

Functional Mathematics

For Junior High Schools

Teacher's Guide

Basic

9

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ISBN: 978-9988-9222-2-1

Published and Printed in Ghana
By Masterman Publications Ltd.
P. O. Box AN 19720
Accra – North
Ghana.

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PREFACE

Functional Mathematics for Junior High Schools, Basic 7 to 9 is a set of three books that have been carefully developed for use by learners in Junior High Schools. These books conform, by all standards to the new Mathematics Curriculum developed by the National Council for Curriculum and Assessment (NaCCA) September, 2020 for the Common Core Programme.

The books are written to assist learners develop the core skills namely:

- Critical Thinking and Problem Solving Abilities.
- Collaborative and Team Work.
- Personal Development and Leadership.
- Attention to Precision.
- Creativity and Innovation.
- Cultural Identity and Global Citizenship.
- Digital Literacy

Significant features of the three set of books include:

- The use of simple language and expressions with enough practical activities.
- The use of locally available materials as Teaching and Learning Resources (TLRs).
- Adequate relevant illustrations for easy understanding of the various concepts.
- Enough examples and exercises which could be useful for School Based Assessment (S.B.A)

It is also noteworthy that the structure of the Teacher's Guides and the Learner's Books follow that of the curriculum. Facilitators and learners therefore need a resource material in communication and collaboration, creativity and innovation, digital literacy and competence in the world of work.

The guides fulfill the requirement considering the in-depth treatment of the strands in the Mathematics curriculum. In addition, the guides provide activities, diagnostic assessment, progressive assessment and additional information that further enhance both the facilitator's and learner understanding.

It is our hope that the Teacher's Guide and the Learner's Books would meet the needs of both facilitators and learners and help them to translate classroom interactions into effective teaching and learning. Facilitators must always consult the Teacher's Guides when using the Learner's Books so as to conform to the requirement of the Mathematics curriculum.

GENERAL AIM

The general aim of the curriculum is to develop individuals to become mathematically literate. Good problem solvers, have the ability to think creatively and possess the confidence and competence to participate fully in the affairs of the Ghanaian society as a responsible local and global citizen.

RATIONALE

The rationale is that, mathematics forms an integral part of our everyday lives and that development is hinged on mathematics. To provide quality Mathematics education, the teacher must facilitate learning of mathematics in the classroom. This will provide foundations for discovery and understanding the world around us and lay the grounds for mathematics and mathematics-related studies at higher levels of education.

TEACHING PHILOSOPHY

The teaching philosophy is that Ghana believes that an effective Mathematics education needed for sustainable development should be inquiry-based. Thus, mathematics education must provide learners with opportunities to expand, change, enhance and modify the ways in which they view the world. It should be pivoted on learner centred teaching and learning approaches that engage learners physically and cognitively in the knowledge-acquiring process in a rich and rigorous inquiry-driven environment.

LEARNING PHILOSOPHY

The learning philosophy is that mathematics learning is an active contextualised process of constructing knowledge based on learners' experiences rather than they acquiring new ones. Teachers serve as facilitators by providing the enabling environment that promote the construction of learners' own knowledge based on their previous experiences. Learners are information constructors who operate as researchers. This makes learning more relevant to the learners and leads to the development of critical thinkers and problem solvers.

LEARNING AND TEACHING APPROACHES

The core competencies describe the relevant global skills for learning that helps learners to develop in addition to arithmetic, writing, reading and creativity. The global skills for learning allow learners to become critical thinkers, problem-solvers, creators, good communicators, collaborators, digitally literate and culturally and globally sensitive citizens who are life-long learners with a keen interest in their personal development.

Pedagogical approaches; The common core programme (CCP) emphasises creative and inclusive pedagogies that are anchored on authentic and enquiring-based learning, collaborative and cooperative learning, differentiated learning and holistic learning as well as cross disciplinary learning.

SPECIFIC AIMS

The Mathematics curriculum is designed to help learners to achieve the following:

1. recognise that Mathematics permeates the world around us.
2. appreciate the usefulness, power and beauty of Mathematics.
3. enjoy mathematics and develop patience and persistence when solving problems.
4. understand and be able to use the language, symbols and notations of Mathematics.
5. develop Mathematical curiosity and use inductive and deductive reasoning when solving problems.
6. become confident in using Mathematics to analyse and solve problems both in school and in real-life situations.
7. develop the knowledge, skills and attitudes necessary to pursue further studies in Mathematics.
8. develop abstract, logical and critical thinking abilities to reflect critically upon their work and the works of others.

The Teacher's Guide continues explanation on some of the concepts and methodologies to be used by the teacher in teaching the learners in the classroom. The teacher's guide is made up of solved questions on strands and sub-strand/units. It also provides answers to exercises in the Learner's Book as well as appropriate references to the Learner's Book. The teacher is expected to follow carefully all the strands, sub-strand/units and examples in order to achieve the following core competencies.

CORE COMPETENCIES

1. Critical thinking and Problem Solving

Developing learners' cognitive and reasoning abilities to enable them analyse issues and situations leading to the resolution of problems. This skill enables learners to draw on and discuss what they have learned and from their own experiences.

2. Creativity and Innovation

This competency promotes in learners, entrepreneurial skills through their ability to think of new ways of solving problems and developing technologies for addressing problems at hand.

3. Communication and Collaboration

This competency promotes in learners, skills in making use of language, symbols and texts to exchange information about themselves and their life experiences. Learners actively participate in sharing their ideas, engage in dialogue with others by listening to and learning from them in ways that respect and value the many perspectives of all persons involved.

4. Cultural Identity and Global Citizenship

Developing learners who put country and service foremost through an understanding of what it means to be active citizens. This is by inculcating in them a strong sense of

social and economic development awareness. Learners make use of the knowledge, skills and attitudes acquired to contribute effectively towards the socio-economic development of the country and on the global stage.

5. Personal Development and Leadership

Improving self-awareness, skills, building and renewing self-esteem, identifying and developing talents, fulfilling dreams and aspirations, learning from the mistakes and failures of the past and developing other people or meeting other people's needs. It involves the recognition of values such as honesty and empathy, seeking the well-being of others, distinguishing between right and wrong, fostering perseverance, resilience and self-confidence and developing love for lifelong learning.

6. Digital Literacy

Developing learners to discover, acquire, use and communicate through Information and Communication Technology (I.C.T) to support their learning and to make use of digital media responsibly.

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STRAND/CHAPTER 1: NUMBER

Sub-Strand/Unit 1: Number And Numeration Systems

Refer to pages 1-49 of the Learner's Book 9

Content Standards

B9.1.1.1: Apply the understanding of place value in solving real-life problems involving integers of any size, rounding this to given decimal places and significant figures.

B9.1.1.2: Demonstrate an understanding of the relationship between members of the rational number system and solve real-life problems involving the union and intersection of three sets.

Learning Expectations:

After studying this sub-strand/unit, the learner will be able to:

- use place value to solve real life problems
- use diagram to show the relationship between the various real numbers
- represent numbers on the Venn diagram
- apply mental mathematics and properties to determine answers for addition and subtraction of basic facts
- use Commutative property of addition and multiplication and distributive property to do calculations
- apply understanding of addition and subtraction, multiplication and division of decimal numbers to solve problems and round answers to given decimal places and significant figures
- add, Subtract, Multiply and Divide decimal numbers
- create and Solve world problems involving two or more operations and round the answer nearest to two decimal places or some number of significant figures

Keywords: Refer to Learner's Book page 1

Guide learners to use their dictionaries to find the contextual meaning of the keywords.

- *integers, real life, significant figures digit, rational, irrational, integers, associative, commutative, distributive property, decimal places, significant figures, round to the nearest*

Core Competencies

- Communication and Collaboration
- Creativity and Innovation
- Personal Development and Leadership

Lesson Presentation

Lead and guide learners by revising their previous knowledge about what is a number and then stating some types of numbers.

What is a number?

A number is defined as an arithmetic value that is expressed using a word, a symbol or a figure that represents a quantity.

Numbers are used in calculations and in counting. Numbers are integral part of our everyday lives right from the number of hours we sleep at night to the number of rounds we run around the racing track and much more. In maths, numbers can be even or odd, prime composite, decimals, fractions, rational or irrational, natural, integers, real and whole.

Application of place value in solving real-life problems involving integers of any size, rounding this to given decimal places and significant figures

Refer to page 2 of Learner's Book 9.

Place value in Math is the basis of our entire number system. This is the system in which the position of a digit in a number determines its value.

What is an Integer?

“Integer” is a latin word which means “whole” or “intact”.

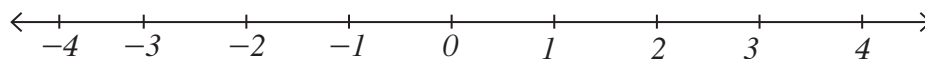
An integer is the number zero (0), a positive number or a negative number. The negative numbers are the additive inverses of the corresponding positive numbers. The set of integers is denoted by the letter Z.

The set of integers, $Z = \{\dots, -3, -2, -1, 0, 1, 2, 3, \dots\}$

Representing Integers on a number line

Refer to page 2 of Learner's Book 9

Involve learners to represent integers on a number line



Significant figures

Refer to page 3 of Learner's Book 9.

Lead and guide learners to read and discuss the rules for significant figures.

Let learners follow the rules to state or write a given number to a stated number of significant figures. *Refer to pages 3 - 5 of Learner's Book 9.*

Let learners work in groups of five and present their solutions to the class

The Numeration System

Refer to page 6 of Learner's Book 9

Lead and guide learners in a step by step approach to solve the examples 1 and 2.

Diagnostic Assessment

1. Show that $(48)_{10}$ is a base ten numeral.

Solution

$$\begin{aligned}(48)_{10} &= (4 \times 10^1) + (8 \times 10^0) \\ &= 40 + 8 \times 1 \\ &= 40 + 8 = 48\end{aligned}$$

2. $(32.41)_{10} = (3 \times 10^1) + (2 \times 10^0) + (4 \times 10^{-1}) + (1 \times 10^{-2})$

$$\begin{aligned}&= 30 + 2 \times 1 + 4 \times \frac{1}{10} + 1 \times \frac{1}{10^2} \\ &= 30 + 2 = \frac{4}{10} + \frac{1}{100} \\ &= 32 + \frac{40 + 1}{100} \\ &= 32 + \frac{41}{100} \\ &= 32 + 0.41 = 32.41\end{aligned}$$

Types of Decimal Numbers (Refer to pages 6 – 7 of Learner's Book 9)

1. Recurring decimal numbers (Repeating or Non-Terminating Decimals)

Example of recurring decimal is;

1. 3.121212.... (infinite). This can also be written as $3.\dot{1}\dot{2}$ or $3.\overline{12}$. This is recurring or repeating decimals.
2. 5.2569 (Finite) This is a finite or terminating decimal in which the decimal numbers do not recur.

Converting the decimal number into Fraction

Refer to page 7-10 of Learner's Book 9.

1. Write the given decimal in the form $\left(\frac{a}{b}\right)$, where $b \neq 0$
2. Multiply the numerator and denominator by multiples of 10 for every decimal point such that the decimal in the numerator becomes a whole number.
3. Simplify the resulting fraction if possible.

Diagnostic Assessment

Let learners solve the questions at pages 5 of LB in groups and present their solutions to the class.

1. Convert the following decimal numbers into fractions:

a. 0.45 (2 decimal places)

Solution:

$$\begin{aligned}\frac{0.45}{1} &= \frac{0.45 \times 100}{1 \times 100} \\ &= \frac{45}{100} = \frac{9}{20}\end{aligned}$$

b. 2.346 (3 decimal places)

Solution

$$\begin{aligned}2.346 &= 2.346 = \frac{2.346}{1} \\ &= \frac{2.346 \times 1000}{1 \times 1000} \\ &= \frac{2346}{1000} = \frac{1173}{500}\end{aligned}$$

Let learners work in groups of three and then present their solutions to the class.

Refer to pages 8 - 9 of Learner's Book 9.

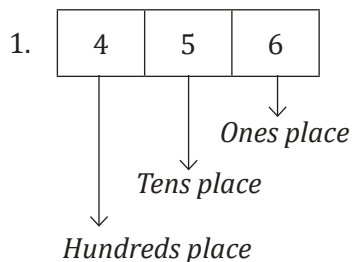
Lead and guide learners to solve other examples and let them discuss their solutions.

Place Value in Decimals

Refer to page 10-11 of Learner's Book 9

Lead and guide learners to determine the place value of digits in a given number.

