



THE PRESIDENT'S
RECOVERY
PRIORITIES

Education

Ministry of
Education,
Science and
Technology

Lesson plans for
JSS
Mathematics

JSS
2

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NOT FOR SALE

Foreword

Our country's future lies in the education of our children. The Government of Sierra Leone is committed to doing whatever it takes to secure this future.

As Minister of Education, Science and Technology since 2007, I have worked every day to improve our country's education. We have faced challenges, not least the Ebola epidemic which as we all know hit our sector hard. The Government's response to this crisis – led by our President – showed first-hand how we acted decisively in the face of those challenges, to make things better than they were in the first place.

One great success in our response was the publication of the Accelerated Teaching Syllabi in August 2015. This gave teachers the tools they needed to make up for lost time whilst ensuring pupils received an adequate level of knowledge across each part of the curriculum. The Accelerated Teaching syllabi also provided the pedagogical resource and impetus for the successful national radio and TV teaching programs during the Ebola epidemic.

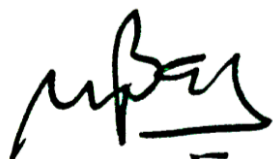
It is now time to build on this success. I am pleased to issue new lesson plans across all primary and JSS school grades in Language Arts and Mathematics. These plans give teachers the support they need to cover each element of the national curriculum. In total, we are producing 2,700 lesson plans – one for each lesson, in each term, in each year for each class. This is a remarkable achievement in a matter of months.

These plans have been written by experienced Sierra Leonean educators together with international experts. They have been reviewed by officials of my Ministry to ensure they meet the specific needs of the Sierra Leonean population. They provide step-by-step guidance for each learning outcome, using a range of recognised techniques to deliver the best teaching.

I call on all teachers and heads of schools across the country to make best use of these materials. We are supporting our teachers through a detailed training programme designed specifically for these new plans. It is really important that these Lesson Plans are used, together with any other materials you may have.

This is just the start of education transformation in Sierra Leone. I am committed to continue to strive for the changes that will make our country stronger.

I want to thank our partners for their continued support. Finally, I also want to thank you – the teachers of our country – for your hard work in securing our future.



Dr. Minkailu Bah

Minister of Education, Science and Technology














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Introduction to the Lesson Plan Manual

These lesson plans are based on the National Curriculum and meet the requirements established by the Ministry of Education, Science and Technology.

- 1  The lesson plans will not take the whole term, so use spare time to review material or prepare for exams
 - 2  Teachers can use other textbooks alongside or instead of these lesson plans.
 - 3  Read the lesson plan before you start the lesson. Look ahead to the next lesson, and see if you need to tell pupils to bring materials for next time.
 - 4  Make sure you understand the learning outcomes, and have teaching aids and other preparation ready – each lesson plan shows these using the symbols on the right.
 - 5  Quickly review what you taught last time before starting each lesson.
 - 6  Follow the suggested time allocations for each part of the lesson. If time permits, extend practice with additional work.
 - 7  Lesson plans have a mix of activities for the whole class and for individuals or in pairs.
 - 8  Use the board and other visual aids as you teach.
 - 9  Interact with all students in the class – including the quiet ones.
 - 10  Congratulate pupils when they get questions right! Offer solutions when they don't, and thank them for trying.
-  Learning outcomes
 Teaching aids
 Preparation

Lesson Title: Converting Between Mixed and Improper Fractions	Theme: Numbers and Numeration	
Lesson Number: M-08-001	Class/Level: JSS 2	Time: 35 minutes

 <p>Learning Outcomes By the end of the lesson, pupils will be able to:</p> <ol style="list-style-type: none"> Express mixed numbers as improper fractions. Express improper fractions as mixed numbers. 	 <p>Teaching Aids None</p>	 <p>Preparation Definitions of terms: numerator, denominator, mixed number, proper fraction, and improper fraction.¹</p>
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Opening (5 minutes)

- Say:** Today we are going to learn how to do something very special: turn one thing into something else! Sometimes one thing can ‘transform’ into something else. For example, water and flour can become bread. In this lesson, you will learn how to turn improper fractions into mixed numbers and how to turn mixed numbers into improper fractions. In maths, we call this process ‘converting’ or ‘conversion’.
- Ask:** Can you give any other examples of when you’ve converted something in maths to something else? (Example Answers: Converting decimals to fractions, fractions to decimals, whole numbers to fractions)
- Say:** Those are all good examples! In those conversions we used a set of steps to help us. Today we will use a set of steps to help us in converting mixed numbers to improper fractions and improper fractions to mixed numbers.
- Ask 2 volunteers to tell the class what a ‘mixed number’ and ‘improper fraction’ are. (Answer: A mixed number is a whole number and a fractional part in which the numerator is less than the denominator. An improper fraction is a fraction in which the numerator is bigger than the denominator. An improper fraction is greater than 1.)

Introduction to the New Material (15 minutes)

- Say:** When we do maths conversions from one thing to another, the first step is to find out what we have and what we want.
- Write the following rational numbers on the board. Ask pupils to copy them into their exercise books:

1) $\frac{41}{5}$
2) $3\frac{7}{10}$
3) $20\frac{2}{3}$
4) $\frac{35}{7}$
- Say:** We want to convert these rational numbers. Let’s first find out what type of number each one is. Then, let’s find out what we want to convert it into.
- Ask 4 volunteers to come to the board to help. Lead the class in finding the answer and using the correct vocabulary for each. (Answer: 1 and 4 are improper fractions, so we want to convert them into mixed numbers. 2 and 3 are mixed numbers, so we want to convert them into improper fractions.)

¹ Pupils should have prior knowledge of these terms; if they do not, the teacher should review them prior to the lesson.

5. Ask pupils to write this in their exercise books. For example, they may write '1 is an improper fraction, so I want to convert it to a mixed number'.
6. Show, using 1 and 2, the steps for converting each type of problem.
7. **Say:** When we have an improper fraction like $\frac{41}{5}$, we first have to find out the whole number that's 'hidden'. To find out how many whole numbers we have, we need to find out how many parts are in each whole.
8. **Ask:** Can anyone tell me how many parts are in each whole for the first problem on the board? (Answer: 5)
9. **Say:** That's right! We know how many parts make up one whole by looking at the denominator. In this problem, the denominator is 5 so we know that 5 parts make up 1 whole. This is the secret to doing this type of maths conversion!
10. Write $5/5 = 1$ and $1 = 5/5$ on the board. Then write $2 = ?$ and $? = 3$ on the board. Ask pupils to find out how many parts make up 2 and 3 wholes. Ask pupils to think of a mental image that can help them. For example, if one bar of soap was cut into 5 equal pieces, how many equal pieces would be in 2 bars of soap? (Answer: $2 = 10/5$ and $15/5 = 3$)
11. **Ask:** Can anyone see a pattern that we can use to help us find out how many wholes we have in $41/5$? (Answer: You can divide.)
12. **Say:** That's correct! Remember that the fraction bar means division, so another way of thinking of $41/5$ is 41 divided by 5.
13. Write on the board the division problem using both common forms of the division symbol $41 \div 5$ and $5 \overline{)41}$.
14. **Ask:** How many wholes are in $41/5$? (Answer: 8)
15. **Say:** Correct! $40/5 = 8$ so if we have $41/5$ then we have 8 wholes and 1 part (fifth) left over.
16. Write on the board:

$$\frac{41}{5} = 8\frac{1}{5}$$
17. **Say:** This is how we write what we found. We have converted the improper fraction into a mixed number! Please write this in your exercise book. Now, let's look at how we convert a mixed number into an improper fraction. Look at $3\frac{7}{10}$. Talk to a fellow pupil about your ideas on how we could do that.
18. Give the pupils 1 minute to talk to their fellow pupils about the steps to convert from a mixed number to an improper fraction. Then, allow 1 or 2 pupils to share their ideas.
19. **Say:** You have good ideas and you are on the right track! When we have a mixed number and want to find the equivalent improper fraction, we will do the opposite process of what we just did for the first problem on the board. So, instead of dividing, the primary operation will be multiplication.
20. **Ask:** What was the strategy we used for these types of problems? (Answer: Knowing how many parts make up one whole.)
21. **Say:** That's right! We need to know the number of equal parts that make up each whole.
22. **Ask:** For the second problem on the board, how many parts make up one whole? (Answer: 10)
23. **Say:** Excellent! We know that 10 parts make up one whole because the denominator is 10.
24. Write on the board $1 = 10/10$. Ask pupils to write their work in their exercise books.
25. **Ask:** We know 10 parts make up a whole. How many parts are there if we have 3 wholes? (Answer: 30 because $3 \times 10 = 30$ and $30/10 = 3$.)

26. **Say:** Good!

27. **Ask:** What was the fractional part of our mixed number? (Answer: 7/10.)

28. **Say:** That's right! We have 7 more parts plus the parts that make up the 3 wholes.

29. Write on the board:

$$\begin{aligned} 3\frac{7}{10} &= \frac{30}{10} + \frac{7}{10} \\ &= \frac{37}{10} \end{aligned}$$

30. **Say:** This is how we write what we found. We have converted the mixed number that we were given into a brand new improper fraction! Please write this in your exercise book. Now, I want you to try the other two problems on the board.

Guided Practice (10 minutes)

1. Ask pupils to work with their fellow pupils. They will convert questions 3 and 4 from the board.
2. Ask both pupils to write their work in their exercise book. (The teacher should walk around and check the correctness of the conversions and the vocabulary being used by pupils.)
3. Ask pupils to bring their exercise book to the teacher to mark. (Answers: $20\frac{2}{3} = \frac{62}{3}$ and $\frac{35}{7} = 5$)

Independent Practice (8 minutes)

1. Write the following rational numbers on the board:

$$\frac{123}{20} \qquad 4\frac{9}{14}$$

2. Ask pupils to copy the 2 rational numbers in their exercise book. Ask pupils to write a sentence next to each number in the form, 'This number is given as a(n) ___ so I need to convert it to a(n) ____'. They fill in the blank with the appropriate term 'mixed number' or 'improper fraction'.
3. Ask pupils to convert both rational numbers independently in their exercise books.
4. Ask pupils to check their work with their fellow pupils.
5. Ensure that pupils have the correct answers. (Answers: $\frac{123}{20} = 6\frac{3}{20}$ and $4\frac{9}{14} = \frac{65}{14}$.)

Closing (2 minutes)

1. Ask 2 pupils to complete the following sentence: 'Today I learned ____'. Allow about 1 minute for each pupil to give their response.

Lesson Title: Converting Decimals to Fractions	Theme: Numbers and Numeration	
Lesson Number: M-08-002	Class/Level: JSS 2	Time: 35 minutes

 Learning Outcomes By the end of the lesson, pupils will be able to express decimals as fractions.	 Teaching Aids None	 Preparation None
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Opening (5 minutes)

- Say:** Today we are going to learn how to do more conversions! By the end of this lesson, you will be able to convert decimals to fractions.
- Ask:** Think about your daily life. Can you give an example of where in your daily life you can find decimals?
- Say:** Converting a decimal to a fraction is easy if you know how to read the number. To read the number, you need to know about 'place value.'
- Write: 53.249
- Ask:** What is the place value for each digit? (Answers: The number 5 is in the tens place; the number 3 is in the ones place; the number 2 is in the tenths place; the number 4 is in the hundredths place; the number 9 is in the thousandths place.)
- Call on a pupil with hand raised to share the place value of one digit. Repeat until each place value has been identified.

Introduction to the New Material (10 minutes)

- Say:** Let's use what we know about place value to help us convert decimals to fractions.
- Write the following decimals on the board:
 - 0.7
 - 1.3
- Say:** Please copy these into your exercise book.
- Say:** We want to convert these decimals into fractions. First, let's read each number together.
- Lead the class in reading each number aloud. (Answers: #1 'seven-tenths', #2 'one and three tenths', #3 'twenty and five tenths', #4 'seven and thirty-six hundredths'.)
- Say:** Good! Now let's write the conversions based on what we just said.
- Write on the board:

$$0.7 = \frac{7}{10}$$
- Say:** This is how we write the conversion of seven-tenths from a decimal to a fraction.
- Say:** 7/10 cannot be simplified any further.
- Say:** Since we cannot simplify the fraction, 7/10 is our final answer. Please write it in your exercise book.
- Say:** 1.3 is the same as 1 and 3 tenths or 13 tenths.
- Write on the board:




$$1.3 = 1\frac{3}{10}$$

or $\frac{13}{10}$

Closing (2 minutes)

1. **Say:** Complete the following sentences in your exercise book.
2. Write: When I convert decimals to fractions, it is important that I _____.
3. Write: One question I have about today's lesson is _____.

Lesson Title: Converting Fractions to Decimals	Theme: Numbers and Numeration	
Lesson Number: M-08-003	Class/Level: JSS 2	Time: 35 minutes

	Learning Outcomes By the end of the lesson, pupils will be able to express fractions as decimals		Teaching Aids None		Preparation 1. Definitions of terms: decimal. 2. Ability to identify place value. ²
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Opening (7 minutes)

- Say:** Today we will learn how to do more conversions! By the end of this lesson, you will know how to convert fractions to decimals.
- Ask:** Do you remember what we learned in the last lesson? (Answer: We learned how to convert from decimals to fractions.)
- Say:** That's correct! In the last lesson, we learned how the number and 'place value' can help us convert from a decimal to a fraction. We will build on what we learned in that lesson. Today we will learn how to convert from a fraction to a decimal. Let's begin with an easy problem.
- Write $2\frac{36}{100}$ on the board.
- Ask:** How do we convert this mixed number to a decimal?
- Ask 2 different volunteers to come to the board. They will write what they think the answer is. (Answer: 2.36)
- Say:** The way we read this mixed number is "two and 36 hundredths". Reading this number helps us to convert it to a decimal.
- Write $2\frac{9}{25}$ on the board.
- Ask:** But what if the mixed number was written like this instead? What is different now? (Answer: It is an equivalent value, but now the fraction is simplified.)
- Say:** Yes! This is the same value, but now it is simplified. In this form, the denominator is not a power of 10. Because of this, it is harder to 'see' the answer is 2.36. Today we will learn how to write fractions as decimals. We will learn to do this with fractions that have all different kinds of denominators.

Introduction to the New Material (12 minutes)

- Ask:** What operation is represented by the fraction bar? (Answer: Division)
- Say:** Right! Converting from fractions to decimals will always be easy. It will be easy even if the denominator is not 10 or 100 or 1000, because you simply have to divide.
- Say:** Let's use division to help us convert some fractions to decimals.
- Write the following fractions on the board. Ask pupils to copy them into their exercise books:
 1) $\frac{3}{5}$ 2) $3\frac{5}{8}$ 3) $\frac{9}{5}$ 4) $519\frac{20}{80}$
- Say:** We want to convert these fractions into decimals. First, write down the whole number part, if any, and the decimal point.
- Say:** Check 2 things. First, check that your fractions are written as mixed numbers if they are greater than one. Secondly, check that your fraction is simplified to lowest terms.

² Pupils should have prior knowledge of these items; if they do not, the teacher should review them prior to the lesson.

7. Lead the class in writing the whole number part of each mixed number correctly. (Answers: 1) 0 ; 2) 3 , 3) 1 (If pupils incorrectly had written 0, remind them of the process to convert an improper fraction to a mixed number); 4) 519.)
8. **Say:** Good! Now let's find out the decimal part by dividing the given fraction for each problem.
9. Write on the board:

$$\frac{3}{5} = 3 \div 5$$
10. **Say:** We already know this fraction is less than 1. This is because it is a proper fraction. In order to divide and find the decimal equivalent of this fraction, we have to add a decimal point in the quotient and a zero to the dividend.
11. Write on the board: $5 \overline{)3.0}$
12. **Ask:** Three-fifths converted to a decimal is equal to what? (Answer: 0.6)
13. **Say:** Good. Write that in your exercise book. Now, complete number 2.
14. Give pupils 1 minute to work.
15. Write on the board: $3\frac{5}{8} = 3.625$
16. **Ask:** Is this what you got?
17. Call on 1 or 2 volunteers to tell whether they got the correct answer. If they did not, correct their mistakes. For example, they might have forgotten to keep adding zeroes and dividing until they had no remainder. Ask pupils who got the correct answer to help fellow pupils who may have got it incorrect.
18. **Say:** We have converted the first 2 fractions into decimals. Now, let's convert the rest!

Guided Practice (8 minutes)

1. **Say:** Please convert number 3 from the board. Ask your fellow pupil if you have a question. I will give you 2 minutes to work.
2. Set timer for 2 minutes, or use a watch or clock to mark the time.
3. **Say:** Compare your answers with your fellow pupil. If you both got the same answer for number 3, please stand up.
4. Notice the pairs who are not standing. Give them more help during independent practice.
5. Ask one of the pairs who are standing to come to the board and write their answer. Tell the others they can sit down.
6. Tell pupils to check their work in their exercise book. Tell them to correct any mistakes. (Answer: see below.)

$$\frac{9}{5}$$

This fraction is improper so the decimal will be greater than one.

$$\frac{9}{5} = 1\frac{4}{5} \text{ and } \frac{4}{5} = 0.8$$

$$\text{So, the final answer is: } \frac{9}{5} = 1.8$$

Note: It is also correct if pupils divide 9 by 5 to arrive at the correct decimal of 1.8

7. **Ask:** Did anyone get the correct answer for number 3 in a different way?
8. For example, some pupils may see that $\frac{4}{5} = \frac{8}{10}$. If so, ask a pupil to explain how they got the correct answer.

9. **Say:** Please convert number 4 from the board. Ask your fellow pupil if you have a question. You will have 2 minutes to work.
10. Set timer for 2 minutes, or use a watch or clock to mark the time.
11. **Say:** Compare your answers with your fellow pupil. If you both got the same answer for number 4, please stand up.
12. Notice the pairs who are not standing. Give them more help during independent practice.
13. Ask one of the pairs who are standing to come to the board and write their answer. Tell the others they may be seated.
14. Tell pupils to check their work in their exercise book. Tell them to correct any mistakes they may have made. (Answer: see below.)

$$519\frac{20}{80} = 519.25$$

Tell pupils to simplify the fraction before dividing. Some pupils may know $\frac{1}{4} = 0.25$ without having to divide at all.

Tell pupils that it doesn't matter whether they divided 20 by 80 or 2 by 8 or 1 by 4, because they still get the same answer.
15. **Say:** Good work! Now I want you to practise doing a few more conversions on your own.




Independent Practice (8 minutes)

1. Write the following fractions on the board: a) $4\frac{9}{15}$; b) $\frac{1}{8}$; c) $\frac{12}{10}$
2. **Say:** Please convert these fractions to decimals. Write the whole number and the decimal if the fraction is improper. Simplify all fractions before dividing. You will have 4 minutes to work.
3. Set timer for 4 minutes, or use a watch or clock to mark the time.
4. Ask pupils to bring their exercise book to the teacher to mark. (Correct answers: a) 4.6 ; b) 0.125 ; c) 1.2)

Closing (2 minutes)

1. Ask pupils to complete the following sentences in their exercise books:
 - a) 'When I convert fractions to decimals, it is important that I _____'.
 - b) 'One question I have about today's lesson is _____'.

Lesson Title: Comparing and Ordering Mixture of Numbers	Theme: Numbers and Numeration	
Lesson Number: M-08-004	Class/Level: JSS 2	Time: 35 minutes

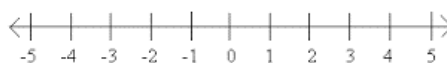
	Learning Outcomes By the end of the lesson, pupils will be able to order and compare integers, decimals and fractions using a number line.		Teaching Aids String or rope		Preparation 1. Definitions of terms: integers. 2. Ability to identify whether numbers are positive or negative. ³
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Opening (5 minutes)

- Say:** We are learning about different ways we can ‘represent’ numbers. ‘Represent’ means to show them in different forms. We can use integers, fractions and decimals to represent numbers. Today we are going to learn a way to see, or ‘illustrate’, these different numbers using a number line.
- Choose 5 volunteers to come to the front of the room. The pupils should be of different heights. Have the pupils form a straight line. Then, hand the string or rope to the pupils. Each pupil should hold the string.
- Ask:** Can you think of a way we could ‘arrange,’ or ‘order’, these people in some way that makes sense just by looking at them? (Answer: put them in order from tallest to shortest, or from shortest to tallest.)
- If no one mentions height, say, ‘What do you notice about their height?’.
- Say:** Yes! There are many possible answers. One way would be if we ‘arranged,’ or ‘ordered’, the people according to height.
- Ask pupils to lay the rope down. Then, ask them to get in order from shortest to tallest. Ask them to pick the rope back up once they are in order.
- Say:** By putting the people like this, we can ‘visualise’, or see, a relationship between them. Today we are going to use a similar idea to illustrate a relationship between different numbers.
- Ask pupils to go back to their desks.

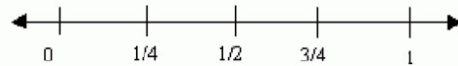
Introduction to the New Material (10 minutes)

- Say:** Let’s imagine that we have the following numbers. We want to arrange the numbers in a way that makes sense just by looking. We want to arrange them the way we arranged the 5 pupils a few minutes ago.
- Write the following numbers on the board. Ask pupils to copy them into their exercise books:
8 -2 5 12 0
- Say:** A number line is one way to see the relationship between numbers. It is similar to how we could see the relationship between pupils by looking at their heights. A number line is like the rope. Here is what a number line looks like.
- Draw a number line on the board that looks like this:

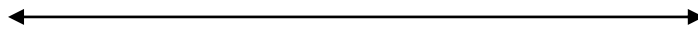


³ Pupils should have prior knowledge of these terms; if they do not, review them prior to the lesson.

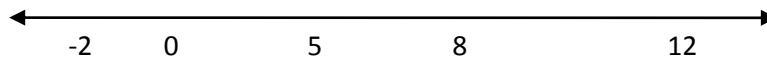
5. **Say:** Please copy this number line in your exercise book. There are several things about the number line that are important to know. Please write these in your exercise book as well.
6. Write on the board:
 - a) Number lines do not end. They keep going forever in both directions. We show this by putting an arrow at both ends of the number line.
 - b) Number lines include marks to represent where the number lies on the line. We draw these marks 'to scale'.
 - c) Number lines can show different ranges of numbers by using a different scale. For example, we could create a number line that shows certain fractions from 0 to 1 like this:



- d) Number lines can show integers, fractions or decimals.
 - e) Number lines always 'increase,' or go up, from left to right.
7. **Say:** We are starting with a 'blank' number line.
8. Draw a blank number line on the board. Ask pupils to copy it in their exercise books.



9. **Say:** Put the 5 numbers on the number line in a way that makes sense to you. Follow the rules about number lines. Talk to your fellow pupil if you have a question. You will have 1 minute to work.
10. After 1 minute, call on a volunteer to come to the board and put the numbers on the blank number line.
11. **Ask:** Do you think the numbers are correct? Does it follow the rules about number lines?
12. **Say:** The correct number line should look like this:

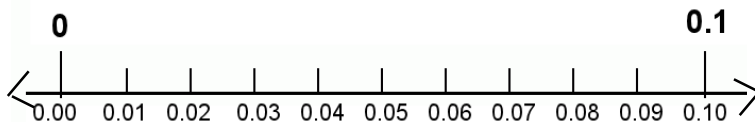


13. **Ask:** Why is -2 the first number as we read from left to right? (Answer: Because it is the smallest number. Number lines increase from left to right so they start with the smallest and end with the largest.)
14. **Ask:** Why is the 12 farther away from the 8 than the 5 is from the 8? (Answer: Because number lines are to scale. There is a difference of 4 between 8 and 12 and a difference of 3 between 5 and 8. 4 is bigger than 3, so the distance between those two numbers is greater.)
15. **Ask:** How could we make our number line easier to read? (Answer: We could put dashes that are one unit apart. This shows the missing numbers.)
16. **Say:** Number lines are very helpful tools to see how numbers are related to each other. Let's see how a number line can be used with decimals.

Guided Practice (6 minutes)

1. Write on the board:
 - a) Create a number line that illustrates these decimals:
0.1, 0.09, 0.01, 0.08, 0.02, 0.07, 0.03, 0.06, 0.04, 0.05, 0
2. **Say:** First, Put the decimals in order from least to greatest. Then, find an appropriate scale. To do that, ask yourself what each mark should represent. For example, will each mark represent 1 or 100 or 1/2? Remember that the number line should show the relationship each number has to the others. I will give you 4 minutes to work.

3. Set timer for 4 minutes, or use a watch or clock to mark the time.
4. **Say:** Compare your number line with your fellow pupil. If you both have number lines that look the same, please stand up.
5. Notice the pairs who are not standing. You can give them more help during independent practice.
6. Ask one of the pairs who are standing to come to the board and write their answer. Tell the others they may be seated.
7. Tell pupils to check their work in their exercise book. Tell them to correct any mistakes they may have made. (Answer: see below.)



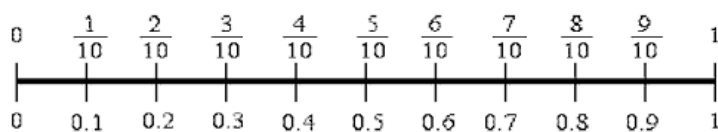
8. **Ask:** Did your number line follow all the rules?
9. Hopefully, they said 'yes'. If not, tell them to refer to their notes as they do the independent work.
10. **Say:** Good work! Now you will practise doing number lines on your own.

Independent Practice (10 minutes)

1. Write on the board:
 - a) Create a number line that shows the fractions in fifths from zero to 2.
 - b) Create a number line that shows the even integers from -10 to 10.
 - c) Create a number line that shows the decimals in tenths from 3 to 4.
2. **Say:** Please create these 3 number lines in your exercise book. Remember to follow all of the rules about number lines. You will have 6 minutes to work.
3. Set the timer for 6 minutes, or use a watch or clock to mark the time.
4. Ask pupils to bring their exercise book to the teacher to mark.




Closing (4 minutes)

1. Draw the following number line on the board.



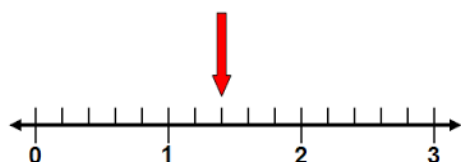
2. Ask pupils to complete the following sentences in their exercise book:
 - a) 'When I look at this number line, I know that the smallest number is _____ and the largest number is _____ because _____'.
 - b) 'When I look at this number line, I know the scale is _____ because _____'.
 - c) 'One thing I like about using number lines is _____'.
 - d) 'I think number lines are helpful because _____'.

Lesson Title: Locating a Mixture of Numbers on the Number Line	Theme: Numbers and Numeration	
Lesson Number: M-08-005	Class/Level: JSS 2	Time: 35 minutes

 Learning Outcomes By the end of the lesson, pupils will be able to locate integers, decimals and fractions on the number line.	 Teaching Aids None	 Preparation 1. Definitions of terms: integers. 2. Ability to identify whether numbers are positive or negative. ⁴
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Opening (3 minutes)

- Ask:** Do you remember what we used in the last lesson to help us see the relationships between different numbers? If you remember, then raise your hand.
- Call on a pupil with his/her hand raised. (Answer: Number lines)
- Say:** Today we are going to learn how to find and name different numbers on a number line. Here is your first challenge.
- Draw the number line and arrow shown below on the board:



- Ask:** What number is shown by the arrow?

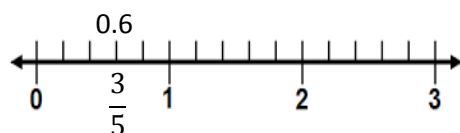
Introduction to the New Material (7 minutes)

- Call on 2 or 3 volunteers to get their ideas on how to find the mystery number. If they do not have ideas on how to start thinking about the challenge, use the following questions to help.
- Ask:** Can you find 2 numbers that the mystery number is in-between? (Answer: 1 and 2)
- Ask:** Can you figure out what scale this number line is using? (Answer: Fifths)
- Say:** You are right. We know the mystery number is between 1 and 2. We also know that each mark on the number line represents a fifth. This is because each unit is cut into five equal parts. That means we know the mystery number is one and two-fifths.
- Write the value $1\frac{2}{5}$ under the arrow. Tell pupils to copy the completed number line into their exercise books.
- Say:** Finding the value of a number shown on a number line is easy if you follow these steps. Please write these steps in your exercise book to help you in the rest of today's lesson.
- Write on the board:
 - Find 2 numbers so that your mystery number is between them.
 - Find out what scale is being used in the number line.
 - Write the value of the mystery number on the number line.
- Say:** Let's use this strategy to help us locate and name more mystery numbers using a number line!

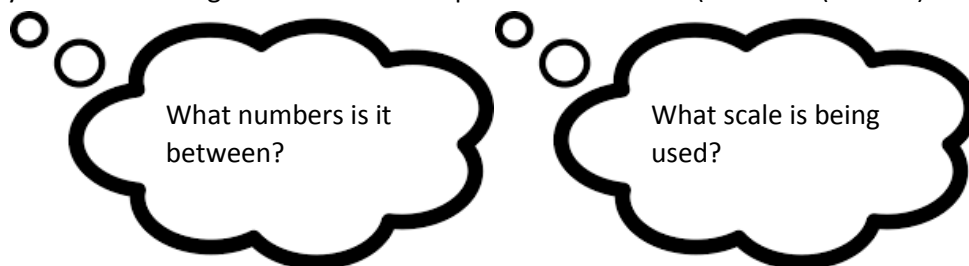
⁴ Pupils should have prior knowledge of these items; if they do not, the teacher should review them prior to the lesson.

Guided Practice (10 minutes)

1. **Say:** Look at the number line on the board. Find the number $\frac{3}{5}$. Put an arrow above the mark where you think the fraction is located on the number line.
2. **Say:** Compare your mark with your fellow pupil's. See if you agree. If you agree, figure out what decimal is shown. If you don't agree, talk about why you have different locations on the number line. Try to discover who is correct. You will have 2 minutes to work.
3. Set timer for 2 minutes or use a watch or clock to mark the time.
4. **Ask:** If you and your fellow pupil have agreed on where this fraction is located on the number line, please raise your hands.
5. Notice the pairs who do not have their hands up. Give them more help during independent practice.
6. **Ask:** If you and your fellow pupil have agreed on what this fraction is as a decimal, please stand up.
7. Notice the pairs who are not standing. Give them more help during independent practice.
8. Ask one of the pairs who are standing to come to the board and write their answer. Have them write the fraction below the line and the decimal above the line.
9. Tell pupils to check their work in their exercise book. Tell them to correct any mistakes. (Answer: see below.)



10. **Ask:** Did you remember to use your steps?
11. Hopefully, they said 'yes'! If they did not, ask them to write a reminder in their exercise book. They can write 'thought clouds'. An example is shown below. (Answers: (0 and 1) and (fifths).)



12. **Ask:** What did you have to do to convert three-fifths to a decimal? (Answer: divide 3 by 5.)
13. **Say:** That's right! You remembered from our previous lesson! Well done!
14. **Say:** Now I want you to locate the mixed number $2\frac{4}{5}$ on this number line. I will give you a minute then I will ask for a volunteer to come to the board and point to where it is located.
15. Give pupils 1 minute to work. Ask for a volunteer to come to the board and point to where the mixed number is located on the number line. Ask that pupils who got it correct raise their hand. Notice which pupils do not have their hands up. Give them more help during independent practice.
16. **Say:** Now you will find some mystery numbers on your own.

Independent Practice (10 minutes)

1. Draw the following number line problems on the board:

Pick the correct number to go on the red balloon

a) 2 26 16 21

Pick the correct number to go on the red balloon

b) 2 17 11 25

Pick the correct number to go on the red balloon

c) 64 75 73 82

2. **Say:** Please find the mystery number for the tall balloons. Look at all the choices before you decide on the best number. Copy these problems into your exercise book. Then write the answers into your exercise book. You will have 5 minutes to work.
3. Set timer for 5 minutes, or use a watch or clock to mark the time.
4. Ask 3 pupils to share the correct answers. Tell everyone to check their work. (Answer: a) 26, b) 17, c) 73)
5. **Say:** Good work! Now let's try some mystery numbers that include integers, fractions and decimals.
6. Draw the following number line problems on the board:

a)

b)




c)

7. **Say:** Find the mystery number indicated by the arrows for each problem shown. For 2 and 3, give your answer both as a fraction and as a decimal. Copy these problems and your answers into your exercise book. You will have 5 minutes to work.
8. Set timer for 5 minutes, or use a watch or clock to mark the time.
9. Ask 3 pupils to share the correct answers. Tell everyone to check their work. (Answers: 1) -7, 2) $0.24 = \frac{24}{100} = \frac{6}{25}$, 3) $\frac{3}{8} = 0.375$)
10. **Say:** Very good!

Closing (5 minutes)

1. Ask pupils to complete the following sentences in their exercise books:
 - a) 'When I locate numbers on a number line, two important steps are _____ and _____'.
 - b) 'One question I have about today's lesson is _____'.

Lesson Title: Classification of Decimal Numbers	Theme: Numbers and Numeration	
Lesson Number: M-08-006	Class/Level: JSS 2	Time: 35 minutes

	<p>Learning Outcomes By the end of the lesson, pupils will be able to:</p> <ol style="list-style-type: none"> 1. Identify terminating decimals. 2. Identify recurring decimals. 		<p>Teaching Aids None</p>		<p>Preparation</p> <ol style="list-style-type: none"> 1. Write notes on board (see Opening). 2. Definition of 'finite' and 'infinite'.
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Opening (4 minutes)

1. **Say:** Today we are going to talk about 2 different kinds of decimal numbers.
2. **Ask:** What might these 2 kinds of decimals be? Raise your hand if you have an idea.
3. Call on 2 or 3 pupils with his/her hands raised. Accept all responses. Ask questions to clarify their ideas if needed.
4. **Say:** Those are all good ideas. The 2 kinds of decimals we are going to learn about are called 'terminating' and 'recurring'.
5. Write the following notes on the board:
A 'terminating' decimal is a decimal that has an end.
In other words, terminating decimals have a finite number of digits.
For example, $\frac{1}{2}$ is equal to the terminating decimal 0.5 and $\frac{3}{4}$ is equal to the terminating decimal 0.75.
A 'recurring' decimal, also called a 'repeating' decimal, has an infinite number of digits.
In other words, it never ends. Some digit(s) repeat forever.
For example, $\frac{1}{3}$ is equal to the recurring decimal 0.33333....
We use a bar over the digit or digits that repeat to show that it never ends, like this
$$\frac{1}{3} = 0.\bar{3}$$

This notation is used to show that the digit 3 repeats forever.
6. **Say:** Please write these notes in your exercise book.
7. **Ask:** Are you ready to identify some decimals? (Answer: Yes!)

