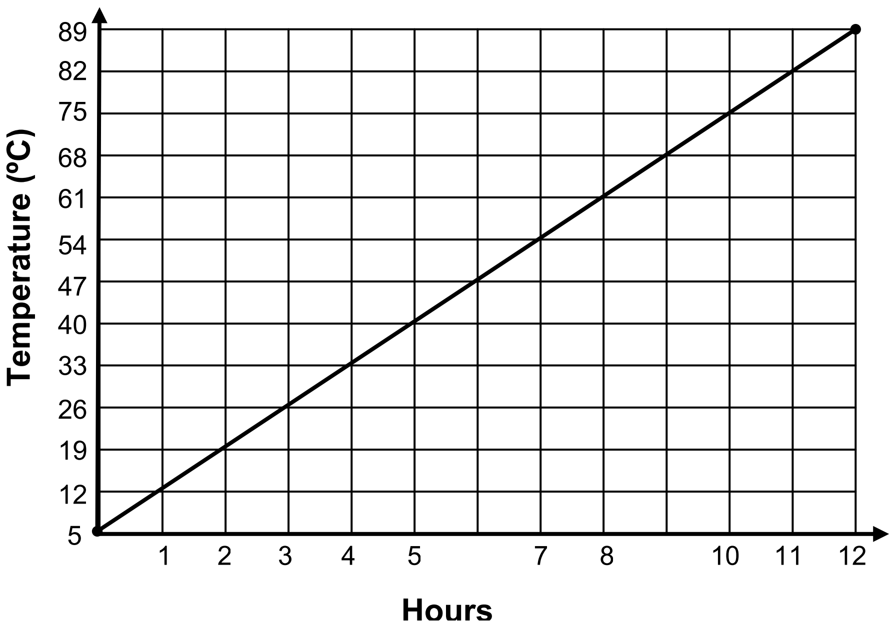
Solution: In the problem, the temperature of water starts at 5ºC and increase by 7ºC every hour for the next 12 hours. This means that after every hour 7ºC is added to the temperature.

So, after 1 hour the temperature is 5ºC + 7ºC = 12ºC
2 hours 12ºC + 7ºC = 19ºC
3 hours 19ºC + 7ºC = 26ºC
4 hours 26ºC + 7ºC = 33ºC
5 hours 33ºC + 7ºC = 40ºC
6 hours 40ºC + 7ºC = 47ºC
7 hours 47ºC + 7ºC = 54ºC
8 hours 54ºC + 7ºC = 61ºC
9 hours 61ºC + 7ºC = 68ºC
10 hours 68ºC + 7ºC = 75ºC
11 hours 75ºC + 7ºC = 82ºC
12 hours 82ºC + 7ºC = 89ºC

Therefore, the temperature of water after 12 hours is 89ºC.

(b) In Grade 7, you learnt how to draw a line graph. To draw the graph of the increase in water temperature for the 12 hours, do the following steps.

1. Draw the horizontal and vertical axes. Choose the proper scale to use.
2. Arrange the data in pairs. The pairs of values will be used to locate the points on the graph.
3. Connect the points in the order they are plotted.



Example 4

Ford was told to put some containers in one of the cold stores at work. The labels read ‘Store below -5ºC‘. There are two store rooms. One is kept at 15ºF and one at 25ºF.

Which store room should Ford choose?

Solution: In order for Ford to decide which store room to choose; Ford should know first which of the two temperatures is below -5ºC.

First, convert 15ºF and 25ºF to ºC using the formula:

$$°C = \frac{5}{9}(°F - 32)$$

Hence, we have, (a) 25ºF to ºC $= \frac{5}{9}(25 - 32)$

$= \frac{5}{9}(-7)$

$= \frac{-35}{9}$

$= -3.9°C$

(b) 15ºF to ºC $= \frac{5}{9}(15 - 32)$

$= \frac{5}{9}(-17)$

$= \frac{-85}{9}$

$= -9.4°C$

Since **-3.9ºC is warmer than -5ºC and -9.4ºC is colder than -5ºC,** we say **Ford** should choose the store **at 15ºF.**

Example 5

Jean has a houseplant that needs to be kept at a temperature above 50ºF. Her room is at 15ºC. Is this warm enough for her houseplant?

Solution: First you need to convert 15ºC to ºF to find out if it is above or below the temperature the houseplant needs. Use the formula:

$$°F = \frac{9}{5}°C + 32$$

Hence, you have 15ºC to ºF $= \frac{9}{5}(15) + 32$

$= \frac{135}{5} + 32$

$= 27 + 32$

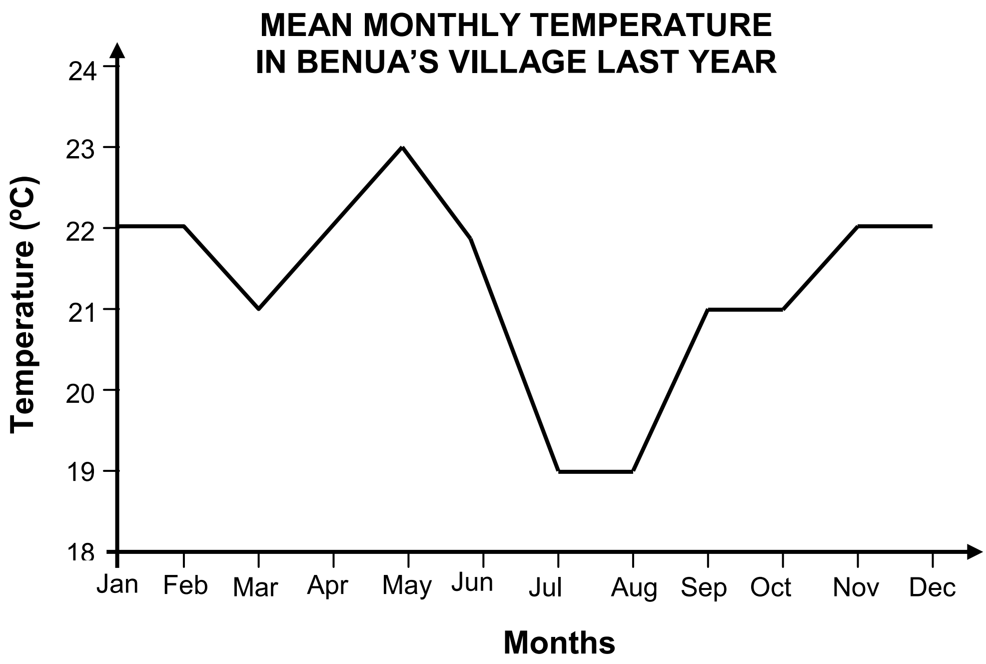
$= 59°C$

So, your answer will be **YES**. 15ºC = 59ºF. This is above 50ºF which the plant needs.

Jane’s room is warm enough for her houseplant.

Example 6

The graph below shows the mean monthly temperature in Benua's village last year.



(a) Which month was the hottest in the village?

(b) Which was the coolest month?

(c) If the mean temperature for May this year is 25ºC, how does this compare to the mean temperature for May shown on the graph?

(d) Which month is warmer: June or October?

Analysing the graph we come to the following answers:

(a) The hottest month is May because it has the highest point on the graph.

(b) The coolest months are July and August because they both have the same lowest point on the graph.

(c) It would be 2ºC higher.

(d) June is warmer.

NOW DO PRACTICE EXERCISE 10

Practice Exercise 10

1. Use the conversion table below for the questions that follow:

ºC	ºF
-25	-13
-20	-4
-15	5
-10	14
-5	23
0	32
5	41
10	50
15	59
20	68
30	86
40	104

(a) Which is warmer 20ºC or 20ºF?

(b) What is 25ºC in Fahrenheit? Is it about 5ºF or about 80ºF?

(c) Buddy is looking at holiday brochures. He wants a comfortable temperature and knows that this is about 20ºC. He should choose a place where the temperature is about 70ºF. True or false?

(d) Judy is used to temperature of about 63ºF at home. This is about 18ºC. True or false?

(e) Jessie was told to put some containers in one of the cold stores at work. The labels read ‗Store below -10ºC‘. There are two storage rooms. One is kept at 5ºF and one at 23ºF.

Which one should Jessie choose?

2. Sarah had the flu for the thanksgiving weekend. Her temperature was 103.2ºF at the highest. Her normal temperature is 98.6ºF.

   How much higher was her temperature during her fever?

---

3. Metal mercury at room temperature is a liquid. Its melting point is -39ºC. The freezing point of alcohol is -114ºC.

   How much warmer is the melting point of mercury than the freezing point of alcohol?

---

4. In Sahara Desert one day, the temperature was recorded at 136ºF. In the Gobi Desert a temperature of -50ºF was recorded.

   What is the difference between these two temperatures?

---

5. The table below shows the temperature recorded in some cities of the world.

City	Temperature
Winnipeg	6ºC
London	10 ºC
Chicago	20 ºC
Madrid	18 ºC
Beijing	31 ºC
Moscow	-8 ºC

(a) What was the coldest temperature recorded?

Answer:___________

(b) Where was the second coldest temperature recorded?

Answer:___________

(c) Which was the hottest city?

Answer:___________

6. The table below shows the temperature recorded in some of the towns in Papua New Guinea in September 6, 2012.

Town	Temperature(ºC)	Town	Temperature(ºC)
Kerema	25	Hoskins	28
Wewak	32	Kiunga	27
Port Moresby	29	Daru	26
Madang	31	Bulolo	23
Kavieng	30	Erave	20
Lae	25	Mendi	16
Goroka	20	Mt. Hagen	21
Rabaul	28	Vanimo	30

(a) Which was the coldest town?

Answer:___________

(b) Which was the hottest town?

Answer:___________

(c) Where was the third coldest temperature recorded?

Answer:___________

(d) What is the difference between the temperature recorded at Port Moresby and Mendi?

Answer:___________

(e) Which towns experienced the same temperature?

Answer:___________

CHECK YOUR WORK. ANSWERS ARE AT THE END OF SUB-STRAND 2

SUB-STRAND 2: SUMMARY

- Temperature is the measure of the hotness or coldness of something.
- To read a temperature in degrees you need a reference frame that begins with a zero point and has a number line scale.
- The two most commonly used temperature scales are the Fahrenheit and the Celsius Scales.
- On the Fahrenheit Scale, water freezes at 32ºF and boils at 212ºF. The normal temperature for the human body is 98.6ºF. The Fahrenheit scale is used primarily in the United States.
- On the Celsius Scale, water freezes at 0ºC and boils at 100ºC. The normal temperature for the human body is 37ºC. The Celsius Scale is the standard for most people outside United States and for scientists everywhere.
- A thermometer measures temperature. The common thermometer is a glass tube that contains a liquid. When the temperature goes up, the liquid expands and moves up the tube. When the temperature goes down, the liquid shrinks and moves down the tube.
- The formulas for converting from degrees Fahrenheit (ºF) to degrees Celsius (ºC) and vice versa respectively are:

$$°C = \frac{5}{9}(°F - 32) \qquad \text{and} \qquad °F = \frac{9}{5}°C + 32$$

- Maximum temperature means the highest or hottest temperature reached during a period of time.
- Minimum temperature means the lowest or coldest temperature reached during a period of time.
- Altitude is one factor that affects temperature. **If the altitude increases, the temperature decreases.** This means that the higher the location is, the cooler its temperature will be.
- The range for normal body temperatures, taken orally, is 37ºC ± 0.5ºC or 98.6ºF ± 0.9ºF. This means that any oral temperature between 36.5ºC and 37.5ºC or 97.7ºF and 98.5 ºF is likely to be normal. Anything below 36.5ºC or above 37.5ºC is worth a call to the doctor for a check-up.
- Like humans, the normal body temperature of the domestic animals also varies greatly between animals. Any temperature below 99ºF (37.2ºC) or above 102.5ºF (39.5ºC) is worth a call to the veterinarian.

REVISE LESSONS 1 TO 5. THEN DO SUB-STRAND TEST 2 IN ASSIGNMENT 4.

ANSWERS TO PRACTICE EXERCISES 6-10

Practice Exercise 6

1.

NO	Temperature (˚C)	Describe temperature
a	37	Very hot
b	18	warm
c	0	Very cold
d	-21	freezing
e	68	Very hot

2. cold
3. 16ºC
4. (a) +19 (b) -15 (c) -5 (d) +6 (e) +39 (f) -43

Practice Exercise 7

1. (a) 8.8ºC (d) 12.8ºC
   (b) 43.3ºC (e) 204.4ºC
   (c) 115.6ºC (f) 262.8ºC

2. (a) 42.8ºF (d) 311ºF
   (b) 230ºF (e) 194ºF
   (c) 118.4ºF (f) 282.2ºF

3. (a) 10ºC (d) 36.6ºC
   (b) 232.2ºC (e) 38.3ºC
   (c) 93.3ºC

Practice Exercise 8

1. (a) 11ºC (b) 21ºC
   (c) 13ºC (d) Mount Kare

2. (a) 40ºC (e) temperature rise
   (b) 20ºC (f) 18ºC
   (c) 40ºC (g) 9 a.m. is warmer
   (d) 30ºC (h) 12 p.m.

Practice Exercise 9

1.

26,5ºC	<	38.4ºC
38.5ºC	**>**	37.5ºC
21ºC	**<**	26.5ºC
12ºC	**>**	-14ºC
15ºC	**>**	-15ºC
-6ºC	**<**	2ºC

2. all levels
3. 1800 metres and above
4. at 2 p.m.
5. (a) 12.7ºC (b) 2.2ºC (c) 1.5ºC

Practice Exercise 10

1. (a) 20ºC
   (b) 25ºC is halfway between 20ºC and 30ºC. The table gives those as 68ºF and 86ºF. 25ºC will be about halfway between those. **So it is about 80ºF**.
   (c) **True**. The table tells you that 20ºCis 68ºF. This is close to 70ºF. So it is close to the temperature he wants.
   (d) **True**. Look down the ºF column of the table. 63ºFis not there, but, 59ºF and 68ºF are there. 63ºF is about halfway these two. So it is about halfway between the temperatures they match up to. So it is about halfway between 15ºC and 20ºC.
   (e) 23ºF is warmer than 14ºF and the table shows that 14ºF is -10ºC. So 23ºF is warmer than -10ºC. That one is to warm by a small amount. The other one is 5ºF which is less than 14ºF, so is less than -10ºC. **Jessie should choose the store at 5ºFsince it is cold enough.**

2. 4.6ºF

3. 75ºC

4. 186ºF

5 (a) -8ºC (b) Winnipeg (c) Beijing

6. (a) Mendi (b) Wewak (c) Mt Hagen (d) 13ºC
   (e) Kavieng and Vanimo (30ºC); Hoskins and Rabaul (28ºC)
   Kerema and Lae (25ºC): Goroka and Erave (20ºC)

END OF SUB-STRAND 2

SUB-STRAND 3

TIME

SUB-STRAND 3: TIME

Introduction

In ancient times, people used the rising and setting of the Sun to tell time. They needed to know when it would be light and when it would be dark.

The Sun looks as if it goes across the sky, but that‘s because the Earth is turning. The Sun stays still. When the Sun rises, it is daytime. When the Sun sets, it is night-time. When the Sun is at its highest point in the sky, it is noon, halfway through the day.

People say that time flies. They ask where the time went. They say that time marches on. You look at a clock or your watch to tell time. Do you ever wonder what time is?

Time isn‘t something you can see or touch. You can only tell that time passes because other things change. Change, such as how tall you are, tells you that there is a past, present, and future.

In Grade 7, you learnt how measurement of time was done during the ancient times and what advanced instruments we are using now to measure time. You also learnt why keeping time is very important for reasons like:

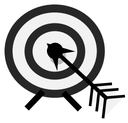
(a) We do not like to come late to work or to class or to any appointment.
(b) Keeping time is very important in science, agriculture and business.

In this sub-strand, you will:

- recognize relationships between location and time
- use time rate calculations

Lesson 11: Time

Time is one of the fundamental quantities of the physical world, similar to length and mass in this respect.



In this lesson you will:

- revise time
- recall your knowledge of the different units of time, equivalence and the conversion table
- express units of time in terms of smaller or larger units and vice versa.

In Grade 7, you have learnt the meaning of time and how time is measured. It is very important to master the basic units of time.

Below is a Table of the basic time units. Study the table carefully.

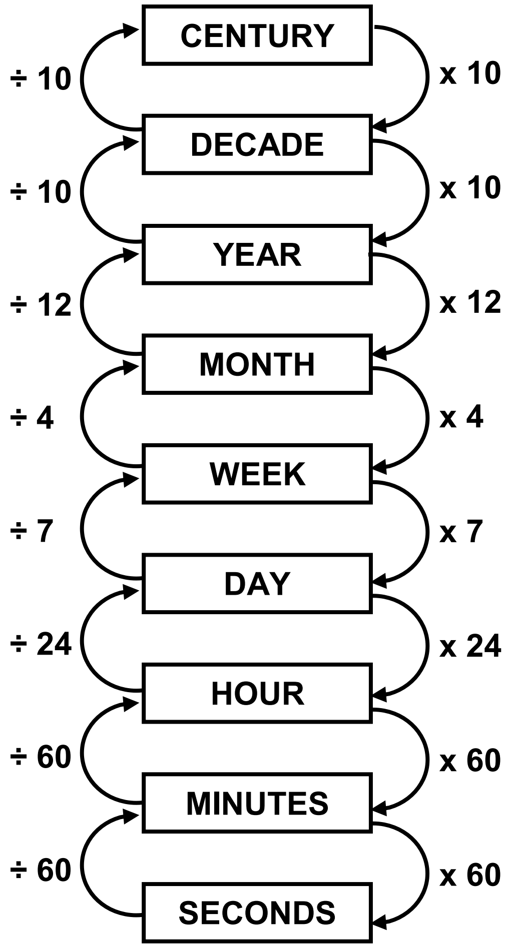
BASIC UNITS OF TIME

Basic unit	Equivalent unit
60 seconds(sec)	1 minute (min)
60 minutes (min)	1 hour (h)
24 hours (h)	1 day(d)
7 days(d)	1 week (wk)
4 weeks (wk)	1 month (mo)
52 weeks (wk)	12 months (mo)
12 months (mo)	1 year (yr)
365 days (d)	1 year (yr)
366 days (d)	1 leap year (yr)

There are other units of time we may come across, like:

Basic unit	Equivalent unit
10 years	1 decade
20 years	1 score
100 years	1 century
1000 years	1 millennium

The chart below shows how to convert between different units of time.



Notice two things when converting units.

1. To change larger units of time to smaller units, **multiply** the number by the unit equivalence.
2. To change smaller units of time to larger units, **divide** the number by the unit equivalence.

Now look at the following examples. Confirm to see if the answers are correct.

Examples:

Convert the following to the units indicated.

1. 8 minutes = ________ seconds
2. 3 centuries = ________ decades
3. 180 seconds = ________ minutes
4. 90 minutes = ________ hours
5. 2 century = ________ years

Solutions:

1. 8 minutes = ________ seconds

   This is changing larger to smaller unit, so we multiply.

   Since 1 min = 60 sec,

   Then, 8 min. = (8 x 60) sec

   = 480 sec

   Therefore, there are 480 seconds in 8 minutes.

2. 3 centuries = ________ decades

   Again, this is changing larger to smaller unit, so we multiply.

   Since 1 century = 10 decades

   Then, 3 centuries = (3 x 10) decades

   = 30 decades

   Therefore, there are 30 decades in 3 centuries.

3. 180 seconds = ________ minutes

   This is changing smaller to larger unit, so we divide.

   Since 1 minute = 60 seconds

   Then, 180 seconds = (180 ÷ 60) min

   = 3 min

   Therefore, there are 3 min in 180 seconds.

4. 90 minutes = ________hours

   Again, this is changing smaller to larger units, so we divide.

   Since 60 minutes = 1 hour

   Then, 90 minutes = (90 ÷ 60)h

   = 1.5 hours or $1\frac{1}{2}$ hours

   Therefore, there are $1\frac{1}{2}$ hours in 90 minutes.

5. 2 centuries = ________ years

This is changing larger to smaller units, so we multiply.

Since 1 century = 100 years

Then, 2 centuries = (2 x 100) years

= 200 years

Therefore, there are 200 years in 2 centuries.

Now study this problem example which requires you to convert units to get your answer.

It took 4320 seconds to walk to Tape's village from Tari station. How many days did he take to make this journey?

Solution:

Time taken is 4320 seconds. The question is how many days.

In this case, we will have to convert from smaller unit to larger unit.

4320 sec = 4320 ÷ 60 (since 1 minute is 60 sec) =720 minutes

720 min = 720 ÷ 60 (since 1 hr is 60 min) = 12 hours

12 hours = 12 ÷ 24 (since 1 day is 24 hours) = ½ day

Therefore, it took Tape half a day to walk from Tari station to his village.

Now let us look at problems involving operations with time.

In problems involving operations with time, usually addition and subtraction, we sometimes need to change or convert the units.

Study the following examples.

Example 1

Add 17 minutes 7 seconds and 9 minutes 55 seconds.

Solution:
17 min 7 sec
+ 9 min 55 sec
26 min 62 sec = 26 min + 1 min 2 sec

= 27 min 2 sec

We know that 60 sec = 1 min. Since there are 62 sec after addition, we change 62 sec to 1 min and 2 secs.

Example 2

Add: (24 h 18 min 19 sec) + (19 h 11 min 37 sec) + (6 h 49 min 30 sec)

Solution:

$$
\begin{array}{rl}
 & 24 \text{ h } 18 \text{ min } 19 \text{ sec} \\
+ & 19 \text{ h } 11 \text{ min } 37 \text{ sec} \\
 & \underline{\ \ 6 \text{ h } 49 \text{ min } 30 \text{ sec}} \\
 & 49 \text{ h } 78 \text{ min } 86 \text{ sec} = 49 \text{ h} + (1 \text{ h } 18 \text{ min}) + (1 \text{ min } 26 \text{ sec}) \\
 & \qquad\qquad\qquad\quad \mathbf{= 50 \text{ h } 19 \text{ min } 26 \text{ sec.}}
\end{array}
$$

We know that 60 min = 1 h and 60 sec = 1 min. Since there are 78 min and 86 sec after addition, we change 78 min to 1 h 18 min and 86 sec to 1 min and 26 sec.

In subtraction, regrouping is applied when the subtrahend (number we subtract) is greater than the minuend (number from which we subtract).

Example 3

Subtract: (8 h 22 min) from (10 h 8 min)

Solution:

$$
\begin{array}{rl}
 & 10 \text{ h } \ 8 \text{ min} \rightarrow 9 \text{ h } 68 \text{ min} \\
\underline{-} & \underline{\ \ 8 \text{ h } 22 \text{ min} \rightarrow 8 \text{ h } 22 \text{ min}} \\
 & \qquad\qquad\quad \mathbf{=1 \text{ h } 46 \text{ min}}
\end{array}
$$

Example 4

Subtract: (5 days 9 h 55 min) from (27 days 13 h 17 min)

Solution:

$$
\begin{array}{rl}
 & 27 \text{ days } 13 \text{ h } 17 \text{ min} \rightarrow 27 \text{ d } 12 \text{ h } 77 \text{ min} \rightarrow 26 \text{ d } 36 \text{ h } 77 \text{ min} \\
\underline{-} & \underline{5 \text{ days } \ 19 \text{ h } 55 \text{ min} \rightarrow \ 5 \text{ d } 19 \text{ h } 55 \text{ min} \rightarrow \ 5 \text{ d } 19 \text{ h } 55 \text{ min}} \\
 & \qquad\qquad\qquad\qquad\qquad\qquad\qquad \mathbf{= 21 \text{ d } 17 \text{ h } 22 \text{ min}}
\end{array}
$$

We know that 24 h = 1 day and 60 min = 1h. Since the hours and minutes in the subtrahend are greater than that of the minuend, we change 27 d to 26 d; 12 h to 36 h and 17 min to 77 min.

Remember:

When adding and subtracting time, we sometimes need to convert or change the unit of time.

NOW DO PRACTICE EXERCISE 11

Practice Exercise 11

1. Convert the following to the units indicated.

(a) 120 sec = __________ min (b) 180 min = __________h

(c) 240 h = __________days (d) 104 wk = __________ yr

(e) 5 d = __________ min (f) 100 yr = __________ decades

2. Change the following into days:

(a) 49 hours

Answer:__________

(b) ¾ of a month

Answer:__________

(c) ½ a decade

Answer:__________

(d) 2 leap years

Answer:__________

3. Add or subtract as indicated.

(a)
```
   12 min 25 sec
+  17 min 55 sec
```

(b)
```
   9 h 58 min
+  7 h 25 min
```

(c) 32 min 15 sec
$-$ 10 min 50 sec

(d) 8 h 18 min
$-$ 3 h 25 min

(e) 12 d 26 h 15 min
$-$ 8 d 16 h 57 min

(f) 8 h 18 min
$-$ 3 h 25 min

---

4. Sarah took 1800 seconds to do her laundry on Sunday. She then takes $1\frac{1}{2}$ hours to clean her room. How many hours did she take to do these two activities?

Answer:___________

---

5. Joshua takes a quarter of an hour to walk from home to his school while his sister Martha takes 28 minutes. Who walks faster?

Answer:___________

CORRECT YOUR WORK. ANSWERS ARE AT THE END OF SUB-STRAND 3

Lesson 12: Use of Clocks, Diaries and Calendars

You have revised the different units of time, equivalence and conversion tables in your previous lesson. You have also extended further your knowledge of converting units of time from smaller units to larger units and vice versa.

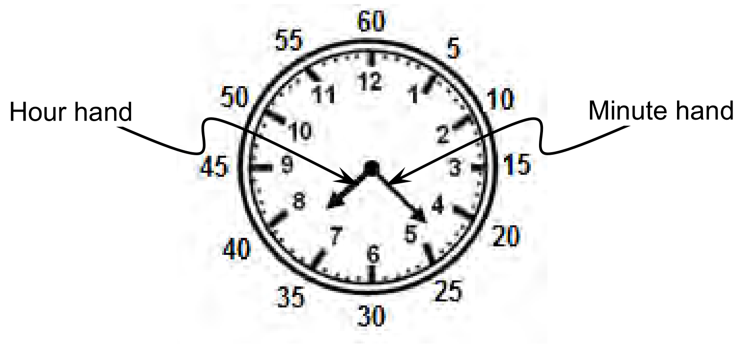
In this lesson you will:

- record time using different time modes
- interpret and calculate time using clocks, diaries and calendars.