For instance,



The place value of 6 is 6

The place value of 5 is 50

The place value of 4 is 400

Hence, we have four hundred and fifty-six (456)

2. 81.75

$$8 \times 10^1 + 1 \times 10^0 + \frac{7}{10} + \frac{5}{100}$$

$$(8 \times 10^1) + (1 \times 10^0) + (7 \times 10^{-1}) + (5 \times 10^{-2})$$

'8' represents the power of 10^1 . That is the tens position. '1' represents the power of 10^0 That is the sub-strand/unit s position.

'7' represents the power of 10^{-1} that is the tenths position and '5' represents the power of 10^{-2} , that is the hundredths position.

Decimal Place

Refer to page 11 of Learner's Book 9

Guide learners to study the decimal place and decimal place value chart. Let learners use the chart provided to solve the questions.

1. 45.722

'4' represents the tens place

'5' represents the ones place

'7' represents the tenths place

'2' represents the hundredths place

'2' represents the thousandths place.

Rounding off to number of decimal places

Refer to page 11 of Learner's Book 9

Diagnostic Assessment

1. Correct 3.264 to two decimal places

Solution: 3.264 = 3.26 to two decimal places

2. Write 0.716 to two decimal places

Solution: 0.716 = 0.72 to two decimal places

3. Correct 1.071119 to two decimal places

Solution: 1.071119 = 1.07 to two decimal places.

Refer to page 11 of Learner's Book 9.

Let learners solve the questions at example 2.

Lead and guide learners to round up and round down given numbers.

Refer to pages 12 – 14 of Learner's Book 9.

Let learners solve the of pages 14 - 15 questions in groups and present their solutions for class discussion.

Relationship between numbers of the Rational Number System

Refer to page 15 of Learner's Book 9

Lead and guide learners to define and give examples of rational and irrational numbers.

1. A rational number is a type of real number which is in the form $\frac{p}{q}$ where q is not equal to zero. Any fraction with a non-zero denominator is a rational number. Examples of rational numbers are; $\frac{1}{3}, 0, \frac{1}{2}, \frac{2}{5}$ and so on. Rational numbers are denoted by Q .
2. An irrational number is a type of real number which cannot be represented as a simple fraction. It cannot be expressed in the form of a ratio. Examples are; $\sqrt{2}, \sqrt{3}, \sqrt{5}, \sqrt{11}, \sqrt{21}, \sqrt{7}, \pi(pi)$ and so on. An irrational number is neither terminating nor recurring. Let us denote an irrational number by Q^i .
3. Integers are negative and positive whole numbers. Examples are, $-3, -2, -1, 0, 1, 2, 3, 4$ and so on. Integers are denoted by Z .
4. Whole numbers are natural numbers including zero. Examples are, $0, 1, 2, 3, 4$ and so on. We denote whole numbers by W .
5. Natural numbers are counting numbers. Examples are; $1, 2, 3, 4$ and so on. Natural numbers are denoted by N .

Refer to pages 15 - 19 of Learner's Book 9 for examples.

Lead and guide learners to list two types of numbers and use the Venn diagram to illustrate them.

Involve learners by asking them to work in groups and individually. Also let them present their work to the class for discussion.

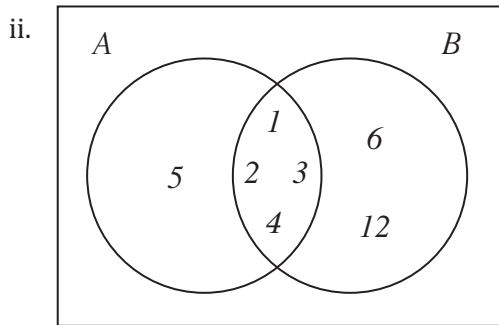
Let learners solve the questions provided at *Exercise 5 page 23 of Learner's Book 9*.

Diagnostic Assessment

1. $A = \{ \text{The first five natural numbers} \}$
 $B = \{ \text{Factors of 12} \}$
 - i. List the members of A and B
 - ii. Illustrate A and B on a Venn Diagram

Solution

- i. $A = \{1, 2, 3, 4, 5\}$
 $B = \{1, 2, 3, 4, 6, 12\}$



Real life problems involving union and intersection of two sets

Refer to page 23 of Learner's Book 9.

Problems on intersection of two sets are easy to solve if we draw a Venn Diagram. When solving problems on intersection of two sets we have to consider the following rules:

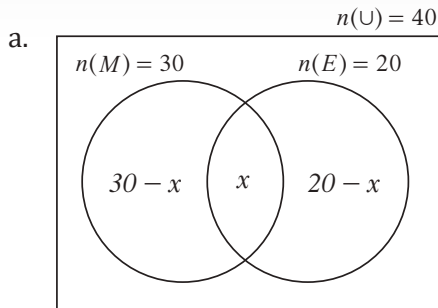
For two sets A and B:

1. $n(A \cup B) = n(A) + n(B) - n(A \cap B)$
2. If $n(A \cap B) = 0$ then sets A and B are disjoint sets and $n(A \cup B) = n(A) + n(B)$

Example:

In a class of 40 students, 30 read Mathematics and 20 read English. Each student reads at least one subject.

- a. Illustrate this information on a Venn Diagram
- b. How many students read both subjects?

Solution

$$30 - x + x + 20 - x = 40$$

$$50 - x = 40$$

$$50 - 40 = x$$

$$10 = x$$

$$x = 10$$

- b. 10 students read both subjects.

Guide learners to investigate the rules stated earlier.

$$n(M) = 30, n(E) = 20, n(M \cap E) = 10 \text{ and } n(U) = 40$$

By the rule,

$$n(M \cup E) = n(M) + n(E) - n(M \cap E)$$

$$= 30 + 20 - 10 = 50 - 10$$

$$n(M \cap E) = 40$$

$$\text{Note that } n(M \cup E) = n(U)$$

Lead and guide learners to solve the questions at example 2 on page 24 of *Learner's Book 9*.

Involve learners and let them discuss their solutions.

Multiply and divide given numbers by powers of 10 including decimals and benchmark fractions

Lead and guide learners to study the given multiplication chart at page 26 of *Learner's Book 9* and use it to answer the questions at exercise 1.

Multiply numbers by powers of 10 (Refer to page 26-27 of Learner's Book 9)

Lead and involve learners to solve the examples provided.

Diagnostic Assessment

Multiply the numbers by power of 10

1. $108 \times 10 = 1080$
2. $234 \times 1000 = 234000$
3. $7091 \times 10000 = 70910000$
4. $8902 \times 100000 = 890200000$
5. $75.109 \times 10000 = 751090$

Divide a given number by power of 10

Division is the reverse form of multiplication.

Refer to page 27-28 of Learner's Book 9 and use the multiplication chart as a guide to do the reverse form of multiplication.

For example; $42 \div 7$

Using the multiplication chart, identify the divisor 7 on the first column and trace along the row to find 42. Now, trace from 42 upwards to locate 6. Therefore; $42 \div 7 = 6$

Refer to page 26 of Learner's Book 9.

Let learners use the multiplication chart at page 26 to answer the questions at exercise 7 of page 26.

Dividing a number by power of 10

When dividing a number by power of 10, we move the decimal point to the left by the same number of places as the exponent or the number of zeros.

For instance $3845 \div 1000$

Since there are three zeros, we move the decimal point which is presumed to be at the end of the last number 5 towards the left thrice.

$$3845 \div 1000 = 3.845$$

Diagnostic Assessment

Solve the following

1. $0.0135 \div 100$

Solution

$$0.0135 \div 100 = 0.000135$$

2. $7210 \div 10^3 = 7.21$

3. $12907 \div 10^5 = 0.12907$

4. $6782 \div 10^6 = 0.006782$

5. $\frac{192027}{1000} = 192.027$

Let learners solve the questions at *page 27 of exercise 8* individually.

Decimal names of benchmark fractions

Benchmark fraction is a reference or guide for identifying other fractions. Common fractions that are more familiar are used as benchmarks to help find the less familiar fractions. Some benchmark fractions are;

$$\frac{1}{3}, \frac{1}{4}, \frac{1}{8}, \frac{3}{8}, \frac{1}{2}, \frac{5}{8}, \frac{2}{3} \text{ etc.}$$

Converting benchmark fractions to decimals (Refer to page 29-30 of Learner's Book 9)

Lead and guide learners to convert common fractions into decimals.

Example

1. Change $\frac{1}{2}$ into decimal

Solution

$$\frac{1}{2} = \frac{1 \times 5}{2 \times 5} = \frac{5}{10} = 0.5$$

2. Convert $\frac{2}{3}$ into a decimal

Solution

$$\begin{array}{r} 0.666 \\ 3 \overline{) 20} \\ \underline{18} \\ 20 \\ \underline{18} \\ 20 \\ \underline{18} \\ 2 \end{array}$$

$$\frac{2}{3} = 0.6\bar{6}$$

Let learners solve the given questions at examples 1 and 2 respectively.

Converting decimals to fractions

Refer to page 30 of Learner's Book and guide learners through the procedure stated

Example

1. Convert 0.2 to a fraction

Solution

$$0.2 = \frac{0.2 \times 10}{1 \times 10} = \frac{2}{10} = \frac{1}{5}$$

2. Write 1.5 in the form $\frac{a}{b}$, $b \neq 0$

Solution

$$1.5 = \frac{1.5 \times 10}{1 \times 10} = \frac{15}{10} = \frac{3}{2}$$

Convert from fraction to percentage (Refer to page 32 of Learner's Book 9)

Functions that are expressed as percentages can be easier to understand.

Expressing a fraction as a percentages means the same as converting a fraction to a percentage. Percent means per hundred or out of 100.

To convert a fraction to a percentage by multiplying by 100 we either;

1. Divide the numerator by the denominator and multiply the result by 100% or
2. Multiply the numerator by 100 and divide the result by the denominator.

Example

1. Write $\frac{2}{5}$ as a percentage

Solution:

$$\frac{2}{5} = \frac{2}{5} \times \frac{100}{1} \% = \frac{2}{1} \times 20\% = 40\%$$

Lead and guide learners to solve all the questions at example 4

Convert from percentage to fraction (*Refer to page 33 of Learner's Book 9*)

Lead and guide learners to understand the following steps to follow when changing percentage to fractions.

1. Divide the given percent by 100 to get the decimal number.
2. If the percent is not a whole number, then multiply every number by 10 after the decimal point
3. Simplify the resulting fraction

Example

1. Change 25% to a fraction in its lowest term.

Solution

$$25\% = \frac{25}{100} = \frac{1}{4}$$

Convert from decimal to percentage

Refer to page 33 – 35 of Learner's Book 9

Convert from percentage to decimal

Refer to page 36 - 37 of Learner's Book 9

Converting mixed number percent to fraction (*Refer to page 38-39 of Learner's Book 9*)

Lead and guide learners to study and follow the steps to convert mixed number percent to fraction.

1. Convert the mixed fraction percent into a proper fraction.
2. Multiply the result by $\frac{1}{100}$ to remove the percent symbol
3. Simplify the fraction if possible

Involve learners to solve the example 5 and also put learners in groups of three to answer the questions provided at exercise 2.

Let the learners present their solutions to the class

Diagnostic Assessment

1. Convert $12\frac{1}{2}\%$ to a fraction

Solution:

$$12\frac{1}{2}\% = \frac{25}{2} \times \frac{1}{100} = \frac{1}{2} \times \frac{1}{4} = \frac{1}{8}$$

2. Write $\frac{13}{5}$ as a decimal

Solution

$$\begin{array}{r} \frac{13}{5} = 5 \overline{)13} \\ \underline{10} \\ 30 \\ \underline{30} \\ 0 \end{array}$$

$$\frac{13}{5} = 2.6$$

3. Convert $\frac{2}{5}$ to a percentage

Solution: $\frac{2}{5} = \frac{2}{5} \times \frac{100^{20}}{10} = 2 \times 20 = 40\%$

4. Write 0.125 as a common fraction

Solution

$$0.125 = \frac{0.125 \times 1000}{1 \times 1000} = \frac{125}{1000} = \frac{5}{40} = \frac{1}{8}$$

5. Convert 0.26 to a percentage

Solution

$$0.26 = \frac{0.26 \times 100}{1 \times 100} = \frac{26}{100} = \frac{13}{50}$$

$$\frac{13}{50} \times \frac{100^2}{1} = 13 \times 2 = 26\%$$

Product of a given decimal number when it is multiplied by 10, 100, 1000, $\frac{1}{10}$, $\frac{1}{100}$, $\frac{1}{1000}$, etc.
Refer to page 40 of Learner's Book 9

Lead and guide learners to solve the given examples at page 36-39 of Learner's Book 9.