Introduction to the New Material (8 minutes)

1. **Say:** Let's look at 2 fractions.
2. Write the fractions $\frac{2}{3}$ and $\frac{7}{8}$ on the board.
3. **Say:** We want to find out what types of decimals are represented here.
4. **Ask:** Do you remember how to convert a fraction to a decimal? Raise your hand if you do.
5. Call on a pupil with his/her hand raised. (Answer: Divide)
6. **Say:** That's correct. So, to determine what kind of decimal we have, we must divide. Please do this now. Write your answer in your exercise book.
7. Walk around to a few pupils and check their work. Help them if they have difficulty.
8. Do the division on the board (or have two pupil volunteers do it). Correct answers are below:
$$\frac{2}{3} = 0.\bar{6} \text{ and } \frac{7}{8} = 0.875$$
9. **Say:** Now that we know the decimal equivalent for each fraction, let's identify what 'type' each fraction is. Use your notes and write the type of the decimal next to each one.

10. Correct types are shown below:

$\frac{2}{3} = 0.\overline{6}$ is a recurring decimal and $\frac{7}{8} = 0.875$ is a terminating decimal

11. Ask pupils to write a sentence in their exercise books that explain why those answers are correct. (Answer: $0.\overline{6}$ is a recurring decimal because it never ends; the 6 repeats forever. 0.875 is a terminating decimal because it ends; it has a finite number of digits (three).)

Guided Practice (8 minutes)

- Say:** Let's practise identifying decimal types. Copy the decimals from the board. Then, next to each one, write whether it is a recurring or terminating decimal. You will have 4 minutes to work.
- Set the timer for 4 minutes or use a clock or watch to mark the time.
- Write the following decimals on the board:
1) 0.28 2) 0.3 3) $6.\overline{45}$ 4) $2.0\overline{18}$ 5) 9.12512
- After the time is up, call on 5 pupils to give their responses. (Answers: 1) terminating; 2) terminating; 3) recurring (make sure pupils understand the 45 repeat forever like this 6.4545454545...; 4) recurring (make sure pupils understand the 8 repeats forever like this 2.018888888...; 5) terminating)
- Tell pupils to check their work in their exercise books. Tell them to correct any mistakes.
- Say:** Now you will identify some more decimal types on your own.

Independent Practice (12 minutes)

1. Write the following fractions and decimals on the board:

a) 0.22	b) $\frac{1}{6}$	c) $0.\overline{125}$
d) 9.76	e) $\frac{9}{5}$	f) $\frac{7}{9}$

- Ask pupils to classify each as either a 'terminating decimal' or a 'recurring decimal'. Tell them that if the number is written as a fraction, they must first find the decimal equivalent. Then, they can classify the type. Tell them to use correct notation to record the recurring decimals.
- Say:** I will give you 10 minutes to work.
- Set the timer for 10 minutes or use a clock or watch to mark the time.




1) Terminating	2) Recurring	3) Recurring
4) Terminating	5) Terminating	6) Recurring

- Say:** Let's check our work! (Answers: see below.)
- Say:** Good work!

Closing (3 minutes)

- Ask pupils to complete the following sentences in their exercise book:
 - 'One example of a fraction that has a terminating decimal is ____ because ____'.
 - 'One example of a fraction that has a recurring decimal is ____ because ____'.

Lesson Title: Rounding off Decimal Numbers to the Nearest Whole	Theme: Numbers and Numeration	
Lesson Number: M-08-007	Class/Level: JSS 2	Time: 35 minutes

	Learning Outcomes By the end of the lesson, pupils will be able to round off decimal numbers to the nearest whole number.		Teaching Aids None		Preparation Write notes on board (see Opening).
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Opening (4 minutes)

- Say:** Today we are going work more with decimal numbers.
- Ask:** Raise your hand if you know what 'rounding' a number means.
- Call on 2 or 3 pupils with his/her hands raised to get several responses. Accept all responses. Ask questions to clarify their ideas if needed.
- Say:** Those are all good responses. We will use this definition in our class.
- Write the following notes on the board:
 'Rounding' a number means to give an approximation.
 In other words, a rounded number is 'close to' the original, but not exactly the same.
 For example, the fraction $\frac{2}{3}$ is closer to 1 than to 0, so we might 'round' it to one.
 In maths, we can round numbers to varying degrees of precision.
 In other words, we can round to the nearest whole number, or the nearest tenth, or even the nearest hundred-millionth!
 We use a symbol to show the number has been rounded, like this:

$$\frac{2}{3} = 0.\bar{6} \approx 1$$

 The first symbol (=) shows that the fraction is equal to the repeating decimal shown. The second symbol (\approx) shows that the decimal is approximately equal to 1 (if we round to the nearest whole number).
 The wavy equal sign is the symbol for approximation.
- Say:** Please write these notes in your exercise book.
- Ask:** Are you ready to round some decimals? (Answer: Yes!)

Introduction to the New Material (8 minutes)

- Say:** Let's look at 3 decimals.
- Write the 3 decimals 1.3, 0.9, and 42.5 on the board.
- Say:** We want to round each of these decimal numbers to the nearest whole number.
 Sometimes you will hear this called 'rounding to the nearest unit'. It means the same thing: we will round to the nearest one's place in place value.
- Say:** There are 3 rules we will follow when rounding. Please write these in your exercise book.
- Write the 3 rules on the board:
 - If the digit in the tenths' place is greater than 5, then round up to the next consecutive whole number. For example, 56.7 would round to 57.
 - If the digit in the tenths' place is less than 5, then leave the whole number the same. For example, 673.2 would round to 673.

- c) If the digit in the tenths' place is equal to 5, then round up to the next consecutive whole number. For example, 1,326.5 would round to 1,327.
6. **Say:** Let's use these rules to correctly round our decimals to the nearest unit.
7. Lead pupils in applying the rules to the 3 given decimals and rounding correctly to the nearest unit. Also write the approximations on the board using the correct notation. (Answers: 1) $1.3 \approx 1$, 2) $0.9 \approx 1$, 3) $42.5 \approx 43$)
8. Some comments you may use to help pupils can include:
- 3 is in the tenths' place. 3 is less than 5. That means we leave the ones' place unchanged. Therefore, 1.3 rounds to 1.
 - 9 is in the tenths' place. 9 is greater than 5. That means we increase the ones' place by one. Therefore, 0.9 rounds to 1.
 - 5 is in the tenths' place. 5 is equal to 5. That means we increase the ones' place by one. Therefore, 42.5 rounds to 43.

Guided Practice (8 minutes)

- Say:** Let's practise rounding some more decimals to the nearest whole number.
- Write the following on the board:
Round each of the following to the nearest whole number:
a) 2.5 b) 100.4 c) 53.8
- Say:** Copy the decimals from the board. Then, underneath each one please write the correct approximation. Use your rules to help you round correctly. You will have 3 minutes to work.
- Set the timer for 3 minutes or use a watch or clock to mark the time.
- After the time is up, call on 3 pupils to come to the board and write the answers. (Answers: a) $2.5 \approx 3$, b) $100.4 \approx 100$, c) $53.8 \approx 54$)
- As each pupil writes his/her approximation, ask the following questions:
 - Ask:** Which digit is in the tenths' place?
 - Ask:** Is it greater than, less than, or equal to 5?
 - Ask:** What does that mean?
 - Ask:** What does the ones' digit become?
- Tell pupils to check their work in their exercise book. Tell them to correct any mistakes they made.
- Say:** Now you will round some more decimals on your own.

Independent Practice (12 minutes)

- Write the following on the board:
Round each decimal to the nearest unit:

1. 86.6	2. 700.8	3. 0.91
4. 9.7	5. 1,555.5	6. 19.5

- Say:** Round each decimal. Write the answers as approximations using the correct notation. Look at the rules to help you round correctly. You will have 10 minutes to work.
- Set the timer for 10 minutes or use a watch or clock to mark the time.
- Say:** Let's check our work!
- Ask 6 volunteers to come to the board and write their approximations. (Answers: See below.)




1. $86.6 \approx 87$	2. $700.8 \approx 701$	3. $0.91 \approx 1$
4. $9.7 \approx 10$	5. $1,555.5 \approx 1,556$	6. $19.5 \approx 20$

- Say:** Good work!

Closing (3 minutes)

1. Ask pupils to solve the following story problems in their exercise book:
 - a) 'I go to the store and need to pay in US Dollars. My bill is \$4.96. Will I have enough money if I only have a \$5 bill?' Explain your answer using rounding. (Answer: Yes, because 4.96 rounds to 5)
 - b) 'I go to the store and need to pay in US Dollars. My bill is \$10.50. Will I have enough money if I only have a \$10 bill?' Explain your answer using rounding. (Answer: No, because 10.5 rounds to 11)

Lesson Title: Rounding off Decimal Numbers to the Nearest Whole	Theme: Numbers and Numeration	
Lesson Number: M-08-008	Class/Level: JSS 2	Time: 35 minutes

	Learning Outcomes By the end of the lesson, pupils will be able to round off decimal numbers to a given number of decimal places.		Teaching Aids None		Preparation Place value: pupils should be able to name the place value for every digit of a given decimal number.
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Opening (6 minutes)

- Say:** Today we will work more with rounding decimal numbers.
- Ask:** Do you remember place values? If you remember, raise your hand.
- Call on 2 or 3 pupils with their hands raised. Get several responses. Put a decimal number on the board to help if needed. For example, 1.2345 (Answers should include powers of ten: tenths, hundredths, thousandths, ten-thousandths, etc.)
- Say:** Those are all correct! Today we are going to use our knowledge of place value to round decimals to a given number of decimal places.
- Say:** When rounding to a specific level of precision, it is important to read the directions. The directions will tell you what number of decimal places to use in your rounding process.
- Say:** Fortunately, this process for rounding is exactly the same as what we used in the last lesson. The only difference is that, today, we will be using different digits to round depending on the level of precision we are asked to give.
- Write the following notes on the board:
 ‘Rounding’ to a given place value is the same as rounding to a given number of decimal places. In other words, a number rounded to the nearest tenth is the same as a number rounded to 1 decimal place.
 A number rounded to the nearest hundredth is the same as a number rounded to two decimal places.
 A number rounded to the nearest thousandth is the same as a number rounded to three decimal places.
 We can round to any number of decimal places!
 We will use the same approximation symbol to show our work, like this:
 $34.567 \approx 34.57 \approx 34.6$
 This shows 2 degrees of precision. The original decimal is rounded to the nearest hundredth and the original decimal is rounded to the nearest tenth.
 Each additional place value increases the degree of precision because the approximation gets closer to the exact number.
- Say:** Please write these notes in your exercise book.
- Ask:** Are you ready to round some decimals? (Answer: Yes!)

Introduction to the New Material (6 minutes)

- Say:** Let’s look at 2 rounding problems.
- Write on the board:
 - Round 67.89346 to the nearest thousandth.

- b) Round 817.900421 to 4 decimal places.
3. Ask 2 volunteers to read each problem out loud for the class.
4. **Say:** We want to round each of these decimal numbers to the given degree of precision.
5. **Say:** When rounding to different numbers of decimal places, it is helpful to mark the digits you will use. To do this, you can underline the digit in the place value that is given. You can put a circle around the digit that is in the next smallest place value. Remember to look at the digit that follows the given place value. This is the digit that you will use to decide how to round.
6. Write the way to mark each problem on the board:
 - a) Round 67.89356 to the nearest thousandth.
 - b) Round 817.900421 to four decimal places.
7. **Say:** Let's use the rules from the last lesson to correctly round our decimals to the given number of decimal places.
8. Lead pupils in applying the rules to the given problems and rounding correctly. Write the approximations on the board using the correct notation. (Answers: 1) $67.89356 \approx 67.894$, 2) $817.900421 \approx 817.9004$)
9. Some comments you may use to help pupils can include:
 - a) 3 is in the thousandths' place so we will look at the digit in the ten-thousandths' place to see how we round. 4 is in the ten-thousandths' place. 5 is equal to 5. That means we increase the thousandths' place by one. Therefore, 67.89356 rounds to 67.894.
 - b) 4 is in the fourth decimal place, which is the ten-thousandths' place value. So we will look at the digit in the hundred-thousandths' place to see how we round. 2 is in the ten-thousandths' place. 2 is less than 5. That means we leave the ten-thousandths' place unchanged. Therefore, 817.900421 rounds to 817.9004.
10. **Say:** Write these problems and the correct answers in your exercise book. Write notes to yourself about the process of rounding to a given number of decimal places. For example, you may write notes like, "I will underline the given decimal place. I will put a circle around the next smallest digit in place value. The next smallest digit in place value is one spot to the RIGHT of the given decimal place."
11. Write these suggested notes on the board, if needed.

Guided Practice (8 minutes)

1. **Say:** Let's practise rounding some more decimals to a given place value or number of decimal places.
2. Write the following on the board:
Round each of the following to the degree of precision asked for:
 - a) Round 2.509 to two decimal places
 - b) Round 100.445 to the nearest tenth
 - c) Round 0.5555 to the nearest thousandth
3. **Say:** Copy the problems from the board. Then, mark each problem to help you know how to round as directed. Use our rules to help you round correctly. You will have 4 minutes to work.
4. Set the timer for 4 minutes or use a watch or clock to mark the time.
5. After the time is up, call on 3 pupils to come to the board and write the answers. (Answers: 1) $2.509 \approx 2.51$, 2) $100.445 \approx 100.4$, 3) $0.5555 \approx 0.556$)
6. As each pupil to write his/her approximation, ask them the following questions:
 - a) **Ask:** Which digit is in the given place value? (Ask the pupil to underline that digit)

- b) **Ask:** Which digit is in the next smallest place value? (Ask the pupil to put a circle around that digit)
 - c) **Ask:** Is it greater than, less than or equal to 5?
 - d) **Ask:** What does that mean?
 - e) **Ask:** What does the given digit become?
7. Tell pupils to check their work in their exercise book. Encourage them to correct any mistakes they may have made.
 8. **Say:** Now you will round some more decimals on your own.

Independent Practice (12 minutes)

1. Write the following on the board:

Round each of the following to the degree of precision asked for:

a) Round 186.69072 to three decimal places.
b) Round 3.9162 to the nearest hundredth
c) Round 7.0361 to two decimal places
d) Round 909.801 to the nearest unit
e) Round 14.518 to the nearest tenth

2. **Say:** Round each decimal as asked for. Write your answer as an approximation using the correct notation. Use our rules to help you round correctly. You will have 10 minutes to work.
3. Set the timer for 10 minutes or use a watch or clock to mark the time.
4. **Say:** Let's check our work!
5. Call on 5 pupils to come to the board and write their approximations. Correct answers:




a) $186.69072 \approx 186.691$
b) $3.9162 \approx 3.92$
c) $7.0361 \approx 7.04$
d) $909.801 \approx 910$
e) $14.518 \approx 14.5$

Say: Good work! Please correct your work if needed.

Closing (3 minutes)

1. Ask pupils to write 2 rounding problems of their own in their exercise books.
2. Ask pupils to solve their own problems.

Lesson Title: Introduction to Significant Figures	Theme: Numbers and Numeration	
Lesson Number: M-08-009	Class/Level: JSS 2	Time: 35 minutes

	Learning Outcomes By the end of the lesson, pupils will be able to identify significant figures in whole numbers and decimals.		Teaching Aids None		Preparation None
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Opening (5 minutes)

- Say:** Today we are going to learn a new maths word.
- Ask:** Raise your hand if you have heard the word 'significant' before.
- Choose 2 or 3 pupils with his/her hands raised and have them stand up. Ask them to tell you what they heard. If appropriate, ask them what they think the word means. Ask them to be seated once they have answered. Accept all responses. Ask questions to clarify their ideas if needed.
- Say:** Those are all good responses. In maths, sometimes we have a problem like this.
- Write on the board: What is 56.8721 to five significant figures?
- Ask:** If you saw this problem, what would you think it is asking of you?
- Say:** Stand up if you have an idea.
- Call on 2 or 3 pupils who are standing and ask them to share their thoughts. Accept all responses. Ask questions to clarify their ideas if needed.

Introduction to the New Material (7 minutes)

- Say:** Those are all good thoughts. Today we are going to learn how to answer this problem correctly. First, we need to know what is meant by a 'significant figure'.
- Write the following notes on the board:
 A 'significant figure' (sometimes also called a 'significant digit') is each of the digits of a number that are used to express it to the required degree of accuracy, starting with the first non-zero digit.
 For example, 10.23456 would be written as 10 to 2 significant digits, as 10.2 to 3 significant figures, as 10.23 to 4 significant digits, as 10.235 to 5 significant figures, and as 10.2346 to 6 significant digits.
- Say:** Please copy these notes into your exercise book. Now, answer the question from earlier.
- Call on one volunteer to give their answer. (Answer: 56.872)
- Say:** There are 3 rules that will help you figure out whether or not a digit is significant. Please write these rules in your exercise book.
- Write the following notes on the board:
 - 1) All non-zero digits are significant.
 - 2) All zeros between significant digits are significant.
 - 3) All zeros which are both to the right of the decimal point and to the right of all non-zero significant digits are themselves significant.
- Say:** Let's practise finding how many significant digits there are in a particular number.

Guided Practice (7 minutes)

- Write the following numbers on the board:
Tell how many significant figures are in each number:
1) 2.5 2) 100.4 3) 53.80
- Say:** Copy the numbers from the board. Then, underneath each one, please write the correct number of significant digits in each. Use your notes to help you. You will have 3 minutes to work.
- Set the timer for 3 minutes or use a watch or clock to mark the time.
- After the time is up, call on 3 pupils to come to the board and write the answers. (Answers: 1) 2 significant figures; 2) 4 significant figures; 3) 3 significant figures)
- Point out, if needed, in number 3 that the final 0 is not significant because it does not affect the value of the number. In other words, 53.8 is the same as 53.80 or 53.800. There are only 3 significant digits.
- Tell pupils to check their work in their exercise book. Tell them to correct any mistakes they made.
- Say:** Now I will give you a chance to practise on your own.

Independent Practice (12 minutes)

- Write the following on the board:
How many significant digits are shown for each number?

a) 86.6	b) 700.8	c) 0.91
d) 9.7	e) 1,505.5	f) 7000

- Say:** Find the number of significant digits for each number. Look at your notes to help. You will have 10 minutes to work.
- Set the timer for 10 minutes or use a watch or clock to mark the time.
- Say:** Let's check our work!
- Have 6 pupils come to the board and write their responses. (Answers: see below.)




a) 3 significant digits	b) 4 significant digits	c) 2 significant digits
d) 2 significant digits	e) 5 significant digits	f) 1 significant digit

- Say:** Good work! Please make any corrections that are needed.

Closing (4 minutes)

- Ask pupils to write 2 different numbers that meet the following requirements in their exercise book. Write these on the board:
 - 1 significant digit
 - 3 significant figures
 - 5 significant digits

Lesson Title: Introduction to Significant Figures	Theme: Numbers and Numeration	
Lesson Number: M-08-010	Class/Level: JSS 2	Time: 35 minutes

	<p>Learning Outcomes By the end of the lesson, pupils will be able to round decimal numbers to a given number of significant figures.</p>		<p>Teaching Aids None</p>		<p>Preparation None</p>
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Opening (5 minutes)

- Say:** Today we are going to use what we learned before about significant figures to round decimal numbers.
- Say:** As we saw in previous lessons, we might have to give a numerical response to different degrees of precision. There are different ways to do this. In order to know how to proceed, it is important to read the instructions. Let's look at an example.
- Write on the board:
 - What is 65.9271 to four significant digits?
 - What is 65.9271 to two decimal places?
 - What is 65.9271 to the nearest hundredth?
- Ask:** What can you say about these 3 questions?
- Say:** Stand up if you have an idea.
- Call on 2 or 3 pupils who are standing and ask them to share their thoughts. Accept all responses. Ask questions to clarify their ideas if needed.

Introduction to the New Material (7 minutes)

- Say:** Those are all good thoughts. Mathematically, all 3 of those questions will give the same answer: 65.93.
- Say:** Today we are going to round to a given number of significant digits. To do this, you will need to refer to your notes from our last lesson. Please get those out now.
- Write the following problems on the board:
 - Give 789.0355 to six significant figures
 - Round 742,396 to two significant digits
 - Round 0.07284 to three significant figures
- Say:** Please copy these problems into your exercise book.
- Say:** It is helpful to think about how many significant digits there are in the original number. Remember that 'significant digits' and 'significant figures' mean the same thing.
- Ask:** How many significant digits are there in number 1? (Answer: 7)
- Ask:** How many significant digits are there in number 2? (Answer: 6)
- Ask:** How many significant digits are there in number 3? (Answer: 4)
- Say:** In your exercise book, copy how many significant figures are given in the original number.
- Say:** Good! Now, let's use our notes and find the answers.

Guided Practice (7 minutes)

1. **Say:** In your exercise book, underneath each problem, please write the given number rounded to the correct number of significant figures. Use your notes to help you.
2. **Say:** I will give you 4 minutes to work.
3. Set the timer for 4 minutes or use a watch or clock to mark the time.
4. After the time is up, ask for 3 volunteers to come to the board and write the answers. (Answers: 1) 789.036 ; 2) 740,000 ; 3) 0.0728)
5. Point out, if needed, in number 2 that none of the zeros are significant because they are placeholders.
6. Point out, if needed, in number 3 the leading zeroes are not significant because they are placeholders.
7. Tell pupils to check their work in their exercise book. Tell pupils to correct any mistakes they may have made.
8. **Say:** Often significant figures help us make statements about the degree of accuracy of the numbers given. For example, we would say number 2 is 'accurate to' the ten-thousands' place.
9. **Say:** Now I will give you a chance to practise on your own.

Independent Practice (12 minutes)

1. Write the following on the board:

Answer the following questions:

a) The measurement 309 cm has how many significant figures?
b) The measurement 20° C has how many significant digits?
c) The measurement 0.002507 g has how many significant digits?
d) The measurement 2,500,000 kilograms has how many significant digits?
e) The measurement 22.75° C has how many significant figures?

2. **Say:** Find the number of significant digits shown for each question. Use your notes to help. You will have 10 minutes to work.
3. Set the timer for 10 minutes or use a watch or clock to mark the time.
4. **Say:** Let's check our work!
5. Have 5 volunteers come to the board and write their responses. (Answer: see below.)




a) 3 significant figures
b) 1 significant digit
c) 4 significant digits
d) 2 significant digits
e) 4 significant figures

6. **Say:** Good work! Please make any corrections that are needed.

Closing (4 minutes)

1. Ask pupils to write 2 different numbers that meet the requirements below in their exercise book. Write these on the board:
 - a) Rounds to 2 significant figures.
 - b) Rounds to 4 significant digits.

Lesson Title: Adding and Subtracting Integers and Decimals	Theme: Numbers and Numeration	
Lesson Number: M-08-011	Class/Level: JSS 2	Time: 35 minutes

 Learning Outcomes: By the end of the lesson, pupils will be able to add and subtract a mixture of integers and decimals.	 Teaching Aids None	 Preparation None
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Opening (5 minutes)

1. **Say:** Today we will practise adding and subtracting integers and decimals.
2. **Say:** Today I am going to tell you a story about how the temperature changes through one day in Sierra Leone. I want you to write down the details of the story in your exercise book. Then, I want you to tell me the temperature at the end of the story.
3. **Ask:** Are you ready to hear the story?
4. **Say:** It is still dark and the temperature is 23°C . As the sun rises, the temperature increases by 3.5° . Then, a storm comes and clouds gather. It rains and the wind blows. The rain and wind cool the air. The temperature decreases 2° . After the storm, the sun comes back out. The temperature gets 1.5° warmer.
5. **Ask:** What temperature is it at the end of the story?
6. Read the story again if needed, until the pupils get the details.
7. **Say:** Work it out and write your answer in your exercise book. I will give you 3 minutes to work.

Introduction to the New Material (10 minutes)

1. **Say:** Stand up if you have the final temperature at the end of the story.
2. Look around the room to see how many pupils are standing. Make note of those who are not to offer help to later in the lesson.
3. Call on 1 or 2 volunteers to share their answers. (Answer: 26°).
4. Tell pupils they may be seated.
5. **Say:** Stories like this about temperature allow us to practise adding and subtracting integers and decimals.
6. **Say:** Let's talk about how you found your final temperature from the story.
7. Lead a whole class discussion to find out how they solved the problem given in the story. Ask for volunteers to raise their hands to share the "next thing" they did in each step. Work each step on the board. Read the story again if needed.
 - Remind pupils how to add or subtract integers and decimals. They must line up the numbers with the same place value. Remind them to write a decimal and zero after a whole number to hold the tenths' place.

➤ The steps are below:

$$\begin{array}{r}
 23.0 \\
 + 3.5 \\
 \hline
 26.5
 \end{array}
 \rightarrow
 \begin{array}{r}
 26.5 \\
 - 2.0 \\
 \hline
 24.5
 \end{array}
 \rightarrow
 \begin{array}{r}
 1 \\
 24.5 \\
 + 1.5 \\
 \hline
 26.0
 \end{array}$$

Guided Practice (7 minutes)

- Write 2 problems on the board:
 - Sam’s father is 2 meters tall, and Sam is 0.5 meters shorter than his father. How tall is Sam?
 - Add: $26.82 + 25$
- Ask pupils to work in pairs or with fellow pupils to solve the problems.
- Walk around to check for understanding and clear misconceptions.
- Ask 2 pairs to solve the 2 problems on the board. (Answer: a. 1.5; b. 51.8; see solutions below)

$$\begin{array}{r}
 1 \\
 2.10 \\
 - 0.5 \\
 \hline
 1.5
 \end{array}
 \qquad
 \begin{array}{r}
 1 \\
 26.82 \\
 + 25.00 \\
 \hline
 51.82
 \end{array}$$




Independent Practice (10 minutes)

- Write the following problems on the board:
 - There are 550.6 g of flour in the house. The recipe calls for Bintu to use 300 g of flour. How much flour will she have left over?
 - What is $5 - 1.57$?
 - Your younger brother Sahr was 122 cm tall last year. He grew 3.8 cm. How tall is he now?
- Ask pupils to work the problems independently in their exercise books.
- Walk around to check for understanding and clear up misconceptions.
- Have 3 pupils come to the board and write their responses. (Answers: a) $550.6 - 300 = 250.6$ Bintu has 250.6 g of flour left; b) $5 - 1.57 = 3.43$; c) $122 + 3.8 = 125.8$. Sahr is now 125.8 cm tall)

Closing (3 minutes)

- Say:** Now I want you to be creative. Write your own story that includes a problem that involves addition or subtraction of integers and decimals.
- Say:** Solve the problem in your story.
- Ask pupils to write their story and the problems in their exercise book.
- Ask pupils to share their story with a fellow pupil if there is time remaining.

Lesson Title: Adding and Subtracting Fractions with Integers and Decimals	Theme: Numbers and Numeration	
Lesson Number: M-08-012	Class/Level: JSS 2	Time: 35 minutes

 Learning Outcomes: By the end of the lesson, pupils will be able to add and subtract a mixture of fractions, integers and decimals.	 Teaching Aids None	 Preparation None
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Opening (3 minutes)

- Say:** Today we are going to add and subtract a mixture of fractions, integers, and decimals.
- Write on the board: $5 - \frac{7}{5} + 2.9$
- Ask: How do you think we would solve this problem?
- Allow pupils to share their ideas and discuss how they think is the best way to solve the problem.

Introduction to the New Material (10 minutes)

- Say:** We begin by noticing that there are really two problems in one because we see two operations, subtraction and addition. Since addition and subtraction are the same in the order of operations (BODMAS), we do them in the order we come to them. In our example, we are going to subtract first.
- Write on the board: $5 - \frac{7}{5}$
- Say:** We already know how to subtract fractions so please work out this problem in your exercise book. Please look up at me when you are done.
- Ask for a volunteer to come to the board and work out the first problem. Ask all other pupils to check their work. (Answer: $5 - \frac{7}{5} = \frac{25}{5} - \frac{7}{5} = \frac{18}{5}$)
- Say:** Good! Now we can do the second problem, which is to add our result to 2.9.
- Write on the board: $\frac{18}{5} + 2.9$
- Ask:** How do you think we should add these two numbers? (Answer: Convert the improper fraction to a decimal and add decimals, OR convert the decimal to an improper fraction and add fractions.)
- Say:** In this case, converting the improper fraction to a decimal is easier because fifths are common fractions with easy decimal equivalents.
- Convert $\frac{18}{5}$ to a decimal on the board by doing the division. →
- Write on the board: $3.6 + 2.9$
- Say:** We already know how to add decimals, so please work out this problem in your exercise book. Please look up at me when you are finished.
- Ask for a volunteer to come to the board and work out the second problem. (Answer: $3.6 + 2.93 = 6.53$) Help pupils see they must align the decimal points if they need this review. →
- Say:** When operating with a mixture of fractions and decimals, it is important to convert all numbers to one type. This means you could choose to work the same problem in different ways. You could convert everything to fractions or to decimals.

$$\begin{array}{r}
 3.6 \\
 5 \overline{) 18.0} \\
 \underline{- 15} \\
 30 \\
 \underline{- 30} \\
 0
 \end{array}$$

Guided Practice (7 minutes)

1. Ask pupils to work in pairs.
2. Write another problem on the board: $4.2 + 30 - \frac{1}{5}$
3. Walk around to check for understanding and any misconceptions. For example, remind pupils to convert everything to either decimals or fractions before doing the operations.
4. Ask one pair to write their solution on the board and explain. (Answer: $4.2 + 30 - \frac{1}{5} = 34$; see solution below)

$$\begin{array}{r} 1 \\ 3.60 \\ + 2.93 \\ \hline 6.53 \end{array}$$

Convert the fraction to a decimal:

$$\begin{array}{r} 0.2 \\ 5 \overline{) 1.0} \\ - 1.0 \\ \hline 0 \end{array}$$

Do the operations:

$$\begin{array}{r} 4.2 \\ + 30.0 \\ \hline 34.2 \end{array} \rightarrow \begin{array}{r} 34.2 \\ - 0.2 \\ \hline 34.0 \end{array}$$

Independent Practice (11 minutes)

1. Write the following questions on the board:
 - a. $15 - \frac{20}{4} + 0.92$
 - b. $\frac{9}{4} + 2.08 - 4$
 - c. $1.25 + 11 - \frac{3}{10}$
2. Ask pupils to work independently to solve the problems.
3. Walk around to check for understanding and any misconceptions.
4. Ask pupils to compare their work with their fellow pupils if they finish early.
5. Have three volunteers come to the board and write their responses. (Answers: a. 10.92; b. 0.33; c. 11.95)
6. **Say:** Good work! Please make any corrections that are needed.

Closing (4 minutes)

1. Write on the board: Write a problem that:
 - a) Only includes addition and subtraction;
 - b) Includes the following numbers: 0.65, 3, and $\frac{9}{10}$.
2. Ask pupils to write such a problem in their exercise books. (Example problem: $0.65 + 3 - \frac{9}{10}$)
3. Ask pupils to solve the problem. Ask them to check the problems written by their fellow pupils if there is enough time.

Lesson Title: Multiplying and Dividing Integers and Decimals	Theme: Numbers and Numeration	
Lesson Number: M-08-013	Class/Level: JSS 2	Time: 35 minutes

Guided Practice (6 minutes)

1. Write on the board:
 - a) $18 \div 3 \times 1.6$
 - b) $8 \times 0.26 \div 4$
2. Ask pupils to work in pairs to solve the problems.
3. Monitor the pupils and offer help if needed. Give them a few minutes to work.
4. Call for 2 pairs to come work out the two problems on the board. (Answers: a) 9.6; b) 0.52)
5. **Say:** Great work! Now I will give you a chance to practise on your own.




Independent Practice (12 minutes)

1. Write on the board: Solve the following problems:
 - a) $6 \times 4.2 \div 3$
 - b) $9.2 \div 2.3 \times 0.8$
 - c) $9.69 \div 3 \times 1.5$
2. Ask pupils to work independently to solve the problems. If they finish early they can check their answers with their fellow pupils.
3. Have four pupils come to the board and work out the problems.
(Answers: a. 8.4; b. 3.2; c. 4.845)
4. **Say:** Good work! Please make any corrections that are needed.

Closing (3 minutes)

1. Write on the board: Round the answer to c to: (i) 2 decimal places (ii) 2 significant figures
2. Ask pupils to write the rounded answers to problem c in their exercise books.
3. Ask pupils to share their answers with the class and discuss. (Answer: c. (i) 2 decimal places: 4.85; 2 significant figures: 4.8)

Lesson Title: Multiplying and Dividing Fractions by Integers and Decimals	Theme: Numbers and Numeration	
Lesson Number: M-08-014	Class/Level: JSS 2	Time: 35 minutes

 Learning Outcomes: By the end of the lesson, pupils will be able to multiply and divide a mixture of fractions, integers and decimals.	 Teaching Aids None	 Preparation None
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Opening (4 minutes)

1. Write a review problem on the board: $0.5 \times 6 \div 0.1$
2. Ask pupils to solve the problem in their exercise books. Allow them to discuss in pairs if they need to.
3. Ask one pupil to write the answer on the board while others check. (Answer: $0.5 \times 6 \div 0.1 = 3 \div 0.1 = 30$)
4. **Say:** Today we are going to multiply and divide a mixture of fractions, integers, and decimals.

