DEPARTMENT OF EDUCATION

GRADE 9

MATHEMATICS

UNIT 1

MATHEMATICS IN OUR COMMUNITY

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PAPUA NEW GUINEA

GRADE 9

MATHEMATICS

UNIT 1

MATHEMATICS IN OUR COMMUNITY

TOPIC 1: NUMBERS AND OPERATIONS

TOPIC 2: MONEY AND PERCENTAGES

TOPIC 3: RATIO AND RATES

TOPIC 4: MEASUREMENTS

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Mathematics Department- CDAD

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MR. DEMAS TONGOGO
Principal-FODE

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SECRETARY'S MESSAGE

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

This course is part and parcel of the new reformed curriculum – the Outcome Base Education (OBE). Its learning outcomes are student centred and written in terms that allow them to be demonstrated, assessed and measured.

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

This is a provision of 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, Government policies and reports. It is developed in line with the National Education Plan (2005 – 2014) and addresses an increase in the number of school leavers coupled with a limited access to secondary and higher educational institutions.

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

- to facilitate and promote integral development of every individual
- to develop and encourage an education system which 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 education accessible to the physically, mentally and socially handicapped as well as to those who are educationally disadvantaged

The College is enhanced to provide alternative and comparable pathways for students and adults to complete their education, through one system, many path ways and same learning outcomes.

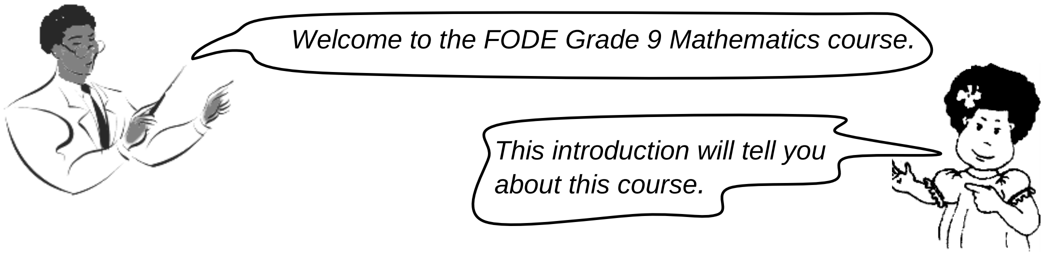
It is our vision that Papua New Guineans harness all appropriate and affordable technologies to pursue this program.

I commend all those teachers, curriculum writers and instructional designers, who have contributed so much in developing this course.

……………………………………

DR. UKE KOMBRA, PhD
Acting Secretary for Education

COURSE INTRODUCTION



HOW TO STUDY YOUR GRADE 9 MATHEMATICS COURSE?

1. YOUR LESSONS

In Grade 9 Mathematics there are 6 books for you to study. Each book corresponds to each of the six strands of the course.

Unit 1: Mathematics in Our Community
Unit 2: Patterns of Change
Unit 3: Working with Data
Unit 4: Graphs and Probabilities
Unit 5: Design in 2D and 3D Geometry: Part 1
Unit 6: Design in 2D and 3D Geometry: Part 2

Each Unit is divided into 4 Topics and each Topic consists of a minimum of 5 to 7 lessons.

Here is a list of the Units in this Grade 9 course and the topics you will study:

UNITS	TOPICS	TITLE
1 MATHEMATICS IN OUR COMMUNITY	1	NUMBERS AND OPERATIONS
	2	MONEY AND PERCENTAGES
	3	RATIO AND RATES
	4	MEASURMENTS
2 PATTERNS OF CHANGE	1	DIRECTED NUMBERS
	2	INDICES
	3	ALGEBRAIC EXPRESSIONS
	4	EQUATIONS
3 WORKING WITH DATA	1	ORGANIZING DIFFERENT TYPES OF DATA
	2	PRESENTATION OF DATA ON GRAPHS
	3	MEASURES OF CENTRAL TENDENCY
	4	MEASURES OF SPREAD
4 GRAPHS AND PROBABILITIES	1	INTERPRETING GRAPHS
	2	LINEAR GRAPHS
	3	PROBABILITIES
	4	STATISTICAL ESTIMATION

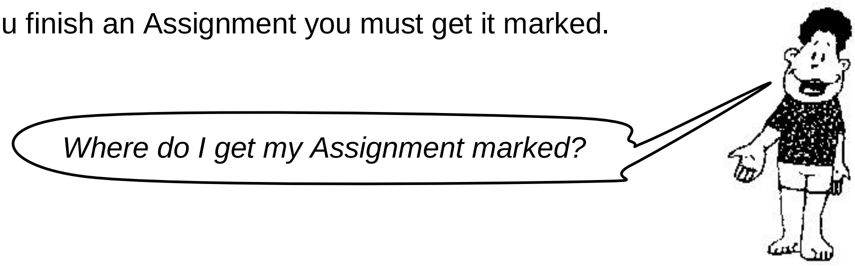
5 DESIGN IN 2D AND 3D GEOMETRY PART 1	1	LINES AND ANGLES
	2	POLYGONS
	3	AREA
	4	SURFACE AREA AND VOLUME
6 DESIGN IN 2D AND 3D GEOMETRY PART 2	1	SYMMETRY
	2	SIMILARITY AND CONGRUENCY
	3	CIRCLES
	4	CONSTRUCTION

2. YOUR ASSIGNMENTS

In this course you will also do six ASSIGNMENTS.

You will study Unit 1 and do Assignment 1 at the same time. Then you will study Unit 2 and do Assignment 2 at the same time, and so on up to Assignment 6.

When you finish an Assignment you must get it marked.

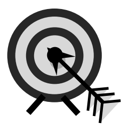


1. **Students in a Registered Study Centre** must give their finished Assignments to their Supervisor for marking.
2. **Students who study at Home by themselves but who live in the Provinces** must send their finished Assignment books to their Provincial Centres for marking.

3. LESSON ICONS

Below are the icons used by FODE in its courses.


Lesson Introduction


Aims


Summary


Activities/Practice Exercises

UNIT 1: MATHEMATICS IN OUR COMMUNITY

Introduction

Dear Student,

This is the **first Unit** of the **Grade 9 Mathematics Course**. You will study it by following the steps suggested in the **Study Guide** on the next page. This Unit is based on the NDOE Lower Secondary Mathematics Syllabus. You will study at Home what students in High Schools study at school.

The four Topics in this Unit are:

Topic 1: Number and Operations
Topic 2: Money and Percentages
Topic 3: Ratios and Rates
Topic 4: Measurements

In Topic 1-**Number and Application**- You will consider revising basic facts on whole numbers. Perform the fundamental operations (addition, subtraction, multiplication and division) with whole numbers, fractions and decimals with more speed and accuracy. You will also learn to estimate and round off numbers. It is assumed that you are familiar with the computations which are revised only briefly here. Our emphasis will be on how the operations are related to each other, as well as their applications to real world situations.

In Topic 2-**Money and Percentages**- You will extend further your knowledge of converting fractions to decimals, decimals to fractions, fractions to percentages, decimals to percentages or vice versa. You will also learn to calculate the value of an increase or decrease of a quantity using percentages. Further you will apply percentages in dealing with problems involving money such as taxes, commission, profit and loss, and budgeting in real life situations.

In Topic 3-**Ratios and Rates**- You will revise the meaning of ratio and rates. You will learn what direct and inverse proportions are as well as the methods used to solve direct and inverse proportion problems like the unitary and ratio methods. You will learn also how to estimate rates and interpret rate graphs and table. Lastly, you will learn about conversion graphs.

In Topic 4-**Measurements**- You will revise the metric units of measures for length, weight, area, volume and capacity. You will also extend further your knowledge and skills in the conversion of each unit to another in calculating and solving problems involving length, weight, area, and capacity and volume problems.

All lessons in this unit are written in simple language and many worked examples are given to help you.

We hope you enjoy using this unit.

Mathematics Department
FODE

STUDY GUIDE

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

Step 1: Start with TOPIC 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 TOPIC 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 Lesson, on the Contents Page (page 3) like this:

[√] Lesson 1: Directed numbers in Practical Situations

Then go on to the next Lesson. Repeat the same process until you complete all of the lessons in Topic 1.

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

Step 6: Revise the Topic using Topic 1 Summary, then, do Topic test 1 in Assignment 2.

Then go on to the next Topic. Repeat the same process until you complete all of the four Topics in Unit 2.

Assignment: (Four Topics and a Unit Test)
When you have revised each Topic using the Topic Summary, do the Topic Test in your Assignment. The Unit book tells you when to do each Topic 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 Topic Tests and the Unit 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 consecutive Assignments, you will not be allowed to continue. So, work carefully and make sure that you pass all of the Assignments.

TOPIC 1

NUMBERS AND OPERATIONS

TOPIC 1: NUMBERS AND OPERATIONS

Introduction

In many situations, we have to work out number problems correctly. It is good to work them out quickly too. All students need this ability. For students of Mathematics, this need is even greater.

Look at these situations which we all face in day-to-day life:

At home…

How much of these ingredients will be used to bake a cake?

At the market…

Is cash on hand enough to buy a kilogram of meat?

At work…

Does cash on hand agree with the receipts?

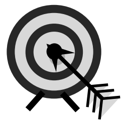
In business…

Is my balance correct?

In this topic, you will revise basic number facts, practice whole number, fractions and decimal operations and learn to work out problems involving number estimation and rounding off.

Lesson 1: Whole Numbers

Earlier in your study of Mathematics, you have learned something about numbers and operations.



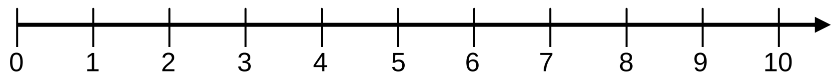
In this lesson, you will:

- define and identify whole numbers
- write whole numbers in order of size
- perform operations with whole numbers.

What are whole numbers?

Whole numbers are basically any number that is not followed by decimal or any fractional parts.

Whole Numbers are simply the numbers 0, 1, 2, 3, 4, 5, and so on. They can be shown on a number line.



No Fractions and Decimals!

The first 100 whole numbers are:

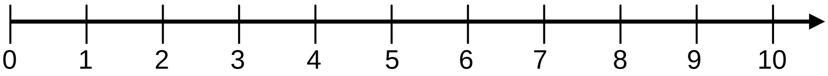
0	1	2	3	4	5	6	7	8	9	10	
11	12	13	14	15	16	17	18	19	20	21	
22	23	24	25	26	27	28	29	30	31	32	
33	34	35	36	37	38	39	40	41	42	43	
44	45	46	47	48	49	50	51	52	53	54	
55	56	57	58	59	60	61	62	63	64	65	
66	67	68	69	70	71	72	73	74	75	76	
77	78	79	80	81	82	83	84	85	86	87	
88	89	90	91	92	93	94	95	96	97	98	99

More about Whole Numbers

- Whole numbers are neither fractions nor decimals.
- Whole numbers are non-negative integers.

Next you will see how these whole numbers should be presented in order of size, from the smallest to the largest or vice versa.

To present whole numbers in order of size, first we need to compare the values of numbers using the number line.



From the number line shown you can see that the numbers to the **right are greater** in value and the numbers to the **left are lesser** in value of a chosen number.

Example 1: If we choose the number 5, all the numbers to the right of 5 are greater than 5 and all the numbers to the left of 5 are less than 5.

Take note that, the further the numbers are to the right of a chosen number the greater their values are to that number. Likewise, the further the numbers are to the left of a chosen number the lesser their values are to that number.

Now we can arrange the numbers in order of size from the smallest to the largest and vice versa.

When arranging numbers from the *smallest number to the largest number*, the numbers are arranged in an **ascending orde**r.

For example, 81, 97, 123, 137 and 201 are arranged in ascending order.

When arranging numbers from the *largest number to the smallest number*, the numbers are arranged in an **descending orde**r.

For example, 187, 121, 117, 103 and 99 are arranged in descending order.

Ascending order means arranging numbers from the smallest number to the largest number.

Examples on arranging numbers in ascending order (Lowest to highest or smallest to largest).

Example 1 Write the following numbers in ascending order:

42 734, 5358, 42 876, 52 287

Solution:

Count the digits in each number.

5358 is the smallest number as it has only 4 digits

Line up the number accordingly to place value.

Begin comparing from the left.

5358 ← smallest number

42**7**34

42**8**76

$7 < 8$

52287 ← largest number

The ascending order is 5358; 42734; 42876; 52287

Example 2

Arrange the following numbers in ascending order:

3679; 3542; 3797; 3545

Solution:

The digit in the thousands place in each number is 3.

On comparing the hundreds place; 3**6**79; 3**5**42; 3**7**97; 3**5**45

We find: 3797 to be the greatest and 3679 is the next.

On comparing the tens place in the two remaining numbers we find both numbers to be the same. 35**4**2; 35**4**5

On comparing the ones place, we find 3545 > 3542

So, the ascending order is 3542, 3545, 3679, 3797

Now look at the example on arranging numbers in descending (largest to smallest) order.

Descending order means arranging numbers from the largest number to the smallest number.

Example 3

Write in descending order:

32 593; 60 537; 28 524; 57 198

Since 60 537 > 57 198 > 32 593 > 28 524

Therefore, the descending order is 60 537, 57 198, 32 593, 28 524.

Next in this section we will work on the four basic operations with whole numbers. These are addition, subtraction, multiplication and division. It is assumed that you are familiar with basic operations, so they are reviewed only briefly here. Our emphasis will be on how the operations are related to each other, as well as their application to real-world situations.

Adding and Subtracting Whole Numbers

Addition represents the idea of finding a total count, or summing up of values. Since we use only ten digits in our system (remember base 10), it is often necessary to use place value to "carry" digits.

Unless you are using a calculator, it is easier to organize this problem vertically using the Place-value table:

To add or subtract whole numbers, add or subtract the digits in each place-value position. <u>Start at the ones place</u>.

Example 1 Find each sum or difference.

(a) 125 + 203

(b) 587 - 162

Solution:

(a)

$$\begin{array}{r} 125 \\ +\,203 \\ \hline 328 \end{array}$$

Line up the digits at the ones place

Add the ones.

Add the tens.

Add the hundreds.

(b)

$$\begin{array}{r} 587 \\ -\,162 \\ \hline 425 \end{array}$$

Line up the digits at the ones place.

Subtract the ones.

Subtract the tens.

Subtract the hundreds.

You may need to regroup when adding and subtracting whole numbers. Look at the next example.

Example 2 Find each sum or difference.

(a) 387 + 98

(b) 612 – 59

Solution:

(a)

$$\begin{array}{r} {\scriptstyle 11} \\ 387 \\ +\;\;98 \\ \hline 485 \end{array}$$

Line up the digits at the ones place.

Add the ones. Put the 5 in the ones and place the1 above the tens place.

Add the tens. Put the 8 in the tens place and the 1 above the hundreds place.

Add the hundreds.

(b)

$$\begin{array}{r} {\scriptstyle 5\ 10\ 12} \\ 612 \\ -\;59 \\ \hline 553 \end{array}$$

Line up the digits at the ones place.

Since 9 is larger than 2, rename 2 as 12. Rename The 1 in the tens place as 10 and the 6 in the hundreds place as 5. Then subtract.

Now let us do multiplication and division of whole numbers.

To multiply a whole number by a 1-digit whole number, multiply from right to left, regrouping as necessary. When you multiply by a number with two or more digits, write individual products and then add.

Example 3: 76 × 8

Solution:

$$\begin{array}{r} {\scriptstyle 4} \\ 76 \\ \times\,8 \\ \hline 608 \end{array}$$

8 × 6 = 48. Put the 8 in the ones place. Put the 4 above the tens place.

8 x 70 = 560 and 560 + 40 = 600

Example 5: 535 × 24

Solution:

$$\begin{array}{r} 535 \\ \times\,24 \\ \hline 2140 \\ +\;10700 \\ \hline 12{,}840 \end{array}$$

Multiply. 535 × 4 = 2,140

Multiply. 535 × 20 = 10,700

Add. 2,140 + 10,700 = 12,840

Dividing Whole Numbers

When dividing whole numbers; divide in each place-value position from left to right.

Recall that in the statement 50 ÷ 2 = 25, 50 is the **dividend**,
2 is the **divisor**, and 25 is the **quotient**.

Example 6: 342 ÷ 9

Solution:

```
   38
9 |342     Divide in each place-value position from left to right.
 - 27
    72
   -72     Since 72 – 72 = 0, there is no remainder.
     0
```

Example 7: 6 493 ÷ 78

Solution:

```
    83R19
78 |6493   Divide in each place-value position from left to right.
   -624
     253
    -234
      19   Since 253 – 234 = 19, the remainder is 19.
```

NOW DO PRACTICE EXERCISE 1

Practice Exercise 1

1. Arrange the following numbers in an ascending order:

   (a) 5, 0, 22, 7, 10

   (b) 89, 98, 101, 110, 99.

   (c) 2345, 2675, 2354, 2711, 2524

---

2. Arrange the following numbers in descending order:

   (a) 999, 250, 55,775, 575

   (b) 100, 106, 68, 2, 15

   (c) 44, 14, 999, 1, 36

---

3. Write True or False for each of these statements:

   (a) -2, -1, 0 and 1 are all whole numbers

   (b) $\frac{1}{3}$, $\frac{5}{8}$, 0.25 are also called whole numbers

   (c) 10, 20, 30, 40 are whole numbers.

4. Find the sum of:

(a) 29 + 121 + 19 + 4 =

(b) 1000 + 675 + 220 =

---

5. Find the difference of:

(a) 355 – 119 =

(b) 10 294 – 9294 =

---

6. Find the product of:

(a) 25 x 7 =

(b) 87 x 32 =

---

7. Find the quotient of:

(a) 2354 ÷ 8 =

(b) 5568 ÷ 16 =

---

8. If an egg tray contains 12 eggs, how many trays can be filled with 600 eggs?

---

9. There are six grade 9 classes at Gordon Secondary School. If each class has 45 students, how many grade 9 students are there altogether?

CORRECT YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 1.

Lesson 2: Fractions

You have learned about whole numbers in the last lesson. You have also learnt to work out problems using the four fundamental operations on whole numbers.

In this lesson you will:

- revise the different types of fractions
- arrange fractions in order of size
- compare fractions.

We learnt earlier that when an object is **divided** into a number of **equal** parts, then each part is called a **fraction**.

There are different ways of writing fractions. For example, two fifths of an object can be written as:

- Common fraction $\frac{2}{5}$
- Decimal 0.4
- Percentage 40%

We will learn about decimals and percentages later.

Now let us have a closer look at the common fractions.

2 ⟵ **Numerator** says how many parts in the fraction

5 ⟵ **Denominator** says how many equal parts in the whole object

There are four types of fractions:

1. Unit fractions are fractions whose numerator is always one.

   For example: $\frac{1}{2}, \frac{1}{3}, \frac{1}{4}, \frac{1}{7}$ and so on.

2. Proper fractions are fractions whose numerator is less than the denominator. They are amounts less than a whole.

   For example: $\frac{2}{5}, \frac{11}{33}, \frac{7}{8}, \frac{5}{7}$ and $\frac{9}{13}$.

3. Improper fractions are fractions whose numerator is greater or equal to the denominator. They are amounts more than a whole.

   For example: $\frac{5}{2}, \frac{11}{8}, \frac{7}{4}, \frac{7}{7}$ and $\frac{17}{10}$

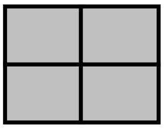
4. Mixed Fractions are fractions that have a whole number and a proper fraction.

   For example: $3\frac{1}{2}$, $2\frac{7}{10}$ and $12\frac{2}{5}$,

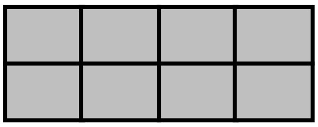
Improper Fractions can be written as mixed numbers, consisting of a whole number and a proper fraction.

$\frac{4}{4}$ and $\frac{3}{4}$ = $1\frac{3}{4}$

Fractions which have equal numerator and denominator represent <u>one whole</u>.



$\frac{4}{4} = 1$



$\frac{8}{8} = 1$

Next, you will discover how to arrange fractions in descending and ascending orders.

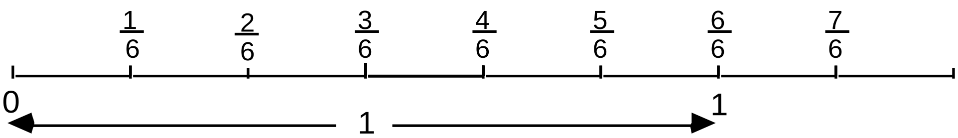
Comparing Fractions

Sometimes we need to compare two fractions to discover which is larger or smaller.

A number line helps us to do this and so we shall first revise a number line for fractions.

Fractions on a number line:

Look at the number line shown below:



If two fractions have the **same denominator** then they are easy to compare:

Example 1: $\frac{4}{9}$ is less than $\frac{5}{9}$ (because 4 is less than 5)

But if the denominators are not the same you need to **make them the same** (using <u>Equivalent Fractions</u>).

Example: Which is larger: $\frac{3}{8}$ or $\frac{5}{12}$?

If you multiply 8 × 3 you get 24 , and if you multiply 12 × 2 you also get 24, so let's try that (*important: what you do to the bottom, you must also do to the top*):

x 3 x 2

$\frac{3}{8} = \frac{9}{24}$ and $\frac{5}{12} = \frac{10}{24}$

x 3 x 2

It is now easy to see that $\frac{9}{24}$ is smaller than $\frac{10}{24}$, (because 9 is smaller than 10).

So $\frac{5}{12}$ is the larger fraction.

If we use the symbols for **greater than (>) and less than (<)**, this can be shown as: $\frac{5}{12} > \frac{3}{8}$. This can also be written as $\frac{3}{8} < \frac{5}{12}$ meaning that $\frac{3}{8}$ is smaller than $\frac{5}{12}$.

Now you will learn how to make the denominators the same. The trick is to find the **Least Common Multiple** of the two denominators.

In the previous example, the Least Common Multiple of 8 and 12 was 24.

Then it is just a matter of changing each fraction to make it's denominator the Least Common Multiple(LCM).

Example 2: Which is larger: $\frac{5}{6}$ or $\frac{13}{15}$?

The Least Common Multiple of 6 and 15 is **30**. So, let's do some multiplying to make each denominator equal to 30:

x 5 x 2

$\frac{5}{6} = \frac{25}{30}$ and $\frac{13}{15} = \frac{26}{30}$

x 5 x 2

Now we can easily see that $\frac{26}{30}$ is the larger fraction. So $\frac{13}{15}$ is the larger fraction.

This can be shown as $\frac{13}{15} > \frac{5}{6}$ which can also be written as $\frac{5}{6} < \frac{13}{15}$ meaning $\frac{5}{6}$ is smaller than $\frac{13}{15}$.

Therefore, you can use this rule to help you decide which fraction is larger or smaller when comparing two or more fractions;

To compare fractions, change to equivalent fractions with the same denominator and then compare the numerators.

Example 3: Arrange the following fractions in ascending order:

$$\frac{5}{6}, \frac{2}{3}, \frac{3}{4}.$$

Solution:

The LCM of 6, 3,and 4 is 12. So change to fractions with denominator of 12.

So, $\frac{5}{6} \times \frac{2}{2} = \frac{10}{12}$ $\frac{2}{3} \times \frac{4}{4} = \frac{8}{12}$ $\frac{3}{4} \times \frac{3}{3} = \frac{9}{12}$

Now that the denominators are the same, compare the numerators; $\frac{10}{12}, \frac{8}{12}, \frac{9}{12}$

Therefore, the largest of the three fractions given is $\frac{10}{12}$ and the smallest is $\frac{8}{12}$.

Arranging them in descending order will be; $\frac{10}{12}, \frac{9}{12}, \frac{8}{12}$

And to arrange them in ascending order will be; $\frac{8}{12}, \frac{9}{12}, \frac{10}{12}$

Therefore, $\frac{5}{6}, \frac{2}{3}, \frac{3}{4}$ in ascending order is $\mathbf{\frac{5}{6}, \frac{3}{4}, \frac{2}{3}}$.

Here are some more examples.

Example 4 Which is bigger, $\frac{1}{3}$ or $\frac{4}{9}$?

Solution:

Change to equivalent fractions with the same denominator.

L.C.M of 3 and 9 is 9

So, same denominator should be **9.**

$$\frac{1}{3} = \frac{3}{9}$$

So, we compare $\frac{3}{9}$ and $\frac{4}{9}$.

Numerator (4) of $\frac{4}{9}$ is greater than numerator (3) of $\frac{3}{9}$.

Hence, $\frac{4}{9}$ is greater than $\frac{3}{9}$.

Therefore, $\mathbf{\frac{4}{9}}$ is bigger than $\mathbf{\frac{1}{3}}$.

Example 5 Which is bigger, $\frac{1}{4}$ or $\frac{2}{7}$?

Solution:

LCM of 4 and 7 is 28

$\frac{1}{4} = \frac{7}{28}$ and $\frac{2}{7} = \frac{8}{28}$

$\frac{8}{28}$ is greater than $\frac{7}{28}$

$\frac{2}{7}$ is greater than $\frac{1}{4}$

Therefore, $\frac{2}{7}$ is bigger.

Example 6 State true or false: $\frac{3}{7} > \frac{2}{5}$

Solution: LCM of 7 and 5 is 35

$\frac{3}{7} = \frac{15}{35}$ and $\frac{2}{5} = \frac{14}{35}$

$\frac{15}{35} > \frac{14}{35}$

Therefore, $\frac{3}{7} > \frac{2}{5}$ is true

Example 7 Arrange in descending order: $\frac{2}{5}$, $\frac{5}{12}$, $\frac{7}{15}$

Solution: LCM of denominators 5, 12 and 15 = 60.

So, change to fractions with denominators **60.**

$\frac{2}{5} = \frac{24}{60}$, $\frac{5}{12} = \frac{25}{60}$, $\frac{7}{15} = \frac{28}{60}$.

Now compare $\frac{24}{60}$, $\frac{28}{60}$, $\frac{28}{60}$

From biggest to smallest**:** $\frac{28}{60}$, $\frac{28}{60}$, $\frac{24}{60}$

Therefore, the descending order is $\frac{7}{15}$, $\frac{5}{12}$, $\frac{2}{5}$.

NOW DO PRACTICE EXERCISE 2

Practice Exercise 2

1. Change $\frac{17}{15}$ to a mixed number.

2. Change $3\frac{3}{8}$ to an improper fraction.

3. Compare the following fractions in the table. Write <, >, or = in the circles for each question.

a) $\frac{10}{14}$ ○ $\frac{15}{21}$	b) $1\frac{1}{2}$ ○ $\frac{11}{10}$	c) $\frac{5}{8}$ ○ $\frac{7}{16}$
d) $\frac{3}{5}$ ○ $\frac{9}{15}$	e) $\frac{3}{5}$ ○ $\frac{16}{25}$	f) $2\frac{2}{3}$ ○ $\frac{16}{9}$

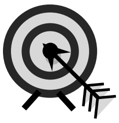
4. Arrange these fractions in an ascending order: $\frac{2}{5}, \frac{5}{12}, \frac{7}{15}, \frac{1}{3}$

5. Arrange these fractions in descending order: $\frac{1}{4}, \frac{1}{6}, \frac{2}{9}, \frac{1}{3}$

CORRECT YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 1.

Lesson 3: Operations Involving Fractions.

You have revised the different types of fractions in the last lesson. You also compared and arranged fractions in order of size.



In this lesson you will:

- add, subtract, multiply and divide fractions and mixed numbers correctly
- apply the concepts to real life situations.

In your earlier study of fractions, you learnt that fractions and mixed numbers can be easily added and subtracted when they have the same denominator. That is, the fractions must be similar.

Example 1

Add: $\frac{1}{6} + \frac{4}{6}$ ← These fractions have the same denominators. It is 6.

Solution: $\frac{1}{6} + \frac{4}{6} = \frac{1+4}{6}$ ← Add the numerators.

$= \frac{5}{6}$ **Answer**

Example 2

Subtract: $\frac{12}{13} - \frac{7}{13}$ ← These fractions have the same denominators. It is 13.

Solution: $\frac{12}{13} - \frac{7}{13} = \frac{12-7}{13}$ ← Subtract the numerators.

$= \frac{5}{13}$ **Answer**

Example 3

Add: $2\frac{2}{9} + 4\frac{6}{9}$

Solution: $2\frac{2}{9} + 4\frac{6}{9} = \frac{20}{9} + \frac{42}{9}$ Change mixed numbers to fractions.

$= \frac{20+42}{9}$ Add the numerators.

$= \frac{62}{9}$ Change to mixed numbers.

$= 6\frac{8}{9}$ **Answer**

To add or subtract fractions and mixed numbers with different denominators, follow the steps given below:

Step1. Find the Lowest common denominator/multiple (LCD or LCM)

Step2. Change the given fractions to equivalent fractions with the same denominators

Step3. Add or subtract the numerators and keep the denominator

Step4. If the answer is an improper fraction simplify to a mixed number or a reduced fraction.

Example 3: $\frac{2}{3} + \frac{4}{5} = \square$

Solution: LCD of 3 and 5 is 15

$\frac{2}{3} \times \frac{5}{5} = \frac{10}{15}$ and $\frac{4}{5} \times \frac{3}{3} = \frac{12}{15}$ change to equivalent fractions

So, $\frac{2}{3} + \frac{4}{5} = \frac{10}{15} + \frac{12}{15} = \frac{10+12}{15} = \frac{22}{15}$ add the numerators

Since $\frac{22}{15}$ is an improper fraction change it to a mixed number.

$\frac{22}{15} = 1\frac{7}{15}$

Therefore, $1\frac{7}{15}$ is the simplified final answer.

Example 4: $\frac{7}{8} - \frac{2}{5} = ?$

Solution: LCM of 8 and 5 is 40

$\frac{7}{8} \times \frac{5}{5} = \frac{35}{40}$ and $\frac{2}{5} \times \frac{8}{8} = \frac{16}{40}$ change to equivalent fractions

$\frac{35}{40} - \frac{16}{40} = \frac{35-16}{40} = \frac{19}{40}$ subtract the numerators

Therefore, $\frac{7}{8} - \frac{2}{5} = \frac{19}{40}$ simplified form

To add or subtract mixed numbers, first change the mixed numbers to improper fractions and then follow the steps as shown for proper fractions.