Being able to work with and tell time is a very valuable skill. In order to tell time, there are several key points to remember. We measure time in seconds, minutes, hours, days, weeks, months, and years. This section covers telling time on clocks—using minutes and hours. In order to work with minutes and hours, you must remember that there are 60 seconds in a minute, and 60 minutes in an hour. There are 24 hours in one day.

First let us study the Parts of a Clock.

A clock is a device that is used to tell time. Clocks measure time in hours and minutes, and have an hour hand (that moves forward one clock number every hour) and a minute hand (that moves forward one tick every minute and it moves forward one clock number every 5 minutes). A clock is divided into 12 sections, and each section is worth 5 minutes (because 5 x 12 = 60, and there are 60 minutes in an hour). One complete trip around the clockface by the minute hand means that one hour has passed. When you read a clock, you look at the hour hand first, and then you look at the minute hand. The hour hand is shorter, and the minute hand is longer. This is how you tell them apart. A normal clock looks like this:



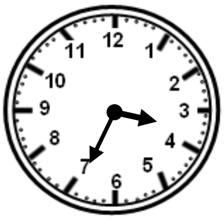
The inside numbers are standard on all clocks. These are clock numbers. You will not see the outside numbers on normal clocks the way they are on the outside of this clock, but these are the minute marks. Thus, every 1 clock number is equal to 5 minutes.

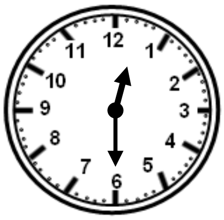
In Grade 7, you learnt about digital clocks and analog clocks. Digital clocks show hours and minutes in 24-hour system while, analog clocks have hands showing hours and minutes in a 12-hour system.

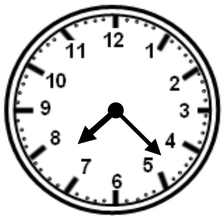
Here are some examples:

Example 1

Write down the time as shown by each of these analog clocks.

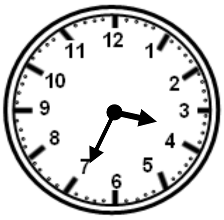
a) 
3.35
“three thirty five”

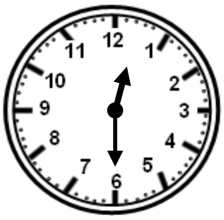
b) 
12.30
twelve thirty

c) 
7.24
seven twenty four

Example 2

If the clocks in example 1 were time in the afternoon or evening, write each time using the 24-hour time notation.

a) 
The time is 1535 h

b) 
The time is 1230 h

c) 
The time is 1924 h

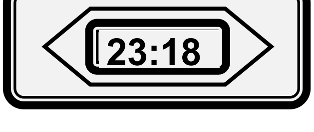
Example 3

The following 24-hour times are written in 12-hour times using a.m. or p.m. equivalents.

a) 0945 h = 9.45 a.m.
b) 2017 h = 8.17 p.m.
c) 2350 h = 11.50 p.m.
d) 1030 h = 10.30 a.m.
e) 1230 h = 12.30 p.m.
f) 0155 h = 1.55 p.m.

Example 4

This is a digital clock showing time in 24-hour notation.



The time is 11.18 p.m. in 12- hour notation.

Calendars and diaries are also useful in telling time. On a calendar, we measure time in days, weeks, months, and years. They are based on the time the Earth takes to revolve around the sun (year), the moon takes to revolve around the Earth (month) and the Earth takes to rotate on its axis (day).

The length of time taken by the Earth to revolve around the sun is not exactly 365 days but in fact it's approximately 365.25 or 365 ¼ days.The Julian calendar was adopted to take account of this, and the leap year was introduced.

Below is an example of a calendar.

2012 CALENDAR

JANUARY

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

FEBRUARY

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29			

MARCH

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

APRIL

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

MAY

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

JUNE

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

JULY

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

AUGUST

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

SEPTEMBER

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

OCTOBER

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

NOVEMBER

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

DECEMBER

S	M	T	W	T	F	S
					1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

You will notice from the calendar that the months in a year contain different numbers of days.

For example:

31 days in January, March, May, July, August, October, December

30 days in April, June, September, November

28 days in February except in a leap year when there are 29 days.

Here is a very useful way of remembering:

Thirty days has September, April, June and November,

All the rest have thirty one, except for February alone

This has twenty-eight days clear, and twenty-nine in each leap year.

Leap years occur every multiple of four years. Most years that can be divided evenly by 4 are leap years.

For example:

2008 is a leap year because it is exactly divisible by 4.

2012 is a leap year because 2012 divided by 4 = 503.

We say, for every rule there is an exception: Century years are NOT leap years UNLESS they can be evenly divided by 400.

For example: 1700, 1800, and 1900 were not leap years, but 1600 and 2000, which are divisible by 400, were leap years.

Diaries are calendars which have written daily records of personal experiences.

Now let us use the calendar in figuring out the number of days between two given dates.

For examples

1. How many days from May 1^{st} to October 1^{st} if we include both these dates?

Solution: Since May 1^{st} and October 1^{st} are inclusive, to find the number of days we count all the days from May 1^{st} to October 1^{st}.

May	= 31 days	
June	= 30 days	
July	= 31 days	
August	= 31 days	Add
September	= 30 days	
October 1st	= 1 day	
	154 days	

Therefore, there are **154 days** from May 1^{st} to October 1^{st} including both these dates.

2. If you were on a holiday and stayed at Ela Beach Hotel from the 9^{th} of January to the 23^{rd} of January inclusive.

a) How many days did you stay there?

Solution:

Inclusive means to include both beginning and ending dates.

The number of days from 9^{th} to 23^{rd} of January is 15.

Therefore, you stayed at Ela Beach hotel for 15 days.

b) How many nights did you stay there?

Solution:

You will only stay for **14 nights** because you will be out of the hotel on the eve of 23rd of January. Thus, the night will be excluded.

3. Marcus forgot to keep record of his diary from the 18th of March to 22nd of March inclusive. How many days was that?

Solution:

MARCH

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

Inclusive means to include both 18th of March to 22nd of March.

Therefore, Marcus forgot to keep record of his diary for 5 days.

4. Gabriel's birthday is on August 6. How many days to her birthday from January 1st in any year?

Solution: Counting all the days using the calendar, from January 1st to August 6.

JANUARY

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

FEBRUARY

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29			

MARCH

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

APRIL

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

MAY

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

JUNE

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

JULY

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

AUGUST

S	M	T	W	T	F	S
		1	2	3	4	5
6						

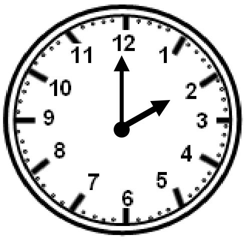
If it is leap year, **219** days and **218** in others.

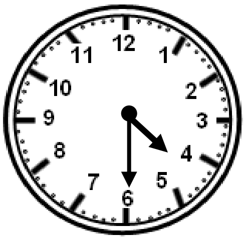
Note: When finding the number of days in a certain period of time it is important to know whether to include or exclude the beginning and end dates.

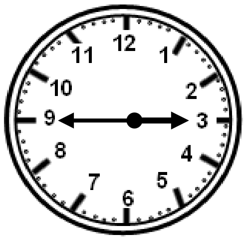
NOW DO PRACTICE EXERCISE 12

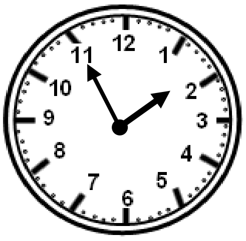
Practice Exercise 12

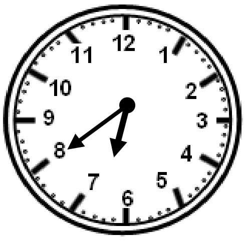
1. Write down the times as shown.

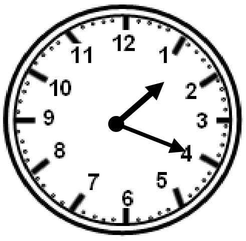
a) 

b) 

c) 

d) 

e) 

f) 

2. Copy and complete this table.

No	24- hour time	12-hour time	Statement of the time
a	1000 h		
b		1.10 am	10 minutes past 1
c	0945h	9.45 am	
d	1150h		10 minutes to 12
e		5.15 am	
f	2345h		
g		1.45 pm	Quarter to 2
h	2220h		20 minutes past 10

3. State whether these years are Leap years or not.

a) 2000

b) 2004

c) 2007

d) 2010

4. How many days are there for the following? (inclusive)

   a) 10^{th} of July to 30^{th} of July

   b) 16^{th} September to 1^{st} of October

   c) 12^{th} of November to 29^{th} of November

   d) 24^{th} of December to 29^{th} of January

---

5. If today was the 3^{rd} of September and Michelle's birthday was on the 19^{th} of September. Exclusively,

SEPTEMBER

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

   a) how many days must she wait for her birthday?

   b) how many weeks and days is that?

---

6. If you were on a holiday and stayed at a motel from the 24^{th} of December to the 5^{th} of January inclusive.

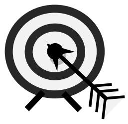
   a) How many days did you stay there?

   b) How many nights did you stay there?

CORRECT YOUR WORK. ANSWERS ARE AT THE END OF SUB-STRAND 3

Lesson 13: Timeline, Timetable and Time Chart

You have learnt to tell the time using clocks, calendars and diaries in the previous lesson.

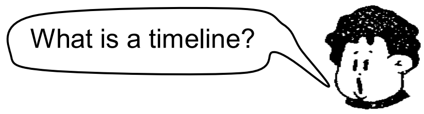


In this lesson you will:

- define timelines, timetables and time charts
- use timeline, timetable and time chart to determine occurrences of events and predict time.

Time cannot be physically seen nor touched. How do we know that time passes? We only see evidence of time passing when we notice changes around us and see events that occurs that tells us that there is a past, present and future. Some practical way of investigating time includes timelines, time tables and time charts.

First, in this section we will be investigating time using timelines.

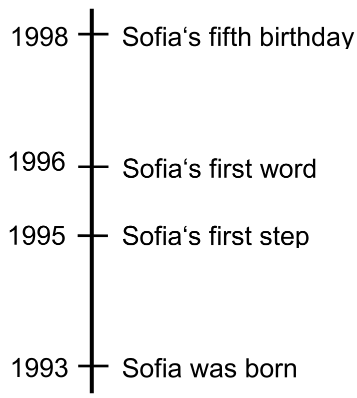


A timeline is a way of displaying a list of events in chronological (consecutive) order.

Timelines are the simplest types of calendars. They record events in the order in which they happen. They are mostly used to show periods of time between two events. Timelines are used to keep track of things that happen on certain days or in certain years.

For example

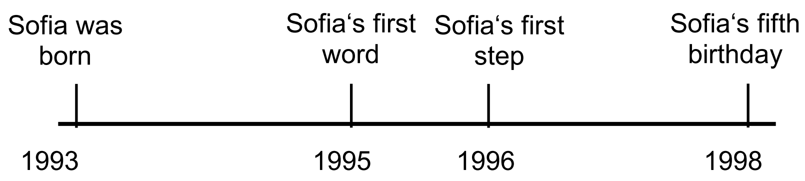
Sofia's parents want to keep track of important events in her life. They decide to make a timeline. Sofia was born in 1993. She walked for the first time in 1995, when she was 2. The next year, she said her first words. And in 1998, she celebrated her fifth birthday. Her parents can keep track of all these events by putting them on a timeline like the one below.



You can see how the events that happened first are at the bottom? Then, as you move toward the top, the event that happened next is recorded as you move up the line. The last event is at the top.

Putting events on a timeline like this gives you a sense of how much time goes by in between each event. It also helps you remember just when those important events happened. Many years from now, when Sofia has her own children, she might want to recallr when she first walked. She can look at this timeline that her parents made and remember that when she first walked, she was 2.

You can also draw Sofia‘s timeline horizontally as shown below.

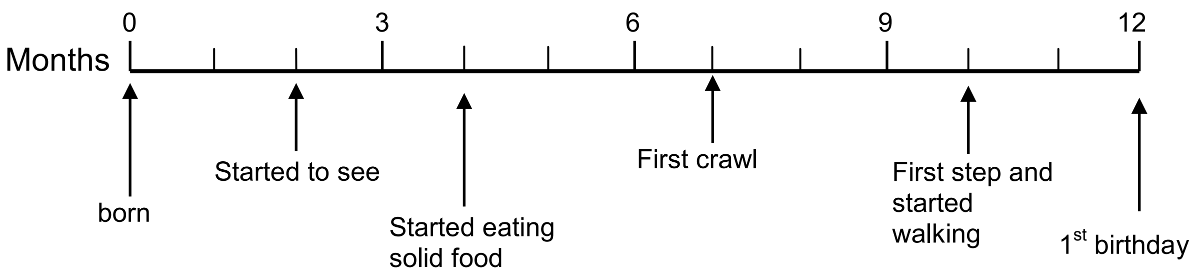


Note how the events that happened first are at the left? Then, as you move toward the right, the event that happened next is listed next as you move right, along the line. The last event is at the far right.

Now look at the following examples of timelines.

Example 1:

A TIME LINE FOR BABY IMMANUEL



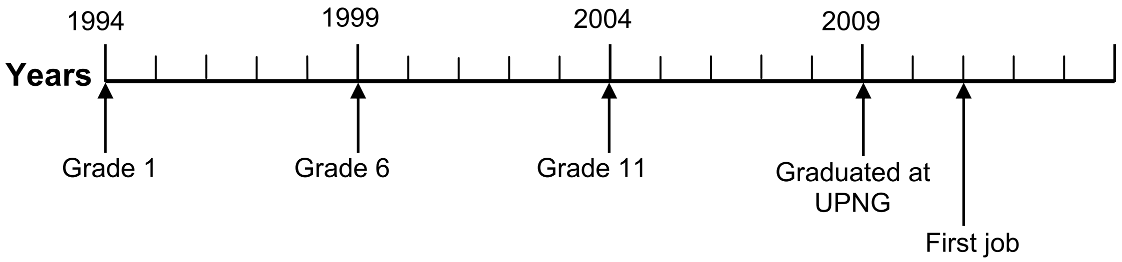
You need to work out the scale used on the timeline before you can get information from it.

On this timeline there are 4 major divisions between 0 and 12, so each division represents 3 months. Each subdivision represents 1 month.

Now you can discover that at 2 months baby Immanuel started to see. He started to eat solid food at 4 months and his first crawl was at 7 months. The line also shows that it took Baby Immanuel 3 months after his first crawl to take his first step and walk.

Example 2:

KEVIN'S EDUCATION TIMELINE

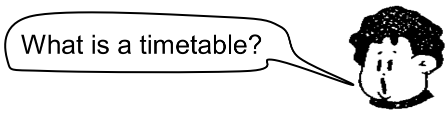


Studying the timeline, it shows that Kevin started his education in 1994 and finished in 2009. It also shows that it took him 2 years after his graduation to a find a job.

You can create a timeline for anything, your own life, the life of a historical figure, the history of a country, etc.

To draw your own timeline, start by turning a piece of paper sideways. Draw a horizontal line across the paper, near the top. Divide it into as many sections as you need (for example, if you're doing a timeline of your life, you could divide the line into sections for each year of your life - e.g., if you are 12 years old, make 12 sections).

Another practical way of investigating time is with timetables or time charts.



A timetable is list or table of events arranged according to the time when they take place.

Timetables or time charts are used for many services in everyday life. They tell you when certain things are going to happen.

For example:

- It is used as a plan, a program or schedule designating the time at or within which certain things occur or are scheduled to occur. This includes:
  - (a) television guides
  - (b) Timetable for research proposals
  - (c) Timetable for studying school lessons.
- it is used as a chart showing the departure and arrival times of trains, buses, or planes.

Here are some examples of timetables or time charts.

Example 1:

Below is the pickup timetable for workers at Ok Tedi Mining Limited.

Campsite to Mining area			
	Bus 1	**Bus 2**	**Bus 3**
Bus tops	**am**	**am**	**am**
Campsite	7.30	8.15	9.00
Camp 1	7.40	8.25	9.10
Camp 2	7.45	8.30	9.15
Camp 3	7.55	8.40	9.25
Camp 4	8.15	9.00	9.45
Mining area	8.20	9.05	9.50

a) Which bus would a worker catch if he wants to get from campsite to Camp 3 by 8.40 a.m.?

Solution: Read across the timetable on the Camp 3 row. The time 8.40 a.m is at column Bus 2.

The worker should catch Bus 2.

b) What time does Bus 1 arrive at Camp 4?

Solution: Read across the timetable at the Camp 4 row. Bus 1 arrival time is 8.15 a.m.

Bus 1 arrives at Camp 4 at 8.15 a.m.

(c) How long does the bus trip take from Campsite to the Mining area? The bus takes 50 minutes.

Solution: Find the time difference between the two times.

Add the time taken from Campsite (7.30 a.m.) to mining area (8.20 a.m.).

From 7.30 a.m. to 7.40 a.m. = 10 minutes
7.40 a.m. to 7.45 a.m. = 5 minutes
7.45 a.m. to 7.55 a.m. = 10 minutes
7.55 a.m. to 8.15 a.m. = 20 minutes
8.15 a.m. to 8.20 a.m. = 5 minutes
Total time: = 50 minutes

Therefore, it takes a bus 50 minutes from Campsite to the mining Area.

(d) What is the shortest time between bus stops?

Solution: 5 minutes

Example 2:

Below is a weekend Personal Timetable for Patrick.

WEEKEND PERSONAL TIMETABLE		
TIME	**DAYS**	
	Saturday	**Sunday**
8.00am	Do all school homework	Attend church service
10.00	Laundry	Do house work
12.00	Break	Do house work
2.00	Study Mathematics notes	Study Science notes
4.00	Play rugby	Study S/Science notes
6.00	Dinner	Dinner
8.00	Study English notes	Study other subjects
10.00 pm	sleep	sleep

a) On what day and at time does Patrick wash his clothes?

Solution: The table shows that the Laundry day and time is Saturday at 10.00 a.m.

b) How long does it take for him to do house work?

Solution: The table shows that Patrick does house work on Sundays between 10.00 a.m. and 12.00 noon, a period of 2 hours.

Therefore Patrick spent 2 hours doing house work.

c) How many minutes does he take to study each subject?

Solution: Patrick spent 2 hours to study each subject.

d) When does he go to sleep?

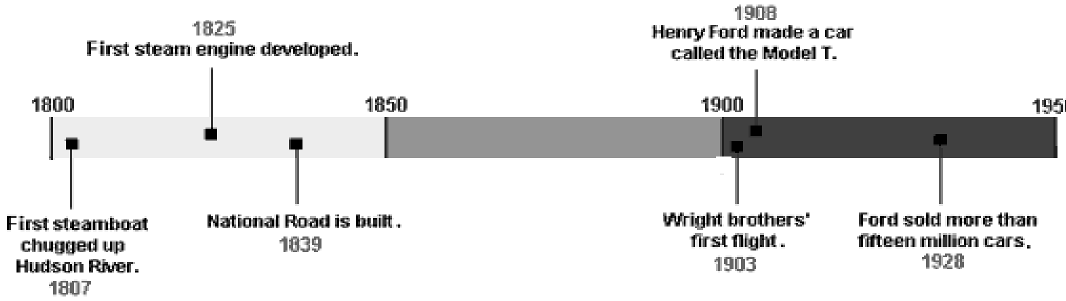
Solution: His time to go to sleep is at10.00 p.m.

NOW DO PRACTICE EXERCISE 13

Practice Exercise 13

1. Refer to the timeline below to answer the questions that follow.

DEVELOPMENT OF TRANSPORTATION



a) Which event took place in 1825?

Answer:__________

b) Was the National Road built before or after Ford's Model T? How do you know?

Answer:__________

c) How much time passed between the year, the Model T was developed and the year in which Ford sold fifteen million cars?

Answer:__________

d) Did the steam engine come before or after the steamboat?

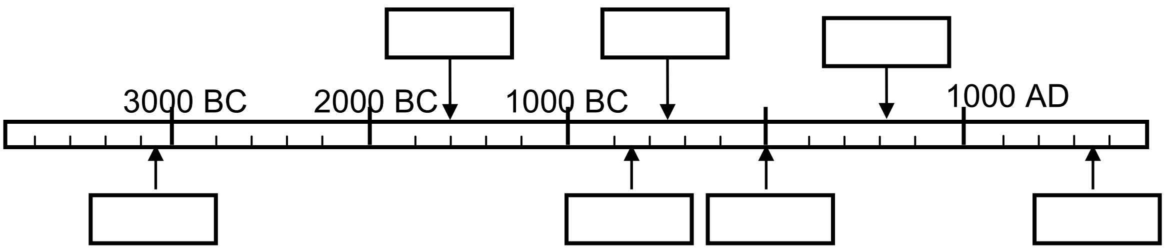
Answer:__________

e) An elevator with a safety clamp was invented in 1852, which led to the first passenger elevator to be built. In which part of the time line would that event appear?

Answer:__________

---

2. Complete this timeline by writing the following dates onto the time line in the correct boxes.



AD 1	Birth of Christ
753 BC	Founding of City of Rome
About 1600 BC	Introduction of the current Chinese year system
3111 BC	Start of Malayan —Long Count”
544 BC	Birth of Buddha
AD 1792	Declaration of first French Republic
AD 622	Traditional date for the flight of Muhammad

3. Refer to the timetable or time chart below to answer the questions that follow.

LIVESTOCK SHIP OPERATION FROM PORT MORESBY		
Port	**Day**	**Hour**
Port Moresby	Departure Sunday	1700
Lae	Arrival Monday	0800
	Departure Monday	1600
Madang	Arrival Tuesday	0800
	Departure Tuesday	1500
Wewak	Arrival Thursday	0700
	Departure Thursday	1300
Rabaul	Arrival Friday	0500
	Departure Friday	1200
Port Moresby	Arrival Saturday	0200

(a) Write the departure times in 12-hour notation (remember to include a.m. or p.m.) from Port Moresby and from Lae.

Answer:__________

(b) How long does it take the ship to arrive in Lae from Port Moresby?(in hours)

Answer:__________

(c) How many days and hours does it take the ship to arrive in Wewak from Port Moresby?

Answer:__________

(d) In which port does the ship stay for a long time before continuing?

Answer:__________

(e) How many hours is that?

Answer:__________

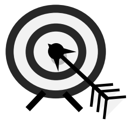
(f) How long is the complete journey in days and hours?

Answer:__________

CORRECT YOUR WORK. ANSWERS ARE AT THE END OF SUB-STRAND 3.

Lesson 14: Location and Time

You learnt what timelines, time tables or time charts were in the previous lesson. You also learnt to read and draw timelines and time tables.



In this lesson, you will:

- work out the time difference between Papua new Guinea and other countries of the world.

Hours, minutes, and seconds are the same unit and length of time anywhere on Earth. But because the Earth turns around once every 24 hours giving day and night, some places on earth is day while in other places it is night.

For example, while it is daytime in Papua New Guinea, it is night time in England and in some other parts of the world.

This is so because as the earth revolves around the sun different parts face the sun at different times. The side of the earth facing the sun has day while the other side has night.

A day has 24 hours and each hour corresponds to one time zone, which is equivalent to 15º of longitude (15º x 24 hours = 360º).

A time zone is a region or part of the earth which has the same standard time.

The Earth is divided into 24 time zones. The time zones look like slices on a beach ball. This means that people living in the same zone, even in different cities in different countries, will use the same local standard time. There is a one-hour difference between each time zone and the one next to it. When you move from one time zone to the next you need to change the time on your watch by one hour. If you travel in an easterly direction, you adjust your watch one hour forwards, if you travel in the westerly direction you adjust your watch one hour backwards.

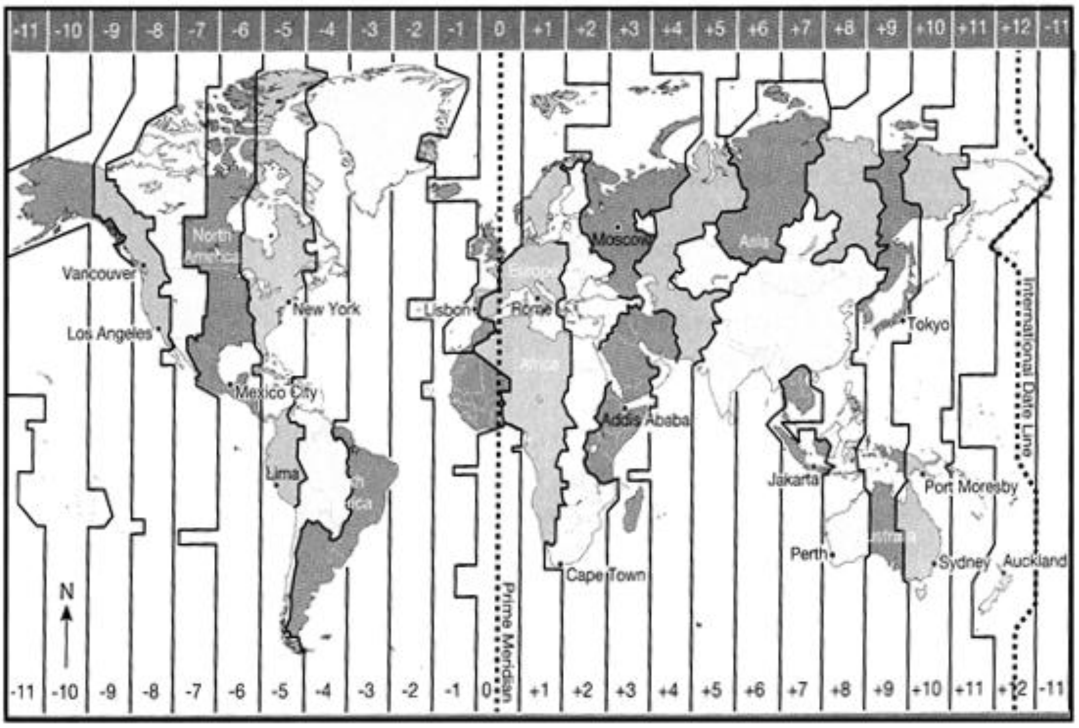
Greenwich in England is used as the standard time all around the world.