Introduction to the New Material (10 minutes)

1. Write on the board: $5.2 \div 8 \times \frac{2}{5}$
2. **Say:** This is the type of problem we will solve. Remember that when operating with a mixture of fractions and decimals it is important to convert all numbers to one type.
3. **Say:** This means you could choose to solve the same problem in different ways. It is up to you which conversion you want to do, to decimals or fractions.
4. **Say:** Notice that that there are really two problems in one because we see two operations, multiplication and division. Since they are the same order of operations (BODMAS), we do them in the order we come to them. In our example, we are going to divide first.
5. Write on the board: $5.2 \div 8$
6. **Say:** We already know how to divide a decimal by an integer, so please solve this problem in your exercise book. Please look up at me when you are done.
7. Ask for a volunteer to come to the board and solve the first problem. (Answer: 0.65; see work to the right)
8. **Say:** Good! Now we can do the second problem, which is to multiply our result by $\frac{2}{5}$.
9. **Ask:** How do you think we should multiply these two numbers? (Answer: Convert the fraction to a decimal and multiply decimals, OR convert the decimal to a fraction and multiply fractions.)
10. **Say:** That's right! In this case, converting the fraction to a decimal is easier because fifths are common fractions with easy decimal equivalents. So, the second problem is this.
11. Write on the board: ' 0.65×0.4 '. (Help pupils see that $\frac{2}{5} = 0.4$ by doing the division on the board if the review is necessary)

$$\begin{array}{r}
 0.65 \\
 8 \overline{) 5.20} \\
 \underline{- 48} \\
 40 \\
 \underline{- 40} \\
 0
 \end{array}$$

12. **Say:** We already know how to multiply decimals, so please solve this problem in your exercise book. Please look up at me when you are finished.

13. Ask for a volunteer to come to the board and solve the second part of the problem. (Answer: 0.26; see work to the right)

- Help pupils see they must place the decimal point in the product (with the same number of decimal places as in the problem) if they need this review.

$$\begin{array}{r}
 \overset{2}{.} \overset{2}{6} \overset{5}{5} \\
 \times \overset{0}{.} \overset{4}{4} \\
 \hline
 0 \ .2 \ 6 \ 0
 \end{array}$$

Guided Practice (7 minutes)

1. Write another problem on the board: $4.2 \div 3 \times \frac{1}{4}$
2. Ask pupils to solve the problem in pairs.
3. After a few minutes, ask the class to discuss the best way to solve the problem (they may convert to either decimals or fractions). Allow them to discuss.
4. Ask 2 pairs to write their solutions on the board. If they worked them differently, allow the class to compare them.

Answer:

With decimals: $4.2 \div 3 \times \frac{1}{4} = 1.4 \times \frac{1}{4} = 1.4 \times 0.25 = 0.35$

With fractions: $4.2 \div 3 \times \frac{1}{4} = \frac{42}{10} \div \frac{3}{1} \times \frac{1}{4} = \frac{21}{5} \times \frac{1}{3} \times \frac{1}{4} = \frac{7}{5} \times \frac{1}{4} = \frac{7}{20}$

5. **Say:** Great work! Now I will give you a chance to practise on your own.




Independent Practice (10 minutes)

1. Write the following on the board:
Answer the following questions:
a) $15 \div \frac{12}{8}$ b) $2.4 \div 4 \times \frac{1}{2}$ c) $1.25 \times 11 \div \frac{1}{4}$
2. Ask pupils to solve each problem in their exercise book. Encourage them to refer to their notes to help.
3. Walk around to check for understanding and any misconceptions.
4. Have 3 volunteers come to the board and solve the problems. (Answers: a) 10, b) 0.3 or $\frac{3}{10}$, c) 55)
5. **Say:** Good work! Please make any corrections that are needed.

Closing (4 minutes)

1. Write on the board:
Requirements:
a) Only includes multiplication and division.
b) Includes the following numbers: 0.5, 4, and $\frac{1}{5}$.
2. Ask pupils to write their own problem that meets the 2 requirements on the board.
3. Ask pupils to solve the problem they wrote in their exercise books. They may work in pairs.
(Example problem and answer: $0.5 \times 4 \div \frac{1}{5} = 10$)

Lesson Title: Story Problems with Operations on Different Number Types	Theme: Numbers and Numeration	
Lesson Number: M-08-015	Class/Level: JSS 2	Time: 35 minutes

 Learning Outcomes: By the end of the lesson, pupils will be able to: 1. Apply operations to different number types in story problems; 2. Give answers to required degree of accuracy.	 Teaching Aids None	 Preparation None
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Opening (4 minutes)

- Write a review problem on the board: $\frac{1}{2} \times 6 \div 0.25$
- Ask pupils to solve the problem in their exercise books. Allow them to discuss in pairs if they need to.
- Ask one pupil to write the answer on the board while others check. (Answer: they may solve it as a decimal or fraction:
 Decimal: $0.5 \times 6 \div 0.25 = 3 \div 0.25 = 12$
 Fraction: $\frac{1}{2} \times 6 \div \frac{1}{4} = 3 \div \frac{1}{4} = 3 \times \frac{4}{1} = 3 \times 4 = 12$)
- Say:** Today we are going to work the same type of problems, but they will be story problems.

Introduction to the New Material (10 minutes)

- Say:** I'm going to tell you a story about shopping. I want you to write down the details in your exercise book. At the end, I'm going to ask you some questions.
- Ask:** Are you ready? (Answer: Yes)
- Say:** You have $\frac{1}{2}$ cup of rice in your kitchen. You go shopping in the market and buy 3 more cups of rice. You give your sister $\frac{3}{4}$ cup of rice, and she takes it to her house.
- Read the story 1-2 more times. Make sure pupils understand and write down the details.
- Say:** Now I'm going to give you a problem to solve with those details.
- Ask:** How much rice do you have now?
- Allow pupils to solve the problem. Ask them to raise their hands when they find the answer.
- Ask one volunteer to come to the board and write the problem to be solved. (Answer: $\frac{1}{2} + 3 - \frac{3}{4}$)
- Ask a few volunteers with their hands raised to share their answer with the class. Ask them to explain how they found it and discuss.
- Ask one pupil with the correct answer to show their work on the board. (Answer: $\frac{1}{2} + 3 - \frac{3}{4} =$
 $3\frac{1}{2} - \frac{3}{4} = \frac{7}{2} - \frac{3}{4} = \frac{14}{4} - \frac{3}{4} = \frac{11}{4} = 2\frac{3}{4}$)

Guided Practice (8 minutes)

- Write 2 problems on the board:
 - You have 2 cups of sugar. You use $\frac{1}{2}$ cup in one recipe, and 0.75 cup in another recipe. How much sugar do you have now?

- b) You have 2 cups of groundnuts and your friend eats 0.45 cup. How much groundnuts do you have now?
- Say:** Work these out in pairs or threes and write your answers in your exercise book.
 - Walk around to check for understanding and any misconceptions.
 - Ask two pairs to write the answers on the board. Ask all other pupils to check their work and do corrections. (Answers: a. $2 - \frac{1}{2} - 0.75 = 2 - 0.5 - 0.75 = 1.5 - 0.75 = 0.75$ cup, OR pupils could solve it with fractions and get $\frac{3}{4}$ cup; b. $2 - 0.45 = 0.55$ cup)
 - Say:** Now I will give you a chance to practise on your own.




Independent Practice (10 minutes)

- Write the following on the board:
Answer the following questions:
 - Mitty has a 500 ml cup. She used half of the cup in a recipe. How many millilitres did she use?
 - Your neighbour Jusu was 120 cm tall the last time you saw him two years ago. He grew 0.75 cm one year, and 1.5 cm. the next. How tall is he now?
- Ask pupils to solve each problem. Encourage them to refer to their notes to help.
- Walk around to check for understanding and any misconceptions. If pupils have a difficult time writing the correct maths problem, allow them to discuss and have 2 pupils write the maths problems on the board. (Problems: a. $\frac{1}{2} \times 500$ ml; b. $120 + 0.75 + 1.5$ cm)
- Ask 2 pupils to come to the board and write the answers. (Answers: a. $\frac{1}{2} \times 500$ ml = $500 \div 2 = 250$ ml; b. $120 + 0.75 + 1.5$ cm. = $120.75 + 1.5 = 122.25$ cm)
- Say:** Good work! Please make any corrections that are needed.

Closing (3 minutes)

- Say:** Now I want you to be creative. Write your own story problem that has a mixture of decimals, fractions, and integers. Then, I want you to solve the problem in your story.
- Ask pupils to write their story problem and solve it in their exercise book.
- Ask them to check the work of their fellow pupils if there is enough time. If there is not enough time to finish solving the problem, you may ask them to do it for homework.

Lesson Title: Review the Concept and Vocabulary of Factors and Multiples	Theme: Numbers and Numeration	
Lesson Number: M-08-016	Class/Level: JSS 2	Time: 35 minutes

 Learning Outcomes By the end of the lesson, pupils will be able to identify factors and multiples of given numbers.	 Teaching Aids None	 Preparation None
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Opening (3 minutes)

- Write the number 10 on the board
- Say:** What are factors of 10?
- Write the pupils' answers on the board as they call them out. (Answers: 1, 2, 5, 10)
 - If they do not understand, ask which whole numbers exactly divide into 10, or which numbers can be multiplied by other numbers to get 10.
- Say:** What are multiples of 10?
- Write the pupils' answers on the board as they call them out. (Answers: 10, 20, 30, 40...)
 - If they do not understand, ask them to multiply numbers (1, 2, 3, ...) by 10 and write their answers on the board.
- Say:** Today, we are going to review factors and multiples.

Introduction to the New Material (14 minutes)

- Ask:** What are factors?
- Allow pupils to share ideas. (For example: These are numbers that can go into another number without a remainder.) From their ideas discuss the meaning of factors with pupils.
- Say:** If a number divides another number without a remainder, that number is a factor. 1, 2, 5, and 10 are the *factors* of 10.
- Ask:** What is a multiple?
- Allow pupils to think and share ideas. (Example answers: A multiple of a given number can be divided exactly by that number; it is a number you get when you multiply a given number by any other whole number)
- Say:** A multiple of a number is formed by multiplying it with another number. 10, 20, 30, and 40 are the *multiples* of 10.
- Say:** Each number has unlimited multiples. Let's consider more multiples of 10.
- Write on the board: Multiples of 10: 10, 20, 30, 40, 50, 60, 70, 80, 90, 100
- Say:** This list can go on forever because the multiples of 10 are unlimited.
- Say:** Here are some facts about multiples:
 - Each number is a multiple of itself.
 - Every number is a multiple of 1.
 - A multiple of a number cannot be less than the number.
 - The list of multiples of any number is infinite, meaning it can continue on and on.
- Ask:** How are factors different from multiples? Allow pupils to share ideas. (Example answers: most factors are less than the given number, while most multiples are greater than the given number; there are a certain number of factors, while multiples are infinite)

12. Write on the board: Write down all multiples of 4 greater than 10 but less than 30.
13. Discuss the question with pupils.
14. **Say:** We consider only the answers between 10 and 30, which are multiples of 4. Let's make a list, and then choose the ones between 10 and 35.
15. Ask pupils to call out the multiples of 4 and write them on the board: 4, 8, 12, 16, 20, 24, 28, 32, 36, 40
16. Ask a pupil to go to the board and circle the multiples of 4 greater than 10 but less than 30. Ask all other pupils to do the task in their exercise books. (Answer: 12, 16, 20, 24, 28)

Guided Practice (6 minutes)

1. Write on the board: Find all factors and the first 4 multiples of 50.
2. Ask pupils to solve the problems in pairs.
3. Move around the pupils to check for understanding and clear up any misconceptions.
4. Allow pairs to compare their answers.
5. Ask 2 pairs to volunteer to come to the board one at a time to present their answers. (Answers: Factors of 50: 1, 2, 5, 10, 25, 50 Multiples of 50: 50, 100, 150, 200)




Independent Practice (10 minutes)

1. Write on the board:
 - a) Find the factors of 36
 - b) Find all the multiples of 5 greater than 15 but less than 70.
2. Ask pupils to work independently to solve the problems in their exercise books.
3. Walk around the class, check whether they are working correctly in their books and clear up any misconceptions.
4. Ask pupils to exchange ideas with their fellow pupils.
5. Ask 2 volunteers to stand and list each of the 2 answers. All other pupils should check their own answers. (Answers: Factors of 36: 1, 2, 3, 4, 6, 9, 12, 18, 36; Multiples of 5: 20, 25, 30, 35, 40, 45, 50, 55, 60, 65)

Closing (2 minutes)

1. Do a brainstorm.
2. Ask pupils to discuss in pairs the differences between factors and multiples.
3. After pupils have had 1 minute to discuss, ask a couple of pairs from the back of the room to volunteer to share their ideas.

Lesson Title: Review Prime and Composite Numbers	Theme: Numbers and Numeration	
Lesson Number: M-08-017	Class/Level: JSS 2	Time: 35 minutes

 Learning Outcomes By the end of the lesson pupils will be able to identify prime and composite numbers.	 Teaching Aids None	 Preparation None
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Opening (3 minutes)

1. Write the following numbers on the board: 3, 12, 17
2. Ask pupils to find the factors of each number in their exercise books.
 - a) If necessary, remind pupils that factors are numbers that divide other numbers exactly.
3. Ask 3 volunteers to share their answers. Write their answers on the board. (Answers: 3: 1, 3; 12: 1, 2, 3, 4, 6, 12; 17: 1, 17)
4. **Say:** Some numbers have only two factors, 1 and the number, while other numbers have more factors. Today we will learn how to identify prime numbers and composite numbers.

Introduction to the New Material (10 minutes)

1. **Ask:** What are prime numbers? (Answer: They are whole numbers that have only two factors, 1 and the number itself.)
2. Ask pupils to identify the prime numbers between 0 and 25. Write their answers on the board. (Answers: 2, 3, 5, 7, 11, 13, 17, 19, 23)
3. **Say:** These on the board are prime numbers. The only numbers that can divide each of these are 1 and the number itself.
4. **Ask:** What are composite numbers? (Answer: Any whole number other than 1 that is not a prime number, meaning it has factors other than 1 and the number itself.)
5. Ask pupils to identify the composite numbers between 0 and 25. Write their answers on the board. (Answers: 4, 6, 8, 9, 10, 12, 14, 15, 16, 18, 20, 21, 22, 24, 25)
6. **Say:** These on the board are composite numbers. They have more than 2 factors.
7. Write one example of a composite on the board: 18
8. Ask pupils to call out the factors of 18. Write their answers on the board. (Answer: 18: 1, 2, 3, 6, 9, 18)
9. **Say:** 18 has 6 factors. It is a composite number because it has more factors than just 1 and itself.
10. **Say:** We could keep listing prime and composite numbers, but we are stopping at 25 for an example.

Guided Practice (10 minutes)

1. Ask pupils to work in pairs.
2. Write the following numbers on the board: 27, 31
3. **Say:** Write down all the factors of each of the numbers in your exercise book and then write if the number is prime or composite.
4. Move around the class and observe the pupils as they work.

5. Make corrections where necessary.
6. Choose 4 volunteers from 4 different pairs.
7. Ask the pupils to present their answers to the class and have the rest of the class check their answers. (Answer: Factors of 27: 1, 3, 9, 27 – composite. Factors of 31: 1, 31 – prime.)

Independent Practice (10 minutes)

1. Draw this table on the board:

Numbers	Factors	Prime or Composite
28		
37		
45		

2. Tell the pupils to work individually.
3. **Say:** Complete the 2nd column by writing down all the factors of each number.
4. **Say:** Complete the last column by writing if the number is prime or composite.




Answers:

Numbers	Factors	Prime or Composite
28	1, 2, 4, 7, 14, 28	Composite
37	1, 37	Prime
45	1, 3, 5, 9, 15, 45	Composite

Closing (2 minutes)

1. Ask the pupils a few questions for review. Allow them to share their ideas with the class.
 - a) What are prime numbers? (Example answer: prime numbers can only be divided by 1 and the number itself)
 - b) What are composite numbers? (Example answer: composite numbers can be divided by other factors in addition to 1 and the number itself)

Lesson Title: Prime Factors of Whole Numbers	Theme: Numbers and Numeration	
Lesson Number: M-08-018	Class/Level: JSS 2	Time: 35 minutes

	Learning Outcomes By the end of the lesson, pupils will be able to find the prime factors of given numbers.		Teaching Aids None		Preparation None
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Opening (3 minutes)

1. Ask a pupil to describe prime numbers in his/her own words. (Example answer: They are numbers that have only two factors, 1 and the number itself)
2. Write a list of 5 numbers on the board: 13, 8, 9, 2, 6 and tell pupils you will give them one minute to decide if they are prime or composite. Then they will volunteer to tell the class.
3. After one minute call on 5 volunteers to answer the questions. (Answers: 13 – prime, 8 – composite, 9 – composite, 2 – prime, 6 – composite)
4. **Say:** Today we will learn how to find prime factors of numbers.

Introduction to the New Material (13 minutes)

1. **Ask:** What are factors? (Answer: Factors are numbers that divide other numbers exactly.)
2. Write 24 on the board.
3. Ask a pupil to come to the board and list all the factors of 24. Ask all other pupils to complete the task in their exercise books. (Answer: 1, 2, 3, 4, 6, 8, 12 and 24)
4. **Say:** The factors of a number that are also prime numbers are referred to as 'prime factors'.
5. Ask a pupil to identify the prime numbers among the factors of 24. (Answer: 2, 3)
6. Write 54 on the board.
7. Ask a pupil to come to the board and write the factors of 54. Ask all other pupils to complete the task in their exercise books. (Answer: 1, 2, 3, 6, 9, 18, 27, 54)
8. Ask a pupil to identify the prime numbers among the factors of 54. (Answer: 2, 3)
9. **Say:** 2 and 3 are the prime factors of 54.
10. **Say:** Learning to find prime factors of numbers will help you to find the highest common factors of numbers (HCF). It will also help you to find the least common multiple (LCM) of numbers. These are used in other math topics.

Guided Practice (7 minutes)

1. Ask pupils to work in pairs.
2. Write on the board: 32 and 60
3. **Say:** Write down all the factors of 32 and 60 in your exercise book. Choose the prime factors from the factors of each number. Make a list of the prime factors.
4. Move around the class and observe the pupils as they work.
5. Make corrections where necessary.
6. Choose a boy from one pair and a girl from another pair.
7. Ask the boy and the girl to present their answers to the class. (Answer: Factors of 32: 1, 2, 4, 8, 16, 32. Prime factors of 32: 2; Factors of 60: 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30, 60. Prime factors of 60: 2, 3, 5)

Independent Practice (10 minutes)

1. Draw this table on the board:

Numbers	Factors	Prime factors
33		
45		
72		

2. Tell the pupils to work individually.
3. **Say:** Complete the 2nd column by writing down all the factors of each number.
4. **Say:** Complete the last column by writing the prime factors among the factors you have listed.
5. Move around the class and observe the pupils as they work.
6. Make corrections where necessary.




Answers:

Numbers	Factors	Prime factors
33	1, 3, 11, 33	3, 11
45	1, 3, 5, 9, 15, 45	3, 5
72	1, 2, 3, 4, 6, 8, 9, 12, 18, 24, 36, 72	2, 3

Closing (2 minutes)

1. Check for proper understanding of the concept of prime factors.
2. **Ask:** What is the difference between factors and prime factors?
3. Ask pupils to discuss the difference with their peers. Ask one pair to share the difference.
(Answer: Factors are any number that can be multiplied to get a given number, prime factors are prime numbers that are factors of a given number.)

Lesson Title: Calculating the Least Common Multiple (LCM)	Theme: NumberS and Numeration	
Lesson Number: M-08-019	Class/Level: JSS 2	Time: 35 minutes

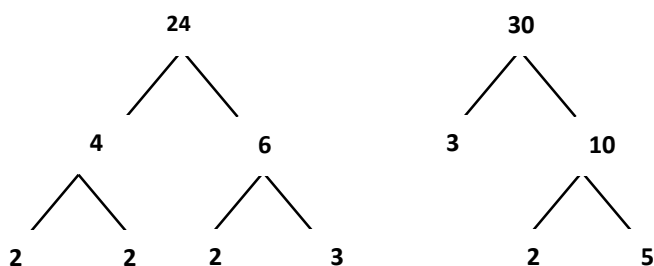
 Learning Outcomes By the end of the lesson, pupils will be able to find the least common multiple (LCM) of given numbers using prime factorisation.	 Teaching Aids None	 Preparation None
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Opening (5 minutes)

- Ask:** What is the meaning of the word multiple? (Example answer: When you multiply a given whole number by any other whole number, the result is a multiple of that number.)
- Ask:** What are the first five multiples of 6? (Answer: 6, 12, 18, 24, 30)
- Write their answers on the board.
- Say:** Please copy the answers into your exercise book.
- Ask:** What are the first six multiples of 10? (Answer: 10, 20, 30, 40, 50, 60)
- Write their answers on the board.
- Say:** Please copy the answers into your exercise book.
- Ask:** What is the first common multiple between 6 and 10. (Answer: 30)
- Say:** Today, we will learn how to identify the least common multiple (LCM), the smallest multiple that both numbers share. We will use the prime factors we found in the last lesson to help us today.

Introduction to the New Material (10 minutes)

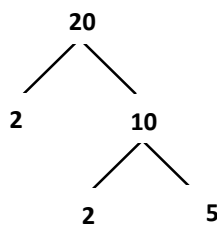
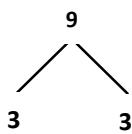
- Write: Find the least common multiple (LCM) of 24 and 30.
- Say:** We are going to use the prime factorisation method in finding the LCM of 24 and 30.
- Explain the steps to find the prime factors of numbers with a factor tree:
 - Write down the numbers.
 - Underneath, write two numbers you multiply to get the number at the top.
 - Continue until you don't have any composite numbers. When you come to a prime number, the branch stops there.
- Find the prime factors of 24 and 30 on the board:



24: 2, 2, 2, 3
 30: 2, 3, 5

- Explain how to find the LCM of 24 and 30 from the factor tree:

- Say:** Look at the prime factors. We want to use them all, but we don't need to use factors twice if they occur in both trees.
 - Say:** The maximum number of times the prime factor 2 occurs is 3 times. This is for 24 and 30. The prime factor 3 occurs once on each list of factors, so we will count it once. The prime factor 5 only occurs once. We will list these together.
 - List these prime factors on the board: 2, 2, 2, 3, 5.
 - Say:** The product of these prime factors is the LCM.
 - Write on the board: $2 \times 2 \times 2 \times 3 \times 5 = 120$.
 - Say:** The LCM of 24 and 30 is 120.
6. Write: Find the LCM of 9 and 20.
7. **Say:** Use the same procedure I showed you earlier in the lesson to write out the factors:

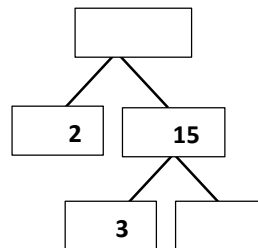
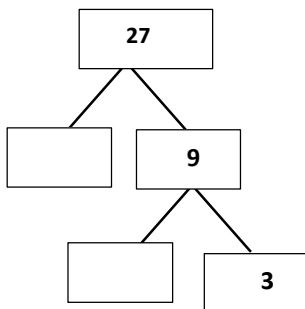


9: 3, 3
20: 2, 2, 5

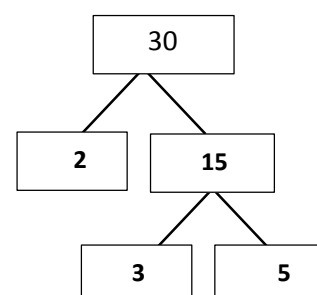
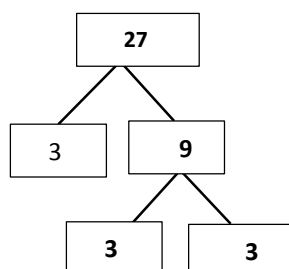
- Say:** There are no duplicate factors between the prime factors of 9 and 20. So we will look at the product of all the factors we listed.
- Say:** The product of the prime factors is the LCM.
- Write: $2 \times 2 \times 3 \times 3 \times 5 = 180$.
- Say:** The LCM of 9 and 20 is 180.

Guided Practice (9 minutes)

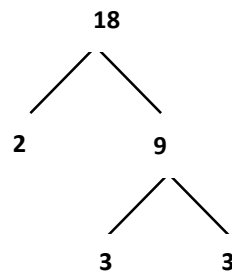
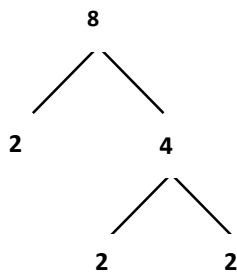
- Write the problem below on the board:



- Say:** Please fill in the blanks and find the LCM in your exercise book.
- Ask:** Who would like to come to the board to fill in one of the blank spaces?
- Call on pupils with hands raised to come to the board one at a time and fill in a blank space on the factor tree.
- Say:** Please check and make sure you have the correct answers written down. (Answer: 27: $3 \times 3 \times 3$; 30: $2 \times 3 \times 5$; LCM = $2 \times 3 \times 3 \times 3 \times 5 = 270$)



6. Write: Find the LCM of 8 and 18.
7. **Say:** Please work in pairs to solve the problem I have written on the board.
8. Walk around the room and assist pupils when needed.
9. **Ask:** Who would like to answer the problem on the board with their partner?
10. Call on a pair with hands raised to write the answer to the problem on the board.



$$8: 2 \times 2 \times 2$$

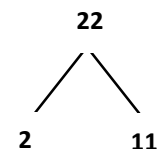
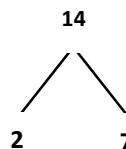
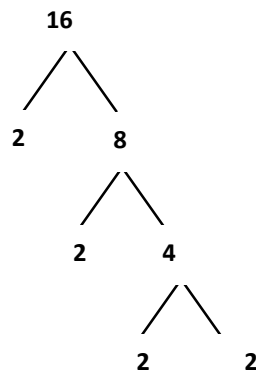
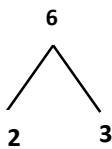
$$18: 2 \times 3 \times 3$$

$$\text{LCM} = 2 \times 2 \times 2 \times 3 \times 3 = 72$$

Independent Practice (10 minutes)

1. Write:
 - a) Find the LCM of 6 and 16.
 - b) Find the LCM of 14 and 22.
2. **Say:** Solve the problems on your own in your exercise book.
3. Walk around the room and assist pupils when needed.
4. **Say:** Please exchange exercise books with a partner and check their answers.

Answers:



a) $6: 2 \times 3$

$$16: 2 \times 2 \times 2 \times 2$$

$$\text{LCM} = 2 \times 2 \times 2 \times 2 \times 3 = 48$$

b) $14: 2 \times 7$




$$22: 2 \times 11$$

$$\text{LCM} = 2 \times 7 \times 11 = 154$$

Closing (1 minute)

1. **Ask:** What is the Least Common Multiple (LCM)? (Example answer: The smallest multiple that both numbers share.)
2. **Say:** Today we learned how to find the Least Common Multiple (LCM). In our next lesson we will learn how to find the Highest Common Factor (HCF).

Lesson Title: Calculating the Highest Common Factor (HCF)	Theme: Numbers and Numeration	
Lesson Number: M-08-020	Class/Level: JSS 2	Time: 35 minutes

 Learning Outcomes By the end of the lesson, pupils will be able to find the highest common factor (HCF) of given numbers using prime factorisation.	 Teaching Aids None	 Preparation None
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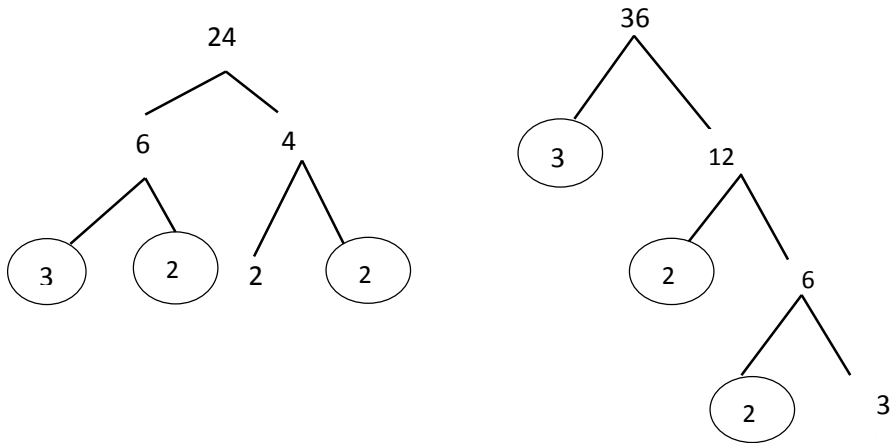
Opening (4 minutes)

- Ask:** What are factors? (Example answers: Numbers that divide another number exactly; numbers that are multiplied together to get a product.)
- Ask:** What are common factors? (Example answer: When two or more numbers have the same factor, that factor is called a common factor.)
- Write: Find all the common factors of 8 and 20.
- Ask:** What are the factors of 8? (Answers: 1, 2, 4, 8)
- Write pupil responses on the board.
- Ask:** What are the factors of 20? (Answers: 1, 2, 4, 5, 10, 20)
- Write pupil responses on the board.
- Ask:** What are the common factors of 8 and 20?
- Circle the common factors on the board as pupils state them: ①, ②, ④
- Say:** Today we will learn how to find the Highest Common Factor (HCF) of numbers. This will help us when we are simplifying fractions.

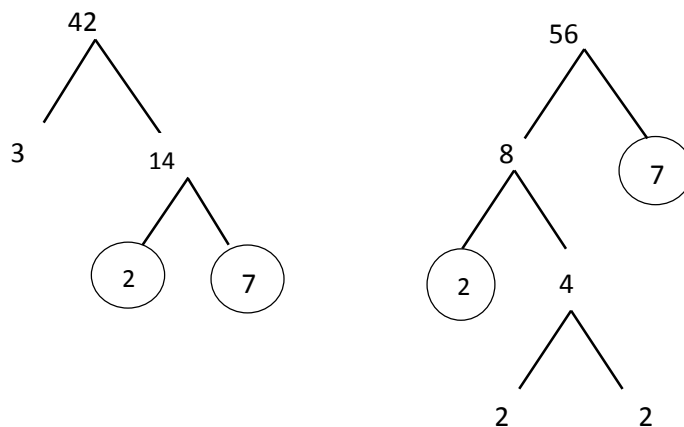
Introduction to the New Material (12 minutes)

- Say:** The HCF of two (or more) numbers is the largest number that divides evenly into both numbers. HCF is the largest of all the common factors.
- Say:** Look at the list of common factors of 8 and 20. Which of these common factors is the largest? (Answer: 4)
- Say:** Therefore the HCF of 8 and 20 is 4.
- Say:** To find the HCF of larger numbers, we use the factor tree.
- Write: Find the HCF of 24 and 36.
- Use the factor tree method to find the HCF of 24 and 36 on the board (see below). As you work on the problem, explain the steps below to the pupils.
- Explain the steps to follow in using the factor tree method to find the HCF of numbers:
 - Write down the two numbers.
 - Choose one of your two numbers and underneath, write two numbers that when multiplied together equal that number.
 - Choose one of the two new numbers and write two more numbers that when multiplied together equal that number.
 - Continue this process until you don't have any composite numbers. When you come to a prime number, the branch stops there.

- e) Repeat the process with the other original number until you don't have any composite numbers and your branches do not go any farther.
- f) Circle the prime factors that the two original numbers have in common.
- g) Multiply the common prime factors of each original number to get the HCF.



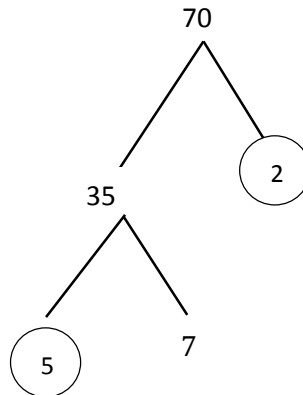
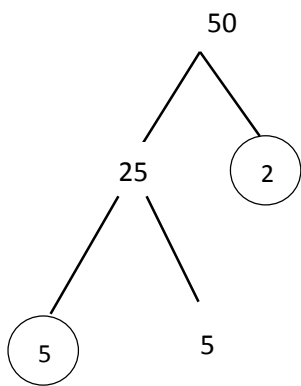
- 10. Write: HCF of 24 and 36: $2 \times 2 \times 3 = 12$.
- 11. **Say:** Therefore the HCF of 24 and 36 is 12.
- 12. Write: Find the HCF of 42 and 56.
- 13. Follow the steps above to get the HCF.
- 14. At each stage of the process, give the two factors that when multiplied together equal the number above them.



- 15. Write on the board: The HCF of 42 and 56: $2 \times 7 = 14$.
- 16. **Say:** Therefore the HCF of 42 and 56 is 14.