Example 5: $1\frac{1}{2} + \frac{1}{3} - 1\frac{2}{4} = ?$

Solution: First, change mixed numbers to Improper fractions

$1\frac{1}{2} + \frac{1}{3} - 1\frac{2}{4} = \frac{3}{2} + \frac{1}{3} - \frac{6}{4}$

LCM of 2, 3 and 4 is 12. Change the fractions to equivalent fractions.

$\frac{3}{2} \times \frac{6}{6} = \frac{18}{12}$; $\frac{1}{3} \times \frac{4}{4} = \frac{4}{12}$; $\frac{6}{4} \times \frac{3}{3} = \frac{18}{12}$

So, $\frac{18}{12} + \frac{4}{12} - \frac{18}{12} = \frac{18 + 4 - 18}{12} = \frac{4}{12}$

$\frac{4}{12}$ can be reduced into its simplest form by dividing the fraction by 4.

Hence, $\frac{4}{12} = \mathbf{\frac{1}{3}}$

Therefore $\mathbf{\frac{1}{3}}$ is the final answer.

Now let us look at multiplication and division of fractions and mixed numbers.

Firstly, let us look at multiplying fractions and mixed numbers.

To multiply fractions, multiply the numerators and denominators. Simplify final answers where possible.

Example 6: $\frac{3}{7} \times \frac{4}{9} = ?$

Solution: $\frac{3}{7} \times \frac{4}{9} = \frac{12}{63}$

To multiply mixed numbers, first change them to improper fractions and follow the same steps for fractions.

Example 7: $4\frac{1}{5} \times 1\frac{3}{7} = ?$

Solution:

$4\frac{1}{5} \times 1\frac{3}{7} = \frac{21}{5} \times \frac{10}{7}$ Change to improper fractions

$= \frac{21 \times 10}{5 \times 7}$ Multiply numerators and denominators

$= \frac{210}{35}$ (÷by35) to simplify fractions

= 6 whole **Answer**

.

Now let us look at dividing fractions and mixed numbers.

Dividing by fractions is just like multiplying fractions, except for one additional step.

To divide fractions:
Step 1: Find the reciprocal of the divisor fraction.
Step 2: Multiply the number by the reciprocal of the divisor fraction.
Step 3: Simplify the resulting fraction if possible.
Step 4: Check your answer: Multiply the result you got by the divisor and be sure it equals the original dividend.

Note that you can only divide by non-zero fractions.

What is a reciprocal?

A **reciprocal** is another fraction with the numerator and denominator reversed or the multiplicative inverse of a number.

For example, the number 8, its reciprocal is $\frac{1}{8}$.

When you multiply a number by its "multiplicative inverse" you get 1.

Example, $8 \times \frac{1}{8} = 1$

To find the **reciprocal** of a **fraction**, flip it over or turn it upside down so that the numerator becomes the denominator and the denominator becomes the numerator.

Other examples of reciprocals:

- The reciprocal of $\frac{1}{4}$ is 4 or $\frac{4}{1}$
- The reciprocal of $\frac{7}{8}$ is $\frac{8}{7}$

Knowing what reciprocal is, we can now work on examples of dividing fractions.

Example 1: $3 \div \frac{1}{4} = 3 \times 4 = 12$ multiply by the reciprocal of $\frac{1}{4}$ which is 4.

Example 2: $3 \div \frac{3}{4} = 3 \times \frac{4}{3}$ multiply by the reciprocal of $\frac{3}{4}$ which is $\frac{4}{3}$.

$= \frac{3 \times 4}{3}$

$= \frac{12}{3}$

$= 4$ **Answer**

Example 3: $\frac{1}{2} \div \frac{1}{8} = \frac{1}{2} \times \frac{8}{1}$

$= \frac{8}{2}$

$=$ 4 whole **Answer**

To divide by a mixed number, firstly change to improper fraction and then follow the rules on dividing and multiplying fractions.

Example 4: Simplify $2\frac{2}{3} \div 1\frac{1}{6}$.

Solution:

$2\frac{2}{3} \div 1\frac{1}{6} = \frac{8}{3} \div \frac{7}{6}$ change to improper fractions

$= \frac{8}{3} \times \frac{6}{7}$ multiply by the reciprocal

$= \frac{8 \times 6}{3 \times 7}$ multiply numerators and denominators

$= \frac{48}{21}$ simplify fractions

$= 2\frac{6}{21}$ Answer

Let us now try to solve a real life problem involving operations on fractions.

Example 1: Anne spends $\frac{1}{2}$ of her pocket money on books, $\frac{1}{3}$ of it on entertainment and saves the balance.

What fraction of her pocket money does she save?

Solution:

Spends: $\frac{1}{2} + \frac{1}{3}$

$= \frac{3}{6} + \frac{2}{6}$

$= \frac{5}{6}$ *of the pocket money*

Savings is $1 - \frac{5}{6}$

$= \frac{6}{6} - \frac{5}{6}$

$= \frac{1}{6}$ *of the pocket money*

Answer = $\mathbf{\frac{1}{6}}$

Example 2 Anna is a shop assistant and is paid K2 per hour on normal working days. On Saturdays, she is paid $1\frac{1}{2}$ times the normal rate as overtime rate.

(a) What is the overtime rate, in kina per hour?

(b) How much does she earn in $3\frac{1}{2}$ hours on a Saturday?

Solution:

(a) Normal rate = K2.00

Overtime rate = K2.00 x $1\frac{1}{2}$ ⟵ change to improper fraction

$= 2 \times \frac{3}{2}$

$= \frac{6}{2}$

$= 3$

Therefore, overtime rate is K3.00 per hour. **Answer**

(b) Saturday rate = K3.00 per hour

For $3\frac{1}{2}$ hours $= 3 \times 3\frac{1}{2}$

$= 3 \times \frac{7}{2}$

$= \frac{21}{2}$

$= 10\frac{1}{2}$ or 10.5, that is K10.50. **Answer**

NOW DO PRACTICE EXERCISE 3

Practice Exercise 3

1. Add these fractions and write your answer as simple as possible.

(a) $\frac{5}{6} + \frac{1}{6}$

(b) $\frac{7}{8} + \frac{2}{3}$

(c) $3\frac{1}{4} + 2\frac{3}{5}$

(d) $\frac{3}{4} + \frac{1}{2} + \frac{3}{8}$

---

2. Andrew eats $\frac{1}{2}$ of a cupcake on Monday, $\frac{2}{6}$ of another cupcake on Tuesday and 1 whole one on Wednesday. How much cake did he eat altogether for the three days?

---

3. Subtract these fractions and write your answers as simply as possible.

(a) $\frac{20}{21} - \frac{3}{7}$

(b) $2\frac{7}{9} - 1\frac{1}{5}$

(c) $7 - 4\frac{1}{6}$

4. Rose has $1\frac{1}{4}$ kilograms of flour. She gives $\frac{2}{3}$ of a kilogram to Karen. How much does she have left?

---

5. Simplify the following:

(a) $\frac{3}{7} \times \frac{5}{12} =$

(b) $2\frac{3}{4} \times \frac{5}{7} =$

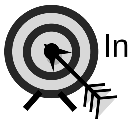
(c) $4\frac{1}{2} \div 2\frac{1}{4} =$

(d) $3\frac{1}{4} \div 1\frac{5}{8} =$

CORRECT YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 1.

Lesson 4: Decimals

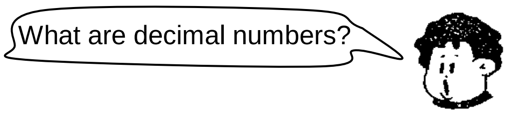
You have extended further your knowledge of fractions and their operations in the previous lessons.



In this lesson, you will:

- define decimals
- determine place values
- arrange decimals in order of size
- compare decimals.

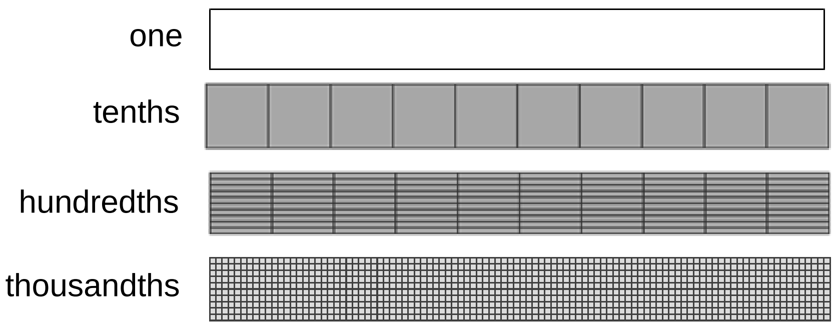
You will find examples of decimal numbers in use all around you. For example, the mobile phone you want costs K1459.95. You need a study table, 0.575 metres to fit between your bed and your wardrobe. You need to feel comfortable working with decimal numbers in your day-to-day life.



Decimal numbers are numbers written with a decimal point.

A decimal number usually includes a part, or fraction of a whole unit. They occur when a unit is divided into ten parts (tenths), hundred parts (hundredths), or one thousand parts (thousandths) or any power of ten parts.

Examples



To understand **decimal** numbers you must first know about Place Value. When we write numbers, the position (or "place") of each number is important.

Hundreds	tens	Ones	tenths	hundredths	thousandths
100's	10's	1's	$\frac{1}{10}$	$\frac{1}{100}$	$\frac{1}{1000}$

← Whole numbers → • ← Decimal parts →

The decimal point separates the whole numbers from the decimal numbers or decimal parts. Zeros fill places in which there are no digits. If there is no whole number, we write a zero to the left of the decimal point.

Example 0.605 is the proper way to write it and not .605

Decimal notation is just a shorthand way of expressing certain fractions, namely those fractions with denominators that are powers of 10. For example, consider these numbers;

0.4 the first figure after the decimal point shows 4 tenths or $\frac{4}{10}$

0.04 the second figure after the decimal point shows 4 hundredths or $\frac{4}{100}$

0.004 the third figure after the decimal point shows 4 thousandths or $\frac{4}{1000}$

Now, consider the number 2.345

Because of the place-values of the decimal digits, 2.345 really means

$2 + \frac{3}{10} + \frac{4}{100} + \frac{5}{1000}$ or 2 ones, 3 tenths, 4 hundredths and 5 thousandths

This should be read as 'two point three four five' and <u>not</u> two point three hundred and forty five.

Other examples; $46.7 = 40 + 6 + \frac{7}{10}$ and read as 'forty six point seven'

$0.605 = \frac{6}{10} + \frac{0}{100} + \frac{5}{1000}$ and read as 'zero point six zero five'

The digits in the decimal part are read one by one.

Next, we will look at arranging decimals in order of size.

The following steps will help us to compare decimal numbers.

STEP 1 Obtain the decimal numbers.

STEP 2 Compare the whole parts of the numbers. The whole number part with the greater number will be greater. If the whole number parts are equal, then go to next step.

STEP 3 Compare the last left digits of the decimal parts of the two numbers. The number with the greater left digit will be greater. If the left digits of decimal parts are equal, then compare the next digits and so on.

Note: Now we will follow the steps and try to solve the various types of questions on comparing decimals. While comparing the two decimal numbers, convert each of the decimal numbers into the same decimals and then solve.

There are three different types of questions on comparing decimals:

A. First compare the whole number part of the decimal number. Decimals with the greater whole number are greater.

Example1

Compare 23.14 and 8.67

Solution:

In 23.14 the whole number part is **23** and in 8.67 the whole number part is **8**.

But 23 > 8.**Therefore, 23.14 > 8.67**

B. If the whole number part is the same, then compare the digit at the tenths place. The decimal with the greater tenths digit is greater.

Example 2

Compare 53.47 and 53.81.

Solution:

In 53.47 and 53.81, the whole number part is the same, i.e., 53.

In 53.47, the decimal part is .47 and the digit in the tenths place is **4**.

In 53.81, the decimal part is .81 and the digit in the tenths place is **8**.

But 8 > 4

Therefore, 53.81 > 53.47

C. If the whole number part and the digit in the tenths place are the same, then compare the digit at the hundredths place and so on.

Example 3

Compare 81.39 and 81.37.

Solution:

In **81**.39 and **81**.37, the whole number part is the same, i.e., 81.

In 81.39 and 81.37, the decimal part in the tenths place is the same, i.e., **3**

In 81.39, the decimal part is .39 and the digit in the hundredths place is **9**.

In 81.37, the decimal part is .37 and the digit in the hundredths place is **7**.

But 9 > 7

Therefore, 81.39 > 81.37

On the next page you will find worked-out examples on comparing decimals and arranging decimals:

Example 1: Which is greater of 58.23 and 49.35?

Solution:

The given decimals have distinct whole number parts, so we compare whole number parts only.

In 58.23, the whole number part is 58.

In 49.35, the whole number part is 49.

But 58 > 49

Therefore, 58.23 > 49.35 Answer+++

Example 2

Write the following decimals in <u>ascending</u> order (smallest to the largest):

5.64, 2.54, 3.05, 0.259 and 8.32

Solution:

To convert the given decimal numbers into like decimals, we get

5.640, 2.540, 3.050, 0.259 and 8.320

Therefore, 0.259 < 2.540 < 3.050 < 5.640 < 8.320

Hence, the given decimals in ascending order are:

0.259, 2.54, 3.05, 5.64 and 8.32 Answer

Example 3:

Arrange the following decimals in descending order (largest to the smallest).

8.14, 5.96, 0.863, 6.4, 3.81 and 0.5

Solution:

By converting each of the decimal number to like decimals we get

8.140, 5.960, 0.863, 6.400, 3.810 and 0.500

Therefore, 8.140 > 6.400 > 5.960 > 3.810 > 0.863 > 0.500

Hence, the given decimals in descending order are:

8.14, 6.4, 5.96, 3.81, 0.863, 0.5 Answer

NOW DO PRACTICE EXERCISE 4

Practice Exercise 4

1. Write the fraction represented by the digit 9 in each of the following decimal numbers (the first one has been done for you).

   (a) 431.92 = 9 tenths = $\frac{9}{10}$

   (b) 5.493 =

   (c) 0.0094 =

   (d) 9.27 =

---

2. Write in words how these numbers should be read:

   (a) 5.382

   (b) 0.704

---

3. Write 'true' or 'false' for each of the following number statements:

   (a) $67.14 < 67.2$ (b) $2.11 > 2.09$

   (c) $105.06 > 105.07$ (d) $0.082 < 0.601$

---

4. Arrange these decimal numbers in ascending order (from smallest to largest).

   (a) 5.72, 5.071, 5.7

   (b) 218.099, 218.009, 217.99

---

5. Arrange these decimal numbers in descending order (from largest to smallest).

   (a) 0.0125, 0.003, 0.014

   (b) 11.84, 11.91, 11.89

6. Three students were asked to time themselves while they each completed a problem. The times they took are shown below:

Florence: $\frac{1}{2}$ minute
Justin: 0.58 minute
Ben: 0.52 minute

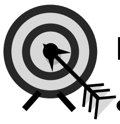
(a) Who took the longest time?

(b) Whose time was greater, Florence or Ben?

CORRECT YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 1

Lesson 5: Operations Involving Decimals

In the previous lesson, you defined decimals and discussed the place-values. You also compared decimals and arranged them in order.



In this lesson, you will:

- add, subtract, multiply and divide decimals
- apply the concept of decimals to solve problems in real life situations.

Decimal numbers are used much more commonly than fractions. They are commonly used in areas such as banking, construction, measurement and research as well as in everyday life. Decimal fractions are also used to write fractions of a Kina.

Money related problems are **actually good practical examples** of adding and subtracting decimal fractions.

To add or subtract decimal fractions, remember to:

(i) write in columns; decimal points are one below the other
(ii) use zeros to hold vacant places.

Here are two examples to show you how we do this:

Write in Columns

K1.48 + K2.99 + K0.55 = ?

To add, write in columns like this

1.48	Decimal points one below the other
+ 2.99	Tenths digits one below the other
0.55	Hundredths digits are below the other.
5.02	

Answer: K5.02

Use zeros to fill places

Using zeroes to fill vacant places avoids confusion.

K10 – K4.48 = ?

10•**00**	write zero in vacant places
– 4•48	
5•52	

Answer: K5.52

If you are sure of adding and subtracting whole numbers, you could add and subtract decimals easily by observing the two steps given above.

The examples below will help you further.

Example 1. 2.51 + 0.536 + 16.2 = ?

2.510	write in columns
0.536	decimal points come one below the other
+ 16.200	write zeros to hold places
19.246	add like adding whole numbers.

Answer: 19.246

Example 2. 59.78 – 23.4 = ?

59.78	write in columns, decimal points are one below the other.
– 23.40	write zero to hold place.
36.38	subtract like whole numbers
	(check by adding 23.4 + 36.38 = ?)

Answer: 36.38

Example 3. What is the difference between K5 and K4.26?

5.00	write zeros to hold place
– 4.26	borrow in stages.
0.74	

K0.74 means 74 toea.

Answer: K0.74 or 74^{t}

Remember: To add or subtract decimals, we need to keep the decimal points under each other. This will keep all the digits in their correct place value positions.

Here are other examples.

Example 1: Find 8.372 + 15.4

Solution:
8.372
+ 15.400 ← insert zeros as place holders and keep the digits in their correct place value positions.
23.772

Therefore, the **Answer is 23.772**

Example 2: Calculate 356.7 – 39.97

Solution:
356.70 ← Insert zero as a place value
– 39.97
316.73 **Answer**
316.74

On the next page, we will work on multiplication and division of decimals.

Multiplying and Dividing Decimals

We will begin multiplying and dividing by powers of 10.

Because decimal points are based on the powers of 10, it is very easy to multiply or divide by 10, 100, 1000 and so on. The answer will contain the same digits as when we multiply or divide by 1, but the decimal point will be in a different position.

The following examples include steps showing you how to multiply and divide by powers of 10:

Example 3: Calculate 6.75 x 10.

Solution:

Step 1: Ignoring the decimal point multiplying by 10 gives 6750.

Step 2: There are two decimal places in the numbers in the question, so there must be two decimal places in the answer.

6.75 x 10 = 67.50

= 67.5

Here we can see that, when we **multiply** by 10, the decimal point moves one place to the **right**.

Similarly when we multiply by 100, the decimal point moves two places to the right and by 1000 the decimal point moves three places to the right, and so on.

Example 4:

Calculate: 24.76 x 100.

Solution: 24.76 x 100 = 2476 Answer.

However, when we **divide** by 10, 100, 1000, etc. the decimal point moves to the **left** according to the number of zeros.

Here are some examples to show you how this is done:

Example 5:

Find 243.7 ÷ 10.

Solution: 243.7 ÷ 10 = **24.37** Move one decimal place to the left.

Example 6: Find 1050.6 ÷ 100

Solution: 1050.6 ÷ 100 = **10.506** Move two places to the left.

The pattern we can see in the movement of the decimal point is:

> To **multiply** by the powers of 10, just move the decimal point in the answer to the **right**. The number of decimal places the decimal point moves will depend on the number of zeros you are multiplying by.
>
> To **divide** by the powers of 10, move the decimal point in the answer to the **left** according to the number of zeros you are dividing by.

Next, we will go onto multiplying decimal numbers together.

> To multiply decimals:
>
> - Multiply the numbers ignoring the decimal point(s)
> - Count the total number of decimal places in both numbers being multiplied in the question
> - Insert the decimal point in the answer, making sure the answer has the same number of decimal places in the question.

Here is an example to show you how to multiply decimals;

Example 7: Find 85.3 x 4.2

Solution: 85.3 x 4.2 there is a total of two decimal places
An estimate is 80 x 4 = 320.

```
   853
  x 42
  1706
+ 34120
 35826
```

The answer is **358.26** (two decimal places).

Now we will move onto dividing decimals.

Dividing Decimals by a Whole Number

When dividing by a whole number, the decimal point stays fixed.

Example 8 Divide 25.5 by 12

```
     2.125
12)25.500
   24        12 x 2 = 24
    15
    12
     30      Place additional zero
     24      12 x 2 = 24
      60     Place additional zero
      60     12 x 5 = 60
```

Answer: 2.125

Now let us do division of Decimals by other decimals.

Dividing a decimal by a decimal

We shall learn the steps involved in the process of division, by looking at an example.

Consider this division: $3.96 \div 0.3 = ?$

You know how to divide numbers by 3. So, to divide by 0.3, **we first change the divisor <u>0.3</u> to 3.**

Step 1 Change divisor to a whole number.

$0.3 \times 10 = 3$

We have multiplied the divisor by 10. So, we should compensate by multiplying the dividend 3.96 also by 10.

Step 2 Multiply the dividend also by 10.

$3.96 \times 10 = 39.6$

Now, divide the new dividend by the new divisor.

Step 3 Workout $39.6 \div 3$

We could show the steps of working like this: $\frac{3.96}{0.3} = \frac{3.96 \times 10}{0.3 \times 10} = \frac{39.6}{3}$

So, $\frac{3.96}{0.3} = 13.2$

To Divide by a Decimal

- Change the divisor to a whole number multiply by 10, 100 or 1000 depending on how many numbers after the decimal point.
- Compensate by doing exactly the same thing to the dividend
- Divide the new dividend by the new divisor.

Example 1 $14 \div 0.7 = ?$

The divisor is 0.7. To change 0.7 to the whole number 7, we multiply it by 10.

So, we work like this: $\frac{14}{0.7} = \frac{14 \times 10}{0.7 \times 10}$

$= \frac{140}{7}$

$= 20.$

Example 2 Workout: 0.132 ÷ 0.11 = ?

$$\frac{0.132}{0.11} = \frac{0.132 \times 100}{0.11 \times 100} = \frac{13.2}{11} = 1.2$$

Working out:

```
    1.2
11)13.2
   11
    22
    22
    00
```

Answer: 1.2

Now, let's solve a practical problem involving decimals.

Example 10

Joey is given K50 as his weekly lunch money. However, on the third day of the week he had spent K31.26. How much does he have left for the remaining days?

Solution:

```
  50.00
 −31.26
  18.74
```

Therefore, Joey has **K18.74** left for the remaining days.

Example 11

Five packets of meat cost K36.95 what is cost of one packet of meat?

Solution: 5 pkts cost K36.95

So, 1 pkt will cost K36.95 ÷ 5

```
   7.39
5)36.95
 -35
   19
 - 15
    45
  - 45
    00
```

Therefore, one packet of meat will cost **K7.39** Answer.

NOW DO PRACTICE EXERCISE 5

Practice Exercise 5

1. Add these decimal numbers:

   (a) 14.67 + 4.3 + 143.99 (b) 89 + 1.99 + 0.4 + 16.56

2. From 100.75 take away 69.7

3. Calculate:

   (a) 1.7 x 0.2 (b) 21.363 x 9

4. Find:

   (a) 1.44 ÷ 1.2 (b) 18.2 ÷ 0.14

5. A tank holding 1080 litres of water is leaking at a rate of 4.5 litres per hour.

   (a) How many litres of water are in the tank after one day?

   (b) How long before the tank is empty?

6. The rainfall recorded for four months in a city was:

April: 56.7 mm
May: 19 mm
June: 76.5 mm
July: 45 mm

(a) What was the total rainfall over the four months?

(b) How much more rain fell in June than in May?

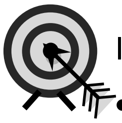
(c) What was the average rain over the four months?

(d) If the average monthly rainfall for the year for this city was 52.3 mm, what was the total rainfall of the other eight months?

CORRECT YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 1

Lesson 6: Estimating and Rounding Off

In the previous lesson, you learnt addition, subtraction, multiplication and division of decimals. You also learnt to solve problems in real life situations.



In this lesson, you will:

- describe estimation, approximation and rounding off
- estimate and round off numbers
- solve problems involving estimation and rounding off.

Sometimes we do not need an exact answer, we just want an estimate.

For example, the exact number of candies in this jar cannot be determined by looking at it, because most of the candies are not visible. The amount can be estimated by assuming or guessing that the part of the jar that cannot be seen contains an amount equivalent to the amount contained in the same volume for the part that can be seen. We call this process **estimation**.

Estimation is the process of finding an **estimate** or **approximation**. It is finding a value that is close enough to the right answer.

Estimating is an important part of mathematics and a very handy tool in everyday life.

Rounding off is a kind of estimation.

Rounding off means reducing the digits in the number while trying to keep its value similar.

When a number is rounded off, it is approximated by eliminating the least significant digits. When rounding, you are finding the closest multiple of ten (or one hundred, or other place value) to your number.

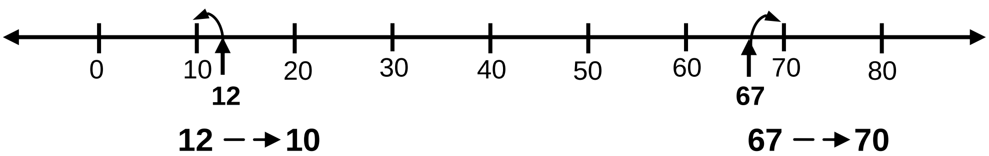
For example, 42 can be rounded down to 40 (this number was rounded to the tens place). Similarly, 285 can be rounded up to 300 (this number was rounded to the hundreds place.

Rounding is used to make a number easier to work with.

For example, if you know that there are 422 students in your school, you can say that there are approximately 400 students in your school.

On a number line, you can see how rounding a number approximates its value.

Rounding numbers to the tens place.



Whole numbers can be rounded to the tens place, hundreds place, thousands place, and so on. When a number is rounded to the tens place, the final form has a zero for the ones digit. When a number is rounded to the hundreds place, the final form has a zero for both the tens digit and the ones digit.

Decimal numbers can also be rounded: this approximates the number to the nearest tenth, hundredth, thousandths, or other decimal place. When a decimal number is rounded to the tenths place, the final form has no digit in the hundredths place (or any places to the right of that). When a decimal number is rounded to the hundredth place, the final form has no digit in the thousandths place (or any places to the right of that).

How to Round off a Number
To round off a number, the digit to be rounded either remains the same or is increased by one, and one or more of the digit on the right are eliminated or changed to zero. In order to round off a number, do the following:

- Decide which is the last digit to keep (rounding digit), and look at the next digit just to the right of it.

  For example, if you are rounding the number 538 to the tens digit, the digit "3" (the tens digit) will be rounded and the "8" (the ones digit) is the digit that will become zero.

- Leave it the same if the next digit is less than 5 (we called this **rounding down**)

- Increase it by one if the next digit is more than 5 (we called this **rounding up**)

Example 1 Round 94 to the nearest 10

Solution: We want to keep the 9 as it is in the tens position
The next digit is 4 which is less than 5, so no change is needed to the 9

Therefore, the answer is **90**. (94 gets rounded down)

Example 2 Round 76 to the nearest 10

Solution: We want to keep the 7 as it is in the tens position
The next digit is 6 which is more than 5, so increased the 7 by 1 to 8.

Therefore, the answer is **80**. (76 gets rounded up)

- If the next digit is a 5, (like 15 rounded to the tens digit or 357 rounded to the hundreds digit), then there are two possibilities:

  - If there is at least one digit after the 5, then the digit to be rounded increases by one and the 5 becomes zero (as do all the remaining digits).

    For example, 257 rounded to the hundreds digit becomes 300, and 1531 rounded to the thousands place becomes 2000.

- If there are no digits after the 5 (or digits after the 5 are all zeros), then the number could equally be rounded up or down. The 5 becomes zero, and the number to be rounded remains the same if it is **even,** increased by 1 if it is **odd.**

Example 3 5 rounded to the tens digit is 0
15 rounded to the tens digit is 20
275 rounded to the tens digit is 280

Now look at the following tables showing examples of rounding whole numbers and decimals.

Examples of rounding whole numbers

Number	Nearest ten	Nearest hundred	Nearest thousand
478	480	500	0
1234	1230	1200	1000
69 355	69 360	69 400	69 000

Examples of rounding decimals

Number	Nearest tenth	Nearest hundredth	Nearest thousandth
1.2347	1.2	1.23	1.235
31.6479	31.6	31.65	31.648
9.7463	9.7	9.75	9.746

We can round numbers to make estimations. An estimate is a good guess or a good try at working out the answer to a problem. It probably won't give you the exact answer to a problem but it will give you a rough idea of the answer.

Let us do the following examples.

Example 1 Estimate the sum 5290 + 17986 to their nearest:

(a) Hundreds

(b) thousands

Solution: (a) 5290 + 17986 to their nearest hundreds

5290 can be rounded to 5300.

17986 can be rounded to 18000

The estimated sum is 5300 + 18000 ≈ **23300.** (**≈** means nearly equal to)

(b) 5290 + 17986 to their nearest thousands

5290 can be rounded to 5000.

17986 can be rounded to 18000

The estimated sum is 5000 + 18000 ≈ **23000.** (**≈** means nearly equal to)

Example 2 Estimate: 5673 – 436 by rounding off the numbers to their greatest places. Also find the reasonable estimate.

Solution: We have, 5673 – 436 = 5237. (Actual difference)

The greatest place in 5673 is thousands place and in 436 the greatest place is hundreds place.

5673 to nearest thousand is 6000
436 to nearest hundred is 400
Estimated difference is 6000 – 400 $\approx$ **5600**

Clearly, it is not close to the actual difference. So, it is not a reasonable estimate.

Let us round off 5673 and 436 to nearest hundreds.

5673 to the nearest hundred is 5700
436 to the nearest hundred is 400

Therefore, estimated difference = 5700 – 400 = 5300

Example 3 Give a rough estimate and also a closer estimate of 489342 – 48365.

Solution: We have, 489342 – 48365 = 440877 (Actual difference)

To find rough estimate, let us round off each number to nearest ten thousands.

489342 to the nearest ten thousand is 490000
48365 to the nearest ten thousand is 50000
Estimated difference is 490000 – 50000 $\approx$ 440000

So, rough estimate is 440000

In order to obtain a closer estimate, let us round off each number to nearest thousands.

489342 rounds off as 489000
48365 rounds off as 48000
Estimated difference = 489000 – 48000 $\approx$ 441000

Clearly, it is closer to the actual difference 440977.

Hence, closer estimate is 441000.

Example 4 Estimate 8 × 189

Solution: 189 can be rounded to 200.

The estimated product is 8 × 200 $\approx$ **1,600.** (**≈** means nearly equal to)

Example 5 Estimate 21 × K4.46

Solution: 21 can be rounded to 20
K4.46 can be rounded to K4.50
Estimated product is 20 x K4.50 $\approx$ **K90.**

Example 6 Make an estimate of the answer for 65.25 ÷ 1.8

Solution: 65.25 can be rounded to 70

1.8 can be rounded to 2

Rough estimate is $\frac{70}{2} \approx \mathbf{35}$ (≈ means nearly equal to)

Here are some more examples of problems on estimation.