What is Local Standard Time?

The Local Standard Time is the official time in a local region (adjusted for location around the Earth).

Here is a map which shows Papua New Guinea and other countries of the world.

WORLD TIME ZONES



The map shows the world time zones.

You can see that all of Papua New Guinea is in the same zone .The prime meridian (longitude 0º) is the starting point from which time is measured either east or west.

For example to travel from Port Moresby to New York in the USA you cross 15 time zones (15 x 15º) in a westerly direction or 9 time zones (9 x 15º) in an easterly direction.

To find the time in New York you can add 9 hours (one hour for each 15º) or you subtract 15 hours for each 15º). If it is 10 a.m. in Papua New Guinea, it will be 7 p.m. in New York: 10 a.m. – 15 hours = 7 p.m.

Papua New Guinea is in the Eastern zone. Eastern Standard Time is 10 hours ahead of Greenwich Mean Time (GMT).

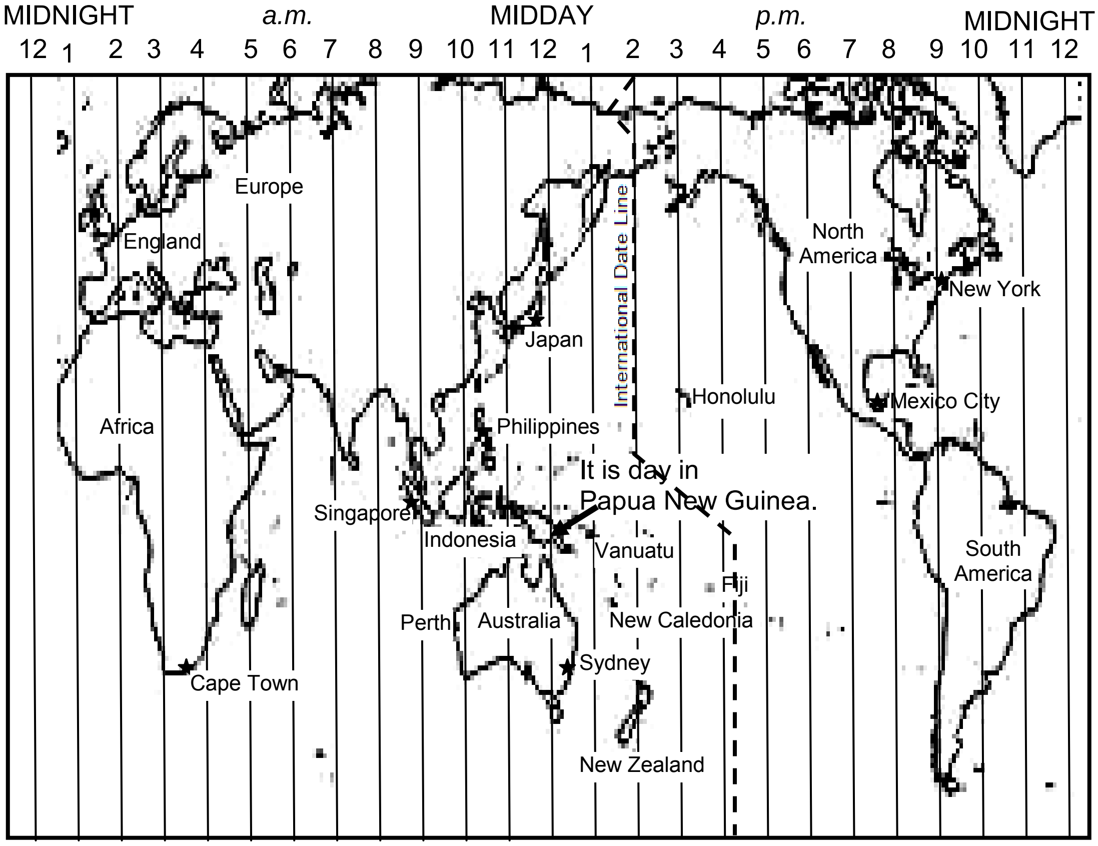
You will see a line called the International Date Line on the map above.

The International Date Line is a line going from North to South, where each new day in our calendar begins.

The International Date Line sits on the 180º line of longitude in the middle of the Pacific Ocean, and is the imaginary line that separates two consecutive calendar days.

Immediately to the left of the International Date Line, the date is always one day ahead of the date (***or day***) **immediately to the right** of the International Date Line in the *Western Hemisphere.*

Here is a map which shows Papua New Guinea and other countries of the world.



The numbers above the lines on the map show the time in other parts of the world when it is 12 midday in Papua New Guinea.

For example, if it is 12 midday in PNG, it is 9 p.m. in New York, USA.

Look at the table below.

Places	Time	
Papua New Guinea	1200 h	It is midday in PNG
Sydney(Australia)	1200 h	Same as PNG
Fiji	1400 h	Already afternoon (ahead of PNG)
New Zealand	1400 h	
New Caledonia	1300 h	
Singapore	0930 h	Still morning (behind PNG)
Hongkong	1000 h	
Japan	1100 h	
Honolulu	1600 h	This is a time ―yesterday" (behind PNG)

There is no time difference between Papua New Guinea and Sydney in Australia. However, some places are <u>ahead</u> of PNG and others are <u>behind</u>.

You will see that Honolulu is on the other side of the International Date Line from PNG. Honolulu is 20 hours behind PNG.

If the time in PNG is 1200 h, it is still "yesterday" in Honolulu. (We cannot take away 20 h away from 1200 h to get a time today.)

We can show the time difference between PNG and another country using a table.

Places	**Time Difference**
Sydney(Australia)	0
Fiji	+ 2 h
New Zealand	+ 2 h
New Caledonia	+1 h
Singapore	- 2 h 30 min
Hongkong	- 2 h
Japan	- 1 h
Honolulu	- 20 h

Remember: For places with no time difference we write 0.
For places ahead of PNG we write + (plus sign)
For places behind PNG we write – (minus sign)

To find the time difference between two places, we subtract the smaller time number from the bigger time number.

Example 1

The time difference between PNG and FIJI is

		h min
Solution:	FIJI	14 00
	PNG	- 12 00
		2 00 ⟵ 2 hours difference

We say, PNG is 2 h behind Fiji, so Fiji is 2 hours ahead of PNG.

Example 2

The time difference between PNG and Singapore is

		h min		
Solution:	PNG	12 00	=	11 60
	Singapore	- 09 30	=	09 30
				2 30 ⟵ 2 h 30 min difference

We say, PNG is 2 h 30 min ahead of Singapore, so Singapore is 2 h 30 min behind PNG.

Here are some examples using time zones and time differences.

Example 1: If in Port Moresby the time is 0800, Monday,

a) What is the time in Sydney?

Solution:

Since Sydney and Port Moresby are in the same zone the time in Sydney is 0800, Monday.

b) What is the time in Greenwich?

Since Greenwich is 10 hours behind, its time is 2200, Sunday.

Example 2: Perth is 8 hours ahead of GMT.

a) What is the time difference between Perth and Port Moresby?

Solution: PNG is 10 hours ahead of GMT.
Perth is 8 hours ahead of GMT

Time difference = 10 hours – 8 hours
= 2 hours

Therefore, Port Moresby is 2 hours ahead of Perth.

b) If Perth is 0900, what would be the time in Lae?

Solution: Since Port Moresby is 2 hours ahead of Perth.

The time in Port Moresby would be 1100 the same as Lae.

Example 3

The Prime Minister of Papua Guinea was schedule to travel to India on Monday. His route of travel was from Port Moresby to Darwin (9 h 30 min ahead of GMT) and then to India. If he leaves Jacksons Airport at 0700 h and the journey takes 5 hours.

(a) When will he arrive in Darwin in terms of PNG‘s local standard time?
(b) When will he arrive in Darwin in terms of Darwin‘s local standard time?
(c) The pilot instructed the passengers to change the timing on their watches from Darwin‘s local standard time to India‘s time (5 h 30 min. ahead of GMT) at 1200.
What would be the time in India?

Solutions:

(a) Since the travelling time is 5 hours

Arrival time in terms of PNG local standard time would be 1200 h.

(b) PNG is 10 hours ahead of GMT

Darwin is 9 h 30 min ahead of GMT

Time difference = 10 h – 9 h 30 min

= 30 minutes.

Darwin is 30 minutes behind PNG.

Therefore, the **local standard time** for Darwin would be **1130 h**.

(c) Darwin is 9 h 30 min ahead of GMT

India's is 5 h 30 min ahead of GMT

Time difference = 9 h 30 min - 5 h 30 min

= 4 hours

India is 4 hours behind Darwin.

Therefore, the time in India would be 0800.

NOW DO PRACTICE EXERCISE 14

Practice Exercise 14

Below is a table showing the time difference between Papua New Guinea and other countries.

Places	Time Difference	Places	Time Difference
Sydney(Australia)	0	China	-2 h
Fiji	+ 2 h	India	-4 h 30 min
New Zealand	+ 2 h	Philippines	- 2 h
New Caledonia	+1 h	Iran	- 6 h 30 min
Singapore	- 2 h 30 min	Solomon Islands	+ 1 h
Afghanistan	- 5 h 30min	Morocco	- 10 h
Japan	- 1 h	Alaska	-18 h
Guam	0	Poland	- 8 h

Use the table to answer questions 1 to 4.

1. If it is 2.45 p.m. in PNG, what time is it in the following countries?

   (a) Afghanistan

   Answer:__________

   (b) Iran

   Answer:__________

   (c) Poland

   Answer:__________

   (d) Philippines

   Answer:__________

   (e) Solomon Islands

   Answer:__________

2. Mira rang her sister in Guam from Port Moresby. If she made the phone call at 8.30 a.m., at what time would her sister receive the call?

   Answer:__________

3. If the time in PNG is 9 p.m., what is the time in Japan?

Answer:__________

4. If you are travelling to India from Jackson Airport at 1300 h. Change the time on your watch to India's Local Standard Time. What would be the time?

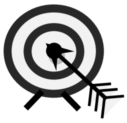
Answer:__________

5. Alaska is 18 hours behind Papua New Guinea. If Kira starts to travel from Alaska to Papua New Guinea at 5.30 p.m. Thursday, what time will she arrive?

CORRECT YOUR WORK. ANSWERS ARE AT THE END OF SUB-STRAND 3

Lesson 15: Time Rate Calculations: Speed and Distance Travelled

You learnt to work out time differences between different countries in the previous lesson.



In this lesson, you will:

- use speed to determine time traveled
- apply the appropriate unit for speed.

When you are doing something and you are able to measure how much you could achieve over a set amount of time, you are measuring the rate or speed.

Speed is how fast something is going or moving when the direction in which it is travelling is unimportant. In other words speed is the distance something travels within a given amount of time.

For example

- You can type at 40 words per minute
- An athlete can run a distance of about 100 metres in 9 seconds.
- Light travels at roughly 1 000 000 000 kilometres per hour and sound at about 1000 kilometres per hour.
- The speed limit on the highway is 60 km per h.

Speed is concerned with the distance travelled and the time it takes to cover that distance.

We will be learning to use one of the most basic mathematical formulas in working out speed.

Speed is the distance travelled per unit of time.

Speed is calculated using the formula:

$$\textbf{Speed} = \frac{\textbf{Distance}}{\textbf{Time}} \quad \text{or} \quad \mathbf{S} = \frac{\mathbf{D}}{\mathbf{T}}$$

Where: S = speed or rate
D = distance in km, m or cm
T = time in hours, minutes or seconds

Thus, Distance is obtained by multiplying the speed and the time.

In formula:

Distance = speed x time or **D = S x T**

Time is obtained by dividing the distance by the speed.

In formula:

$$\boxed{\textbf{Time} = \frac{\textbf{Dis tance}}{\textbf{Speed}} \quad \text{or} \quad \textbf{T} = \frac{\textbf{D}}{\textbf{S}}}$$

Units for Speed

It is important that, for all of these calculations, the **units** used correspond with each other.

If the distance is given in **kilometres** and the time in **hours**, **minutes** and **seconds** then the measurement of **speed** should be given in the form of kilometres per hour, kilometres per minute or kilometres per second respectively. This is written as **km/h, km/min** or **km/sec**.

If the distance is given in **metres** and the time in **hours**, **minutes** and **seconds** then the measurement of **speed** should be given in the form of metres per hour, metres per min or metres per second respectively. This is written as **m/h, m/min** and **m/sec**.

Now look at the following examples.

Example 1

If a truck takes 4 hours to travel 300 kilometers, find the speed.

Solution: Since the question is asking for the speed, use the formula:

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}} \quad \text{or } S = \frac{D}{T}$$

Given that: Distance = 300 km

Time = 4 hours

Substitute the given information into the formula we have,

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$

$$= \frac{300\text{km}}{4\text{h}}$$

$$= 75 \text{ km/h}$$

Therefore, the speed of the truck is 75 km/h.

Example 2

Alan travels 100 km in 5 hours. Find his average speed in km/h.

Solution: Since the question is asking for the speed, use the formula:

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}} \quad \text{or } S = \frac{D}{T}$$

Given that: Distance = 100 km

Time = 5 hours

Substitute the given information into the formula we have,

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$

$$= \frac{100\text{km}}{5\text{h}}$$

$$= 20 \text{ km/h}$$

Therefore, Alan's average speed is 20km/h.

Example 3

Find the speed of a train which travels 243km in 2hrs 15mins.

Solution: Since the question is asking for the speed, use the formula:

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}} \quad \text{or } S = \frac{D}{T}$$

Given that: Distance = 243 km

Time = 2 hours 15 min = 2.25 h (15 min = 0.25 h)

Substitute the given information to the formula we have,

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$

$$= \frac{243\text{km}}{2.25\text{h}}$$

$$= 108 \text{ km/h}$$

Therefore, the train is travelling at 108 km/h.

Example 4

Odette drives for 400 km at an average speed of 80 km/h. How long was her journey?

Solution: Since the question is asking for the length of time for the journey, use the formula:

$$\text{Time} = \frac{\text{Distance}}{\text{Time}} \quad \text{or } T = \frac{D}{S}$$

Given that: Distance = 400 km

Speed = 80 km/h

Substitute the given information to the formula we have,

$$\text{Time} = \frac{\text{Distance}}{\text{Time}}$$

$$= \frac{400\,\text{km}}{80\,\text{km/h}}$$

$$= 5\text{ h}$$

Therefore, Odette's journey was 5 hours long.

Example 5

Ralph cycles at 4km/h and covers a distance of 13 km. How long does his journey take?

Solution: Again this is asking for the time. Use the formula:

$$\text{Time} = \frac{\text{Distance}}{\text{Time}} \quad \text{or } T = \frac{D}{S}$$

Given that: Distance = 13 km

Speed = 4 km/h

Substitute the given information into the formula we have,

$$\text{Time} = \frac{\text{Distance}}{\text{Time}}$$

$$= \frac{13\,\text{km}}{4\,\text{km/h}}$$

$$= 3.25\text{ h}$$

The time is 3.25 h. But we do not write 3.25 hours.
The answer should be in hours and minutes.

So, the answer is 3 h 15 min.

Example 6

Bogie cycles at an average speed of 8km/h. How far has he travelled if he cycles for 4 hours?

Solution: The problem is asking for the distance travelled. Use the formula:

Distance = Speed x Time or D = S x T

Given: Speed = 8 km/h

Time = 4 hours

Substitute the given information into the formula.

Distance = Speed x Time

D = 8 x 4

= 32 km

Bogie has travelled 32 km.

Example 7

Michelle runs from 4.50 p.m. until 5.20 p.m. at an average speed of 7km/h. How far did she go?

Solution: Again this is a Distance problem. Use the Formula:

Distance = Speed x Time

Given: Speed = 7 km/h

Time = from 4.50 p.m. until 5.20 p.m.

Find the time difference of the two times. Hence,

Time = 4.50 p.m. - 5.20 p.m. = 30 min

However, the speed is given in km/h, so our time must be given in **hours**.

Hence, 30 min = 0.5hr

Now, substitute the given information into the formula.

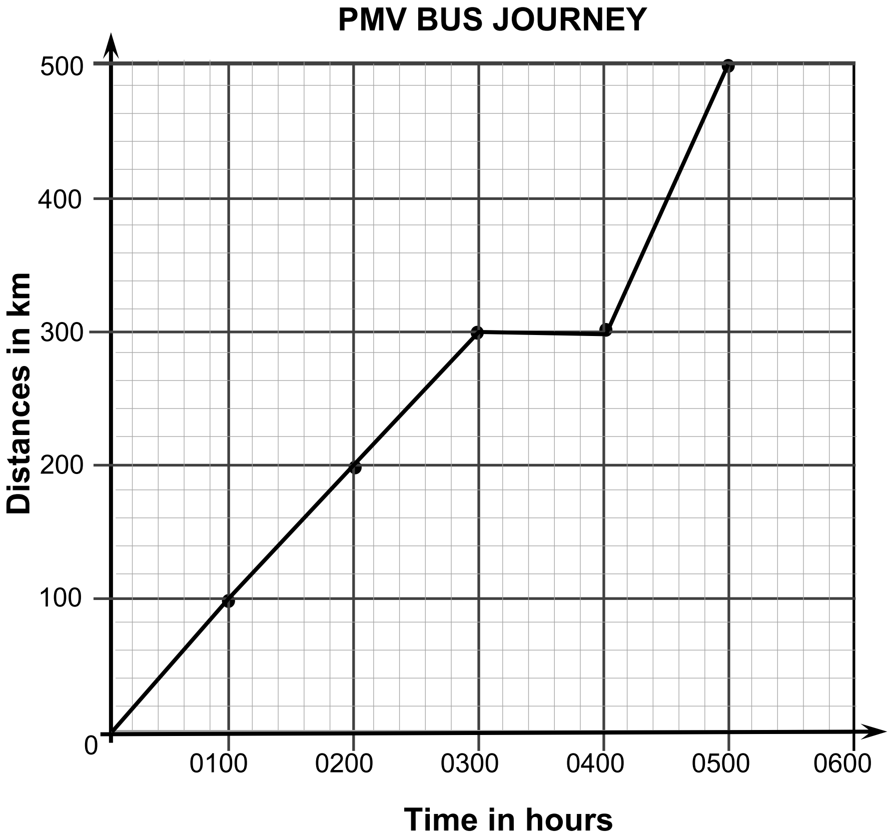
Distance = Speed x Time

D = 7 x 0.5

D = 3.5 km

Michelle ran 3.5 km.

Now look at the graph below.



Looking at the graph, you will discover that the PMV travelled as far as 300 km after the first 3 hours at a uniform speed of 100 km per hour. It then stopped and rested for 1 hour from 0300 h to 0400 h and then continued to travel at the speed of 200 km/h until 0500 h.

Now, study the graph. Can you find the average speed of the PMV in the entire journey? You should get an answer of 100 km/h.

Solution: Speed = Distance ÷ Time
= 500 km ÷ 5 h
= 100 km/h

You are now familiar with one of the most basic mathematical formulas in this lesson, The Distance Formula and its variations.

NOTE: Whenever you read a problem that involves "how fast", "how far", or "for how long", you should think of the distance, speed and time equation.

NOW DO PRACTICE EXERCISE 15

Practice Exercise 15

1. Calculate the speed.

(a) Distance: 15 km and time: 2 h

Answer:__________

(b) Distance: 20 km and time: 4 h

Answer:__________

(c) Distance: 390 m and time: 30s

Answer:__________

(d) Distance: 160 m and time: 20s

Answer:__________

2. A car is travelling at 72 km/h. How far would it travel at this speed?

(a) 4 hours

Answer:__________

(b) 7.5 hours

Answer:__________

(c) 50 minutes

Answer:__________

(d) 2 h 20 min

Answer:__________

3. Max slides smoothly and speedily at 5 m/h. how far will Max travel in:

(a) 6 hours

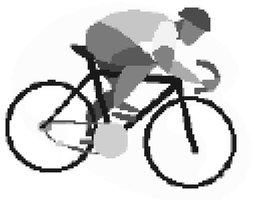
Answer:__________

(b) 30 minutes

Answer:__________

4. Problem Solving;

(a) Bob took a 7 hour bicycle trip. In all, he travelled 112 kilometres. What was his average rate of speed in kilometres per hour?



Answer:__________

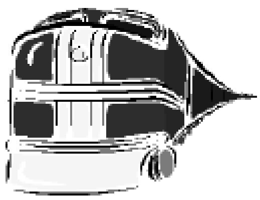
(b) Ella travelled from Boroko to March Girls Beach on Saturday. The trip took 3.5 hours and she travelled at an average rate of 62 km/h. How many kilometres did Ella travel?

Answer:__________

(c) Paul and Beth decided to travel to Europe one summer. The jet flew at an average rate of 550 km/h and covered 3437.5 km. How long did the flight take?

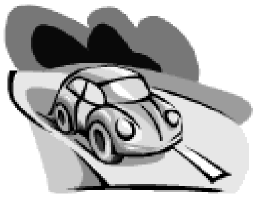
Answer:__________

(d) A train left Sydney at 10:00 a.m. and arrived in Melbourne at 1:45 p.m. If the distance between the two cities is 713 km, what was the average rate of speed of the train?



Answer:__________

(e). Damien drove 45 km/h for 3 hours, and then 60 km/h for another 2.5 hours. What was the total distance the man travelled?



Answer:__________

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5. The table below shows the distance-time relationship of a car journey.

Time	1000	1005	1010	1020	1030	1040	1050	1100
Distance (km)	0	5	10	10	15	20	25	30

a) In the period of 10 minutes from 1000 h to 1010h, what is the speed of the car?

Answer:__________

b) Between what times is the car at rest?

Answer:__________

c) What is the speed of the car from 1030 h to 1100 h?

Answer:__________

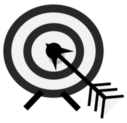
d) What is the average speed of the whole journey?

Answer:__________

CORRECT YOUR WORK. ANSWERS ARE AT THE END OF SUB-STRAND 3

Lesson 16: Time Rate Calculations: Pay Rates and Pay Earned

You have learnt to calculate time, speed and distance travelled using the distance formula and its variations.



In this lesson you will:

- use pay rates to determine pay earned
- express the result of your calculations in the correct units as required
- calculate pay earned.

Self-employed people charge fees for the services or goods they provide. However, people who are employed are paid in various ways for the work they do. The most popular method of payment is Wages or Salary. When employees are paid for the amount of time they spend at work this is referred to as **time rates.**

> **Time rates** are used when employees are paid for the amount of time they spend at work.

The usual forms of time rates are wages and salaries.

However, generally speaking, the term **'wages'** is used where the amount of money the employee receives may vary from one pay period to the next, as the amount paid is directly dependant on the number of hours worked; and the term **'salary'** refers to an agreed and fixed annual amount of money the employee receives regardless of the hours worked.

> **Wages** are paid to the workers on a time basis at a specified pay rate.
>
> The pay rate may be fixed on an hourly, daily, weekly, fortnightly, or monthly basis made by an employer to an employee, especially to a manual or unskilled worker.

Known by various other names such as time work, day work, day wages and day rate, the payment is made on the basis of attendance.

Calculation of wages under this method of wage payment takes into account: (i) the time spent by the worker and, (ii) the wage rate per unit of time fixed. The formula is:

Wages = Time spent x pay rate per unit time

Where: Wages = Pay earned

Time spent = number of working hours

Pay rate = amount of pay per unit time

Thus, **Pay rate =** $\dfrac{\text{Wages}}{\text{Time spent}}$

and **Time Spent** = $\dfrac{\text{pay earned}}{\text{pay rate}}$

Example 1

A worker gets K10 per hour. He works for 8 hours per day and has been present for duty on 25 days during the month. What is his wages for the month?

Solution: The problem is asking for the worker's wage during the month, so we use the formula:

Wages = Time spent x pay rate

Given: Pay rate = K10 per hour

Time spent = 25 x 8 h per day

Substitute the given information to the formula

Thus, we have: Wages = (25 x 8 h) x K10/h

= 200 x K10

= K2000

Thus the worker is paid K2000 for the month.

Example 2

Anna works a basic week of 35 hours and her weekly wage is K260. Work out her hourly pay rate.

Solution: The problem asked for Anna's hourly pay rate.

Use the formula: Pay rate = $\dfrac{\text{Wages}}{\text{Time spent}}$

Given: Weekly pay earned = K260.00
Time spent = 35 h a week.

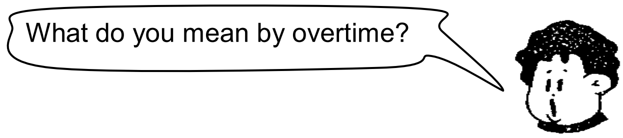
Substitute the given information to the formula.

Pay rate = $\dfrac{\text{K280.00}}{\text{35 h}}$

= K8.00 per hour

Therefore, Anna's hourly pay rate is K8.00.

Most employees except for those in certain industries and professions are entitled to overtime pay.

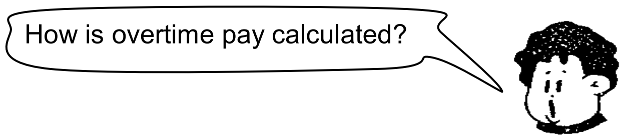


Overtime refers to extra hours of work spent on the job by an employee in excess of the normal working hours.

For most employees, overtime pay begins after they have worked 44 hours in a work week. The basic overtime is all hours worked in excess of:

- eight hours a day, or
- 44 hours a week.

Overtime hours are to be calculated both on a daily and weekly basis. The higher of the two numbers is overtime hours worked in the week. All employees, including those who are paid a weekly, monthly, or annual salary, must be paid overtime pay for overtime hours they work.



Except where overtime hours are accumulated under an overtime agreement, all overtime hours must be paid at the rate of at least:

- Time-and-a-quarter (1.25 x) the employee's regular wage rate
- Time-and-a-half (1.5 x) the employee's regular wage rate
- Double time (2x) the employee's regular rate

Overtime Pay = overtime rate x regular rate of pay

Suppose your regular rate of pay is K10.00 an hour. If you work more than 44 hours in a work week, your overtime rate is:

Overtime Pay = overtime rate x regular pay

= 1.5 x K10.00

= **K15.00** an hour for every hour worked after 44 in that work week.

The examples on the next pages show how to calculate overtime pay for employees who are paid on an hourly basis.