Dividing decimals by powers of 10 (*Refer to pages 41 – 42 of Learner's Book 9*)

Powers of 10 to a negative exponent can be written in two ways

1. Written in an exponent; $10^{-1}, 10^{-2}, 10^{-3}, etc$
2. Written in an expanded form; $\frac{1}{10}, \frac{1}{10^2}, \frac{1}{10^3}, etc$

Lead and guide learners to divide decimals by the powers of 10.

To divide a decimal by a power of 10, move the decimal point to the left the same number of places as the number of zeros or exponent(s). For each zero in the power of 10, move the decimal point one place to the left.

Let learners work the example 2 and answer the questions given at exercise 11 of page 39 of Learner's Book 9.

Commutative property of addition and multiplication

Refer to page 43 of Learner's Book 9

The commutative property deals with the arithmetic operations of addition and multiplication. It means that changing the order or position of two numbers while adding or multiplying them does not change the end result.

Commutative property of addition (*Refer to page 43 of Learner's Book 9*)

$$x + y = y + x$$

$$2 + 3 = 3 + 2$$

$$6 + 9 = 9 + 6$$

Commutative Property of Multiplication

$$xy = yx$$

$$2 \times 6 = 6 \times 2$$

$$12 \times 5 = 5 \times 12$$

Let learners solve the questions at exercise 14 of page 44 of Learner's Book 9 and discuss their solutions among themselves.

Associative property of addition and multiplication

Refer to page 44 of Learner's Book 9.

Explain the concept of associative property to learners.

1. $a + (b + c) = (a + b) + c$
2. $x(y \times z) = (x \times y) \times z$

Let learners solve the questions at exercise 15 of page 45-46 of *Learner's Book 9*

Distributive Property in solving problems (*Refer to pages 45-46 of Learner's Book 9*)

1. $a \times (b + c) = ab + ac$. Multiplication is distributed over addition.
2. $a(b - c) = ab - ac$. Multiplication is distributed over subtraction.

Let the learners solve the questions at exercise 6 individually.

Diagnostic Assessment

Expand and simplify the following;

1. $2(x + 3)$

Solution

$$2(x + 3) = 2x + 6$$

2. $-2(-4y - 1)$

Solution

$$-2(-4y - 1) = 8y + 2$$

3. $-3(-7 - 3)$

Solution

$$-3(-7 - 3) = 21 + 9 = 30$$

4. $-(3x - 5)$

Solution

$$-(3x - 5) = -3x + 5$$

5. $(3 - x)(2 + 3x)$

Solution

$$\begin{aligned} (3 - x)(2 + 3x) &= 3(2 + 3x) - x(2 + 3x) \\ &= 6 + 9x - 2x - 3x^2 \\ &= 6 + 7x - 3x^2 \end{aligned}$$

Addition, Subtraction, Multiplication and Division, Using Word Problems

Refer to page 46 of Learner's Book 9.

Put learners in groups of three and let them solve the questions at exercise 1 pages 45-46 and present their solutions to the class.

Diagnostic Assessment

1. Sarah makes jewelry with beads. Bracelets have 37 beads. Necklaces have 74 beads. Sarah makes 28 bracelets and 81 necklaces. How many beads does she use altogether?

Solution

Jewelry with beads.

Bracelets have 37 beads $\times 28 = 1036$

Necklaces have 74 beads $\times 81 = 5994$

We have to add the number of beads to get the total number of beads. Therefore,
 $1036 + 5994 = 7030$

Hence Sarah used 7030 beads altogether.

Word problems involving the four basic operations and round the answers to the nearest two decimal places or to some significant figures

Refer to pages 48 - 49 of Learner's Book 9

STRAND/CHAPTER 1: NUMBER

Sub-Strand/Unit 2: Number Operations

Refer to page 50-82 of Learner's Book 9.

Content Standards

B.9.1.2.1: Apply mental mathematics and properties to determine answers for addition and subtraction of basic facts.

B9.1.2.2: Apply the understanding of subtraction, addition, multiplication and division of decimal numbers to solve problems, and round answers to given decimal places and significant figures

B9.1.2.4: Demonstrate understanding of surds as real numbers, the process of adding and subtracting surds as well as determining (using a calculator) the approximate square root of a number that is not a perfect square.

Learning Expectations:

After studying this sub-strand/unit, the learner will be able to:

- demonstrate understanding of surds as real numbers, the process of adding and subtracting of surds as well as determining (using calculator) the approximate square root of a number that is not a perfect square.
- add and Subtract surds
- find square root of a number that is not perfect square using a calculator
- find square root of non-perfect square numbers
- apply the understanding of operations on fractions to solve problems involving fractions of given quantities and round the results to given decimal places and significant figures.
- add, subtract, multiply and divide given fractions using the principles of BODMAS or PEDMAS rule.

Keywords: Refer to Learner's Book, page 50.

Lead learners to use their dictionaries to find the contextual meaning of the keywords.

- *square root, surds, approximate, BODMAS, PEMDAS, Simplify, Parenthesis, Exponents*

Core Competencies

- Creativity and Innovation
- Critical Thinking and Problem Solving
- Communication and Collaboration
- Personal Development and Leadership
- Cultural Identity and Global Citizenship

Identify simple and compound surds (Refer to page 50 of Learner's Book 9)

Surds are square root representations of irrational numbers that cannot be expressed in fractional or recurring decimals. Examples are; $\sqrt{2}$, $\sqrt{3}$, $\sqrt{5}$, $\sqrt{11}$, etc.

Lead and guide learners to discuss the types of surds.

Involve learners to solve the questions at example 1 page 51 of Learner's Book 9.

Diagnostic Assessment

1. Simplify $\sqrt{8}$

Solution

$$\sqrt{8} = \sqrt{4 \times 2} = \sqrt{4} \times \sqrt{2} = 2\sqrt{2}$$

2. Simplify $\sqrt{48}$

$$\begin{aligned}\sqrt{48} &= \sqrt{16 \times 3} \\ &= \sqrt{16} \times \sqrt{3} = 4\sqrt{3}\end{aligned}$$

3. Simplify $\sqrt{\frac{50}{9}}$

$$\sqrt{\frac{50}{9}} = \frac{\sqrt{50}}{\sqrt{9}} = \frac{\sqrt{25 \times 2}}{3} = \frac{5\sqrt{2}}{3}$$

4. Simplify $\sqrt{\frac{48}{100}}$

$$\sqrt{\frac{48}{100}} = \frac{\sqrt{48}}{\sqrt{100}} = \frac{\sqrt{16 \times 3}}{10} = \frac{4\sqrt{3}}{10} = \frac{2\sqrt{3}}{5}$$

Operations on Surds

Addition of Surds (Refer to page 53 of Learner's Book 9)

Involve and guide learners to perform addition of like surds and unlike surds.

For instance;

$$\sqrt{2} + \sqrt{2} = 2\sqrt{2}$$

$$\sqrt{3} + \sqrt{2} = \sqrt{3} + \sqrt{2}$$

$$2\sqrt{5} + 3\sqrt{5} = 5\sqrt{5}$$

Combination of Addition and Subtraction of Surds

Refer to page 55 of Learner's Book 9.

Let learners to solve the given examples at page 54 of Learner's Book 9.

Multiplication of Surds

Refer to page 56 of Learner's Book 9

In general,

1. $\sqrt{a} \times \sqrt{a} = a$
2. $n\sqrt{a} \times m\sqrt{b} = nm\sqrt{ab}$

Examples

- a. $\sqrt{3} \times \sqrt{3} = 3$
- b. $2\sqrt{3} \times 6\sqrt{7} = (2 \times 6)\sqrt{3 \times 7} = 12\sqrt{21}$

Let learners solve the given examples and discuss their solutions.

Refer to pages 54-55 of Learner's Book 9.

Division of Surds

Refer to page 58 of Learner's Book 9.

We have examples like $\frac{1}{\sqrt{3}}, \frac{3}{\sqrt{8}}, \frac{-1}{\sqrt{5}}, \frac{\sqrt{5}}{3}$, etc.

Rationalisation of Surds (Refer to pages 58-61 of Learner's Book 9)

Lead and guide learners to understand and do rationalisation of surds.

Rationalisation of surds is where we can convert the denominator of a fraction from an irrational number to a rational number. In more complex cases, it is useful to multiply the denominator by its conjugate to cancel out the surds in the denominator.

Diagnostic Assessment

Rationalise the following;

1. $\frac{1}{\sqrt{3}} = \frac{1}{\sqrt{3}} \times \frac{\sqrt{3}}{\sqrt{3}} = \frac{\sqrt{3}}{3}$
2. $\frac{3}{2\sqrt{5}} = \frac{3}{2\sqrt{5}} \times \frac{2\sqrt{5}}{2\sqrt{5}} = \frac{6\sqrt{5}}{4 \times 5} = \frac{3\sqrt{5}}{10}$
3. $\frac{1}{3+\sqrt{2}} = \left(\frac{1}{3+\sqrt{2}}\right) \times \left(\frac{3-\sqrt{2}}{3-\sqrt{2}}\right)$

$$\begin{aligned} &= \frac{3 - \sqrt{2}}{3(3 - \sqrt{2}) + \sqrt{2}(3 - \sqrt{2})} \\ &= \frac{3 - \sqrt{2}}{9 - 3\sqrt{2} + 2\sqrt{2} - 2} \\ &= \frac{3 - \sqrt{2}}{7} \end{aligned}$$

$$\begin{aligned} 4. \quad \frac{2 + \sqrt{2}}{5 - \sqrt{2}} &= \left(\frac{2 + \sqrt{2}}{5 - \sqrt{2}} \right) \times \left(\frac{5 + \sqrt{2}}{5 + \sqrt{2}} \right) \\ &= \frac{2(5 + \sqrt{2}) + \sqrt{2}(5 + \sqrt{2})}{5(5 + \sqrt{2}) - \sqrt{2}(5 + \sqrt{2})} \\ &= \frac{10 + 2\sqrt{2} + 5\sqrt{2} + 2}{25 + 5\sqrt{2} - 5\sqrt{2} - 2} \\ &= \frac{12 + 7\sqrt{2}}{23} \end{aligned}$$

Involve learners to practice how to rationalise surds using conjugate surds.

Rules of surds (Refer to page 62 of Learner's Book 9)

Lead and guide learners to study, understand and use the rules to solve surd problems.

Concept of Fraction

Refer to page 65 of Learner's Book 9.

Lead and involve learners to write equivalent fractions. For example $\frac{1}{2}$ is equivalent to $\frac{5}{10}$

$$1. \quad \frac{3}{5} = \frac{6}{10}$$

$$3. \quad \frac{2}{7} = \frac{14}{49}$$

$$5. \quad \frac{3}{8} = \frac{9}{24}$$

$$2. \quad \frac{3}{5} = \frac{6}{10}$$

$$4. \quad \frac{1}{9} = \frac{9}{81}$$

Also, let learners distinguish between the types of fractions; proper fractions, improper fractions, mixed number, sub-strand/unit fraction, like fraction and unlike fraction.

Lead and guide learners to simplify fractions. Involve learners to convert improper fractions to mixed number and also convert mixed numbers to improper fractions.

Addition of like Fractions (Refer to page 68 of Learner's Book 9)

Lead and guide learners to add like fractions. Like fractions are fractions that have the same denominator. Examples are; $\frac{1}{3}, \frac{2}{3}, \frac{5}{7}, \frac{6}{7}, etc$

1. Simplify $\frac{2}{5} + \frac{1}{5}$

$$\frac{2}{5} + \frac{1}{5} = \frac{3}{5}$$

2. Simplify $\frac{3}{13} + \frac{7}{13}$

$$\frac{3}{13} + \frac{7}{13} = \frac{10}{13}$$

3. Simplify $\frac{2}{17} + \frac{2}{17}$

$$\frac{2}{17} + \frac{2}{17} = \frac{4}{17}$$

Subtraction of like Fractions (Refer to page 69 of Learner's Book 9)

1. Simplify $\frac{3}{13} - \frac{1}{13}$

Solution

$$\frac{3}{13} - \frac{1}{13} = \frac{2}{13}$$

Addition of unlike Fractions

Refer to page 70 of Learner's Book 9

Subtraction of unlike Fractions

Refer to page 70 of Learner's Book 9

Involve learners to practice solving subtraction of unlike fractions.

Addition of Mixed Numbers (Refer to page 71 of Learner's Book 9)

Subtraction of Mixed Numbers (Refer to page 72 of Learner's Book 9)

Involve learners to solve the questions and let learners present and discuss their solutions.

Multiplication of Fractions

Refer to page 73-74 of Learner's Book 9.