Example 7

Estimate the total cost of 3 albums marked K7.40, K8.65 and K11.95. Round off to the nearest kina.

Solution: K7.40 rounded to the nearest kina is K7.00
K8.65 rounded to the nearest kina is K9.00
K11.95 rounded to the nearest kina is K12.00

Total cost of the 3 albums $\approx$ K7.00 + K9.00 + K12.00
$\approx$ K28.00

Therefore, the cost of 3 albums is about K28.00.

Example 8

Amanda bought 10 books for K28.45, 5 pens for K15.15 and 5 pencils for K6.75. Estimate the total amount Amanda spent.

Solution: cost of 10 books is 28.45
K28.45 rounded to the nearest kina is K28.00

Cost of 5 pens is K15.15
K15.15 rounded to the nearest kina is K15.00

Cost of 5 pencils is K6.75
K6.75 rounded to nearest kina is K7.00

Cost of all items $\approx$ K28.00 + K15.00 + K7.00
$\approx$ K50.00

Therefore, the total amount spent by Amanda in buying all the items is about K50.00.

Example 9

Melissa purchased K39.46 in groceries at a store. The cashier gave her K1.46 change from a K50 bill. Melissa gave the cashier an angry look. What did the cashier do wrong?

Solution: We need to estimate the difference to see if the cashier made a mistake.

Amount of purchased is K39.46 $\approx$ K40.00

K50.00 – K40.00 = K10.00

Hence, K1.46 is much smaller than the estimated difference of K10.00

So the cashier must have given Melissa the wrong change.

Example 10

Esther wanted to buy the following items: a DVD player for K490.95, a DVD holder for K188.95 and a personal stereo for K209.95. Does Esther have enough money to buy all three items if she has K900 with her?

Solution: The phrase “enough money” tells us that we need to estimate the sum of the three items. We will estimate the sum by rounding each decimal to the nearest one. We must then compare our estimated sum with K900 to see if she has enough money to buy these items.

K490.95 $\approx$ K500
K188.95 $\approx$ K189
K209.95 $\approx$ K210

K500 + K189 + K210 = K899

Therefore, **Yes!** Esther has enough money because rounding each amount to the nearest one, we get an estimate of K899, and Esther has K900 with her.

NOW DO PRACTICE EXERCISE 6

Practice Exercise 6

1. Round off each number as indicated:

(a)

Number	Nearest ten	Nearest hundred	Nearest thousand
784			
45321			
89 255			
456 135			
97			

(b)

Number	Nearest thousandth	Nearest ten-thousandth	Nearest hundredth - thousandth	Nearest millionth
a. 0.5064089				
b. 0. 0009235				
c. 9.3066055				
d. 78.0106547				
e. 63.2345671				

2. Give a rough estimate and a closer estimate of 38 346 – 16 097.

3. Estimate 70.16 x 0.293

4. Estimate 42.054 ÷ 0.815

---

5. Doris just bought a new car with engine fuel capacity of 69.10072 litres. If Doris drives at a constant speed of 8.6731325 km per litre, estimate how far she will get on the highway before she runs out of gas.

---

6. Coritha bought the following grocery items:

4 x 1.5 L of Gala Ice Cream for K23.24
4 x 1 kg of Flame Flour for K22.68
3 x 500 g of Kraft Cheddar Export Cheese for K98.52
1 kg of pork belly bone-in for K42.64
1 kg local bitter melon for K7.72
2 dozen NTB Eggs 60g for K19.20

Estimate the total amount Coritha spent.

CORRECT YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 1

TOPIC 1: SUMMARY

- Whole Numbers are simply the numbers **0, 1, 2, 3, 4, 5, …** (and so on).
- **Ascending order** means arranging numbers from the smallest number to the largest number.
- **Descending order** means arranging numbers from largest number to the smallest number.
- To add or subtract whole numbers, add or subtract the digits in each place-value position.
- To multiply a whole number by a 1-digit whole number, multiply from right to left, regrouping as necessary. When you multiply by a number with two or more digits, write individual products and then add.
- When dividing whole numbers; divide in each place-value position from left to right.
- Fractions are part or portion of a whole.
- To compare fractions, change to equivalent fractions with the same denominator and then compare the numerators.
- To add or subtract fractions add the numerators over the same denominator. If the fractions have different denominators, find the LCD. Change the fractions to equivalent fractions with the same denominator then add or subtract the numerators and keep denominator simplifying the answer to its simplest form.
- To multiply fractions, multiply the numerators and multiply the denominators. Simplify final answers if possible.
- To multiply mixed numbers, first change them to improper fractions and multiply following the steps for multiplying fractions.
- To divide fractions, multiply the dividend by the reciprocal of the divisor and simplify the answer if possible.
- Reciprocal is another name for the multiplicative inverse of a number.
- To compare decimals
  - ➢ Compare the whole number part of the decimal. The decimal with greater whole number is greater.
  - ➢ If the whole number part is the same, compare the digit at the tenths place. The decimal with the greater tenths digit is greater.
  - ➢ If the whole number part and the digit in the tenth place are the same compare the digit at the hundredth place and so on.
- Estimation is finding a value that is close enough to the right or actual answer.
- Rounding off means reducing the digits in the number while trying to keep its value similar.

REVISE LESSONS 1 – 6 THEN DO TOPIC TEST 1 IN ASSIGNMENT BOOK 1.

ANSWERS TO PRACTICE EXERCISES 1-6

Practice Exercise 1

1. (a) 0, 5, 7, 10, 22
   (b) 89, 98, 99, 101, 110
   (c) 2345, 2354, 2524, 2675, 2711

2. (a) 999, 775, 575, 250, 55
   (b) 106, 100, 68, 15, 2
   (c) 999, 44, 36, 14, 1

3. (a) False (b) False (c) True

4. (a) 173 (b) 1895

5. (a) 236 (b) 1000

6. (a) 175 (b) 2784

7. (a) 294.25 (b) 348

8. 50 eggs

9. 270 students

Practice Exercise 2

1. $1\frac{2}{15}$

2. $\frac{27}{8}$

3.

a) $\frac{10}{14}$ (=) $\frac{15}{21}$	b) $1\frac{1}{2}$ (>) $\frac{11}{10}$	c) $\frac{5}{8}$ (>) $\frac{7}{16}$
d) $\frac{3}{5}$ (=) $\frac{9}{15}$	e) $\frac{3}{5}$ (<) $\frac{16}{25}$	f) $2\frac{2}{3}$ (>) $\frac{16}{9}$

4. $\frac{1}{3}, \frac{2}{5}, \frac{5}{12}, \frac{7}{15}$

5. $\frac{1}{3}, \frac{1}{4}, \frac{2}{9}, \frac{1}{6}$

Practice Exercise 3

1. (a) $\frac{6}{6}$ or 1 (b) $1\frac{13}{24}$ (c) $5\frac{17}{20}$ (d) $1\frac{5}{8}$

2. $1\frac{5}{6}$

3. (a) $\frac{11}{21}$ (b) $1\frac{26}{45}$ (c) $2\frac{5}{6}$

4. $\frac{7}{12}$

5. (a) $\frac{5}{28}$ (b) $1\frac{27}{28}$ (c) 2 (d) 2

Practice Exercise 4

1. (a) $\frac{9}{10}$ (b) $\frac{9}{100}$ (c) $\frac{9}{1000}$ (d) $\frac{9}{1}$ or 9

2. (a) five and three hundred eighty two thousandths
   (b) seven hundred four thousandths

3. (a) True (b) True (c) False (d) True

4. (a) 5.071, 5.7, 5.72
   (b) 217.99, 218.009, 218.099

5. (a) 0.014, 0.0125, 0.003
   (b) 11.91, 11.89, 11.84

6. (a) Justin (b) Ben

Practice Exercise 5

1. (a) 162.96 (b) 107.95

2. 31.05

3. (a) 0.34 (b) 192.267

4. (a) 1.2 (b) 130

5. (a) 972 litres (b) 10 days

6. (a) 197.2 mm (b) 57.5 mm (c) 49.3 mm (d) 430.4 mm

Practice Exercise 6

1. (a)

Number	Nearest ten	Nearest hundred	Nearest thousand
784	780	800	1000
45321	45320	45300	45000
89 255	89260	89300	89000
456 135	456140	456100	456000
97	100	100	0

(b)

Number	Nearest thousandth	Nearest ten-thousandth	Nearest hundredth - thousandth	Nearest millionth
a. 0.5064089	0.506	0.5064	0.50641	0.506409
b. 0. 0009235	0.001	0.0009	0.00092	0.000924
c. 9.3066055	9.307	9.3066	9.30661	9.306606
d. 78.0106547	78.011	78.0107	78.01066	78.010655
e. 63.2345671	63.235	63.2346	63.23457	63.234567

2. **Rough estimate: 20 000**
   Closer estimate: 22 000
   Actual answer: 22 249

3. 21

4. 52.5

5. 630 km

6. K210

END OF TOPIC 1

TOPIC 2

MONEY AND PERCENTAGES

TOPIC 2: MONEY AND PERCENTAGES

Introduction

Money is an important aspect of life today. Almost everything we do, need and want revolves around the use of money.

Traditionally, in Papua New Guinea, all goods, services, trade and barter were done using valuables which had the equivalent value of money that we use today.

Such were salt, rare bird's feather, shell money and even vegetables which were significant to some societies.

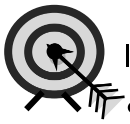
These of course have been replaced by money in the form of decimal currency. In PNG, the standard unit of currency is the Kina which is divided into 100 toea.

One hundred (100) toea is equal to 1 Kina and written as K1.00 in decimal.

In this topic, you will do activities and lessons that will explain terms and applications that involve the use of percentages with money such as tax, commission, profit and loss.
You will also be able to apply percentage calculations with other money problems and help you improve your knowledge of percentages and dealing with money in real life situations.

Lesson 7: Percentages, Decimals and Fractions

You learnt in previous lessons that a percentage is a special kind of fraction with a denominator of 100 and is represented by the symbol "**%** ".



In this lesson, you will:

- convert fractions to decimals and vice versa
- convert decimals to percentages and vice versa
- express percentages to fractions and vice versa
- solve decimal, fraction and percentage problems.

Every percentage can be written as a fraction or a decimal. The following examples will show you how to convert from fractions to decimals to percentages and vice versa.

Converting Fractions to Decimals

To convert a fraction to a decimal, divide the top number by the bottom number (divide the numerator by the denominator in mathematical language).

Example 1 Convert $\frac{2}{5}$ to a decimal

Solution: Divide 2 by 5: 2 ÷ 5 = 0.4

Answer: $\frac{2}{5}$ **= 0.4**

Example 2 Convert $\frac{5}{8}$ to a decimal.

Solution: Divide 5 by 8: 5 ÷ 8 = 0.625

Answer: $\frac{5}{8}$ **= 0.625**

Converting Decimals to Fractions

To convert a decimal to a fraction, express the decimal to an equivalent decimal fraction whose denominator is a power of ten, then simplify the fraction into its simplest form.

Example 3 Convert 0.75 to a fraction

Solution: Express 0.75 to a decimal fraction

Answer: $0.75 = \frac{75}{100} = \mathbf{\frac{3}{4}}$

Example 4 Express 0.375 as a fraction.

Solution: Express 0.375 to a decimal fraction

Answer: $0.375 = \frac{375}{1000}$

$= \frac{3}{8}$

Converting Percentages to Decimals

To convert percentage to decimal, divide by 100 and remove the "%" sign.

The easiest way to divide by 100 is to **move the decimal point 2 places to the left**.

Example 5 Convert 75% to decimal.

Solution: 75% = 7.5. Move the decimal point **2 places to the left**, and remove the "%" sign.

= 0.75 Answer

Example 6 Convert 8.5% to decimal

Solution: 8.5% = 0 8.5. Move the decimal point **2 places to the left** and remove the "%" sign.

= 0.085 Answer

Converting from Decimal to Percent

To convert decimal to percent, multiply by 100 and add the "%" sign.

The easiest way to multiply by 100 is to **move the decimal point 2 places to the right**.

Example 7 Convert 0.125 to percent

Solution: 0.125 = 0.125 Move the decimal point **2 places to the right**, and add the "%" sign.

= 12.5 % Answer

Example 8 Convert the decimal 87.5 to a percent

Solution: 87.5 = 87.50. Move the decimal point **2 places to the right**, and add the "%" sign.

= 8750% Answer

Converting Fractions to Percentages

To convert fraction to percentage, divide the numerator (top number) by the denominator (bottom number) then multiply the result by 100 or move the decimal point two places to the right and add the “%” sign.

Example 9 Convert $\frac{3}{8}$ to a percentage

Solution:

First divide 3 by 8: 3 ÷ 8 = 0.375

Then multiply by 100 or move decimal point 2 places to the right:

0.375 x 100 = 37.5

Add the "%" sign: 37.5%

Answer: $\frac{3}{8}$ **= 37.5%**

Converting Percentages to Fractions

To convert percentage to fraction, put the number over 100 and reduce to its simplest form. Then drop or remove the “%” sign.

Example 10 Convert 80% to a fraction.

Solution: $80\% = \frac{80}{100}$ Put the number 80 over 100.

$= \frac{80}{100} \frac{\div 20}{\div 20}$ Simplify or reduce

$= \frac{4}{5}$ **Answer**

Example 11 Express 125% as a fraction.

Solution: $125\% = \frac{125}{100}$ Put the number 125 over 100.

$= \frac{125}{100} \frac{\div 25}{\div 25}$ Simplify or reduce

$= \frac{5}{4}$ Change to mixed number

$\mathbf{= 1\frac{1}{4}}$ **Answer**

Here is a table of commonly occurring values shown in Percent, Decimal and Fraction form:

Percent	**Decimal**	**Fraction**
1%	0.01	$\frac{1}{100}$
5%	0.05	$\frac{1}{20}$
10%	0.1	$\frac{1}{10}$
12½%	0.125	$\frac{1}{8}$
20%	0.2	$\frac{1}{5}$
25%	0.25	$\frac{1}{4}$
$33^1/_3$%	0.333...	$\frac{1}{3}$
50%	0.5	$\frac{1}{2}$
75%	0.75	$\frac{3}{4}$
80%	0.8	$\frac{4}{5}$
90%	0.9	$\frac{9}{10}$
100%	1	1
125%	1.25	$^5/_4$
150%	1.5	$^3/_2$
200%	2	2

NOW DO PRACTICE EXERCISE 7

Practice Exercise 7

1. Change the following percentages to fractions. Simplify your answers as far as possible.

a) 15% ___________ b) 28 % ___________

c) 35 % ___________ d) 90 % ___________

e) 64% ___________ f) 22 % ___________

2. Change the following fractions into percentages

a) $\frac{9}{20}$ = _________ b) $\frac{4}{25}$ = _________

c) $\frac{49}{50}$ = _________ d) $\frac{24}{25}$ = _________

d) $\frac{3}{5}$ = _________ f) $\frac{19}{20}$ = _________

3. Change the following percentages into decimals.

a) 25% __________ b) 10% __________

c) 75% __________ d) 50% __________

e) 20% __________ f) 150% __________

4. Change the following decimals into percentages

a) 0.03 _________ b) 0.05 _________

c) 0.35 _________ d) 0.42 _________

e) 0.72 _________ f) 1.09 _________

5. From the total number of students at Wani High School, 66% are girls.

(a) What percentage of the students are boys? ___________

(b) What fraction of students are girls? ___________

(c) What fraction of the students are boys? ___________

5. Three students were asked how much of their projects had they completed. Kiri said, 62%, Numa said, 3/5 and Nanai said 0.64. Who completed;

   (a) the most of their project? ___________

   (b) the least of their project? ___________

---

7. Renson scored 24 marks correct out of 30 in his mathematics test. What is his score as a percentage?

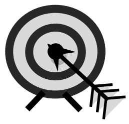
---

8. Pouna has 95% percent of his money left while Elai spent $\frac{1}{27}$ of his. Who has most of his money left?

CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 2.

Lesson 8: Percentage Change

You learnt in the last lesson how to write percentages in different ways by converting from fractions to decimals to percentages and from percentages to decimals to fractions.



In this lesson, you will:

- define increase and decrease
- calculate increase and decrease in quantity
- define percentage increase and decrease
- identify steps in solving percentage increase and decrease
- solve problems on percentage increase and decrease.

When you make something become larger in size or quantity, it is called an "**increase".**

A "**decrease**" is simply the opposite of an increase where the quantity or size is reduced or lessened.

To find an increase or decrease, calculate the amount or quantity by the percentage it has been increased or decreased by.

Example 1

Karo's fortnightly pay of K300 was increased by 2.5%.By how much was her pay increased?

Solution: Increased is 2.5% of K300

So, 2.5% x 300 = 7.5

Therefore, Karo's pay increased by **K7.50**

Example 2

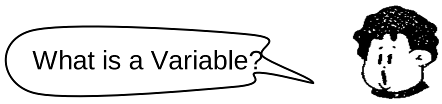
After a year of staying in the village, Peto's weight of 80 kg decreased by10%. By how much did his weight decrease?

Solution: Decreased is 10% of 80 kg

Hence, 10% x 80 = 8

Therefore, Peto's weight has decreased by **8 kilograms**.

A percentage change is a way to express a change in a variable. It represents the change between the old value and the new one.



A **variable** is a value or quantity that may change.

What is percentage increase and decrease?

Percent increase and percent decrease is a way of finding percent change, when a **variable** increases or decreases.

Increases or decreases are measured as a number or as a percentage of the original.

Using percentages to calculate the value of an increase is helpful because it relates the size of the increase to the original value.

When finding the percent increase or decrease, we take the absolute value of the difference between the original and the new value and divide it by the original value.

Absolute value means the value of the number regardless of it sign. It is denoted by the symbol $|\ |$.

For example, $|2| = 2$ means the absolute value of 2 is 2.

$|-2| = 2$ means the absolute value of -2 is 2.

The formula to calculate percent change (increase or decrease) is;

$$\textbf{PERCENT CHANGE} = \frac{|\text{new value} - \text{original value}|}{\text{original value}} \times 100$$

Example 1

At a supermarket, a certain item has increased from 75 toea per kilo to 81 toea per kilo. What is the percent increase in the cost of the item?

Solution: $\text{Percent Change} = \frac{|\text{new value} - \text{original value}|}{\text{original value}} \times 100$

$$= \frac{|81 - 75|}{75} \times 100$$

$$= \frac{|6|}{75} \times 100$$

$$= \frac{6}{75} \times 100$$

The absolute value of 6 is 6.

$$= 0.08 \times 100$$

$$= 8\%$$

There was an 8% increase in the cost of the item.

Example 2

Ann works in a supermarket for K10.00 per hour. If her pay is increased to K12.00, then what is her percent increase in pay?

Solution: Percent Change = $\frac{|\text{new value} - \text{original value}|}{\text{original value}} \times 100$

$= \frac{|12 - 10|}{10} \times 100$

$= \frac{|2|}{10} \times 100$

$= \frac{2}{10} \times 100$

The absolute value of 2 is 2.

$= 0.20 \times 100$

$= 20\%$

The percent increase in Ann's pay is 20%.

Example 3

Four meters are cut from a 12 meters board. What is the percent decrease in length?

Solution: Percent Change = $\frac{|\text{new value} - \text{original value}|}{\text{original value}} \times 100$

Since, 4 meters where cut from the original length of 12 meters, the new value is 8 meters.

Substituting this to the formula, we have:

$= \frac{|8 - 12|}{12} \times 100$

$= \frac{|-4|}{12} \times 100$

The absolute value of -4 is

$= \frac{4}{12} \times 100$

$= 0.33\bar{3} \times 100$

$= 33.3\%$

Therefore, there was a 33.3% decrease in length.

Example 4

The staff of Big Rooster went from 40 to 29 employees. What is the percent decrease in staff?

Solution: Percent Change = $\frac{|\text{new value} - \text{original value}|}{\text{original value}} \times 100$

$= \frac{40 - 29}{40} \times 100$

$= \frac{|11|}{40} \times 100$

$= \frac{11}{40} \times 100$

The absolute value of 11 is 11.

$= 0.275 \times 100\%$

$= 27.5\%$

There was a 27.5% decrease in staff.

Remember:

To find the percent increase or decrease, always compare how much a quantity has changed from the original amount.

NOW DO PERACTICE EXERCISE 8

Practice Exercise 8

1. Word Problems:

(a) At a sale, a Sepik painting that costs K40 is reduced by 20%.By how much did it decrease?

(b) The number of children in Miss Tommy's class has gone up from 40 to 50. What is the percentage increase for the class?

(c) A 50 kilogram bag of rice was stored in a warehouse. A few months later it weighed 35 kilos because some had been eaten by mice and rats. What is the percentage decrease of the rice?

2. Complete the table by calculating the new value after **increase**. One has been done for you as an example.

Original Value	% Increase	New Value
(a) 56	25%	
(b) 6	50%	
(c) 5	20%	
(d) 8	75%	**14**
(e) 10	90%	
(f) 30	70%	
(g) 50	2%	
(h) 21	100%	

3. Write the **percentage increase** for the following. One has been done for you.

Original Value	% Increase	New Value
(a) 32		56
(b) 24	**25%**	30
(c) 15		18
(d) 30		33
(e) 150		153
(f) 120		126
(g) 200		202
(h) 20		50

---

4. Calculate the new value after the decrease

Original Value	% Decrease	New Value
(a) 50	30%	
(b) 18	50%	
(c) 25	4%	
(d) 60	35%	
(e) 40	15%	
(f) 64	75%	**16**
(g) 40	45%	
(h) 45	60%	

---

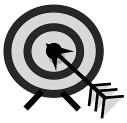
5. Complete the table by calculating the percentage decrease. One has been done for you.

Original Value	% Decrease	New Value
(a) 20		19
(b) 14		7
(c) 90	**10%**	81
(d) 35		21
(e) 400		4
(f) 50		47
(g) 125		115
(h) 150		132

CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 2.

Lesson 9: Expressing Quantities as Percentages

You learnt about percentage increase and decrease in the previous lesson. You also learnt to calculate the percentage increase and decrease in a quantity as well as solving word problems in real situations involving percentage change.



In this lesson, you will:

- express one quantity as a percentage of another

Sometimes we want to describe a quantity as a percentage of another.

To express one quantity as a percentage of another quantity:	
Step 1.	Express both the quantities in the same units.
Step 2.	Write the given quantity as a fraction of the total quantity.
Step 3.	Multiply by 100, simplify and add the "%" sign.

Example 1

What percent of 80 kilogram is 10 kilogram?

Solution: Both the quantities are in the same units.

Expressing as a fraction: $\frac{10}{80} = \frac{1}{8}$

Multiply by 100: $\frac{1}{8} \times 100 = \frac{100}{8}$

Simplify and add % sign: $= 12.5\ \%$

Therefore, 10 kg is 12.5% of 80 kg.

Example 2

What percent of 1 ream is 30 sheets?

Solution: Express both the quantities in the same units.

1 ream = 500 sheets

Express 30 out of 500 as a fraction: $\frac{30}{500} = \frac{3}{50}$

Multiply by 100: $\frac{3}{50} \times 100 = \frac{300}{50}$

Simplify and add % sign: $= 6\ \%$

Therefore, 30 sheets is 6% of 1 ream.

Example 3

There are 500 cats in the zoo, and 75 of them are black. What is the percentage of black cats in the zoo?

Solution: Total number of cats = 500

Number of black cats = 175

Percentage of black cats in the zoo = $\frac{175}{500}$

Multiply by 100 $= \frac{175}{500} \times 100$

Simplify and add % sign. $= \frac{17500}{500}$

$= 35\%$

Therefore, 35 % of the cats are black.

Example 4

There are 70 people in a swimming club, and 56 go to squad training. Calculate the number of people who go to squad training as a percentage of the swimming club members.

Solution: 56 of the 70 go to squad training

Percentage in squad training = $\frac{56}{70} \times 100$

Simplify and add % sign. $= \frac{5600}{70}$

$= 80\%$

Therefore, 80% go to squad training.

Percentage is often used to compare quantities by expressing them as percentages.

For example, in two mathematics tests a student receives 37 out of 45 and 72 out of 85. Expressing these results as percentages gives 82.2% and 84.7%, where the percentages are given correct to one decimal place. Hence the second result is better.

Go to the next page for other example.

Example 5

On a particular day, 27 out of 40 loaves of bread were baked in Best Bake Bakery. At the DeLuxe Bakery 57 out of 90 loaves of bread were baked on the same day. Which bakery was selling the larger percentage of loaves on that particular day?

Solution: The percentage of loaves baked on the particular day for Best Bake Bakery is:

$$\frac{27}{40} \text{ x } 100\% = \frac{2700}{40}\%$$

$$= 67.5\%$$

The percentage of loaves sold on the particular day for DeLuxe Bakery is:

$$\frac{57}{90} \text{ x } 100\% = \frac{5700}{90}\%$$

$$= 63.3\%$$

Therefore, the Best Bake Bakery had the greater percentage of loaves sold on that particular day.

NOW DO PERACTICE EXERCISE 9

Practice Exercise 9

1. Express the first quantity as a percentage of the second.

(a) 243 mm; 30 cm (b) 1600 grams; 2 kg

(c) 15; 60 (d) 16; 64

(e) 2.64 kg; 8.8 kg (f) 400 m, 1 km

2. Change to percentages:

(a) 18 marks out of 20 (b) 52 out of 80

(c) 300 kg of 900 kg (d) K67 out of K1000

(e) K45 out of K200 (f) 98 boxes out of 100 boxes

3. Three boys in different classes all had mathematics tests on the same day.

Maru scored 27 out of 50.

Benua scored 28 out of 40.

Jack scored 39 out of 75.

Work out their marks as percentages and arranged them in order with highest first.

---

4. A motorist has to drive a distance of 400 km journey. After an hour he has driven 84 km. What percentage of his journey has he completed?

---

5. In a survey, 1600 people were asked which television channel they preferred.

800 chose HBO
640 chose BBC
160 chose CNN

(a) What percentage chose HBO?

(b) What percentage chose BBC?

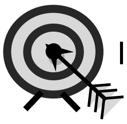
(c) What percentage chose CNN?

6. In a group of tourists, 17 came from France, 22 came from UK, 32 came from China and 9 from Italy. What percentage of the group came form China?

CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 2.

Lesson 10: Money Calculations

You learnt in the previous lesson about expressing quantities as fractions or percentage of another quantity and applied them in problems in real life.



In this lesson, you will:

- identify the use of money in everyday life
- add, subtract, multiply and divide money
- find the percentage of an amount
- solve applied problems.

Managing money transactions is important especially when shopping.

Modern buying and selling is done using a decimal currency system in the form of Kina and toea in Papua New Guinea.

Money is used almost every day for bus-fare, lunch money, paying for bride price, entertainment and many more. It is the main form of payment today to pay for goods, services and trade and has replaced other traditional forms of payment such as pigs, salt, shell-money and Barter System.

Some of these traditional forms of payment or barter is still being practiced in many societies.

> **Money** is a medium of exchange issued by a government or other public authority in the form of coins of gold, silver, or other metal, or paper bills, used as the measure of the value of goods and services.

Money is a decimal currency so apply the rules and steps you learnt on operations with decimals when we add, subtract, multiply and divide money.

See the following examples.

Example 1 Adding K2.55 + K17.10 + K0.40

Solution: To add the amounts, line up the decimal points.

```
    2.55
   17.10      Insert zeros as place holders
 + 00.40
   20.05
```

Answer: **K20.05**

Example 2 Subtract: K356.70 – K39.70.

Solution:

```
  356.70
 - 39.70
  317.00
```

Answer: **K317.00**

Example 3 Multiply K85.30 x K4.20

Solution:

```
      85.30  } 4 decimal
    x  4.20  } places
      00 00
 +  1706 00
   34120 00
   35826 00        358.2600   (4 decimal places)
```

Answer: **K358.26** (rounded to nearest toea)

Example 4 Division K95.50 ÷ 0.20

Solution: Change the decimal numbers to whole numbers by multiplying by 100.

95.50 x 100 = 9550 and 0.20 x 100=20

```
        477.5
 20 ) 9550          Cancel the zeros to reduce the numbers
    - 8
      15
    - 14
       15
    -  14
        10  <-----  Insert a zero as a place holder
        10
```

Answer: **K477.5**

Now we are going to work on finding percentage of an amount of money.

To find the percentage of an amount, we express the percentage as a fraction out of 100 and multiply. Then simplify the result.

Example 1 What is 25% of K50?

Solution: 25 % of 50 = $\frac{25}{100}$ x 50 25% as fraction out of 100 and multiply

= $\frac{1250}{100}$ simplify

= 12.50

Another way to find the percentage of an amount is to convert the percentage to a decimal and multiply by the amount.

Example 1: What is 25% of K50

Solution: $\frac{25}{100} = 0.25$ ⟵ 25% as a decimal

$0.25 \times 50 = 12.5$ ⟵ multiply

Answer: **K12.50**

Oftentimes, we use percentages in the following way.

Example 2

25% of people in the city watched the Rugby League Final. Calculate how many people watched the Rugby League Final if the population of the city is 3 000 000.

Solution: Number of people watched = 25% of 3 000 000

$= \frac{25}{100} \times 3\,000\,000$

$= 750\,000$

Therefore, the number of people who watched the rugby league final is 750 000.

Now let us look at some applications in real life. In business, especially in buying and selling, there are cases where money is paid as a percentage in the form of commissions and taxes.

Commissions and taxes are often expressed as percentages.

> A **commission** is a percentage, or part, of sales. It is the amount of money an individual receives on a sale.

For example,

(a) A real estate agent earns a portion of the selling price of a house that she helps a client purchase or sell.

(b) A car dealer earns a portion of the selling price of an automobile that she sells.It is usually a percentage of how much they sell.

Example 1:

A salesman sold a carving for K300 and was given 15% commission. How much was he given as commission?

Solution: 15% of K300 = $\frac{15}{100} \times 300$

$= \frac{1500}{100}$

$= 45$

Answer: **K45**

Example 2

Calculate the commission earned on sales of K3500 at 25%.

Solution: 25% of K3500 = $\frac{25}{100}$ of K3500

= $\frac{87500}{100}$

= K 875

Answer: **K875**

Tax is a fee charged by a government on a product, income or activity. It is an amount of money levied by a government on its citizens and used to run the government, the country, a state, a county, or a municipality.

A **tax** on the estimated market **value added** to a product or material at each stage of its manufacture or distribution, ultimately passed on to the consumer is called the **Value added Tax (VAT).** Value added tax (VAT), in PNG is 10%.