Example 1

Stephanie is paid a regular pay rate of K3.00 per hour. Calculate her hourly overtime pay rate when this is paid at

(a) time-and-a-quarter,
(b) time-and-a-half
(c) double time.

Solution: (a) Overtime pay rate = 1.25 x K3.00
= k3.75 per hour

(b) Overtime pay rate = 1.5 x K3.00
= K4.50 per hour

(c) Overtime pay rate = 2 x K3.00
= K6.00 per hour

Example 2

David's regular pay is K6.00 an hour for a 44 hour work week. His overtime rate is K9.00 an hour. This week David worked for the following hours:

Day	Hours David worked
Sunday	0
Monday	8
Tuesday	12
Wednesday	9
Thursday	8
Friday	8
Saturday	8
Total hours	**53**

What is David's total pay for the week?

Solution: Any hours worked over 44 in a week are overtime hours. David worked nine overtime hours (53 – 44 = 9).David's pay for the week is calculated as follows:

Regular pay = Time spent x Pay rate
= 44 x K6.00
= K264.00

Overtime pay= overtime hours x overtime rate
= 9 x K9.00
= 81.00

Total weeks pay = K264.00 + K81.00
= K345.00

Therefore, David's total weeks pay is K345.00.

Example 3

Matilda is paid K428.75 for a normal 38-hour week and double that for over time. For working on Sundays and public holidays, she receives double time. What is her gross or total wage for a week in which she works 43 hours?

Solution: Matilda earned K428.75 in a 38 hour week work, to find her gross or total wage for the week, do the following steps:

Step 1: Find Matilda's pay rate for the week.

$$\text{Pay rate} = \frac{\text{Pay earned}}{\text{Time spent}} = \frac{K428.75}{38} = K11.28$$

Step 2: Find Matilda's overtime hours worked

43 - 38 = 5 hrs.

Step 3: Find the overtime pay = 2(Pay rate × extra hours)

= 2 (K11.28 x 5 hrs.)

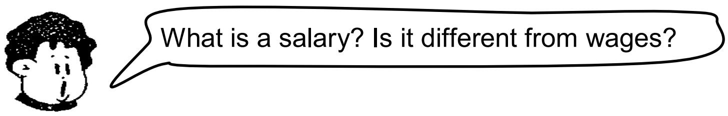
= K112.80

Step 4: Find the total wage= K425.75 + K112.80=K538.55

Therefore, Matilda's total wage is K538.55

Now you will learn how to calculate salary.

People like public servants, teachers, company managers and executives are paid a fixed amount each year and are rarely paid overtime.



A salary is a fixed annual or yearly amount, usually paid at a fortnightly or monthly basis. There is no extra pay for hours outside the normal work period. It is a fixed compensation for services, paid to a person on a regular basis.

Example1

Martha is paid K22 800 per annum(per year).What is her monthly salary?

Solution: There are 12 months in a year, so

$$\text{Monthly salary} = \frac{\text{Yearly salary}}{12}$$

$$= \frac{K22800}{12}$$

$$= K1900$$

Therefore, Martha's monthly salary is K1900.

Example 2

Morgan has an annual salary of K22 039.85. How much is he paid on a:

a) Fortnightly basis?

Solution: There are 26 fortnights in a year. Hence,

$$\text{Fortnightly salary} = \frac{\text{K}22039.85}{26} \approx \text{K}847.69$$

Therefore, Morgan's fortnight salary is K847.69

b) Monthly basis?

Solution: There are 12 months in a year. Hence,

$$\text{Monthly salary} = \frac{\text{K}22039.85}{12} \approx \text{K}1836.65$$

Therefore, Morgan's monthly salary is K1836.65

Example 4

Paul receives K40 950.25 per annum and is given a 4 % rise in his pay. Calculate the pay rise and his new fortnight salary.

Solution: To calculate Paul's pay rise and his new fortnight salary, follow the following steps:

Step 1: Find the pay rise

Pay rise = 4% of yearly pay
= 4 % of K40 950.25
= 0.04 x K40 950.25
= K1 638.01

Step 2: Calculate the new salary per annum

New salary = Yearly salary + pay rise
= K40 950.25 + K1 638.01
= K42 588.26

Step 3: Find the new fortnight salary

There are 26 fortnight in a year. Hence,

$$\text{Fortnightly salary} = \frac{\text{K}42588.26}{26} = \text{K}1\ 638.01$$

Therefore, Paul's fortnightly salary is K1 638.01

NOW DO PRACTICE EXERCISE 16

Practice Exercise 16

1. Morris gets K5.75 per hour. He works for 8 hours per day and has been present for duty on 25 days during the month. What is his wages for the month?

Answer:__________

2. Phillip works a basic week of 40 hours and her weekly wage is K375. Work out her hourly pay rate.

Answer:__________

3. Monica is paid a regular pay rate of K4.50 per hour. Calculate her hourly overtime pay rate when this is paid at

   (a) time-and-a-quarter,

   Answer:__________

   (b) time-and-a-half

   Answer:__________

   (c) double time.

   Answer:__________

4. Mr. Scotch's regular pay is K10.00 an hour for a 44 hours work week. His overtime rate is K15.00 an hour. This week Mr. Scotch worked at the following hours:

Day	Hours David worked
Sunday	0
Monday	10
Tuesday	12
Wednesday	9
Thursday	8
Friday	8
Saturday	12
Total hours	**59**

What is Mr. Scotch's total pay for the week?

Answer:__________

---

5. Sophia is paid K100.80 for a basic week of 40 hours.

(a) What is her basic hourly rate?

Answer:__________

(b) Overtime pay is paid at —time-and-a-quarter". What is her overtime rate?

Answer:__________

(c) She works 12 hours overtime in a certain week. How much was she paid in overtime?

Answer:__________

(d) What was her total pay for the week?

Answer:__________

6. The following are the annual salaries of the following people.

(a) Smith = K5320
(b) Wilson =K6000
(c) Tom = K9600
(d) Gerry = K6096

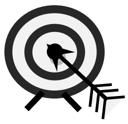
How much is each paid monthly?

Answer:__________

CORRECT YOUR WORK. ANSWERS ARE AT THE END OF SUB-STRAND 3

Lesson 17: Solving Problems Involving Time

You have learnt about time rate and time rate calculations in the previous lessons.



In this lesson, you will:

- solve problems involving time.

In everyday activities whether going on a journey, studying, cooking or playing, timing is very important. By managing your time, you will have an effective and productive day. In this lesson, you will need the skills you have learnt in the previous lessons to solve problems involving time especially the conversion of time units and operations with time.

One type of problem involves counting in hours or minutes, with questions such as the examples below.

Example 1

Matthew started to walk to school at 7.50 a.m. He took 50 minutes. At what time did he arrive at school?

Solution:

To find what time Matthew arrived at school; add 50 minutes to his start time.

End Time = start time + time taken
= 7 h 50 min + 50 min
= 7 h 100 min (100 min = 1 h 40 min)
= 7h + 1h 40 min
= 8 h 40 min

Therefore, Matthew arrived at school at 8.40.

Example 2

Lucy put a cake in the oven at 4.50. She took it out at 5.22. How long was the cake in the oven?

Solution: The problem asked for the time it took the cake in the oven.
To find how long the cake was in the oven; subtract the start time at which the cake was put in the oven from time it was taken from the oven.

Hence, we have Time taken = end time – start time
= 5 h 22 min – 4 h 50 min
= 4 h 82 min – 4 h 50 min
= 32 min

Therefore, the cake took 32 minutes in the oven.

The second type of question involves days and months of the year, such as the next lot of examples

Example 2

Raka went for a fortnight's holiday on 23rd July. On what date did he return from holiday?

In this case it would be worthwhile pointing out that he would return on the same day of the week as he left and that travel companies really mean 14 nights rather than 14 days. A tricky one!

It also means that the number of days in a month needs to be known.

Solution: 1 fortnight is = 14 days

Counting 14 days from 23rd July Raka's holiday ends on the 5th of August.

Therefore, his return date was 6th of August.

JULY						
S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

AUGUST						
S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

Here are some more examples of problems involving time.

Example 3

A ship was sailing to Madang. It takes 2-and-a-half days to travel to Lae and takes 2-and-a-quarter days to travel from Lae to Madang. How long is the ship's journey?

Solution: First, outline the given information:

Given: Time taken by the ship to sail from Port Moresby to Lae = 2 ½ days
Time taken by the ship to sail from Lae to Madang = 2 ¼ days

The problem is asking for the total time taken by the ship's journey. So, add the two given times. Hence we have

$$\text{Total time taken} = 2\frac{1}{2}\text{days} + 2\frac{1}{4}\text{days}$$

$$= (\frac{5}{2} + \frac{9}{4})\text{ days}$$

$$= \frac{19}{4}\text{days}$$

$$= 4\ \frac{3}{4}\ \text{days} \qquad (\text{since } 1 \text{ day} = 24 \text{ h})$$

$$= 4 \text{ d } 18 \text{ h} \qquad (\text{Convert } \frac{3}{4}\text{d to h} = \frac{3}{4} \times 24 \text{ h} = 18 \text{ h})$$

Therefore, the ship's journey took 4 days and 18 hours.

Example 4

Jiro has 4 hours to study during night study at school. Monday nights he budgets his time for the following subjects.

Mathematics: $\frac{2}{5}$ Science: $\frac{1}{5}$ English: $\frac{1}{4}$ Social Science: remaining time

Which subject does he spend the most time on and which the least time?

Solution: To find which subject Jiro spends the least and most time studying do the following steps.

Step 1: Convert 4 h to minutes: since 1 h = 60 min, then
4 h = 4 x 60 min
= 240 min

Step 2: Find the time allocated for each subject.

- Mathematics: $\frac{2}{5} \times 240 =$ **96 min.**
- Science: $\frac{1}{5} \times 240 =$ **48 min**.
- English: $\frac{1}{4} \times 240 =$ **60 min.**
- Social Science: 240 – (96 + 48 + 60) = 240 – 204= **36 min**.

Therefore, Jiro spends the most time studying Mathematics and the least time studying Social Science.

Example 5

Victor has three-fourths of the day to complete three tasks. He has decided to spent equal time on each task. If the first task starts at 0100 h, what would be the completion time for task 2 and task 3?

Solution: First you need to find how many hours is three-fourths of a day.

Step 1: Since 1 day = 24 hour, therefore: $\frac{3}{4} \times 24 \text{ h} = 18 \text{ h}$

Step 2: Divide 18 h equally to the three tasks: $\frac{18}{3} = 6$ h each task

Step 3: Find what time the first task will end.

Task 1 starts at 0100 h and ends after 6 hours. The time will be **0700 h**.

Since Task 1 ends at 0700 h, then task 2 begins. After 6 hours, Task 2 will be completed. The completion time for Task 2 will be **1300 h.**

Since Task 2 ends at1300 h, then completion time for Task 3 is **1900 h.**

Therefore, the completion time for Task 2 and Task 3 are 1300 h and 1900 h.

NOW DO PRACTICE EXERCISE 17

Practice Exercise 17

1. Kila's P.E. lesson started at 10.20 and lasted for 50 minutes.

   At what time did the lesson finish?

   Answer: 11.10

2. The train from Sydney to Cairns usually takes 3 hours 10 minutes. It left Sydney at 2.55 p.m.

   What time did it arrive?

   Answer: 6.06 p.m.

3. How many hours is it from 2.30 p.m. on Wednesday to 6.30 a.m. on Thursday?

   Answer: 16 hours

4. Kristoff took part in his school mini triathlon. He took 24 minutes to swim, cycled for half an hour and ran for 36 minutes.

   How long did he take altogether?

   Answer: 90 minutes

5. Daniel went for a fortnight's holiday from 15th October. On what date did he return from holiday?

Answer: 29th October

---

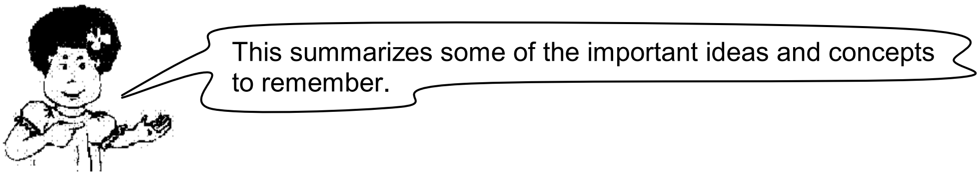
6. Hero went to the hairdresser at 12.50. He had to wait for half an hour and then her haircut took 15 minutes.

At what time did he finish?

Answer: 1.35 p.m.

CORRECT YOUR WORK. ANSWERS ARE AT THE END OF SUB-STRAND 3

SUB-STRAND 3: SUMMARY



- Time is defined as the indefinite continued progress of existence and events in the past, present and future regarded as a whole.
- The basic units of measure for time are the year, month, week, day, hour, minutes and seconds.
- Other units of time are the decade, score, century and millennium.
- To convert units of time from larger to smaller; multiply the number by the unit equivalence.
- To convert units of time from smaller to larger- divide the number by the unit equivalence.
- A clock is a device use to tell time. It measures time in hours and minutes and seconds.
- The digital clock shows hours and minutes in a 24-hour system.
- The analog clock shows time in a 12-hour system.
- A calendar is a chart or a series of pages showing the days, weeks, and months of a particular year.
- Diaries are calendars which have written daily records of personal experiences.
- When finding the number of days in a certain period of time it is important to know whether to include or exclude the beginning and end dates.
- A timeline is a way of displaying a list of events in consecutive order.
- A timetable is a list or table of events arranged according to the time when they take place.
- A time zone is a region or part of the earth which has the same standard time.
- Greenwhich in England is the standard time all around the world.
- The Local Standard Time is the official time in a local region.
- The International Date Line is a line going from North to South, where each new day in a calendar begins.
- To find the time difference between two places, subtract the smaller time number from the bigger time number.
- Speed is distance travelled per unit time.
- A time rate method of payment is used when employees are paid for the amount of time they spend at work. Wages and salaries are the usual forms of time rates.
- Wages are paid to workers on a time basis at specified pay rates.
- Overtime is extra hours of work performed by an employee in excess of the normal working hours.
- A salary is a fixed annual amount, usually paid on a fortnightly or monthly basis. It is a fixed compensation for services rendered and paid to a person on a regular basis.

REVISE LESSONS 11 TO 17 . THEN DO SUB-STRAND TEST 3 IN ASSIGNMENT 4.

ANSWERS TO PRACTICE EXERCISES 11-17

Practice Exercise 11

1. (a) 2 min (b) 3 hours (c) 10 days
   (d) 2 years (e) 7200 min (f) 10 decades

2. (a) 2.04 d (b) 22.5 d (c) 1825 d (d) 732 d

3. (a) 30 min 20 sec (b) 17 h 23 min (c) 21 min 25 sec
   (d) 4 h 53 min (e) 4 d 9 h 18 min (f) 4 h 53 min

4. 2 hours

5. Joshua (15 min)

Practice Exercise 12

1. (a) 2.00 (b) 4.30 (c) 3.45
   (d) 1.55 (e) 6.40 (f) 1.20

2.

No	24- hour time	12-hour time	Statement of the time
a	1000 h	**10.00 a.m.**	**10 o'clock**
b	**0110 h**	1.10 a.m.	10 minutes past 1
c	0945 h	9.45 a.m.	**Nine-forty five** or **Quarter to 10**
d	1150 h	**11.50 a.m.**	10 minutes to 12
e	**0515 h**	5.15 a.m.	**15 minutes past 5** or **Five quarter**
f	2345 h	**11.45 p.m.**	**Quarter to 12** or **eleven forty-five**
g	**1345 h**	1.45 p.m.	Quarter to 2
h	2220 h	**1020 p.m.**	20 minutes past 10

3. (a) leap year (b) leap year
   (c) not a leap year (d) not a leap year

4. (a) 21 days (b) 16 days
   (c) 18 days (d) 37 days

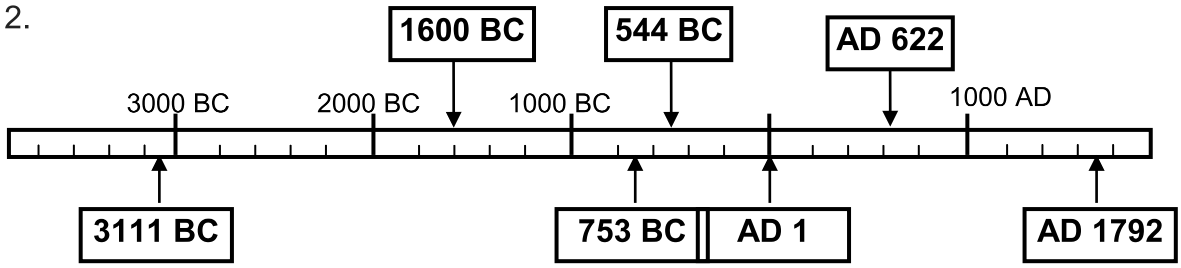
5. (a) 15 days (b) 2 wk and 1 day

6. (a) 13 days (b) 12 nights

Practice Exercise 13

1. (a) development of first steam engine
   (b) Before. Because the road was built in 1839 while Ford's Model T was developed in 1908.
   (c) 20 years
   (d) After
   (e) Second Part scaled 1850 to 1900

2.



3. (a) Departed Port Moresby at 5.00pm Sunday
   Departed Lae: 4.00 pm Monday

   (b) 15 hours (c) 3 days 14 hours (d) Lae

   (e) 8 hours (f) 5 days 9 hours

Practice Exercise 14

1. (a) Afghanistan - 9.15 a.m.
   (b) Iran - 8.15 a.m.
   (c) Poland - 6.45 a.m.
   (d) Philippines - 12.45 p.m.
   (e) Solomon Islands - 3.45 p.m.
2. 8.30 a.m.
3. 8 p.m.
4. 8.30.a.m.
5. 11.30 a.m.; Friday

Practice Exercise 15

1.	(a)	7.5 km/h	(b)	5 km/h	(c)	13 m/s	(d)	8 m/s
2.	(a)	288 km	(b)	550 km	(c)	60 km	(d)	96 km
3.	(a)	30 m	(b)	2.5 m				
4.	(a)	16 km/h	(b)	217 km/h	(c)	6.25 h or 6 h 15 min		
	(d)	60 km/h	(e)	285 km				
5.	(a)	1 km/min			(b)	1010 h to 1020 h		
	(c)	0.5 km/min or $\frac{1}{2}$ km/min			(d)	0.5km/min or $\frac{1}{2}$ km/min		

Practice Exercise 16

1. K1150
2. K7.65
3. (a) K5.625 (b) K6.75 (c) K9.00
4. K665.00
5. (a) K2.52 (b) K3.15
   (c) K37.80 (d) K138.60
6. (a) K443.33 (b) K500
   (c) K800 (d) K508

Practice Exercise 17

1. 11.10
2. 6.06 p.m.
3. 16 hours
4. 90 minutes or 1 h 30 min
5. 29^{th} October
6. 1.35 p.m.

END OF SUB-STRAND 3

SUB-STRAND 4

MAPS AND COORDINATES

Lesson 18:	**Maps and Scales**
Lesson 19:	**Using Maps and Scales**
Lesson 20:	**Reading Maps using Longitude and Latitude**
Lesson 21:	**Coordinates, Number Planes and Map Grids**
Lesson 22:	**Using Map Grids and Coordinates to Locate Points**
Lesson 23:	**Introducing Straight Lines**

SUB-STRAND 4: MAPS AND COORDINATES

Introduction

Maps can be drawn to represent a variety of information. This information might include things such as roads, tourist attractions, and campgrounds, or they might represent the latest weather patterns. The objects on a map are represented using symbols. A symbol is a picture on the map that represents something in the real world.

Understanding these symbols require the use of a key. Maps use a key, or legend to explain the meaning of each of the symbols used in the map. These keys usually show a small picture of each of the symbols used on the map, along with a written description of the meaning of each of these symbols.

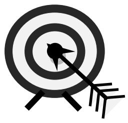
In Strand 4 of your Grade 7 Mathematics, (if you studied in FODE) you learnt something about maps and coordinates.

In this Sub-strand you will:

- read, identify and show map scale in three ways
- measure distances between places on a map using map scale and a ruler
- identify locations on a map using latitude and longitude
- identify and describe locations on a map using number pairs as coordinate references
- Use the four quadrant plane to graph straight lines using a table of values

Lesson 18: Maps and Scales

You have learnt about the maps and scales for length in your Grade 7 Mathematics Strand 4 Sub-strand 4.



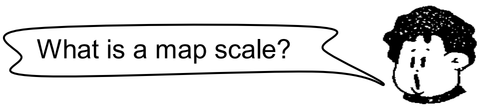
In this lesson, you will:

- revise maps and scale for length
- discuss three ways of showing scales on a map
- read, identify and write scales on the map in three ways.

First, let us revise what maps are.

Maps are simply plans, drawings, charts or diagrams of landscapes or areas of land and water on paper.

Map makers show large areas of land and water on small pieces of paper. Places that are actually thousands of metres or kilometres apart may be only centimetres apart on a map. When you use a map, you can estimate real distances by using a **map scale.**



Map scale is *defined* as **the ratio of a distance on the map to the corresponding actual distance on the ground.**

SCALE = Map Distance: Actual Distance

A map cannot be of the same size as the area it represents. So, the measurements are **scaled down** to make the map of a size that can be conveniently used by users such as motorists, cyclists and bushwalkers. Different maps use different scales. A map scale usually is given or is shown in three ways:

1. By writing it in words

Example: 1 centimetre to 1 metre

This means that 1 centimetre on the map represents 1 metre on the ground.

Other examples in words are:

(a) 1 centimetre to 1 kilometre

(b) 1 centimetre to 10 metres

(c) 2 centimetre to 2000 metres

(d) 2 inches to 2000 miles

(e) 1 inch to 300 miles

and many more.

2. As a fraction or as a ratio

e.g. **as a fraction** $\frac{1}{10\,000}$

as a ratio 1: 10 000

This means that if a map has a scale of $\frac{1}{10\,000}$ or 1:10 000, then this means that one distance on the map is ten thousand times bigger in actual distance.

$\frac{1}{10\,000}$ or 1:10 000 means that:

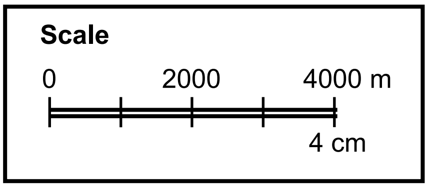
- 1 mm on the map represents 10 000 mm (or 10 m) in actual distance
- 1 cm on the map represents 10 000 cm (or 100 m) in actual distance
- 1 m on the map represents 10 000 m (or 10 km) in actual distance

Look at the examples used on maps:

Map Scale	Meaning in words
1:20 000	1 centimetre to 200 metres
1:24 000	1 centimetre to 240 metres
1:100 000	1 centimetre to 1 kilometre
1:125,000	1 centimetre to 1.25 kilometres

3. by drawing it as a line or a bar scale

e.g.



On this map scale, the bar is 4 cm long. 4 cm on the map represent 4000 actual metres. That is, 4 cm : 4000 m. 1 cm on the map represents 1000 actual metres. To write the scale in useful form we have, 1:100 000.

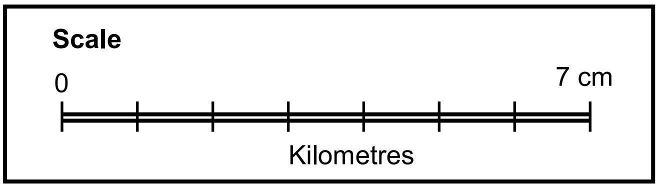
You may see a map scale written as —4cm = 4000 m.”

This statement is not mathematically correct because 4 cm is not equal to 4000 m. What is meant is that a 4 cm distance on the map represents 4000 m on the ground.

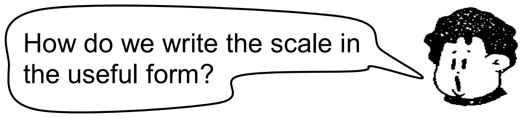
You can see other examples on the next page.

Here are other examples of line or bar scales.

Example 1



On this map scale, the bar is 7 cm long. So for this map scale 7 cm on the map represent 7 actual kilometres. That is, 7 cm : 7 km. 1 cm on the map represents 7 km in actual distance. To write the scale in useful form we have 1:100 000.



To write the scale in the useful form 1: actual measure, do the following:

7 cm : 7 km (measured and read from the diagram)

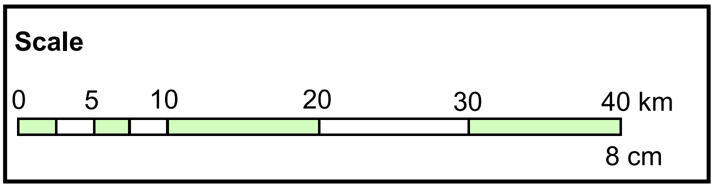
7 cm : 7 x (1000 x 100) cm (convert each measure to the same units)

7 cm : 700 000 cm (make the map measure I unit by dividing each measure by 7)

1 cm : 100 000 cm

The scale is 1:100 000.

Example 2



On this map scale, the bar is 8 cm long. 8 cm on the map represent 40 real kilometres. That is, 8 cm : 40 km. 1 cm on the map represents 5 km in actual distance on the ground. To write the scale in useful form we have 1:500 000.

Example 1

Write the scale 1 cm to 1 m in ratio form.

Solution:

1 cm to 1 m = 1 cm : 1 m

= 1 cm : 100 cm   Convert each measure to the same unit

= 1 : 100   useful form

Example 2

Simplify the scale 5 mm : 1 m.

Solution:

5 mm : 1 m = 5 mm : 100 cm

= 5 mm : 1000 mm

= 5 : 1000

= 1 : 200

Example 3

Simplify the scale 5 cm : 2 km.