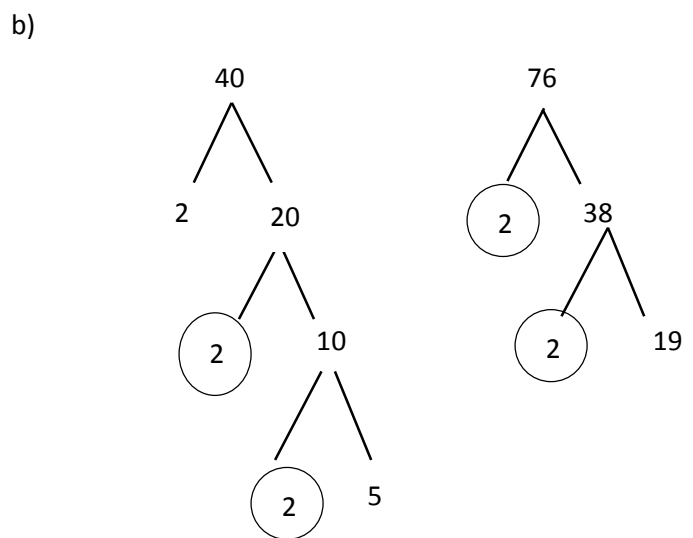
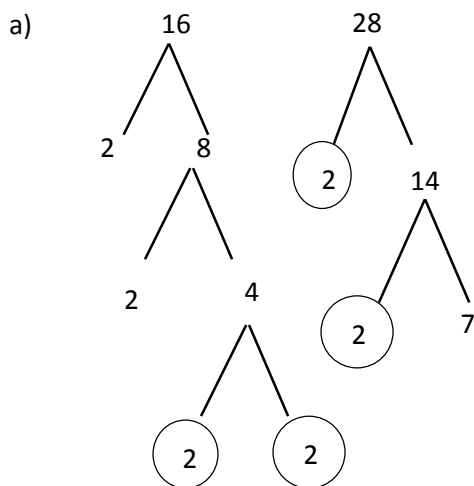
Guided Practice (7 minutes)

- 1. Write: Use the factor tree to find the HCF of 50 and 70.
- 2. Guide the pupils through using the factor tree to find the HCF of 50 and 70.



Independent Practice (10 minutes)




- Write: Use a factor tree to find the HCF of:
 - 16 and 28
 - 40 and 76
- Say:** Work on your own to solve the problems on the board in your exercise book.
- Walk around the room and assist pupils when needed.
- Say:** Exchange books with the pupil next to you and compare answers.
- Ask:** Who would like to come to the board and solve the problems?
- Choose one boy and one girl with hands raised (Answers: a) $2 \times 2 = 4$; b) $2 \times 2 = 4$)



Closing (2 minutes)

- Write:
 - Today I learned that an HCF is _____. (Example answer: HCF is the largest factor among the common factors of the numbers.)
 - Today I learned how to find the HCF of two or more numbers by _____. (Example answers: Using prime factorisation; finding all the factors of a number and multiplying the common prime factors to get the HCF.)
- Ask:** Who would like to share their answers?
- Call on pupils with hands raised to share.

Lesson Title: Index Notation	Theme: Numbers and Numeration	
Lesson Number: M-08-021	Class/Level: JSS 2	Time: 35 minutes

 <p>Learning Outcomes By the end of this lesson, pupils will be able to:</p> <ol style="list-style-type: none"> 1. Identify the index and base in index notation. 2. Identify that the index indicates the number of times the base is multiplied by itself. 3. Identify that any integer raised to the power of one gives itself ($a^1 = a$). 	 <p>Teaching Aids None</p>	 <p>Preparation None</p>
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Opening (5 minutes)

1. Write on the board:
Express the following equations in index notation:
 $2 \times 2 =$
 $2 \times 2 \times 2 =$
 $2 \times 2 \times 2 \times 2 =$
2. **Say:** Think about the problems on the board for a moment and write the answers in your exercise book.
3. **Ask:** How do we write the first equation in index notation? (Answer: $2 \times 2 = 2^2$)
4. **Ask:** How do we write the second equation in index notation? (Answer: $2 \times 2 \times 2 = 2^3$)
5. **Ask:** How do we write the third equation in index notation? (Answer: $2 \times 2 \times 2 \times 2 = 2^4$)
6. **Say:** These numbers are all written in index notation. Today we will review index notation.

Introduction to the New Material (6 minutes)

1. **Say:** Remember that numbers are written in index notation when there is a power.
2. Point to 2^2 on the board.
3. **Say:** This is read as two squared or two to the second power.
4. Point to 2^3 on the board.
5. **Say:** This is read as two cubed or two to the third power.
6. Point to 2^4 on the board.
7. **Say:** This is read as two to the fourth power.
8. Write on the board: Simplify $7 \times 7 \times 7 \times 7 \times 7$
9. **Say:** This is in expanded form.
10. **Say:** This is 7 to the fifth power.
11. Write: 7^5
12. Label the base (7) and the index (5) on the board. \rightarrow Base $\rightarrow 7^5 \leftarrow$ Index
13. **Say:** The bottom number is the 'base' and it is written bigger than the other number. The smaller, raised number is called the 'index'. 'Index' is another way to say 'power'.

Guided Practice (12 minutes)

1. **Say:** We will work on the next problems together.
2. Write: Simplify $3 \times 3 \times 3 \times 3 \times 3 \times 3$
3. **Say:** Write this equation in your exercise book and simplify.
4. **Ask:** What is the answer? (Answer: 3^6)
5. Write: 3^6
6. **Say:** This is three to the sixth power as the base is three and the base is multiplied 6 times.
7. **Say:** It can also be read as three to the power six.
8. **Ask:** What is the base? (Answer: 3)
9. **Ask:** What is the index? (Answer: 6)
10. Write: Expand 4^5
11. **Say:** This example is in index form.
12. **Say:** Write the answer in expanded form in your exercise book.
13. **Ask:** What is the expanded form? (Answer: $4^5 = 4 \times 4 \times 4 \times 4 \times 4$)
14. Write: $4^5 = 4 \times 4 \times 4 \times 4 \times 4$
15. Write: Expand 5^1
16. **Say:** Think about this for a moment and write down the answer in your exercise book.
17. **Ask:** What is the answer? (Answer: 5)
18. **Say:** Any base raised to an index of 1 simply gives the base as the answer.
19. Write on the board: $5^1 = 5$
20. Write: $a^1 = a$
21. **Say:** This rule is true for any number a .
22. Write: Simplify: $12 \times 12 \times 12 \times 12$
23. **Say:** Please simplify in your exercise book.
24. **Ask:** What is the answer? ($12 \times 12 \times 12 \times 12 = 12^4$)
25. Write: $12 \times 12 \times 12 \times 12 = 12^4$
26. **Say:** Here is the last one we will do together.
27. Write: Simply: $2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2$
28. **Ask:** What is the answer? (Answer: $2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 = 2^8$)
29. Write: $2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 = 2^8$

Independent Practice (10 minutes)

1. Write the following problems on the board:
Simplify the following: (a) $6 \times 6 \times 6$ (b) $7 \times 7 \times 7 \times 7 \times 7 \times 7$ (c) $11 \times 11 \times 11 \times 11$
Expand the following: (d) 8^5 (e) 21^4 (f) 130^1
2. **Say:** Solve the problems on your own in your exercise books.
3. Walk around the room and assist pupils when needed.
4. **Say:** When you are finished you may compare answers with a partner.
5. **Ask:** What is the answer for problem a? (Answer: 6^3)
6. Write: 6^3
7. **Ask:** What is the answer for problem b? (Answer: 7^6)
8. Write: 7^6
9. **Ask:** What is the answer for problem c? (Answer: 11^4)
10. Write: 11^4




11. **Ask:** What is the answer for problem d? (Answer: $8 \times 8 \times 8 \times 8 \times 8$)
12. Write: $8 \times 8 \times 8 \times 8 \times 8$
13. **Ask:** What is the answer for problem e? (Answer: $21 \times 21 \times 21 \times 21$)
14. Write: $21 \times 21 \times 21 \times 21$
15. **Ask:** What is the answer for problem f? (Answer: 130)
16. Write: 130

Closing (5 minutes)

1. Write a challenging problem on the board: Simplify $2 \times 2 \times 2 + 3 \times 3 \times 3 \times 3 + 4 \times 4$
2. Ask pupils to think about the problem alone before working with a partner to find the answer.
3. Ask a pair to come to the board and share their answer. (Answer: $2^3 + 3^4 + 4^2$)
4. **Say:** We can't add two indices with different bases. We cannot simplify the expression any further.

Lesson Title: Index Law 1: Multiplication of Indices	Theme: Numbers and Numeration	
Lesson Number: M-08-022	Class/Level: JSS 2	Time: 35

minutes

 <p>Learning Outcomes By the end of the lesson, pupils will be able to:</p> <ol style="list-style-type: none"> 1. Identify that $a^m \times a^n = a^{m+n}$ 2. Multiply two or more indices 	 <p>Teaching Aids None</p>	 <p>Preparation None</p>
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Opening (3 minutes)

1. Write: $2^2 \times 2$
2. **Ask:** How can we rewrite this in expanded form? (Answer: $2^2 \times 2 = 2 \times 2 \times 2$)
3. Write on the board: $2^2 \times 2 = 2 \times 2 \times 2$
4. **Say:** Here is the equation in expanded form. Now I will rewrite it in index notation.
5. Write: $2 \times 2 \times 2 = 2^3$
6. **Say:** Today's topic is multiplying two or more indices.

Introduction to the New Material (11 minutes)

1. Write: Simplify: $3^2 \times 3^4$
2. **Say:** Let's simplify by writing out the expanded form of each index.
3. Write: $3^2 \times 3^4 = 3 \times 3 \times 3 \times 3 \times 3 \times 3 = 3^6$
4. **Say:** When multiplying two indices with the same base, simply add the powers. This is the first law of indices. In the problem, we see powers of 2 and 4. We can simply add them together to get the 6 in the answer.
5. Write the first law of indices on the board: $a^m \times a^n = a^{m+n}$
6. **Say:** m and n are the powers of a , and a is the base. This rule *only* works if two bases are the same.
7. **Say:** Please copy this law of indices into your exercise book.
8. Write: $4^3 \times 4^2 \times 4^4$
9. **Say:** The base for this problem is 4.
10. **Say:** The powers are 3, 2, and 4.
11. **Say:** The first law of indices also applies to multiplying more than 2 indices. We simply add all of the powers together.
12. Write the solution on the board and explain aloud: $4^3 \times 4^2 \times 4^4 = 4^{3+2+4} = 4^9$

Guided Practice (9 minutes)

1. We will work on the next problems together.
2. Write: $12 \times 12^3 \times 12^2$
3. **Ask:** What are the 3 powers in this problem? (Answer: 1, 3, and 2.)
4. **Say:** Remember that if there is a number written without a power, the power is actually 1.
5. **Say:** Solve the problem in your exercise book.
6. **Ask:** What is the answer? (Answer: 12^6)
7. Write: $12 \times 12^3 \times 12^2 = 12^{1+3+2} = 12^6$

8. **Say:** The base stays the same and the powers are added together.
9. **Say:** You can use this law to solve many different math problems involving indices.
10. Write: $4^2 \times 4$
11. **Say:** Simplify in your exercise book and leave your answer in index form.
12. **Ask:** What is the answer? (Answer: 4^3)
13. Write: $4^2 \times 4 = 4^2 \times 4^1 = 4^{2+1} = 4^3$
14. **Say:** Let's try one more.
15. Write: $2^3 \times 2^{14}$
16. **Say:** Simplify in your exercise book and leave your answer in index form.
17. **Ask:** What is the answer? (Answer: 2^{17})
18. Write: $2^3 \times 2^{14} = 2^{3+14} = 2^{17}$




Independent Practice (10 minutes)

1. Write on the board: Simplify the following. Leave your answer in index form:
 (a) $30^4 \times 30^2$ (b) $5^2 \times 5 \times 5^4$ (c) $8^{12} \times 8^{50}$ (d) $7^3 \times 7^5 \times 7^8$
2. **Say:** Work on your own and write your answers in your exercise book.
3. Walk around the room and assist pupils when needed.
4. **Ask:** Who would like to simplify problem a on the board? (Answer: $30^4 \times 30^2 = 30^{4+2} = 30^6$)
5. Call on a pupil with hand raised to simplify problem a on the board.
6. **Ask:** Who would like to simplify problem b on the board? (Answer: $5^2 \times 5 \times 5^4 = 5^{2+1+4} = 5^7$)
7. Call on a pupil with hand raised to simplify problem b on the board.
8. **Ask:** Who would like to simplify problem c on the board? (Answer: $8^{12} \times 8^{50} = 8^{12+50} = 8^{62}$)
9. Call on a pupil with hand raised to simplify problem c on the board.
10. **Ask:** Who would like to simplify problem d on the board? (Answer: $7^3 \times 7^5 \times 7^8 = 7^{3+5+8} = 7^{16}$)
11. Call on a pupil with hand raised to simplify problem d on the board.

Closing (2 minutes)

1. **Ask:** How do you multiply two indices with the same base? (Answer: Add the powers.)
2. **Say:** Today you learnt how to multiply two or more indices.
3. **Say:** In the next lesson you will learn how to divide two or more indices.

Lesson Title: Index Law 2: Division of Indices	Theme: Numbers and Numeration	
Lesson Number: M-08-023	Class/Level: JSS 2	Time: 35 minutes

	Learning Outcomes By the end of the lesson pupils will be able to: 1. Identify that $a^m \div a^n = a^{m-n}$ 2. Divide two or more indices		Teaching Aids None		Preparation None
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Opening (2 minutes)

1. Write: Simplify $5^5 \times 5^2 \times 5$
2. **Say:** Turn to a partner and talk about the problem.
3. **Ask:** What is the answer? (Answer: $5^5 \times 5^2 \times 5 = 5^{5+2+1} = 5^8$)
4. **Say:** The topic today is dividing two indices.

Introduction to the New Material (8 minutes)

1. Write: $3^5 \div 3^2$
2. **Say:** We can rewrite division problems as fractions: $3^5 \div 3^2 = \frac{3^5}{3^2}$
3. Expand each index on the board: $3^5 \div 3^2 = \frac{3^5}{3^2} = \frac{3 \times 3 \times 3 \times 3 \times 3}{3 \times 3}$
4. **Say:** This is the problem in expanded form.
5. **Say:** We can cancel two 3s from the numerator and two 3s from the denominator.
6. Show pupils the 3s that can be cancelled: $3^5 \div 3^2 = \frac{3^5}{3^2} = \frac{\textcircled{3} \times \textcircled{3} \times 3 \times 3 \times 3}{\textcircled{3} \times \textcircled{3}}$
7. **Say:** This leaves $3 \times 3 \times 3$.
8. Write: $3^5 \div 3^2 = \frac{3^5}{3^2} = \frac{\textcircled{3} \times \textcircled{3} \times 3 \times 3 \times 3}{\textcircled{3} \times \textcircled{3}} = \frac{3 \times 3 \times 3}{1} = 3 \times 3 \times 3 = 3^3$
9. **Say:** When we divide two indices, we subtract the powers to get the answer. This is the second law of indices.
10. Write the second law of indices on the board: $a^m \div a^n = a^{m-n}$
11. **Say:** Please copy this law of indices into your exercise book.
12. **Say:** m and n are the powers of a , and a is the base. This rule only works if two bases are the same.
13. Write: $9^{10} \div 9^2 \div 9^3$
14. **Say:** The second law of indices also applies to dividing more than 2 indices. We simply subtract each of the powers of the indices we are dividing by.
15. Write the solution on the board and explain aloud: $9^{10} \div 9^2 \div 9^3 = 9^{10-2-3} = 9^5$

Guided Practice (12 minutes)

1. **Say:** Now let's do some together.
2. Write: $7^3 \div 7$
3. **Ask:** How do I solve this problem? (Answer: Subtract the indices.)
4. Write: $7^3 \div 7 = 7^3 \div 7^1 = 7^{3-1} = 7^2$
5. **Say:** Remember that $7 = 7^1$.

6. **Say:** Please work in pairs to solve the next problems.
7. Write: Simplify.
 (a) $12^5 \div 12$ (b) $8^{36} \div 8^{12}$ (c) $2^9 \div 2^6 \div 2^2$
8. Walk around the room and assist pupils when needed.
9. **Ask:** Who would like to come to the board with their partner and simplify problem a? (Answer: $12^5 \div 12 = 12^{5-1} = 12^4$)
10. Call on a pair of pupils with hands raised to simplify problem a on the board.
11. **Ask:** Who would like to come to the board with their partner and simplify problem b? (Answer: $8^{36} \div 8^{12} = 8^{36-12} = 8^{24}$)
12. Call on a pair of pupils with hands raised to simplify problem b on the board.
13. **Ask:** Who would like to come to the board with their partner and simplify problem c? (Answer: $2^9 \div 2^6 \div 2^2 = 2^{9-6-2} = 2^1 = 2$)
14. Call on a pair of pupils with hands raised to simplify problem c on the board.




Independent Practice (10 minutes)

1. Write: a) $20^4 \div 20$ b) $\frac{13^6}{13^3}$ c) $3^{15} \div 3^3 \div 3^2$
2. **Say:** Please work on your own to simplify the problems. Write the answers in your exercise book.
3. Walk around the room and assist pupils when needed.
4. **Ask:** Who would like to come to the board and simplify problem a? (Answer: $20^4 \div 20 = 20^{4-1} = 20^3$)
5. Call on a pupil with hand raised to simplify problem a on the board.
6. **Ask:** Who would like to come to the board and simplify problem b? (Answer: $\frac{13^6}{13^3} = 13^{6-3} = 13^3$)
7. Call on a pupil with hand raised to simplify problem b on the board.
8. **Ask:** Who would like to come to the board and simplify problem c? (Answer: $3^{15} \div 3^3 \div 3^2 = 3^{15-3-2} = 3^{10}$)
9. Call on a pupil with hand raised to simplify problem c on the board.

Closing (3 minutes)

1. Write: $4^5 \div 4^? = 4^2$
2. **Ask:** What is the missing power? (Answer: 3)
3. **Say:** The missing power is 3 because $5 - 3 = 2$

Lesson Title: Index Law 3: Power of Zero	Theme: Numbers and Numeration	
Lesson Number: M-08-024	Class/Level: JSS 2	Time: 35 minutes

	Learning Outcomes By the end of the lesson, pupils will be able to identify that any integer raised to the power of zero equals one ($a^0 = 1$).		Teaching Aids None		Preparation None
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Opening (5 minutes)

- Write: Simplify a) $2^{25} \div 2^{15}$ b) $13^7 \times 13^{21}$
- Say:** Please work on these problems with a partner.
- Ask:** Who would like to come to the board with their partner and solve problem a? (Answer: $2^{25} \div 2^{15} = 2^{25-15} = 2^{10}$)
- Call on a pair of pupils with hands raised to solve problem a on the board.
- Ask:** Who would like to come to the board with their partner and solve problem b? (Answer: $13^7 \times 13^{21} = 3^{7+21} = 3^{28}$)
- Call on a pair of pupils with hands raised to solve problem b on the board.
- Say:** Today we will look at another law of indices. The third law says that any number raised to the power of zero equals one.

Introduction to the New Material (7 minutes)

- Write on the board: 3^0
- Say:** Three to the power zero means we multiply 3 by itself zero times. This gives us 1.
- Write on the board: $3^0 = 1$
- Say:** To understand why this is 1, let's solve another problem.
- Write on the board: $3^2 \div 3^2$
- Say:** We can use the second law of indices to solve this problem.
- Write:** $3^2 \div 3^2 = 3^{2-2} = 3^0$
- Say:** Another way to write 3 squared is 9.
- Write on the board: $3^2 \div 3^2 = 9 \div 9$
- Say:** 9 divided by 9 is 1 as any number divided by itself is 1.
- Write: $3^0 = 3^2 \div 3^2 = 9 \div 9 = 1$
- Say:** This is why any number raised to the power zero will always be equal to 1.
- Write the general statement on the board: $a^0 = 1$
- Say:** This is the third law of indices.
- Say:** Please copy the third law of indices into your exercise book.

Guided Practice (11 minutes)

- Say:** Let's work together to solve the next problems.
- Write: Simplify 5^0
- Say:** Write the problem in your exercise book and solve.
- Ask:** What is the answer? (Answer: $5^0 = 1$)

5. Write: Simplify 125^0
6. **Say:** Write the problem in your exercise book and solve.
7. **Ask:** What is the answer? (Answer: $125^0 = 1$)
8. **Say:** In both problems the answer is 1.
9. **Say:** Please work in pairs to solve the next problems.
10. Write and ask pupils to solve these problems:
a) 36^0 b) $8^{31} \div 8^{31}$ c) $4^{10} \div 4^6 \div 4^4$
11. Walk around the room and assist pupils when needed.
12. **Ask:** Who would like to come to the board with their partner and solve problem a? (Answer: $36^0 = 1$)
13. Call on a pair of pupils with hands raised to solve problem a on the board.
14. **Ask:** Who would like to come to the board with their partner and solve problem b? (Answer: $8^{31} \div 8^{31} = 8^{31-31} = 8^0 = 1$)
15. Call on a pair of pupils with hands raised to solve problem b on the board.
16. **Ask:** Who would like to come to the board with their partner and solve problem c? (Answer: $4^{10} \div 4^6 \div 4^4 = 4^{10-6-4} = 10^0 = 1$)
17. Call on a pair of pupils with hands raised to solve problem c on the board.
18. **Say:** We were able to use our knowledge of indices to reduce each problem to a number with a power of zero. All of the answers were 1.




Independent Practice (10 minutes)

1. Write on the board: a) $7^4 \div 7^0$ b) $\frac{2^8}{2^8}$ c) $2^8 \times 2^3 \times 2^0$
2. **Say:** Please work on your own to simplify the problems. Write the answers in your exercise book.
3. Walk around the room and assist pupils when needed.
4. **Ask:** Who would like to come to the board and simplify problem a? (Answer: $7^4 \div 7^0 = 7^4 \div 1 = 7^4$ or $7^4 \div 7^0 = 7^{4-0} = 7^4$)
5. Call on a pupil with hand raised to simplify problem a on the board.
6. **Ask:** Who would like to come to the board and simplify problem b? (Answer: $\frac{2^8}{2^8} = 2^{8-8} = 2^0 = 1$)
7. Call on a pupil with hand raised to simplify problem b on the board.
8. **Ask:** Who would like to come to the board and simplify problem c? (Answer: $2^8 \times 2^3 \times 2^0 = 2^{8+3+0} = 2^{11}$)
9. Call on a pupil with hand raised to simplify problem c on the board.

Closing (2 minutes)

1. Write on the board: $2^3 \div 2^? = 1$
2. **Ask:** What is the missing power? (Answer: 1)
3. **Say:** The missing power is 3 because that would give $2^3 \div 2^3 = 2^{3-3} = 2^0 = 1$

Lesson Title: Index Law 4: Power of Zero	Theme: Numbers and Numeration	
Lesson Number: M-08-025	Class/Level: JSS 2	Time: 35 minutes

	Learning Outcomes By the end of the lesson, pupils will be able to: 1. Identify that $(a^m)^n = a^{mn}$ 2. Apply an additional power to an index		Teaching Aids None		Preparation None
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Opening (4 minutes)

1. Write: Simplify $22^5 \div 22^5$
2. **Say:** Please work on this problem with a partner.
3. **Ask:** Who would like to come to the board with their partner and simplify this problem?
(Answer: $22^5 \div 22^5 = 22^{5-5} = 22^0 = 1$)
4. Call on a pair of pupils with hands raised to simplify problem a on the board.
5. **Say:** Remember that any number raised to a power of zero equals one.
6. **Say:** Today we will look at another law of indices. The fourth law is about raising an index to another power.

Introduction to the New Material (7 minutes)

1. Write: $(2^3)^2$
2. **Say:** This says that the index “two cubed” is raised to the power 2. In other words, 2 cubed is multiplied by itself.
3. Write: $(2^3)^2 = 2^3 \times 2^3$
4. **Say:** We will use the rule for multiplying indices to simplify this problem.
5. Write on the board as they explain aloud: $(2^3)^2 = 2^3 \times 2^3 = 2^{3+3} = 2^6$
6. **Say:** The powers are multiplied together to get the power in the answer.
7. **Say:** The fourth law of indices says that if an index is raised to another power, we can multiply the two powers together to get the power in the answer. The base stays the same.
8. Write on the board: $(2^3)^2 = 2^{3 \times 2} = 2^6$
9. Write the general statement on the board: $(a^m)^n = a^{mn}$
10. **Say:** Please copy the fourth law of indices into your exercise book.
11. **Say:** This is true when a, m, and n are any whole numbers.

Guided Practice (10 minutes)

1. **Say:** Let's do the next one together.
2. Write: $(3^5)^4$
3. **Ask:** How do I simplify this problem? (Answer: Multiply the indices.)
4. Write: $(3^5)^4 = 3^{5 \times 4} = 3^{20}$
5. **Say:** The answer is 3^{20}
6. **Say:** Please work in pairs to simplify the next problems.
7. Write:
a) $(12^3)^8$ b) $(2^7)^6$
8. Walk around the room and assist pupils when needed.

9. **Ask:** Who would like to come to the board with their partner and simplify problem a? (Answer: $(12^3)^8 = 12^{3 \times 8} = 12^{24}$)
10. Call on a pair of pupils with hands raised to simplify problem a on the board.
11. **Ask:** Who would like to come to the board with their partner and simplify problem b? (Answer: $(2^7)^6 = 2^{7 \times 6} = 2^{42}$)
12. Call on a pair of pupils with hands raised to simplify problem b on the board.




Independent Practice (10 minutes)

1. Write: a) $(7^7)^{10}$ b) $(100^3)^3$ c) $(5^2)^{12}$
2. **Say:** Please work on your own to simplify the problems. Write the answers in your exercise book.
3. Walk around the room and assist pupils when needed.
4. **Ask:** Who would like to come to the board and simplify problem a? (Answer: $(7^7)^{10} = 7^{7 \times 10} = 7^{70}$)
5. Call on a pupil with hand raised to simplify problem a on the board.
6. **Ask:** Who would like to come to the board and simplify problem b? (Answer: $(100^3)^3 = 100^{3 \times 3} = 100^9$)
7. Call on a pupil with hand raised to simplify problem b on the board.
8. **Ask:** Who would like to come to the board and simplify problem c? (Answer: $(5^2)^{12} = 5^{2 \times 12} = 5^{60}$)
9. Call on a pupil with hand raised to simplify problem c on the board.

Closing (4 minutes)

1. Write: $(2^4)^3 \div 2^2$
2. **Say:** Simplify the problem with a partner.
3. **Say:** Find the power of the first term before dividing by the second term.
4. **Ask:** What is the answer? (Answer: 2^{10})
5. Write: $(2^4)^3 \div 2^2 = 2^{4 \times 3} \div 2^2 = 2^{12} \div 2^2 = 2^{12-2} = 2^{10}$

Lesson Title: Index Laws 5 and 6: Power of a Product and Quotient	Theme: Numbers and Numeration	
Lesson Number: M-08-026	Class/Level: JSS 2	Time: 35 minutes

	<p>Learning Outcomes</p> <p>By the end of the lesson, pupils will be able to:</p> <ol style="list-style-type: none"> 1. Identify that $(a \times b)^n = a^n \times b^n$ and $\left(\frac{a}{b}\right)^n = \frac{a^n}{b^n}$, where $b \neq 0$. 2. Apply index laws 5 and 6 to simplifying problems. 		<p>Teaching Aids</p> <p>None</p>		<p>Preparation</p> <p>None</p>
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Opening (3 minutes)

1. Write: Simplify $(2^7)^3$
2. **Say:** Please work on this problem with a partner.
3. **Ask:** Who would like to come to the board with their partner and simplify this problem?
(Answer: $(2^7)^3 = 2^{7 \times 3} = 2^{21}$)
4. Call on a pair of pupils with hands raised to simplify the problem on the board.
5. **Say:** Today we will look at two more laws of indices. The fifth and sixth laws are about finding the power of a product and a quotient.

Introduction to the New Material (10 minutes)

1. Write on the board: $(2 \times 3)^2$
2. **Say:** The fifth law is about finding the power of a product. When I say the power of a product, I mean something like this: '2 times 3'.
3. Write: $(2 \times 3)^2 = (2 \times 3) \times (2 \times 3) = 2 \times 3 \times 2 \times 3$
4. **Say:** We can rewrite this because the order does not matter in multiplication.
5. Write on the board: $2 \times 3 \times 2 \times 3 = 2 \times 2 \times 3 \times 3 = 2^2 \times 3^2$
6. **Say:** This has given us the fifth law of indices.
7. Write on the board: $(2 \times 3)^2 = 2^2 \times 3^2$
8. **Say:** This is true when any product of two numbers is raised to a power.
9. Write the general statement on the board: $(a \times b)^n = a^n \times b^n$
10. **Say:** Please copy the fifth law of indices into your exercise book.
11. **Say:** We have a similar rule for the quotient of two numbers.
12. Write: $\left(\frac{2}{3}\right)^2$
13. **Say:** The fifth law is about finding the power of a quotient. When I say the power of a quotient, I mean something like this: '2 divided by 3'.
14. Write: $\left(\frac{2}{3}\right)^2 = \left(\frac{2}{3}\right) \times \left(\frac{2}{3}\right)$
15. **Say:** We can rewrite this by multiplying the numerators and the denominators.
16. Write: $\left(\frac{2}{3}\right) \times \left(\frac{2}{3}\right) = \frac{2 \times 2}{3 \times 3} = \frac{2^2}{3^2}$
17. **Say:** This has given us the sixth law of indices.
18. Write: $\left(\frac{2}{3}\right)^2 = \frac{2^2}{3^2}$
19. **Say:** This is true when any quotient of two numbers is raised to a power.

20. Write the general statement on the board: $\left(\frac{a}{b}\right)^n = \frac{a^n}{b^n}$, where $b \neq 0$
21. **Say:** Please copy the sixth law of indices into your exercise book.
22. **Say:** This is true for any numbers a and b , except where b is zero. b cannot be equal to zero because it is in the denominator of a fraction.

Guided Practice (8 minutes)

1. **Say:** Let's solve the next problem together.
2. Write: $(4 \div 5)^3$
3. **Ask:** Can you think of another way to write this problem? Maybe as a fraction?
4. Write: $(4 \div 5)^3 = \left(\frac{4}{5}\right)^3$
5. **Say:** Remember that a quotient can be written either with the division sign or as a fraction. The same rule applies to both cases. You can rewrite the problem with the power on both the dividend and the divisor.
6. **Say:** Work together on the next two problems with a partner.
7. Write: Use the fifth and sixth laws of indices to rewrite the following:
a) $(2 \times 9)^6$ b) $(8 \div 10)^4$
8. Walk around the room and assist pupils when needed.
9. **Ask:** Who would like to come to the board with their partner and simplify problem a? (Answer: $(2 \times 9)^6 = 2^6 \times 9^6$)
10. Call on a pair of pupils with hands raised to simplify problem a on the board.
11. **Ask:** Who would like to come to the board with their partner and simplify problem b?
(Answer: $(8 \div 10)^4 = \left(\frac{8}{10}\right)^4 = \frac{8^4}{10^4} = 8^4 \div 10^4$)
12. Call on a pair of pupils with hands raised to simplify problem b on the board.

Independent Practice (10 minutes)




1. Write: Use the fifth and sixth laws of indices to rewrite the following:
a) $(3 \times 8)^{10}$ b) $\left(\frac{10}{11}\right)^3$ c) $(5 \div 4)^{12}$
2. **Say:** Please work on your own to simplify the problems. Write the answers in your exercise book.
3. Walk around the room and assist pupils when needed.
4. **Ask:** Who would like to come to the board and simplify problem a? (Answer: $(3 \times 8)^{10} = 3^{10} \times 8^{10}$)
5. Call on a pupil with hand raised to simplify problem a on the board.
6. **Ask:** Who would like to come to the board and simplify problem b? (Answer: $\left(\frac{10}{11}\right)^3 = \frac{10^3}{11^3}$)
7. Call on a pupil with hand raised to simplify problem b on the board.
8. **Ask:** Who would like to come to the board and simplify problem c? (Answer: $(5 \div 4)^{12} = \left(\frac{5}{4}\right)^{12} = \frac{5^{12}}{4^{12}} = 5^{12} \div 4^{12}$)
9. Call on a pupil with hand raised to simplify problem c on the board.

Closing (4 minutes)

1. Write: Simplify: $\frac{(2 \times 3)^6}{2^6}$
2. **Say:** Simplify the problem with a partner.
3. **Say:** Rewrite the numerator as the first step.

4. **Ask:** What is the answer? (Answer: 3^6)
5. Write: $\frac{(2 \times 3)^6}{2^6} = \frac{2^6 \times 3^6}{2^6} = \frac{3^6}{1} = 3^6$
6. **Say:** We were able to simplify this by canceling 2^6 from the numerator and denominator. We can often simplify indices after using the laws to rewrite them. In the next class we will practise simplifying expressions using the 6 laws of indices.

Lesson Title: Application of the Laws of Indices	Theme: Numbers and Numeration	
Lesson Number: M-08-027	Class/Level: JSS 2	Time: 35 minutes

	Learning Outcomes By the end of the lesson, pupils will be able to use the six laws of indices to simplify problems.		Teaching Aids None		Preparation None
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Opening (4 minutes)

- Write: Simplify: a) $(5^{13})^2$ b) $9^{21} \times 9^{14}$
- Say:** Please work on this problem with a partner.
- Ask:** Who would like to come to the board with their partner and simplify problem a? (Answer: $(5^{13})^2 = 5^{13 \times 2} = 5^{26}$)
- Call on a pair of pupils with hands raised to simplify problem a on the board.
- Ask:** Who would like to come to the board with their partner and simplify problem b? (Answer: $9^{21} \times 9^{14} = 9^{21+14} = 9^{35}$)
- Call on a pair of pupils with hands raised to simplify problem b on the board.
- Say:** Now that you know the laws of indices, you can use the order of operations to simplify many different types of problems. Today we will practise simplifying problems.