Example 1: Find 10% VAT of K96

Solution: = $\frac{10}{100}$ x 96

= $\frac{960}{100}$

= 9.6

Answer: **K9.60**

Example 2

A married couple bought a set of kitchen units, price K1200 + VAT. How much did they pay for the units if the VAT rate is 15%?

Solution: VAT due is 15% of K1200 = $\frac{15}{100}$ x K 1200

= K180

Total cost of the units = K1200 + 180

= K1380

NOW DO PERACTICE EXERCISE 10

Practice Exercise 10

1. Find the sum of the following amounts.

   (a) K3.78 + K4.49 + 2.84

   (b) K2.61 + K9.38 + K1.67

   (c) K13.49 + K34.89 + K5.72

   (d) K0.46 + K1.16 + 39t + 63t

---

2. Subtract the first amounts from the second.

   (a) K4.37 ; K7.68

   (b) K4.82 ; K6.34

   (c) 48t ; 0.76

   (d) 33t ; K2.12

---

3. Senien earns K134.50 per fortnight. How much will she earn in a year?

---

4. In a class of 36 students, each student brought 75 toea for their class to buy a new clock. How much did they contribute all together?

---

5. A dozen pencils cost K32.40. How much does each one cost?

---

6. Sixty students went on a trip. The trip cost K216. How much did each student pay to meet the cost?

7. Find the amounts of the following using the given percentages.

   (a) 40% of K60
   (b) 76% of K300
   (c) 11% of K700
   (d) 24% of K350

---

8. Calculate the amounts and round off to the nearest toea.

   (a) 25% of K624.56
   (b) 20% of K2096
   (c) 125% of K250
   (d) 74% of K4522

---

9. Wari wins K50 in a raffle and gave 40% of the money to his sister. How much did his sister receive?

---

10. A shop buys a bicycle for K175 and re-sells it for 15% more. What is the new selling price?

---

11. Maria's shopping totaled K374.20 excluding VAT. How much will she pay altogether including VAT, if the VAT is 10%?

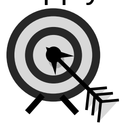
---

12. Kasties total sales for two weeks were K1250. She was given a commission of 20% plus her normal pay of K300. What was her total pay that fortnight?

CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 2.

Lesson 11: Percentages and Money

You identified the uses of money in everyday life in the last lesson. You also learnt to add, subtract, multiply and divide amounts of money as well as finding the percentage of an amount and applying the skills in solving problems in real life.



In this lesson, you will:

- identify situations in real life where percentage increase and decrease are applied
- define appreciation and depreciation
- solve word problems involving appreciation and depreciation in real life situations.

Everything has its price. We are all familiar with the price of a bottle of milk, a loaf of bread, a kilo of rice, a litre of petrol, a car or a house, but often we do not appreciate that money too has its price. The price of most things depends on “supply and demand”. The more articles are available, the cheaper they tend to be or vice versa. When the government announces that prices have increased by 10% it means that for every K100 we previously needed to buy goods and services we now need K110. All these entail the application of percentage changes in real life.

Let us work on some examples of the applications of percentage increase and decrease.

Profit and Loss

When a retailer buys goods and is able to sell them at a higher price, a **profit** or a **gain** is made.

The price at which an article or good is purchased, is called the **cost price**, abbreviated as **CP**.

The price at which an article or good is sold is called the **selling price,** abbreviated as **SP**.

If the selling price is greater than the cost price, the seller is said to have made **a profit** or a **gain**.

Profit or **Gain** is the difference between the selling price (**SP**) and cost price (**CP**).

In formula: Profit = Selling price – Cost Price

P = SP - CP

The percentage profit made is always calculated by expressing the profit as a percentage of the cost price.

Thus we have the formula: Percentage Profit = $\frac{\text{Profit}}{\text{Cost Price}} \times 100$

$$\mathbf{\% P = \frac{SP - CP}{CP} \times 100}$$

Similarly, if the selling price is less than the cost price, the seller is said to have incurred a **loss**.

Loss is the difference between the cost price (**CP**) and selling price (**SP**).

In formula: Loss = Cost price – Selling Price

$$\mathbf{L = CP - SP}$$

The percentage loss made is always calculated by expressing the loss as a percentage of the cost price.

Thus we have the formula: Percentage Loss = $\frac{\textbf{Loss}}{\textbf{Cost Price}} \times 100$

$$\mathbf{\% L = \frac{CP - SP}{CP} \times 100}$$

Look at the following examples.

Example 1

A retailer bought a clock for K55 and sold it for K77. Find his percentage profit.

Solution: Selling Price (SP) = K77
Cost Price (CP) = K55

Profit = SP – CP
= K77 – K55
= K22

% Profit = $\frac{\text{Profit}}{\text{Cost Price}} \times 100$

= $\frac{K22}{K55} \times 100$

= 40%

Therefore the percentage profit is 40%.

Example 2

Marina bought a can of milk for K80 and sold it at a profit of 25%. What is the selling price?

Solution: This problem can be solved using two methods.

Method 1 To find the selling price, add the cost price and the profit amount. To do this: calculate the amount of profit.

Since the profit is 25% or 25% of the cost price (CP).

Hence, Profit = $\frac{25}{100}$ x K80

= K20

Now calculate the Selling price (SP)

SP = Cost Price + Profit

= K80 + K20

= K100

Therefore the selling price is K100.

Method 2

In general term, if the profit is P%

$$SP = CP \times \frac{100 + P}{100}$$

$$SP = K80 \times \frac{100 + 25}{100}$$

$$SP = K80 \times \frac{125}{100}$$

SP = K100

Therefore the selling price is K100.

Remember:

- If an article or good is sold at **a gain of**, say for example **15%**, then **SP** = **115%** of **CP**.
- If an article or good is sold at **a loss of**, say for example **15%**, then **SP** = **85%** of **CP**.

On the next pages, you will learn more application of percentage changes in real life such as in computing discount in prices, markup and sale price.

Stores will often sell items for a discounted sale price. The store will discount an item by a percent of the original price or cost price. Discount is calculated by using the formula:

D = r% x CP

Where: **D** is the amount of discount
CP is the original or cost price
r% is the rate of discount

For example, an item that originally cost K20 may be discounted by 20%.

To find the **amount of discount**, calculate 20% of the **original price** (K20).

Hence, amount of discount = 20% of K20
= 0.20 x K20
= K4.00

Subtract the discount from the original price to find the **sale price**.

Hence, the **Sale price = Original price – Discount**
= K20 – K4
= K16

The following are terms you may see for discounted items: 50% Off, Save 50 % Discounted by 50%.

Here is another example.

The original price of the jacket on the picture is K69.00.

How much is the sale price if it is advertised at 20% discount as shown.

Solution:

Given on the problem: Original Price or Cost price (CP) = K69.00
Rate of Discount = 20%

Unknown in the problem: Amount Discount (D) = ______
Sale Price (SP) = ______

We have to find the amount of discount first to get the sale price.

Discount = 20% of K69.00
= K13.80

Therefore, Sale Price = K69.00 – K13.80
= K55.20

The sale price of the jacket is K55.20.

The table below shows the important ideas and formulas to remember when working out problems involving discount.

To find the discount (**D**) when the cost price (**CP**) and the rate of discount (**r%)** are given, multiply the cost price by the rate of discount.

$$\mathbf{D = CP \times r\%}$$

To find the sale price (SP), subtract the discount from the cost price.

$$\mathbf{SP = CP - D}$$

To find the rate of discount (**r%**), find what percent of the cost price the discount is.

$$\mathbf{r\% \text{ of } CP = D \quad or \quad r\% = \frac{D}{CP}}$$

To find the cost price (CP) when the sale price (SP) and rate of discount (r%) are given, subtract the given rate from 100%. Then divide the sale price by the result.

$$\mathbf{CP = \frac{SP}{100\% - r\%}}$$

Now look at this.

Often, stores buy items from wholesaler or distributor of goods and increase the price when they sell the items to consumers. The increase in price provides money for the operation of the store and the salaries of people who work in the store.

A store may have a rule that the price of a certain type of goods or items needs to be increased by a certain percentage to determine how much to sell it for. This percentage is called the **markup.**

$$\mathbf{Markup = r\% \times Cost\ Price(CP)}$$

If the cost price is given and the amount of markup is known, the rate of markup or markup rate is amount of markup over the original cost price.

$$\mathbf{r\% = \frac{Markup}{Cost\ Price}}$$

If the cost price is known and the percentage markup is known, the sale price is the original cost plus the amount of markup.

$$\mathbf{Sale\ Price(SP) = Cost\ Price(CP) + Markup}$$

At the same time, if the Sale price and the original price is known, the mark up is the sale price minus the original price.

$$\mathbf{Markup = Sale\ Price(SP) - Cost\ Price(CP)}$$

Example 1

If the original cost of an item is K8.00 and the markup is 25%, what is the sale price?

Solution: We need to find the amount of Markup.

Markup = 25% of K8.00
= 0.25 x K8.00
= K2.00

Now, computing the sale price, we have:

Sale price = K8.00 + K2.00
= K10.00.

A faster way to calculate the sale price is to make the original cost equal to 100%. The markup is 25%, so the sale price is 125% of the original price.

In example 1 we have, K8.00 x $\frac{125}{100}$ = **K10.00**

Example 2

A golf shop pays its wholesaler K40 for a certain club, and then sells it to a golfer for K75. What is the markup rate?

Solution: We need to find the amount of markup.

Amount of Markup = Sale price – Cost Price
= K75 – K 40
= K35

Now find the markup rate.

r% = $\frac{K35}{K40}$
= 0.875
= 87.5 %

NOW DO PERACTICE EXERCISE 11

Practice Exercise 11

1. Complete these statements:

   (a) Cost price + __________ = Sale price

   (b) Markup = Sale price – __________price

   (c) Markup is the amount of money added to the _________ price to find the _________ price.

   (d) Markup and ___________ profit mean the same.

2. Jeremy buys a second-hand car for K7250 and sells it for K8700.

   (a) What profit does he make?

   Answer: __________

   (b) What is his percentage profit?

   Answer: __________

3.. Complete the blank spaces.

	Cost price	Selling price	Mark-up
(a)	K15.70	K22.30	K ______
(b)	K999	K ______	K284
(c)	K ______	K148.50	K39.80

---

4. Find the markup in kina in each of the following:

   (a) Cost price = K57.80. Markup = 15%

   Answer: ______________

   (b) Cost price = K148. Markup = $12\frac{1}{2}$ %

   Answer: ______________

5. The cost of a refrigerator is K1250 and the markup is 10%.

(a) What is the markup in kina?

Answer: _______________

(b) What is the selling price?

Answer: _______________

---

6. A trade store owner's markup of a couch with cushions is 25%.
It costs him K120.

(a) What is the markup in kina?

Answer: _______________

(b) What is the selling price?

Answer: _______________

---

7. The cost of a bale (12 packets) of Ramu Sugar is K20.56. The markup allowed is $12\frac{1}{2}$ %.

(a) What is the selling price of the bale of sugar?

Answer: _______________

(b) What is the selling price of a packet of sugar?

Answer: _______________

---

8. A retailer buys a table for K120 and sells it for K135. What is the gross profit percent (markup percent)?

Answer: _______________

9. A retailer buys a carton (24 tins) of fish for K61.20. He sells each tin for K2.85.

(a) What is the cost price of one tin?

Answer: ______________

(b) What is the mark-up percent?

Answer: ______________

---

10. Jim buys T.V.'s at K750 each and sells them at K840 each.

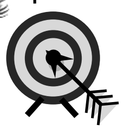
What is his percent markup?

Answer: ______________

CHECK YOUR WORK.ANSWERS ARE AT THE END OF TOPIC 2.

Lesson 12: Budgeting

You have learnt to work out problems involving money and percentages in the previous lesson.



In this lesson, you will;

- define budget and budgeting
- identify the different types of budget
- identify the different features of a budget plan
- draw a simple household or personal budget plan.

Successful businesses around the world have one thing in common: they budget their money. And they do budgeting because it works.

First in this lesson, we will learn what budgeting and a budget means.

Budgeting is the process of creating a plan to spend money. This means budgeting involves a number of activities performed in order to prepare a budget.

A **budget** is a plan used as a tool for deciding which activities will be chosen for a future time period. **It is an estimation of the revenue and expenses over a specified future period of time.**

A budget can be made for a person, family, group of people, business, government, country, multinational organization or just about anything else that makes and spends money.

A budget in general, is a written plan that outlines an organization's financial or operational goals. It is an action plan; it helps a business allocate resources, evaluate performance, and formulate plans. Understanding the importance of budgeting is the first step in successful financial planning.

There are different types of budget and each type serves a different purpose.

1. **Capital Budgets**

   A capital budget estimates all capital asset acquisitions and summarizes all expenses and costs of major purchases for the next year. Its main purpose is to forecast costs of major capital purchases.

2. **Operating Budgets**

   Operating budgets indicates the products and services a firm expects to use in a budget period. It describes all the income-generating activities of a firm, including production, sales and inventories of finished goods. It typically has two distinct parts: the **expense** budget and the **revenue** budget.

The expense budget indicates all expected expenses of a firm for the coming year, while the revenue budget shows all projected revenues for the coming year.

3. Cash Budgets

A cash budget projects all cash inflows and outflows for the year. It has four distinct elements: cash disbursements, cash receipts, net change in cash and new financing. A cash budget is important because it allows administrators to identify the days with cash overages and shortages in a timely manner so they can take necessary remedial actions.

4. Household or Personal Budgets

A household or personal budget is a finance plan that allocates future personal income towards expenses, savings and debt repayment. Past spending and personal debt are considered when creating a household or personal budget.

How to create or set up a budget?

Many people complain that they cannot create a budget because they do not know exactly how much money they will earn in a given week. While it is true, that earnings might not get exact same kina figure in each paycheck, the amount you earn has much less to do with the basics of budgeting than the amount you spend.

Instead of focusing on whether you earn enough each week, month or year, focus on your weekly, monthly or yearly spending. The question is simple: Where does your money go?

In this lesson, we are going to look at how to work out a simple **Household or Personal budget.**

The main purpose of having a personal or household budget is to help you in the following ways:

- You can plan savings
- You can plan your essential or necessary expenses.

  Essential expenses include rent or mortgages, insurance (medical, dental, etc), utilities, insurance, car maintenance, gas, food and groceries, transportation or bus fares and clothing
- You can plan how much money you can spend on non-essential expenses

  Non-essential expenses include **luxuries** (items that you can cut out or do not provide you with the level of enjoyment worthy of the price) and **sanity savers (**items that the level of enjoyment you get from them far-weigh the financial cost and are not budget busters). Examples are entertainment (concerts and movies), cigarettes, drinks, rugby games and dining out.

This type of personal or household budget must be based on a regular income. That is, the person planning the budget must always know the amount of money that is coming in. So, it is planned on a person's income, expenses and savings.

Here are some things to think about when drawing or setting up a budget.

1. Estimate your regular income. That is, the money which you will be getting each fortnight or each month.

2. Decide how much money you would want to save each fortnight or each month and what you want to save for.

   People save money for different reasons.

   Some save money to buy things like cars, computers, televisions, etc.

   Some save money for their children's school fees in the future.

   Some people save money for airfares, so they can fly home and visit their families.

3. Estimate how much money you need for essential expenses each fortnight.
4. Decide if you need to spend what is left on non-essential expenses.

   You can increase your savings by cutting down on your non-essential expenses.

Here is an example of a Household Budget.

Example

Kasi Abaniko's fortnightly wages are K1080. He saves K50 for his retirement, K40 for his children's education and K35 for emergency savings. Kasi's essential expenses per fortnight are as follows:

Rent	K300
Food/groceries	K250
Electricity and gas bills	K110
Health insurance	K50
Phones/Cell Phone)	K45
Petrol for car	K60

Kasi found that he still had K140 left, which he spent on non-essential items:

Entertainment	K80
Cigarettes	K15
Drinks	K25
Gifts	K20

When Kasi planned his budget, it looked like the one on the next page.

KASI'S FORTNIGHTLY BUDGET

Income each fortnight		Expenses and savings each fortnight	
Wages	K1080	Essential expenses:	
		Rent	K300
		Food/groceries	K250
		Electricity and Gas Bills	K110
		Health Insurance	K50
		Phones (mobile and landline)	K45
		Petrol for car	K60
		Sub – Total	K815
		Non-essential expenses	
		Entertainment	K80
		Cigarettes	K15
		Drinks	K25
		Gifts	K20
		Sub - Total	K955
		Savings:	
		Retirement Savings	K50
		Children's Education	K40
		Emergency savings	K35
		Sub- Total	K125
		Total	K1080

When planning a budget, you will notice the following:

INCOME = TOTAL EXPENSES + SAVINGS

The first rule in budgeting is simple: **Spend less than you earn!**

You can make your own budget, too. All you have to do is change the income and spending categories to reflect your personal situation. Then copy the table so you have a plan for each fortnight or month of the year. This makes it easy to plan in advance as well as look back on past fortnights or months and see how you did.

NOW DO PRACTICE EXERCISE 12

Practice Exercise 12

1. Fill in the blank spaces by choosing the correct word from the following box list.

INCOME, EXPENSES, BUDGETING, SAVINGS,
FINANCE PLAN, TAX, BUDGET

(a) ___________ is a process of creating a plan to spend money.

(b) The total amount of money which you will be getting each fortnight or each month for getting a job is called your __________.

(c) ___________is the money you kept for special purpose.

(d) A ____________is an estimation of the revenue and expenses over a specified future period of time.

(e) A personal budget is ______________ that allocates future personal income towards expenses, savings and debt repayment.

---

2 Answer the following briefly.

(a) Why do people make a budget?

(b) Why do people save money?

(c) What are non-essential expenses?

.

3. Joe Map's budget is written below.

Study the budget carefully and answer the questions that follow:

JOE MAP'S BUDGET

Income each fortnight	**Expenses and savings each fortnight**	
Joe's Income K2125	Essential expenses:	
Wife's income K 420	Rent	K500
	Food/groceries	K450
	Electricity and Gas Bills	K210
	Health Insurance	K150
	Phones (mobile and landline)	K95
	Petrol for car	K80
	Sub-total	K_______
	Non-essential expenses	
	Entertainment	K180
	Cigarettes	K70
	Drinks	K65
	Gifts	K40
	Sub-total	K_______
	Savings:	K_______
Total income K_____	Total Expenses	_______

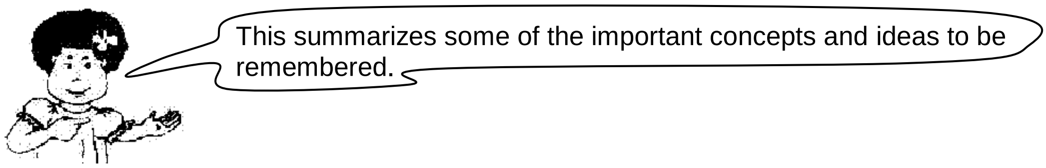
(a) What was Joe's family total Income?

(b) How much did Joe save each fortnight?

(c) How much did Joe spend altogether on essential expenses?

CHECK YOUR WORK.ANSWERS ARE AT THE END OF TOPIC 2.

TOPIC 2: SUMMARY



- To convert a fraction to a decimal, divide the top number by the bottom number (divide the numerator by the denominator in mathematical language).
- To convert a decimal to a fraction, express the decimal to equivalent decimal fraction whose denominator is a power of ten, then simplify the fraction into its simplest form.
- To convert percentage to decimal, divide by 100 and remove the "%" sign.
- To convert fraction to percentage, divide the numerator (top number) by the denominator (bottom number) then multiply the result by 100 or move the decimal point two places to the right and add the "%" sign.
- To convert percentage to fraction, put the number over 100 and reduce to its simplest form. Then drop or remove the "%" sign.
- When you make something become larger in size or quantity, it is called an "**increase".**
- A "**decrease**" is simply the opposite of an increase where the quantity or size is reduced or lessened.
- To find an increase or decrease, calculate the amount or quantity by the percentage it has been increased or decreased by.
- A percentage change is a way to express a change in a variable. It represents the change between the old value and the new one.
- To express one quantity as a percentage of another quantity:
    1. Express both the quantities in the same units.
    2. Write the given quantity as fraction of the total quantity.
    3. Multiply by 100, simplify and add the "%" sign.

- A **commission** is a percentage, or part, of sales. It is the amount of money an individual receives on a sale.
- **Tax** is a fee charged by a government on a product, income or activity
- **Profit** or **Gain** is the difference between the selling price (**SP**) and cost price (**CP**).
- **Loss** is the difference between the cost price (**CP**) and selling price (**SP**).
- **Markup** is the amount of money added to the cost price to find the sale price.
- **Budgeting** is a process of creating a plan to spend money.This means budgeting is a number of activities performed in order to prepare a budget.
- A **budget** is a quantitative plan used as a tool for deciding which activities will be chosen for a future time period. **It is an estimation of the revenue and expenses over a specified future period of time.**

REVISE LESSONS 7 – 12 THEN DO TOPIC TEST 2 IN ASSIGNMENT BOOK 1.

ANSWERS TO PRACTICE EXERCISE 7-12

Practice Exercise 7

1. (a) $\frac{3}{20}$ (b) $\frac{7}{25}$ (c) $\frac{7}{20}$ (d) $\frac{9}{10}$ (e) $\frac{16}{25}$ (f) $\frac{11}{50}$

2. (a) 45% (b) 16% (c) 98% (d) 96% (e) 60% (f) 95%

3. (a) 0.25 (b) 0.1 (c) 0.75 (d) 0.5 (e) 0.2 (f) 1.5

4. (a) 3% (b) 5% (c) 35% (d) 42% (e) 72% (f) 109%

5. (a) 34% (b) $\frac{66}{100}$ or $\frac{33}{50}$ (c) $\frac{34}{100}$ or $\frac{17}{50}$

6. (a) Nanai (b) Numa

7. 80%

8. Elai

Practice Exercise 8

1. (a) K8 (b) 25% (c) 30%

2.

Original Value	% Increase	New Value
(a) 56	25%	**70**
(b) 6	50%	**9**
(c) 5	20%	**6**
(d) 8	75%	**14**
(e) 10	90%	**19**
(f) 30	70%	**51**
(g) 50	2%	**51**
(h) 21	100%	**42**

3.

Original Value	% Increase	New Value
(a) 32	**75%**	56
(b) 24	**25%**	30
(c) 15	**20%**	18
(d) 30	**10%**	33
(e) 150	**2%**	153
(f) 120	**5%**	126
(g) 200	**1%**	202
(h) 20	**1.5%**	50

4.

Original Value	% Decrease	New Value
(a) 50	30%	35
(b) 18	50%	9
(c) 25	4%	24
(d) 60	35%	39
(e) 40	15%	34
(f) 64	75%	**16**
(g) 40	45%	22
(h) 45	60%	18

5.

Original Value	% Decrease	New Value
(a) 20	5%	19
(b) 14	50%	7
(c) 90	**10%**	81
(d) 35	20.4%	21
(e) 400	99%	4
(f) 50	6%	47
(g) 125	8%	115
(h) 150	12%	132

Practice Exercise 9

1. (a) 81% (b) 80% (c) 25% (d) 25% (e) 30% (f) 40%

2 (a) 90% (b) 65% (c) $33\frac{1}{3}\%$ (d) 6.7% (e) $22\frac{1}{2}\%$ (f) 98%

3. Benua, 70%; Maru, 54%; Jack, 52%

4. 21 %

5. (a) 50% (b) 40% (c) 10%

6. 40% came from China

Practice Exercise 10

1. (a) K11.11 (b) K13.66 (c) K54.10 (d) K2.64

2. (a) K3.31 (b) K1.52 (c) K0.28 (d) K1.79

3. K3497

4. K27

5. K2.70

6. K3.60

7. (a) K24 (b) K228 (c) K77 (d) K84

8. (a) K156.10 (b) K419.20 (c) K312.50 (d) K3346.30

9. K20

10. K201.25

11. K411.62

12. K550

Practice Exercise 11

1. (a) Cost price + **Markup** = Sale price

   (b) Markup = Sale price – **Cost** price

   (c) Markup is the amount of money added to the **Cost** price to find the **sale** price.

   (d) Markup and **percentage** profit mean the same.

2. (a) K1450 (b) 20%

3.

	Cost price	Selling price	Mark-up
(a)	K15.70	K22.30	K6.60
(b)	K999	**K1283**	K284
(c)	**K108.70**	K148.50	K39.80

4. (a) K8.67 (b) K18.50

5. (a) K125 (b) K1375

6. (a) K30 (b) K150

7. (a) K23.13 (b) K1.93

8. 12.5% or $12\frac{1}{2}$

9. (a) K2.55 (b) 11.8 %

10. 12%

Practice Exercise 12

1. (a) Budgeting
   (b) Income
   (c) Savings
   (d) Budget
   (e) Finance plan

2. (a) People make budget to help them plan how to spend their income. A budget helps you plan for your (a) essential expenses (b) non-essential expenses and savings.
   (b) People save money for special purposes such as buying a new car, paying children's education, and so on.
   (c) Non-essential expenses are the expenses due to things that you do not really need in order to live properly. This includes luxury items and sanity savers. For examples, cigarettes, entertainments like movies and videos or film shows, drinks, etc.

3. (a) Joe's family total income = Joe's income + wife's income

   = K2125 + K420

   = K2545

   (b) Joe's fortnightly savings is = Income - total expenses.
   = K2545 – K1840
   = K705

   (c) Joe's essential expenses = Total expenses – Non-essential expenses
   = K1840 – K355
   = K1485

END OF TOPIC 2

TOPIC 3

RATIO AND PROPORTION

Lesson 13:	**Equivalent Ratios**
Lesson 14:	**Dividing a Quantities into Given Ratios**
Lesson 15:	**Direct Proportions**
Lesson 16:	**Inverse Proportions**
Lesson 17:	**Estimating and Interpreting Rate Tables and Graphs**
Lesson 18:	**Conversion Graphs**

TOPIC 3: RATIO AND PROPORTION

You have learnt that fractions are used to compare two given sets. If there are 3 men for every 5 women in a party, using the language of rational numbers, we may say that there are $\frac{3}{5}$ as many men as women. Another way of expressing the comparison is "the ratio of men to women is 3 to 5." Ratio is just another language for thinking about rational numbers.

Many problems we encounter in real life can be solved when we think in terms of ratios and proportions. For examples

1) Advertisements are effective instruments in attracting the buying public by imploring better quality or better prices. Let us say one store offers $\frac{1}{4}$ off and another store offers 30% off. Which store offers the greater price reduction?

2) Often times, you wish to draw a reduced or enlarged version of an object. For example, you want to make the floor plan of your bedroom. If you use the actual measurement in your drawing, you will have a drawing as large as your bedroom. This would not be convenient. So what do you do?

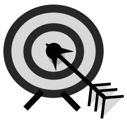
3) In a cultural presentation, 8 tickets cost K200, how much will 12 tickets costs?

Ratios and proportions are the surest ways to find the answers to such questions.

In this topic, you will learn to find equivalent ratios to create proportions; solve direct and inverse proportion problems; estimate and interpret rate tables and graphs and use conversion graphs in expressing or changing one quantity to another.

Lesson 13: Equivalent Ratios

You have learned something about ratios in your earlier study of Mathematics.



In this lesson, you will:

- revise the meaning of ratio and its notation
- define equivalent ratios
- find equivalent ratios to create proportions

As we already know, a ratio is a comparison of two quantities by division and can be written in several ways. A colon (**:**) is often used.

Example: The ratio 3 to 5 can also be written as 3**:**5 or $\frac{3}{5}$.

Since we are more familiar with fractions, we usually write a ratio as a fraction.

It must be noted the order in which the numbers appear in a ratio is important.

Example: The ratio of 10 cm to 21 cm is 10**:**21 or 10 to 21.

The ratio of 21 cm to 10 cm is 21**:**10 or 21 to 10.

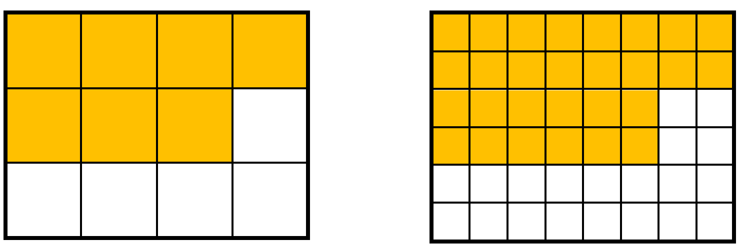
Now, consider this information.

Relative density is the ratio of a substance to the density of water at 4ºC. The relative density of silver is 10.5. This means that silver is 10.5 times as heavy as an equal volume of water.

The comparisons of water to silver presented in the table below are **ratios** that are all equivalent.

COMPARISON OF MASS OF EQUAL VOLUME OF WATER AND SILVER				
Water	1 g	2 g	3 g	4 g
Silver	10.5 g	21 g	31.5 g	42 g

Now look at these diagrams.



In one rectangle, the ratio of shaded squares to un-shaded squares is 7**:**5.

In the other rectangle, the ratio is 28**:**20.

Both rectangles have equivalent shaded areas.

Ratios that make the same comparison are **equivalent or equal ratios**.

Finding equivalent ratios

Since ratios can be written in the form of fractions, finding equivalent ratios is similar to finding equivalent fractions.

To find ratios that are equivalent to a given ratio, multiply or divide the numerator and the denominator by the same number.

Some examples of finding equivalent ratios are shown below.

Example 1

Find two ratios that are equivalent to each given ratio.

(a) 6 : 8 or $\frac{6}{8}$

Solution: $\frac{6}{8} = \frac{6 \times 2}{8 \times 2} = \frac{12}{16}$

$\frac{6}{8} = \frac{6 \div 2}{8 \div 2} = \frac{3}{4}$

Multiply the numerator and the denominator by the same non-zero number.

Two ratios equivalent to $\mathbf{\frac{6}{8}}$ are $\mathbf{\frac{12}{16}}$ and $\mathbf{\frac{3}{4}}$**.**

(b) 48 : 27 or $\frac{48}{27}$

Solution: $\frac{48}{27} = \frac{48 \times 2}{27 \times 2} = \frac{96}{54}$

$\frac{48}{27} = \frac{48 \div 3}{27 \div 3} = \frac{16}{9}$

Multiply the numerator and the denominator by the same non-zero number.

Two ratios equivalent to $\mathbf{\frac{48}{27}}$ are $\mathbf{\frac{96}{54}}$ and $\mathbf{\frac{16}{9}}$**.**

Simplifying a ratio in its simplest form

A ratio is in its simplest form when both the numerator and the denominator are whole numbers and no whole number can divide them except 1.