Solution:

5 cm : 2 km = 5 cm : 2000 m

= 5 cm : 200 000 cm

= 5 cm : 200 000 cm

= 1 : 40 000

NOW DO PRACTICE EXERCISE 18

Practice Exercise 18

1. For each scale, complete the following statements:

(a) 1: 2000

i. 1 cm on the map = ________m in actual distance
ii. 10 cm on the map = ________km in actual distance
iii. 18.5 cm on the map = ________m in actual distance
iv. 65 mm on the map = ________ m in actual distance
v. 125 mm on the map = ________ km in actual distance

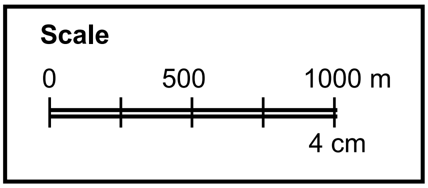
(b) 1: 100

i. 1 mm on the map = ________mm in actual distance
ii. 5 mm on the map = ________cm in actual distance
iii. 1 cm on the map = ________m in actual distance
iv. 12 cm on the map = ________ m in actual distance
v. 2.5 mm on the map = ________ km in actual distance

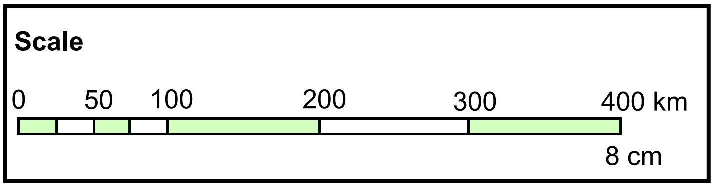
---

2. For each of the following map scales given as a diagram, write the scale in the useful form 1: actual distance.

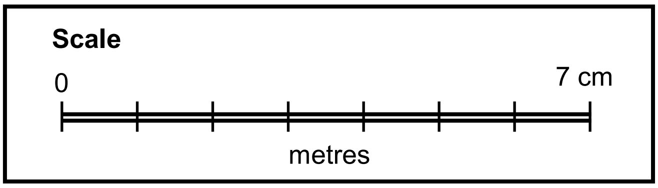
(a)



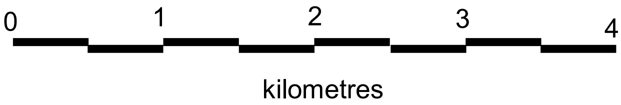
(b)



(c)



(d)



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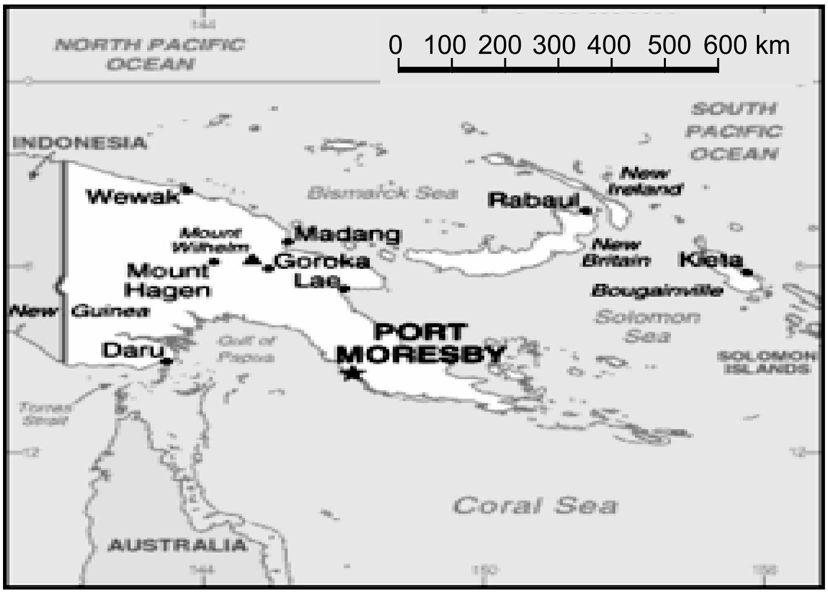
3. Refer to the Map of PNG to answer the following questions.



(a) What map scale is shown on the map?

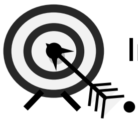
(b) Explain what the map scale means.

(c) Write the scale in ratio form.

CORRECT YOUR WORK. ANSWERS ARE AT THE END OF SUB-STRAND 4

Lesson 19: Using Maps and Scales

You have learnt about the maps and scales for length in your Grade 7 Mathematics Strand 4 Sub-strand 4.



In this lesson, you will:

- Identify ways to measure distances on a map.
- find the actual distance between two places on the map by conversion of units
- measure the distance between two places using a map and a ruler

There are many ways to measure distances on a map. In this lesson, we will use the ruler and the map scale.

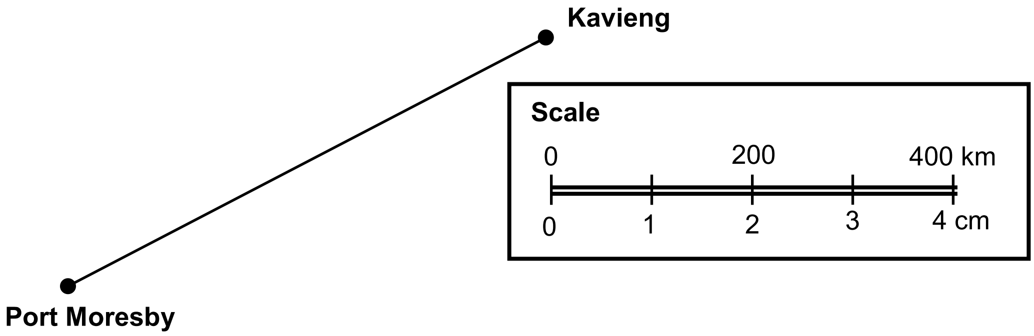
Here are some.

Using a ruler

Sometimes the distance you want to measure on a map is along a straight line. Measure the straight line distance with a ruler. Then use the map scale to change the map distance to real distance.

Example

Use the map and the scale to find the air distance from Port Moresby to Kavieng.



The line segment connecting Port Moresby and Kavieng is 7 cm long.

The map scale shows that 1 cm represents 100 km.

So 7 cm must represent 7 x 100 km, or 700 km.

Therefore, the air distance from Port Moresby to Kavieng is **700 km.**

Calculating the Actual Distance using the Map Scale

Example 1

A particular map shows a scale of 1: 5000. What is the actual distance if the map distance is 8 cm?

Solution: The Scale is 1:5000. This means that 1 cm : 5000 cm or 1 cm : 5 m. .

Map Distance = 8 cm

If we let x be the actual distance, then using the formula:

Scale = Map Distance : Actual Distance

We have: 1 : 5000 = 8 : x (Units are in cm)

(1)(x) = 8 x 5000 (Proportion Rule)

x = 400 000 cm

Therefore, Actual distance = 400 000 cm

$$= \frac{400\,000}{100} \text{ m}$$

= 400 m

Alternative way: Scale = Map Distance : Actual Distance

1 : 5000 = 8 : x

Writing the ratios as fractions: $\frac{1}{5000} = \frac{8}{x}$

Using cross multiplication: (1)(x) = (8)(5000)

x = 400 000 cm

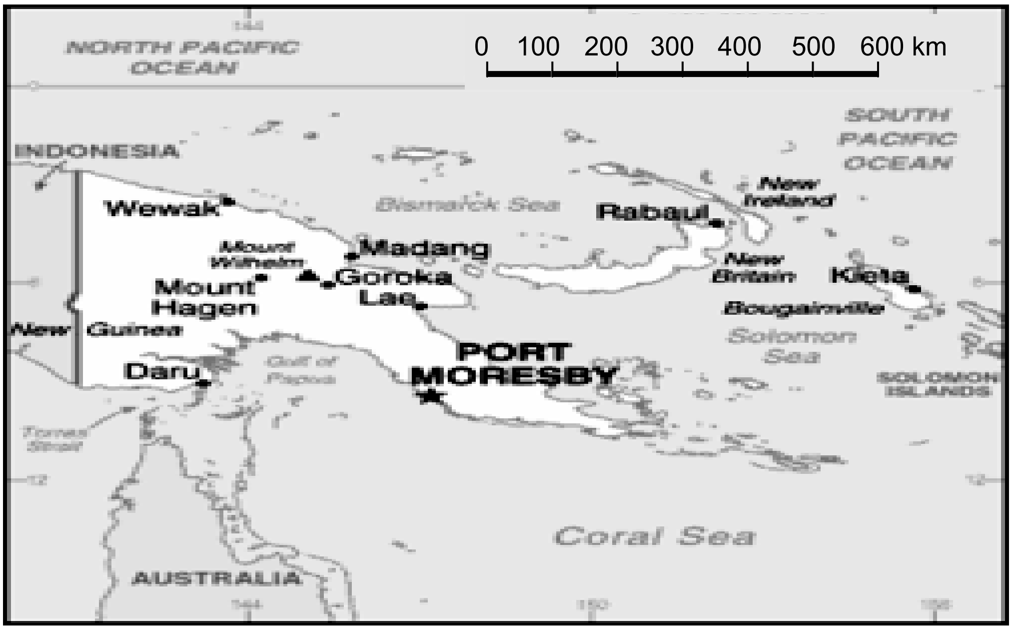
Therefore, Actual distance = 400 000 cm

$$= \frac{400\,000}{100} \text{ m}$$

= 400 m

Example 2

Look at the Map of PNG.



(a) What map scale is shown on the map?

The map is drawn using the scale 1 cm : 100 km

(b) Explain what the map scale means.

The scale means 1 centimetre on the map represents 100 kilometres.

(c) Write the scale in useful form 1: actual distance.

1 cm : 100 km = 1 cm : 1000 x 100 cm

= 1 cm : 100 000 cm

= 1 : 100 000

(d) If on the map the distance between Daru and Rabaul is 6 cm, what is the actual distance between them?

Solution: Use the map scale 1 cm : 100 km

So, 6 cm = 6 x 100 km

= 600 km

Therefore, the distance between Daru and Rabaul is 600 km.

Calculating the Scaled Distance using the Actual Distance

Example 3

A particular map shows a scale of 1 cm : 5 km. What would the map distance (in cm) be if the actual distance is 14 km?

Solution:

Scale = 1 cm : 5 km

Actual Distance = 14 km

If we let the Map Distance = x , then using the formula;

Map Distance : Actual Distance = Scale

We have: x : 14 km = 1 cm : 5 km

$$\frac{x}{14\text{ km}} = \frac{1\text{ cm}}{5\text{ km}} \qquad \text{(cancel the units)}$$

$$\frac{x}{14} = \frac{1}{5} \qquad \text{(cross multiply)}$$

$$5x = 14 \qquad \text{(Divide both sides by 5)}$$

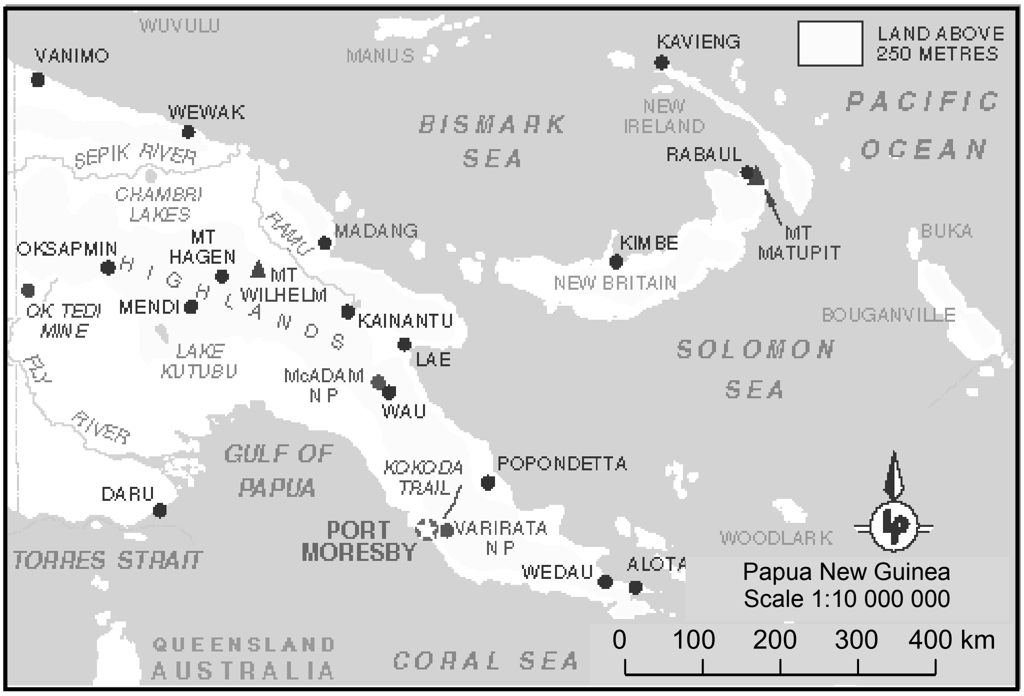
$$x = 2.8$$

So, the map distance is **2.8 cm.**

NOW DO PRACTICE EXERCISE 19

Practice Exercise 19

Refer to the map of Papua New Guinea below to answer questions 1 to 8.



1. On the map you will see the scale 1:10 000 000 written.

   (a) What does this mean?

   (b) How much smaller is this map of Papua New Guinea than the actual size of the country? Write your answer as a fraction.

---

2. Another map of Papua New Guinea has a scale of 1: 30 000 000.

   (a) Would it be larger or smaller than the map above?

   (b) How much smaller would this be than the actual country of Papua New Guinea? Write your answer as a fraction.

3. How many kilometres along the ground in real world is shown by one centimetre on the map?

---

4. What lengths on the map would represent the following distances on the ground?

   (a) 275 km

   (b) 920 km

   (c) 1200 km

   (d) 850 km

   (e) 1075 km

   (f) 500 km

   (g) 200 km

---

5. What actual distance on the ground is represented by these measurements on the map?

   (a) 8.7 cm

   (b) 6.75 cm

   (c) 3 cm

   (d) 1.25 cm

   (e) 10.25 cm

6. Use a ruler and the map scale to find the approximate distances, if you travel in a straight line, between the following places:

   (a) Vanimo and Kavieng

   (b) Mendi and Kimbe

   (c) Port Moresby and Wewak

   (d) Alotau and Rabaul

   (e) Daru and Lae

---

7. A businessman planned to fly in a straight line from Port Moresby to Vanimo and then on to Madang before returning to Port Moresby, approximately how many kilometres would he have travelled altogether?

CORRECT YOUR WORK. ANSWERS ARE AT THE END OF SUB-STRAND 4

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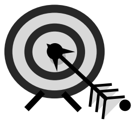
Lesson 20: Reading Maps Using Longitude and Latitude

You have learned how to read and use maps and map scales in Lesson 19.



In this lesson, you will:

- define the terms longitude and latitude
- identify locations on the map using longitude and latitude.

Another way of reading maps is by using latitude and longitude.

The earth is almost a perfect sphere. All points on earth are about the same distance from its centre. The earth rotates on an axis, which is an imaginary line through the centre of the Earth connecting the North Pole and the South Pole.

Reference lines are drawn on globes and maps to make places easier to find. Lines that go east and west around the earth are called **lines of latitude**.

Latitudes are the lines that run east and west around the earth.

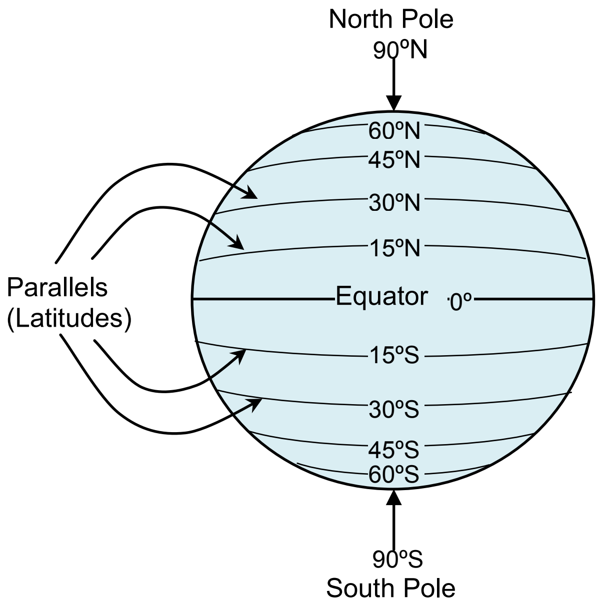
The **equator** is a special line of latitude. Every point on the equator is the same distance from the North Pole and the South Pole.

The lines of latitude are often called **parallels** because each one is a circle that is parallel to the equator.

The latitude of a place is measured in **degrees**. The symbol for degrees is (º). Each degree can be divided into 60 minutes. The symbol for minute is (**’**).

Lines north of the equator are labelled ºN (degrees North).

Lines south of the equator are labelled ºS (degrees South).



The number of degrees tells us how far north or south of the equator a place is. The area north of the equator is called the **Northern Hemisphere.** The area south of the equator is called the **Southern Hemisphere.**

Examples

1. The latitude of the North Pole is 90ºN.

2. The latitude of the South Pole is 90ºS.

3. The latitude of Cairo, Egypt, is 30ºN. We say Cairo is 30 degrees north of the equator. Cairo is in the Northern Hemisphere.

4. The latitude of Durban, South Africa, is 30ºS. We say Durban is 30 degrees south of the equator. Durban is in the Southern Hemisphere.

A second set of lines run from north to south. These are semicircles (half-circles) that connect the poles. They are called **lines of longitude or meridians**.

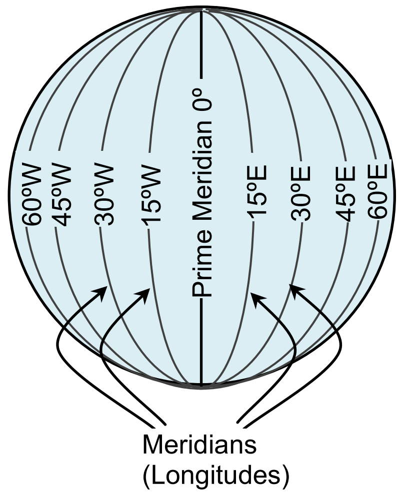
The meridians are not parallel, since they meet at the poles.

The **Prime meridian** is a special meridian labelled 0º. The prime meridian passes through Greenwich, England (near London). Another special meridian is the **International dateline.** This is labelled 180º and is exactly opposite the prime meridian on the other side of the world.

The longitude of a place is measured in degrees.

Lines west of the prime meridian are labelled ºW.

Lines east of the prime meridian are labelled ºE.



The number of degrees tells how far west or east of the prime meridian a place is. The area west of the prime meridian is called **Western Hemisphere.** The area east of the prime meridian is called **Eastern Hemisphere**.

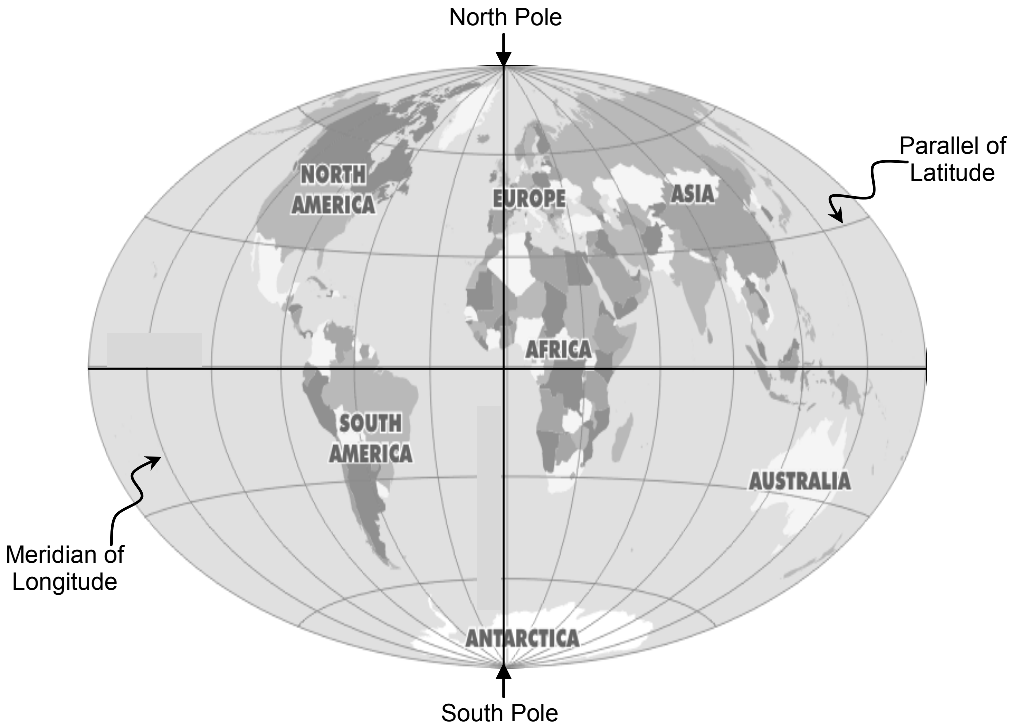
Examples

1. The longitude of Greenwich, England is 0º because it lies on the Prime Meridian.

2. The longitude of Durban, South Africa is 30ºE. We say Durban is 30 degrees east of the prime meridian. Durban is in the Eastern hemisphere.

3. The longitude of Gambia,(a small country in Africa) is about 15ºW. We say that Gambia is 15 degrees west of the prime meridian.

In order to understand latitude and longitude, you have to look at the diagrams below.



Lines of longitude appear vertical with varying curvature in this projection, but are actually halves of great ellipses, with identical radii at given latitude.

Lines of latitude appear horizontal with varying curvature in this projection; but are actually circular with different radii. All locations with given latitude are collectively referred to as a circle of latitude.

There are five major circles of latitudes. These are the following:

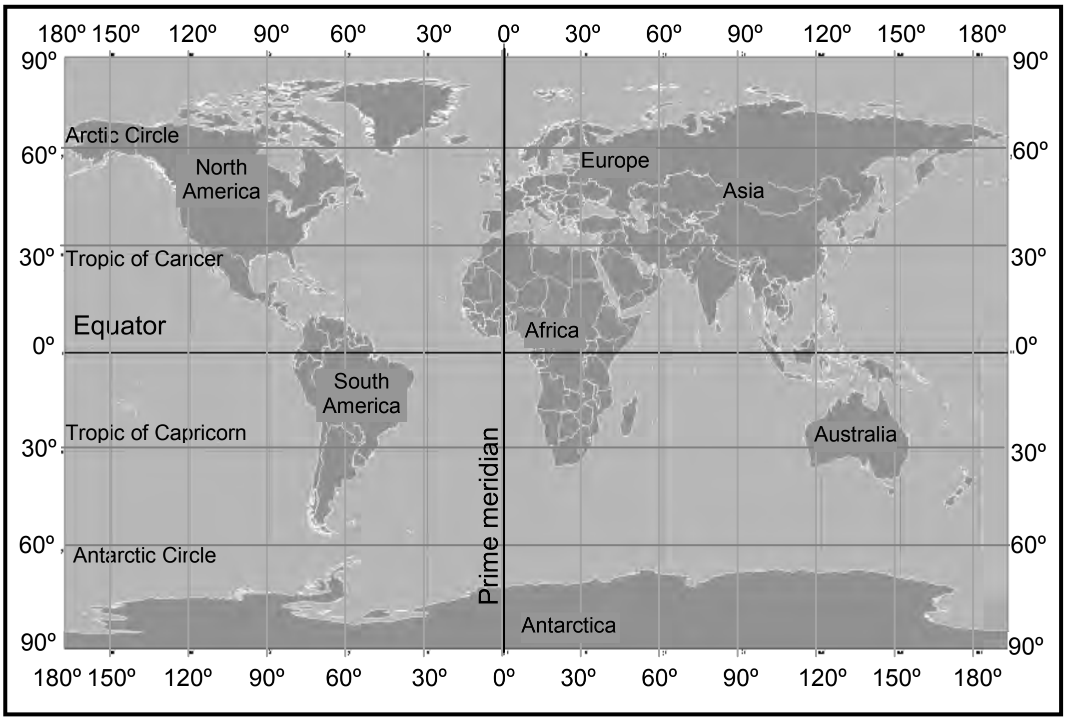
- The Arctic Circle has a latitude of 66° 33′ 38″ N.
- The Tropic of Cancer has a latitude of 23° 26′ 22″ N.
- The Equator Has a latitude of 0° latitude.
- The Tropic of Capricorn has a latitude of 23° 26′ 22″ S.
- The Antarctic Circle Has a latitude of 66° 33′ 38″ S.

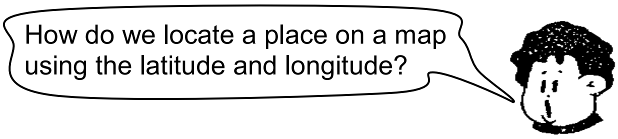
The **equator** divides the planet into a Northern Hemisphere and a Southern Hemisphere, and has latitude of 0º.

The Prime Meridian divides the planet into a Western Hemisphere and an Eastern hemisphere, and has a longitude of 0º.

On the next page is a diagram showing the locations of the five major circles of latitude on an Equirectangular projection of the Earth.

EQUIRECTANGULAR PROJECTION OF THE EARTH





Any place on the map can be located by naming its latitude and longitude. It is usual to give the latitude of a place first and the longitude second. Latitude and longitude are like imaginary streets on the earth.

For example, you would say –60 degrees north, 40 degrees east”. This eliminates the need to say the words latitude and longitude. Make sure you give the direction with the number. If you simply say –60 degrees latitude”, there are two of them- one in the north and one in the south.

To find a latitude line such as 60 degrees north latitude, you must do the following:

1. Go to your starting line (the equator).
2. Determine which direction you must go (north or south).
3. Determine the distance in degrees you must go (60).