Introduction to the New Material (6 minutes)

- Write: Simplify $(2^3)^4 \times 2^5$
- Say:** Remember the order of operations. The order is very important when applying the laws of indices.
- Write on the board: BODMAS
- Say:** Brackets Of/Order Division Multiplication Addition Subtraction
- Say:** The letter O can stand for 'of' or 'order'. Remember that indices fall under O.
- Say:** Look at the problem on the board. To simplify it, we need to apply law 4 for powers of indices, and law 1 for multiplying indices.
- Say:** We will apply law 4 for power of indices first because we work powers before multiplication.
- Simplify the problem on the board and explain aloud. $(2^3)^4 \times 2^5 = 2^{12} \times 2^5 = 2^{12+5} = 2^{17}$

Guided Practice (10 minutes)

- Say:** We will solve the next one together.
- Write: $\frac{(2^2)^3}{(2 \times 3)^6}$
- Say:** Work on solving this problem in your exercise book. Remember to work the numerator and denominator separately because they fall under 'Of' in BODMAS.
- Walk around the room and assist pupils when needed. You may need to remind them that they can cancel any like terms from the numerator and denominator.
- Solve the problem on the board and explain aloud. $\frac{(2^2)^3}{(2 \times 3)^6} = \frac{2^6}{2^6 \times 3^6} = \frac{1}{3^6}$
- Say:** Work together on the next two problems with a partner.

7. Write: Simplify: a) $(3^4 \times 3^5)^2$ b) $\frac{(5 \times 4)^6}{5^6}$
8. Walk around the room and assist pupils when needed.
9. **Ask:** Who would like to come to the board with their partner and simplify problem a? (Answer: $(3^4 \times 3^5)^2 = (3^{4+5})^2 = (3^9)^2 = 3^{18}$)
10. Call on a pair of pupils with hands raised to simplify problem a on the board.
11. **Ask:** Who would like to come to the board with their partner and simplify problem b? (Answer: $\frac{(5 \times 4)^6}{5^6} = \frac{5^6 \times 4^6}{5^6} = \frac{4^6}{1} = 4^6$)
12. Call on a pair of pupils with hands raised to simplify problem b on the board.




Independent Practice (10 minutes)

1. Write: Simplify:
a) $(4^2 \times 4^4)^{10}$ b) $\frac{(3 \times 2)^2}{3^2}$ c) $3^2 \times (3^8)^3$
2. **Say:** Please work on your own to simplify the problems. Write the answers in your exercise book.
3. Walk around the room and assist pupils when needed.
4. **Ask:** Who would like to come to the board and simplify problem a? (Answer: $(4^2 \times 4^4)^{10} = (4^6)^{10} = 4^{60}$)
5. Call on a pupil with hand raised to simplify problem a on the board.
6. **Ask:** Who would like to come to the board and simplify problem b? (Answer: $\frac{(3 \times 2)^2}{3^2} = \frac{3^2 \times 2^2}{3^2} = \frac{2^2}{1} = 2^2$)
7. Call on a pupil with hand raised to simplify problem b on the board.
8. **Ask:** Who would like to come to the board and simplify problem c? (Answer: $3^2 \times (3^8)^3 = 3^2 \times 3^{24} = 3^{26}$)
9. Call on a pupil with hand raised to simplify problem c on the board.

Closing (5 minutes)

1. Write: Simplify: $(5^2 \times 4^2)^3$
2. **Ask:** What is the first step in simplifying this problem? (Answer: First apply law 5, to find the power of a product.)
3. Write: $(5^2 \times 4^2)^3 = (5^2)^3 \times (4^2)^3$
4. **Say:** Finish simplifying the problem on your own or with a partner.
5. **Ask:** What is the answer? (Answer: $5^6 \times 4^6$)
6. Write: $(5^2 \times 4^2)^3 = (5^2)^3 \times (4^2)^3 = 5^6 \times 4^6$

Lesson Title: Indices with Negative Powers	Theme: Numbers and Numeration	
Lesson Number: M-08-028	Class/Level: JSS 2	Time: 35 minutes

 <p>Learning Outcomes By the end of the lesson, pupils will be able to:</p> <ol style="list-style-type: none"> 1. Identify that a number with a negative index can be rewritten as a fraction ($a^{-n} = \frac{1}{a^n}$). 2. Simplify simple indices with negative powers. 	 <p>Teaching Aids None</p>	 <p>Preparation None</p>
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Opening (4 minutes)

1. Write: Simplify: $(3^3)^2 \times (3^2)^5$
2. **Say:** Please work on this problem with a partner.
3. **Ask:** Who would like to come to the board with their partner and solve the problem? (Answer: $(3^3)^2 \times (3^2)^5 = 3^{3 \times 2} \times 3^{2 \times 5} = 3^6 \times 3^{10} = 3^{6+10} = 3^{16}$)
4. Call on a pair of pupils with hands raised to solve problem a on the board.
5. **Say:** Now we can solve many types of problems with powers. Today we will be learning about negative powers.

Introduction to the New Material (6 minutes)

1. Write: 2^{-3}
2. **Say:** Negative powers are the opposite of positive powers. Positive powers told us to multiply. The opposite of multiplication is division. So negative powers tell us to divide.
3. **Say:** A negative power tells us how many times to divide by that number.
4. **Say:** Look at this index on the board.
5. **Say:** This 2 has a power of *negative* 3. That means we *divide* by 2 three times.
6. Write: $2^{-3} = 1 \div (2 \times 2 \times 2) = \frac{1}{2 \times 2 \times 2} = \frac{1}{2^3}$
7. **Say:** All of these statements on the board are equal.
8. **Say:** If we have a negative power, it means we divide.
9. **Say:** We put the index with a positive power in the denominator of a fraction. Remember that fractions are divisions.
10. Write: 5^{-2}
11. **Say:** We need to rewrite this as a fraction with a positive power.
12. Write on the board: $5^{-2} = \frac{1}{5^2}$
13. Write the general case on the board: $(a^{-n} = \frac{1}{a^n})$
14. **Say:** Please copy this formula into your exercise book.
15. **Say:** When any number a has a negative power, it can be rewritten in the denominator of a fraction with a positive power.

Guided Practice (10 minutes)

1. **Say:** We will work on the next one together.

2. Write: 3^{-2}
3. **Say:** Please rewrite 3^{-2} in your exercise book.
4. **Ask:** Who would like to write their answer on the board?
5. Call on a pupil with hand raised to write their answer on the board. (Answer: $3^{-2} = \frac{1}{3^2}$)
6. **Ask:** What is another way we can write 3^2 ? (Answer: $3^2 = 3 \times 3 = 9$)
7. **Say:** We know that 3^2 is 9. We can rewrite this fraction with 9 in the denominator.
8. Write: $3^{-2} = \frac{1}{3^2} = \frac{1}{9}$
9. **Say:** Now you can see that a whole number raised to a negative power gives a proper fraction.
10. **Say:** Work together on the next two problems with a partner.
11. Write on the board: Simplify: a) 15^{-4} b) 2^{-100}
12. Walk around the room and assist pupils when needed.
13. **Ask:** Who would like to come to the board with their partner and simplify problem a? (Answer: $15^{-4} = \frac{1}{15^4}$)
14. Call on a pair of pupils with hands raised to simplify problem a on the board.
15. **Ask:** Who would like to come to the board with their partner and simplify problem b? (Answer: $2^{-100} = \frac{1}{2^{100}}$)
16. Call on a pair of pupils with hands raised to simplify problem b on the board.




Independent Practice (10 minutes)

1. Write on the board: Simplify:
a) 9^{-20} b) 12^{-5} c) 1^{-4}
2. **Say:** Please work on your own to simplify the problems. Write the answers in your exercise book.
3. Walk around the room and assist pupils when needed.
4. **Ask:** Who would like to come to the board and simplify problem a? (Answer: $9^{-20} = \frac{1}{9^{20}}$)
5. Call on a pupil with hand raised to simplify problem a on the board.
6. **Ask:** Who would like to come to the board and simplify problem b? (Answer: $12^{-5} = \frac{1}{12^5}$)
7. Call on a pupil with hand raised to simplify problem b on the board.
8. **Ask:** Who would like to come to the board and simplify problem c? (Answer: $1^{-4} = \frac{1}{1^4}$)
9. Call on a pupil with hand raised to simplify problem c on the board.
10. **Say:** Please look at the last answer: $\frac{1}{1^4}$
11. **Ask:** Can you think of a way to rewrite this? (Answer: 1)
12. Rewrite the answer: $\frac{1}{1^4} = \frac{1}{1} = 1$
13. **Say:** Remember that 1 raised to any power equals 1.

Closing (5 minutes)

1. Write: Simplify: 2×4^{-5}
2. **Say:** Please simply this problem with a partner.
3. Walk around the room and assist pupils when needed.
4. **Ask:** What is the answer? (Answer: $2 \times 4^{-5} = 2 \times \frac{1}{4^5} = \frac{2 \times 1}{4^5} = \frac{2}{4^5}$)
5. **Write:** $2 \times 4^{-5} = 2 \times \frac{1}{4^5} = \frac{2 \times 1}{4^5} = \frac{2}{4^5}$

Lesson Title: Multiplying and Dividing Indices with Negative Powers	Theme: Numbers and Numeration	
Lesson Number: M-08-029	Class/Level: JSS 2	Time: 35 minutes

 Learning Outcomes By the end of the lesson, pupils will be able to apply the laws for multiplying and dividing indices to those with negative powers.	 Teaching Aids None	 Preparation None
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Opening (4 minutes)

- Say:** When multiplying and dividing indices with positive powers, we add the powers for multiplication and subtract the powers for division.
- Write two revision problems on the board: Simplify: a) $4^3 \times 4^5$ and b) $6^7 \div 6^3$.
- Say:** Please solve the problems with a partner.
- Ask:** Who would like to write their answer on the board with their partner?
- Call on 2 different pairs of pupils with hands raised to each write an answer on the board. (Answers: a) $4^3 \times 4^5 = 4^{3+5} = 4^8$; b) $6^7 \div 6^3 = 6^{7-3} = 6^4$)
- Say:** Remember that for multiplication, we add the powers. For division, we subtract the powers.
- Say:** Today, we will use these rules to multiply and divide indices with negative powers.

Introduction to the New Material (12 minutes)

- Write: $2^{-3} \times 2^{-5}$.
- Say:** The rule for multiplying two indices is to add the powers. We will add -3 and -5.
- Write: $2^{-3} \times 2^{-5} = 2^{(-3)+(-5)}$.
- Say:** When adding two negative numbers we add their values and carry the negative sign to the answer.
- Solve the problem on the board: $2^{-3} \times 2^{-5} = 2^{(-3)+(-5)} = 2^{-8}$.
- Say:** Now I will rewrite the answer as a fraction.
- Write: $2^{-8} = \frac{1}{2^8}$.
- Say:** This is the simplified answer.
- Write: $4^{-6} \div 4^{-4}$.
- Say:** The rule for dividing two indices is to subtract the powers. We will subtract -4 from -6.
- Write: $4^{-6} \div 4^{-4} = 4^{(-6)-(-4)}$.
- Say:** When we subtract a negative, it makes addition, so we *add* 4 to -6. When we add a negative and positive, we do a subtraction problem and write the sign of the larger number on the answer. 6 is larger than 4, so the answer is -2.
- Solve the problem on the board: $4^{-6} \div 4^{-4} = 4^{(-6)-(-4)} = 4^{-6+4} = 4^{-2}$.
- Say:** Now I will rewrite the answer as a fraction.
- Write: $4^{-2} = \frac{1}{4^2}$

Guided Practice (5 minutes)

- Write: Simplify: $12^{-4} \times 12^{-2}$

2. **Ask:** Do we need to add or subtract the powers? (Answer: Add)
3. **Say:** Please add the powers and simplify the problem. Also write the answer as a fraction.
4. Walk around the room and assist pupils when needed.
5. **Ask:** What is the answer? (Answer: $12^{-6} = \frac{1}{12^6}$)
6. Write: $12^{-4} \times 12^{-2} = 12^{(-4)+(-2)} = 12^{-6} = \frac{1}{12^6}$
7. **Say:** I have simplified the answer and also written it as a fraction.
8. Write: Simplify $2^{-50} \div 2^{-30}$
9. **Ask:** Do we need to add or subtract the powers? (Answer: Subtract)
10. **Say:** Please subtract the powers and simplify the problem. Also write the answer as a fraction.
11. **Ask:** What is the answer? (Answer: $2^{-20} = \frac{1}{2^{20}}$)
12. Write: $2^{-50} \div 2^{-30} = 2^{-50-(-30)} = 2^{-50+30} = 2^{-20} = \frac{1}{2^{20}}$
13. **Say:** Please check your work to make sure you came up with the same answers when solving the problems.




Independent Practice (10 minutes)

1. Write: Simplify: a) $8^{-12} \div 8^{-4}$; b) $10^{-5} \times 10^{-2}$; c) $3^{-10} \times 3^{-4}$
 2. **Say:** You will now be working on your own to simplify the problems.
 3. Walk around the room and assist pupils when needed.
 4. **Ask:** Who would like to show how you solved a problem on the board?
 5. Call on 3 different pupils with hand raised to come to the board and show how they solved the problems.
(Answers: See below.)
- a) $8^{-12} \div 8^{-4} = 8^{-12-(-4)} = 8^{-12+4} = 8^{-8} = \frac{1}{8^8}$;
- b) $10^{-5} \times 10^{-2} = 10^{(-5)+(-2)} = 10^{-7} = \frac{1}{10^7}$;
- c) $3^{-10} \times 3^{-4} = 3^{(-10)+(-4)} = 3^{-10-4} = 3^{-14} = \frac{1}{3^{14}}$

Closing (4 minutes)

1. **Say:** Please look at problem b in the independent practice again.
2. **Ask:** Is there another way to write the problem ($10^{-5} \times 10^{-2}$)?
3. Write: $10^{-5} \times 10^{-2} = \frac{1}{10^5} \times \frac{1}{10^2}$
4. **Say:** Remember that each factor can be written as a fraction. Now I will solve the problem.
5. Write: $10^{-5} \times 10^{-2} = \frac{1}{10^5} \times \frac{1}{10^2} = \frac{1}{10^5 \times 10^2} = \frac{1}{10^{5+2}} = \frac{1}{10^7}$
6. **Say:** This is the same answer that we got when we solved problem b previously. This is another way to think about problems with negative indices.

Lesson Title: Negative Powers and the Index Laws	Theme: Numbers and Numeration	
Lesson Number: M-08-030	Class/Level: JSS 2	Time: 35 minutes

 <p>Learning Outcomes By the end of the lesson, pupils will be able to apply the index laws to simplifying expressions containing positive and negative powers.</p>	 <p>Teaching Aids None</p>	 <p>Preparation None</p>
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Opening (5 minutes)

1. Write on the board: Simplify: $4^{-5} \times 4^9$.
2. **Say:** You know all of the information you need to solve this problem. Please solve it in pairs or threes.
3. Move around to check for understanding and provide help. Encourage pupils to use what they know about addition of negative and positive numbers.
4. Ask a group to describe what they did, and allow other classmates to discuss.
5. Write the answer on the board and ask pupils to check their work. (Answer: $4^{-5} \times 4^9 = 4^{-5+9} = 4^4$)
6. **Say:** Today, we will apply the laws of indices to simplify expressions with both positive and negative powers.

Introduction to the New Material (10 minutes)

1. Write two problems on the board: a) $2^{10} \div 2^{-5}$ and b) $(2^{-3})^4$.
2. Ask pupils to look at the problems on the board for a minute and think about how they would solve them.
3. Ask a pupil to tell how to solve problem a). Allow other pupils to help and discuss if needed. (Example answer: Subtract -5 from 10 in the index. Subtracting a negative means we add.)
4. Ask pupils to solve problem a) in their exercise books. While they are working, ask one pupil to solve it on the board. (Answer: $2^{10} \div 2^{-5} = 2^{10-(-5)} = 2^{10+5} = 2^{15}$)
5. Walk around and make sure pupils understand. Ask them to check their work and do any corrections.
6. Ask a volunteer to explain how to solve problem b). Allow other pupils to help and discuss if needed. (Example answer: Multiply the powers: -3×4)
7. Ask pupils to solve problem b) in their exercise books. While they are working, ask one pupil to solve it on the board. (Answer: $(2^{-3})^4 = 2^{-3 \times 4} = 2^{-12} = \frac{1}{2^{12}}$)
8. Walk around and make sure pupils understand. Ask them to check their work and do any corrections.
9. **Say:** Today, you will solve more problems with positive and negative powers. You already have all of the knowledge you need. You will use your problem solving skills.

Guided Practice (7 minutes)

1. Ask pupils to work in pairs.

- Write on the board: Simplify: a) $4^{-8} \div 4^4$ and b) $12^4 \times (12^{-2})^3$
- Move around to check for understanding and to clear misconceptions. For example, pupils may need to be reminded of the order of operations (BODMAS), which tells us to solve the exponent before multiplication in problem b).
- Ask 2 different pairs to each write an answer on the board. Ask all other pupils to check their answers. (Answers: a) $4^{-8} \div 4^4 = 4^{-8-4} = 4^{-12} = \frac{1}{4^{12}}$; b) $12^4 \times (12^{-2})^3 = 12^4 \times 12^{-2 \times 3} = 12^4 \times 12^{-6} = 12^{4+(-6)} = 12^{4-6} = 12^{-2} = \frac{1}{12^2}$)

Independent Practice (11 minutes)

- Write on the board: Simplify: a) $8^{-12} \div (8^{-3})^2$; b) $10^5 \times 10^{-2} \div 10$; c) $3^{10} \times 3^{-4} \times 5^{-2}$.
- Ask pupils to work independently to simplify.
- Move around to check for understanding and to clear up misconceptions. For example, remind pupils that the laws of indices only apply to indices with the same base. For problem c), they can simplify the first part, but the indices with base 3 and base 5 cannot be combined.
- Allow pupils to discuss with fellow pupils if needed.
- Ask 3 different pupils to each write an answer on the board. Ask all other pupils to check their answers.

Answers:

$$\text{a) } 8^{-12} \div (8^{-3})^2 = 8^{-12} \div 8^{-3 \times 2} = 8^{-12} \div 8^{-6} = 8^{-12-(-6)} = 8^{-12+6} = 8^{-6} = \frac{1}{8^6}$$




$$\text{b) } 10^5 \times 10^{-2} \div 10 = 10^5 \times 10^{-2} \div 10^1 = 10^{5+(-2)-1} = 10^2$$

$$\text{c) } 3^{10} \times 3^{-4} \times 5^{-2} = 3^{10-4} \times 5^{-2} = 3^6 \times 5^{-2} = 3^6 \times \frac{1}{5^2} = \frac{3^6}{5^2}$$

Closing (2 minutes)

- Ask pupils questions to review operations on indices. Allow them to discuss as a class. For example:
 - How can we rewrite an index with a negative power? (Example answer: As a fraction. The denominator is the same index, but the power is positive.)
 - When do the laws of indices apply? (Example answer: When the bases' indices are the same. The powers can be positive or negative.)

Lesson Title: Identifying the Percentage of a Given Quantity	Theme: Numbers and Numeration	
Lesson Number: M-08-31	Class/Level: JSS 2	Time: 35 minutes

 Learning Outcomes By the end of the lesson, pupils will be able to calculate the given percentage of a given quantity.	 Teaching Aids None	 Preparation None
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Opening (5 minutes)

- Write: Express 64% as:
 - fraction, and
 - decimal
- Ask:** What is the answer to problem a? (Answer: 64% as a fraction = $\frac{64}{100} = \frac{16}{25}$)
- Ask:** What is the answer to problem b? (Answer: 64% as a decimal = .64)
- Say:** Today we will learn how to calculate the given percentage of a given quantity.

Introduction to the New Material (7 minutes)

- Say:** A percentage is any part or share of a whole.
- Write:
 - Calculate 20% of 200.
 - Calculate 15% of 60,000
- Say:** To solve problem a, first we will express 20% as a fraction.
- Write: $\frac{20}{100}$
- Say:** The given quantity is 200.
- Say:** I will show you how to calculate 20% of 200.
- Write: $20\% \text{ of } 200 = \frac{20}{100} \times \frac{200}{1} = \frac{4000}{100} = 40$
- Say:** First I changed the percentage to a fraction.
- Say:** Then I multiplied it by the given quantity.
- Say:** Lastly I divided.
- Say:** When we say the word 'of' it often signals multiplication. We often need to simplify the answer.
- Say:** 20% of 200 is 40.

Guided Practice (11 minutes)

- Say:** Let's calculate the next one together.
- Write: 15% of 60,000.
- Ask:** What do I do first? (Answer: Express 15% as a fraction.)
- Ask:** What should that look like? (Answer: $\frac{15}{100}$)
- Write: $\frac{15}{100}$
- Ask:** What is the given quantity? (Answer: 60,000)
- Say:** Calculate the answer in your exercise book with the information we have identified.

8. **Ask:** What is the answer? (Answer: 9,000)
9. Write: $15\% \text{ of } 60,000 = \frac{15}{100} \times \frac{60,000}{1} = \frac{900,000}{100} = 9,000$
10. **Say:** 15% of 60,000 is 9,000
11. Write the following problem on the board:
 - a) Fatu has two brothers. She has Le 40,000 to share with them. She wants to give 30% of Le 40,000 to Sao and 70% of Le 40,000 to Sowa. How many Leones will each brother receive?
12. **Say:** This problem has 2 parts. We must find the amount each brother will receive.
13. **Ask:** What is the first step? (Example answer: Express the percentages as fractions.)
14. **Ask:** What is 30% as a fraction? (Answer: $\frac{30}{100}$)
15. **Ask:** What is 70% as a fraction? (Answer: $\frac{70}{100}$)
16. **Ask:** What is the given amount? (Answer: 40,000)
17. **Say:** Work with a partner to calculate the answers in your exercise books.
18. Walk around the room and assist pupils when needed.
19. **Ask:** Who would like to come to the board with their partner and solve the answer for how much Sao will receive? (Answer: $30\% \text{ of } 40,000 = \frac{30}{100} \times \frac{40,000}{1} = \frac{1,200,000}{100} = 12,000$)
20. Call on a pair of pupils with hands raised to answer to solve the problem on the board.
21. **Ask:** Who would like to come to the board and solve the answer for how much Sowa will receive? (Answer: $70\% \text{ of } 40,000 = \frac{70}{100} \times \frac{40,000}{1} = \frac{2,800,000}{100} = 28,000$)
22. Call on a pair of pupils with hands raised to solve the problem on the board.
23. **Say:** Sao will receive Le 12,000 and Sowa will receive Le 28,000.




Independent Practice (10 minutes)

1. Write:
 - a) Calculate 14% of 200
 - b) Calculate 80% of 80
 - c) Calculate 75% of 120
 - d) Calculate 43% of 400
2. **Say:** Please work on your own to simplify the problems. Write the answers in your exercise book.
3. Walk around the room and assist pupils when needed.
4. **Ask:** Who would like to come to the board and write the answer for problem a? (Answer: $14\% \text{ of } 200 = \frac{14}{100} \times \frac{200}{1} = \frac{2800}{100} = 28$)
5. Call on a pupil with hand raised to answer problem a on the board.
 - a) **Ask:** Who would like to come to the board and answer problem b? ($80\% \text{ of } 80 = \frac{80}{100} \times \frac{80}{1} = \frac{6,400}{100} = 64$)
6. Call on a pupil with hand raised to answer problem b on the board.
 - b) **Ask:** Who would like to come to the board and write the answer for problem c? ($75\% \text{ of } 120 = \frac{75}{100} \times \frac{120}{1} = \frac{9,000}{100} = 90$)
7. Call on a pupil with hand raised to answer problem c on the board.
 - c) **Ask:** Who would like to come to the board and answer problem d? ($43\% \text{ of } 400 = \frac{43}{100} \times \frac{400}{1} = \frac{17,200}{100} = 172$)
8. Call on a pupil with hand raised to answer problem c on the board.

Closing (2 minutes)

1. Write: Tamba has Le 20,000. He wants to give 25% to Mamie. How many Leones will Mamie receive?
2. **Say:** Please solve this problem in your exercise book.
3. **Ask:** What is the answer? (Answer: $25\% \text{ of } 20,000 = \frac{25}{100} \times \frac{20,000}{1} = \frac{500,000}{100} = 5,000$)

Lesson Title: Expressing One Quantity as a Percentage of Another	Theme: Numbers and Numeration	
Lesson Number: M-08-032	Class/Level: JSS 2	Time: 35 minutes

 Learning Outcomes By the end of the lesson pupils will be able to calculate one quantity as a percentage of another.	 Teaching Aids None	 Preparation None
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Opening (4 minutes)

- Write:
 - Calculate 40% of 250
 - Calculate 80% of 70.
- Say:** Please take 3 minutes and solve the problems in your exercise book.
- Ask:** What is the answer to problem a? (Answer: $\frac{40}{100} \times \frac{250}{1} = 100$)
- Ask:** What is the answer to problem b? (Answer: $\frac{80}{100} \times \frac{70}{1} = 56$)
- Say:** Today we will learn how to express one quantity as a percentage of another.

Introduction to the New Material (14 minutes)

- Write:
 - There are 50 eggs in a box, but 6 are broken. What percentage is left?
 - Calculate 40 centimetres as a percentage of 16 metres.
- Say:** There are 50 eggs in a box, but 6 are broken. What percentage is left?
- Say:** We want to find the percentage of eggs that are still good out of all the eggs in the box.
- Say:** So we must first subtract the broken eggs to find the quantity of good eggs.
- Write: Quantity of good eggs = $50 - 6 = 44$ eggs
- Say:** To express a quantity as a percentage of another, express the first quantity as a fraction of the second quantity.
- Say:** Multiply the fraction by 100% and simplify.
- Write: Percentage good = $\frac{\text{quantity of good eggs}}{\text{total quantity of eggs}} \times 100\%$
- Calculate the answer on the board and explain aloud: $\frac{44}{50} \times \frac{100\%}{1} = \frac{4,400\%}{50} = 88\%$
- Say:** 88% of the eggs are good.
- Say:** Calculate 40 centimetres as a percentage of 16 metres.
- Say:** The first quantity is in centimetres while the second is in metres so we need to change both quantities to the same unit.
- Say:** We will change the quantities to centimetres because it is easier to do the calculations with whole numbers rather than fractions or decimals.
- Say:** There are 100 centimetres in 1 metre.
- Write: $100 \text{ cm} = 1 \text{ m}$.
- Say:** So, we know $16 \text{ m} \times 100 \text{ cm} = 1600 \text{ cm}$.
- Say:** Let us rewrite the problem using all centimetres.
- Write: $\frac{40 \text{ centimetres}}{1600 \text{ centimetres}}$

19. **Say:** We will calculate 40 centimetres as a percentage of 1600 centimetres.
20. Calculate the answer on the board and explain aloud: $\frac{40}{1600} \times \frac{100\%}{1} = \frac{4000\%}{1600} = 2.5\%$
21. **Say:** 40 centimetres is 2.5% of 1600 centimetres. This means that 40 cm is also 2.5% of 16 metres.

Guided Practice (5 minutes)

- Say:** Let's do the next problem together.
- Write:
21 out of 25 pupils prefer bananas as their favourite fruit. What percentage likes bananas?
- Ask:** What is the first step of this problem? (Example answer: Write the numbers as a fraction.)
- Write: $\frac{21}{25}$
- Say:** 21 out of 25 pupils prefer bananas.
- Ask:** What is the next step? (Answer: Multiply by 100% and simplify.)
- Write: $\frac{21}{25} \times \frac{100\%}{1} =$
- Say:** Please calculate the answer in your exercise book and simplify.
- Ask:** What is the answer? (Answer: 84%)
- Continue writing the equation: $\frac{21}{25} \times \frac{100\%}{1} = \frac{2100\%}{25} = 84\%$
- Say:** 84% of the pupils prefer bananas.




Independent Practice (10 minutes)

- Write two questions on the board:
 - 40 people watched a football match, 22 of them supported the winning team. What is that as a percentage?
 - On a mathematics quiz, a pupil receives a score of 18 marks out of 20 marks. What is the pupil's percentage score?
- Say:** Solve the questions on the board independently in your exercise books.
- Say:** Please work on your own to simplify the problems. Write the answers in your exercise book.
- Walk around the room and assist pupils when needed.
- Ask:** Who would like to come to the board and write the answer for problem a? (Answer: $\frac{22}{40} \times \frac{100\%}{1} = \frac{2200\%}{40} = 55\%$)
- Call on a pupil with hand raised to answer problem a on the board.
Ask: Who would like to come to the board and answer problem b? (Answer: $\frac{18}{20} \times \frac{100\%}{1} = \frac{1800\%}{20} = 90\%$)
- Call on a pupil with hand raised to answer problem b on the board.

Closing (2 minutes)

- Ask:** What should we do if we want to calculate one quantity as a fraction of another? (Answer: Write the first quantity as a fraction of the second and multiply by 100, then simplify.)
- Ask:** Why it is useful to be able to calculate one quantity as a percentage of another quantity. (Example answers: It can be helpful for figuring out passing scores in school, voting in local or national elections, dividing up distances or amounts of farm land.)

Lesson Title: Percentage Increase	Theme: Numbers and Numeration	
Lesson Number: M-08-033	Class/Level: JSS 2	Time: 35 minutes

	Learning Outcomes By the end of the lesson, pupils will be able to calculate the percentage increase given two numbers.		Teaching Aids None		Preparation None
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Opening (2 minutes)

1. Write: What percentage of 80 litres is 24 litres?
2. **Say:** Please calculate the answer in your exercise book.
3. **Ask:** Who would like to solve the problem and explain the process?
4. Call on a pupil with hand raised to come to the board to solve the problem as they explain the process. (Example answer: Express the first quantity as a fraction of the second quantity; multiply the fraction by 100% and simplify: $\frac{24}{80} \times \frac{100\%}{1} = 30\%$)
5. **Say:** Today, we are going to learn how to calculate percentage increase given two numbers.

Introduction to the New Material (14 minutes)

1. Write: There were 100 pupils registered for JSS2 last year and there are 115 pupils registered for JSS2 this year. What is the percentage increase?
2. **Say:** Increase means addition to a quantity
3. Write: Percentage increase = $\frac{\text{change in quantity}}{\text{original quantity}} \times 100\%$
4. **Say:** This is how we find the percentage increase; we find the *change in quantity* and the *original quantity*.
5. **Say:** Then we substitute the numbers into this formula. We multiply by 100% and then simplify by dividing them.
6. **Say:** To calculate *change in quantity* for an increase, subtract the original quantity from the new quantity (New quantity – Original quantity).
7. **Say:** The new quantity is 115 pupils. The original quantity is 100 pupils. Therefore, the change in quantity is 15 pupils.
8. Rewrite the formula by substituting in the numbers and read the equation aloud as you write it.
9. Write: $\frac{15}{100} \times \frac{100\%}{1} =$
10. Calculate the percentage increase in registration on the board and explain aloud as you solve the equation.
11. Write: $\frac{15}{100} \times \frac{100\%}{1} = 15\%$
12. **Say:** The JSS2 registration increased by 15%.

Guided Practice (7 minutes)

1. Write: A pupil studied for 20 minutes one night. The next night she studied for 50 minutes. What is the percentage increase in minutes?
2. Write: Percentage increase = $\frac{\text{change in quantity}}{\text{original quantity}} \times 100\%$

3. **Say:** We will follow the same steps from the first problem above.
4. **Ask:** What is the new quantity? (Answer: 50 minutes)
5. **Ask:** What is the original quantity? (Answer: 20 minutes)
6. **Ask:** What is the increase in quantity? (Answer: 30 minutes)
7. Write: $50 \text{ minutes} - 20 \text{ minutes} = 30 \text{ minutes}$
8. **Say:** Please calculate the percentage increase in your exercise book.
9. **Ask:** What is the answer? (Answer: $\frac{30}{20} \times \frac{100\%}{1} = 150\%$)
10. **Say:** The pupil increased her studying by 150%.
11. **Ask:** What does the percentage over 100% mean? (Example answer: The pupil spent longer than double the amount of time the second night than the first.)
12. Write: A bag of rice cost Le 160,000, but increased in cost to Le 200,000. Calculate the percentage increase.
13. **Say:** Please work with a partner to solve the problem.
14. Walk around the room and assist pupils when needed.
15. **Ask:** Who would like to share their answer? (Answer: $= \text{Le } 200,000 - \text{Le } 160,000 = \text{Le } 40,000$;
 $\frac{40,000}{160,000} \times \frac{100\%}{1} = 25\%$)
16. **Say:** The bag of rice increased in cost by 25%.




Independent Practice (10 minutes)

1. Write 2 questions on the board:
 - a) Last year you had 100 m^2 of land to farm. This year, you bought more land, and you have 120 m^2 to farm. Calculate the percentage increase.
 - b) The cost of transport increased from Le 30,000 to Le 45,000. Calculate the percentage increase.
2. **Say:** Please work on your own and write the answers in your exercise book.
3. Walk around the class and assist pupils when needed.
4. Ask pupils to turn to their seatmates to check, compare and discuss answers.
5. **Ask:** Who would like to answer the questions?
6. Call on two pupils with hands raised to come on the board and work out the problems.
(Answers: a) $120 - 100 = 20$; $\frac{20}{100} \times \frac{100\%}{1} = 20\%$; b) $\text{Le } 45,000 - \text{Le } 30,000 = \text{Le } 15,000$;
 $\frac{15,000}{30,000} \times \frac{100\%}{1} = 50\%$)

Closing (2 minutes)

1. **Ask:** When would you want to calculate a percentage increase? (Example answers: When figuring out how much more of an ingredient is needed when cooking; when you need to determine how many more materials are needed for a larger class.)

Lesson Title: Percentage Decrease	Theme: Numbers and Numeration	
Lesson Number: M-08-034	Class/Level: JSS 2	Time: 35 minutes

	Learning Outcomes By the end of the lesson, pupils will be able to calculate the percentage decrease given 2 numbers.		Teaching Aids None		Preparation None
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Opening (5 minutes)

- Write: The number of pupils enrolled in primary school increased from 300 to 375. Calculate the percentage increase.
- Write: Percentage increase = $\frac{\text{change in quantity}}{\text{original quantity}} \times 100\%$
- Say:** Please take a minute or two and solve in your exercise book.
- Ask:** Who would like to share their answer to the question? (Answer: $375 - 300 = 75$; $\frac{75}{300} \times \frac{100\%}{1} = 25\%$)
- Call on a pupil with hand raised to share their answer.
- Write: $375 - 300 = 75$; $\frac{75}{300} \times \frac{100\%}{1} = 25\%$
- Say:** There was a 25% increase in enrolment at the primary school.
- Say:** Today, we will learn how to calculate percentage decrease given 2 numbers.