To write ratio in its simplest form, keep on dividing both sides by the same number until you can’t go any further without going into decimals.

Example: Write 160 **:** 240 in its simplest form.

Solution: **Method 1**

160 **:** 240	divide both sides by 4
40 **:** 60	divide both sides by 2
20 **:** 30	divide both sides by 5
4 **:** 6	divide both sides by 2
2 **:** 3	Simplest form

Method 2

160 **:** 240 can be written as fraction

$\frac{160}{240}$ GCF of 160 and 240 is 80

$\frac{160 \div 80}{240 \div 80}$ Divide the numerator and the denominator by 80 (GCF).

$\mathbf{\frac{2}{3}}$ Simplest form

Sometimes we need to write the ratio in the form **N : 1** or **1 : N**

To write a ratio in the form **N : 1**, divide both side s by the left-hand member.

For example, for the ratio **8 : 20** you would divide both sides by **8**, giving the equivalent ratio **1 : 2.5**.

To write a ratio in the form **1 : N**, divide both side s by the right-hand member.

For example, for the ratio **16 : 10** you would divide both sides by **10**, giving the equivalent ratio **1.6 : 1**.

Equivalent ratios are identical when they are written in simplest form. Ratios that are equivalent are said to be **proportional** or in **proportion**.

What do we mean by a proportion?

A proportion is a statement that two ratios are equivalent.

A proportion is usually written as two equivalent fractions or using a colon.

For example:

1. $\frac{3}{5} = \frac{21}{35}$ or 3: 5 = 21: 35

2. $\frac{60\text{ minutes}}{1\text{ hour}} = \frac{360\text{ minutes}}{6\text{ hours}}$

3. $\frac{60\text{ minutes}}{360\text{ minutes}} = \frac{1\text{ hour}}{6\text{ hours}}$

Sometimes you will need to figure out whether two ratios are, in fact, a true or false proportion.

Below is an example that shows the steps of determining whether two equal ratios are a true or false proportion.

Example 1

Is the proportion $\frac{100\text{ grams}}{4\text{ cans}} = \frac{50\text{ grams}}{2\text{ cans}}$ true or false?

Solution:

Step 1 Check to make sure that the units in the individual ratios are consistent either vertically or horizontally

$$\frac{100\text{ grams}}{4\text{ cans}} = \frac{50\text{ grams}}{2\text{ cans}}$$

Grams (check) The units are consistent across the numerators.

Cans (check) The units are consistent across the denominators.

Step 2 Express each ratio as simplified fractions.

$$\frac{100 \div 4}{4 \div 4} = \frac{25}{1}$$

$$\frac{50 \div 2}{2 \div 2} = \frac{25}{1}$$

Step 3 Since the simplified forms are equal, $\frac{25}{1} = \frac{25}{1}$, the proportion is true.

Example 2

Simplify $\frac{40}{84} = \frac{10}{21}$ to tell whether the ratios form a true proportion.

Solution: $\frac{40 \div 4}{84 \div 4} = \frac{10}{21}$

$\frac{10}{21}$ is already in its simplest form.

Since the simplified forms are equal, the ratios form a true proportion.

Remember: There are two ways to determine whether two ratios are in proportion:

1. Writing the two ratios in simplest form
2. Using the cross product or proportion rule.

On the next page, you will look at the proportion rule.

In Grade 7 and 8 you learnt that in any proportion there are four numbers involved, namely the **means** and the **extremes**.

The *extremes* are the end numbers in a proportion, while *means* are the middle numbers in a proportion.

In the proportion: $\mathbf{\frac{a}{b} = \frac{c}{d}}$ or $\mathbf{\overbrace{a : \underbrace{b = c}_{\text{Means}} : d}^{\text{Extremes}}}$

The values in the **a** and **d** positions are called the **extremes** while the values in the **b** and **c** positions are called the **means** of the proportion.

The basic defining property of a proportion **(Proportion Rule)** states that:

The product of the means is equal to the product of the extremes.

In other words, given the proportion $\mathbf{\frac{a}{b} = \frac{c}{d}}$ or **a : b = c : d** we can conclude that **ad = bc.** This is called **Cross Product** method.

These relationships are other ways to figure out whether two equal ratios are a true proportion or not.

Examples

Find whether each of the following statements is a proportion.

(a) $\frac{2}{3} = \frac{6}{9}$ (b) 10 : 5 = 40 : 20 (c) $\frac{4}{3} = \frac{20}{18}$

Solutions:

(a) $\frac{2}{3} = \frac{6}{9}$ Use cross product to verify: $\frac{2}{3} \times \frac{6}{9}$

2 x 9 = 3 x 6

18 = 18

Yes, it is a proportion.

(b) 10 : 5 = 40 : 20 Use proportion rule to verify.

Product of means: 5 x 40 = 200

Product of extremes: 10 x 20 = 200

Yes, it is a proportion.

(c) $\frac{4}{3} = \frac{20}{18}$ Use cross product to verify: $\frac{4}{3} \times \frac{20}{18}$

$4 \times 18 = 3 \times 20$

$72 = 60$

No, it is not a proportion.

If you know that the relationship between quantities is proportional, you can use proportions to find the missing quantities.

Example 1

Find the missing term in the given proportion: $\frac{15}{25} = \frac{n}{5}$

Solution:

$\frac{15}{25} = \frac{n}{5}$ Re-write the proportion

$25 \times n = 15 \times 5$ Multiply to get the cross products.

$25n = 75$ Divide to find n.

$n = \frac{75}{25}$

n = 3

Example 2

Solve for the unknown in the given proportion: 5 : n = 10 : 6

Solution:

5 : n = 10 : 6

$10 \times n = 5 \times 6$ Use the Proportion Rule to get the cross products

$10n = 30$ Divide to find n.

$n = \frac{30}{10}$

n = 3

Example 3

Find the length of a photograph whose width is 10 cm and whose proportions are the same as a 5 cm by 8 cm photograph.

Solution: Determine the relationship: $\frac{\text{Width}}{\text{Length}}$

Original photo: $\frac{5\,\text{cm}}{8\,\text{cm}}$

Enlarged Photo: $\frac{10\,\text{cm}}{n}$

Write a proportion that states that the two ratios are equal. $\frac{5}{8} = \frac{10}{n}$

Cross multiply: $5 \times n = 8 \times 10$

$5n = 80$

Divide both sides by 5 to find the value of n. $\frac{5n}{5} = \frac{80}{5}$

$n = 16$

The length of the enlarged photograph is 16 cm.

NOW DO PRACTICE EXERCISE 13

Practice exercise 13

1. Express each of the following ratios in simplest form.

(a) 20 min to 1 hour

(b) 12 days to 2 week

(c) 25 cm to 1 m

(d) 35 g to 1 kg

(e) K100 to K150

(f) 30 red balls to 45 green balls

(g) 875 girls to 1875 students

(h) 15 hours to 1 day

---

2. Write each of the ratios below in the form **1: N**.

(a) 2 : 5 is equivalent to 1 **:** ______
(b) 5 : 3 is equivalent to 1 **:** ______
(c) 10 : 35 is equivalent to 1 **:** ______
(d) 6 : 9 is equivalent to 1 **:** ______
(e) 5 : 12 is equivalent to 1 **:** ______
(f) 15 : 12 is equivalent to 1 **:** ______
(g) 4 : 10 is equivalent to 1 **:** ______
(h) 3 : 9 is equivalent to 1 **:** ______
(i) 8 : 20 is equivalent to 1 **:** ______

---

3. Write each of the ratios below in the form **N: 1**.

(a) 6 : 5 is equivalent to ______**:** 1
(b) 18 : 3 is equivalent to ______**:** 1
(c) 15 : 2 is equivalent to ______**:** 1
(d) 7 : 10 is equivalent to ______**:** 1
(e) 6 : 12 is equivalent to ______**:** 1
(f) 15 : 12 is equivalent to ______**:** 1
(g) 4 : 5 is equivalent to ______**:** 1
(h) 27 : 3 is equivalent to ______**:** 1
(i) 20 : 4 is equivalent to ______**:** 1

4. Find the missing number in the given proportions.

(a) 12 **:** 20 = 3 **:** _____

(b) 8 **:** 4 = _____**:** 1

(c) 4 **:** 5 = 20 **:** _____

(d) 15 **:** 25 = _____**:** 5

(e) ____**:** 49 = 1**:** 7

---

5. State whether the following ratios are proportional.

(a) 1 **:** 4 and 6 **:** 18 ________________________

(b) 3 **:** 5 and 1 **:** 3 ________________________

(c) 2 **:** 5 and 8 **:** 20 ________________________

(d) 4 **:** 9 and 12 **:** 27 ________________________

(e) 6 **:** 15 and 2 **:** 5 ________________________

---

6. Problem Solving

(a) In a basket, there are 24 good oranges and the rest are bad oranges. The ratio of good oranges to bad oranges is 3 **:** 1.

Find the number of bad oranges.

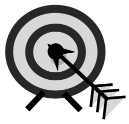
(b) The distance travelled by Tom and Tam is in the ratio 3 **:** 4. The distance travelled by Tom is 18 km.

Find the distance travelled by Tam.

CHECK YOUR WORK.ANSWERS ARE AT THE END OF TOPIC 3.

Lesson 14: Dividing Quantities into Given Ratios

You learnt the meaning of direct proportion in the last lesson. You also learnt to solve direct proportion problems using the unitary and ratio methods.

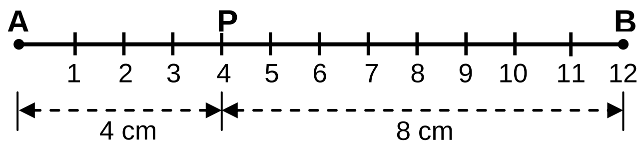


In this lesson: you will:

- divide quantity into a given ratio.

Sometimes we need to divide an amount up according to a particular given ratio. This is sometimes called "division in a given ratio".

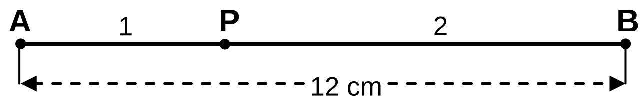
Consider a line segment **AB** of length 12 cm which is divided into two line segments of length 4 cm and 8 cm as shown in the diagram below.



As shown**, AP** = 4 cm and **PB** = 8 cm.

We say, the ratio of **AP** to **PB** = 4 **:** 8

= 1 **:** 2



Conversely, if we know that the point **P** divides the line segment **AB** of length 12 cm in the ratio 1**:** 2, we can determine the length of **AP** and **BP** as follows:

First, work out the total number of parts in the ratio.

Number of parts = 1 + 2 = 3 parts

Since the total length (**AB**) to be divided is 12 cm, which is 3 parts,

Length of **AP** = $\frac{1}{3}$ of 12

= $\frac{1}{3}$ x 12

= 4

Length of **BP** = $\frac{2}{3}$ of 12

= $\frac{2}{3}$ x 12

= 8

So, the length of AP and BP are 4 cm and 8 cm.

A good check is to make sure that the answers add up to the original length.
In this case, 4 cm + 8 cm = 12 cm

Let us look at the following examples.

Example 1

Henry and Ariel worked together on a project and received K250 for their completed work. Ariel worked 2 days and Henry worked 3 days, and they agree to divide the money between them in the ratio 2 **:** 3. How much should each receive?

Solution: We picture the K250 divided into two parts.

The first step is to work out the total number of parts in the ratio.

Ariel is getting 2 parts and Henry is getting 3 parts, so

Total number of parts = 2 + 3
= 5 equal parts

Now there are five parts and the smaller amount (Ariel's share) is 2 of them.

So, Ariel's share = $\frac{2}{5}$ of K250

= $\frac{2}{5}$ x 250

= K100

Hence, Henry's share = $\frac{3}{5}$ of K250

= $\frac{3}{5}$ x 250

= K150

Check:

K100 + K150 = K250

Example 2

Jack, Jill and Judy are given 52 lollipops. They decided to share their lollipops in the ratio of their ages, 10 **:** 9 **:** 7.

(a) What is the total number of equal parts in the ratio?
(b) How many lollipops is one of the parts worth?
(c) How many lollipops does Jack get?
(d) How many lollipops does Jill get?
(e) How many lollipops does Judy get?

Solution:

(a) What is the total number of parts in the ratio?

Jack is getting 10 parts, Jill is getting 9 parts and Judy gets 7 parts.

Total number of parts = 10 + 9 + 7

= 26

There are 26 equal parts in the ratio.

(b) How many lollipops is one of the parts worth?

The total to be shared is 52 lollipops, which is 26 parts,

So, 1 part is 52 ÷ 26 = 2.

(c) How many lollipops does Jack get?

Jack gets 10 parts which is **20 lollipops** (10 x 2 = 20)

(d) How many lollipops does Jill get?

Jill gets 9 parts which is **18 lollipops** (9 x 2 = 18)

(e) How many lollipops does Judy get?

Judy gets 7 parts which is **14 lollipops** (7 x 2 = 14)

Check: 20 + 18 + 14 = 52

Example 3

Charles divided K840 between his three children; James, John and Jayson in the ratio 5 **:** 9 **:** 7. How much did each child receive?

Solution:

Total number of parts in the ratio is 21 equal parts. (5 + 9 + 7 = 21)

Consider the K840 to be divided into 21 equal parts,

Then one part is $\frac{\text{K840}}{21}$ = K40

Therefore, James share = 5 x K40 = K200

John's share = 9 x K40 = K 360

Jayson's share = 7 x K40 = K280

Check: K200 + K360 + K280 = K840

NOW DO PERACTICE EXERCISE 14

Practice exercise 14

1. Work out the answers to the questions below and fill in the boxes at the right.

(a) Divide K100 in the ratio 1:4		and			
(b) Divide 54 km in the ratio 11: 7.		and			
(c) Divide 30 kg in the ratio 1 : 2 : 3		and		and	
(d) Divide K108 in the ratio 3 : 4 : 5		and		and	
(e) Divide 75 L in the ratio 12 : 8 : 5		and		and	

2. Bonny and Clyde get K80 by selling their old toys at a car boot sale. They divide the money in the ratio 2 : 3.

   How much do they each receive?

3. To start up a business, it is necessary to spend K8000. Paul, Sam and Sarah agree to contribute in the ratio 8 : 7 : 1.

   How much does each need to spend?

4. The distance around a triangle is 63 cm. The ratio of the sides of the triangle are in the ratio of 5 : 6 : 7.

   Find the length of each side.

---

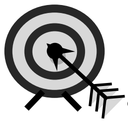
5. In a fruit cocktail drink, pineapple juice, orange juice and apple juice are mixed in the ratio 7 : 5 : 4.

   How much of each juice do you need to make 800 mL of the cocktail?

CHECK YOUR WORK.ANSWERS ARE AT THE END OF TOPIC 3.

Lesson 15: Direct Proportions

You learnt the meaning of ratio and proportion in the previous lesson. You also learnt to find equivalent ratios to create a proportion.



In this lesson, you will:

- define direct proportion
- identify methods in solving direct proportion problems
- solve direct proportion problems.

Often in our everyday life we encounter problems or questions like the following:

If 10 apples costs K27, how much will 8 apples cost?

If three bars of Cadbury's chocolate cost K14.55, how much do five of them cost?

We can use direct proportion to answer questions like these above.

Direct proportion involves situations where two values vary, but the ratio between the values stays the same.

Direct proportion is a proportion of two variable quantities when the rate of the two quantities is constant.

If one quantity is directly proportional to another, it changes in the same way. As it increases, so does the other; as it decreases, the other decreases too.

This means that two quantities are **directly proportional** to each other. As one amount increases, another amount increases in the same rate.

The symbol for "directly proportional" is $\propto$.

For example: You are paid K20 an hour.

How much you earn is directly proportional to how many hours you work. If you work more hours, you get more pay, in direct proportion.

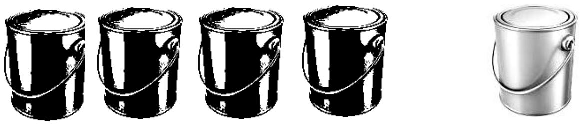
This can be written as:

Earnings $\propto$ Hours worked

If you work 2 hours you get K40
If you work 3 hours you get K60 and so on.

Here is another example.

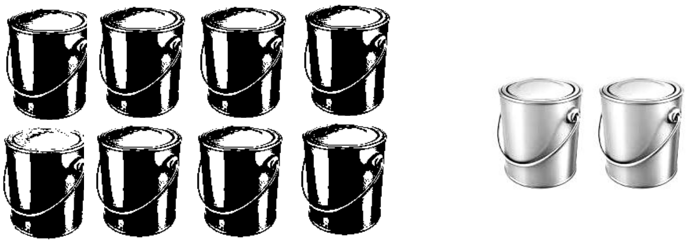
Joe wants to paint his farm so he needs to use the following paint mixture: four black pots and one gray pot.



The ratio is 4 pots black to 1 gray pot, **4 : 1**

If Joe also wants to paint his brother's farm, which is two times his, he has to double the amount of paint and increase it in the same ratio.

He doubles the amount of black paint: 8 pots
He doubles the amount of gray paint: 2 pots



The amount of black and gray paints Joe needs increase in direct proportion to each other.

Understanding direct proportions can help you to work out the value or amount of quantities either bigger or smaller than the one about which you have information.

How to solve proportions using the unitary method

Let us work out the questions in the beginning of the lesson.

1. If 10 apples costs K27, how much will 8 apples cost?

Solution:

Starting fact: 10 apples cost K27

To solve this, we need to change "10 apples" into "8 apples".

We start by finding out what 1 apple costs, by dividing both parts of our fact by 10.

New fact: 1 apple costs K2.70

Now we need to change '1 apple' into '8 apples

We can do this by multiplying both parts of our fact by 8.

Answer: 8 apples cost K21.60

2. If three bars of Cadbury's chocolate bars cost K14.55, how much would five of them cost?

Solution: Starting fact: "3 bars cost K14.55"

To solve this, we need to change '3 bars" into "5 bars".

We start by finding out what 1 bar, by dividing both parts of our fact by 3.

New fact: 1 bar costs K4.85

Now we need to change '1 bar' into '5 bars

We can do this by multiplying both parts of our fact by K4.85.

Answer: 5 bars of chocolates cost K24.25

Every time we want to answer a question like this, we start by changing the fact so that it just shows what one of something costs. In the above examples, we worked out what **one** apple or **one** bar of chocolate cost. We then used this to work out what **eight** apples or **five** bars of chocolate cost.

We called this method the **unitary method**.

> The **Unitary Method** is a **way** of solving problems involving ratios by **working out the value of a single unit**.

How to solve proportions using the ratio method

Using the ratio method means the same as using the cross product or the proportion Rule.

Example 1

To make 3 glasses of orange squash you need 600 mL of water. How much water do you need to make 7 glasses of orange squash?

Solution: Write the relationship as $\frac{3\text{ glasses}}{600\text{ mL}} = \frac{7\text{ glasses}}{n}$

Find the cross product. $\frac{3}{600} = \frac{7}{n}$

$3n = 600 \times 7$

$3n = 4200$

$n = \frac{4200}{3}$

$n = 1400$

Therefore, 1400 mL of water is needed to make 7 glasses of orange squash.

Example 2

A baker uses 1800 grams of flour to make 3 loaves of bread. How much flour will he need to use if he wants to make 7 loaves?

Solution: Let n be the amount of flour needed to make 7 loaves of bread.

Write the possible proportion as $\frac{1800\text{ grams}}{3\text{ loaves}} = \frac{n}{7\text{ loaves}}$

Find the cross product. $\frac{1800}{3} = \frac{n}{7}$

$3n = 1800 \times 7$

Multiply $3n = 12600$

Divide both sides by 3 $n = \frac{12\,600}{3}$

$n = 4200$

Therefore, 4200 grams of flour is needed by the baker to make 7 loaves of bread.

Example 3

Lydia can write 4 pages in 15 minutes. At this rate, how many pages can she write in 45 minutes?

Solution: Let n be the number of pages Lydia can write in 45 minutes

Write the possible proportion as $\frac{4}{15} = \frac{n}{45}$

Find the cross products $15 \times n = 4 \times 45$

Multiply $15n = 180$

Divide both sides by 15 $n = \frac{180}{15}$

$n = 12$

Therefore, Lydia can write 12 pages in 45 minutes.

NOW DO PERACTICE EXERCISE 15

Practice exercise 15

1. If two pencils cost K1.50 how many pencils can you buy with K9.00?

2. Sonny ran 100 metres in 15 seconds. How long did she take to run 1 metre?

3. A car travels 125 km in 3 hours. How far would it travel in 9 hours?

4. A man earns K288 by working for 36 hours. How much would he earn by working for 44 hours at the same rate?

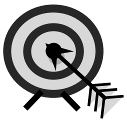
5. A car requires 7 litres of petrol for a journey of 245 km. How many litres of petrol will be required for a journey of 455 km?

6. Three identical buses can carry a total of 162 passengers. How many passengers can be carried on seven of these buses?

CHECK YOUR WORK.ANSWERS ARE AT THE END OF TOPIC 3.

Lesson 16: Inverse Proportions

You have learned to divide quantities using a given ratio in the last lesson.



In this lesson: you will:

- define inverse proportion
- identify steps to solve inverse proportion
- solve inverse proportion problems.

In Lesson 14, you learnt the meaning of direct proportion and worked out the solutions of direct proportion questions. Inverse proportion problems are similar to direct proportion, but the difference is that when one quantity or amount increases, the other one decreases and vice versa.

A relationship where a number or quantity either increases as another decreases or decreases as another increases is called **inverse proportion**.

The most common example of inverse proportion problems would be “the **more** men there are on a job the **less** time is taken for the job to complete.

For example

Suppose it takes 5 men 84 days to lay a section of a parking lot. The same section would be laid by:

1 man in 420 days
2 men in 210 days
3 men in 140 days
4 men in 105 days
5 men in 84 days and so on.

Selecting two of these lines in random and rewriting:

2 men will lay the section in 210 days
and 5 men will lay the section in 84 days

The ratio of the number of men is 2 **:** 5 or $\frac{2}{5}$ and the ratio of the number of days they take is 210 **:** 84 or $\frac{210}{84} = \frac{5}{2}$

Thus the number of men employed is increased in the ratio 5 **:** 2, the time taken decreases in the ratio 2 **:** 5.

The two quantities vary inversely or be inverse proportion since an increase or decrease in one causes a corresponding decrease or increase in the other.

Now let us work out some problems involving inverse proportion.

Example 1

If it takes 64 men 42 hours to assemble a light airplane, how long would it take 21 men?

Solution:

In this example, the number of men and the time are inversely proportional because when the number of men increases, the total time decreases and when the number of men decreases, the total time increases.

Method 1 Using the ratio or proportion rule.

Arrange the data:

No. of men	Time taken in hours
64	42
21	n

Since the values are in inverse proportion, we have

$$\frac{64}{21} = \frac{n}{42}$$

$$21n = 64 \text{ x } 42$$
$$n = \frac{2688}{21}$$
$$n = 128$$

Therefore, the time taken by 21 men to assemble the airplane is **128 hours**.

Method 2 Using the Unitary Method

If 64 men take 42 hours to assemble the airplane, then 1 man takes 64 x 42 hours to assemble the airplane.

21 men take $\frac{64 \text{ x } 42}{21}$ hours = **128 hours**

Method 3 If the number of men is reduced in the ratio $\frac{21}{64}$, the time they will take will be increased in the ratio $\frac{64}{21}$.

Thus, the time taken = 42 x $\frac{64}{21}$ hours

= 128 hours

Example 2

It takes 14 hours for a tap with a flow of 18 litres per minute to fill a container with water. How long will it take if its flow is reduced to 7 litres per minute?

Solution: In this example, the flow and time are inversely proportional, because when the flow decreases, the total times increases and when the flow increases, the total time decreases.

Write down the ratio of the data:

Litres/min	Hours
18	14
7	n

Since the values are in inverse proportion, we have:

$$\frac{7}{18} = \frac{14}{n}$$

Cross multiply: $7n = 18 \times 14$

Divide both sides by 7: $n = \frac{252}{7}$

$n = 36$

Therefore, the tap takes 36 hours to fill the container.

Example 3

It takes 3 workers to build a wall in 12 hours. How long would it have taken 6 equally productive workers?

Solution: In this example, the number of workers and time are inversely proportional, because when the number of workers increases, the total times decreases and when the number of workers decreases, the total time increases.

Write down the ratio of the data:

Workers	Hours
3	12
6	n

Since the values are in inverse proportion, we have:

$$\frac{6}{3} = \frac{12}{n}$$

Cross multiply: $6n = 12 \times 3$

Divide both sides by 6: $n = \frac{36}{6}$

$n = 6$

Therefore, the 6 workers would take 6 hours to complete the wall.

Example 4

It takes 4 men 6 hours to repair a road. How long will it take 7 men to do the job if they work at the same rate?

Solution: In this example the number of men and the time are inversely proportional because when the number of men increase, the time decreases and when the number of men decrease, the time increases.

Write down the ratio of the data:

Workers	Hours
4	6
7	n

Since the values are in inverse proportion, we have:

$$\frac{7}{4} = \frac{6}{n}$$

Cross multiply: $7n = 4 \times 6$

Divide both sides by 6: $n = \frac{24}{7}$

$$n = 3\frac{3}{7}$$

Therefore, the 7 worker take $3\frac{3}{7}$ hours to complete road.

NOW DO PERACTICE EXERCISE 16

Practice Exercise 16

1. A coaster takes 2 hours to make a journey when travelling at 60 kilomtres per hour. How long would the journey take if the coaster travelled at 40 kilometre per hour?

2. A small boat has sufficient food to last its crew of 12 for 9 days. If it rescues six people from the sea, how long will the same food last?

3. A farmer has enough chicken feed to feed 300 hens for 20 days. If he buys 100 more hens, how long would the same amount of feed last to feed the total hens?

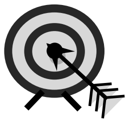
4. It takes 2 workers 12 days to tile the wall of an industrial compound. How many workers would it take to tile the same wall in 6 days?

5. A group of students hire a bus, at a fixed price, to go on a field trip. Initially 22 students were due to go on the trip at a cost of K10 per head but on the day there were 11 students on the bus. What was the cost per head for them?

CHECK YOUR WORK.ANSWERS ARE AT THE END OF TOPIC 3.

Lesson 17: Estimating and Interpreting Rate Tables and Graphs

You have learned the meaning of inverse proportion in the last lesson. You have learnt also how to solve inverse proportion problems.



In this lesson: you will:

- define rate and identify the different types of rate.
- estimate rates from graphs and tables
- interpret rate-related problems from graphs.

Remember, in the Grade 8 Mathematics Course, you used ratios to compare quantities of the same kind. You can compare quantities of different kinds too. When we **compare two quantities of different kinds**, the result we get is called a **rate**.

Rate is a very important type of ratio, used in many everyday problems such as grocery shopping, travelling and medicine, in fact almost every activity involves some types of rate.

The following are types of rate.

1. **Unit rate** is a rate that compares a quantity to its unit measure.
2. **Unit price** is a rate comparing the price of an item to its unit of measure. For example, suppose eggs are on sale for K12.60 per dozen. The unit rate is K12.60 divided by 12 or K1.50 per egg.
3. **Speed** or **rate of travel** is a rate that compares the distance travelled with the time taken. Kilometre per hour and metre per second are both rates of speed.
4. **Heart rate** is a rate that compares the number of heart beats per minute.
5. **Pay rate** is a rate that compares how many kina per hour you will be paid when you do a job.

Here is an example of a rate.

Mike walked 15 kilometres in 3 hours. This information is shown on the Travel Rate Graph below.

As you can see in the graph above that the **rate** Mike walked is **5 kilometres per hour**. This means that Mike walked 5 kilometres for every hour he walked.

We write "5 kilometres per hour" in short form "**5 km/h**".

In finding the rate of walking, we compared the distance traveled with the time taken to travel the said distance. **Distance** and **Time** are the two different quantities we **compared**.

When we compare the distance traveled with the time taken, **the rate of travel** is called **speed**. The walking speed of Mike was 5 km/h.

Rate actually means **how much per one**.

Taking Mike's walking as an example: The rate is **how much distance is covered per one hour**.

The speed of his walking was constant at **5 km/h,** meaning, for every hour, Mike walked 5 km. This is the rate.

5 kilometres in 1 hour at 5 km/h

10 kilometres in 2 hours at 5 km/h

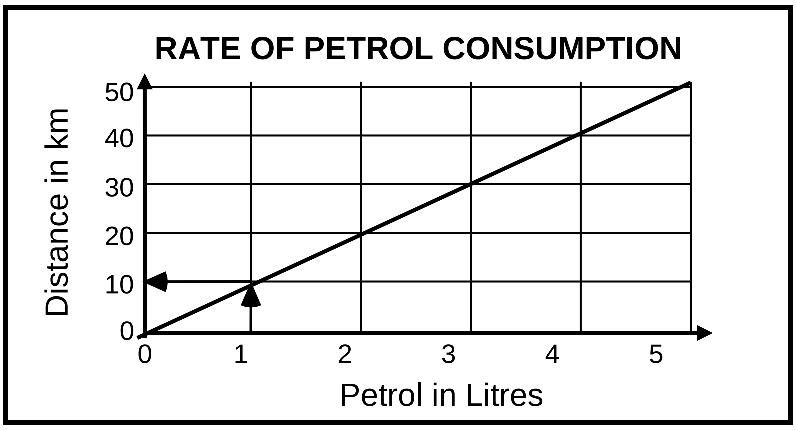
15 kilometres in 3 hours at 5 km/h

Therefore, Mike's travel rate graph is a **straight line graph**. The rate is the same (5 km/h) between any two points on the graph.

Let us look at another example.

A small car driven for 50 kilometres used 5 litres of petrol.

Here is the information on a rate graph.



What was the car's rate of petrol consumption? **Consumption** means the amount used.

From the graph you can read that the **rate** of petrol consumption was **10 kilometres per litre**. In short 10 km/L. This means that the car traveled 10 kilometres for every litre of petrol used.