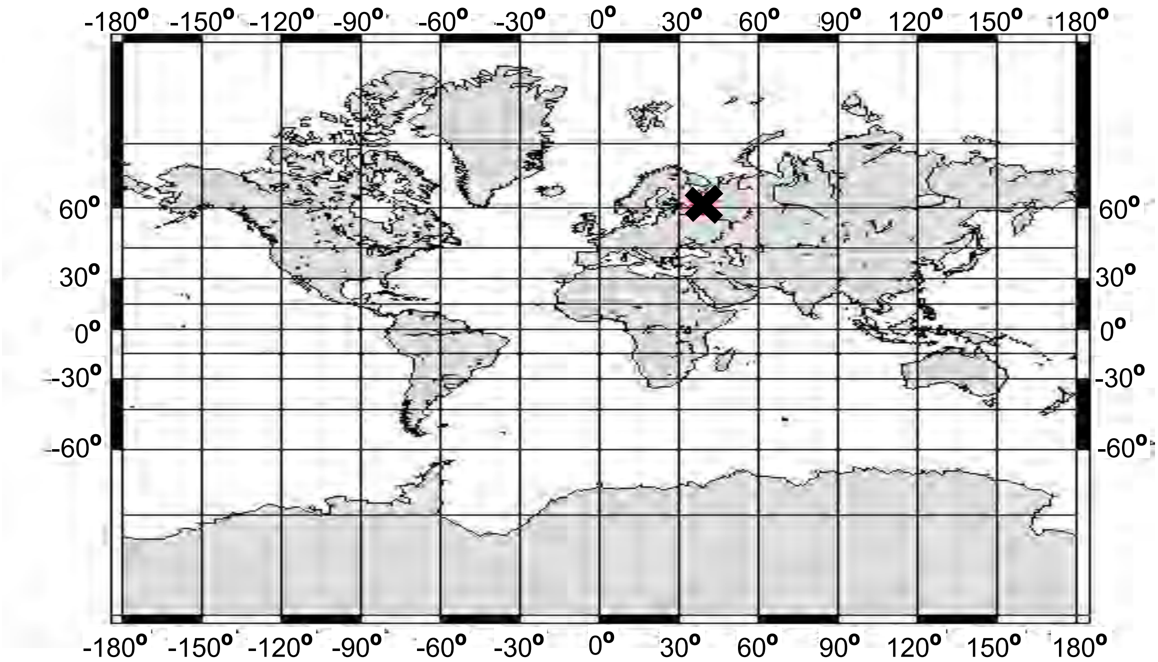
This will give the location of one of your street.

To find longitude lines such as 40 degrees east longitude, you must do the following:

1. Go to your starting line (the Prime Meridian).
2. Determine which direction you must go (east or west).
3. Determine the distance in degrees you must go (40).

This will give the location of you your second street.

If you find the intersection of these two imaginary streets you have found the exact location of a particular place on the earth. (See the x marked and shown on the map below.)



Latitude is measured from the equator, with positive values going north and negative values going south.

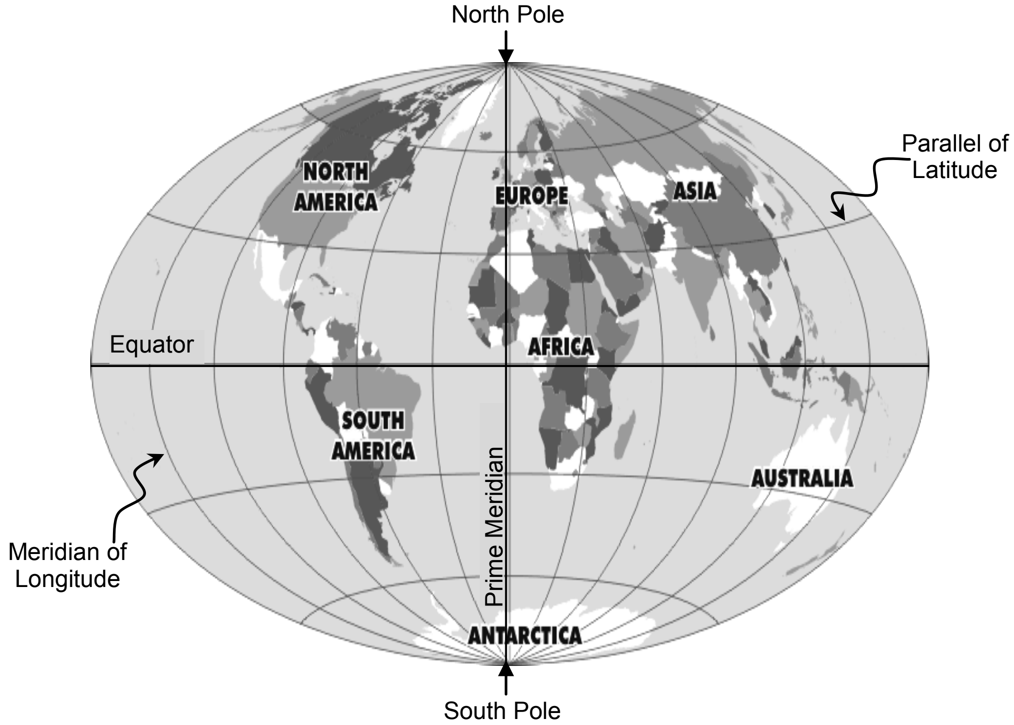
Longitude is measured from the Prime Meridian (which is the longitude that runs through Greenwich, England), with positive values going east and negative values going west.

So, for example, 60 degrees west longitude, 40 degrees north latitude -60 degrees longitude, +40 degrees latitude.

NOW DO PRACTICE EXERCISE 20

Practice Exercise 20

1. Use the diagram to answer the following questions.



(a) Do lines of latitude run east-west or north-south?

(b) The ____________ is the line of longitude that divides the Eastern Hemisphere from the Western Hemisphere.

(c) The _____________ is the line of latitude that divides the Northern Hemisphere from the Southern Hemisphere.

(d) List the seven large landmasses known as continents.

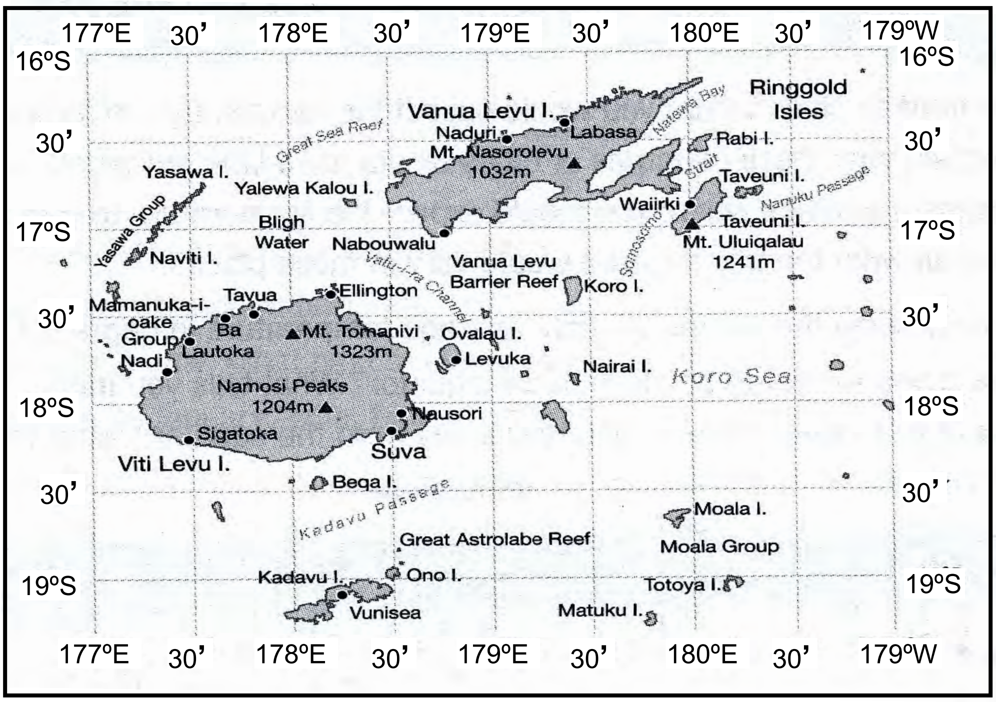
(e) Which two continents lie completely in the Southern Hemisphere?

(f) Which continents lie completely in the Western Hemisphere?

2. Use positive or negative to interpret each of the following
   (a) 34º North latitude =
   (b) 156º West longitude =
   (c) 81º East longitude =
   (d) 54º South latitude =
   (e) 23º North latitude =
   (f) 93º East longitude =

Refer to the information and diagram below to answer Question 3 and 4.

The map below shows the main islands of Fiji, a country to the east of Vanuatu. You will notice that the 180º line of longitude passes through FIJI. As there are a maximum of 180º to the east of the prime meridian, the next line of longitude is measured from west of the Prime Meridian (179ºW). The 180º line of longitude is both east and west and is written as 180º without a direction after it.

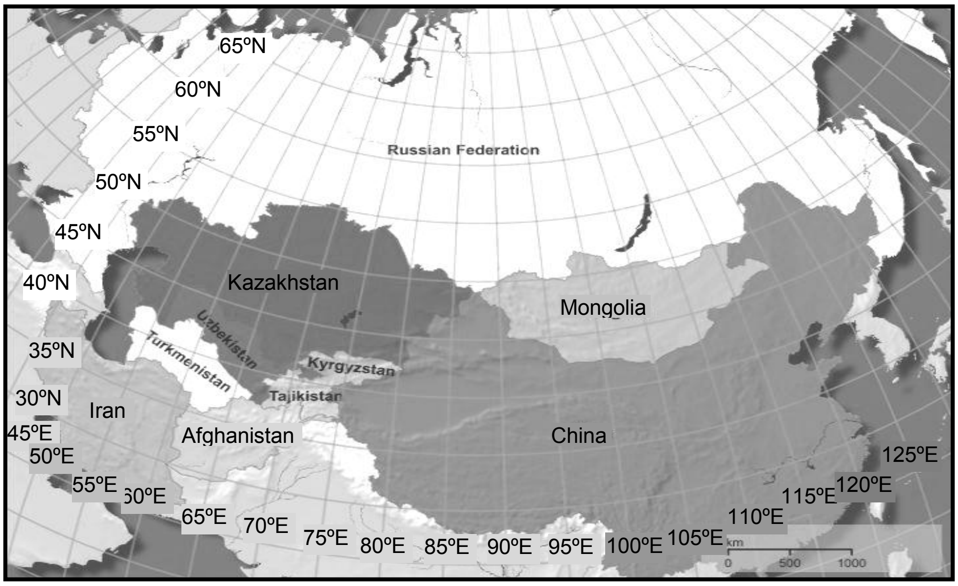


3. Locate the place that is at each of the following latitudes and longitudes.
   (a) 18º15‘S, 177º30‘E
   (b) 18º10‘S, 178º30‘E
   (c) 16º50‘S, 180º
   (d) 17ºS, 178º45‘E

4. Give the location of the following using both degrees and minutes.
   (a) Lautoka
   (b) Levuka
   (c) Nadi

The diagram shows the map of Central Asia.

MAP OF CENTRAL ASIA



5. Using the map of Central Asia, answer the following questions about latitude and longitude.

(a) What country is located at 45°N, 100°E?

(b) What country is located at 30°N, 55°E?

(c) If you are at 50°N, 125°E, where are you?

(d) Pretend you are traveling through Central Asia. You start at 30°N, 65°E. What country are you in?

(e) Now move 10° to the north. What is your *latitude* reading? What country are you in now?

CORRECT YOUR WORK. ANSWERS ARE AT THE END OF SUB-STRAND 4

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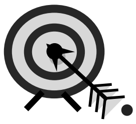
Lesson 21: Coordinates, Number Planes and Map Grids

In the last lesson, you have learned what latitude and longitude are. You also learnt to find a place on the map using latitude and longitude.



In this lesson, you will:

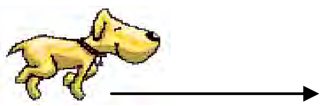
- define coordinates, number planes and map grids
- use number pairs as coordinate references.

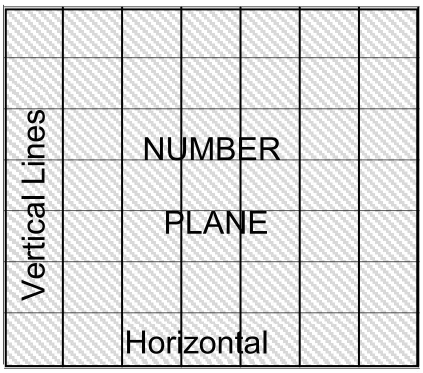
If you studied Grade 7 Mathematics with FODE, you will remember learning about coordinates in Strand 4.

We will revise some of the main ideas in Strand 4 and learn more about coordinates, number planes and map grids.

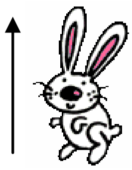
As you have learnt in Grade 7, a **grid** is a pattern of horizontal and vertical lines which are evenly spaced.

There are 8 horizontal lines on the grid. The horizontal lines go across the grid.





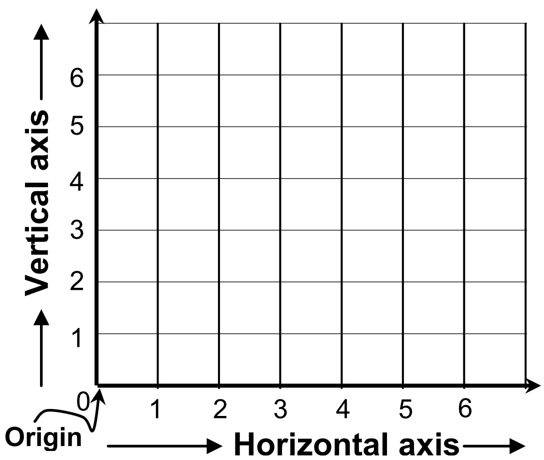
And there are 8 vertical lines on the grid. The vertical lines go across the grid.



The area marked by the grid is called a **Number plane**.

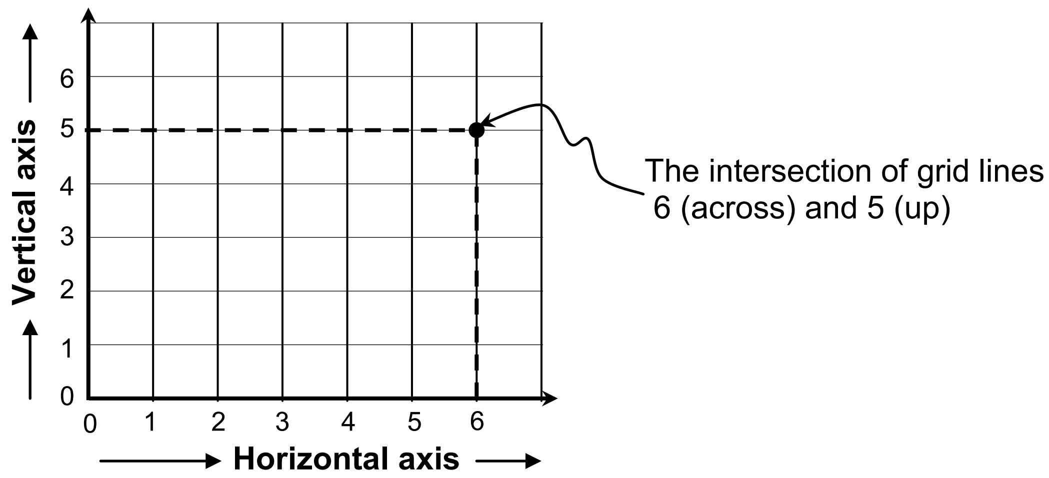
> A **number plane** is a flat surface made up of all the points we can describe using coordinates.

There are two special lines on a grid. We call these two the **horizontal and vertical axes.**



The lines on the grid cross in many places. The point where the two lines cross or meet each other is called the **intersection.**

We can use the horizontal axis number and the vertical axis number to locate the position of a point on the grid.



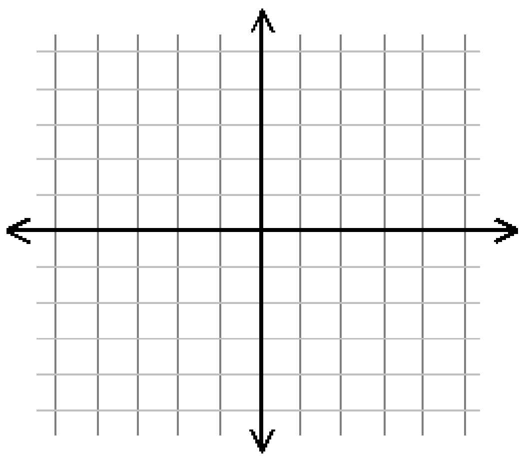
The two numbers (6 and 5) describe and represent the position of a point on the grid and are called **Coordinates.**

Coordinates are ordered pair of numbers which describe the position of a point on a number plane.

So, we say the intersection of the grid lines is the point (6, 5).

In Grade 7 Strand 4 Lesson 22, you were introduced to the Rectangular Coordinate System commonly known as the Cartesian Coordinate Plane, named after Rene Descartes who popularized its use in analytic geometry.

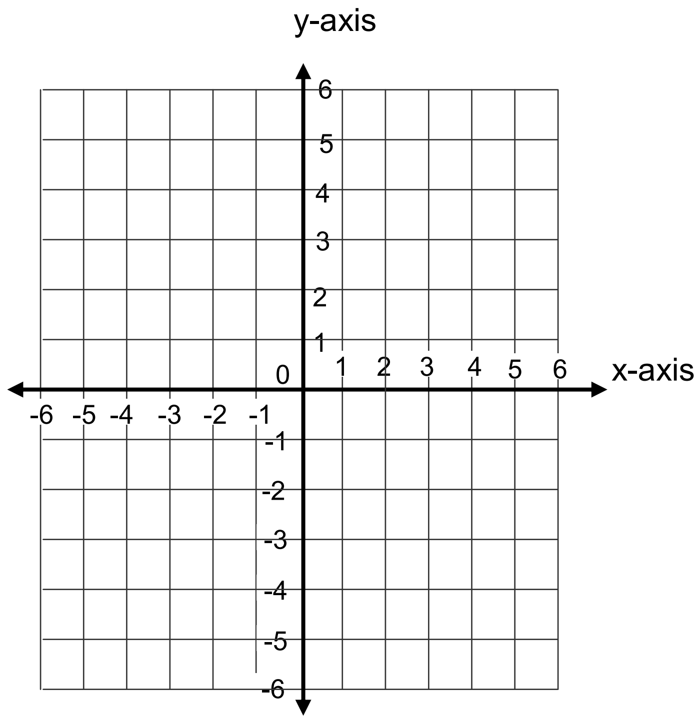
The rectangular coordinate system is based on a grid, and every point on the plane can be identified by unique x and y coordinates, just as any point on the Earth can be identified by giving its latitude and longitude.



Locations on the grid are measured relative to a fixed point, called the **origin**, and are measured according to the distance along a pair of axes.

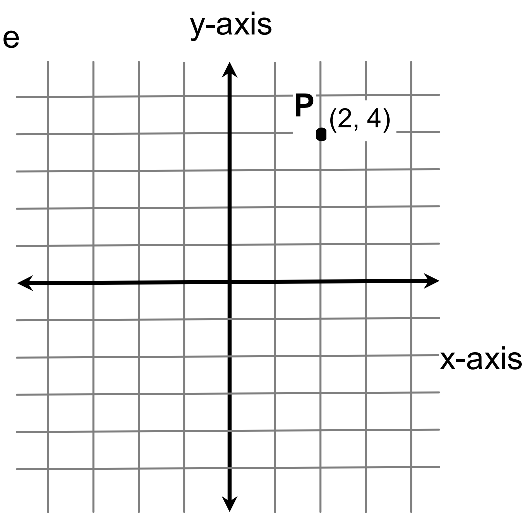
The **horizontal** (**x**) and **the vertical** (**y**) **axes** are just like the number line, with positive distances **to the right** and negative **to the left** in the case of the **x** axis, and positive distances measured **upwards** and negative **down** for the **y** axis.

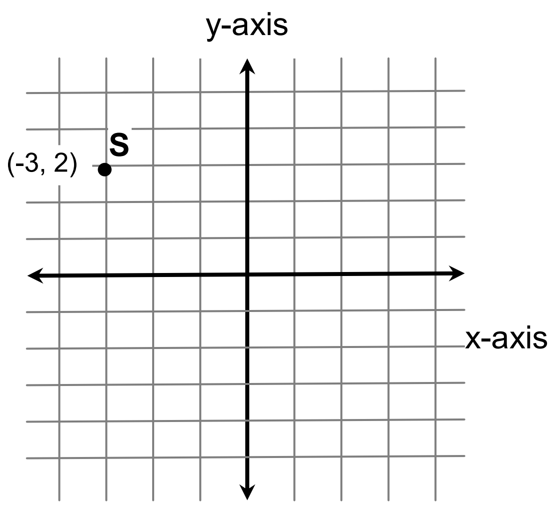
Any displacement (movement) away from the origin can be constructed by moving a specified distance in the **x** direction and then another distance in the **y** direction. Think of it as if you were giving directions to someone by saying something like "go three blocks East and then 2 blocks North."



We specify the location of a point by first giving its **x coordinate** (the left or right movement from the origin), and then the **y coordinate** (the up or down movement from the origin). Thus, every point on the plane can be identified by a pair of numbers (**x, y**), called its coordinates.

Example

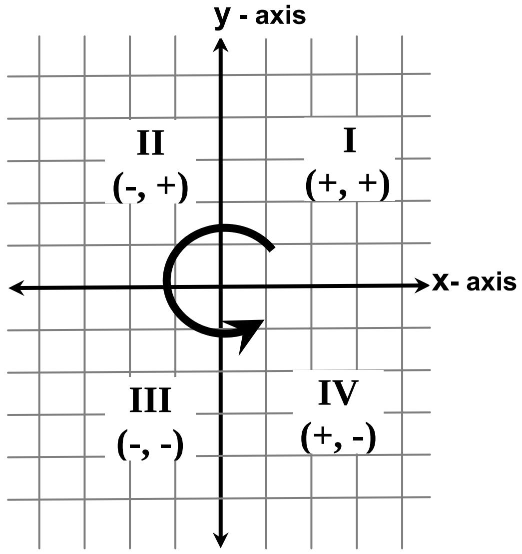




Point **P** represents the ordered pair (2, 4).

Point **S** represents the ordered pair (-3, 2).

Sometimes we just want to know what general part of the graph we are talking about. The axes naturally divide the plane up into quarters. We call these **quadrants**, and number them from one to four.



Notice that the numbering begins in the upper right quadrant and continues around in the counter-clockwise direction. Notice also that each quadrant can be identified by the unique combination of positive and negative signs for the coordinates of a point in that quadrant.

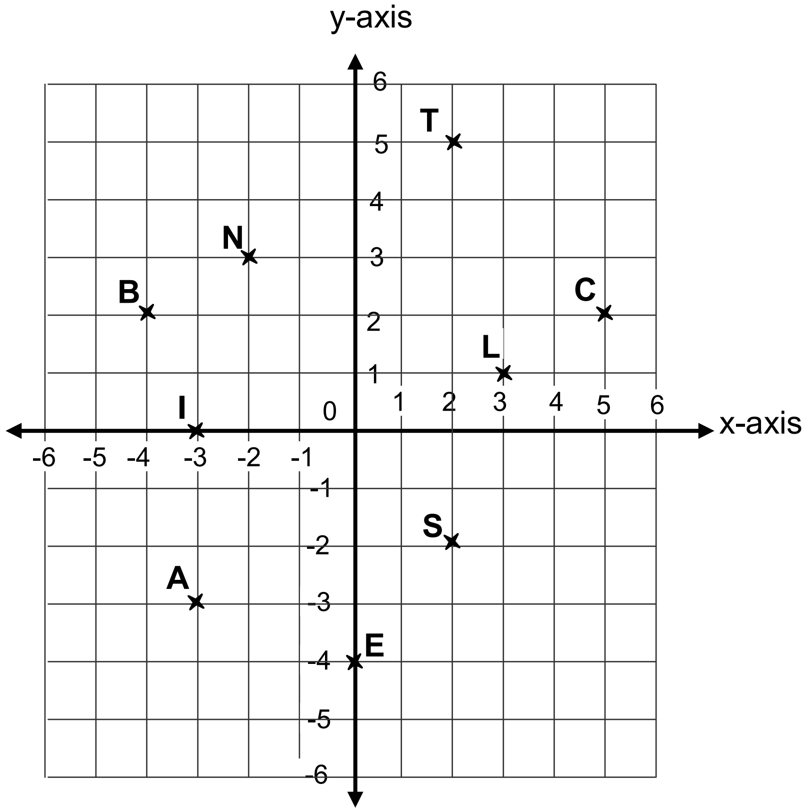
When the first coordinate of a point is zero, the point is located on the y- axis.

When the second coordinate of a point is zero, the point is located on the x-axis.

NOW DO PRACTICE EXERCISE 21

Practice Exercise 21

1. Write the coordinates of each of the labelled parts shown on the number plane below.



2. Use the number plane in Question #1, Write in order, the letters given for the following points. What word is spelled out?

(3, 1) (-3, 0) (2, -2) (2, 5) (0, -4) (-2, 3)

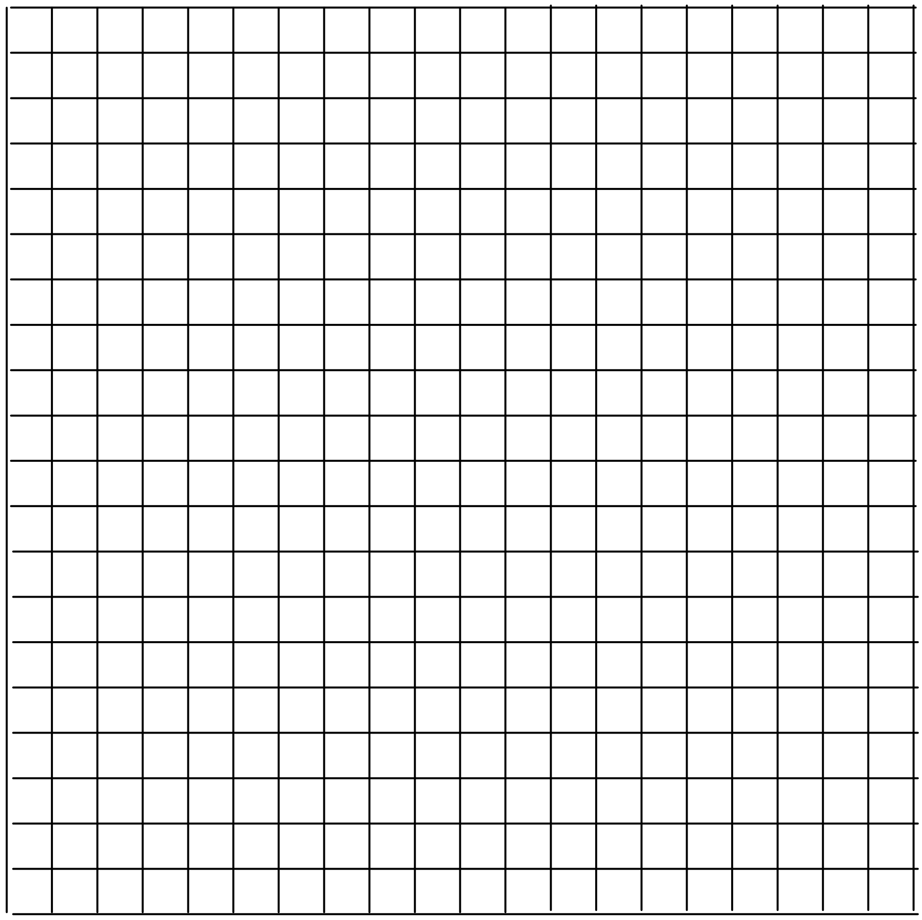
3. Write the labelled points on the number plane in Question #1 which has an x coordinate of:

(a) 2 (b) -3 (c) 0 (d) 5

4. Write the labelled points on the number plane in Question #1 which has a y coordinate of:

(a) -2 (b) -3 (c) 0 (d) 1

5. (a) Use the grid below to draw a number plane labelled from -8 and 8 on both axes.