Introduction to the New Material (8 minutes)

- Write: The cost of transport decreased from Le 60,000 to Le 36,000. Calculate the percentage decrease.
- Say:** Decrease means that a quantity goes down or gets reduced.
- Write: Percentage decrease = $\frac{\text{change in quantity}}{\text{original quantity}} \times 100\%$
- Say:** This is the same equation that we used for percentage increase.
- Say:** To calculate *change in quantity* for a decrease, subtract the new quantity from the original quantity (original quantity – new quantity = change in quantity).
- Say:** This is the opposite of what we did to find the change in quantity for an increase.
- Write:
Increase: new quantity – original quantity
Decrease: original quantity – new quantity
- Say:** Please copy this into your exercise books.
- Say:** The original cost of transport is Le 60,000.
- Say:** The new cost of transport is Le 36,000.
- Calculate the decrease in quantity on the board and read the equation aloud as you write:
 $\text{Le } 60,000 - \text{Le } 36,000 = \text{Le } 24,000$
- Calculate the percentage decrease on the board and read the equation aloud as you write:
 $\frac{24,000}{60,000} \times \frac{100\%}{1} = 40\%$
- Say:** There was a 40% decrease in the cost of transport.

Guided Practice (10 minutes)

1. Write: A seller starts with 75 bags of rice; by the end of the day she has 45 bags of rice. Calculate the percentage decrease.
2. **Ask:** What is the original quantity? (Answer: Original quantity = 75 bags.)
3. **Ask:** What is the new quantity? (Answer: New quantity = 45 bags.)
4. **Ask:** How do we find the size of the decrease? (Answer: Subtract the new quantity from the original quantity.)
5. Write: $75 \text{ bags} - 45 \text{ bags} = 30 \text{ bags}$ of rice.
6. **Ask:** What are the next steps? (Answer: Divide by the original value and multiply by 100%.)
7. Solve on the board and read the equation aloud as you write: $\frac{30}{75} \times \frac{100\%}{1} = 40\%$
8. **Say:** The seller's bags of rice to sell decreased by 40%.
9. Write: At the end of the rainy season the river is 3 m deep, but at the end of the dry season it is 60 cm deep. Calculate the percentage decrease.
10. **Say:** Please work with a partner to solve the problem.
11. **Say:** Remember you need to consider the units. It is easier to convert to the smaller unit: 1 m = 100 cm, so 3 m = 300 cm.
12. Walk around the room and assist pupils when needed.
13. **Ask:** Who would like to share their answer? (Answer: $300 \text{ cm} - 60 \text{ cm} = 240 \text{ cm}$; $\frac{240}{300} \times \frac{100\%}{1} = 80\%$)
14. **Say:** The river decreased by 80%.




Independent Practice (10 minutes)

1. Write 2 questions on the board:
 - a) A village started using mosquito nets, and the number of children with malaria decreased from 25 each month to 8 each month. Calculate the percentage decrease.
 - b) A businesswoman sells her lappa for Le 25,000 per metre, but she sold one metre to her friend for Le 15,000. Calculate the percentage decrease.
2. **Say:** Please work on your own and write the answers in your exercise book.
3. Walk around the room and assist pupils when needed.
4. **Ask:** Who would like to answer the questions?
5. Call on two pupils with hands raised to come on the board and work out the problems.
(Answers: a) $25 - 8 = 17$; $\frac{17}{25} \times \frac{100\%}{1} = 68\%$ decrease in malaria; b) $\text{Le } 25,000 - \text{Le } 15,000 = \text{Le } 10,000$; $\frac{10,000}{25,000} \times \frac{100\%}{1} = 40\%$ decrease on the lappa price)

Closing (2 minutes)

1. **Ask:** When would you want to calculate a percentage decrease? (Example answers: It can be helpful for figuring out discounts for buying or selling, success rates of medicine, how much money you have spent.)

Lesson Title: Applying Percentage Increase and Decrease	Theme: Numbers and Numeration	
Lesson Number: M-08-035	Class/Level: JSS 2	Time: 35 minutes

 Learning Outcomes By the end of the lesson, pupils will be able to calculate a number given the percentage increase or decrease upon a given number.	 Teaching Aids None	 Preparation None
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Opening (4 minutes)

- Write: You start the day with 20 biscuits to share and by the end of the day you only have 5 remaining. Calculate the percentage decrease.
- Say:** Please calculate the answer in your exercise book.
- Ask:** Who would like to solve the problem and explain the process? (Answer: $20 - 5 = 15$; $\frac{15}{20} \times \frac{100\%}{1} = 75\%$)
- Say:** There was a 75% decrease in biscuits.
- Say:** Today, we will learn how to calculate the number that we get after an increase or decrease. We will use the original quantity and the percentage increase or decrease to find this number.

Introduction to the New Material (14 minutes)

- Ask:** What is the difference between increase and decrease? (Example answer: If a quantity increases, it becomes more; if a quantity decreases, it becomes less.)
- Ask:** What is the formula for finding the percentage increase or decrease?
(Answer: $\frac{\text{change in quantity}}{\text{original quantity}} \times 100\%$)
- Say:** If there is a percentage increase, it means we add to the original amount. If there is a percentage decrease, it means we subtract from the original amount.
- Write the following questions on the board:
 - The number 200 is increased by 5%. Calculate the new number.
 - The number 200 is decreased by 5%. Calculate the new number.
- Say:** This is the type of question we will learn to solve today.
- Say:** To calculate a number given the percentage increase or decrease upon a given number, follow these steps.
- Write: State the increase or decrease in percent.
- Say:** State the increase or decrease in percent.
- Write: For percent increase, *add* the percentage to 100%.
- Say:** For percent increase, *add* the percentage to 100%.
- Write: For percent decrease, *subtract* the percentage from 100%.
- Say:** For percent decrease, *subtract* the percentage from 100%.
- Write: Since it is percent, divide the answer by 100 to cancel the percentage.
- Say:** Since it is percent, divide the answer by 100 to cancel the percentage.
- Write: Multiply the answer by the given number to give the new number.
- Say:** Multiply the answer by the given number to give the new number.

17. Write the formula for percentage increase on the board:

$$\text{New number} = \frac{100 + \text{percentage increase}}{100} \times \frac{\text{the given number}}{1}$$

18. **Say:** The percentage increase in problem is 5%.

19. **Say:** When we add this to 100% we get 105%.

20. **Say:** We divide this 105 percent by 100, and multiply it by the given number, 200.

21. Substitute the values into the formula.

22. Solve on the board, reading the equation aloud as you solve it: $\frac{105}{100} \times \frac{200}{1} = 210$

23. **Say:** After a 5% increase, 200 becomes 210.

24. **Say:** Now look at the second problem. We are asked to find the number after a decrease.

25. **Say:** The percentage decrease in problem is 5%.

26. **Say:** When we subtract 5% from 100% we are left with 95%.

27. Write the formula for percentage decrease on the board, reading the equation aloud as you write:

$$\text{New number} = \frac{100 - \text{percentage decrease}}{100} \times \frac{\text{given number}}{1}$$

28. **Say:** To express the new number, we use the same steps. But mind you, we are now using percentage decrease, which is always less than 100.

29. Substitute the values into the formula, and solve on the board. Reading the equation aloud as you solve it. $\frac{95}{100} \times \frac{200}{1} = 190$

30. **Say:** After a 5% decrease, 200 becomes 190.

Guided Practice (5 minutes)

1. Write the following question on the board:

The cost of transportation during the dry season is Le 40,000. During the rainy season, the cost increases 10%. Calculate the cost during the rainy season.

2. **Ask:** Are you trying to calculate an increase or a decrease? (Answer: Increase.)

3. **Ask:** What percentage is the increase? (Answer: 10%)

4. Write: $100 + 10 = 110$

5. **Say:** Please copy this into your exercise book.

6. **Ask:** What do we do next? (Example answer: Divide 110 by 100 and multiply it by the given number 40,000.)

7. Write: $100 + 10 = 110$; $\frac{110}{100} \times \frac{40,000}{1} =$

8. **Say:** Please calculate the answer in your exercise book.

9. **Ask:** What is the answer? (Answer: Le 44,000)

10. Finish the equation: $100 + 10 = 110$; $\frac{110}{100} \times \frac{40,000}{1} = \text{Le } 44,000$

11. **Say:** In the rainy season, the cost of transportation is Le 44,000, 10% more than during the dry season.

Independent Practice (10 minutes)

1. Write the following 2 questions on the board:

a) In 2010, 300 people in a village did not have cell phones. Now the number of people that do not own cell phones has gone down by 90%. How many people remain without a cell phone?

b) The population of a village was 2,500 people eight years ago. Since then, the population has risen by 15%. Calculate the population as of today.

- Ask:** Is question 1 an increase or decrease problem? How do you know? (Answer: Decrease; the word 'remain' tells us it's a decrease (or subtraction) problem.)
- Ask:** Is question 2 an increase or decrease problem? How do you know? (Answer: Increase; the word 'risen' tells us it's an increase (or addition) problem.)
- Say:** Please work on your own to solve the problems in your exercise book.
- Walk around the room and assist pupils when needed.
- Ask:** Who would like to answer the questions?
- Call on two pupils with hands raised to come to the board and work out the problems.
(Answers: a) $100 - 90 = 10$; $\frac{10}{100} \times \frac{300}{1} = 30$ people; b) $100 + 15 = 115$; $\frac{115}{100} \times \frac{2500}{1} = 2,875$ people)

Closing (2 minutes)

- Ask:** What is the process for finding the new amount after a number is *increased* by a percentage? (Example answer: Add 100 to the percentage, divide by 100, and multiply by the given amount.)
- Ask:** What is the process for finding the new amount after a number is *decreased* by a percentage? (Example answer: Subtract 100 from the percentage, divide by 100, and multiply by the given amount.)

[ANOTHER METHOD OF CALCULATION]

Two different methods can be used to find the result after a number is increased or decreased by a certain percentage. Method 1 is described in the introduction and used throughout the lesson. Method 2 is described below. Use the method that you are more comfortable with.

Using method 2 for finding increase:

Example Problem: The number 500 is increased by 10%. Calculate the new number.

Solution Steps:

- State the increase in percent: 10%
- Divide the percent increase by 100% and multiply it by the given number:
$$\frac{10}{100} \times \frac{500}{1} = \frac{5000}{100} = 50$$
- Add the answer to the given number to give the new number:
 $500 + 50 = 550$

Answer: 550

Using method 2 for finding decrease:

Example Problem: The number 500 is decreased by 10%. Calculate the new number.

Solution Steps:

- State the increase in percent: 10%
- Divide the percent increase by 100% and multiply it by the given number:




$$\frac{10}{100} \times \frac{500}{1} = \frac{5000}{100} = 50$$

3. *Subtract* the answer from the given number to give the new number:

$$500 - 50 = 450$$

Answer: 450

Lesson Title: Introduction to Profit and Loss	Theme: Everyday Arithmetic	
Lesson Number: M-08-036	Class/Level: JSS 2	Time: 35 minutes

	<p>Learning Outcomes By the end of the lesson, pupils will be able to:</p> <ol style="list-style-type: none"> 1. Compare profit to loss. 2. Identify that profit is a percentage increase and loss is a percentage decrease. 		<p>Teaching Aids None</p>		<p>Preparation None</p>
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Opening (3 minutes)

1. **Say:** We have been learning about percentage increase and decrease.
2. **Ask:** When do you think being able to calculate percentage increase and decrease will be useful to you? (Example answers: Getting a discount on something; earning money.)
3. **Say:** Today, we will learn what profit and loss are and compare them. We will see that profit is a percentage increase and loss is a percentage decrease.

Introduction to the New Material (14 minutes)

1. **Say:** You can use percentage increase or decrease to calculate how much money you are making or losing in business.
2. **Ask:** What are the costs of starting the business if you want to farm? (Example answers: Seeds; farming tools; land.)
3. **Say:** We have a word for these costs to start a business.
4. Write: Capital - Money you have to start and run a business.
5. **Say:** We have some special terms for businesses. When you have a business that is making money, you have made a profit.
6. **Say:** When your business is losing money, it is called a loss.
7. **Say:** Profit and loss are special types of percent increase and decrease.
8. **Say:** We can calculate the percent of profit and percent of loss using formulae that are similar to percent increase and percent decrease.
9. **Say:** The formula for finding percent increase and percent decrease is $\frac{\text{change in quantity}}{\text{original quantity}} \times 100\%$.
10. Write: $\frac{\text{change in quantity}}{\text{original quantity}} \times 100\%$
11. **Say:** Here are the formulae for calculating profit and loss.
12. Write the formulae on the board:

$$\text{Percent profit} = \frac{\text{profit}}{\text{capital}} \times 100\%$$

$$\text{Percent loss} = \frac{\text{loss}}{\text{capital}} \times 100\%$$

13. **Say:** In these formulae you can see that profit or loss is the change in quantity and capital is the original quantity.
14. Write: Sales - The amount of money gained by selling goods or services.

15. **Say:** With percent increase and decrease remember the change in quantity was the difference between the new quantity and the original quantity.
16. **Say:** For profit and loss we find the difference between the money spent (cost/capital) and the money you earn (sales).
17. Write:
Profit - Money made after costs have been subtracted from sales: $Profit = sales - cost$
Loss - Money lost after costs have been subtracted from sales: $Loss = cost - sales$
18. **Say:** The formula for finding profit or loss is sales minus costs.
19. **Say:** If sales are greater than costs, then the business made a profit.
20. **Say:** If costs are greater than sales, then the business has a loss.
21. **Say:** Loss will be a decrease.

Guided Practice (6 minutes)

1. Write:
 Zinab wants to start a rice farm. She spends Le 100,000 to buy new land, Le 25,000 on new tools, Le 15,000 on seeds, and Le 30,000 for Musa to help her harvest the rice. She sells all of her rice for Le 300,000.
 - a) What are the total costs and sales?
 - b) Did Zinab's farm have a profit or a loss?
 - c) Calculate her profit or loss.
2. **Say:** We start by calculating Zinab's total costs. To find this we must add up her costs.
3. Write and explain aloud: $Cost = Le\ 100,000 + Le\ 25,000 + Le\ 15,000 + Le\ 30,000 = Le\ 170,000$
4. **Ask:** What is her total amount in sales? (Answer: $Sales = Le\ 300,000$)
5. Write: $Sales = Le\ 300,000$
6. **Ask:** Did her farm have a profit or a loss? (Answer: A profit.)
7. **Ask:** How do we know this? (Example answer: She sold more than she spent in costs.)
8. **Say:** Now we will calculate her profit.
9. Write and explain aloud: $Sales - cost = Le\ 300,000 - Le\ 170,000 = Le\ 130,000$




Independent Practice (10 minutes)

1. Write: What if Zinab sold her rice for only Le 100,000 because some of it spoiled, but she already spent the money on the cost of the farm?
 - a) Would Zinab's farm have a profit or a loss?
 - b) Calculate her profit or loss.
2. **Say:** Please work on your own to solve the problems. Write the answers in your exercise book.
3. Walk around the room and assist pupils when needed.
4. **Ask:** Who would like to come to the board and write the answer for problem a? (Answer: A loss.)
5. Call on a pupil with hand raised to answer problem a on the board.
Ask: Who would like to come to the board and answer problem b? (Answer: $Cost - sales = Le\ 170,000 - Le\ 100,000 = Le\ 70,000$)
6. Call on a pupil with hand raised to answer problem b on the board.
7. **Say:** Zinab would have a loss of $Le\ 70,000$

Closing (2 minutes)

1. **Ask:** Is profit a percent increase or decrease? (Answer: Increase)
2. **Ask:** Is loss a percent increase or decrease? (Answer: Decrease)
3. **Ask:** What formulae do we use to find profit and loss? (Answer: $\text{Percent profit} = \frac{\text{profit}}{\text{capital}} \times 100\%$; $\text{Percent loss} = \frac{\text{loss}}{\text{capital}} \times 100\%$)
4. Write: $\text{Percent profit} = \frac{\text{profit}}{\text{capital}} \times 100\%$; $\text{Percent loss} = \frac{\text{loss}}{\text{capital}} \times 100\%$

Lesson Title: Calculating Profit	Theme: Everyday Arithmetic	
Lesson Number: M-08-037	Class/Level: JSS 2	Time: 35 minutes

	Learning Outcomes By the end of the lesson, pupils will be able to: apply percentages to calculate profit on a transaction		Teaching Aids None		Preparation None
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Opening (3 minutes)

- Ask:** What do we mean by the word costs? (Answer: The money spent to produce something.)
- Ask:** What do we mean by the word sales? (Answer: The money gained from selling something.)
- Ask:** What do we mean by the word profit? (Answer: The amount of money gained after the cost is subtracted from sales.)
- Ask:** What do we mean by the word loss? (Answer: The amount of money lost after the sales are subtracted from the cost.)
- Say:** Today, we will learn how to calculate the percentage profit.

Introduction to the New Material (12 minutes)

- Write:
Musa paid his brother Le 2,500 to borrow his machete so he could collect coconuts in the bush. He collected 30 coconuts that he could sell for Le 300 each. Musa was tired so he paid his sister Le 3,500 to sell the coconuts. She sold them all. Calculate Musa's percent profit.
- Say:** In order to solve the problem, we must first calculate the sales and cost to find the profit, and then use the equation for percentage profit.
- Say:** Our first step is to multiply the number of coconuts by the amount he sold them for.
- Calculate on the board: $30 \times \text{Le } 300 = \text{Le } 9,000$
- Say:** Musa's costs to collect the coconuts are the cost of the machete and the money he paid his sister to sell the coconuts.
- Write: $\text{Le } 2,500 + \text{Le } 3,500 = \text{Le } 6,000$
- Say: His costs were Le 6,000
- Say:** In order to calculate how much profit Musa made we need to use the formula profit = sales – cost.
- Write: $\text{Profit} = \text{sales} - \text{cost}$
- Say:** Now I can calculate the answer.
- Write: $\text{Le } 9,000 - \text{Le } 6,000 = \text{Le } 3,000$
- Say:** Musa made Le 3,000 in profit. Now we can calculate what percentage profit that is.
- Say:** The formula for calculating the percentage profit is $\text{Percent profit} = \frac{\text{profit}}{\text{capital}} \times 100\%$
- Write: $\text{Percent profit} = \frac{\text{profit}}{\text{capital}} \times 100\%$
- Say:** Now I can substitute the values into the formula and solve.
- Write and explain aloud: $\text{Percent profit} = \frac{\text{profit}}{\text{capital}} \times 100\% = \frac{\text{Le } 3,000}{\text{Le } 6,000} \times 100\% = 50\% \text{ profit}$
- Say:** Musa made a 50% profit selling the coconuts.

Guided Practice (8 minutes)

1. Write the following problem on the board: Jeneba owns a car. She pays Le 22,500 for gasoline. She drives 5 passengers for Le 8,100 each. Calculate Jeneba's percent profit.
2. **Ask:** What is the first step in solving this problem? (Example answer: Calculate how much she made.)
3. Write: *Sales:* $5 \times \text{Le } 8,100 = \text{Le } 40,500$
4. **Ask:** What is the next step? (Example answer: Identify her costs.)
5. Write: *Cost of gasoline* = Le 22,500
6. **Say:** Now we can calculate her profit.
7. **Say:** Please calculate the profit in your exercise book using the formula profit = sales – cost.
8. **Ask:** What is the answer? (Answer: Le 18,000)
9. **Say:** Now we need to calculate her percent profit.
10. Write: *Percent profit* = $\frac{\text{profit}}{\text{capital}} \times 100\% = \frac{\text{Le } 18,000}{\text{Le } 22,500}$
11. **Say:** Use this formula to calculate her percent profit.
12. **Ask:** What is the answer? (Answer: 80% profit)
13. Write: $\frac{\text{Le } 18,000}{\text{Le } 22,500} \times 100\% = 80\%$ profit
14. **Say:** Jeneba made an 80% profit driving her car.




Independent Practice (10 minutes)

1. Write: Esther sells goods in the market in her village. She pays Le 30,000 for a carton of 200 biscuits, which she buys in Freetown. The cost of her travel from Freetown to her village is Le 18,000. She sells the 200 biscuits for Le 240 each. Calculate Esther's percent profit.
2. **Say:** Please work on your own to solve the problem. Write the answer in your exercise book.
3. Walk around the room and assist pupils when needed.
4. **Ask:** Who would like to come to the board and calculate the sales? (Answer: *Sales:* $200 \times \text{Le } 240 = \text{Le } 48,000$)
5. Call on a pupil with hand raised to calculate the sales on the board.
6. **Ask:** Who would like to come to the board and calculate the costs? (Answer: *Cost of carton + travel* = $\text{Le } 30,000 + \text{Le } 18,000 = \text{Le } 48,000$)
7. Call on a pupil with hand raised to calculate the costs on the board.
8. **Ask:** Who would like to come to the board and calculate the profit? (Answer: *Profit* = $\text{sales} - \text{cost} = \text{Le } 60,000 - \text{Le } 48,000 = \text{Le } 12,000$)
9. Call on a pupil with hand raised to calculate the profit on the board.
10. **Ask:** Who would like to come to the board and calculate the percent profit?
(Answer: *Percent profit* = $\frac{\text{profit}}{\text{capital}} \times 100\% = \frac{\text{Le } 12,000}{\text{Le } 48,000} \times 100\% = 25\%$ profit)
11. Call on a pupil with hand raised to calculate the percent profit on the board.
12. **Say:** Esther made a 25% profit.

Closing (2 minutes)

1. Ask: How does percent increase compare to percent profit (Example answer: Percent profit follows the same pattern as percent increase; you find the difference between the new quantity – the sales, and the original quantity – the costs; then divide by the cost and multiply by 100%.)

Lesson Title: Calculating Loss	Theme: Everyday Arithmetic	
Lesson Number: M-08-038	Class/Level: JSS 2	Time: 35 minutes

	Learning Outcomes By the end of the lesson, pupils will be able to apply percentages to calculate loss on a transaction		Teaching Aids None		Preparation None
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Opening (3 minutes)

1. Write: Johnson spends Le 40,000 on capital to start a business. In the first year he earns Le 35,000.
2. Ask: Did he make a profit or a loss? How do you know? (Answer: He lost money. The difference between sales and costs is $Le\ 40,000 - Le\ 35,000 = Le\ 5,000$. He spent more money than he made back in sales.)
3. **Say:** Today, we will learn how to calculate the percentage loss.

Introduction to the New Material (10 minutes)

1. Write:
Amad spent Le 120,000 on supplies to start a carpentry business, and Le 130,000 on building a shop. During the first month he sold 4 pieces of furniture each costing Le 50,000. Calculate Amad's percent loss.
2. **Say:** To solve this problem we must first calculate the sales and cost to find the loss, and then use the equation for percentage loss.
3. **Say:** First we will calculate Amad's sales by multiplying the number of pieces of furniture by the amount he sold them for.
4. Write: $Amount\ sold \times cost = 4 \times Le\ 50,000 = Le\ 200,000$
5. **Say:** The cost for Amad to set up his business is the cost of supplies and the building of his shop.
6. Write: $The\ cost\ of\ supplies + building\ his\ shop = Le\ 120,000 + Le\ 130,000 = Le\ 250,000$
7. **Ask:** To calculate how much profit Amad made, we will use the formula $Loss = cost - sales$.
8. Write: $Loss = cost - sales$
9. Calculate on the board and explain aloud: $Loss = cost - sales = Le\ 250,000 - Le\ 200,000 = Le\ 50,000$
10. **Say:** Amad had a loss of Le 50,000. Now we can calculate what percentage loss that is.
11. **Say:** The formula for calculating the percentage loss is $Percent\ loss = \frac{loss}{capital} \times 100\%$
12. Write: $Percent\ loss = \frac{loss}{capital} \times 100\%$
13. **Say:** Now we can substitute the values into the formula and solve.
14. Write: $Percent\ loss = \frac{loss}{capital} \times 100\% = \frac{Le\ 50,000}{Le\ 250,000} \times 100\% = 20\% \text{ loss}$
15. **Say:** Amad had a 20% loss in starting his business.

Guided Practice (10 minutes)

1. Write:
Fatima wants to start a tailoring business. She pays Le 780,000 for a sewing machine and Le 20,000 for other supplies. After one month she has tailored two suits for Le 290,000 each. Calculate Fatima's percent loss.
2. **Ask:** What is the first step to solve the problem? (Answer: Calculate the amount sold.)
3. Write: $Sales: 2 \times Le\ 290,000$
4. **Say:** Please calculate the answer in your exercise book.
5. **Ask:** What is the answer? (Answer: Le 580,000)
6. Write: $Sales: 2 \times Le\ 290,000 = Le\ 580,000$
7. **Ask:** What is the next step? (Answer: Calculate Fatima's costs.)
8. **Say:** Please calculate Fatima's costs in your exercise book.
9. Write: $Cost - sales = Le\ 800,000 - Le\ 580,000 =$
10. **Ask:** What is the answer? (Answer: Le 220,000)
11. Finish the equation: $Cost - sales = Le\ 800,000 - Le\ 580,000 = Le\ 220,000$
12. **Say:** Now we need to calculate the percent loss.
13. Write: $Percent\ loss = \frac{loss}{capital} \times 100\% =$
14. **Say:** Please calculate the percent loss in your exercise book.
15. Write: $Percent\ loss = \frac{loss}{capital} \times 100\% = \frac{Le\ 220,000}{Le\ 800,000} \times 100\% =$
16. **Ask:** What is the answer? (Answer: 27.5% loss)
17. Finish the equation: $Percent\ loss = \frac{loss}{capital} \times 100\% = \frac{Le\ 220,000}{Le\ 800,000} \times 100\% = 27.5\% loss$
18. **Say:** Fatima lost 27.5% during the first month of her business.




Independent Practice (10 minutes)

1. Write:
Gbessay sells lappa. She pays Le 160,000 each for 5 lappas. Her friend visits her and she sells the lappa at a discount for Le 150,000 each. Calculate Gbessay's percent loss.
2. **Say:** Please work on your own to simplify the problems. Write the answers in your exercise book.
3. Walk around the room and assist pupils when needed.
4. **Ask:** Who would like to come to the board and calculate the sales? (Answer: $Sales: 5 \times Le\ 150,000 = Le\ 750,000$)
5. Call on a pupil with hand raised to calculate the sales on the board.
6. **Ask:** Who would like to come to the board and calculate the costs? (Answer: $Cost\ of\ lappa = Le\ 160,000 \times 5 = Le\ 800,000$)
7. Call on a pupil with hand raised to calculate the costs on the board.
8. **Ask:** Who would like to come to the board and calculate the loss? (Answer: $Loss = cost - sales = Le\ 800,000 - Le\ 750,000 = Le\ 50,000$)
9. Call on a pupil with hand raised to calculate the loss on the board.
10. **Ask:** Who would like to come to the board and calculate the percent loss?
(Answer: $Percent\ loss = \frac{loss}{capital} \times 100\% = \frac{Le\ 50,000}{Le\ 800,000} \times 100\% = 6.25\% loss$)
11. **Say:** Gbessay made a 6.25% loss.

Closing (2 minutes)

1. **Ask:** how does percent decrease compare to percent loss? (Example answer: Percent loss follows the same pattern as percent decrease. You find the difference between the new quantity – the sales, and the original quantity – the costs. Then divide by the cost and multiply by 100%. Like percent decrease it will be the amount less now.)

Lesson Title: Introduction to Percentages Greater than 100	Theme: Numbers and Numeration	
Lesson Number: M-08-039	Class/Level: JSS 2	Time: 35 minutes

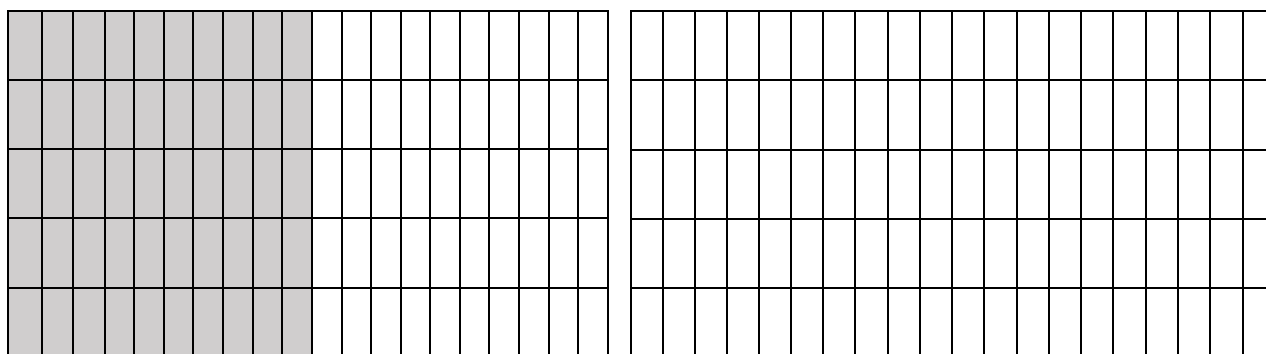
	Learning Outcomes By the end of the lesson, pupils will be able to identify percentages greater than 100 as more than one whole.		Teaching Aids None		Preparation Draw a grid representing 100 squares on the board.
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Opening (2 minutes)

- Ask:** What does the word profit mean? (Example answer: Profit is when you earn money over the original capital.)
- Ask:** What does the word loss mean? (Example answer: Loss is when you lose money in addition to the original money you put in.)
- Say:** Today, we are going to learn about percentages greater than 100.

Introduction to the New Material (14 minutes)

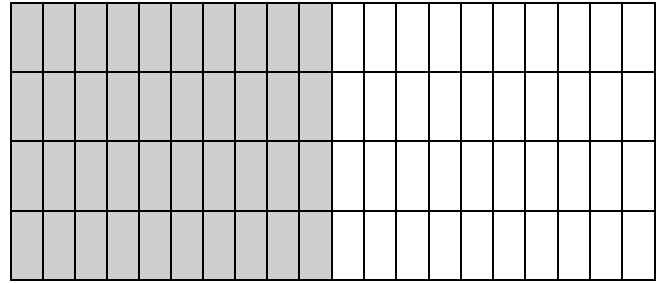
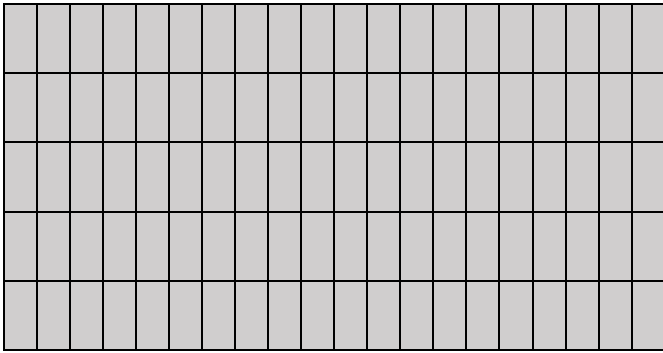
- Say:** We know that a percentage is any part or share of a whole.
- Say:** Percentages always add up to 100, that is one whole, but they can also be more than 100 if you have more than the whole.
- Point to the grid you have drawn



- Say:** When we are talking about percentages under 100% we can think about shading in a portion of this grid, as above.
- On the board shade in a portion of the first grid, for example 50%.
- Say:** When we are talking about percentages over 100% we can think about shading in the whole first grid and then part of the next grid of 100.
- Shade all of the first grid and 50 squares in the second grid:



8. **Say:** I have shaded 150%. All of the first grid



which is 100 squares and half of the second grid which is 50 squares.

9. Write: $100\% + 50\% = 150\%$

10. **Say:** Percentages over 100 follow the same rules as other percentages. For example, to express them as a fraction you still put them over 100.

11. **Say:** 150% as a fraction is expressed as $\frac{150}{100}$.

12. Write: $\frac{150}{100}$

Guided Practice (7 minutes)

1. Write:

A pupil studied for 20 minutes one night. The next night she studied for 50 minutes. What is the percentage increase in minutes?

2. **Say:** We solved this problem previously, but let us look at it again.

3. Write on the board and explain aloud: Percentage increase = $\frac{\text{change in quantity}}{\text{original quantity}} \times 100\% = \frac{30}{20} \times \frac{100\%}{1} = 150\%$

4. **Say:** The pupil increased her studying by 150%.

5. **Ask:** What is the whole 100%? (Answer: 20 minutes)

6. **Say:** Increasing studying by 150% means that the second night the pupil studied one and a half times as much as the first night.

7. **Say:** Express 150% as a fraction in your exercise book.

8. **Ask:** What is the answer? (Answer: $\frac{150}{100}$)

Independent Practice (10 minutes)

1. Write:

The population of a village last year was 500 people. This year it increased by 120%.

a) Explain what it means to increase by 120%

b) Express 120% as a fraction.

2. **Say:** Please work on your own to solve the problems. Write the answers in your exercise book.

3. Walk around the room and assist pupils when needed.




4. **Ask:** What is the answer for problem a? (Answer: It means that this year the population is 1.2 times the population last year. 500 is the whole so it is 500 people larger plus another 20% or over 1000 people now.)

5. **Ask:** Who would like to come to the board and write the answer for problem b? (Answer: $\frac{120}{100}$)

Closing (2 minutes)

1. **Ask:** What is 140% as a fraction? (Answer: $\frac{140}{100}$)
2. **Ask:** What is 250% as a fraction? (Answer: $\frac{250}{100}$)
3. **Ask:** What is 670% as a fraction? (Answer: $\frac{670}{100}$)
4. **Ask:** What is 435% as a fraction? (Answer: $\frac{435}{100}$)

Lesson Title: Calculations with Percentages Greater than 100	Theme: Numbers and Numeration	
Lesson Number: M-08-40	Class/Level: JSS 2	Time: 35 minutes

	Learning Outcomes By the end of the lesson, pupils will be able to calculate the percentage of a number where the percentage is greater than 100		Teaching Aids None		Preparation None
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Opening (3 minutes)

- Ask:** What do percentages always add up to? (Answer: 100%)
- Ask:** What does it mean if a percentage is over 100% (Answer: It is more than one whole.)
- Ask:** If a percentage is over 100%, what do we put it over to express it as a fraction? (Answer: It is still over 100).
- Say:** Today we will learn how to calculate the percentage of a number where the percentage is greater than 100.