Lead and guide learners to multiply common fractions.

Example;

1. Simplify $\frac{3}{4} \times \frac{8}{12}$

Solution

$$\frac{3}{4} \times \frac{8}{12} = \frac{1}{2}$$

2. Simplify $\frac{5}{64} \times \frac{8}{10}$

Solution

$$\frac{5}{64} \times \frac{8}{10} = \frac{1}{16}$$

3. Simplify $\frac{4}{13} \times \frac{2}{24}$

Solution

$$\frac{4}{13} \times \frac{2}{24} = \frac{1}{39}$$

Division of Fractions (Refer to page 74-75 of Learner's Book 9)

Emphasize the changing of the division sign to multiplication and using the reciprocal form of the fraction after the division sign to do the multiplication.

Example

1. Simplify $\frac{4}{21} \div \frac{8}{3}$

Solution

$$\frac{4}{21} \div \frac{8}{3} = \frac{4}{21} \times \frac{3}{8} = \frac{1}{14}$$

Multiplication of Mixed Numbers (Refer to page 75-77 of Learner's Book 9)

Explain the procedure to follow when multiplying mixed numbers to learners. Lead and involve learners to practice with examples provided. Put learners in groups to answer the questions at exercise 4 at page 77 of Learner's Book 9.

Diagnostic Assessment

1. Simplify $1\frac{1}{2} \times \frac{4}{5} \div \frac{5}{6}$

Solution

$$\begin{aligned} 1\frac{1}{2} \times \frac{4}{5} \div \frac{5}{6} \\ = \frac{3}{2} \times \frac{4}{5} \times \frac{6}{5} = \frac{36}{25} = 1\frac{11}{25} \end{aligned}$$

2. Simplify $3\frac{1}{5} \div \frac{3}{5} \times \frac{2}{3}$

Solution

$$\begin{aligned} & 3\frac{1}{5} \div \frac{3}{5} \times \frac{2}{3} \\ & = \frac{16}{5} \times \frac{5}{3} \times \frac{2}{3} = \frac{32}{9} = 3\frac{5}{9} \end{aligned}$$

BODMAS/PEMDAS Rule

Refer to page 78 of Learner's Book 9.

Explain the acronyms BODMAS/PEMDAS as stated at page 78 to learners. Lead and involve learners to use these acronyms to solve problems.

Example;

1. Simplify $3^4 \div 3^2 + 40 - 2^3 \times 3^2 \div 9$

Solution: $3^4 \div 3^2 + 40 - 2^3 \times 3^2 \div 9$

Using PEDMAS, we do not have parenthesis, hence we simplify the exponents first.

$$81 \div 9 + 40 - 8 \times 9 \div 9$$

We now consider Multiplication/Division from left to right.

$$81 \div 9 + 40 - 8 \times 9 \div 9$$

We now consider Multiplication/Division from left to right.

$$\begin{aligned} & (81 \div 9) + 40 - (8 \times 9) \div 9 \\ & \quad 9 + 40 - (72 \div 9) \\ & \quad 9 + 40 - 8 \end{aligned}$$

Next operation to consider is addition before subtraction.

$$49 - 8 = 41$$

Diagnostic Assessment

Use BODMAS or PEDMAS rule to simplify the following:

1. $\frac{2}{3} \times \frac{3}{4} - \frac{5}{8} \div 2\frac{1}{2}$

Solution

$$\begin{aligned} &= \left(\frac{2}{3} \times \frac{3}{4}\right) - \left(\frac{5}{8} \div \frac{5}{2}\right) \\ &= \frac{1}{2} - \left(\frac{5}{8} \times \frac{2}{5}\right) \\ &= \frac{1}{2} - \frac{1}{4} = \frac{1 \times 2}{2 \times 2} - \frac{1}{4} \\ &= \frac{2}{4} - \frac{1}{4} = \frac{1}{4} \end{aligned}$$

2. $\frac{3}{4} + \left(\frac{7}{8} \div \frac{3}{4}\right) \times 2\frac{3}{4}$

Solution

$$\begin{aligned} &= \frac{3}{4} + \left(\frac{7}{8} \times \frac{4}{3}\right) \times \frac{11}{4} \\ &= \frac{3}{4} + \left(\frac{7}{6} \times \frac{11}{4}\right) \\ &= \frac{3}{4} + \frac{77}{24} = \frac{18 + 77}{24} \\ &= \frac{95}{24} = 3\frac{23}{24} \end{aligned}$$

Lead and involve learners to answer at exercises 5 and 6 on pages 80 – 81 of *Learner's Book 9*.

STRAND/CHAPTER 1: NUMBER

Sub-Strand/Unit 3: Number, Ratio, and Proportion

Refer to page 83-110 of Learner's Book 9

Content Standards

B9.1.3.1: Apply the understanding of operations on fractions to solve problems involving fractions of given quantities and round the results to give decimals and significant places.

Learning Expectations:

After studying this sub-strand/unit, the learner will be able to:

- apply the understanding of ratio, rate, and proportion to solve problems that involve rates, ratio and proportional reasoning and use it to solve real-world mathematical problems
- solve simple interest problems
- solve problems on Tax (VAT)
- solve problems on discount
- solve problems on commission
- solve problems on depreciation
- solve problems involving NHIL
- solve problems involving insurance
- solve problems involving SSNIT

Keywords: Refer to Learner's Book 9, page 83.

Help learners to use their dictionaries to find the contextual meaning of the keywords.

- *simple interest, discount, commission, depreciation*

Core Competencies

- Critical Thinking and Problem Solving
- Communication and Collaboration
- Personal Development and Leadership
- Creativity and Innovation
- Cultural Identity and Global Citizenship

Ratio (Refer to pages 83-84 of Learner's Book 9)

Ratio is the comparison of two quantities of the same unit that indicates how much one quantity is present in the other quantity.

Types of Ratios (Refer to page 84 of Learner's Book 9)

Guide learners to identify the types of ratio.

Involve learners to solve and discuss problems involving ratio.

Example 1. A total of 120 balls are shared among three friends; Ama, Kofi and Jennifer in the ratio of 3:4:5 respectively. Find the share of each friend.

Solution

We need to find the total ratio.

$$\text{Total ratio} = 3 + 4 + 5 = 12$$

$$\text{Ama's share} = \frac{3}{12} \times \frac{120}{1} = 30$$

$$\text{Kofi's share} = \frac{4}{12} \times \frac{120}{1} = 40$$

$$\text{Jennifer's share} = \frac{5}{12} \times \frac{120}{1} = 50$$

Ama received 30 balls, Kofi received 40 balls and Jennifer received 50 balls.

Rate

Rate is when two quantities of different units are compared and expressed as a ratio.

Proportion (Refer to page 84 of Learner's Book 9)

A proportion is an equation in which two ratios are set equal to each other.

Lead and involve learners to discuss rates and proportions and solve questions on them.

Proportional Relationships (Refer to page 86 of Learner's Book 9)

Lead and guide learners to understand what proportional relationship is. A proportional relationship is one in which two quantities vary directly with each other.

Equations (Refer to page 86 – 87 of Learner's Book 9)

A proportional relation such as $y = kx$ where k is a constant or constant of proportionality and are x and y variables.

Lead and involve learners to solve example 1 on pages 86.

Proportional Graphs (Refer to page 88 of Learner's Book 9)

Lead and involve learners to study the graph drawn at page 83 of Learner's Book 9.

Proportional Tables (Refer to page 88 – 89 of Learner's Book 9)

Let learners answer the questions at examples 1 and 2 and discuss their solutions.

Simple interest (Refer to page 90 of Learner's Book 9)

Simple interest is a method used to calculate the amount of interest charged on a sum of money at a given rate and for a given period of time. The principal amount is always the same.

Lead, guide and involve learners to solve the given questions at these page 90. Let learners participate in solving the questions and also discuss their solutions.

Diagnostic Assessment

1. Mr. Mensah invested an amount of GH¢13,900.00 at the simple interest rate of 14% per annum for 2 years. Calculate his interest.

Solution

Principal amount = GH¢13,900.00

Interest rate = 14%

Time = 2 years

Interest, $I = P \times T \times R$

$$I = \frac{13,900 \times 2 \times 14}{100} = 139 \times 28 = \text{GH¢}3,892.00$$

Value Added Tax (VAT) (Refer to page 95 – 96 of Learner's Book 9)

In Ghana the value added tax (VAT) is a consumption tax that is charged on goods and services, levied at each stage of a supply chain.

Put learners in groups of three and let them answer exercise 1 on page 95 of Learner's Book 9.

Discount (Refer to page 97 of Learner's Book 9)

Discount is the pricing system in which the price of a commodity (good or services) is lower than its marked price or listed price.

Revise learners previous knowledge on percentages. Lead and guide learners to solve the questions at page 97 of Learner's Book 9.

Commission (Refer to page 98 of Learner's Book 9)

Lead and guide learners to calculate commission.

Diagnostic Assessment

1. Helena is a realtor. She receives 3% commission when she sells a house. How much commission will she receive for selling a house that cost GH¢ 260,000.00

Solution

Amount sold = GH¢ 260,000.00

Percentage commission = 3%

Amount received as commission = $\frac{3}{100} \times 260,000 = 7,800$

Therefore Helena received GH¢ 7,800.00 as her commission.

Depreciation (Refer to page 99 – 100 of Learner's Book 9)

Depreciation is the reduction in the value of an asset that occurs over time due to usage, wear and tear or "out of date".

Lead and involve learners to use the formula provided for calculating depreciation to answer the questions at page 99 of Learner's Book 9.

Problems involving NHIL (Refer to page 101 – 102 of Learner's Book 9)

Lead and involve learners to calculate problems involving National Health Insurance Levy (NHIL) with examples provided.

Problems involving Insurance

(Refer to page 102 of Learner's Book 9)

Rates and Proportional reasoning to solve problems involving SSNIT benefits and contribution. Refer to pages 104 – 109 of Learner's Book 9.

Lead and involve learners to solve the examples provided.

Put learners in groups to solve the questions at exercise 5 page 101 of Learner's Book 9. Let learners discuss their solutions among themselves.

STRAND/CHAPTER 2: ALGEBRA

Sub-Strand/Unit 1: Patterns and Relations

Refer to pages 111 – 122 of Learner's Book 9

Content Standards

B9.2.1.1: Demonstrate the ability to construct tables of values for pairs of linear relations, graph the relations in a number plane and determine the intersection of the lines to solve simultaneous linear equations.

Learning Expectations:

After studying this sub-strand/unit, the learner will be able to:

- construct tables of values for pair of linear relation
- graph the relations in a number plane
- determine the intersection of two lines

Keywords: Refer to Learner's Book 9, page 111.

Guide learners to use their dictionaries to find the contextual meaning of the keywords.

- *linear relation, simultaneous, intersection, linear equations*

Core Competencies

- Critical Thinking and Problem Solving
- Creativity and Innovation
- Personal Development and Leadership
- Digital Literacy

Lesson Presentation (Refer to page 111 of Learner's Book 9)

Discuss the meaning of a pattern with learners.

A pattern is a sequence of repeating shapes or numbers or objects. It has a rule that tells us which objects or numbers belong to the pattern.

A relation is any set of ordered pairs, that is a relationship between inputs and outputs.

Lead and guide learners to study the example 1 under graphs of relations.

Refer to page 112 of Learner's Book 9.

Let learners use their graph books and draw the graph of the relation $y = 2x + 1$ for the interval $-2 \leq x \leq 4$

Graphs of relations (*Refer to page 112 – 116 of Learner's Book 9*)

Guide and involve learners to draw the graphs of relations in their graph books. Ensure that learners use reasonable scale and label the axes when drawing graphs of relations.

STRAND/CHAPTER 2: ALGEBRA

Sub-Strand/Unit 2: Algebraic Expressions

Refer to page 123-138 of Learner's Book 9.

Content Standards

B9.2.2.1: Demonstrate an understanding of (i) change of subject (ii) substituting values to evaluate expressions, and (ii) factorize expressions that have simple binomial as a factor.

Learning Expectations:

After studying this sub-strand/unit, the learner will be able to:

- change the subject of a formula
- make a substitution into a formula
- factorize expressions that have single binomial as a factor

Keywords: Refer to Learner's Book 9, page 123.

Guide learners to use their dictionaries to find the contextual meaning of the keywords.

- *factor, binomial, substitute, formula, expression*

Core Competencies

- Critical Thinking and Problem Solving
- Communication and Collaboration
- Creativity and Innovation
- Digital Literacy

Change of Subject (Refer to pages 123 – 128 of Learner's Book 9)

Lead and guide learners to solve questions under example 1.