(b) On your number plane, plot the following points with the letters given.

M (4.5, 4.5)   N (-4.5, 4.5)   O (-4.5, -4.5) P (4.5, -4.5)

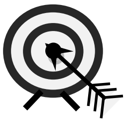
(c) Draw a straight line to join MN, NO, OP and PM. What shape have you drawn?

CORRECT YOUR WORK. ANSWERS ARE AT THE END OF SUB-STRAND 4

.

Lesson 22: Using Map Grids and Coordinates to Locate Points

You learnt to plot points on the number plane using ordered pairs of numbers as coordinate references in the last lesson.



In this lesson, you will:

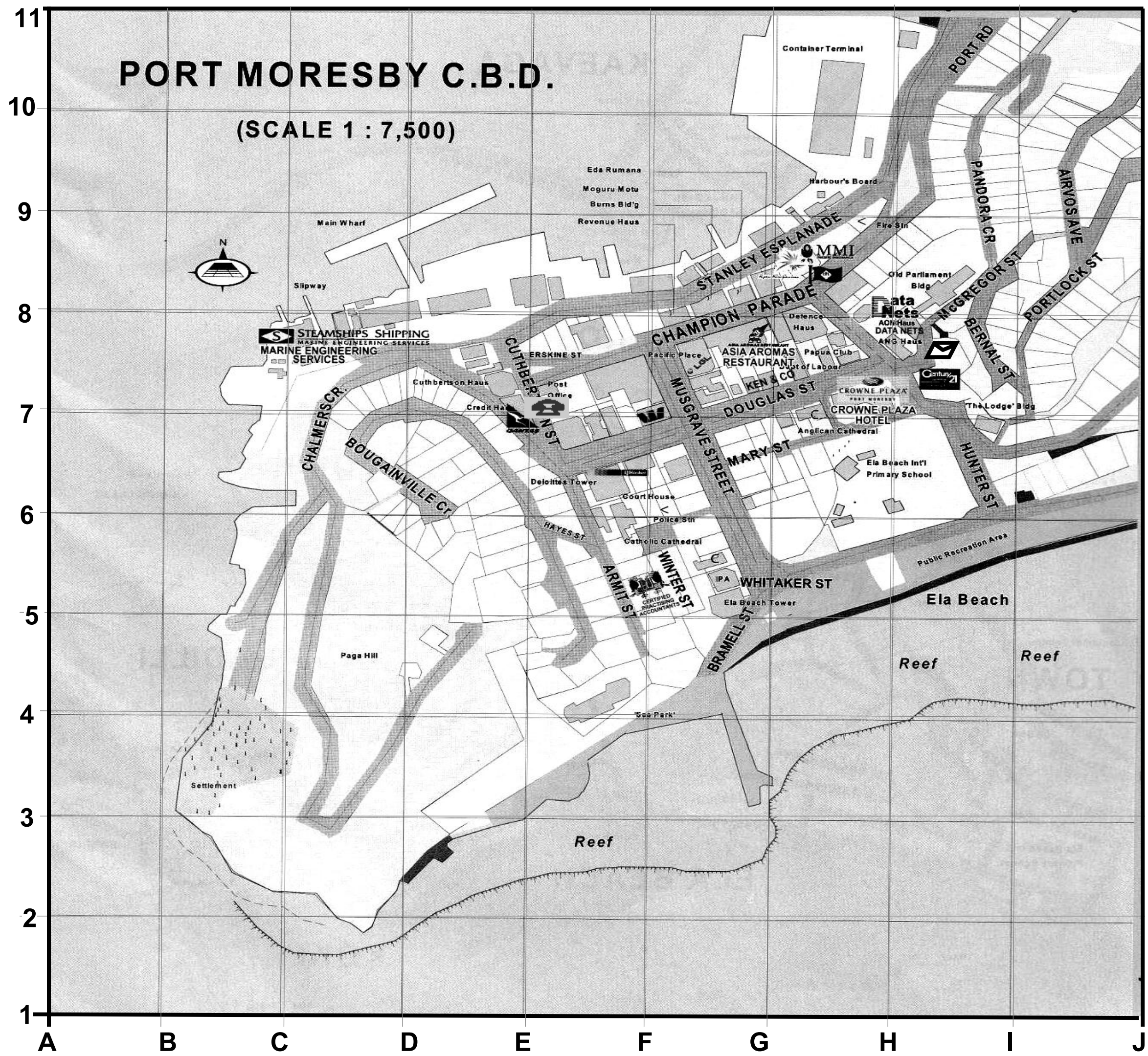
- identify locations on the maps given the grid reference and coordinates.

Earlier you learnt about maps. Maps are used to give accurate information as to where places are located.

When you look at a map you see lots of things. You might see some things you know like shops, a church or a river. But there are lots of other things on a map too.

To locate a point on a map, we use map grids and coordinates.

Example here is a map of Port Moresby town.



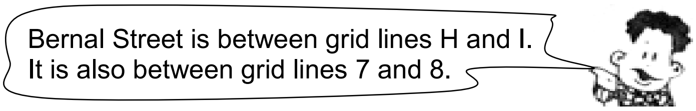
Grid lines have been drawn on the map. We can use the grid to locate different things shown on the map.

The grid has two axes. The horizontal axis is numbered from A to J. The vertical axis is numbered from 1 to 11. We can use the numbers on the grid to give the coordinates of any place on the map of Port Moresby.

Now you are going to learn using letters and numbers to mark coordinates on a map. When you find coordinates, you always write the letter first, which is found at the bottom, then the number, which is found at the side.

Example

1) Your friend lives at BERNAL STREET. You do not know where Bernal Street is so you ask him where it is on the map of Port Moresby Town.



Your friend has given you a GRID REFERENCE. Now you do know which part of the map to look at to find Bernal Street. Bernal Street is in the middle of a small section of the map marked by vertical lines from H and I and by horizontal lines from 7 to 8. This helps you to find Bernal Street quickly.

Can you find Bernal Street?

What are the names of the two streets which Bernal Street joins?

Answer: McGregor Street and Portlock Street

2) You want to make a telephone call from a public telephone.

There is a public telephone at the Post Office.

On the map the positions of public telephones are shown as

The Post Office is in the E7.

Can you find the Post Office?

Step 1: Follow the vertical line up from E on the horizontal axis.

Step 2: Follow the horizontal line across from 7 on the vertical axis.

The point E7 is where line E meets line 7.

What are the names of the two streets closest to the Post Office?

Answer: Champion Parade and Cuthbertson Street

3) You want to post a letter but you are not close to the Post Office. On the map, mail boxes are shown as Mail.

You are staying near the Old Parliament Building which is shown on the map.

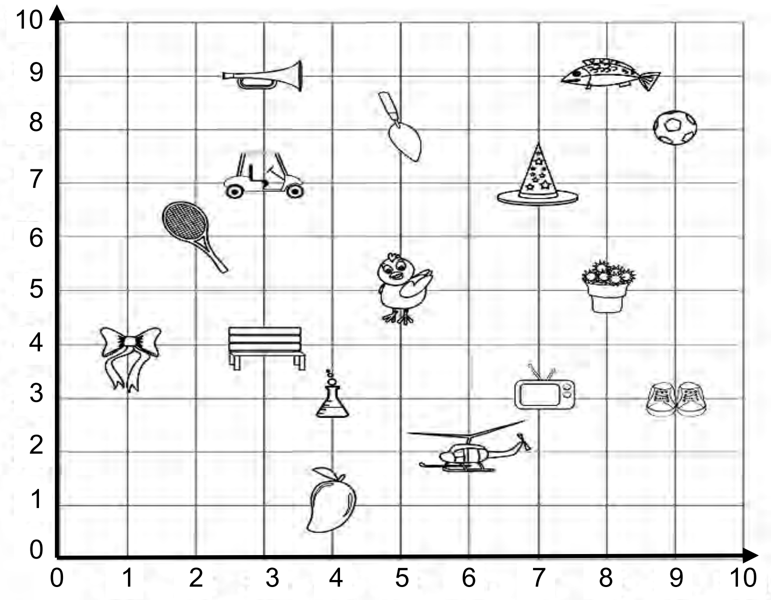
Your position on the map is between grid lines H and I and also between lines 7 and 8.

Can you find a mail box close to you?
What street would you walk along to post your letter?

Answer: Macgregor Street

You can also give the positions on a map in a more exact manner by using the grid and choosing a starting point on the grid called the origin with coordinates (0,0).

Look at the map below.



Example

1. What are the coordinates for the position of the helicopter?

   The helicopter is 6 units across the horizontal axis and 2 units up the vertical axis from the origin.

   We say the coordinates of the helicopter are (6, 2).

2. Write which object is located at point (9, 8)?

   Step 1: Follow the vertical line up from 9 on the horizontal axis.

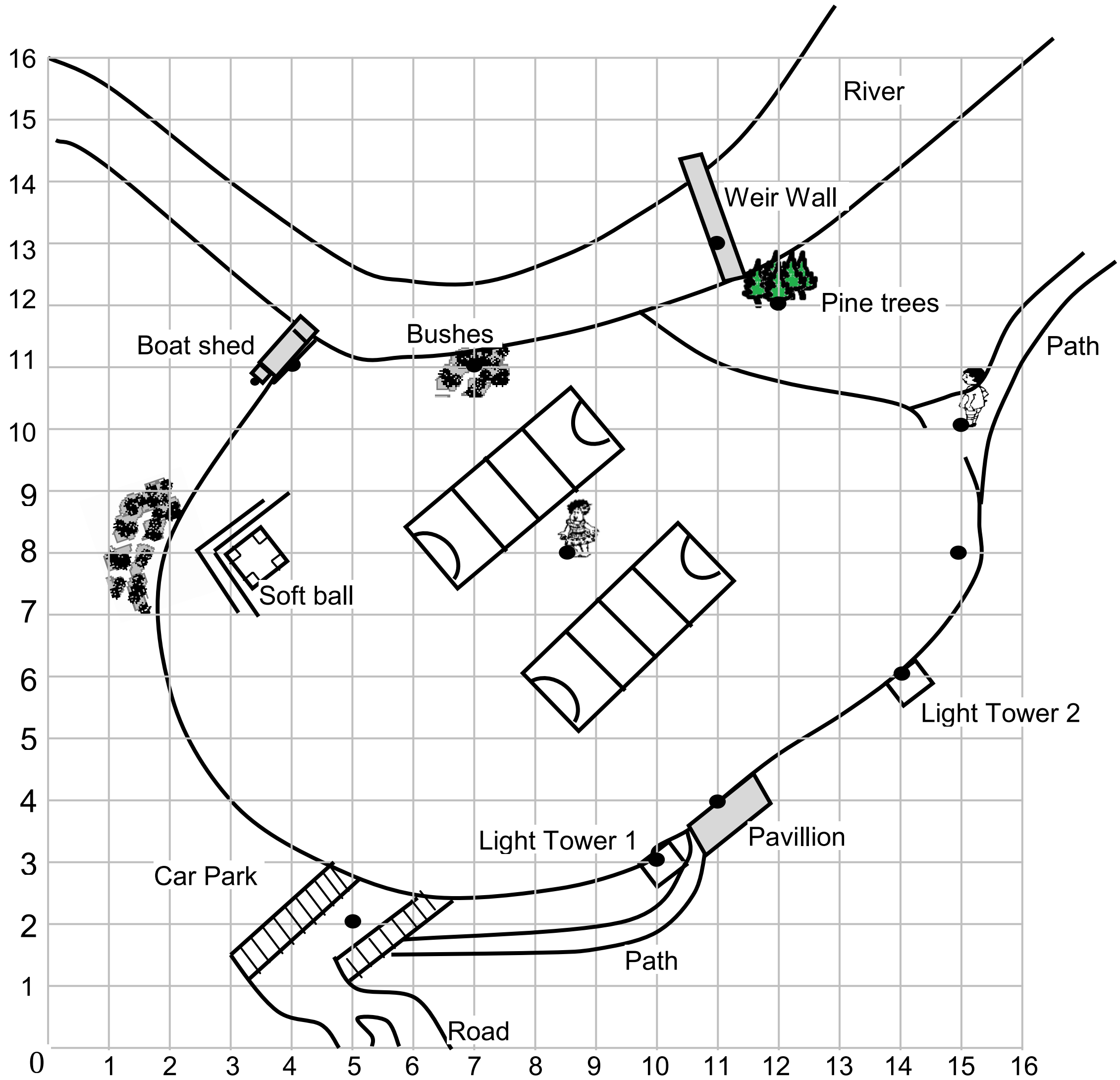
   Step 2: Follow the horizontal line across from 8 on the vertical axis.

   The object which is located at the point (9, 8) is a ball.

NOW DO PRACTICE EXERCISE 22

Practice Exercise 22

Use the map to answer Question 1.



1. Write the ordered pair for each of the following listed items.

(a) Pavillion ____________

(b) girl ____________

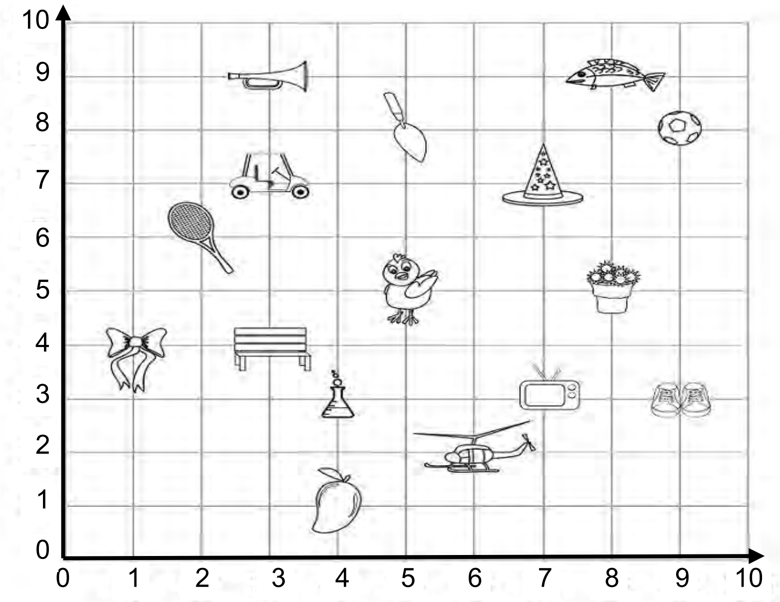
(c) Light tower 1 ____________

(d) Light tower 2 ____________

(e) Boy ____________

(f) Boat shed ____________

2. Look at the map below.



1. Write the ordered pair for each of the objects listed.

(a) television ____________ (b) shoes ____________

(c) mango ____________ (d) wizard's hat ____________

(e) fish ____________ (f) golf cart ____________

2. Which object is located at each of the following points?

(a) (3, 4) ____________ (b) (2, 6) ____________

(c) (1, 4) ____________ (d) (5, 5) ____________

(e) (9, 8) ____________ (f) (3, 9) ____________

CORRECT YOUR WORK. ANSWERS ARE AT THE END OF SUB-STRAND 4

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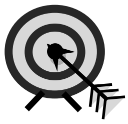
Lesson 23: Introducing Straight Line Graphs

You learnt to identify locations on a map given the grid reference and coordinates.

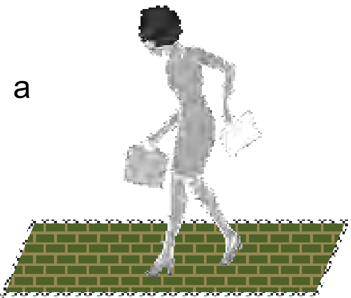


In this lesson, you will:

- be able to draw a table of values and use it to draw a straight line graph

First you will learn how straight line graphs can give us useful information.

Example 1

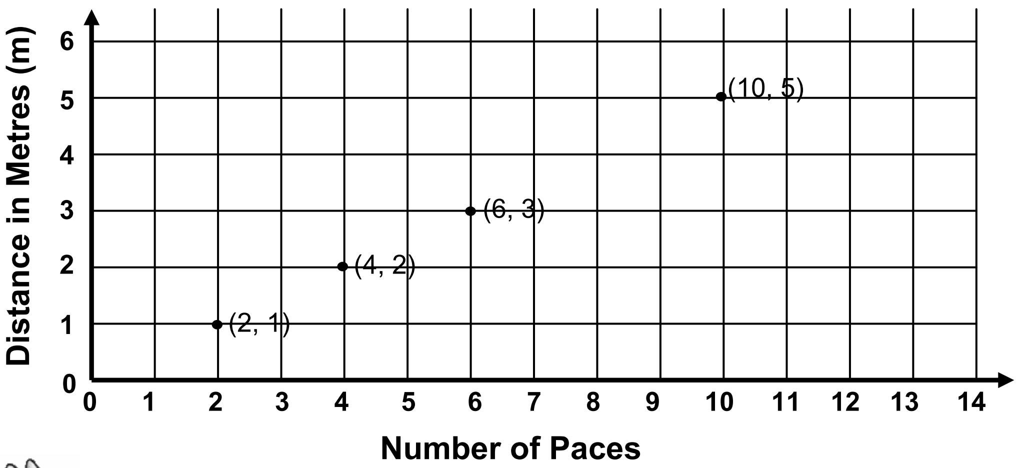


Sarah walked along a road.
Sarah walked 10 paces (that is, 10 steps) and covered a distance of 5 metres.

This means that:
Sarah takes 2 paces to cover a distance of 1 metre,
4 paces to cover a distance of 2 metres,
and 6 paces to cover a distance of 3 metres, etc.

We can show some information about how far Sarah walked like this:

HOW FAR SARAH WALKED



The horizontal axis shows the number of paces Sarah walked.

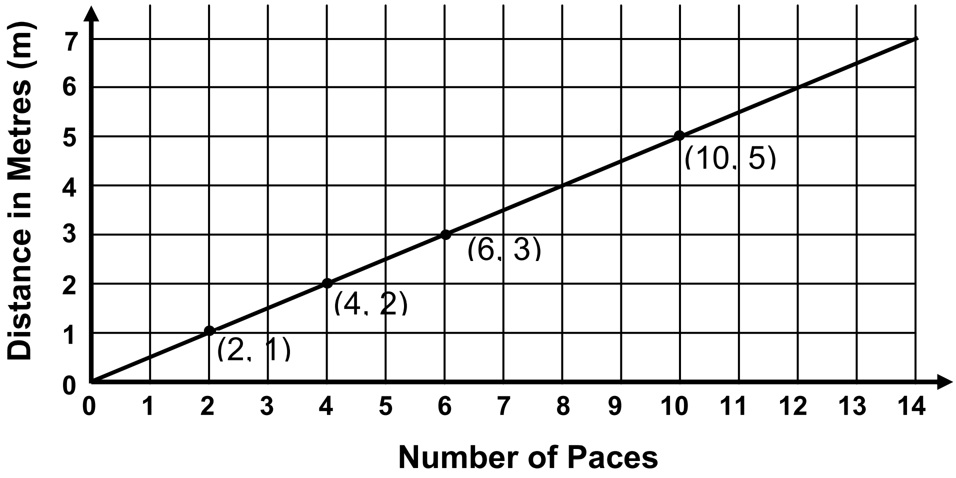
And the vertical axis shows the distance in metres which Sarah walked.

The point (10, 5) on the number plane shows that Sarah took 10 steps to cover 5 metres.
The point (2, 1) shows that 2 of Sarah's steps cover a distance of 1 metre.
The point (4, 2) and the point (6, 3) give us more information of the same kind.

Did you notice that all the points are in a straight line?

We can draw a straight line through these points.

Our result is shown here.

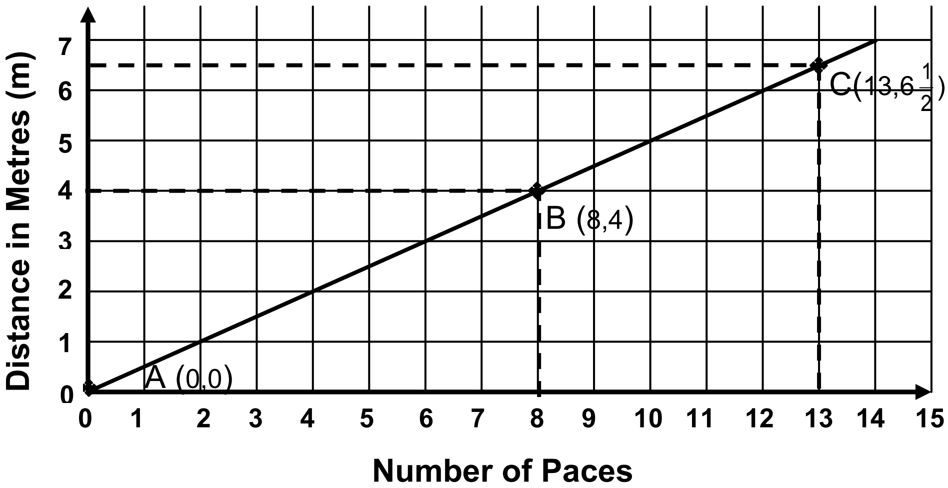


A Straight Line Graph is a straight line drawn on the number plane.

The straight line graph can tell us more information about how far Sarah walked. We can find out how far Sarah goes for any number of steps she takes.

Let us look at some more points on the graph.

Here is the same straight line graph again with points A, B, and C marked on it.



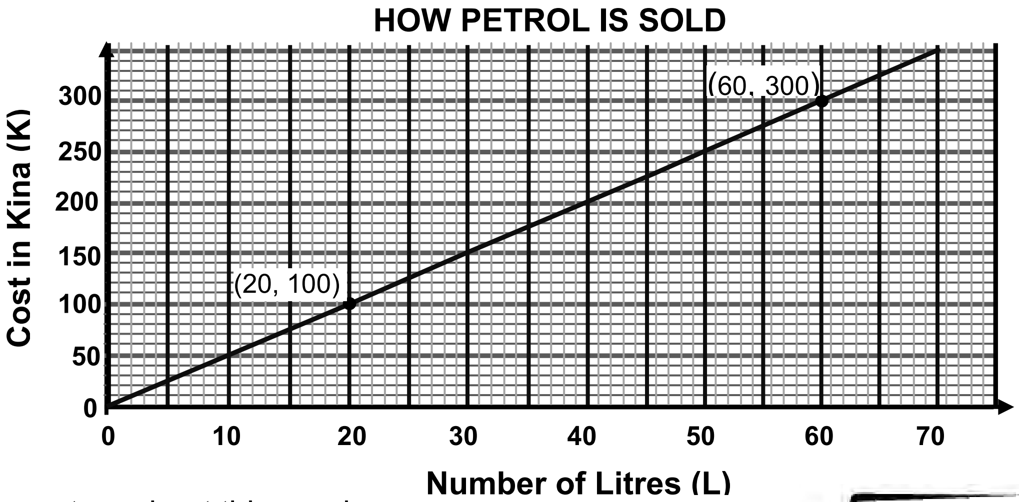
Point A is the point (0, 0). This means that in the beginning, Sarah had walked zero (0) paces and so she had covered a distance of zero (0) metres.

Point B is the point (8, 4). This tells us that after walking 8 paces, Sarah had covered a distance of 4 metres.

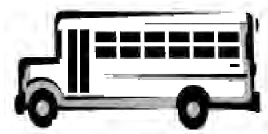
Point C is the point (13, $6\frac{1}{2}$). This means that it took Sarah 13 paces to go $6\frac{1}{2}$ metres.

We can find many more points on the graph. All the points will tell us some information about how far Sarah walked.

Here is another straight line graph.



Here is a story about this graph:



Percy runs a PMV. Every-day he must buy petrol.
He must pay more in Kina if he buys more litres of petrol. He has found out that if he pays K100 he can get 20 litres of petrol. It would cost him K300 if he bought 60 litres and so on. The graph shows Percy how to find out information about the amount of petrol he buys and the cost of the petrol.

1) How much petrol can Percy buy for K50?

Look at the vertical axis and see the cost in Kina. Can you find K50?
Follow the line from K50 across to the graph and see the coordinates of the point on the graph. They are (10, 50)

Amount in Litres ← → **Cost in Kina**

From the graph we can see that Percy would get 10 litres of petrol for K50 Kina.

2) How many litres can Percy get for K only?

Look at the vertical axis and find K10. Each small division is K10.
Follow the line from K10 across to the graph and find the coordinates of the point on the graph. They are (2, 10)

Amount in Litres ← → **Cost in Kina**

From the graph we can see that Percy gets 2 litres for K10.

3) Percy gets the petrol tank of his PMV filled up and it takes 45 litres.
How much will Percy pay for petrol?

Look at the horizontal axis and find 45 litres. Each small division is 1 litre). Follow the line from 45 litres up to the graph and find the coordinates of the point on the graph. They are (45, 225)

Amount in Litres ← → **Cost in Kina**

From the graph we can see that Percy would pay K225 for 45 litres of petrol.

4) What does point (0, 0) on the graph means?