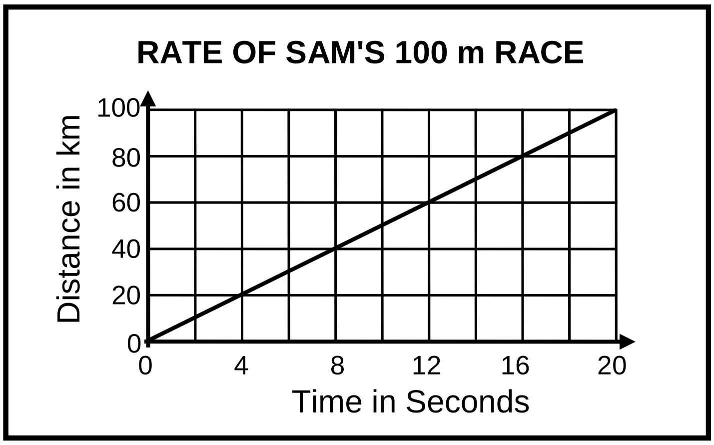
In this example, we are comparing **distance** traveled with the **amount of petrol** used.

You can see from the examples that the rate is obtained by **comparing 1 unit** of the quantity on the **horizontal axis**, to the corresponding **number of units** of the other quantity on the **vertical axis**.

Sometimes, it is not that easy to find the rate from a graph because the scale is too small to find the corresponding amount for 1 unit on the horizontal axis. To find the rate for such a graph, we can choose a **point that can be easily read** and the **origin** and then **use their coordinates** to calculate the **rate**.

For example:

Look at this graph of Sam's running a 100 metres (m) race.



It is hard to find the rate from this travel graph because the vertical scale for the distance is so small. We know that the rate between any two points on the graph have the **same rate** because the graph is a **straight-line graph**.

Therefore, we can always choose one of the points that can be easily read such as the point (20,100) and the origin (0,0). Then use their coordinates to calculate the rate.

The point (20,100) tells us that the boy runs 100 metres in 20 seconds.

$$\text{So, rate of speed} = \frac{\text{Total Distance}}{\text{Time taken}} = \frac{100 - 0}{20 - 0}$$

$$= \frac{100}{20}$$

$$= 5 \text{ metre per seconds}$$

The running speed of Sam for the 100 m race is 5 m/s.

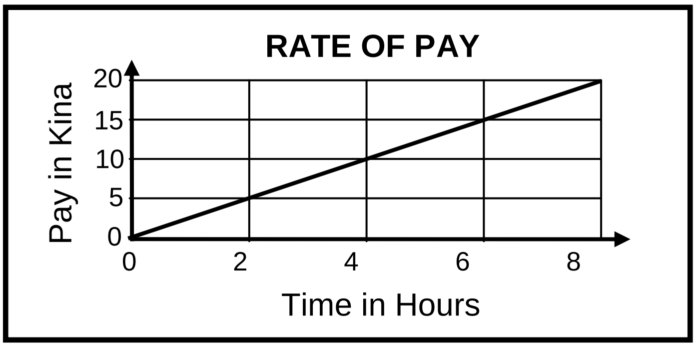
Let us look at some more examples of calculating rates using coordinates of points on rate graphs.

Examples

Calculate the rate for each of the following graphs using coordinates of a point.

Notice that each graph goes through the origin (0, 0).

1. This is a graph of pay rate in Kina.



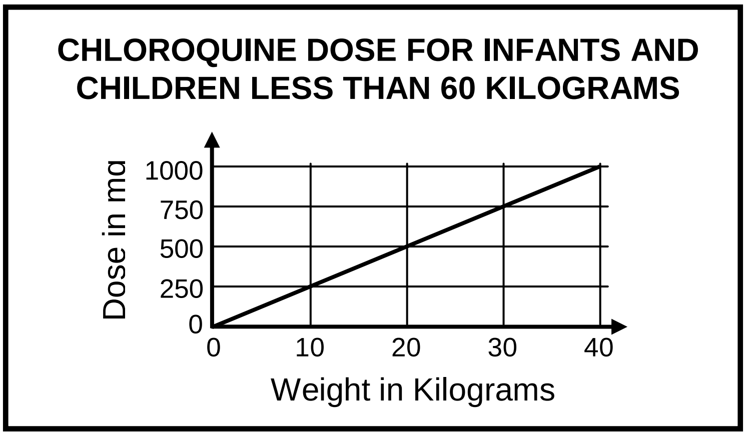
Notice that the result of the total pay taken over time is the same as the coordinates of the given point.

Using the point (2,5) and (0,0), Rate = $\frac{\text{Pay}}{\text{Time}} = \frac{5}{2}$

$= 2.50$

Answer: Rate of Pay is <u>K2.50</u> per hour.

2. This is a graph of chloroquine dose.



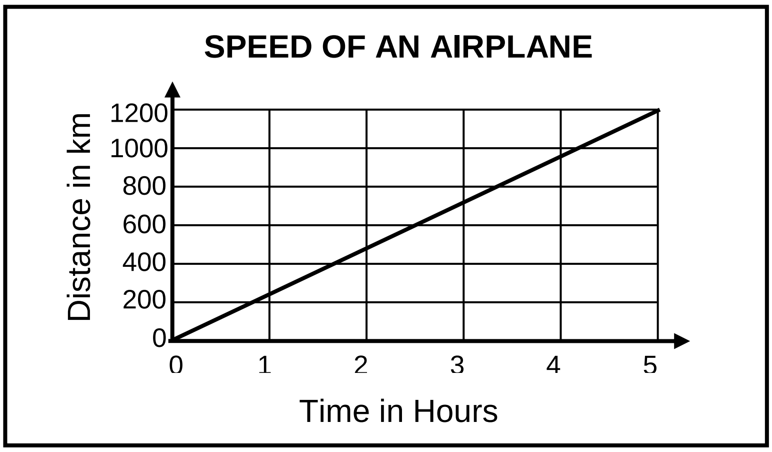
Using the point (10,250) and (0,0), Rate = $\frac{\text{Dose}}{\text{Weight}}$

$= \frac{250}{10}$

$= 25$ mg/kg

Answer: The rate of Chloroquine Dose is <u>25</u> mg/kg

3. An airplane traveled 1200 kilometres in 5 hours as shown on the graph below.



(a) Calculate the speed of the airplane.

From the information given, we can use the co-ordinates (5,1200) and (0,0) to calculate the speed of the airplane.

iroplane.

So, Speed = $\frac{\text{Distance}}{\text{Time}} = \frac{1200}{5}$

Speed = 240

Answer: The speed of the airplane is 240 km/h

(b) Using the rate of travel, calculate the distance that the airplane will travel in 4 hours. Then complete the table below.

Working out:

Speed = $\frac{\text{Distance}}{\text{Time}}$

Distance = Speed (S) x Time (T)

Speed/Rate = 240 km/h

So Distance traveled in 4 hours = 240 x 4

= 960 km

D = S x T

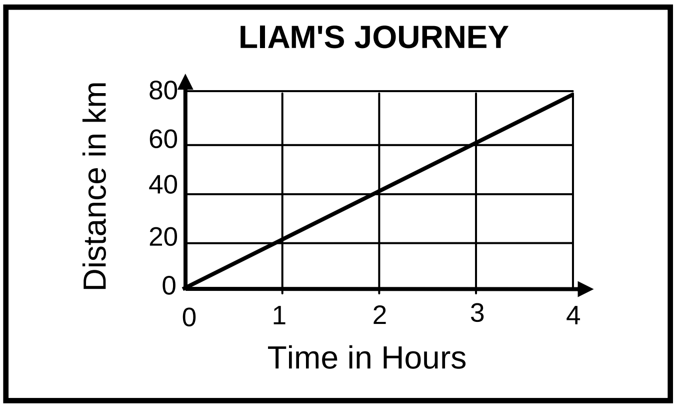
Time in hours(h)	1	2	3	4	5
Distance in km	240	480	720	960	1200

NOW DO PRACTICE EXERCISE 17

Practice exercise 17

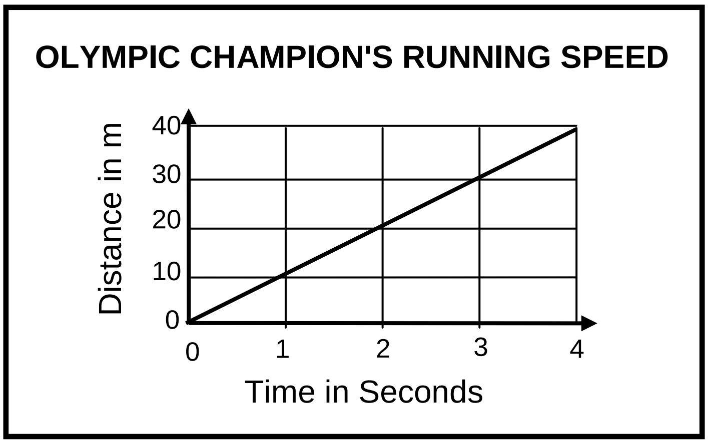
1 Find the rate from each of the following graphs.

(a)



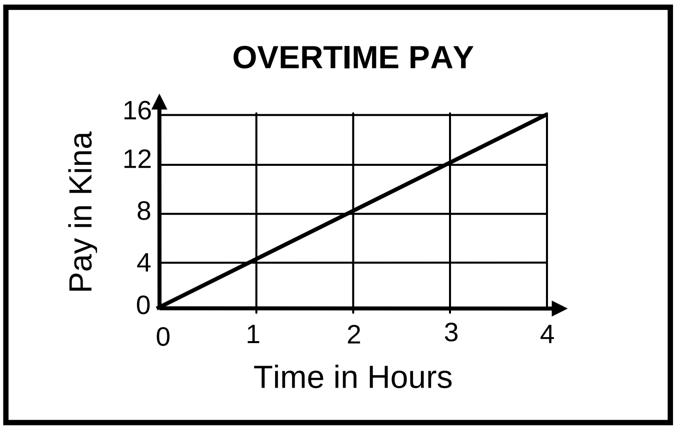
Answer: ____________________

(b)



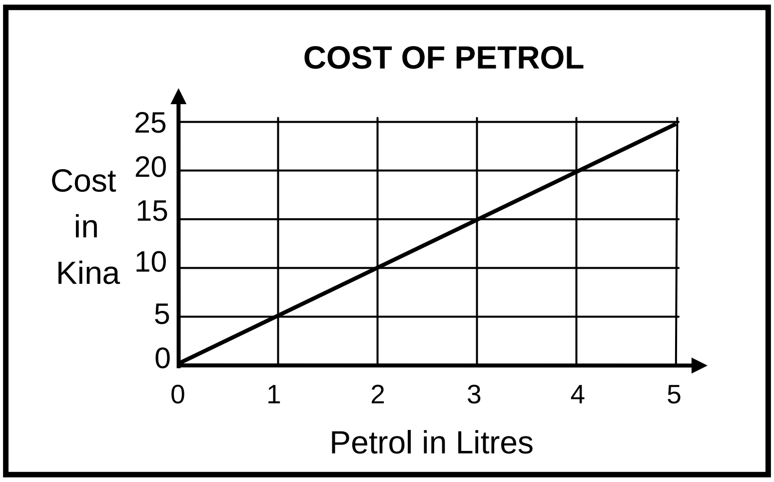
Answer: ______________________

(c)



Answer: _____________________.

2. Look at this rate graph of the Cost of Petrol.



(a) What is the rate of cost of petrol? **Answer:** ___________

(b) How much does 4 litres of petrol cost? **Answer:** ___________

---

3. A car used 10 litres of petrol to travel 150 kilometres.

(a) Calculate the car's rate of petrol consumption.

Answer: ___________

(b) Use the rate calculated above to complete the table below.

<u>Working:</u>

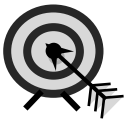
Distance = Rate **x** Number of litres of petrol.

Amount of petrol in L	2	8	10	15	20
Distance in km	30	120	150		

CHECK YOUR WORK.ANSWERS ARE AT THE END OF TOPIC 3.

Lesson 18: Conversion Graphs

You have learned the meaning of rate and identified different types of rates in the last lesson. You have also learnt how to solve rate problems.



In this lesson: you will:

- define a conversion graph.
- identify features of conversion graphs
- convert one quantity to another using conversion graphs.

So far you have used rate graphs to find rates. You can also **use rate graphs to do conversions** from one unit to another.

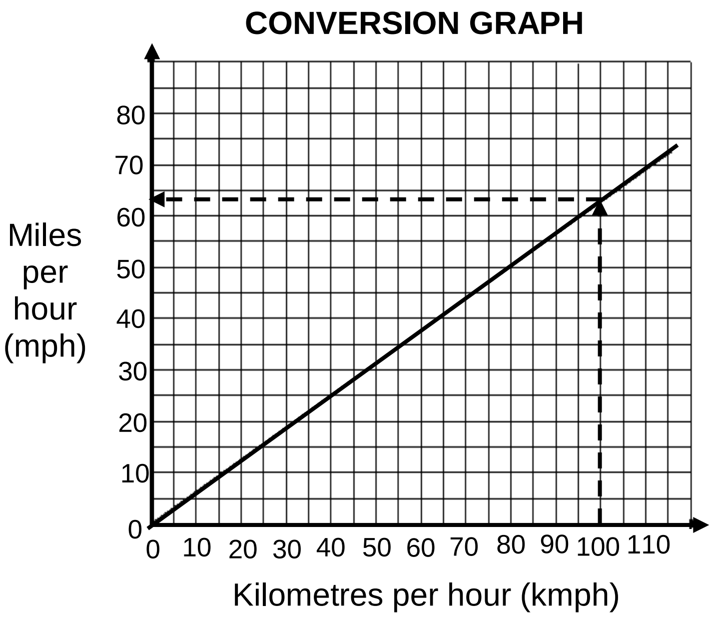
A conversion graph can be used to change one quantity to another when the units are changed.

A conversion graph has all the features of a line graph. It is used to convert from one unit of measurement to another.

Examples of conversion graphs include US$ to PNG Kina, (money conversion), kilometres to miles (distance), pounds to kilograms (weight conversion), etc.

Conversion graphs are straight lines.

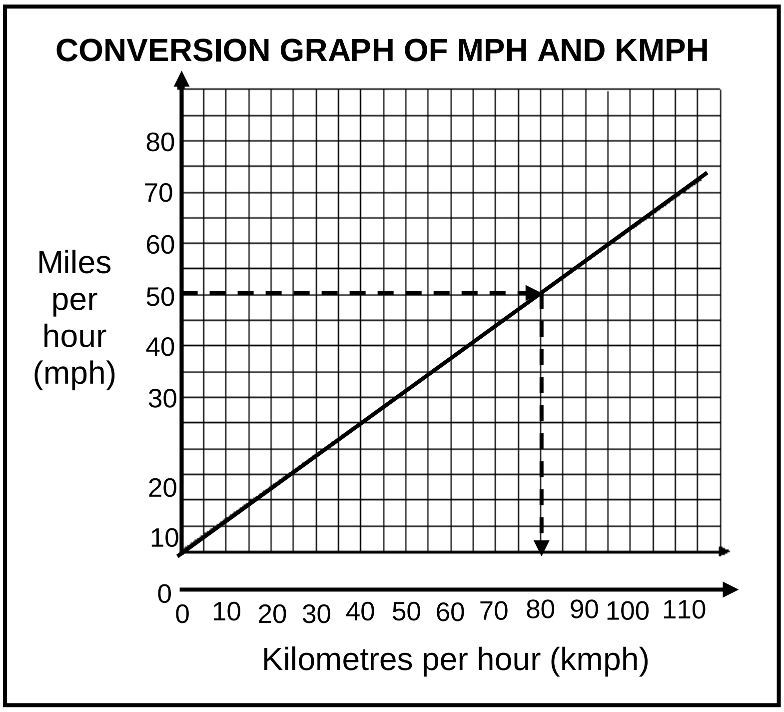
Look at the conversion graph below.



The vertical axis shows the **miles per hour** (mph) and the horizontal axis shows the **kilometres per hour** (kmph). The line on the graph can be used to convert from **mph** to **kmph** and vice versa.

Let us do some conversion based on the graph.

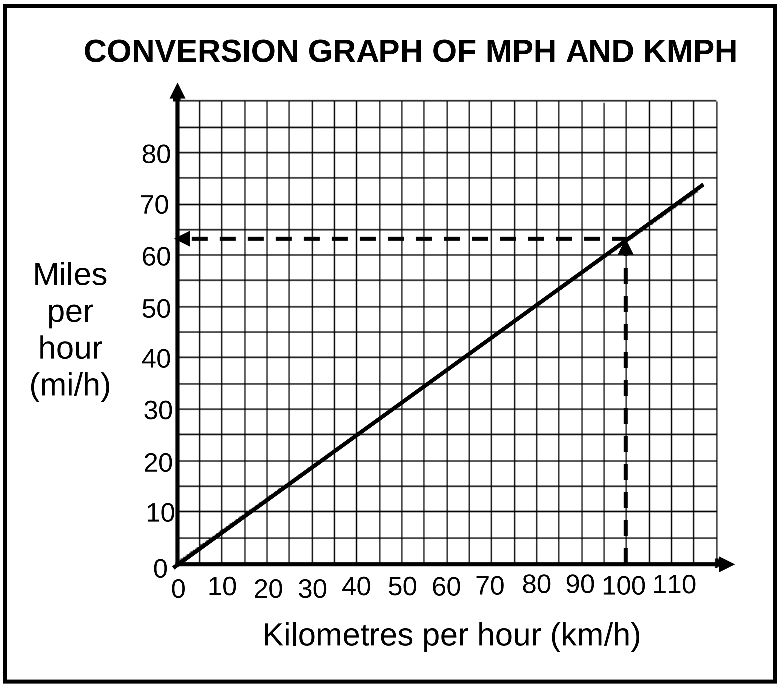
1. To convert 40 miles per hour into kilometres per hour



Start by finding 50 on the **mph or vertical axis**, when you have found it, follow the arrow **across** to the conversion line. On the graph again, follow the arrow **down** to the **kmph or Horizontal axis**. The value is 80 km/h. So,

50 mph = 80 kmph

2. To convert 100 km/h into mi/h



This time, find 100 km/h on the **(km/h) or horizontal axis**. On the graph, follow the arrow **up** to the conversion line. On the graph again follow the arrow **left** to the **mi/h or vertical axis**. The value is 63 mi/h.

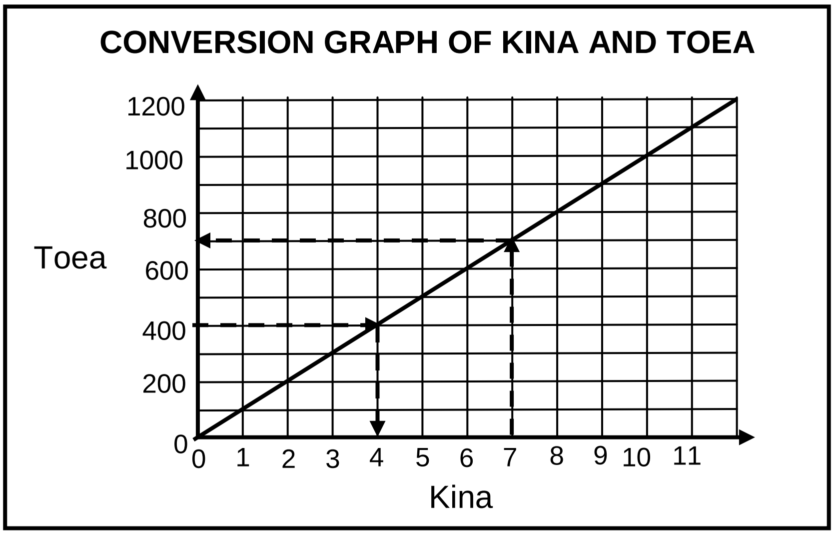
So, **100km/h = 63 m/h**

Remember that you need to read the graph accurately to get accurate answers.

On the next page, you will find further examples of conversion graphs.

Example 2

Look at the conversion graph of Kina and toea below.



Using this conversion graph, you can **convert** or change:

(i) Kina to toea and

(ii) toea to Kina.

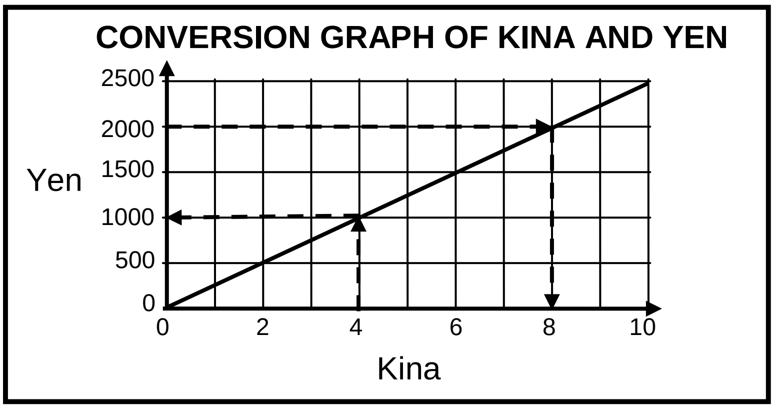
You can see by the lines with arrows on the graph that:

(i) K7 = 700t

(ii) 400t = K4

Example 3

Here is a conversion graph of Papua New Guinea currency in **Kina** and Japanese currency in **Yen**.



Using the graph, you can convert;

(i) Kina to Yen (ii) Yen to Kina

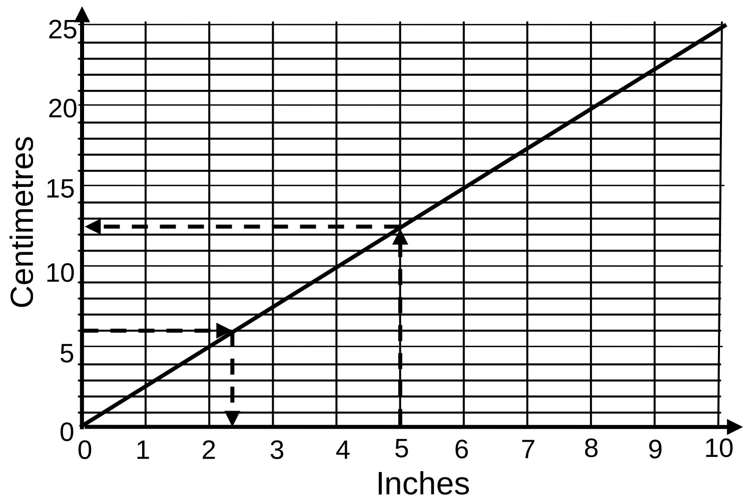
The examples shown in the graph are;

(i) **4** Kina = **1000** Yen (ii) **2000** Yen = **8** Kina

Example 4

This is a conversion graph of lengths in inches and centimetres.
The inch is a unit of length in the English System still in use in the U.S.A.

CONVERSION GRAPH OF INCHES AND CENTIMETRES



Using the graph you can convert the following:

(i) inches to centimetres (ii) centmetres to inches

The examples shown in the graph are:

(i) 5 inches = 12.5 cm (ii) 6 cm = 2.4 inches

Now you will learn to draw conversion graph.

To draw a conversion graph, which is a **straight-line graph**, we need only **two (2) points.** One of the points is obtained from the co-ordinates of a **given rate**. The other is the **origin** point (0,0).

How to do this? Follow the steps below.

Steps to draw a Conversion Graph

1. Use the co-ordinates of the origin and the point given in the rate.
2. Using the space available, choose sensible scales for the axes.
3. Draw the axes. Label them and give a suitable title for the graph.
4. Plot the points on the graph.
5. Draw a straight line through the points.

Now look at the example on the next page.

Here is an example.

Draw a conversion graph of kilometres and miles using the origin (0,0) and the relationship 8 km = 5 miles.

To draw the graph, follow the steps below.

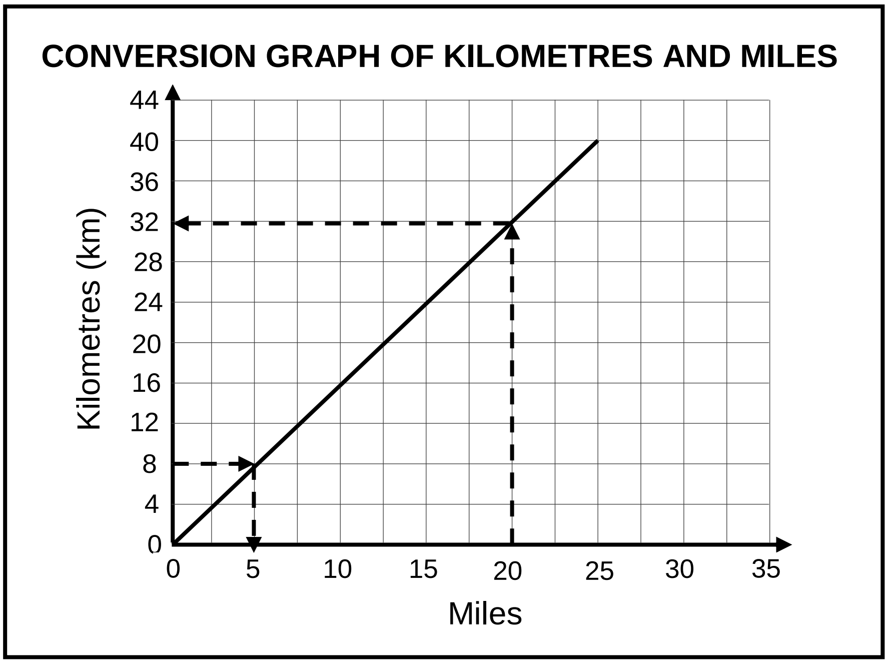
(i) **Use the coordinates** of the **origin** (0,0) and the **point** (8,5) from the given rate.

(ii) **Using the space available, choose sensible scales** for the axes; 1 cm represents 5 miles for the **x**-axis, so the scale is 1 cm: 5 miles, and 1 cm represents 8 kilometres for the **y-** axis, so the scale is 1 cm: 8 km.

(iii) **Draw the axes, label them and give a suitable title** to the graph shown below.

(iv) **Plot the two points**; (0,0) and (8,5) on the graph shown below.

(v) **Draw a straight line through the two points** shown below.



You can use the graph to convert;

(i) kilometres to miles (ii) miles to kilometres

The examples shown in the graph are;

(i) 8 kilometres = 5 miles (ii) 20 miles = 32 kilometres

Use the graph drawn above to complete the table below.

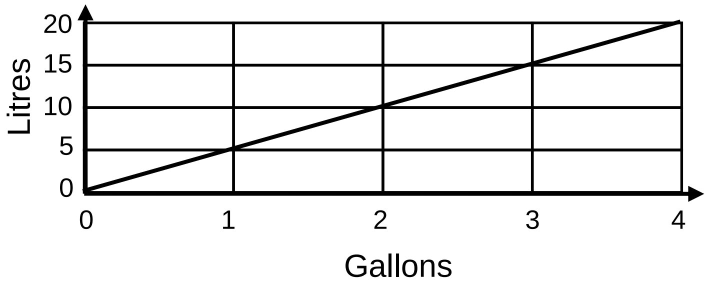
Kilometres	8	12	16	32	40
Miles	5	7.5	**10**	20	**25**

Let us look at more examples of drawing conversion graphs.

1. Draw a conversion graph of gallons and litres using the origin (0,0) and the relationship 4 gallons = 20 litres in the space provided.

   The point from the given rate is **(4, 20)** and the other is the origin **(0, 0)**.

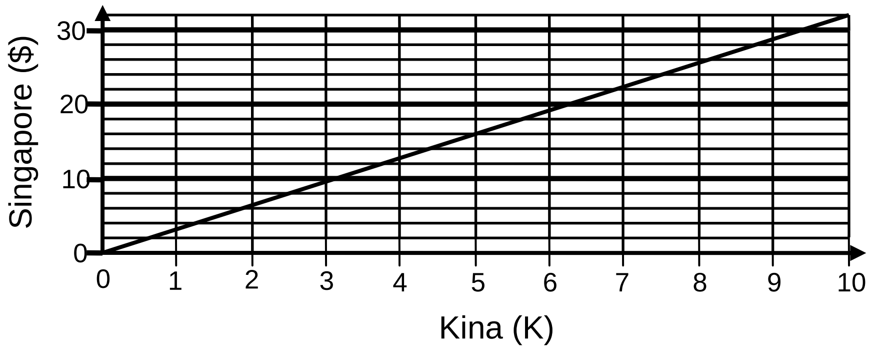
CONVERSION GRAPH OF GALLONS AND LITRES



2. Draw the conversion graph of Kina (K) and Singapore $ using the relationship; 5 Kina = 16 Singapore Dollars in the space below.