Involve learners to discuss their solutions.

Diagnostic Assessment

1. Make m the subject of the relation.

$$2y + 3 = 5m - 20$$

Solution

$$2y + 3 = 5m - 20$$

$$2y + 3 + 20 = 5m - 20 + 20 \text{ (Adding 20 to both sides)}$$

$$2y + 23 = 5m$$

$$\frac{2y + 23}{5} = \frac{5m}{5}$$

$$m = \frac{2y + 23}{5}$$

2. Express m in terms of P in the relation $\frac{3p}{9} = \frac{m}{8}$

Solution

$$\frac{3p}{9} = \frac{m}{8} \text{ (Cross Multiply)}$$

$$3p \times 8 = 9 \times m$$

$$24p = 9m$$

$$\frac{24p}{9} = \frac{9m}{9}$$

$$m = \frac{8}{3}p$$

3. Make x the subject in $2x^2 = 40r$

Solution

$$2x^2 = 40r$$

$$\frac{2x^2}{2} = \frac{40r}{2} \text{ (Divide both sides by 2)}$$

$$x^2 = 20r$$

$$\sqrt{x^2} = \sqrt{20r} \text{ (Take square both sides)}$$

$$x = \sqrt{20r}$$

$$x = 2\sqrt{5r}$$

Substituting Values into a given relation and evaluate it

(Refer to pages 128 – 129 of Learner's Book 9)

Lesson presentation

Lead, guide and involve learners to substitute given values into given relation and evaluate it. Let learners work individually and present their work to the class.

Diagnostic Assessment

1. Given that $f = \frac{uv}{u+v}$, find when $f = 15$ and $v = 10$

Solution

$$f = \frac{uv}{u+v}$$

$$\frac{15}{1} = \frac{10u}{u+10} \text{ (Substituting } f = 15 \text{ and } v = 10)$$

$$15(u+10) = 10u \text{ (Cross multiply)}$$

$$15u + 150 = 10u \text{ (Expand)}$$

$$15u - 10u = -150 \text{ (Solving or grouping like terms)}$$

$$5u = -150$$

$$\frac{5u}{5} = \frac{-150}{5}$$

$$u = -30$$

Factorising expressions that have simple binomials

Refer to pages 130 – 133 of Learner's Book 9.

Factorization is the method of finding out the factors of a given algebraic expression which when multiplied together gives the original expression or number.

Guide learners to factorise simple binomials. Let learners identify a common factor that can divide the terms in the expression. Identify also, a common variable to factorize.

Examples;

1. Factorise $2x + 4$

$$2(x + 4)$$

[Here, the common factor is 2 which is used to divide both terms in the binomial expression]

2. Factorise $4a^2 + 6a$

Solution

$$4a^2 + 6a$$

$$2a(2a + 3)$$

[Note that the common factor is 2 and the common variable is a . We use the variable that has the least exponent to factorise]

Diagnostic Assessment

1. Factorise $\frac{1}{4}x^2 - 1$

Solution

$$\frac{1}{4}x^2 - 1 \text{ [Use the concept of difference of two squares]}$$

$$\left(\frac{1}{2}x\right)^2 - 1^2 = \left(\frac{1}{2}x + 1\right)\left(\frac{1}{2}x - 1\right)$$

2. Factorise $5xy + 10xz$

Solution

$$5xy + 10xz$$

$$5x(y + 2z)$$

3. Factorise $8abc - 12bcd$

Solution

$$8abc - 12bcd$$

$$4bc(2a - 3d)$$

Factorisation by grouping of terms

Refer to pages 133 – 134 of *Learner's Book 9*.

Involve learners to work the given examples, and let learners discuss their solutions.

Factorisation using identities

Refer to pages 134 – 138 of *Learner's Book 9*.

Lead, guide and involve learners to solve the given examples.

STRAND/CHAPTER 2: ALGEBRA

Sub-Strand/Unit 3: Variables and Equations

Refer to page 139 – 154 of Learner’s Book 9.

Content Standards

B9.2.3.1: Demonstrate understanding of single variable linear inequalities with rational coefficients including:

- Solving inequalities
- Verifying
- Comparing
- Graphing

Learning Expectations:

After studying this sub-strand/unit, the learner will be able to:

- solve single variable inequalities
- illustrate solution sets of linear inequalities on the number line
- solve and graph linear inequalities
- solve real-life problems involving linear equations and inequalities

Keywords: Refer to Learner’s Book 9, page 139.

Guide learners to use their dictionaries to find the contextual meaning of the keywords.

- simple linear equation, inequality number line

Core Competencies

- Critical Thinking and Problem Solving
- Personal Development and Leadership
- Digital Literacy

Linear equations and inequalities (Refer to page 139 – 145 of Learner’s Book 9)

Linear inequalities in one variable are expressions in which two linear expressions in one variable are compared using the inequality symbols.

Diagnostic Assessment

1. Solve the inequality $\frac{3}{2}y - \frac{2}{5} < \frac{4}{5}$

Solution

$$\frac{3}{2}y - \frac{2}{5} < \frac{4}{5}$$

[Clear fractions by using the LCM 10 to multiply term by term]

$$\frac{10}{1} \times \frac{3}{2}y - \frac{10}{1} \times \frac{2}{5} < \frac{10}{1} \times \frac{4}{5}$$

$$5 \times 3y - 2 \times 2 < 2 \times 4$$

$$15y - 4 < 8$$

$$15y < 8 + 4 \text{ [Group like terms]}$$

$$\frac{15y}{15} < \frac{12}{15}$$

$$y < \frac{4}{5}$$

2. Solve the inequality $\frac{1}{3}(2x - 1) < \frac{1}{5}(x + 3) - 1$ and illustrate your answer on a number line.

Solution

$$\frac{1}{3}(2x - 1) < \frac{1}{5}(x + 3) - 1$$

$$15 \times \frac{1}{3}(2x - 1) < 15 \times \frac{1}{5}(x + 3) - 15 \times 1 \text{ (clear fractions)}$$

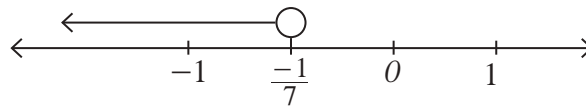
$$5(2x - 1) < 3(x + 3) - 15 \text{ (Remove brackets)}$$

$$10x - 5 < 3x + 9 - 15 \text{ (group like terms)}$$

$$10x - 3x < 9 + 5 - 15$$

$$7x < -1$$

$$x < \frac{-1}{7}$$



3. Solve the inequality $\frac{2}{3}(x + 2) \leq \frac{1}{4}x + 3$

Solution

$$\frac{2}{3}(x + 2) \leq \frac{1}{4}x + 3$$

$$12 \times \frac{2}{3}(x + 2) \leq 12 \times \frac{1}{4}x + 12 \times 3$$

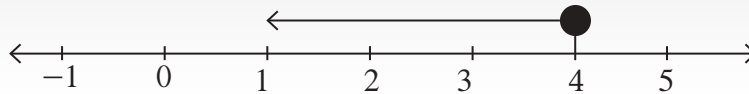
$$4 \times 2(x + 2) \leq 3x + 36$$

$$8x + 16 \leq 3x + 36$$

$$8x - 3x \leq 36 - 16$$

$$5x \leq 20$$

$$x \leq 4$$



Note that when representing the inequality $<$ or $>$ on a number line we do not shade the ring, but we leave it open.

When we are representing the inequality \leq or \geq on the number line, we shade the ring, thus it is closed.

Solving and graphing linear inequalities in one variable on a cartesian plane

Refer to page 145 – 148 of Learner's Book 9

Let learners use their graph books to solve the example on page 146 – 148 of Learner's Book 9. Let learners work individually as you guide them.

Application of linear equations in one variable.

Diagnostic Assessment

1. One board is 24 cm longer than another board.
 - a. If the shorter board is x cm long, how long is the longer board?
 - b. When the boards are laid end to end, the total length is 200 cm. How long is each board?

Solution

Let the length of the shorter board be x

Let the length of the longer board be $x + 24$

The total length of the boards is 200 cm

$$(x + 24) + x = 200$$

$$x + x + 24 = 200$$

$$2x = 200 - 24$$

$$2x = 176$$

$$x = \frac{176}{2} = 88$$

Therefore the shorter board is 88 cm long. The longer board is $88 + 24 = 112$ cm

Refer to page 149 – 151 of Learner's Book 9.

Let learners solve the questions at page 151 exercise 5 of Learner's Book 9.

Applications of linear inequalities in one variable

Refer to page 152 – 153 of Learner’s Book 9.

Lead, guide and involve learners to solve the given examples and questions at exercise 6 of page 154.

Let learners present their solutions and discuss them.

STRAND/CHAPTER 3: GEOMETRY AND MEASUREMENT

Sub-Strand/Unit 1: Shapes and Space

Refer to page 155 – 181 of Learner's Book 9

Content Standards

B9.3.1.1: Apply the properties of angles at a point, angles on a straight line, vertically opposite angles, and corresponding, angles to solve problems.

B9.3.1.2: Construct inscribed and circumscribed triangles and parallelograms with given dimensions.

Learning Expectations:

After studying this sub-strand/unit, the learner will be able to:

- draw and measure lines and angles
- name polygons given the number of sides
- bisect angles and sides of polygons
- inscribe a circle to a polygon
- circumscribe a circle to a polygon

Keywords: Refer to Learner's Book 9, page 155.

Lead learners to use their dictionaries to find the contextual meaning of the keywords.

- *vertically opposite, corresponding angles, polygons, congruent, similar and interior, inscribe, circumscribe, bisect, sector, chord, line segment, parallelogram, dimension, construct*

Core Competencies

- Communication and Collaboration
- Critical Thinking and Problem Solving
- Creativity and Innovation
- Personal Development and Leadership
- Digital Literacy

Polygon (Refer to page 155 – 157 of Learner's Book 9)

A polygon is a plane figure bounded by straight lines. Guide learners to identify the types of polygon.

Types of Triangles (Refer to page 157 of Learner's Book 9)

Lead and guide learners to state the types of triangles and state their properties. Let learners also draw these types of triangles.

Types of Quadrilaterals (Refer to page 158 of Learner's Book 9)

A quadrilateral is a geometrical shape that is bounded by four sides.

Quadrilaterals include; square, rectangle, kite, rhombus, trapezium and parallelogram. Let learners draw the stated quadrilaterals and also state their properties.

Involve learners to solve the examples and discuss their solutions.

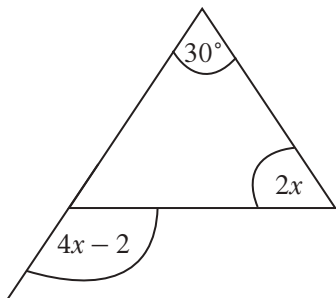
Calculating the interior angles of polygons

Refer to page 162 – 163 of Learner's Book 9

Put learners in groups of three to solve the examples provided and let them present and discuss their solutions

Diagnostic Assessment

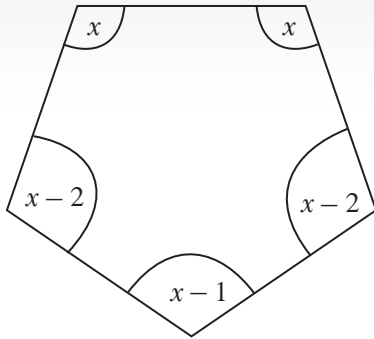
- a). Solve for x .
b). Find angle $4x - 2$



Solution

$$\begin{array}{l} a). \quad 30 + 2x = 4x - 2 \\ \quad \quad 30 + 2 = 4x - 2x \\ \quad \quad 32 = 2x \\ \quad \quad x = 16 \end{array} \quad \begin{array}{l} 4x - 2 = 4(16) - 2 \\ = 64 - 2 = 62^\circ \end{array} \quad b). \quad \begin{array}{l} 4x - 2 = 4(16) - 2 \\ = 64 - 2 \\ = 62^\circ \end{array}$$

2.

*Solution*

The polygon above has 5 sides. Thus, a pentagon.