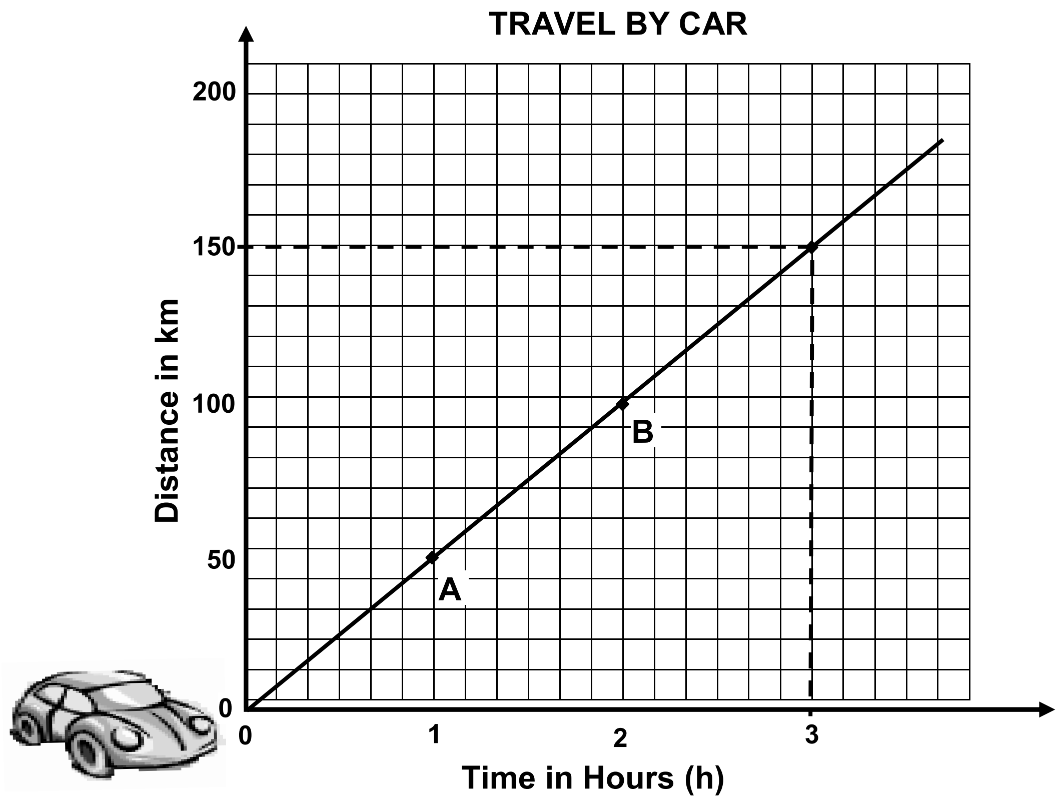
The point (0, 0) means that if Percy buys no petrol (zero) he pays nothing (zero).

(0, 0)

Amount in Litres ← → **Cost in Kina**

Example 2

Here is another graph.



Percy travelled by a car along the Highlands Highway. The speedometer of the car showed that the car was traveling at about 50 kilometres per hour. This means that in 1 hour the car would cover a distance of 50 kilometres. In 2 hours the car would cover a distance of 100 kilometres, etc., if Percy was traveling AT THE SAME SPEED of 50 km/h.

Point A on the graph has a coordinates (1, 50).

1 hour ← → **50 Kilometres**

Point B on the graph has a coordinates (2, 100)

2 hours ← → **100 Kilometres**

We can use the graph to tell us how far Percy travelled in anytime, if he continues to travel AT THE SAME SPEED of 50 km/h.

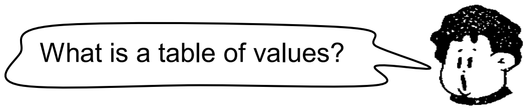
1) If Percy travelled at 50 km/h, how far did Percy travel in 3 hours?

   Look at the horizontal axis and find 3 hours.

   Follow the line from 3 hours **up** to the graph. Mark the point on the graph with a small x.
   Follow the line from the x **across** to the vertical axis. You are now at 150 kilometres on the vertical axis.

   So, Percy travelled 150 km in 3 h.

Now you will learn to draw straight line graphs using table of values.



A table of values is a chart that helps you determine two or more points that can be used to create your graph.

Example 1

Ralph is selling kaukau in a store. The cost of the kaukau is K3 per kilogram. So, if he (Ralph) sells one kilogram of kaukau he will be paid K3. If he sells two kilograms he will be paid K6. For 3 kilogram the cost is K9 and so on.

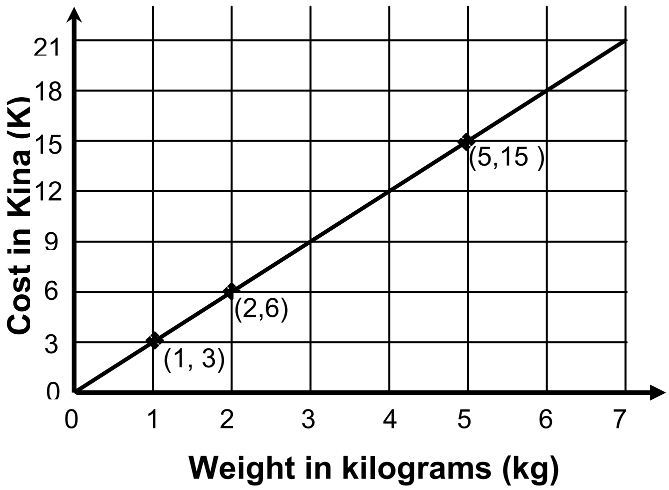
We could make a table of values on the information about the cost of kaukau, like the one below.

Weight in Kilograms	Cost in Kina
1	3
2	6
3	9
4	12
5	15

Now we can use the table of values to draw the straight line graph showing the information about the cost of kaukau.

The points would be: (1,3); (2,6); (3,9), (4,12); (5,15)

HOW KAUKAU ARE SOLD



We do not need all the points to draw the line. You only need two or three points to show you where to draw the line.

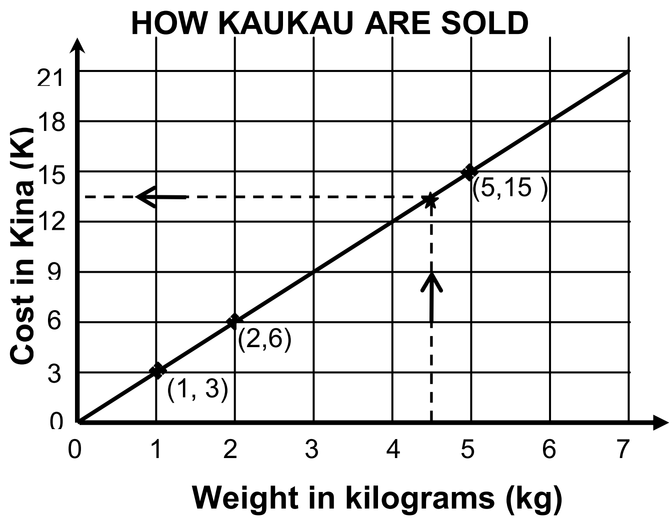
We have chosen points A (1, 3); B (2, 6) and C (5, 15) to show where to draw the line.

Next we can use the graph to give us further information about how the kaukau are sold.

For example if Ralph sold $4\frac{1}{2}$ kilogram of kaukau, how much did he charge for the kaukau?

Answer: **$4\frac{1}{2}$ kg cost K13.50**

Follow the arrow from $4\frac{1}{2}$ kg <u>up</u> to the graph, then across to K13.50.



Here is example 2.

Draw a straight line graph showing how money is changed from Australian dollars into PNG kina.

Use the table of values below which show some of the amounts in Australian Dollars and their equivalent amounts in Kina.

Amount in Australian Dollars($)	Amount in PNG Kina (K)
10	25
20	50
30	75
40	100
50	125
60	150
70	175
80	200

STEP 1: From the table you can see that some of the points on the graph are:

(10, 25) (20, 50) (30, 75) (40, 100) (50,125)

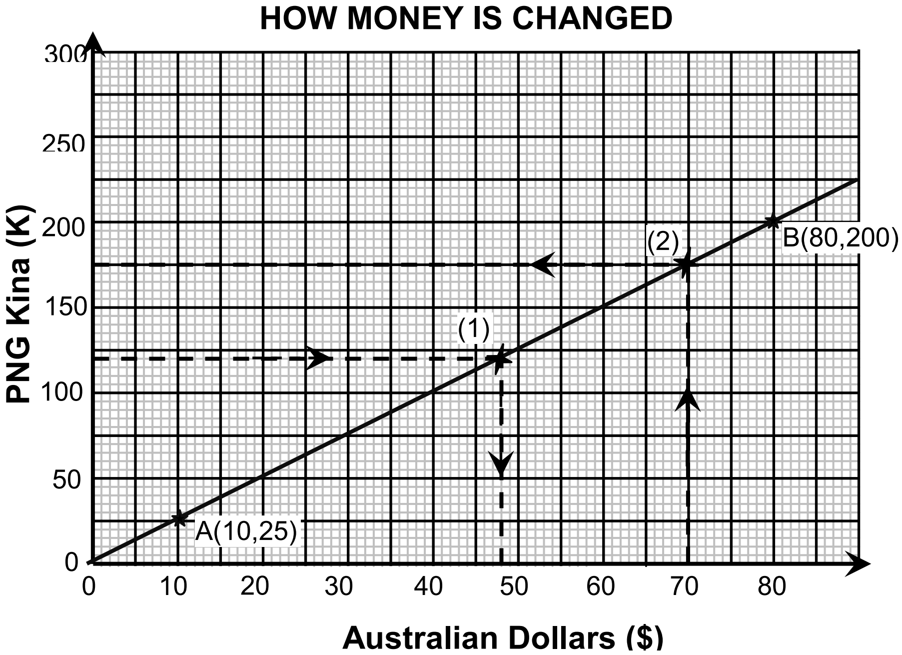
STEP 2: You do not need all the points to make a straight line graph.

In this example you will use only 2 points. The points are the first and the last from the table of values.

STEP 3: Mark the positions of two points A (10, 25) and B (50, 125) on the number plane.

STEP 4: Draw the straight line through the points A and B.

The result is on the next page.



We used points A and B because they are far apart.
All the other points are between A and B on the graph.

Now you can use the graph to give you information about changing PNG kina into Australian dollars.

e.g. (1) How much is K120 in Australian dollar?

Follow the arrow from K120 across to the graph. Mark the point on the graph with a **x**. Follow from the **x** to the horizontal axis.

Answer: **K120** is **Aus$48.**

(2) How much is Aus$60 in PNG Kina?

Follow the arrow from Aus$60 up to the graph. Mark the point on the graph with a **x**. Follow from the **x** to the vertical axis.

Answer: **Aus$60** is **K150**

NOW DO PRACTICE EXERCISE 23

Practice Exercise 23

1) Use the graph of —**HOW FAR SARAH WALKED**” on page 175 to answer the following.

(a) How far did Sarah walk if she went 11 paces?

ANSWER: ___________________________

(b) How many paces does it take Sarah to walk a distance of $3\frac{1}{2}$ metres?

ANSWER: ___________________________

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(2) Use the graph of —HOW PETROL IS SOLD” on page 175 to answer the following.

(a) How much petrol can Percy buy for K30?

ANSWER: ___________________________

(b) Percy bought 40 litres of petrol. How much did he pay for it?

ANSWER: ___________________________

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(3) Use the graph of —**TRAVEL BY CAR**” on page 176 to answer the following.

(a) How far would Percy travel in $1\frac{1}{2}$ hours?

ANSWER: ________________________________

(b) What does the point (0, 0) on the graph mean?

ANSWER: It means that if Percy had travelled for __________ hours he would have covered ______________ kilometres.

(c) What does each small division along the vertical axis represent?

ANSWER: Each small division represents ___________km.

(d) What does each small division along the horizontal axis represent?

(NOTE: There are 60 minutes in one hour and there are 6 small divisions on the axis for each hour).

ANSWER: Each small division represents ___________minutes.

4. A Mobil petrol tanker was unloading its load of fuel into a storage tank at a garage station. The petrol flowed into the storage tank through a fuel line.

In 5 minutes 1000 litres were unloaded. In 10 minutes, 2000 litres were unloaded, etc.

The table below shows the amount of petrol which was discharged or unloaded after every 5 minutes.

Time in Minutes(min)	Petrol unloaded in 1000 Litres
5	1
10	2
15	3
20	4
25	5
30	6
35	7
40	8

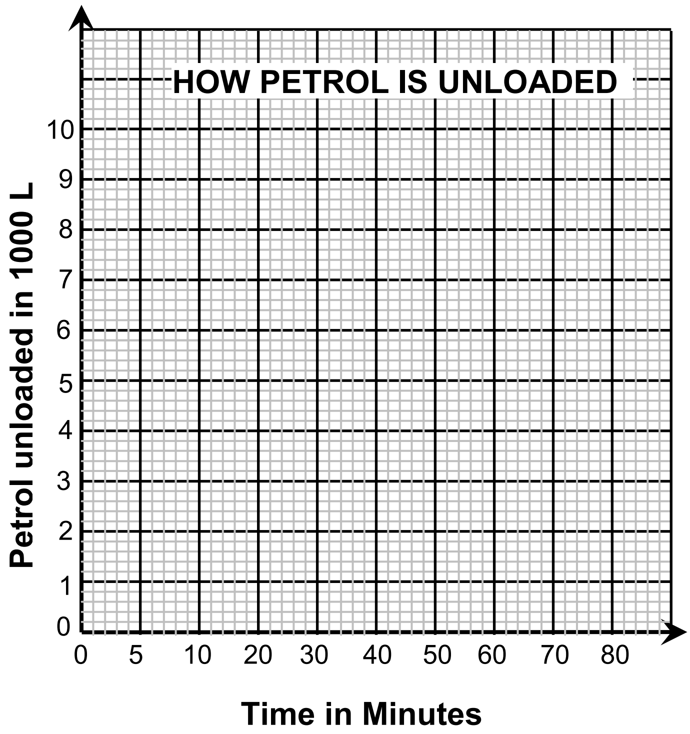
(a) Draw a straight line graph using the information from the table.

STEP 1: From the table you can see that some of the points on the graph are:

(5, 1) (,) (,) (,) (,) (,) (,) (,)

STEP 2: Choose the first and last points, which are far apart.
They are: (,) and (,)

STEP 3: Mark the two points on the graph below.



STEP 4: Draw a straight line through the two points.

(b) Use your graph in (a) to answer the following questions.

i. How long will it take to unload 8000 L of petrol?

ii. Each small division on the vertical axis represents 200 L of petrol.
(There are 5 divisions for every 1000 L. $\frac{1}{5}$ of 1000 L is 200 L)
How many minutes will it take to unload 6200 L of petrol?

iii. How much petrol will be unloaded after 16 minutes?

CORRECT YOUR WORK. ANSWERS ARE AT THE END OF SUB-STRAND 4

SUB-STRAND 4: SUMMARY

- **Maps** are simply plans, drawings, charts or diagrams of landscapes or areas of land and water on paper.
- **Map Scale is** the ratio of a distance on the map to the corresponding actual distance on the ground.
- There are three ways of showing a map scale: **by writing it in words; as a fraction or as a ratio and by drawing it as a line or a bar scale.**
- **Latitudes** are the lines that run east and west around the earth. Often referred to as **parallels** because each one is a circle that is parallel to the equator.
- **The Equator** is the special line of latitude where every point on it is the same distance from the North Pole and the South Pole. It divides the earth into a **Northern Hemisphere** (area north of the equator) and a **Southern Hemisphere** (area south of the equator).
- Lines north of the equator are labelled **ºN.**
- Lines south of the equator are labelled **ºS**
- **Longitudes** are the lines that run from north to south. Often referred to as the **meridians.** They are not parallels, since they meet at the poles.
- **The Prime meridian** is a special line of longitude. The area west of the prime meridian is called the **Western Hemisphere** and the area east of the prime meridian is called the **Eastern Hemisphere**.
- **The International dateline** is another special meridian labeled 180º and is exactly opposite to the prime meridian on the other side of the world.
- Latitudes and Longitudes are measured in **degrees.**
- Lines west of the prime meridian are labelled **ºW.**
- Lines east of the prime meridian are labelled **ºE.**
- **A Grid** is a pattern of horizontal and vertical lines which are evenly spaced.
- **The Number plane** is a flat surface made up of all the points we can describe using coordinates.
- **Coordinates** are ordered pair of numbers which describe the position of a point on a number plane.
- **The Rectangular coordinate system** also known as the Cartesian Coordinate Plane; is a system used to identify points based on a grid using coordinates.
- **A Straight line graph** is a straight line drawn on the number plane.
- **A Table of values** is a chart that helps you determine two or more points that that can be used to create a graph.

REVISE LESSONS 18 TO 23. THEN DO SUB-STRAND TEST 4 IN ASSIGNMENT 4.

ANSWERS TO PRACTICE EXERCISES 18 – 23

Practice Exercise 18

1. (a)
   - i. 20 m
   - ii. 0.2 km
   - iii. 370 m
   - iv. 130 m
   - v. 0.250 km

   (b)
   - i. 100 mm
   - ii. 50 cm
   - iii. 1 m
   - iv. 0.012 km
   - v. 2.5 m

2. (a) 1:250 000
   (b) 1:5 000 000
   (c) 1: 100
   (d) 1:50 000

3. (a) line or bar scale
   (b) 1 cm on the map represents 100 km
   (c) 1: 10 000 000

Practice Exercise 19

1. (a) 1 cm on the map equals 10 000 000 cm in real life
   (b) $\frac{1}{1000000}$

2. (a) smaller1
   (b) $\frac{1}{3000000}$

3. 100 km

4. (a) 2.75 cm (b) 9.2 cm (c) 12 cm
   (d) 8.5 cm (e) 10.75 cm (f) 5 cm
   (g) 2 cm

5. (a) 870 km (b) 675 km (c) 300 km
   (d) 125 km (e) 1025 km

6. (a) 850 km (b) 550 km (c) 600 km
   (d) 600 km (e) 400 km

7. 1600 km

Practice Exercise 20

1.	(a)	east-west	(b)	Prime Meridian	(c)	Equator
	(d)	Asia, Africa, Australia, Antarctica, Europe North America, South America				
	(e)	Australia and Antarctica				
	(f)	North America and South America				
2.	(a)	+ 34	(b)	-156	(c)	+81
	(d)	-54	(e)	+23	(f)	+93
3.	(a)	Sigatoka				
	(b)	Suva				
	(c)	Wairiki				
	(d)	Nabouwalu				
4.	(a)	17º35‘S, 177º30‘E				
	(b)	17º40‘S, 178º50‘E				
	(c)	17º50‘S, 177º20‘E				
5.	(a)	Mongolia				
	(b)	Iran				
	(c)	China				
	(d)	Afghanistan				
	(e)	40ºN, Uzbekistan				

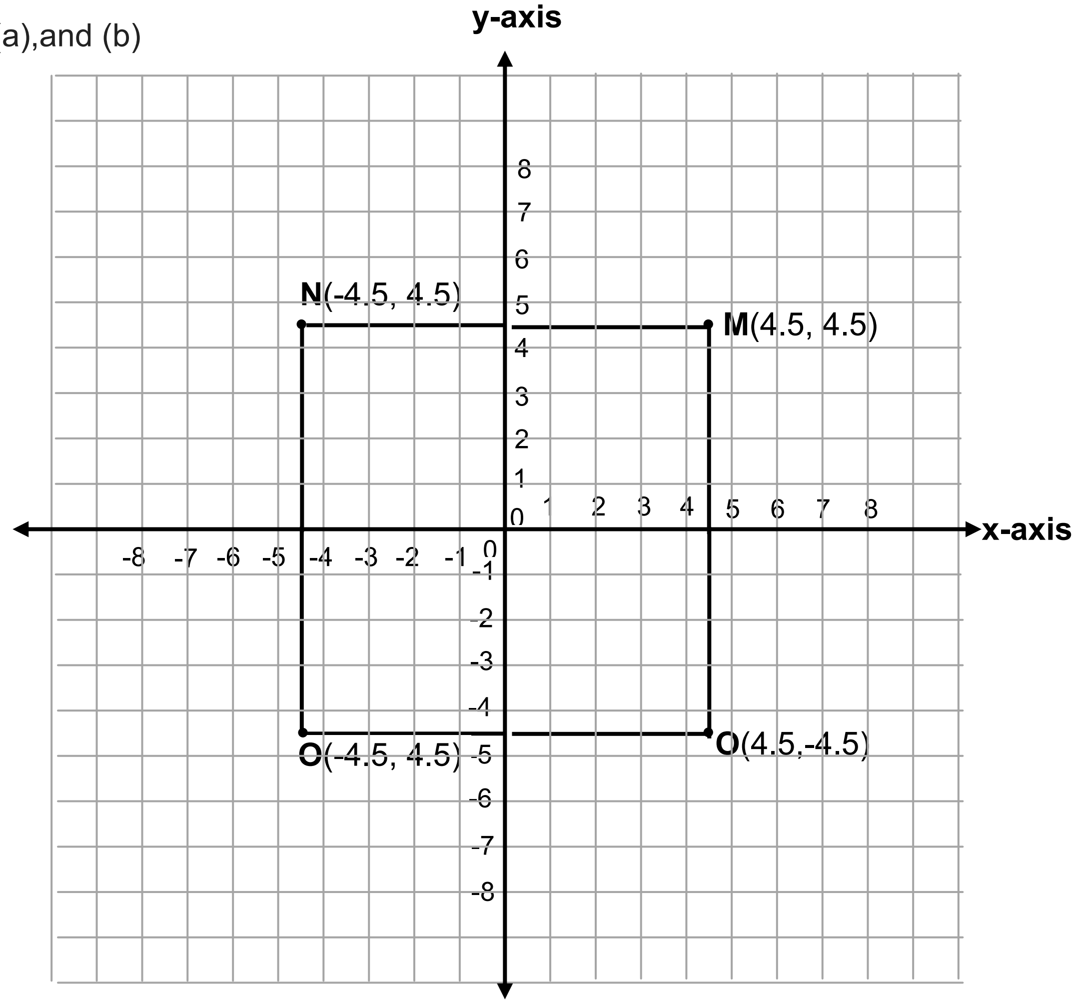
Practice Exercise 21

1.	**T** (2, 5)	**C** (5, 2)	**A** (-3, -3)
	B (-4, 2)	**N** (-2, 53)	**L** (3, 1)
	S (2, -2	**E** (0, - 4)	**I** (-3, 0)

2. **L I S T E N**

3.	(a)	**T**	(b)	**A**	(c)	**E**	(d)	**C**
4.	(a)	**N**	(b)	**A**	(c)	**I**	(d)	**L**

5. (a),and (b)



(c) Square

Practice Exercise 22

1. (a) (7, 3)
   (b) (9, 3)
   (c) (4, 1)
   (d) (7, 7)
   (e) (3, 7)

2. (a) bench
   (b) tennis racket
   (c) ribbon
   (d) bird
   (e) trumpet

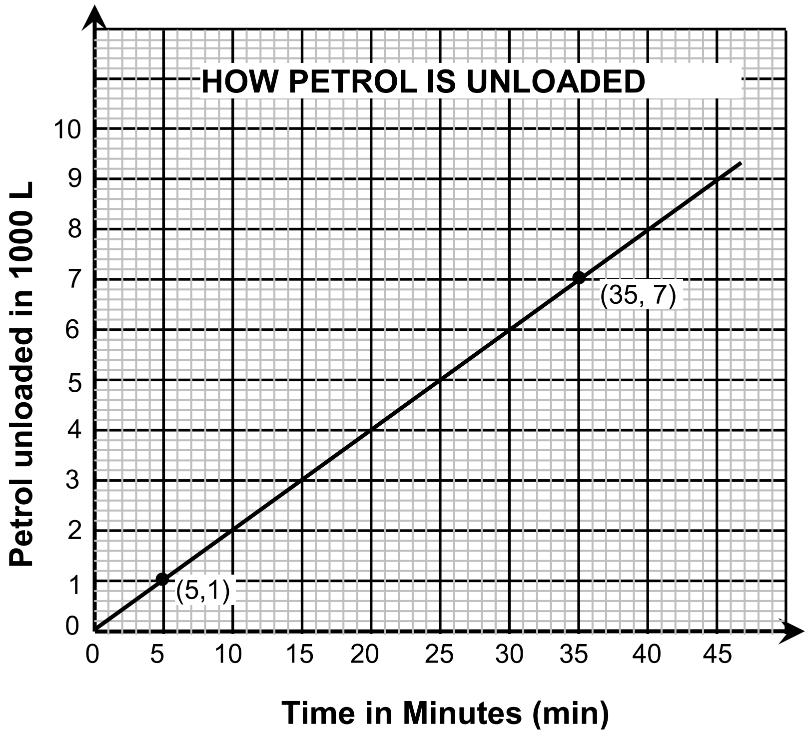
Practice Exercise 23

1. (a) $5\frac{1}{2}$ m (b) 7 paces

2. (a) 6 litres (b) K200

3. (a) 75 km
   (b) It means that if Percy had travelled for zero (0) hours he would have covered zero (0) kilometres.
   (c) 10 km
   (d) 10 minutes

4. (a) The graph is a straight line passing through points (5,1) and (40,8).



   (b) i. 40 minutes
   ii. 31 minutes
   iii. 3200 litres

END OF SUB-STRAND 4

NOW YOU MUST COMPLETE ASSIGNMENT 4.
RETURN IT TO THE PROVINCIAL COORDINATOR.

REFERENCES

- **Outcome Edition for papua new Guinea Mathematics** 8A and 8B
- NDOE(1995)**Secondary Mathematics 8A and 8B**
- FODE **Grade 8 Mathematics Book 5**
- **McGraw Hill; Developmental Mathematics Books 1 and 2** Fourth Edition, by A. Thompson & E. Wrightson; revised by S. Tisdell
- Thomas Nelson Australia; **Nelson Maths 7** by K. Swan, R. Adamson, G. Asp, G, FitzSimons, C. Lovitt and M. Orr
- http//www.google.com/search/en.wikipedia.org/wiki/Temperature
- http//www.engineering toolbox.com
- www.nyu.edu/pages/mathmol/textbook/weightvmass.html
- Stanley Thornes Ltd.; **Mathematics Basic Skills**, Third Edition by S.Llewellyn and A. Greer
- **Geography.**about.com/cs/**latitudelongitude**/a/latlong.htm
- McMillan; **Progress Maths Year 8** by G. Singleton