Introduction to the New Material (7 minutes)

- Write:** Calculate 120% of 20.
- Say:** We express 120% as a fraction by putting it over 100.
- Write:** $\frac{120}{100}$
- Say:** Remember that even through the percentage is over 100% we still express it as a fraction over 100.
- Say:** The given quantity is 20.
- Say:** We calculate this solution the same way we would if the percentage was under 100%.
- Calculate on the board and explain aloud: $120\% \text{ of } 20 = \frac{120}{100} \times \frac{20}{1} = \frac{2,400}{100} = 24$
- Say:** We first change the percentage to a fraction, and then multiply it by the given quantity. When we say the word 'of' it often signals multiplication. We often need to simplify the answer.
- Say:** 120% of 20 is 24.

Guided Practice (12 minutes)

- Say:** Let's do the next one together.
- Write:** Calculate 200% of 30
- Ask:** How do we express 200% as a fraction? (Answer: $\frac{200}{100}$)
- Say:** Please write this in your exercise book.
- Ask:** What is the given quantity? (Answer: 30)
- Ask:** What comes next? (Example answer: Put the percentage over 100 and multiply by the given number.)
- Write:** $200\% \text{ of } 30 = \frac{200}{100} \times \frac{30}{1} =$
- Say:** Please write the equation in your exercise book and calculate the answer.
- Ask:** What is the answer? (Answer: 60)

10. Write: $200\% \text{ of } 30 = \frac{200}{100} \times \frac{30}{1} = \frac{6000}{100} = 60$
11. **Say:** 200% of 30 is 60.
12. **Say:** Since 200% is two times 100% it makes sense that 60 is two times 30.
13. Write: Last year there were 116 pupils enrolled in JSS 1. This year the enrollment is up by 175%.
What is the enrollment in JSS1 this year?
14. **Say:** Work together with a partner to solve the problem.
15. Walk around the room and assist pupils when needed.
16. **Ask:** Who would like to come to the board and solve the problem?
17. Call on a pair of pupils with hands raised to solve the problem on the board. (Answer: $\frac{175}{100} \times \frac{116}{1} = \frac{20,300}{100} = 203$ pupils)
18. **Say:** This year enrollment is at 203 pupils.




Independent Practice (10 minutes)

1. Write the following problems on the board:
 1. Calculate 300% of 200
 2. Calculate 165% of 40
 3. Calculate 230% of 120
 4. Calculate 180% of 80
2. **Say:** Please work on your own to solve the problems in your exercise book.
3. Walk around the room and assist pupils when needed.
4. **Ask:** Who would like to solve problem a on the board?
5. Call on a pupil with hand raised to solve problem a on the board. (Answer: $300\% \text{ of } 200 = \frac{300}{100} \times \frac{200}{1} = \frac{60,000}{100} = 600$)
6. **Ask:** Who would like to solve problem b on the board?
7. Call on a pupil with hand raised to solve problem b on the board. (Answer: $165\% \text{ of } 40 = \frac{165}{100} \times \frac{40}{1} = \frac{6,600}{100} = 66$)
8. **Ask:** Who would like to solve problem c on the board?
9. Call on a pupil with hand raised to solve problem c on the board. (Answer: $230\% \text{ of } 120 = \frac{230}{100} \times \frac{120}{1} = \frac{27,600}{100} = 276$)
10. **Ask:** Who would like to solve problem d on the board?
 - a. Call on a pupil with hand raised to solve problem d on the board. (Answer: $180\% \text{ of } 80 = \frac{180}{100} \times \frac{80}{1} = \frac{14,400}{100} = 144$)

Closing (3 minutes)

1. Write: Calculate 170% of Le 50,000.
2. **Ask:** What is the answer? (Answer: $170\% \text{ of } 50,000 = \frac{170}{100} \times \frac{50,000}{1} = \frac{8,500,000}{100} = \text{Le } 85,000$)

Lesson Title: Ratio	Theme: Everyday Arithmetic	
Lesson Number: M-08-041	Class/Level: JSS 2	Time: 35 minutes

	Learning Outcomes By the end of the lesson, pupils will be able to identify the forms of ratio: m:n and m/n and simplify ratios to their lowest terms		Teaching Aids None		Preparation None
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Opening (3 minutes)

- Ask:** What does the word ratio mean? (Example answer: ratio is a way of comparing two or more quantities.)
- Say:** If I compared the number of boys and girls in this class, that would be a ratio.
- Say:** Today we will learn how to write ratios as fractions in their simplest form.

Introduction to the New Material (8 minutes)

- Say:** Ratios help us to compare two or more quantities
- Say:** 15 pencils is to 20 pens..
- Say:** The symbol for the words “is to” is a colon
- Write a colon on the board. (:)
- Say:** We can now write 15 pencils is to 20 pens as a ratio.
- Write: 15 pencils : 20 pens
- Say:** We can also compare pencils and pens by saying “for every 15 pencils we have 20 pens.”
- Write: 15:20, 15 is to 20, for every 15 pencils we have 20 pens.
- Say:** These are three ways to compare the quantities in a ratio format.
- Say:** The order of a ratio is very important. The ratio of pencils to pens is 15:20 and the ratio of pens to pencils is 20:15.
- Say:** We can also write ratios as fractions.
- Say:** To write ratios as fractions, the first number in the ratio becomes the numerator and the second number becomes the denominator.
- Say:** Then you can simplify the fraction.
- Write: $\frac{15}{20} = \frac{3}{4}$
- Say:** I have simplified the fraction. The ratio of pencils to pens is $\frac{3}{4}$.

Guided Practice (12 minutes)

- Write: Mohamed received an 85% mark on an exam. What ratio of correct answers did Mohamed get?
- Say:** To solve this we must remember that when we talk about percent, we compare a number to 100.
- Ask:** How do we express Mohamed’s mark as a fraction? (Answer: $\frac{85}{100}$)
- Write: $\frac{85}{100}$
- Ask:** How do we express Mohamed’s mark in ratio format. (Answer: 85: 100)

6. Write: 85: 100
7. **Ask:** How do we express Mohamed's mark as a fraction in its lowest terms? (Answer: $\frac{85}{100} = \frac{17}{20}$)
8. Write: $\frac{85}{100} = \frac{17}{20}$
9. **Say:** We have expressed Mohamed's mark as a ratio in three different ways.
10. **Say:** Let's do another one together.
11. Write: Two sellers traveled different distances to the market. Samuel went 6km and Alice went 8km. What is the ratio of Samuel's travel to Alice's in the lowest term?
12. **Ask:** How do we express the distance they traveled as a fraction? (Answer: $\frac{6 \text{ km}}{8 \text{ km}}$)
13. Write: $\frac{6 \text{ km}}{8 \text{ km}}$
14. **Ask:** How do we express the distance they traveled in ratio format. (Answer: 6 : 8)
15. Write: 6 : 8
16. **Ask:** How do we express the distance they traveled in its lowest terms? (Answer: $\frac{6 \text{ km}}{8 \text{ km}} = \frac{3}{4}$)
17. Write: $\frac{6 \text{ km}}{8 \text{ km}} = \frac{3}{4}$




Independent Practice (10 minutes)

1. Write the following two questions on the board:
 - a) Marie sold 200 kg of rice. She has 600 kg. remaining. What is the ratio of sold rice to unsold rice expressed as a fraction in the lowest term?
 - b) This schoolyard is 80m long and 110m wide. What is the ratio of length to width of the schoolyard?
2. **Say:** Please work on your own and write the answers in your exercise book.
3. Walk around the class and assist pupils when needed.
4. **Ask:** What is the answer to problem a? (Answer: $\frac{1}{3}$)
5. Write: $200 \text{ kg} : 600 \text{ kg} = \frac{200 \text{ kg}}{600 \text{ kg}} = \frac{1}{3}$
6. **Ask:** What is the answer to problem b? (Answer: $\frac{8}{11}$)
7. Write: $80 \text{ m.} : 110 \text{ m.} = \frac{80 \text{ m.}}{110 \text{ m.}} = \frac{8}{11}$

Closing (2 minutes)

1. Write: Satta has 18 ml oil, Joe has 36 ml oil Express the ratio of Satta's cooking oil to Joe's cooking oil in three different ways, and then write it as a fraction in its lowest term.
2. **Say:** Please write the answers in your exercise book.
3. **Ask:** What is one way to express the ratio? (Answer: For every 18 ml of oil that Satta has, Joe has 36 ml)
4. **Ask:** What is another way to express the ratio? (Answer: 18 ml is to 36 ml)
5. **Ask:** What is a final way to express the ratio? (Answer: $\frac{18 \text{ ml.}}{36 \text{ ml.}}$)
6. **Ask:** What is the fraction in its lowest term? (Answer: $\frac{1}{2}$)

Lesson Title: Rate	Theme: Everyday Arithmetic	
Lesson Number: M-08-042	Class/Level: JSS 2	Time: 35 minutes

	Learning Outcomes By the end of the lesson, pupils will be able to: 1. Identify that rate is a special ratio that compares two units of measurement. 2. Identify notation for rates.		Teaching Aids None		Preparation None
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Opening (3 minutes)

- Write: Bendu is a farmer. She has 16 goats, and 20 cows on her farm. What is the ratio of goats to cows as a fraction in the lowest term?
- Ask:** What are four different ways to tell the ration of goats to cows? (Answers: 16 goats is to 20 cows; 16:20; for every 16 goats there are 20 cows; $\frac{16 \text{ goats}}{20 \text{ cows}}$)
- Ask:** What is the fraction in lowest terms? (Answer = $\frac{16 \text{ goats}}{20 \text{ cows}} = \frac{4}{5}$)
- Say:** Today we will learn about a special kind of ratio, called a rate.

Introduction to the New Material (13 minutes)

- Say:** A ratio is a way of comparing two or more quantities.
- Say:** Rate is a special ratio that compares two different units of measurement like metres, litres, and grams.
- Say:** If we want to compare the number of grams of rice per Leones, we would be using a rate.
- Write: What is the rate if a man buys 100 grams of rice for Le 3,600?
- Say:** We can express the quantities as a fraction.
- Write: $\frac{\text{Le } 3,600.}{100 \text{ g.}}$
- Say:** The rate is Le 3,600 per 100 g. of rice. This means that for Le 3,600 you can purchase 100 g. of rice.
- Say:** The fraction can be simplified.
- Write: $\frac{\text{Le } 36}{1 \text{ g.}}$
- Say:** When we simplify the fraction we find the rate is Le 36 per 1 g. of rice.

Guided Practice (7 minutes)

- Say:** Let's do one together.
- Write: What rate are you traveling at if it takes you 40 minutes to walk two miles?
- Say:** Express the rate as a fraction in your exercise book.
- Ask:** What is the answer? (Answer: 40 min. per 2 miles. $\frac{40 \text{ min.}}{2 \text{ miles}}$)
- Write: 40 min. per 2 miles. $\frac{40 \text{ min.}}{2 \text{ miles}}$
- Ask:** What is the fraction simplified? (Answer: $\frac{40 \text{ min.}}{2 \text{ miles}} = \frac{20 \text{ min.}}{1 \text{ mile}} = 20 \text{ min./mile}$)
- Say:** Your rate would be 20 min. per mile.
- Say:** Work on the next questions with a partner.

9. Write the following question on the board:
 - a) Ishmael weaves baskets. He can weave 3 baskets in an hour. What is his rate for basket weaving?
 - b) Massa sells fish 3 for Le 4,000. What is the rate for fish?
10. Walk around the room and assist pupils when needed.
11. **Ask:** Who would like to come to the board with their partner and solve problem a?
12. Call on a pair of pupils with hands raised to solve problem a on the board. (Answer: $\frac{3 \text{ baskets}}{1 \text{ hour}} = 3 \text{ baskets/hour}$)
13. **Ask:** Who would like to come to the board with their partner and solve problem b?
14. Call on a pair of pupils with hands raised to solve problem b on the board. (Answer: $\frac{\text{Le } 4,000}{3 \text{ fish}} = \text{Le } 4,000/3 \text{ fish}$)




Independent Practice (10 minutes)

1. Write:
 - a) Jebbeh bakes 12 loaves of bread each day to sell. What is her rate of baking?
 - b) Mustapha wants to buy candles; they are sold in a box of 8 for Le 2,500. What is the rate for candles?
2. **Say:** Please work on your own and write the answers in your exercise book.
3. Walk around the room and assist pupils when needed.
4. **Ask:** What is the answer for problem a? (Answer: 12 loaves of bread/day)
5. Write: $\frac{12 \text{ bread}}{1 \text{ day}} = 12 \text{ loaves of bread/day}$
6. **Ask:** What is the answer for problem b? (Answer: *Le 625 / 2 candles*)
7. Write: $\frac{\text{Le } 2,500}{8 \text{ candles}} = \text{Le } 625 / 2 \text{ candles}$

Closing (2 minutes)

1. **Ask:** What makes a rate different from a ratio? (Answer: It compares two different units of measurement.)
2. **Ask:** What are times when it would be useful to calculate rate? (Example answers: buying gas for a particular length of travel; calculating cost of food per ounce or per piece; etc.)

Lesson Title: Unit Rate	Theme: Everyday Arithmetic	
Lesson Number: M-08-043	Class/Level: JSS 2	Time: 35 minutes

	Learning Outcomes By the end of the lesson, pupils will be able to: 1. Perform basic calculations to find unit rate. 2. Convert different rates to their unit rates.		Teaching Aids None		Preparation None
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Opening (3 minutes)

- Ask:** What is the difference between ratio and rate? (Example answer: Both are comparisons between different quantities, however rates are a special type of ratio that compares different units of measurement.)
- Say:** Today we will learn about unit rate and calculating it for different rates.

Introduction to the New Material (13 minutes)

- Write: I can carry 45 coconuts in 3 bags. How many coconuts fit per bag?
- Say:** When a rate is expressed as a quantity of 1, we call it a unit rate, because it is the rate per 1 unit.
- Say:** The rate for coconuts per bag given in the question is: $\frac{45 \text{ coconuts}}{3 \text{ bag}}$.
- Say:** First I will simplify the ratio.
- Write: $\frac{45 \text{ coconuts}}{3 \text{ bag}} = \frac{15 \text{ coconuts}}{1 \text{ bag}} = 15 \text{ coconuts/ bag}$
- Say:** The unit rate is 15 coconuts per bag.
- Write: Sando is traveling home to the village; it takes her 3 hours to travel 210 km. What is her rate of travel in kph?
- Say:** We need to find out the number of kilometres that Sando traveled in one hour.
- Say:** The rate that Sando is traveling in the question is $\frac{210 \text{ km.}}{3 \text{ hours}}$.
- Write: $\frac{210 \text{ km.}}{3 \text{ hours}}$
- Say:** Now I need to simplify the fraction.
- Write: $\frac{210 \text{ km.}}{3 \text{ hours}} = \frac{70 \text{ km.}}{1 \text{ hr.}} = 70 \text{ km. per hour or } 70 \text{ kph.}$
- Say:** The unit rate is 70 kph for Sando's trip.

Guided Practice (7 minutes)

- Say:** We will do the next problem together.
- Write: There are 270 pupils divided among 6 classrooms. What is the unit rate for 1 classroom?
- Ask:** What do we need to find out? (Answer: The unit rate for one classroom.)
- Ask:** What is the rate in the problem? (Answer: $\frac{270 \text{ pupils}}{6 \text{ classrooms}}$)
- Write: $\frac{270 \text{ pupils}}{6 \text{ classrooms}}$
- Say:** Write this rate in your exercise books.
- Say:** Now we need to simplify.

8. **Say:** Simplify this fraction in your exercise books.
9. **Ask:** What is the answer? (Answer: 45 students/classroom)
10. **Say:** The answer is 45 students to a classroom.
11. Write: The rate for 10 litres of gasoline is Le 45,000. What is the unit rate for gasoline?
12. **Say:** Please work with a partner to solve this problem.
13. Walk around the class and assist pupils when needed.
14. **Ask:** What is the answer? (1 litre/Le 4,500)
15. Write: $\frac{\text{Le } 45,000}{10 \text{ litres}} = 1 \text{ litre/Le } 4,500$
16. **Say:** The answer is 1 litre to Le 4,500.




Independent Practice (10 minutes)

1. Write:
 - a) 30 pupils take 6 cars to a field trip. What is the unit rate per car?
 - b) Sai can paint 100 m.² in 4 hours. What is his unit rate per hour?
2. **Say:** Work on your own to solve the problems in their exercise books.
3. Walk around the room and assist pupils when needed.
4. **Ask:** What is the answer for problem a? (Answer: 5 pupils/car)
5. Write: $\frac{30 \text{ pupils}}{6 \text{ cars}} = 5 \text{ pupils/car}$
6. **Ask:** What is the answer for problem b? (Answer: = 25 m.²/ hour)
7. Write: $\frac{100m.^2}{4 \text{ hours}} = 25 \text{ m.}^2/ \text{ hour}$

Closing (2 minutes)

1. **Ask:** What unit rates are you familiar with that you may see in your daily life? (Example answers: The cost of 1 litre of gasoline, the costs of individual items such as tissue, soap, or measurements of food, etc.)

Lesson Title: Calculation of Unit Price	Theme: Everyday Arithmetic	
Lesson Number: M-08-044	Class/Level: JSS 2	Time: 35 minutes

	Learning Outcomes By the end of the lesson, pupils will be able to calculate the unit price of goods sold by various units (l., kg., etc.).		Teaching Aids None		Preparation None
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Opening (3 minutes)

- Ask:** What are things you frequently buy? (Example answers: fruit, rice, cooking oil.)
- Ask:** How do you know when it is a good price? (Example answers: You may purchase something often enough that you know when the price goes up or down and you know when it is too expensive)
- Say:** Today we will learn about calculating the unit price of goods.

Introduction to the New Material (7 minutes)

- Write: 5 kilograms of cassava costs Le 6,000. What does 1 kg. cassava cost?
- Say:** The question is asking us to find the unit rate.
- Say:** The rate for cassava given in the question is $\frac{Le\ 6,000}{5\ kg.}$.
- Say:** This rate can be simplified.
- Write: $\frac{Le\ 6,000}{5\ kg.} = \frac{Le\ 1,200}{1\ kg.} = Le\ 1,200/kg.$
- Say:** The unit rate of a kilogram of cassava is Le 1,200.
- Say:** The unit rate in questions involving price can also be called the unit price. The price per unit of cassava is Le 1,200.
- Say:** When we calculate the unit rate for questions involving price it can help us determine if what we are paying is a good price.

Guided Practice (13 minutes)

- Write: 3 kg. peanuts costs Le 4,500. What does 1 kg. cost?
- Ask:** What is the rate for peanuts given in the question? (Answer: $\frac{Le\ 4,500}{3\ kg.}$)
- Write: $\frac{Le\ 4,500}{3\ kg.}$
- Say:** Simplify the fraction in your exercise book.
- Ask:** What is the fraction simplified? (Answer: $Le\ 1,200/1kg$)
- Write: $\frac{Le\ 4,500}{3\ kg.} = \frac{Le\ 1,500}{1\ kg.} = Le\ 1,200/1kg$
- Say:** The unit price for 1 kg peanuts is Le 1,200.
- Say:** Work with a partner to solve the next few problems.
- Write: A carton of 500 biscuits is Le 30,000. What is the unit price per biscuit?
- Walk around the room and assist pupils when needed.
- Ask:** Who would like to write their answer on the board?

12. Call on a pupil with hand raised to write their answer on the board. (Answer: $\frac{\text{Le } 30,000}{500 \text{ biscuits}} = \text{Le } 60 / \text{biscuits}$)
13. Write: Gasoline is Le 200,000 for 40 litres. What is the unit price per litre?
14. Walk around the room and assist pupils when needed.
15. **Ask:** Who would like to write their answer on the board?
16. Call on a pupil with hand raised to write their answer on the board. (Answer: $\frac{\text{Le } 200,000}{40 \text{ litres}} = \text{Le } 5,000 / 1 \text{ litre}$)




Independent Practice (10 minutes)

1. Write the following two questions on the board:
 - a. A bus ticket for a 300 km. trip is Le 6,000. What is the unit price per km. traveled?
 - b. A bucket of 30 mangos is Le 360. What is the unit price per mango?
2. **Say:** Please work on your own and solve the problems in their exercise books.
3. Walk around the room and assist pupils when needed.
4. **Ask:** What is the answer for problem a? (Answer: $\frac{\text{Le } 6,000}{300 \text{ km.}} = \text{Le } 20 / \text{km}$)
5. Write: $\frac{\text{Le } 6,000}{300 \text{ km.}} = \text{Le } 20 / \text{km}$
6. **Ask:** What is the answer for problem b? (Answer: $\frac{\text{Le } 360}{30 \text{ mangos}} = \text{Le } 12 / \text{mango}$)
7. Write: $\frac{\text{Le } 360}{30 \text{ mangos}} = \text{Le } 12 / \text{mango}$

Closing (2 minutes)

1. Write: Calculate the price per unit for onions, if you buy 500 onions for Le 8,000.
2. **Ask:** What is the answer? (Answer: $\frac{\text{Le } 8,000}{500 \text{ onions}} = \text{Le } 16 / 1 \text{ onion}$)

Lesson Title: Making Comparisons with Unit Price	Theme: Everyday Arithmetic	
Lesson Number: M-08-045	Class/Level: JSS 2	Time: 35 minutes

	Learning Outcomes By the end of the lesson, pupils will be able to compare goods to find which one has a better unit price.		Teaching Aids None		Preparation None
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Opening (3 minutes)

- Ask:** If two sellers have the same goods for sale, how do you decide which one to purchase from?
- Ask:** Do some sellers offer better prices or deals than others.
- Say:** Today we will learn how to compare goods to find out which one has a better unit price.

Introduction to the New Material (13 minutes)

- Write: Seller A has 50 kilograms of rice for Le 200,000. Seller B has 60 kg of rice for Le 222,000. Which rice has a lower unit price?
- Say:** First we will calculate the unit price for Seller A.
- Say:** The rate for rice for Seller A given in the question is $\frac{Le\ 200,000}{50\ kg.}$
- Write: $\frac{Le\ 200,000}{50\ kg.}$
- Say:** Simplified this is $Le\ 4,000/ kg.$
- Write: $\frac{Le\ 200,000}{50\ kg.} = Le\ 4,000/ kg.$
- Say:** The unit rate of a Seller A's rice is Le 4,000.
- Say:** Now we must calculate the unit price for Seller B.
- Say:** The rate for rice for Seller B given in the question is $\frac{Le\ 222,000}{60\ kg.}$
- Write: $\frac{Le\ 222,000}{60\ kg.}$
- Say:** Simplified this is $Le\ 3,700/ kg.$
- Write: $\frac{Le\ 222,000}{60\ kg.} = Le\ 3,700/ kg.$
- Say:** The unit rate of a Seller B's rice is Le 3,700.
- Say:** Seller B has a lower unit price for their rice.
- Say:** Unit price can be very helpful to allow us to compare prices of different quantities. Even though Seller B's rice was more expensive, because you get more rice for the cost it is a lower unit price.
- Say:** You would want to buy rice from Seller B, assuming it is the same rice, because you get more for your money.
- Say:** A lower unit price for the same product is a better deal.

Guided Practice (7 minutes)

1. **Say:** Let's work together on the next problem.
2. Write: In the market you can buy 2 litres of cooking oil for Le 80,000 or 3.5 litres of cooking oil for Le 120,000. Which option has the lower unit price?
3. **Ask:** What do we do first? (Answer: Calculate the unit prices.)
4. **Say:** Please calculate the unit price for the 2 litres of cooking oil for Le 80,000 in your exercise book.
5. **Ask:** What is the unit price? (Answer: Le 40,000/litre)
6. Write: $\frac{\text{Le } 80,000}{2 \text{ litres}} = \text{Le } 40,000 / \text{litre}$
7. **Say:** Please calculate the unit price for the 3.5 litres of cooking oil for Le 120,000 in your exercise book.
8. **Ask:** What is the unit price? (Answer: Le 35,000/litre)
9. Write: $\frac{\text{Le } 122,500}{3.5 \text{ litres}} = \text{Le } 35,000 / 1 \text{ litre}$
10. **Ask:** Which option is a better deal? (Answer: The 3.5 litres for Le 120,000)




Independent Practice (10 minutes)

1. Write: Massa sells 500 g. beans for Le 2,000. Yatta sells 400 g. of beans for Le 1,800. Which has the lower unit price?
2. **Say:** Work on your own to solve the problem in your exercise books.
3. Walk around the room and assist pupils when needed.
4. **Ask:** What is Massa's unit price? (Answer: Le 4/g)
5. Write: Massa: $\frac{\text{Le } 2,000}{500 \text{ g.}} = \text{Le } 4/\text{g}$
6. **Ask:** What is Yatta's unit price? (Answer: Le 4.5/g)
7. Write: Yatta: $\frac{\text{Le } 1,800}{400 \text{ g.}} = \text{Le } 4.5/\text{g}$
8. **Ask:** Who has the lower unit price for beans? (Answer: Massa)

Closing (2 minutes)

1. **Ask:** When do you use unit price to make a decision about purchasing something? (Example answers: choosing with person to buy from in the market, negotiating for a better deal.)

Lesson Title: Direct Proportion	Theme: Everyday Arithmetic	
Lesson Number: M-08-046	Class/Level: JSS 2	Time: 35 minutes

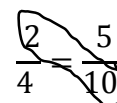
 <p>Learning Outcomes By the end of the lesson, pupils will be able to:</p> <ol style="list-style-type: none"> 1. Identify that a proportion is two ratios set equal to each other. 2. Identify the symbol for proportionality (\propto), the means and extremes 	 <p>Teaching Aids None</p>	 <p>Preparation None</p>
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Opening (3 minutes)

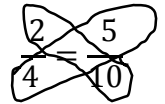
1. Write: For every 10 g. of rice John has, Massa has 15 g. Write the proportion in two different ways, and then write it as a fraction in its lowest term.
2. **Say:** Please answer this question in your exercise book.
3. **Ask:** What are they answers? (Answers: 10 g is to 15 g; $10\text{ g}:15\text{ g}; \frac{10\text{ g.}}{15\text{ g.}} = \frac{2}{3}$)
4. **Say:** Today our lesson topic to identify that a proportion is two ratios set equal to each other, and learn about the symbol of proportionality.

Introduction to the New Material (14 minutes)

1. Write: $\frac{2}{4} = \frac{5}{10}$
2. **Say:** You will see that these fractions are equivalent.
3. **Say:** A proportion is a pair of equivalent ratios in which the units must be the same.
4. **Say:** Direct proportions mean that as one ratio goes up, the other does too.
5. **Say:** On the other hand as one ratio goes down the other does too. For example, 2 increases to 4, so 5 increases to 10.
6. Write: $y = kx$
7. **Say:** Direct proportions are shown by the relationship one value (y) is equal to another value (x) multiplied by a constant (k).
8. **Say:** When two values are directly proportional to each other, we can use a special symbol \propto
9. Write the symbol on the board: \propto
10. **Say:** For example, we can write: $y \propto x$, meaning that y is directly proportional to x.
11. Write on the board: $\propto = \textit{proportional}$
12. **Say:** When we have a proportion with two equivalent ratios, we can use *cross multiplication*.
13. **Say:** Cross multiplication is multiplying the diagonals of equal fractions.
14. **Say:** If we multiply the numbers diagonally across from each other, the two products will be equal.
15. **Say:** When you cross multiply you multiply the *extremes* first. The extremes are the outside terms.
16. Point to 2 and 10 as the outside terms of the proportions $2:4 = 5:10$.
17. Circle the numbers on the board as shown.

$$\frac{2}{4} = \frac{5}{10}$$


18. **Say:** Then you multiply the *means*. The means are the inside terms.
19. Point to 5 and 4 as the inside terms of the proportions $2:4 = 5:10$.
20. Circle the numbers as shown.
21. Write the numbers on the board as: $2 \times 10 = 5 \times 4$
22. **Say:** Multiplying the means and extremes like this shows that the proportions are equivalent.
23. Write: $2 \times 10 = 5 \times 4$; $20 = 20$
24. **Say:** Since these ratios are equal, the cross products are equal too.



Guided Practice (5 minutes)

1. **Say:** Let's do the next one together.
2. Write: Express the following direct proportion as fractions, $3:6 = 9:18$. What are the means and extremes of the proportion? Use the means and extremes to demonstrate the ratios are equal.
3. Write: $\frac{3}{6} = \frac{9}{18}$
4. **Say:** I have written the fractions here on the board.
5. **Ask:** What are the extremes? (Answer: 3 and 18)
6. **Ask:** What are the means? (Answer: 6 and 9)
7. **Ask:** What is 3×18 ? (Answer: 54)
8. **Ask:** What is 6×9 ? (Answer: 54)
9. Write: $3 \times 18 = 54$ and $6 \times 9 = 54$
10. **Say:** The ratios are equal and the cross products are equal too.




Independent Practice (10 minutes)

1. Write: Express the following direct proportion as fractions $2:8 = 7:28$. What are the means and extremes of the proportion? Use the means and extremes to demonstrate the ratios are equal.
2. **Say:** Work on your own to solve the problem in your exercise books.
3. Walk around the room and assist pupils when needed.
4. **Ask:** Who would like to solve the problem on the board?
5. Call on a pupil with hand raised to solve the problem on the board.
(Answer: $\frac{2}{8} = \frac{7}{28}$; the extremes are 2 and 28 and the means are 8 and 7; $2 \times 28 = 56$ and $8 \times 7 = 56$)

Closing (3 minutes)

1. **Ask:** What does the term means mean? (Answer: The inside terms of a proportion which you multiply by the extremes)
2. **Ask:** What does the term extremes mean? (Answer: The outside terms of a proportion which you multiply by the means)
3. Write: \propto
4. **Ask:** What does that symbol mean? (Answer: It is a symbol meaning proportional to.)

Lesson Title: Identifying Direct Proportions	Theme: Everyday Arithmetic	
Lesson Number: M-08-047	Class/Level: JSS 2	Time: 35 minutes

	<p>Learning Outcomes By the end of the lesson, pupils will be able to:</p> <ol style="list-style-type: none"> 1. Identify true proportions. 2. Find the constant of proportionality. 		<p>Teaching Aids None</p>		<p>Preparation None</p>
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Opening (2 minutes)

1. Ask pupils to answer the following questions in their own words:
 - a. What are the means and extremes of a proportion?
 - b. What does \propto mean?
2. Example answers: (a) the means are the inside terms of two proportions, the extremes are the outside terms. You can cross-multiply them when two ratios are equal to each other. (b) The symbol means proportional.
3. **Say:** Today we will learn to identify true proportions and find the constant of proportionality.

Introduction to the New Material (15 minutes)

1. Write the following question on the board:
 $Y \propto x$. When $x = 2$, $y = 10$. Find the constant of proportionality
2. **Say:** We can rewrite this using the directly proportional equation: $y = kx$
➤ Remind pupils that we identified this equation in the last lesson.
3. **Ask:** What is k ? (Answer: a constant, some number that does not change)
4. **Say:** We call k the *constant of proportionality*, because it does not change. It is the difference between the two ratios in the proportion.
5. **Ask:** How can we figure out what k is? (Answer: Substitute the values for x and y , then solve)
6. Write on the board:
 $10 = k \times 2$
7. Ask pupils to solve the equation for k in their exercise books.
8. Write the following steps on the board:
 $\frac{10}{2} = k$
 $5 = k$
9. **Say:** $K = 5$, 5 is the constant of proportionality. We can rewrite our equation: $y = 5x$
10. Write on the board: $\frac{2}{10} =$
11. **Say:** Now that we have an equation with the constant of proportionality, we can create a proportion using the number we already have.
12. **Say:** Let us use 3 for x .
13. **Ask:** What is the value for y , according to the constant of proportionality? (Answer: $y = 5 \times 3 = 15$)
14. Write on the board: $\frac{2}{10} = \frac{3}{15}$
15. **Say:** Now we can complete our proportion.

16. **Ask:** Are these fractions equivalent? (Answer: Yes)
17. **Say:** Two proportions can be called true proportions when the product of the means equals the product of the extremes.
 ➤ If necessary, remind pupils what the means and extremes are.
18. **Ask:** How can we find out if two proportions are true proportions? (Answer: Cross-multiply)
19. Ask pupils to guide you through the steps to cross-multiply the means and extremes of the proportion you created.
20. Write the steps on the board as pupils do so in their exercise books:
- $$\frac{2}{10} = \frac{3}{15}$$
- $$2 \times 15 = 10 \times 3$$
- $$30 = 30$$
21. **Ask:** Is this proportion a true proportion? (Answer: Yes)

Guided Practice (5 minutes)

- Write a problem on the board:
 $Y \propto x$. When $x = 4$, $y = 16$. Find the constant of proportionality
- Ask pupils to work in pairs.
- Ask pupils to solve the problem in their exercise books.
- Move around the room, clear up any misconceptions.
- Ask one pupil from the class to come to the board and write their answer while the rest of the class check their work in their exercise books.