Now, the total sum of interior angles of a polygon is given by $(n - 2) \times 180^\circ$ where n is the number of sides of the polygon, hence, $n = 5$

$$\begin{aligned} \text{Sum of interior angles} &= (5 - 2) \times 180^\circ \\ &= 3 \times 180^\circ = 540^\circ \end{aligned}$$

$$x + x + x - 2 + x - 2 + x - 1 = 540^\circ$$

$$5x - 5 = 540^\circ$$

$$5x = 540^\circ + 5$$

$$5x = 545$$

$$\frac{5x}{5} = \frac{545}{5}$$

$$x = 109^\circ$$

$$x - 2 = 109 - 2 = 107^\circ$$

$$x - 1 = 109 - 1 = 108^\circ$$

Similar Triangles (Refer to page 169 -170 of Learner's Book 9)

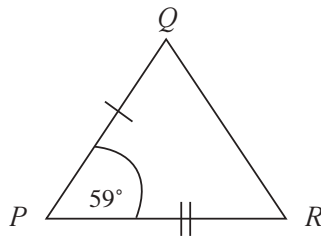
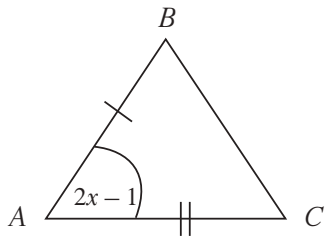
Similar Triangles are triangles that have the same angles.

Congruent Triangles (Refer to page 170 - 171 of Learner's Book 9)

Two triangles are said to be congruent when they are exactly the same size and shape. Also, if two pairs or more corresponding triangles have the same angle measures then they are congruent.

Diagnostic Assessment

1. Determine the value of x from the diagrams below



Solution

Triangle ABC and Triangle PQR are congruent and similar. Hence,

$$2x - 1 = 59$$

$$2x = 59 + 1$$

$$2x = 60$$

$$x = 30$$

Construction of Inscribed and Circumscribed Triangles and parallelograms

Refer to page 173 – 181 of Learner's Book 9.

Guide and involve learners to use pair of compasses, ruler and pencils to do the various constructions.

STRAND/CHAPTER 3: GEOMETRY AND MEASUREMENT

Sub-Strand/Unit 2: Measurement

Refer to page 182 – 202 of Learner’s Book 9

Content Standards

B.9.3.2.1: Derive the formulas for determining the surface area of prisms (i.e. cuboid and triangular prism) and use them to solve problems.

B9. 3.2.2: Solve problems involving bearings and addition/subtraction of vectors

Learning Expectations:

After studying this sub-strand/unit, learner will be able to:

- identify prisms by their bases
- find the total surface area of prisms
- express points on the cartesian plane as position vectors
- state the triangular law of adding vectors
- apply the laws (i.e. triangular law and parallelogram law) to solving everyday problems

Keywords: Refer to Learner’s Book 9, page 182.

Lead learners to use their dictionaries to find the contextual meaning of the keywords.

- *cuboid, prism, triangles, plane, polygon, surface area, Cartesian plane, law, parallelogram, triangular, vectors*

Core Competencies

- Critical Thinking and Problem Solving
- Creativity and Innovation
- Digital Literacy

Prisms and Cuboids (Refer to page 182 – 183 of Learner’s Book 9)

Let learners mention some prisms and cuboids. Let learners draw the nets of prisms and cuboids.

Total surface area of a prism

Refer to pages 184 – 185 of Learner’s Book 9.

Lead and guide learners to calculate the total surface area of the prism drawn at page 184 of Learner’s Book 9. Let learners answer the questions at exercise 1 of page 185 of Learner’s Book 9. Let learners present and discuss their solutions.

Finding the surface area of cuboids

Refer to page 186 – 187 of Learner's Book 9.

Lead and involve learners to draw a cuboid and calculate the surface area.

Vectors in the plane

Refer to page 188 – 190 of Learner's Book 9

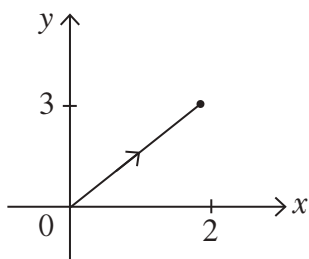
Let learners understand the difference between writing vectors in column form, thus $\begin{pmatrix} x \\ y \end{pmatrix}$ and writing a point in coordinate form (x,y)

Lead and guide learners to draw and write the position vectors of given point with respect to the origin O.

Diagnostic Assessment

1. Draw and write the position vector of the point A (2,3) with O as the origin.

Solution



The position vector of $A(2,3)$ with O as the origin is $\vec{OA} = \begin{pmatrix} 2 \\ 3 \end{pmatrix}$. We can also use small letter 'a' to represent \vec{OA}

$$\text{Hence } \vec{OA} = a = \begin{pmatrix} 2 \\ 3 \end{pmatrix}$$

Bearings (Refer to page 190 – 192 of Learner's Book 9)

Bearings are angles measured in a clockwise direction from the north pole of the cardinal points. Bearings are expressed in three digits. For instance; $030^\circ, 200^\circ, 045^\circ, 060^\circ$ etc.

Parallel vectors and Perpendicular Vectors

Refer to page 193 – 195 of Learner’s Book 9.

Lead, guide and involve learners to solve and discuss problems, involving parallel and perpendicular vectors.

If two vectors are parallel, they have the same gradient/slope.

Also if two vectors are parallel one will have a scalar multiple of the other.

If two vectors are perpendicular then, their dot product is equal to zero

Deducing the triangle law of vector addition

Refer to page 197 of Learner’s Book 9

Lead and guide learners to deduce the triangle law of vector addition.

Magnitude of a vector (*Refer to page 198-199 of Learner’s Book 9*)

The magnitude of a vector $\vec{AB} = \begin{pmatrix} x \\ y \end{pmatrix}$ is given by $|\vec{AB}| = \sqrt{x^2 + y^2}$

Involve learners to solve further questions on how to find the magnitude of a vector.

Equality of a vector

Refer to page 199-200 of Learner’s Book 9

Parallelogram law of Vector addition

Refer to page 200 – 202 of Learner’s Book 9

STRAND/CHAPTER 3: GEOMETRY AND MEASUREMENT

Sub-Strand/Unit 3: Position and Transformation

Refer to page 203 – 211 of Learner's Book 9

Content Standards

B9.3.3.1: Demonstrate understanding of how to perform an enlargement on a geometrical shape given a scale factor and describe the properties of the image under the transformation (i.e. congruence, similarity, etc.)

Learning Expectations:

After studying this sub-strand/unit, the learner will be able to:

- identify similar shapes
- draw congruent objects
- share things based on congruency and similarity

Keywords: Refer to Learner's Book 9 page 203

Help learners to use their dictionaries to find the contextual meaning of the keywords.

- *congruent, similar, transformation, scale factor, images, objects*

Core Competencies

- Creativity and Innovation
- Personal Development and Leadership
- Digital Literacy

Transformation means to change. Therefore, a geometric transformation means to make certain changes in a given geometric shape.

A transformation is a general term for specific ways used to manipulate the shape and/or position of a point, a line or geometric figure. Again, transformation is a general term for specific ways used to manipulate the shape and/or position of a point, a line or geometric figure.

Again, transformation is a mathematical manipulation that moves a geometrical shape or fraction from one space to another. This new space could be a quadrant in a cartesian coordinate system or this new space could be a new plane or number set altogether.

There are four major types of transformation:

- i. Rotation
- ii. Translation

- iii. Reflection and
- iv. Enlargement

Enlargement (*Refer to page 203 – 204 of Learner’s Book 9*)

An enlargement is a type of transformation where we change the size of the original shape to make it bigger or smaller by multiplying it by a scale factor.

Let learners use graph paper to draw the objects whose coordinates are given at the exercise provided.

The concept of congruent and similar shapes (*Refer to page 208-211 of Learner’s Book 9*)

Congruent shapes are shapes that are exactly the same. The corresponding sides are the same and the corresponding angles are the same.

Lead and guide learners to draw the given shapes at *page 208 – 209 of Learner’s Book 9* in their graph books.

STRAND/CHAPTER 4: HANDLING DATA

Sub-Strand/Unit 1: Data

Refer to page 212-231 Learner's Book 9

Content Standards

B9.4.1.1: Select, justify, and use appropriate methods of collecting data (grouped/ungrouped), use the data to construct and interpret frequency tables and histogram and use it to determine the mode and to solve and/or pose problems.

B9.4.1.2: Select, justify, and use appropriate methods of collecting data (quantitative and qualitative), organise and analyse the data (grouped/ungrouped) to interpret the results using descriptive statistics (measures of central tendency and range).

Learning Expectations:

After studying this sub-strand/unit, the learner will be able to:

- use appropriate methods of collecting data
- draw a histogram for a given data
- use appropriate formula to calculate the mean

Keywords: *Refer to Learner's Book 9 page 212*

Guide learners to use their dictionaries to find the contextual meaning of the keywords.

- *organise, infographics, pictograph, histogram, mean, maximum, minimum*

Core Competencies

- Critical Thinking and Problem Solving
- Communication and Collaboration
- Creativity and Innovation
- Personal Development and Leadership
- Digital Literacy

What is data? *Refer to page 212 – 213 of Learner's Book 9.*

Data is a collection of facts such as numbers, words, measurements, observations or even just descriptions of things.

Lead and guide learners to differentiate between quantitative data and qualitative data. Let learners study and discuss the examples given at pages 214 and 215 of Learner's Book 9.

Some methods used for Data Collection *(Refer to page 213 of Learner's Book 9)*

Lead and involve learners to mention and discuss some methods that are used for data collection. Examples are; survey, questionnaires, interviews, etc.

Organize Data (Grouped/ Ungrouped)

Data can be organised in a grouped or ungrouped form.

Grouped frequency Table *(Refer to page 214 - 217 of the Learner's Book 9)*

A grouped frequency table can be made to show the number of values for a group or a class. It is very useful when the values have a large range and /or many small frequencies in a distribution.

Pictograph *(Refer to page 217 - 219 of the Learner's Book 9)*

A pictograph is a representation of data using images, icons or symbols. They are typically used in concepts such as data handling.

A key is provided in a pictograph that indicates what image it represents.

Diagnostic Assessment

The data below gives a distribution of heights of youth at an interview.

180	174	158	166	166	180	176	159	159
162	176	163	163	172	166	179	156	160
164	164	174	175	175	163	162	169	178
180	180	162	159	159	173	162	173	173
164	164	159	156	156	156	177	162	177
174	159	157	164	158	180	179	159	158
180	156	172	165	166	166	171	166	171
171	163	163	156	161	172	180	179	166
156	156	159	159	156	156	161	159	

- Using a class interval of 156 – 160, 161 – 165, etc. Construct a frequency distribution table for the data.
- State the modal group.

Solution

i.

Height	Tally	Frequency
156 - 160	/// /// /// /// ///	23
161 - 165	/// /// /// ///	18
166 - 170	/// //	7
171 - 175	/// /// ////	14
176-180	/// /// ////	14

ii. The modal group is 156 – 160

Lead and guide learners to construct a frequency distribution table

Using Histogram to determine the mode of a given data

Refer to pages 220 – 224 of Learner’s Book 9.

Lead and guide learners to draw a histogram based on a given data and use it to determine the mode.

Let learners work individually

STRAND/CHAPTER 4: HANDLING DATA

Sub-Strand/Unit 2: Chance or Probability

Refer to page 232 - 243 of the Learner's Book 9

Content Standards

B9.4.2.1: Identify the sample space for a probability experiment involving two dependent events and express the probabilities of given events as fractions, decimals, percentages and/or ratios to solve problems.

Learning Expectations:

After studying this sub-strand/unit, the learner will be able to:

- determine the sample space of an experiment involving two dependent events
- draw and use tree diagrams to express probability as fraction, percentage and decimal.

Keywords: Refer to Learner's Book 9, page 232.

Guide learners to use their dictionaries to find the contextual meaning of the keywords.

- *Probability, dependent, experiment, decimals, percentage, sample space.*

Core Competencies

- Critical Thinking and Problem Solving
- Personal Development and Leadership

Probability of Dependent Events

Refer to page 232 of Learner's Book 9

Two events are said to be dependent if the outcome of the first event affects the outcome of the second event.

Refer to pages 234 – 235 of Learner's Book 9 for examples.

Put learners in groups to solve the questions provided at the exercise at page 235-236 of Learner's Book 9.

Probability of an event using a tree diagram method

Tree diagrams may represent a series of independent events (such as a set of coin flips) or conditional probabilities (such as drawing cards from the cards). Each node on the diagram represents an event and is associated with the probability of that event.

The root node represents the certain event and therefore has probability 1. Each set of sibling nodes represents an exclusive and exhaustive partition of the parent event. [en.m.wikipedia.org]

Probability tree diagrams are a way of organizing the information of two or more probability events.

Probability tree diagrams show all the possible outcomes of the events and can be used to solve probability questions.

For example:

A coin is flipped and a dice is rolled.