   The point from the given rate is **(5,16)** and the other point is **(0,0).**

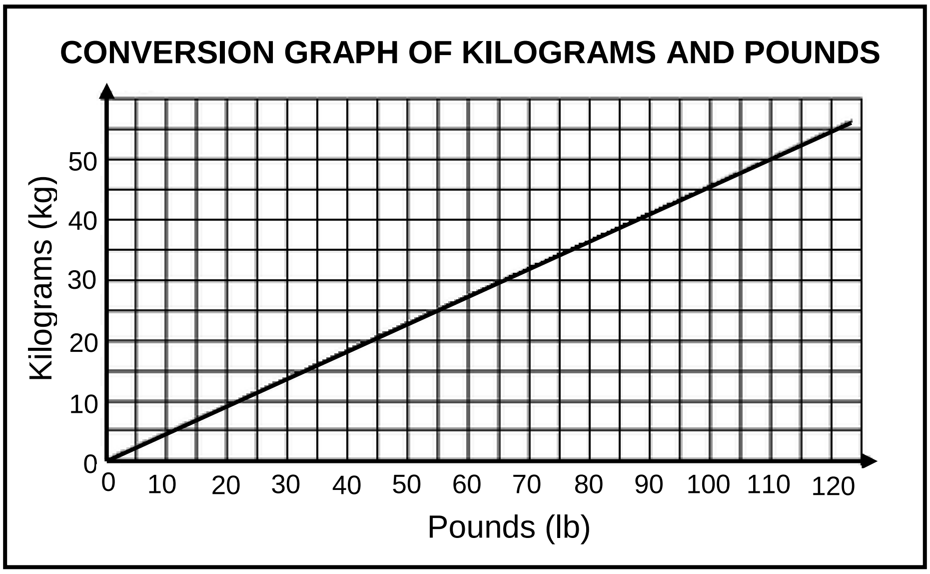
CONVERSION GRAPH OF KINA AND SINGAPORE DOLLARS



NOW DO PRACTICE EXERCISE 18

Practice exercise 18

1. The graph below can be used for converting between weights in kilograms (kg) and weight in pounds (lb).



Using the graph, answer the following:

(a) Convert these from kilograms to pounds.

i. 45 kg is __________ pounds
ii. 30 kg is __________ pounds
iii. 25 kg is __________ pounds
iv. 10 kg is __________ pounds
v. 40 kg is __________ pounds

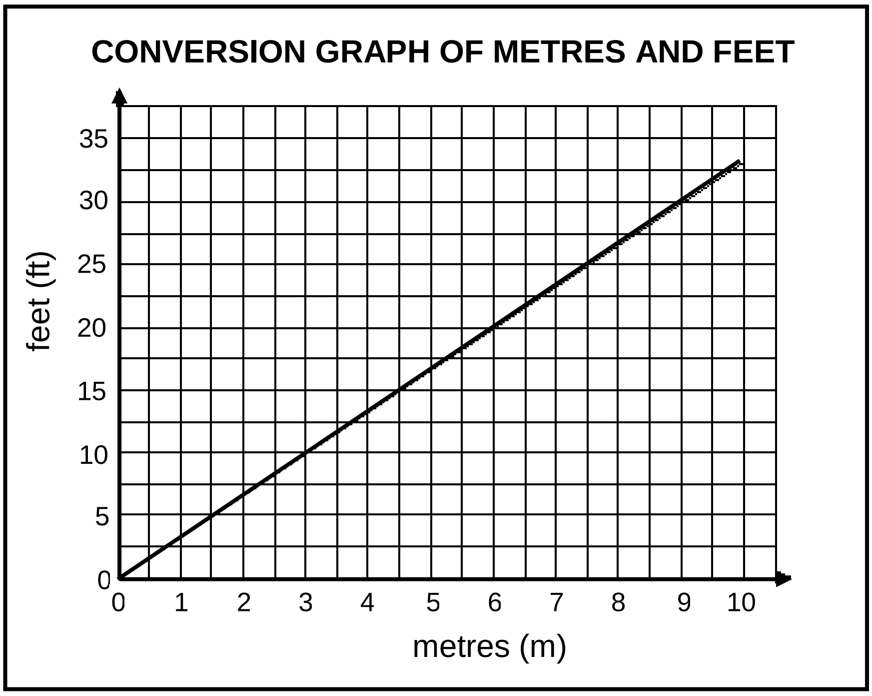
(b) Convert these from pounds to kilograms.

i. 85 pounds is __________ kg
ii. 20 pounds is __________ kg
iii. 55 pounds is __________ kg
iv. 110 pounds is __________ kg
v. 120 pounds is __________ kg

(c) A baker bought 50 kg of wheat flour. What is the weight of the wheat flour in pounds?

2. The graph below can be used for converting between length in metres (m) and length in feet (ft).

Foot is an imperial unit of length still used in the U.S.A



Use the graph to answer the following questions.

(a) In a long-jump competition, Kim jumps 4 metres and Gerald jumps 12 feet. Who wins?

(b) Which is longer, 20 feet or 6.5 metres?

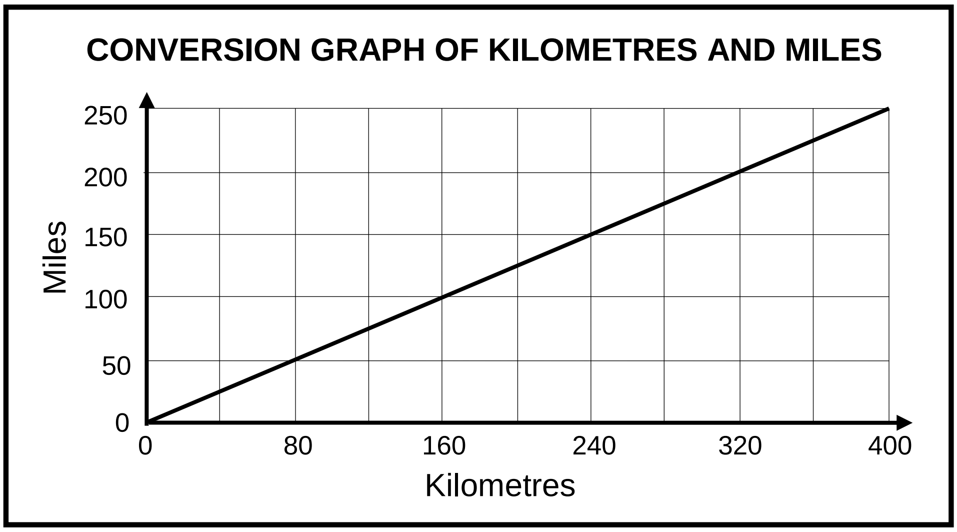
(c) Harry says that 8 metres is less than 28 feet. Is he right?

(d) A rope is 9 m long. What is its length to the nearest foot?

(e) A new flagpole arrives at a school. It is 1 metre taller than the old one. The old flagpole was 18 ft tall. How tall is the new flagpole in metres?

3. (a) Draw a conversion graph to convert miles into kilometres and kilometres into miles using the relationship.

150 miles = 240 kilometres on the scaled grid provided.



(b) Use the graph to convert the following to miles.

(i) 240 km = _____ miles (iii) 40 km = _____ miles

(ii) 80 km = _____ miles (iv) 200 km = _____ miles

(c) Use the graph to convert the following to kilometres.

(i) 50 miles = _____ km (iii) 175 miles = _____ km

(ii) 100 miles = _____ km (iv) 225 miles = ____ km

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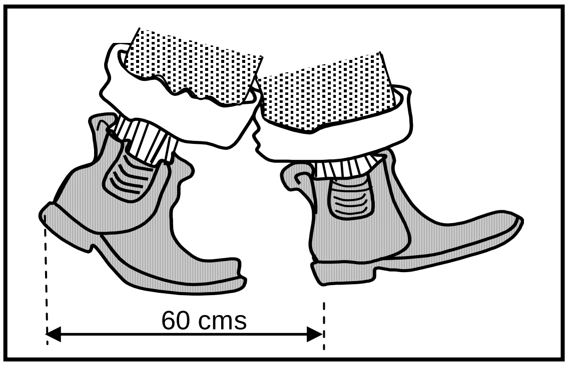
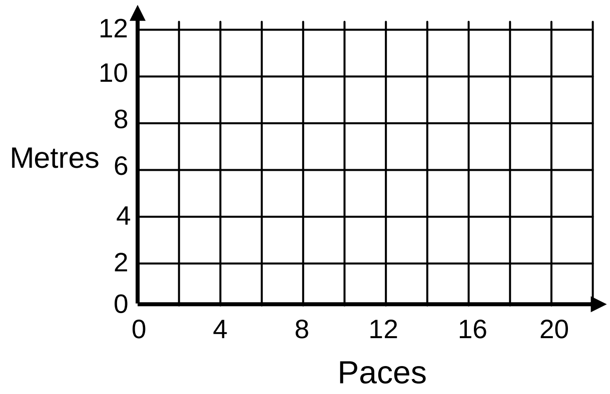
4. A builder has an average pace of 60 centimetres. He often measures distances by pacing them out using the relationship 10 paces = 6 m.



(a) Draw a conversion graph for these distances using the axes provided on the next page.

CONVERSION GRAPH OF PACES AND METRES



(b) Using the graph, answer the following questions.

(i) The front fence of a house is 20 paces long.

How long is the fence in metres?

Answer: ________ metres

(ii) What are the approximate measurements of a room 18 paces long and 10 paces wide in metres?

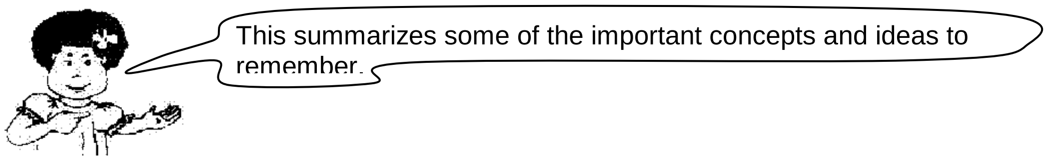
Answer: _____ m long and _____ m wide.

(iii) What is the approximate number of paces needed to measure a room 10 metres long and 6 metres wide?

Answer: _____ paces long and _____ paces wide.

CHECK YOUR WORK.ANSWERS ARE AT THE END OF TOPIC 3.

TOPIC 3: SUMMARY



- **Ratio** is a comparison of two quantities by division and is written in several ways.
  For example: the **ratio of 3 yellow squares to 2 blue squares** can be shown as:
  (a) using the colon (**:**) to separate the values: 3 **:** 2
  (b) Instead of the (**:**) we can use the word "**to**": 3 to 2
  (c) Or write as a fraction: $\frac{3}{2}$
- **Equivalent ratios** are ratios that make the same comparison.
- To find ratios that are equivalent to a given ratio, multiply or divide the numerator and the denominator by the same number.
- A ratio is in its simplest form when both the numerator and the denominator are whole numbers.
- To write ratio in its **simplest form**, keep on dividing both sides by the same number until you can't go any further without going into decimals.
- To write a ratio in the form **N : 1**, divide both sides by the left–hand member.
- To write a ratio in the form **1 : N**, divide both sides by the right –hand member.
- A **proportion** is a statement that two ratios are equivalent
- **The *extremes* are the end numbers in a proportion, while *means* are the middle numbers in a proportion.**
- The **Unitary Method** is a **way** of solving problems involving ratios by **working out the value of a single unit** in order to solve the problem.
- **Direct proportion** is a proportion of two variable quantities when the rate of the two quantities is constant**.**
- **Inverse proportion** is a relationship where a number or quantity either increases as another decreases or decreases as another increases.
- **Rate is a comparison between two different quantities**. For example: In a travel graph, we **compare distance** traveled with **time** taken to travel that distance.
- The **Unit rate** is a rate that compares a quantity to its unit measure.
- The **Unit price** is a rate comparing the price of an item to its unit of measure.
- **Speed or Travel rate** is a rate that compares the distance travelled with the time taken.
- The formula for Speed is : **Speed =** $\frac{\textbf{Distance}}{\textbf{Time}}$
- The **Conversion graph** is a line graph used to convert from one unit of measurement to another. They are straight lines.

REVISE LESSONS 13-18 THEN DO TOPIC TEST 3 IN ASSIGNMENT BOOK 1.

ANSWERS TO PRACTICE EXERCISES 13-18

Practice exercise 13

1. (a) 1 : 3 (b) 6 : 7 (c) 1 : 4 (d) 7 : 200

   (e) 2 : 3 (f) 2 : 3 (g) 7 : 15 (h) 5 : 8

2. (a) 2 : 5 is equivalent to 1 **: 2.5**
   (b) 5 : 3 is equivalent to 1 **: 0.6**
   (c) 10 : 35 is equivalent to 1 **: 3.5**
   (d) 6 : 9 is equivalent to 1 **: 1.5**
   (e) 5 : 12 is equivalent to 1 **: 2.4**
   (f) 15 : 12 is equivalent to 1 **: 0.8**
   (g) 4 : 10 is equivalent to 1 **: 2.5**
   (h) 3 : 9 is equivalent to 1 **: 3**
   (i) 8 : 20 is equivalent to 1 **: 2.5**

3. Write each of the ratios below in the form **N: 1**.

   (a) 6 : 5 is equivalent to **1.2:** 1
   (b) 18 : 3 is equivalent to **6 :** 1
   (c) 15 : 2 is equivalent to **7.5:** 1
   (d) 7 : 10 is equivalent to **0.7:** 1
   (e) 6 : 12 is equivalent to **0.5:** 1
   (f) 15 : 12 is equivalent to **1.25:** 1
   (g) 4 : 5 is equivalent to **0.8:** 1
   (h) 27 : 3 is equivalent to **9:** 1
   (i) 20 : 4 is equivalent to **5:** 1

4. (a) 5 (b) 2 (c) 25 (d) 3 (e) 7

5. (a) Not proportion
   (b) Not proportion
   (c) Proportion
   (d) Proportion
   (e) Proportion

6. (a) 8 oranges

   (b) 24 km

Practice exercise14

1. (a) 20 and 80
   (b) 33 and 21
   (c) 5 and 10 and 15
   (d) 27 and 36 and 45
   (e) 36 and 24 and 15
2. Bonny receives K32; Clyde receives K48
3. Paul need to spend K4000;
   Sam need to spend K3500;
   Sarah need to spend K500.
4. 17.5 cm by 21 cm by 24.5 cm
5. Pineapple, 350 mL; orange juice, 250 mL; apple juice, 200 mL

Practice exercise15

1. 12 pencils
2. 0.15 seconds
3. 375 km
4. K352
5. 13 litres
6. 378 passengers

Practice exercise16

1. 3 hours
2. 6 days
3. 15 days
4. 4 workers
5. K20

Practice exercise 17

1. (a) 20 km/h (b) 10 m/s (c) K4/h
2. (a) K5/L (b) K20
3. (a) 15 km/ L
   (b)

Amount of petrol in L	2	8	10	15	20
Distance in km	30	120	150	**225**	**300**

Practice exercise 17

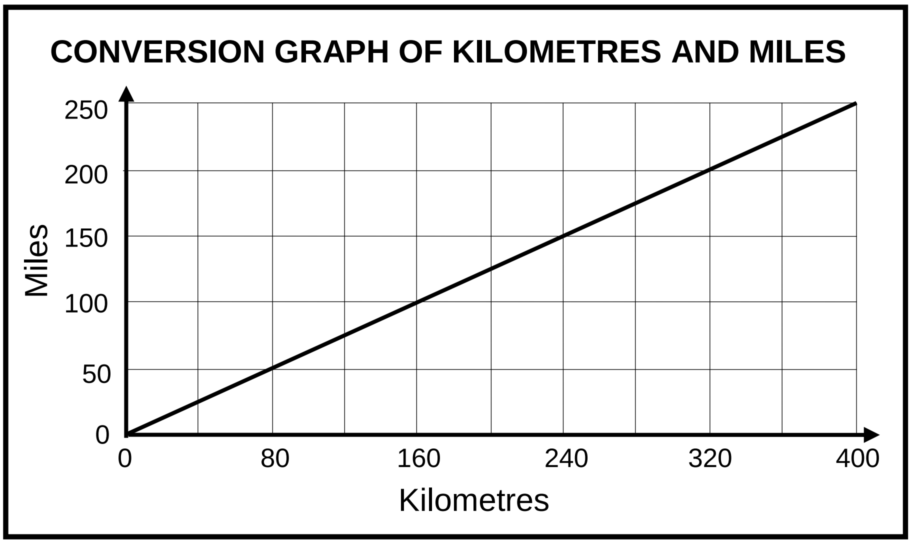
1. (a) i. 98 pounds
   ii. 65 pounds
   iii. 55 pounds
   iv. 22 pounds
   v. 88 pounds

   (b) i. 39 kg
   ii. 9 kg
   iii. 25 kg
   iv. 50 kg
   v. 55 kg

   (c) 110 pounds

2. (a) Kim
   (b) 6.5 m
   (c) Yes
   (d) 30 ft
   (e) 6.5 m

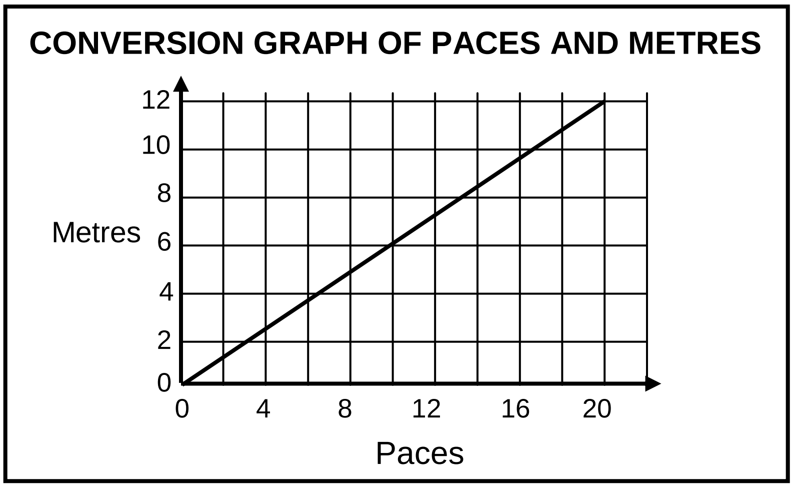
3. (a)



   (b) i. 150 miles ii. 50 miles
   iii. 25 miles iv. 125 miles

   (c) i. 80 km ii. 280 km
   iii. 160 km iv. 360 km

4. (a)



(b) (i) 12 m

(ii) 11 m long and 6 m wide

(iii) 17 paces long and 10 paces wide

END OF TOPIC 3

TOPIC 4

MEASUREMENTS

TOPIC 4: MEASUREMENT

Measurement is a process of comparing an unknown quantity with a known standard. By standard, we mean something must be available for everyone to use and is the same all over the world. At present, there are two known widely accepted systems, the English and the Metric System.

From the 17^{th} to the 19^{th} century, the English system achieved greater degree of standardization and dominated world commerce. The measurement units spread in many parts of the world including the United States.

Due to the rapid technological advances and differences in measurements in most countries particularly the United States and United Kingdom, a single common and coordinated system had to be recognized worldwide. In 1790, the Metric system was created by the commission appointed by the French Academy of Science. Though it was not accepted at first, different countries adopted its use initiated by France in 1840. In 1866, the United States by virtue of the act of Congress required the US to employ the metric systems in all contracts, dealings and court proceedings.

The rapid spread of the Metric System is not surprising since its features are well suited for scientific and engineering advances.

Nowadays, the Metric system also known as the International System of units or SI is widely used all over the world. Its units are based on the multiples of 10 which give an easier understanding of the relationships among the units of length, mass and volume.

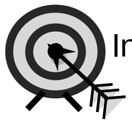
The following are the base units of SI, their symbols and the quantities they measure.

Metre (m)	– length
Kilogram (kg)	– mass
Litre (L)	– capacity
Seconds(s)	– time
Ampere (A)	– electric current
Degree Celcius (°C)	– temperature

In this topic, you will revise different metric units of length, weight, areas and volume. You will also revise and extend further your knowledge and skills on conversion of one unit to another in calculating and solving capacity and volume problems.

Lesson 19: Metric Units

You have learned something about Measurement in your Grade 7 and 8 Mathematics.



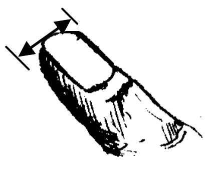
In this lesson, you will:

- identify the units of measurement for length and weight used in ancient times
- identify the units of length and weight in the metric system
- convert metric units from one to another.

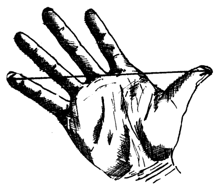
People have always needed to measure things around them.

For examples: How high is a tree?
How wide is the river?
How long will it take to run 100 metres?
How much water is in the water tank?
How much rain fell last night?

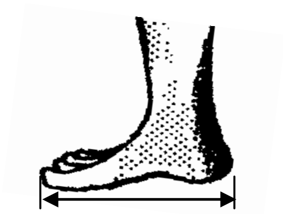
Earlier, in your study of Mathematic, you learnt that the earliest measurements used by man usually involved a reference to the parts of the body. Early man may have used the following:



the width of a thumb



the width of a hand



the length of a foot.

Here are some other earlier units used.

1) Span – this is given as the distance between the tips of the middle finger when the arms stretched to the side as far as possible from the body.

2). Cubit – is the ancient unit of length based on the length of the forearm from the elbow to the tip of the middle finger. It is usually equal to about 46 cm but has been measured at 53.34 cm or more.

Because the measure of ancient units varied from person to person, it became necessary to have exactly the same unit of measurement, no matter who was using it. As a result, standard units of measurement were introduced. In Papua New Guinea we now use the Metric system of units.

The Metric System is a system of measurement based on decimal units. It simplifies the process of mathematical and scientific calculation. It is a deliberate attempt to create a universal, standardized system of measurement and was first introduced in France in 1791.

Length is the measured distance of something from end to end.

The basic unit of length in the SI system is the **metre**. Most doors are about 1 metre wide. Your bed would be about 2 metres long and about I metre wide.

The standard measure for longer distances is the **kilometre**. The distance from Boroko to Gerehu would be measured in kilometres.

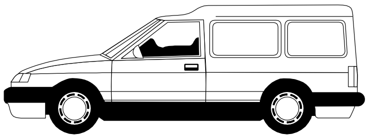
For shorter lengths we usually used the **centimetre** or the **millimetre**. The width of your little finger is about 1 centimetre.

Weight is the amount or quantity of heaviness of an object.

The basic unit of weight or mass in the SI system is the **kilogram.** A bunch of banana would weigh about 1 kilogram.

1 kg

The standard measure of the weight of a large object is **tonne**. The modern Honda CRV weighs about 2.2 tonnes.



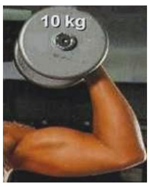
2.2 tonnes

To measure the weight of smaller objects we usually use the **gram** and the **milligram.**
One gram is as light as one paper clip.

1 gram

Following are other examples of how heavy things are:

Typical dumbbell used by weightlifter, 10 kg



A one litre bottle of water: 1 kg

Average new born baby: 3 to 3.6 kg

An average man: 74 kg

An average women: 60 kg

Other units of measurement, such as **area**, **volume** and **capacity** are obtained from these base units. We will learn about them later in this Topic.
The table summarizes the metric units of length and weight.

TABLE OF METRIC UNITS

Quantity	Name of Unit	Symbol	Value
Length	metre	m	Base unit **metre**
	millimetre	mm	1000 mm = 1 m
	centimetre	cm	100 cm = 1 m
	kilometre	km	1 km = 1000 m
Weight	kilogram	kg	Base unit **gram**
	milligram	mg	1 000 000 mg = 1 kg
	gram	g	1000 g = 1 kg
	tonne	t	1 t = 1000 kg

Now let us extend your knowledge further and the skills learnt earlier about conversion of metric units.

Conversion of Metric Units

To do conversions, we must know the Metric Units. We must also know which units are small and which are large.

A. To convert large Metric Units into smaller units we **multiply**.

Example 1 Convert 5 metres into centimetres.

5 m = 5 **x** 100 .... {**1** m = **100** cm}

= 500 cm

Example 2 Convert 3.5 tonne into grams.

(first change **3.5** t into kg)

3.5 t = 3.5 **x** 1000 .... {**1000** kg = **1** t }

= 3500 kg

(now change **3500** kg into g)

= 3500 **x** 1000 .... {**1000** g = **1** kg }

= 3 500 000 g

B. To convert small metric units into larger units we **divide**.

Example 1 Convert 25 000 kg to tonnes.

$\frac{25000}{1000}$ = 25 tonnes .... (**1000** kg = **1** t)

Example 2 Convert 60 000 centimetres into kilometres.

(first change **60 000** cm into m)

60 000 cm $= \frac{60\,000}{100}$ .... {**100** cm = **1** m}

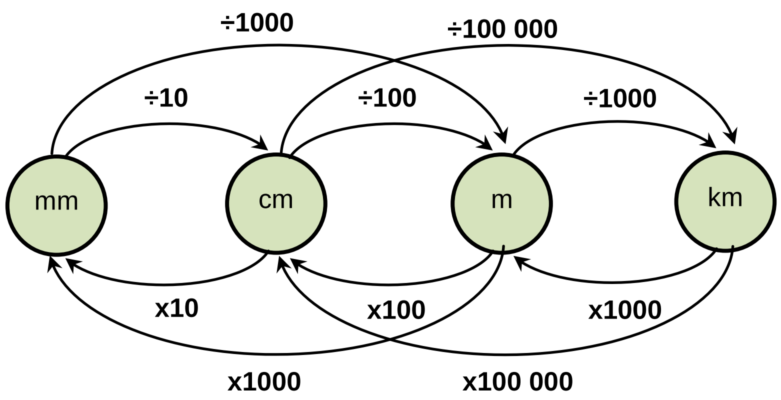
= 600 m

(now change **600** m into km)

$= \frac{600}{1000}$ .... {**1000** m = **1** km}

= 0.6 km

Here is a flow chart that you can follow to convert linear measures from small to big unit and vice versa.

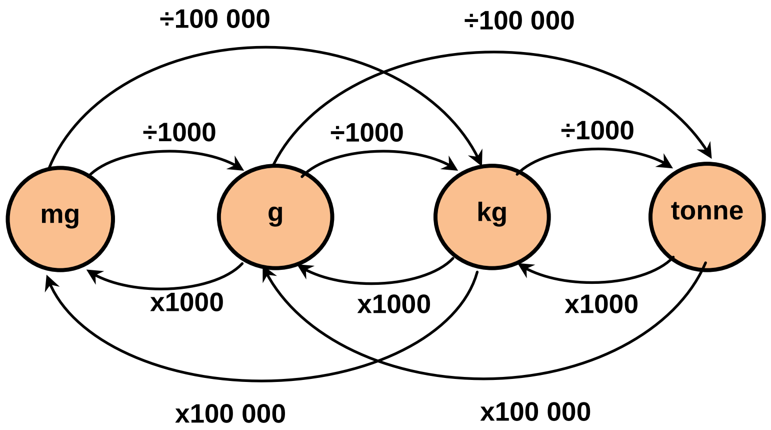


Start at the circle that shows the measure you wish to convert from. Follow the arrows and instructions until you arrive at the measure you want to convert to.

Units of Length	
10 millimetres (mm)	= 1 centimetre (cm)
100 centimetres (cm)	= 1 metre (m)
1000 metres (m)	= 1 kilometre (km)
1 metre (m)	= 0.001 kilometre (km)
1 centimetre (cm)	= 0.01 metre (m)
1 millimetre (mm)	= 0.1 centimetre (cm)

Below is a flow chart for converting units of weight.

Start at the box with the unit you wish to convert from. Follow the arrows and instructions until you arrive at the unit you want to covert to.



Units of Weight	
1000 milligrams (mg) = 1 grams (g)	
1000 grams (g)	= 1 kilograms (kg)
1000 kilograms (kg) = 1 tonne (t)	
1 gram (g)	= 0.001 kilogram (kg)
1 milligram (mg)	= 0.001gram (g)
1 kilogram kg)	= 0.001 tonne (t)

NOW DO PRACTICE EXERCISES 19

Practice Exercise 19

1. Write down the base unit for each of the following quantities:

   (a) length **Answer**: _______________

   (b) weight **Answer**: _______________

2. Write down the symbol for each of the following units.

   (a) tonne **Answer:** _______________

   (b) kilometre **Answer**: _______________

   (c) millimetre **Answer**: _______________

   (d) milligram **Answer**: _______________

   (e) centimetre **Answer**: _______________

3. State the suitable unit we would use to measure the following:

   (a) the weight of a small kundu drum. **Answer**: _______________

   (b) the distance between Lae and Madang. **Answer**: _______________

   (c) the weight of a Toyota truck. **Answer**: _______________

   (d) the perimeter of a house. **Answer**: _______________

4. Work out the following conversions.

   (a) Convert 6500 metres to kilometres. **Answer**: ______________

   (b) Convert 3.2 tonne (t) to kilograms. **Answer**: _______________

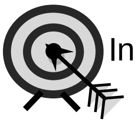
   (c) Convert 480 millimetres to centimetres. **Answer**: _______________

   (d) Convert 9612 kilogram to tonnes **Answer**: _______________

CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 4.

Lesson 20: Measuring Lengths and Weights

You learnt the different metric units as well as how to convert one metric unit to another in the last lesson.

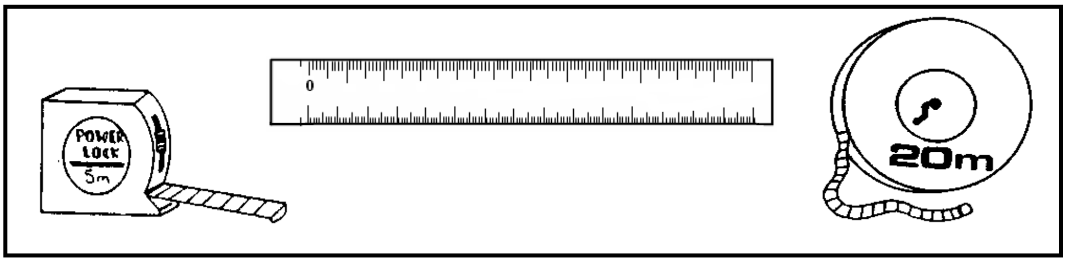


In this lesson, you will:

- identify metric units of length and weight.
- identify instruments used to measure length and weight
- measure length and weight using the appropriate instrument.

First, we will revise measuring of length and then weight.

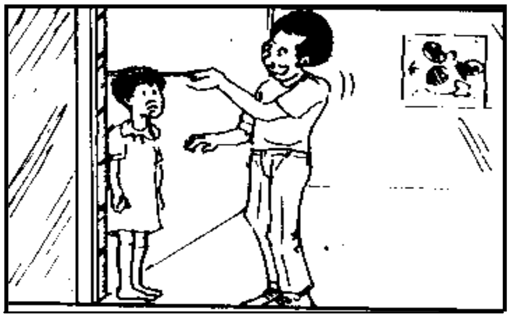
To find the length of an object we use measuring instruments such as a ruler or a tape measure.



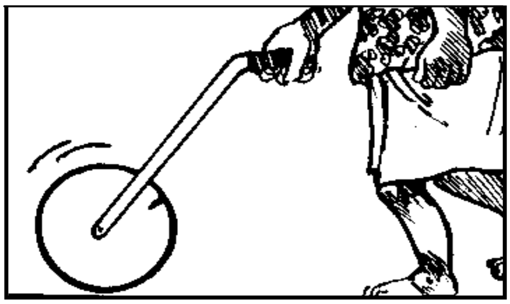
These instruments are used for measuring the length or distance between two points.

Measuring instruments can have different **scales** depending on what they are used for.

For example: Our height is measured in centimetres. So, we use a ruler or tape measure which has **centimetre** and **millimetre** scales.



A trundle wheel is used to measure longer distance in **metres**.
For example: Measuring a soccer field.



The scales on the measuring instruments help you to find the length of objects or distance between them.

Do you remember the metric units of length? If not, then here they are again.

Units of Length

10 millimetres (mm) = 1 centimetre (cm)
100 centimetres (cm) = 1 metre (m)
1000 metres (m) = 1 kilometre (km)

Answer the following questions based on the units of length.

Questions

Write down the name of the appropriate unit that would be used to measure the following:

(a) the height of a door

Answer: ___________

(b) the distance from Port Moresby to Lae

Answer: ___________

(c) the width of this page:

Answer: ___________

(d) the perimeter of a soccer field:

Answer: ___________

(e) the width of your thumb nail:

Answer: ___________

You must have answered the same as the one below.