Solution

First event: Coin	Second Event : Dice	Outcomes	Probabilities
	$\frac{1}{6}$ → 6	Head and 6	$\frac{1}{2} \times \frac{1}{6} = \frac{1}{12}$
	$\frac{5}{6}$ → Not a 6	Head and Not a 6	$\frac{1}{2} \times \frac{5}{6} = \frac{5}{12}$
	$\frac{1}{6}$ → 6	Tail and 6	$\frac{1}{2} \times \frac{1}{6} = \frac{1}{12}$
	$\frac{5}{6}$ → Not a 6	Tail and Not a 6	$\frac{1}{2} \times \frac{5}{6} = \frac{5}{12}$

The first event is flipping the coin. The two possible outcomes are 'heads' and 'tails'. These are mutually exclusive events. They cannot happen at the same time.

The second event is rolling the dice. The possible outcomes are 1,2,3,4,5 and 6. What is the probability of getting a 'tail' and a '6'?

These outcomes can occur whether the coin landed on heads or tails, so we add these outcomes to the end of both branches in order to show all possible combinations of outcomes.

The probability of getting a '6' is $\frac{1}{6}$

The probability of getting "not a 6" will be $1 - \frac{1}{6} = \frac{5}{6}$

Remember that the probabilities on each set of branches add up to 1

How to use a tree diagram to find probability

In order to use a tree diagram to find probability:

1. Fill in the probabilities on the branches
2. Consider which outcomes are required to answer the question
3. Find the probability of those outcomes by multiplying along the branches
4. Use the probability/probabilities you have calculated to answer the question.

Refer to page 236 – 240 of Learner's Book 9.

Lead and guide learners to work on the examples given and answer the questions at the pages stated.

ANSWERS TO THE LEARNER'S BOOK EXERCISES

STRAND/CHAPTER 1: NUMBER

SUB-STRAND/UNIT 1: NUMBER AND NUMERATION SYSTEM

Exercise 1 (Refer to page 4 of the Learner's Book 9)

- 2 significant figures
- 4 significant figures (trailing and interior zeros).
- 3 significant figures (only decimal part counts).
- Both 1 and 1000 are exact numbers. Unlimited significant figures.

Exercise 2 (Refer to page 5 of the Learner's Book 9)

- a. 4 b. 2 c. 3 d. 1 e. 5 f. 4 g. 4 h. 3 i. 4
j. unlimited significant figures
- a. 945678240000 b. 945678200000 c. 945678000000

Exercise 3 (Refer to page 14-15 of the Learner's Book 9)

- a. 45.9 b. 40.0 c. 2.1 d. 4876.5
- a. 4892.375 b. 78.654 c. 10.001 d. 34.301
- a. 111.46 b. 672.34 c. 901.68 d. 90.000
- a. 89475.695 b. 89475.69 c. 89475.7

Exercise 4 (Refer to page 17 of the Learner's Book 9)

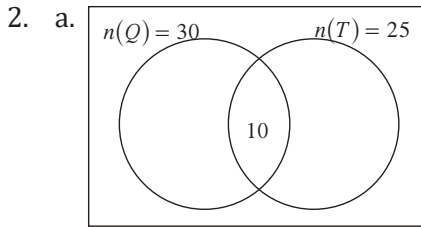
- 9876543
- 235711
- 369246848

Exercise 5 (Refer to page 23 of the Learner's Book 9)

- Refer to page 15 of the Learner's Book for answer to question 1.
- Task learners' to answer questions 2 - 4.

Exercise 6 (Refer to page 25 of the Learner's Book 9)

1. a. 30 b. 50



b. $Q \cup T = 45$

3. a. 31 b. 17 c. 25

Exercise 7 (Refer to page 26 of the Learner's Book 9)

- | | |
|--------|--------|
| 1. 72 | 6. 110 |
| 2. 96 | 7. 108 |
| 3. 132 | 8. 80 |
| 4. 81 | 9. 30 |
| 5. 56 | 10. 48 |

Exercise 8 (Refer to page 27 of the Learner's Book 9)

1. 1080
2. 1,586,000,000
3. 4,880,000,000
4. 607,000,000,000
5. 25,600,000

Exercise 9 (Refer to page 28 of the Learner's Book 9)

- | | | |
|------|------|------|
| 1. 4 | 3. 8 | 5. 8 |
| 2. 6 | 4. 6 | |

Exercise 10 (Refer to page 28 of the Learner's Book 9)

- | | |
|----------------|-------------|
| 1. 0.024567 | 6. 0.00043 |
| 2. 0.000048932 | 7. 24.5 |
| 3. 0.873467231 | 8. 9 |
| 4. 34.56734 | 9. 89.345 |
| 5. 0.6542 | 10. 0.06782 |

Exercise 11 (Refer to pages 39-40 of the Learner's Book 9)

- | | | | | |
|------------------------|--------------------|--------------------|------------------|-------------------|
| 1. a. 0.25 | b. 0.6667 | c. 0.3 | d. 2.6 | e. 0.125 |
| 2. a. $\frac{9}{25}$ | b. $\frac{5}{4}$ | c. $\frac{1}{8}$ | d. $\frac{1}{2}$ | e. $\frac{3}{4}$ |
| 3. a. 40% | b. 75% | c. 20% | d. 85% | e. 12.5% |
| 4. a. $\frac{39}{100}$ | b. $\frac{12}{25}$ | c. $\frac{43}{50}$ | d. $\frac{1}{4}$ | e. $\frac{7}{20}$ |
| 5. a. 36.4% | b. 71.2% | c. 26% | d. 10% | e. 0.2% |
| 6. a. 0.41 | b. 0.383 | c. 0.55 | d. 0.0002 | e. 0.0104 |

Exercise 12 (Refer to pages 42 of the Learner's Book 9)

- | | |
|---------------|---------------------|
| 1. 30023000 | 5. 4567820 |
| 2. 0.0056782 | 6. 10000 |
| 3. 0.000456 | 7. $\frac{1}{1000}$ |
| 4. 0.00248347 | |

Exercise 13 (Refer to pages 44 of the Learner's Book 9)

- | | |
|--------------------|--------------------|
| 1. commutative | 4. Not commutative |
| 2. commutative | 5. commutative |
| 3. Not commutative | 6. commutative |

Exercise 14 (Refer to pages 44 of the Learner's Book 9)

- | | |
|--------------|---------------|
| 1. Not equal | 6. equal |
| 2. equal | 7. equal |
| 3. equal | 8. equal |
| 4. Not equal | 9. Not equal |
| 5. equal | 10. Not equal |

Exercise 15 (Refer to page 45-46 of the Learner's Book 9)

- $8 \times 4 = 4(2 + 6)$
 $= 8 + 24$
 $= 32$
- $8 \times 14 = 8(10 + 4)$
 $= 80 + 32$
 $= 112$

$$3. \quad 9 \times 24 = 9(20 + 4) \\ = 180 + 36 = 216$$

$$4. \quad 7 \times 16 = 7(10 + 6) \\ = 70 + 42 = 112$$

Exercise 16 (Refer to page 47-48 of the Learner's Book 9)

1. $(28 \times 37) + (74 \times 81)$
 $1036 + 5994 = 7030$
2. $450m^2$
3. GH¢210.00

Exercise 17 (Refer to page 49 of the Learner's Book 9)

1. a. GH¢1244.92
b. GH¢124
2. a. GH¢587.74
b. GH¢59

STRAND/CHAPTER 1: NUMBER SUB-STRAND/UNIT 2: NUMBER OPERATIONS

Exercise 1 (Refer to page 64 of the Learner's Book 9)

- | | |
|---|-------------------------------|
| 1. $5\sqrt{3} - \sqrt{2}$ | 6. $6\sqrt{6}$ |
| 2. $\frac{8\sqrt{11} + 7\sqrt{5}}{459}$ | 7. $2\sqrt{7}$ |
| 3. $\sqrt{14}$ | 8. 7 |
| 4. $5\sqrt{2}$ | 9. $\frac{15 - 5\sqrt{5}}{4}$ |
| 5. $3\sqrt{x}$ | 10. $\frac{3\sqrt{10}}{10}$ |

Exercise 2 (Refer to page 64 of the Learner's Book 9)

- | | |
|-------------------------|---------------------------|
| 1. $3\sqrt{3}$ | 4. $\frac{2\sqrt{3}}{11}$ |
| 2. $6\sqrt{2}$ | 5. 2 |
| 3. $\frac{\sqrt{2}}{2}$ | |

6. $\frac{3\sqrt{29}}{29}$

7. $\frac{6}{5}$

8. $\frac{3\sqrt{5}}{5}$

9. $10\sqrt{10}$

10. 20

Exercise 3 (Refer to page 65 of the Learner's Book 9)

a. i. 41
ii. 41

b. i. 2.24
ii. 2.24

c. i. 1.73
ii. 1.73

d. i. 3.46
ii. 3.46

e. i. 5.48
ii. 5.48

f. i. 6.71
ii. 6.71

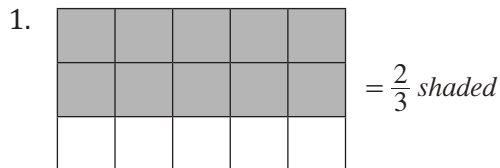
g. i. 10.25
ii. 10.2

h. i. 7.42
ii. 7.42

i. i. 9.95
ii. 9.95

j. i. 3.87
ii. 3.87

Exercise 4 (Refer to page 77 of the Learner's Book 9)



2. a. $\frac{4}{6}, \frac{6}{9}, \frac{8}{12}$

b. $\frac{10}{12}, \frac{15}{18}, \frac{25}{30}$

c. $\frac{12}{14}, \frac{18}{21}, \frac{24}{28}$

3. a. $\frac{5}{3}$

b. $\frac{3}{2}$

c. $\frac{2}{3}$

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

4. a. $2\frac{1}{6}$

b. $1\frac{1}{7}$

c. $2\frac{3}{10}$

5. a. $\frac{19}{5}$

b. $\frac{85}{11}$

c. $\frac{21}{5}$

6. i. $1\frac{7}{15}$

ii. $\frac{23}{35}$

iii. $2\frac{1}{24}$

iv. $\frac{11}{15}$

v. $\frac{7}{8}$

7. i. $1\frac{11}{25}$ ii. $\frac{1}{6}$ iii. $3\frac{5}{9}$ iv. $\frac{1}{7}$ v. $1\frac{1}{7}$

Exercise 5 (Refer to page 80 of the Learner's Book 9)

1. 20 2. 17 3. 15 4. 126 5. 39

Exercise 6 (Refer to page 81 of the Learner's Book 9)

1. $\frac{1}{2}$ 4. $\frac{69}{88}$
2. $3\frac{3}{10}$ 5. $3\frac{23}{24}$
3. 0

Solve word problems based on fraction (Refer to page 82 of the Learner's Book 9)

1. 16
2. 10%
3. Invalid by 281 more voters
4. Fusena's drink

STRAND/CHAPTER 1: NUMBER
SUB-STRAND/UNIT 3: NUMBER RATIO AND PROPORTION

Exercise 1 (Refer to page 86 of the Learner's Book 9)

1. 18 gallons
2. GH¢13.2
3. \$41.25

Exercise 2 (Refer to page 89 of the Learner's Book 9)

1. $p = 12, q = 9, r = 1, m = 36, n = 12$
2. 14×10^6

Exercise 3 (Refer to page 90 of the Learner's Book 9)

1. 8m
2. 80
3. 300
4. 3

Exercise 4 (Refer to page 95 of the Learner's Book 9)

1. GH¢3,892.00
2. GH¢8,925.00
3. 4 year
4. 6.1%
5. GH¢5,693.33

Exercise 5 (Refer to page 96 of the Learner's Book 9)

1. a. GH¢11,375.00 b. GH¢1,625.00
2. a. GH¢937.50 b. GH¢8,437.50
3. GH¢65.25
4. GH¢2,187.50
5. GH¢75.38

Exercise 6 (Refer to page 98 of the Learner's Book 9)

1. GH¢40.00
2. 23.5%
3. GH¢72,450.00

Exercise 7 (Refer to page 99 of the Learner's Book 9)

1. GH¢7,800.00
2. GH¢273.00
3. GH¢294.20
4. 6%
5. 4%
6. GH¢1680.00

Exercise 8 (Refer to page 101 of the Learner's Book 9)

1. First year GH¢26,320.00
Second year GH¢25,200.00
Third year GH¢22,960.00
Fourth year GH¢21,000.00

2. First year GH¢27,000.00
Second year GH¢24,300.00
Third year GH¢21,870.00

Exercise 9 (Refer to page 102 of the Learner's Book 9)