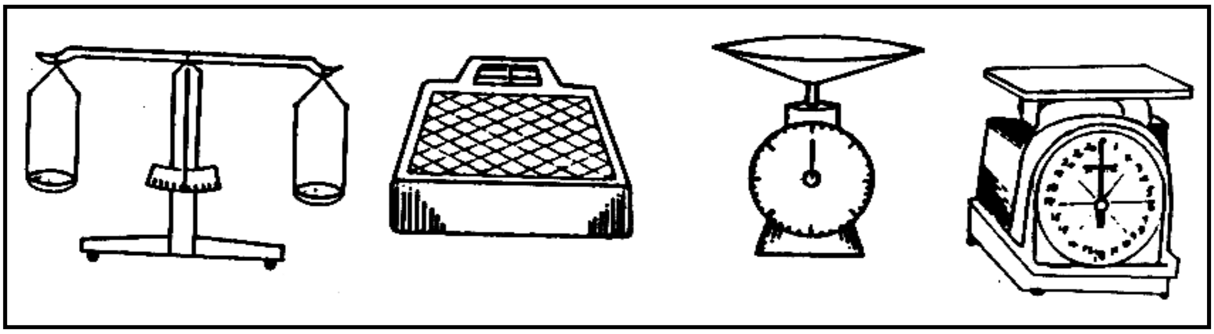
Answers: (a) centimetres (b) kilometres (c) centimetres
(d) metres (e) millimetres

Now on the next page, you will learn the metric units of weight and identify some of the measuring instrument we use to find the weight of an object.

Weight

To find the weight of an object, we use a weighing machine. The type of machine we use depends on what we are weighing.

Here are some examples of weighing instruments that we can use to measure the weight of objects.



Weighing machines

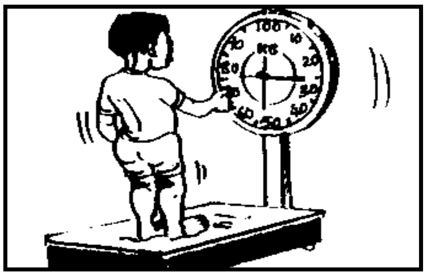
Weighing machines have different shapes and sizes. In most shops, they are used to weigh vegetables, meat and other items.

The type of instrument we would use to measure will depend on:

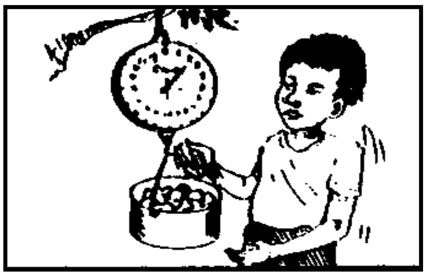
a) the object we want to measure

b) how accurate we want our measurement to be.

To find our weight, we measure to the nearest **kilogram**. So, we use a weighing machine like this with gram and kilogram scales.



To find the weight of a small object we measure to the nearest gram. So we use a weighing machine which measures in **grams.**



Do you remember the metric units for weight?

Weight	
Base unit is **gram**	
1000 mg	= 1 g
1000 g	= 1 kg
1000 kg	= 1 t

Questions

Answer these questions about metric units of weight.

Write the appropriate unit that would be used to measure the following:

(a) a large bag of rice

Answer: ______________

(b) the weight of a match box

Answer: ______________

(c) your weight

Answer: ______________

(d) the weight of a truck

Answer: ______________

Answers: (a) kilograms (b) grams (c) kilograms (d) tonnes

Note:

When we estimate the weight of objects, we must have some idea of how heavy they are.

NOW DO PRACTICE EXERCISE 22

Practice Exercise 20

1. What metric units would you use to measure the following?

   (a) the length of a pencil. **Answer**: _______________

   (b) the perimeter of a soccer field. **Answer**: _______________

   (c) the weight of a K1 coin. **Answer**: _______________

   (d) the width of your unit book. **Answer**: _______________

2. Fill in the blank spaces.

   If a pen is 130 mm long (13 cm), work out the length in cm for:

   (a) 6 pens

   6 **x** __________ cm = ____________ cm

   (b) 12 pens

   ___________ **x** 13 cm = ___________ cm

3. Convert the following metric units:

   (a) Change 5600 kilograms into tonnes.

   Answer: ______________

   (b) Change 500 centimetres to millimetres

   Answer: ______________

   (c) Change 1.8 kilometres to metres.

   Answer: ______________

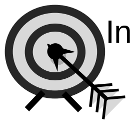
   (d) Change 1.9 grams to milligrams.

   Answer: ______________

CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 4.

Lesson 21: Measuring Time

You learnt about the different units of length and weight in the last lesson. You also learnt how to measure length and weight using the appropriate instrument.



In this lesson, you will:

- identify the units used to measure time
- convert units of time
- differentiate between 12-hour time and 24-hour time
- convert 12-hour time to 24-hour time and vice versa

You learnt in your Grade 7 and 8 Mathematics something about measurement of time. In this lesson, we will revise the two ways of measuring time and extend further your knowledge and skills in measuring time.

First, we will revise the basic units used to measure time.

Here is a table of units of time. Their symbols and how they are related to each other. The seconds is the base unit.

Time		
Name of Unit	**Symbol**	**Value**
second	s	Base unit: **second**
minute	min	1 min = 60 s
hour	h	1 h = 60 min = 3600 s
day	d	1 d = 24 h = 1440 min = 86400 s
week	wk	1 wk = 7 days
month	mo	1 mo = 28 to 31 days = 4 wks
year	yr	1 yr = 52 wks = 12 months = 365 days
1 leap year		= 366 days

There are other units of time we may come across. These are:

1 fortnight = 2 weeks

1 Decade = 10 years

1 Century = 100 years

Usually when we solve problems involving operations with time, we sometimes change or convert the unit.

Now study the following examples on conversion of time units.

Examples

1. To convert a smaller unit into a larger unit we **divide**.

a) Convert 5760 minutes into hours

5760 min $= \frac{5760}{60}$ .... **{1 h = 60 min}**

$= 96$

Therefore, 5760 min = 96 hours

b) Convert 79 200 seconds into hours

79 200 m^2 $= \frac{79\,200}{3600}$ .... **{1 h = 3600 s}**

$= 22$

Therefore, 79 200 seconds = 22 h

2. **To convert a larger unit to a smaller unit we multiply.**

a) Convert $3\frac{3}{4}$ days into hours

3.75 d = 3.75 x 24 .... **{1 d** = **24 hours}**

= 90

Therefore, 3.75 days = 90 hours

b) Convert 18 months into weeks

18 mo = 18 x 4 .... {**1 mo** = **4 wk**}

= 72

Therefore, 18 months = 72 weeks

Here are some more examples.

1. How many hours in 5 days?

Solution:

5 days = 5 **x** 24 .... {**24 hours = 1 day**}

= 120 hours

Therefore, there are 120 hours in 5 days.

2. Samuel has spent the last 32 weeks living in Kokopo. How many fortnights is that?

Solution:

32 weeks = $\frac{\not{3}\not{2}^{16}}{\not{2}_1}$

= 16 fortnights .... (**2 weeks = 1 fortnight**)

Therefore, there are 16 fortnights in 32 weeks.

3. John has been working for $4\frac{1}{2}$ hours. Change this time into seconds.

Solution:

First change **4 $\frac{1}{2}$** hours into minutes.

$4\frac{1}{2}$ hrs = $\frac{9}{\not{2}_1}$ **x** $\not{6}0^{30}$ .... {**60 min = 1 h**}

= 270 min

Now change **270** minutes into seconds.

150 min = 270 **x** 60 .... {**60 sec** = **1 min**}

= 16200 sec

Therefore, there are 16200 seconds in $4\frac{1}{2}$ hours

Remember that we may need to convert once or twice to get the required unit for the answer.

Showing the Time

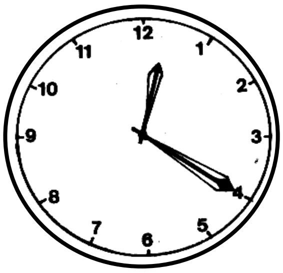
There are two major ways to show the time: "AM/PM" or "24 Hour Clock".

- With **12 Hour Clock** (or "**a.m./p.m.**") the day is split into the 12 Hours running from Midnight to Noon (the a.m. hours) and the other 12 Hours running from Noon to Midnight (the p.m. hours).
- With the **24 Hour Clock** the time is shown as how many hours and minutes since midnight.

A 12-hour Clock

We are quite familiar with a 12-hour clock. The hours are from 1 to 12.
The two hands are the **hour** (short) and **minute** (long) hand.

What is the time on this clock?



As you can see on the clock, the hour hand has gone past 12 while the minute hand is pointing at 4.

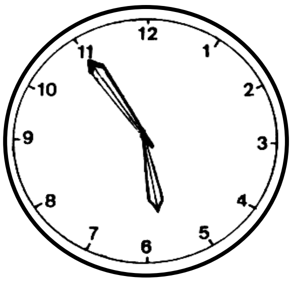
So the time is **20 minutes past the hour of 12.**

We can write this time in two ways like this:

(a) **20 past 12** or (b) **12.20**

Notice that in (b) a **dot** is used to separate the minutes (20) from the hour (12).

Let us look at another example.



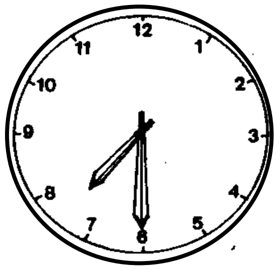
The hour hand of this clock is almost pointing at 6, while the minute hand is pointing to 11. So the time is, **5 minutes to 6.**

We can also write this time in two ways like this:

5 to 6 or **5.55**

We know that in one day, the clock shows the same clock-face two times. One in the morning and the other in the afternoon.

For example, the time **7.30**
can be in the morning as well
as in the evening (late afternoon).



In a 12-hour clock, we write these times as either **a.m.** or **p.m.**
a.m and **p**.**m** comes from the Latin words **ante meridian (**meaning before noon) and **post meridian** (meaning afternoon).

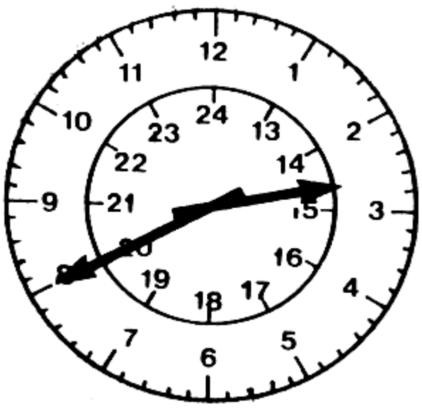
a.m. – ante meridian (refers to times before noon)
p.m. – post meridian (refers to times after noon)

So, 7.30 in the morning is **a.m.** and 7.30 in the evening is **p.m**.

A 24-hour Clock

The flight schedules for Air Niugini and all other Air Line Companies are written in 24-hour times. For the purpose of travelling, it is important to know how to read these times.

Notice that in a 24-hour clock, the hours are from 1 to 24 hours. We know that in one day, there are altogether 24 hours.



A 24-hour Clock

In here, the numbers represent the hours of a day.

Reading Time on the 24-hour clock

When it is **a.m.** time, we use the hours 0 to12, the numbers around the outer circle of the clock-face. When it is **p.m** time, we use the hours 12 to 24, around the inside circle of the clock-face.

Take for example the following times:

12 hour to 24 hour time	12 hour to 24 hour time
3.35 a.m. ------- 0335 h	3.35 p.m. -------- 1555 h
9.18 a.m. ------- 0918 h	9.18 p.m. -------- 2118 h
10.35 a.m. ------- 1035 h	10.35 p.m. ------- 2235 h
11.40 a.m. ------- 1140 h	11.40 p.m. ------- 2340 h

Notes:

i. we always use **four** digit numbers, for example, 0045

ii. we **do not** use a **dot** to separate hours from minutes.

iii. for **a.m**. (12 hour) times which have only 3 digits, a **zero** is added at the front, for example, 1.15 a.m. as 0115 .

iv. for **p.m**. times, we use the hours on the outside of the clock. for example, 1.15 p.m. as 1315 .

Here is part of an Air Nuigini flight schedule.

	DEP	SECTOR	ARR		DEP	SECTOR	ARR
PX205	0700	RAB-POM	0820	PX260	0700	POM-LA	0745
PX254	1005	POM-KIE	1150		0815	LAE-HKN	0910
PX070	1230	KIE-CNS	1500		0915	HKN-RAB	1010
QF199	1550	CNS-POM	1715		1035	RAB-KIE	1130
PX108	1850	POM-LAE	1935	PX255	1135	KIE-POM	1340
PX109	2000	LAE-POM	2045	PX254	1500	POM-KIE	1645

Notice that both the departure and arrival times have been written in the 24-hour clock system.

Take this flight time:

	DEP	SECTOR	ARR
PX205	0700	RAB-POM	0820

In the 12 hour time, the departure time is 7.00 a.m. and arrival time is 8.20 a.m.

NOW DO PRACTICE EXERCISE 21

Practice Exercise 21

1. Write the following times as 24-hour clock times.

(a) 12.30 p.m. ____________ (c) 6.15 a.m. ____________

(b) 10.24 p.m. ____________ (d) 9.46 p.m. ____________

2. Write the following times as 12-hour clock times.

(a) 0900 h _____________ (c) 0950 h _____________

(b) 2130 h _____________ (d) 1845 h _____________

3. What is the base unit for time? **Answer**: _______________

4. Convert 400 minutes into hours.

Answer: _______________

5. Convert 92 months into years.

Answer: ______________

6. Convert $7\frac{1}{2}$ minutes to seconds.

Answer: ________________

7. It takes 2 hours to travel by air from Port Moresby to Madang. What will be the departure time if the arrival time is 1800 hours?

Write your answer below:

(a) 12 hour time

Answer:________________

(b) 24 hour time

Answer::_______________

8. It takes $1\frac{1}{2}$ hours for Ram to walk from his village to school each morning. If Ram leaves his village at 7.45 a.m, when does he arrive at school? Write your answer below in:

(a) 12 hour time **Answer**: ______________

(b) 24-hour time. **Answer**: ______________

---

9. Here is part of an Air Niugini flight schedule.

	DEP	SECTOR	ARR		DEP	SECTOR	ARR
PX205	0700	RAB-POM	0820	PX260	0700	POM-LAE	0745
PX254	1005	POM-KIE	1150		0815	LAE-HKN	0910
PX070	1230	KIE-CNS	1500		0915	HKN-RAB	1010
QF199	1550	CNS-POM	1715		1035	RAB-KIE	1130
PX108	1850	POM-LAE	1935	PX255	1135	KIE-POM	1340
PX109	2000	LAE-POM	2045	PX254	1500	POM-KIE	1645
PX184	0700	POM-LAE	0745	QF539	0700	TSV-CNS	0745
	08I0	LAE-HGU	0850		0820	CNS-POM	0945
PX181	0915	HGU-POM	1015	PX116	1045	POM-HGU	1145
PX114	1100	POM-GKA	1150		1210	HGU-MAG	1240
	1215	GKA-MAG	1235	PX115	1305	MAG-GKA	1325
PX115	1300	MAG-GKA	1320		1350	GKA-POM	1440
	1345	GKA-POM	1435	PX128	1530	POM-LAE	1615
PX530	1630	POM-CNS	1755		1640	LAE-MAG	1715
	1835	CNS-TSV	1915		1740	MAG-WWK	1820

Write the 12-hour times for the following:

(a) Departure time of flight PX530 from CNS to TSV.

Answer: ______________

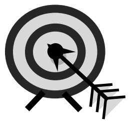
(b) Arrival time of the same flight.

Answer: ______________

CORRECT YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 1.

Lesson 22: Units for Measuring Area

You learnt something about the units of measuring time in the last lesson.



In this lesson, you will:

- define area
- identify the units to measure area
- converts units of area.

Let us first recall the definition of area.

> The area of a shape is the amount of surface it covers or occupies.

For example: A garden plot occupies a certain amount of land surface.

Area Units of Measure

To measure an area, we must use a unit which occupies a fixed amount of surface.

Look at the square below. It occupies a certain amount of surface. Each side of the square is 1 cm in length.

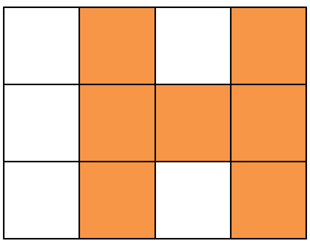
We call the amount of surface in this square, 1 square centimetre (1 cm^2)

1 cm^2

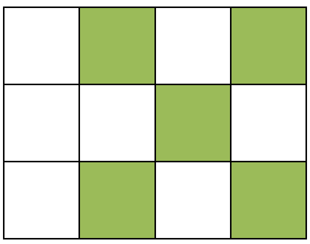
The square centimetre is a unit for measuring area. We can use this square unit to measure the area of other shapes.

Questions:

How many 1 cm^2 make up the shaded area of shapes **A** and **B**?



A



B

We can find the answer by counting the number of shaded square centimetres in each shape.

Answers: Shape **A** = 7 cm^2 Shape **B** = 5 cm^2

A square centimetre is a small unit so it is used to measure the area of surface of small shapes.

To find the area of larger surfaces such as a basketball court or a soccer field, we must use bigger square units.

For larger surface areas, we use the following square units:

1 square metre (1m^2) .... (100 X 100) cm^2
1 hectare (1 ha) .... (100 X 100) m^2
1 square kilometre (1 km) .... (1000 x 1000) m^2

To give us some idea about the size of these area units, here are two examples:

i. A rugby field is about $\frac{1}{2}$ hectare............. (120 x 90) m^2

ii. A basketball court is 364 m^2 ....…....... (26 x 14) m^2

Conversion of Area Units

We have learnt how to convert Metric units of length and weight. Area units can also be converted from one to the other.

Remember the measurement units for area. These are based on the Metric units of length.

Area Unit
1 m^2 = 10 000 cm^2 ....**(100 X 100) cm^2**
1 ha = 10 000 m^2 ....**(100 X 100) m^2**
1 km^2 = 1 000 000 m^2 ....**(1000 X 1000) m^2**

We will use this table to help us do conversions.

To be able to do the correct conversion, it is important to know which unit is small and which is larger.

For example: A cm^2 is smaller than a m^2.

A m^2 is smaller than a hectare.

A hectare is smaller than a square kilometre.

Now study the following examples on conversion of area units.

Examples

1. To convert a smaller unit into a larger unit we **divide**.

a) Convert 40 000 cm^2 into square metres (m^2)

$$40\,000\ cm^2 = \frac{40\,000}{10\,000}$$ .... **{1 m^2 = 10 000 cm^2}**

$$= 4$$

Therefore, 40 000 cm^2 = 4 m^2

b) Convert 55 000 m^2 into hectares.

$$55\,000\ m^2 = \frac{55\,000}{10\,000}$$ .... **{1 ha = 10 000 m^2}**

$$= 5.5$$

Therefore, 55 000 m^2 = 3.5 ha

2. **To convert a larger unit to a smaller unit we multiply.**

a) Convert 9.5 m^2 into square centimetres (cm^2)

$9.5\ m^2 = 9.5 \times 10\,000$ .... **{1 m^2 = 10 000 cm^2}**

$= 95\,000$

Therefore, 9.5 m^2 = 95 000 cm^2

b) Convert 0.7 of a hectare into square metres (m^2).

$0.7\ ha = 0.7 \times 10\,000$ .... {**1 ha** = **10 000 m**^{2}}

$= 7\,000$

Therefore, 0.7 ha = 7 000 m^2

NOW DO PRACTICE EXERCISE 22

Practice Exercise 22

1. Complete the blank spaces.

   (a) Area means the amount of ________________________________

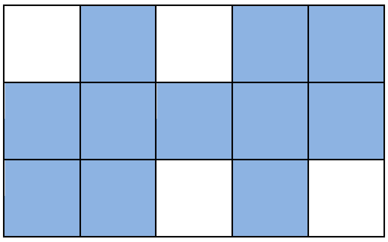
   (b) ha is the short form for ___________________________________

   (c) cm^2 is read as __________________ centimetre.

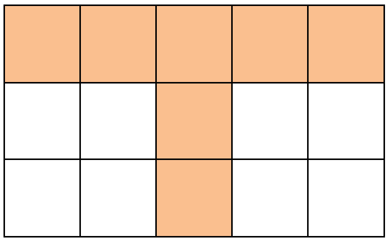
   (d) 10 000 cm^2 will fit exactly into _____________ square metres.

2. Find the area in each of the following figures by counting the number of shaded square centimetres.

A



B



Area of **A** = ____________

Area of **B** = ____________

3. Write down the area unit most suitable for measuring the following:

   (a) the page of a book. **Answer:** ____________

   (b) the area of a cocoa plantation. **Answer:** ____________

   (c) the floor of a house. **Answer:** ____________

4. Convert the following to square metres.

   (a) 1.8 hectares

   Answer: ____________

   (b) 88 000 cm^2

   Answer: ____________

5. Convert the following to hectares.

(a) 9500 m^2

Answer: ____________

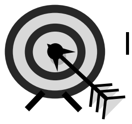
(b) 1 000 000 m^2

Answer: ____________

CHECK YOUR WORK.ANSWERS ARE AT THE END OF TOPIC 4.

Lesson 23: Units for Measuring Volume

You learnt about the different units of measuring area in the last lesson. You also learnt to convert units of area from one unit to another.



In this lesson, you will:

- define volume and identify objects that occupy space
- differentiate between volume and capacity
- identify units used to measure volume and capacity
- convert units of volume and capacity
- solve problems involving conversion of volumes and capacity

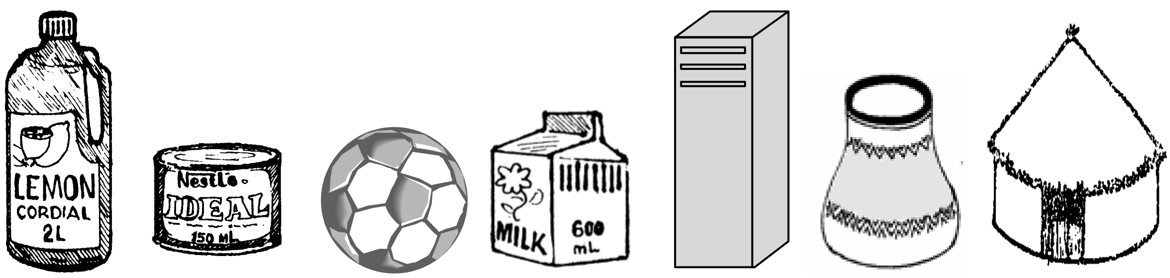
In this lesson, we will revise some of the work we did in Grade 8 on volume and capacity.

In Mathematics, volume and capacity are often interchanged in use and meaning. To give you an idea of the real differences between these two terms, let us make a comparison of their definitions.

Firstly, to what exactly does volume refer? When we talk about the volume of an object, we differentiate between whether something is a liquid, a solid or a gas. **Volume** refers to the amount of three-dimensional space that an object occupies.

Secondly, **capacity** refers to the ability of something to hold, receive or absorb. Capacity is how 'much' can fit into something. It is similar in concept to volume, but there are a few differences.

Here are some objects that occupy space.



To help us calculate these two quantities let us first recall their units of measurements.

Volume is measured in cubic centimetres (cm^3) and cubic metres (m^3). Capacity is measured in litres (L) and millilitres (mL).

MEASURES OF VOLUME AND CAPACITY

Volume	Capacity
1 000 000 cm^3 = 1 m^3	1000 L = 1 m^3 1000 mL = 1 L 1000 L = 1 kL
1 cm^3 is equivalent to 1 mL	

For the purpose of calculation, we will treat both quantities (volume and capacity) as the same. That is, we will call both quantities volume.

Let us start by doing some revision work on conversion of volume units.

Example 1

Convert 6 litres into millilitres.

Solution: 6 L = 6 **x** 1000 mL .... **{1000 mL = 1 L}**

= 6000 mL

Example 2

Convert 2.6 litres to millimetres.

Solution: 2.6 L = 2.6 **x** 1000 mL .... **{1000 mL = 1 L}**

= 2600 mL

Example 3

Convert 4.3 litres into cubic centimetres

Solution: 4.3 L = 4.3 ÷ 1000 L .... **{1000 L = 1 m^3}**

= 0.0043 m^3 **{1 m^3 = 1000 000 cm^3}**

= 4300 cm^3

Example 4

Convert 3275 cubic centimetres into litres.

Solution: 3275 cm^3 = 3275 ÷ 1 000 000…………… **{1 000 000 cm^3 = 1 m^3}**

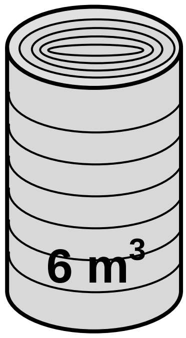
= 0.003275 m^3

= 0.003275 x 1000 …………….**{1000 L = 1 m^3}**

= 3.275 L

Example 5

A sauce container has a capacity of 6 m^3 as shown.



(a) What is its capacity in litres?

(b) How many litres of oil will it contain when $\frac{3}{4}$ full?

Solution:

(a) Capacity in litres

6 m^3 = 6 x 1000 …………………….. **{1 m^3 = 1000 L}**

= 6000 L

(b) When full, it contains 6000 L.

So, when $\frac{3}{4}$ full, it contains $\frac{3}{4}$ x 6000 L

= 4500 L

Example 6

A water tank has a volume of 13 5000 cm^3.

How many litres of water can the tank can hold when full?

Solution: Volume = 135 000 cm^3

So, capacity when full = 135 000 cm^3

(Change cm^3 to litres.)

1000 cm^3 = 1 L

So, 135 000 cm^3 = 135 000 x $\frac{1}{1000}$ L

= 135 L

NOW DO PRACTICE EXERCISE 23

Practice Exercise 23

Use the units in the table above to help you work through these questions.

1. Convert the following to the indicated unit.

(a) 7.6 litres ______________ mL

(b) 2550 litres ____________ kL

(c) 5.3 litres ______________ cm^3

(d) 1750 mL _____________L

(e) 68750 cm^3______________L

(f) 496 L ______________m^3

g) 3350 m^3 ______________L

h) 0.000234 cm^3 ______________m^3

2. A rectangular container is 3 cm long, 1.5 cm wide and 0.8 cm high.

   How many litres of water can it hold when full?

Answer: __________

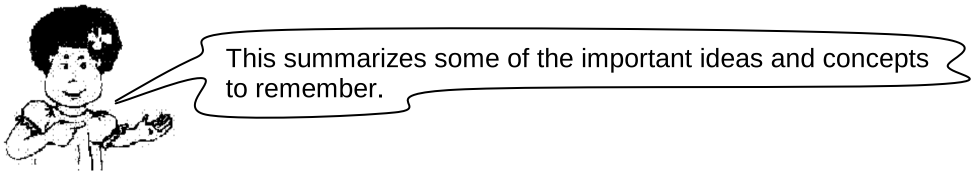
---

3. A rectangular pool measures 20 m by 50 m and is 6.5 m deep.
   Find the capacity of the pool (in m^3).

Answer: __________

CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 4.

TOPIC 4: SUMMARY



- The basic unit of length in the metric system is the **metre.**
- **Kilometre** is the standard unit for longer distances.
- **Centimetre** or **the millimetre** is usually used for short distances.
- The basic unit of mass in the metric system is the **kilogram.**
- **Tonne** is the standard unit of mass or weight use for large object.
- **Gram** and **milligram** are used to measure mass or weight of smaller object.
- To convert **large** metric units into **smaller** units, we **multiply**.
- To convert **small** metric units into **larger** units, we **divide**.
- **Second, minute** and **hour** are the basic units of time.
- There are two major ways to show the time: **"AM/PM" or "24 Hour Clock".**
- With **12 Hour Clock** (or "**a.m./p.m.**") the day is split into the 12 Hours running from Midnight to Noon (the a.m. hours) and the other 12 Hours running from Noon to Midnight (the p.m. hours).
- With the **24 Hour Clock** the time is shown as how many hours and minutes since midnight.
- **Volume** refers to the amount of three-dimensional space that it occupies. It is measured in cubic centimetres (cm^3) and cubic metres (m^3).
- **Capacity** refers to the ability of something to hold, receive or absorb. It is measured in litres (L) and millilitres (mL).

MEASURES OF VOLUME AND CAPACITY

Volume	Capacity
1 000 000 cm^3 = 1 m^3	1000 L = 1 m^3 1000 mL = 1 L 1000 L = 1 kL
1 cm^3 is equivalent to 1 mL	

REVISE LESSONS 19-23 THEN DO TOPIC TEST 4 IN ASSIGNMENT BOOK 1.

ANSWERS TO PRACTICE EXERCISES 19-23

Practice exercise 19

1. (a) metre
   (b) gram

2. (a) t (b) km (c) mm (d) mg (e) cm

3. (a) gram (b) kilometer (c) tonne (d) metre

4. (a) 6.5 km (b) 3200 kg (c) 48 cm (d) 9.612 kg

Practice exercise 20

1. (a) centimetres (b) metres (c) gram (d) centimetres

2. (a) 6 x **<u>13 cm</u>** = **<u>78</u>** cm

   (b) **<u>12</u>** x 13 cm = **<u>156</u>** cm

3. (a) 5.6 tonnes (b) 5000 mm (c) 1800 m (d) 1900 mg

Practice exercise 21

1. (a) 1230 h (b) 2224 h (c) 0615 h (d) 2146 h

2. (a) 9.00 a.m. (b) 9.30 p.m. (c) 9.50 a.m. (d) 6.45 p.m.

3. Seconds

4. 6.66 h or $6\frac{2}{3}$ h

5. $7\frac{2}{3}$ yrs. or 7.66 yrs.

6. 450 sec

7. (a) 4.00 p.m. (b) 1600 h

8. (a) 9.15 a.m. (b) 0915 h

9. (a) 6.35 p.m. (b) 7.15 p.m.

Practice exercise 22

1. (a) surface an object covers or occupies
   (b) hectares
   (c) square
   (d) one (1)

2. A= 11 cm^2 B = 7 cm^2

3. (a) cm^2
   (b) hectares
   (c) m^2

4. (a) 18 000 m^2
   (b) 8.8 m^2

5. (a) 0.95 ha
   (b) 100 ha

Practice exercise 23

1. (a) 7600 mL
   (b) 2 .55 kL
   (c) 5300 cm^3
   (d) 1.75 L
   (e) 68.75 L
   (f) 0.496 m^3
   (g) 3 350 000 L
   (h) 0.000000000234 m^3

2. 0.0036 L

3. 6500 m^3

END OF UNIT 1

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