1. a. GH¢60.00
b. GH¢2,460.00
2. a. GH¢27,849.90
b. GH¢714.10

Exercise 10 (Refer to page 103 of the Learner's Book 9)

1. GH¢37.50
2. GH¢1,600.00
3. GH¢300.00

Exercise 11 (Refer to page 106 of the Learner's Book 9)

1. GH¢4405.40
- a. GH¢550.68
b. GH¢220.27
c. GH¢770.95

Exercise 12 (Refer to page 109 of the Learner's Book 9)

1. a. GH¢294.20
b. GH¢695.37
c. GH¢989.57
d. GH¢11,874.84 per annum
2. a. GH¢567.48
Basic Salary GH¢4,365.20 per month
3. GH¢8,251.20
4. GH¢1,320.12

STRAND/CHAPTER 2: ALGEBRA

SUB-STRAND/UNIT 1: PATTERNS AND RELATIONS

Exercise 1 (Refer to page 117 of the Learner's Book 9)

1.	x	-1	0	1	2	3	4	5	6
	$x + y = 4$	5	4	3	2	1	0	-1	-2
	$3x - y = 8$	-11	-8	-5	-2	1	4	7	10

Draw two linear graphs

2. i. $(x, y) = \left(-\frac{1}{2}, 4\right)$
- ii. $y = 13$ or $y = -5$
- iii. y - values for $y = 2x + 5$
 $-3, -1, 1, 3, 5, 7, 9$
- y - values for $y = -2x + 3$
 $11, 9, 7, 5, 3, 1, -1$

Exercise 2 (Refer to pages 117 and 118 of the Learner's Book 9)

1. $x = 2, y = 5$
2. $x = \frac{2}{3}, y = \frac{5}{3}$
3. $x = 1, y = 2$
4. $x = -1, y = -2$
5. $x = 1, y = 5$
- 6.
- | | | | | | | | |
|--------------------------|------|----|------|----|------|----|------|
| x | -3 | -2 | -1 | 0 | 1 | 2 | 3 |
| $y_1 = -x + 5$ | 8 | 7 | 6 | 5 | 4 | 3 | 2 |
| $y_2 = \frac{1}{2}x - 3$ | -4.5 | -4 | -3.5 | -3 | -2.5 | -2 | -1.5 |

STRAND/CHAPTER 2: ALGEBRA

SUB-STRAND/UNIT 2: ALGEBRAIC EXPRESSIONS

Exercise 1 (Refer to page 125 of the Learner's Book 9)

a. $m = \frac{2}{5}y + \frac{23}{5}$

b. $m = \frac{3x+6}{5d}$

c. $m = \frac{AR}{L}$

d. $m = 4K + u$

e. $m = \frac{c}{x+2}$

f. $m = \frac{v-a}{t}$

g. $m = \frac{24p}{q}$

h. $m = \sqrt{20r}$ or $m = 2\sqrt{5r}$

Exercise 2 (Refer to page 128 of the Learner's Book 9)

1. $4cm$

2. $1.578 \times 10^{-8} mm$

3. $3.5cm$

4. a. $n = \frac{360}{180 - \theta}$ b. $n = 30^\circ$

Exercise 3 (Refer to page 130 of the Learner's Book 9)

1. 3234 cubic sub-strand/unit

2. a. $h = \frac{v}{\pi r^2}$ b. $9.43cm$

3. $u = -30$

4. i. -12 ii. $\frac{13}{16}$

Exercise 4 (Refer to page 133 of the Learner's Book 9)

1. $ax(x+a)$

2. $\pi r(2+h)$

3. $yz(x-a)$

4. $6x(3x+2y)$

5. $5x(y+2z)$

6. $ax^2(1+x)$

Exercise 5 (Refer to page 138 of the Learner's Book 9)

1. $(a-c)(a+b)$

2. $(y+6)(y+10)$

3. $(7x+1)(7x-1)$

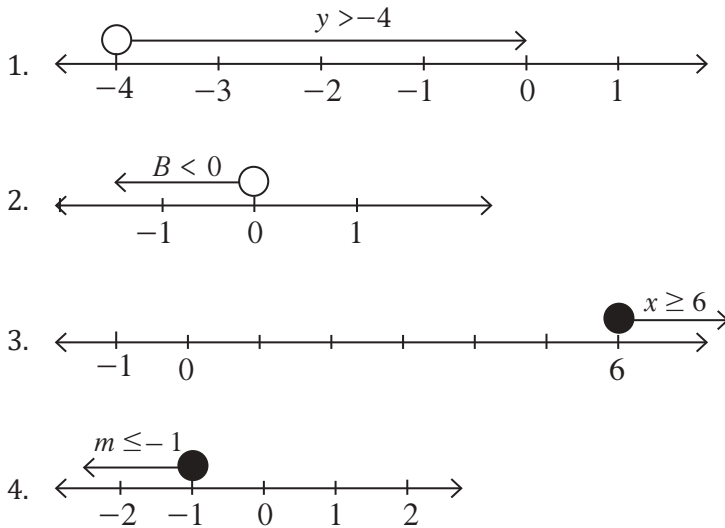
4. $(2y-3)(3x-2)$

STRAND/CHAPTER 2: ALGEBRA
SUB-STRAND/UNIT 3: VARIABLES AND EQUATIONS

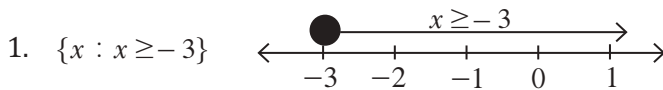
Exercise 1 (Refer to page 141 of the Learner's Book 9)

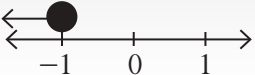
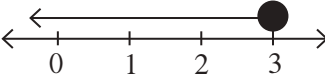
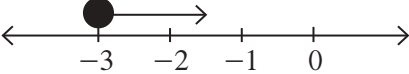
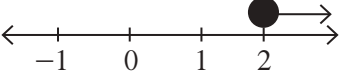
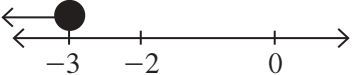
1. $x < \frac{11}{7}$
2. $x > \frac{13}{25}$
3. $x < \frac{27}{8}$
4. $x < 4$
5. $x < 3$

Exercise 2 (Refer to page 143 of the Learner's Book 9)

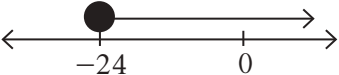
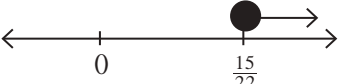
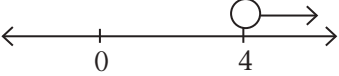
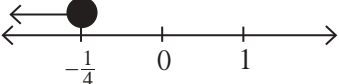
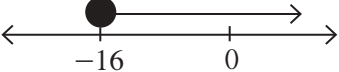


Exercise 3 (Refer to page 145 of the Learner's Book 9)



2. $\{x : x \leq -1\}$ 
3. $\{x : x \leq 3\}$ 
4. $\{x : x \geq -3\}$ 
5. $\{x : x \geq 2\}$ 
6. $\{x : x \leq -3\}$ 

Exercise 4 (Refer to page 149 of the Learner's Book 9)

1. $x \geq -24$ 
2. $x \geq \frac{15}{22}$ 
3. $x > 4$ 
4. $x \leq -\frac{1}{4}$ 
5. $x \geq -16$ 

Exercise 5 (Refer to page 151 of the Learner's Book 9)

1. a. $x + 24$
b. Shorter board = 88cm
Longer board = 112cm
2. $\frac{3}{2}$

Exercise 6 (Refer to page 154 of the Learner's Book 9)

1. 33
2. 13cm
3. $x \leq 7$
4. 49
5. $\frac{119}{2}$

STRAND/CHAPTER 3: GEOMETRY AND MEASUREMENT

SUB-STRAND/UNIT 1: SHAPE AND SPACE

Exercise 1 (Refer to page 169 of the Learner's Book 9)

1. a. 16 b. 58.67 c. 109° d. 43°

Exercise 2 (Refer to page 172 of the Learner's Book 9)

1. a. 30° b. 40°

STRAND/CHAPTER 3: GEOMETRY AND MEASUREMENT

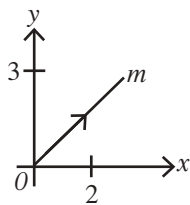
SUB-STRAND/UNIT 2-MEASUREMENTS

Exercise 1 (Refer to page 185 of the Learner's Book 9)

1. 310cm^2
2. 510cm^2
3. 142cm^2
4. 334cm^2

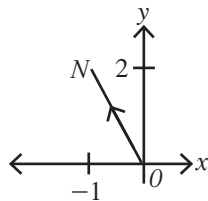
Exercise 2 (Refer to page 190 of the Learner's Book 9)

i. $\overrightarrow{OM} = \begin{pmatrix} 2 \\ 3 \end{pmatrix}$

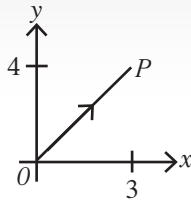


i.

ii. $\overrightarrow{ON} = \begin{pmatrix} -1 \\ 2 \end{pmatrix}$

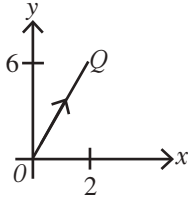


iii. $\vec{OP} = \begin{pmatrix} 3 \\ 4 \end{pmatrix}$



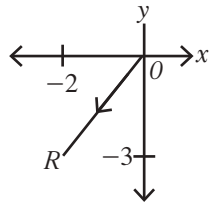
iv.

v. $\vec{OQ} = \begin{pmatrix} 2 \\ 6 \end{pmatrix}$



vi.

vii. $\vec{OR} = \begin{pmatrix} -2 \\ -3 \end{pmatrix}$



Exercise 3 (Refer to page 193 of the Learner's Book 9)

- | | |
|----------------|----------------|
| 1. 255° | 4. 115° |
| 2. 025° | 5. 180° |
| 3. 215° | |

Exercise 4 (Refer to page 195 of the Learner's Book 9)

1. $a = 2b$
2. Not parallel
3. $\vec{PQ} = 5\vec{MN}$
4. Not parallel

Exercise 5 (Refer to page 197 of the Learner's Book 9)

1. $x = 2$
2. a. Not perpendicular b. Not perpendicular
- c. $\begin{pmatrix} 3 \\ 4 \end{pmatrix}$ is perpendicular to $\begin{pmatrix} -4 \\ 3 \end{pmatrix}$ d. Not perpendicular

Exercise 6 (Refer to page 200 of the Learner's Book 9)

- i. $\overrightarrow{PQ} = \begin{pmatrix} 5 \\ 8 \end{pmatrix}, \overrightarrow{QR} = \begin{pmatrix} -10 \\ 0 \end{pmatrix}, \overrightarrow{PR} = \begin{pmatrix} -5 \\ 8 \end{pmatrix}$
- ii. $\triangle PQR$ is isosceles of $|PQ| = |QR|$
- iii. $y = -\frac{8}{5}x + \frac{1}{5}$

Exercise 7 (Refer to page 202 of the Learner's Book 9)

1. i. $\overrightarrow{PQ} = \begin{pmatrix} 1 \\ 1 \end{pmatrix}, \overrightarrow{SR} = \begin{pmatrix} 1 \\ 1 \end{pmatrix}$
 ii. $x = 4, y = 6$
2. a. $\begin{pmatrix} 2 \\ 8 \end{pmatrix}$ b. $\begin{pmatrix} 13 \\ 4 \end{pmatrix}$
3. $m = \frac{51}{34}$
 i. $B(2, -2)$
4. a. $D(1, 4), \overrightarrow{AB} = \begin{pmatrix} 4 \\ -4 \end{pmatrix}, \overrightarrow{DC} = \begin{pmatrix} 4 \\ -4 \end{pmatrix}$
 b. $|\overrightarrow{DB}| = 5.1$
5. $\overrightarrow{XY} = \begin{pmatrix} 6 \\ 8 \end{pmatrix}, \overrightarrow{YZ} = \begin{pmatrix} -10 \\ 0 \end{pmatrix}, \overrightarrow{ZX} = \begin{pmatrix} 4 \\ -8 \end{pmatrix}$

STRAND/CHAPTER 4: HANDLING DATA

SUB-STRAND/UNIT 1: DATA

Exercise 1 (Refer to page 219 of the Learner's Book 9)

i.

Height	Tally	Frequency
156 – 160	### ### ### ### ###	25
161 – 165	### ### ### ///	18
166 – 170	### ///	8
171 – 175	### ### ////	14
176 – 180	### ### ###	15

ii. Modal group is 156 – 160

iii. Range is 24