Answer: $y = kx$
 $16 = k \times 4$
 $\frac{16}{4} = k$
 $4 = k$
 $K = 4$, 4 is the constant of proportionality: $y = 4x$




Independent Practice (10 minutes)

- Write the following problem on the board:
 $Y \propto x$. When $x = 5$, $y = 30$.
 Find the constant of proportionality, rewrite the equation, and create a true proportion.
- Ask pupils to solve the problem individually.
- Ask pupils to write their answers in their exercise books.
- Move around the room, clear up any misconceptions.
- Ask two volunteers to come to the board and share their answers to the different parts of the question. (Answers: $y = kx$; $30 = k \times 5$; $\frac{30}{5} = k$; $6 = k$; the equation is $y = 6x$; $\frac{5}{30} = \frac{7}{42}$)

Closing (3 minutes)

- Ask pupils to answer the following open-ended question in their own words:
 What does the constant of proportionality tell us? (Example answer: It tells us the relationship between any x and y value that could be part of a true proportion.)
- Allow pupils to discuss, ask 1-2 pupils to share their ideas with the class.

Lesson Title: Solving Direct Proportions	Theme: Everyday Arithmetic	
Lesson Number: M-08-048	Class/Level: JSS 2	Time: 35 minutes

	Learning Outcomes By the end of the lesson, pupils will be able to find the value of an unknown term in a direct proportion.		Teaching Aids None		Preparation None
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Opening (3 minutes)

- Ask pupils to define the following terms in their own words:
 - Constant of proportionality (Example answer: the constant that shows the relationship between two values in a ratio.)
 - Cross-multiply (Example answer: Multiply diagonally across the means and extremes of two equivalent fractions.)
- Say:** Today we will learn to find the values of an unknown term in a direct proportion.

Introduction to the New Material (14 minutes)

- Write the following problem on the board: $\frac{3}{5} = \frac{c}{10}$; Find the value for c that completes the direct proportion.
- Ask a pupil to read the question out loud.
- Ask pupils to discuss to understand that this question is asking them to find the unknown term in a direct proportion.
- Say:** We have two ratios that are equal to each other.
- Ask:** How can we solve for c ? (Answer: Cross-multiply)
- Ask pupils to call out the steps for cross-multiplying as you do so on the board:

$$3 \times 10 = 5 \times c$$
 ← Multiply the means by the extremes

$$30 = 5c$$
 ← Solve for c

$$\frac{30}{5} = c$$

$$6 = c$$
- Ask pupils to rewrite the completed proportion in their exercise books
- Write on the board: $\frac{3}{5} = \frac{6}{10}$
- Ask:** Are the two ratios equivalent? (Answer: Yes)
- Write another question on the board: $\frac{a}{16} = \frac{7}{28}$; Find the value for a that completes the direct proportion.
- Ask:** How should we solve this question? (Answer: Cross-multiply and solve)
- Ask pupils to call out the steps for cross-multiplying as you do so on the board:

$$a \times 28 = 16 \times 7$$
 ← Multiply the means by the extremes

$$28a = 112$$
 ← Solve for c

$$a = \frac{112}{28}$$

$$a = 4$$

13. Ask pupils to rewrite the completed proportion in their exercise books
14. Write on the board: $\frac{4}{16} = \frac{7}{28}$
15. **Ask:** Are the two ratios equivalent? (Answer: Yes)
16. **Say:** You can always confirm your answer by cross-multiplying again with the unknown value filled in. Remember the cross products of a true proportion should always be equal.

Guided Practice (5 minutes)

1. Write another question on the board: $\frac{8}{32} = \frac{10}{d}$; Find the value for d that completes the direct proportion.
2. Ask pupils to work in pairs.
3. Ask pupils to solve the problem in their exercise books.
4. Move around the room and clear up misconceptions.
5. Ask one pair of pupils to come to the board and solve the problem while the rest of the class check their work in their exercise books. (Answers: $8 \times d = 32 \times 10$; $8d = 320$; $d = 40$)




Independent Practice (10 minutes)

1. Write the following questions on the board:
Find the missing values that complete the direct proportions for:
 - a) $\frac{25}{5} = \frac{100}{d}$
 - b) $\frac{2}{30} = \frac{c}{135}$
2. Ask pupils to solve the problems individually.
3. Ask pupils to write their answers in the exercise books.
4. Move around the room and clear up misconceptions.
5. Ask two pupils to come to the board and write their answers to the two questions while the rest of the class check their work in their exercise books. (Answers: (a) $25 \times d = 5 \times 100$; $25d = 500$; $d = 20$; (b) $2 \times 135 = 30 \times c$; $270 = 30c$; $c = 9$)

Closing (3 minutes)

1. Ask pupils to quickly find the values for the unknown terms in the following direct proportions:
 - a) $\frac{1}{2} = \frac{c}{4}$
 - b) $\frac{2}{3} = \frac{4}{d}$
 - c) $\frac{3}{b} = \frac{6}{4}$
2. Call on 3 pupils randomly to answer the question.
3. Check for understanding and clear up any misconceptions. (Answers: $c = 2$; $d = 6$; $b = 2$)

Lesson Title: Applications of Direct Proportions	Theme: Everyday Arithmetic	
Lesson Number: M-08-049	Class/Level: JSS 2	Time: 35 minutes

	Learning Outcomes By the end of the lesson, pupils will be able to: 1. Solve problems with direct proportions. 2. Solve proportions that include units.		Teaching Aids None		Preparation None
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Opening (2 minutes)

- Write the following proportion on the board and ask pupils to find the value of the missing term.

$$\frac{5}{2} = \frac{c}{8}$$
- Ask pupils to solve the problem in their exercise books.
- Ask one girl pupil to volunteer to share her answer with the class. (Answer: $5 \times 8 = 2 \times c$; $40 = 2c$; $20 = c$)
- Say:** Today we will learn to apply our understanding of direct proportions to solve problems with units.

Introduction to the New Material (13 minutes)

- Write the following problem on the board:
If Joe can read 4 books in 2 days, how many books can he read in 8 days?
- Ask pupils to discuss the question, lead them to the understanding that the values are ratios that we can compare to each other.
- Say:** We can solve this problem two different ways. The first way is called the *unitary method*.
- Say:** First we should find out how many books Joe can read in 1 day.
- Ask:** How can we find out how many books he can read in 1 day? (Answer: By dividing the number for 2 days in half.)
- Write on the board: $4 \text{ books} \div 2 \text{ days} = 2 \text{ books in 1 day}$
- Say:** Now we can multiply the rate for 1 day by the number of days. It is called the unitary method because we use the rate for 1 unit.
- Write on the board: $\text{Number of books in 8 days} = 2 \text{ books} \times 8 =$
- Ask pupils to calculate the number of books in 8 days in their exercise books, while you do so on the board: $2 \text{ books} \times 8 = 16 \text{ books}$
- Say:** Joe can read 16 books in 8 days.
- Say:** The other method we can use to solve this problem is the *ratio method*.
- Ask pupils to write the proportions as fractions.
- Say:** Let y represent the unknown number of books Joe can read.
- Write on the board: $\frac{4 \text{ books}}{2 \text{ days}} = \frac{y}{8 \text{ days}}$
- Say:** Now this looks like the kind of problem we solved in the last lesson, when we found the value of the missing term.
- Ask:** How do we solve for y ? (Answer: Cross-multiply and solve)

17. **Say:** Let us cross-multiply the means and extremes of the proportions. It is called the ratio method because use ratios and cross-multiply to solve.
18. Ask pupils to call out the steps of what to multiply while you do so on the board.
19. Write on the board:

$$4 \text{ books} \times 8 \text{ days} = 2 \text{ days} \times y$$

$$32 = 2y$$

$$\frac{32}{2} = \frac{2y}{2}$$

$$16 = y$$
20. **Say:** Again, we find that Joe can read 16 books in 8 days.
21. **Say:** Either method can be useful to solve problems with direct proportions.

Guided Practice (6 minutes)

1. Write the following problem on the board:
Jebbeh can paint 60 m.² with 2 cans of paint. What area can she paint with 5 cans of paint?
2. **Say:** Use the letter a to equal the area you are solving for.
3. Ask pupils to work in pairs.
4. **Say:** One pupil in each pair should use the unitary method and the other should use the ratio method. Then you should compare answers to check your work.
5. Ask pupils to solve the problem in their exercise books.
6. Move around the room and clear up misconceptions.
7. Ask one pair of pupils to come to the board and solve the problem using both methods while the rest of the class check their work in their exercise books. (Answers: *Unitary:* $\frac{60m.^2}{2 \text{ cans}} = 30m.^2 \text{ per can} = 30 m.^2 \times 5 \text{ cans} = 150 m.^2$; *Ratio:* $\frac{60m.^2}{2 \text{ cans}} = \frac{a}{5 \text{ cans}}$; $300 = 2a$; $a = 150 m.^2$)




Independent Practice (10 minutes)

1. Write the following problem on the board:
Paul rode his bicycle 45 km in 3 hours. What distance could he bike in 5 hours, if he kept the same rate?
2. **Say:** Use the letter d to equal the area you are solving for.
3. Ask pupils to solve the problem individually.
4. **Say:** You may use either the unitary method or the ratio method to solve the problem. If you finish early, please check your answer by using the other method.
5. Ask pupils to solve the problem in their exercise books.
6. Move around the room and clear up any misconceptions.
7. Ask two pupils to come to the board and solve the problem, while the rest of the class check their work in their exercise books. Ask for one pupil who used the unitary method and one who used the ratio method. (Answers: *Unitary:* $\frac{45 \text{ km.}}{3 \text{ hr.}} = 15kph = 15 \text{ kph} \times 5 \text{ hours} = 75 \text{ km.}$; *Ratio:* $\frac{45 \text{ km.}}{3 \text{ hr.}} = \frac{d}{5 \text{ hr.}}$; $225 = 3d$; $d = 75 \text{ km.}$)

Closing (4 minutes)

1. Ask pupils the following open-ended question to encourage them to think about their own strengths in maths:
Do you prefer the unitary method or ratio method to solve problems with proportions, and why?
2. Ask pupils to think for 1 minute and then turn to their neighbour and share.
3. Ask 1-2 pupils to share their opinions and reasons with the class. (Answers will vary, but it is possible some students will prefer the unitary method because it keeps the numbers smaller, or some may prefer the ratio method because it is more structured.)

Lesson Title: Direct Proportion Story Problems	Theme: Everyday Arithmetic	
Lesson Number: M-08-050	Class/Level: JSS 2	Time: 35 minutes

	Learning Outcomes By the end of the lesson, pupils will be able to solve story problems involving direct proportion.		Teaching Aids None		Preparation None
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Opening (2 minutes)

- Write the following question on the board:
50 g of rice cost Le 2,000. What would be the cost for 125 g of rice at the same rate?
- Ask pupils to solve the problem in their exercise books.
- Ask one pupil to share their answer with the class. (Answer: $\frac{50 \text{ g}}{\text{Le } 2000} = \frac{125 \text{ g}}{c}$; $50 \text{ g} \times c = \text{Le } 2000 \times 125 \text{ g}$; $50c = 250,000$; $c = \text{Le } 5,000$ or $\frac{125 \text{ g}}{50 \text{ g}} = 2.5$; $2.5 \times \text{Le } 2000 = \text{Le } 5,000$)
- Say:** Today we will learn to solve story problems involving direct proportions.

Introduction to the New Material (13 minutes)

- Write the following problem on the board:
Musa's farm is 1,050 m². He can plant 6 m² of seeds each hour. How many days will it take Musa to plant his whole farm if he works 10 hours per day?
- Ask pupils to discuss the question, and figure out that the first thing we must do is calculate the total number of hours it will take Musa to plant, and then divide into 10 hour days.
- Say:** Let us set up ratios for the question.
- Ask pupils to write the proportions as fractions in their exercise books.
- Say:** Let x represent the unknown number of hours.
- Write on the board: $\frac{6 \text{ m}^2}{1 \text{ hr}} = \frac{1,050 \text{ m}^2}{x}$
- Say:** Say, if Musa can plant 6m² in 1 hour, we can calculate how many hours it will take him to plant 1,050 m² at the same rate by finding the missing value.
- Ask:** How do we solve for x? (Answer: Cross-multiply and solve)
- Say:** Let us cross-multiply the means and extremes of the proportions.
- Ask pupils to call out the steps of what to multiply while you do so on the board, and solve the problem in their exercise books.
- Write on the board:

$$6\text{m}^2 \times x = 1 \text{ hr} \times 1,050 \text{ m}^2$$

$$6x = 1050$$

$$\frac{6x}{6} = \frac{1050}{6}$$

$$x = 175 \text{ hours}$$
- Say:** It will take Musa 175 hours to plant his farm.
- Ask:** What is the next step? (Answer: divide the number of hours by the number of hrs. he works each day)
- Ask pupils to calculate the number of days in their exercise books, while you do so on the board:
 $175 \text{ hours} \div 10 \text{ hr/day} = 17.5 \text{ days}$

15. **Say:** It will take Musa 17.5 days to plant his farm.

Guided Practice (6 minutes)

1. Write the following problem on the board:

Maima and Princess started a business together. Maima contributed Le 20,000 and Princess contributed Le 15,000. They agreed to split income from the business according to how much they put in. Maima received Le 30,000. What is Princess's portion?

2. **Say:** Use the letter p to represent Princess's money.

3. Ask pupils to work in pairs.

4. Ask pupils to solve the problem in their exercise books.

5. Move around the room and clear up any misconceptions.

6. Ask one pupil to come to the board and solve the problem while the rest of the class check their work in their exercise books. (Answers: $\frac{\text{Le } 20,000}{\text{Le } 15,000} = \frac{\text{Le } 30,000}{p}$; $20,000p = 450,000,000$; $p = \text{Le } 22,500$)

Independent Practice (10 minutes)

1. Write the following problem on the board:

An architect is drawing a scale model of a new building in Freetown. The drawing shows the building being 5 cm tall. The scale of the drawing is 1 cm = 15 m. Calculate the height of the real building when it is finished.

2. **Say:** Use the letter h to equal the area you are solving for.

3. Ask pupils to solve the problem individually in their exercise books.

4. Move around the room and clear up any misconceptions.




5. Ask a pupil to come to the board and solve the problem, while the rest of the class check their work in their exercise books. (Answers: $\frac{1 \text{ cm}}{15 \text{ m}} = \frac{5 \text{ cm}}{h}$; $1h = 5 \times 15$; $h = 75 \text{ m}$)

Closing (4 minutes)

1. Allow pupils to choose: either writing their own story problem, or brainstorming situations in every day life when they could calculate a proportion.

2. Allow 1-2 pupils to share with the class, as time allows. (Example answers: pupils could discuss drawing scale models, calculating the length of time it will take to get a task accomplished, sharing portions fairly, etc.)

Lesson Title: Indirect Proportion	Theme: Everyday Arithmetic	
Lesson Number: M-08-051	Class/Level: JSS 2	Time: 35 minutes

 <p>Learning Outcomes By the end of the lesson, pupils will be able to:</p> <ol style="list-style-type: none"> 1. Identify the form of an indirectly proportional relationship ($t \propto \frac{1}{d}$). 2. Compare indirect proportion to direct proportion. 	 <p>Teaching Aids None</p>	 <p>Preparation None</p>
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Opening (3 minutes)

1. Ask pupils the following questions:
 - a) What does it mean to be directly proportional?
 - b) What symbol do we use to show that something is proportional?
2. Allow pupils to discuss in pairs or threes.
3. Ask 2 volunteers for the answers. (Answers: a) The ratios move in the same direction, if one increases, the other does too; b) \propto).
4. **Say:** Today we will learn to identify the form of an indirectly proportional relationship and compare indirect proportion to direct proportion.

Introduction to the New Material (14 minutes)

1. **Ask:** What is a proportion? (Answer: A pair of equivalent ratios in which the units must be the same.)
2. **Say:** Indirect proportions mean that as one ratio goes up, the other goes down. Or as one ratio goes down the other goes up. The ratios move in opposite directions instead of in the same direction like a directly proportional relationship.
3. **Ask:** Can anyone think of examples of times where one value increasing will cause another value to decrease? (Example answers: working together to accomplish something faster.)
 - If necessary, guide pupils to understand this example by asking them how long it takes 1 person to do a task compared to 2 or 3 people together.
4. Write on the board: $y = k\frac{1}{x}$ or $y = \frac{k}{x}$
5. **Say:** Indirect proportions are shown by the relationship one value (y) is equal to another value ($\frac{1}{x}$) multiplied by a constant (k).
6. **Say:** When two values are indirectly proportional to each other, we can still use the special symbol \propto , because it just means proportional and then the numbers around it tell what kind of relationship exists.
7. Write the symbol on the board.
8. **Say:** However, this time we would write: $y \propto \frac{1}{x}$, meaning that y is indirectly proportional to x.
9. Write on the board: $\propto = \textit{proportional}$
10. **Say:** When we have an inverse proportion with two equivalent ratios, we can still use *cross-multiplication*, however it needs to be set up differently, because the ratios have a different relationship to each other.

- a) Remind pupils that cross-multiplication involves multiplying the diagonals of equal fractions
11. **Say:** To use cross-multiplication to solve an inverse proportion, (1) make sure each ratio is one unit, do not mix units, (2) flip one of the ratios upside down, and (3) then you can solve as normal.
 12. **Say:** Since the relationship is indirect ($y \propto \frac{1}{x}$), not direct ($y \propto x$) we cannot say they are equal until we flip the ratio.
 13. **Say:** If we follow those steps first, when we multiply the numbers diagonally across from each other, the two products will be equal.
 - a) Remind pupils to follow the extremes and means pattern.

Guided Practice (5 minutes)

1. Write the following questions on the board:
 - a) Express the following indirectly proportional ratios as fractions $3:6 \propto 8:4$ and rearrange the fractions so you could accurately cross-multiply.
 - b) What are the means and extremes of the proportion?
 - c) Demonstrate it is a true proportion by cross-multiplying.
2. Ask pupils to work in pairs.
3. Ask pupils to solve the problem.
4. Move around the room and clear misconceptions.
5. Ask one pupil from the class to write the answer on the board while the rest of the pupils check their work in their exercise books.

(Answers: a) $\frac{3}{6}$ and $\frac{8}{4} \rightarrow \frac{3}{6} = \frac{4}{8}$; b) *the extremes are 3 and 8 and the means are 6 and 4*;
c) $3 \times 8 = 6 \times 4$; $24 = 24$)




Independent Practice (10 minutes)

1. Write the following question on the board:
 - a) Express the following indirectly proportional ratios as fractions $5:10 \propto 12:6$ and rearrange the fractions so you could accurately cross-multiply
 - b) What are the means and extremes of the proportion?
 - c) Demonstrate it is a true proportion by cross-multiplying
2. Ask pupils to solve the problem individually in their exercise books.
3. Move around the room to check for understanding and clear up any misconceptions.
4. Ask one pupil to come to the board and write his/her answer on the board while the rest of the class checks their work in their exercise books. (Answers: (a) $\frac{5}{10}$ and $\frac{12}{6} \rightarrow \frac{5}{10} = \frac{6}{12}$;
b) *the extremes are 5 and 12 and the means are 6 and 10*; (c) $5 \times 12 = 6 \times 10$; $60 = 60$)

Closing (3 minutes)

1. Ask pupils to explain in their own words the difference between direct and indirect proportions.
2. Allow pupils to discuss with their neighbours and then call on 1-2 pupils to share their answers with the class. (Example answer: Directly proportional means the ratios move in the same direction, indirectly proportional means they move in opposite directions)

Lesson Title: Solving Indirect Proportions	Theme: Everyday Arithmetic	
Lesson Number: M-08-052	Class/Level: JSS 2	Time: 35 minutes

	Learning Outcomes By the end of the lesson, pupils will be able to find the value of an unknown term in an indirect proportion.		Teaching Aids None		Preparation None
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Opening (2 minutes)

- Ask pupils the following questions:
 - What formula shows the relationship for direct proportions? (Answer: $y \propto x$)
 - What formula shows the relationship for indirect proportions? (Answer: $y \propto \frac{1}{x}$)
- Call on two volunteers to stand up and share the answers.
- Say:** Today we will learn to find the values of an unknown term in an indirect proportion.

Introduction to the New Material (14 minutes)

- Write the following problem on the board:
 $3 : b \propto 8 : 4$ are two indirectly proportional ratios; find the value for b that completes the proportion.
- Ask a pupil to read the question out loud.
- Ask pupils to discuss to understand that this question is asking them to find the unknown term in an indirect proportion.
- Ask:** How can we solve for b ? (Answer: Create fractions and cross-multiply)
- Ask:** What did we learn in the last lesson about cross-multiplication of indirect proportions? (Answer: You have to flip one of the ratios upside down)
- Ask pupils to call out the steps for cross-multiplying as you do so on the board:

$$\frac{3}{b} \text{ and } \frac{8}{4} \rightarrow \frac{3}{b} = \frac{4}{8} \quad \leftarrow \text{Flip one ratio}$$

$$3 \times 8 = b \times 4 \quad \leftarrow \text{Multiply the means and extremes}$$

$$24 = 4b \quad \leftarrow \text{Solve for } b$$

$$\frac{24}{4} = 4b$$

$$6 = b$$
- Ask pupils to rewrite the completed proportion in their exercise books.
- Write on the board: $3 : 6 \propto 8 : 4$
- Ask:** Are the two ratios indirectly proportion? (Answer: Yes: $\frac{3}{6} = \frac{1}{2}$ and $\frac{8}{4} = 2$; $\frac{1}{2} \propto 2$)
- Write another question on the board:
 $a : 16 \propto 10 : 5$ are two indirectly proportional ratios; find the value for a that completes the proportion.
- Ask a pupil to read the question out loud.
- Ask:** How should we solve this question? (Answer: cross-multiply and solve)
- Ask pupils to call out the steps for cross-multiplying as you do so on the board:

$$\frac{a}{16} \text{ and } \frac{10}{5} \rightarrow \frac{a}{16} = \frac{5}{10} \quad \leftarrow \text{Flip one ratio}$$

$$a \times 10 = 16 \times 5 \quad \leftarrow \text{Multiply the means and extremes}$$

$$10a = 80$$

$$\frac{10a}{10} = \frac{80}{10} \quad \leftarrow \text{Solve for } a$$

$$a = 8$$

14. Ask pupils to rewrite the completed proportion in their exercise books.

15. Write on the board: $8:16 \propto 10:5$

16. **Ask:** Are the two ratios indirectly proportion? (Answer: Yes: $\frac{8}{16} = \frac{1}{2}$ and $\frac{10}{5} = 2; \frac{1}{2} \propto 2$)

Guided Practice (6 minutes)

- Write another question on the board: $100:25 \propto c:24$ are two indirectly proportional ratios; find the value for a that completes the proportion.
- Ask pupils to work in pairs.
- Ask pupils to solve the problem in their exercise books.
- Move around the room and clear up misconceptions.
- Ask one pair of pupils to come to the board and solve the problem while the rest of the class check their work in their exercise books.

Answer:

$$\frac{100}{25} \text{ and } \frac{c}{24} \rightarrow \frac{100}{25} = \frac{24}{c}$$

$$100 \times c = 24 \times 25$$

$$100c = 600$$

$$\frac{100c}{100} = \frac{600}{100}$$

$$c = 6$$

Independent Practice (10 minutes)

- Write the following questions on the board:
 - $60:b \propto 5:15$ are two indirectly proportional ratios; find the value for a that completes the proportion.
 - $8:32 \propto 48:d$ are two indirectly proportional ratios; find the value for d that completes the proportion.
- Ask pupils to solve the problem individually.
- Ask pupils to write their answers in the exercise books.
- Move around the room and clear up any misconceptions.
- Ask two pupils to come to the board and write their answers to the two questions while the rest of the class checks their work in their exercise books. (Answers: a) $\frac{60}{b}$ and $\frac{5}{15} \rightarrow \frac{60}{b} = \frac{15}{5}; 60 \times 5 = b \times 15; 300 = 15b; \frac{300}{15} = \frac{15b}{15}; 20 = b$; b) $\frac{8}{32}$ and $\frac{48}{d} \rightarrow \frac{8}{32} = \frac{d}{48}; 8 \times 48 = 32 \times d; 384 = 32d; \frac{384}{32} = \frac{32d}{32}; 12 = d$)

Closing (3 minutes)




1. Ask pupils to demonstrate that each of the proportions completed in the independent practice were indirectly proportionate by simplifying the fractions.
2. Ask two pupils to come to the board and share their work, while the rest of the class check their exercise books.

Answers:

a) $\frac{60}{20} = 3$ and $\frac{5}{15} = \frac{1}{3}$; $3 \propto \frac{1}{3}$

b) $\frac{8}{32} = \frac{1}{4}$ and $\frac{48}{12} = 4$; $\frac{1}{4} \propto 4$

Lesson Title: Applications of Indirect Proportions	Theme: Everyday Arithmetic	
Lesson Number: M-08-053	Class/Level: JSS 2	Time: 35 minutes

	<p>Learning Outcomes By the end of the lesson, pupils will be able to:</p> <ol style="list-style-type: none"> 1. Solve problems with indirect proportions. 2. Solve indirect proportions that include units. 		<p>Teaching Aids None</p>		<p>Preparation None</p>
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Opening (3 minutes)

1. Write the following question on the board:
10: 5 \propto c: 14 are two indirectly proportional ratios; find the value for a that completes the proportion.
2. Ask pupils to solve the problem in their exercise books.
3. Ask one girl pupil to share her answer with the class. (Answer: $\frac{10}{5}$ and $\frac{c}{14} \rightarrow \frac{10}{5} = \frac{14}{c}$; $10c = 70$; $c = 7$)
4. **Say:** Today we will learn to apply our understanding of indirect proportions to solve problems with units.

Introduction to the New Material (13 minutes)

1. Write the following problem on the board:
 - a) If 5 people dig a hole for construction, it takes 8 hours. If 10 people are digging, how many hours will it take?
2. Ask pupils to discuss the question, lead them to the understanding that this is indirect because the more people helping, the faster the work will go by.
3. **Say:** We can solve this problem two different ways. The first way is called the *unitary method*.
4. **Say:** First we should find out how many hours it would take 1 person to do all the work.
5. **Ask:** How can we find out how many hours it would take 1 person? (Answer: To get 1 person you would divide 5 people by 5. Then you must perform the opposite function on the hours, because this is an indirect proportion, so you would multiply by 5.)
6. Write on the board: $5 \times 8 \text{ hours} = 40 \text{ hours}$
7. **Say:** Now we do the same thing to calculate the hours for 10 people. To get from 1 person to 10 people we multiply by 10. We must perform the opposite operation on the hours.
8. Write on the board: $10 \text{ people} = 40 \text{ hours} \div 10 =$
9. Ask pupils to calculate the number of hours in their exercise books, while you do so on the board: $10 \text{ people} = 40 \text{ hours} \div 10 = 4 \text{ hours}$
10. **Say:** If 10 people did the work together it would only take 4 hours.
11. **Say:** The other method we can use to solve this problem is the *ratio method*.
12. Ask pupils to write the proportions as fractions.
 - a) Remind them of the rules for an inverse proportion. Keep the units together and flip one ratio upside down.
13. **Say:** Let h represent the unknown number of hours.

14. Write on the board: $\frac{5 \text{ people}}{10 \text{ people}} = \frac{8 \text{ hours}}{h} \Rightarrow \frac{5 \text{ people}}{10 \text{ people}} = \frac{h}{8 \text{ hours}}$
15. **Say:** Now we are ready to solve for the missing term.
16. **Ask:** How do we solve for h? (Answer: Cross-multiply and solve)
17. **Say:** Let us cross-multiply the means and extremes of the proportions.
18. Ask pupils to call out the steps of what to multiply while you do so on the board.
19. Write on the board:

$$5 \text{ people} \times 8 \text{ hours} = 10 \text{ people} \times h$$

$$40 = 10h$$

$$\frac{40}{10} = \frac{10h}{10}$$

$$4 = h$$

20. **Say:** Again, we find that it would take 10 people only 4 hours.
21. **Say:** Either method can be used to solve problems with indirect proportions, as long as you do your work carefully.

Guided Practice (6 minutes)

- Write the following problem on the board:
3 kg rice can last 4 people for 9 days. How many days would the rice last if there were 5 people?
- Say:** Use the letter d to equal the number of days you are solving for.
- Ask pupils to work in pairs.
- Say:** One pupil in each pair should use the unitary method and the other should use the ratio method. Then you should compare answers to check your work.
- Ask pupils to solve the problem in their exercise books.
- Move around the room and clear misconceptions.
 - Remind pupils to reverse their operations since the proportion is indirect.
- Ask one pair of pupils to come to the board and solve the problem using both methods while the rest of the class check their work in their exercise books. (Answers: *Unitary:* $\frac{4 \text{ people}}{4} = 1 \text{ person}; 9 \text{ days} \times 4 = 36 \text{ days for 1 person. } 1 \text{ person} \times 9 = 9 \text{ people}; 36 \div 9 = 7.2 \text{ days};$ *Ratio:* $\frac{4 \text{ people}}{5 \text{ people}} = \frac{9 \text{ days}}{d} \rightarrow \frac{4 \text{ people}}{5 \text{ people}} = \frac{d}{9 \text{ days}}; 36 = 5d; d = 7.2 \text{ days}$)

Independent Practice (10 minutes)




- Write the following problem on the board:
2 pupils can brush the schoolyard in 4 hours. If it needs to be done in 2 hours, how many pupils need to help?
- Say:** Use the letter x to equal the number of pupils you are solving for.
- Ask pupils to solve the problem individually.
- Say:** You may use either the unitary method or the ratio method to solve the problem. If you finish early, please check your answer by using the other method.
- Ask pupils to solve the problem in their exercise books.
- Move around the room and clear up any misconceptions.
- Ask two pupils to come to the board and solve the problem, while the rest of the class check their work in their exercise books. Ask for one pupil who used the unitary method and one who used the ratio method. (Answers: *Unitary:* $\frac{2 \text{ pupils}}{2} = 1 \text{ person}; 4 \text{ hours} \times 2 =$

8 hours for 1 person. $8 \text{ hours} \div 2 \text{ hours} = 4 \text{ pupils}$; Ratio: $\frac{2 \text{ pupils}}{x} = \frac{4 \text{ hrs.}}{2 \text{ hrs.}} \rightarrow \frac{2 \text{ pupils}}{x} = \frac{2 \text{ hrs.}}{4 \text{ hrs.}}$; $8 = 2x$; $x = 4 \text{ pupils}$)

Closing (3 minutes)

1. Ask pupils to make a list of the steps to remember when solving problems using inverse proportions.
2. Ask pupils to brainstorm their own list in their exercise book for 1 minute and then turn to their neighbour and share.
3. Ask pupils to share their lists with the class. (Answers: 1. Set up cross-multiplication differently: always have units together, flip one ratio upside down; 2. Always do reverse operations; if you multiply the next step should be able to divide to balance it. 3. Always check that the values are going in opposite directions, if one gets bigger the other should get smaller.)

Lesson Title: Indirect Proportion Story Problems	Theme: Everyday Arithmetic	
Lesson Number: M-08-054	Class/Level: JSS 2	Time: 35 minutes

	Learning Outcomes By the end of the lesson, pupils will be able to solve story problems involving indirect proportions.		Teaching Aids None		Preparation None
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Opening (2 minutes)

- Ask pupils to answer the following questions in their own words:
 - What is the unitary method to solving proportions?
 - What is the ratio method to solving proportions?
- Allow pupils to discuss with their neighbours.
- Ask 2 pupils to share their answers and ask any questions. (Answers: a) Unitary method solves the proportion by finding the rate for 1 unit and multiplying by the value asked for. b) The ratio method sets up ratios as equivalent fractions to cross-multiply and solve for the unknown value.)
- Say:** Today we will learn to solve story problems involving indirect proportions.

Introduction to the New Material (13 minutes)

- Write the following problem on the board:
Kumba has land to graze animals on. There is enough grass for 50 animals for 6 days. How many days would the food last if there were 75 animals? What about 100 animals?
- Ask pupils to discuss the question, to understand that this is an indirect proportion because as the numbers of animals go up the food goes down.
- Say:** Let us set up ratios for the question.
- Ask pupils to write the proportions as fractions.
- Say:** Let x represent the unknown number of days.
- Write on the board: $\frac{50 \text{ animals}}{75 \text{ animals}} = \frac{6 \text{ days}}{x} \rightarrow \frac{50 \text{ animals}}{75 \text{ animals}} = \frac{x}{6 \text{ days}}$
- Say:** We have set up our ratios and flipped one upside down.
- Ask:** How do we solve for x ? (Answer: Cross-multiply and solve)
- Say:** Let us cross-multiply the means and extremes of the proportions.
- Ask pupils to call out the steps of what to multiply while you do so on the board, and solve the problem in their exercise books.
- Write on the board:

$$50 \text{ animals} \times 6 \text{ days} = 75 \text{ animals} \times x$$

$$300 = 75x$$

$$\frac{300}{75} = \frac{75x}{75}$$

$$4 \text{ days} = x$$
- Say:** The piece of land will last for 4 days.
- Say:** Now we must do the calculations again for 100 animals.
- Write on the board: $\frac{50 \text{ animals}}{100 \text{ animals}} = \frac{6 \text{ days}}{x} \quad \frac{50 \text{ animals}}{100 \text{ animals}} = \frac{x}{6 \text{ days}}$
- Say:** We have set up our ratios and flipped one upside down.

16. **Ask:** How do we solve for x ? (Answer: Cross-multiply and solve)
17. **Say:** Let us cross-multiply the means and extremes of the proportions.
18. Ask pupils to call out the steps of what to multiply while you do so on the board, and solve the problem in their exercise books.
19. Write on the board:

$$50 \text{ animals} \times 6 \text{ days} = 100 \text{ animals} \times x$$

$$300 = 100x$$

$$\frac{300}{100} = \frac{100x}{100}$$

$$3 \text{ days} = x$$
20. **Say:** The piece of land will last for 3 days if there are 100 animals on it eating.

Guided Practice (6 minutes)

1. Write the following problem on the board:
Momo, Gbessay, and Prince were hired to build a house and expect it will take them 8 days. If they complete the house in 4 days, they will be paid a bonus of Le 500,000. How many friends do they need to ask to join them to get the bonus?
2. **Say:** Use the letter f to represent the unknown number of people.
3. Ask pupils to work in pairs.
4. Ask pupils to solve the problem in their exercise books.
5. Move around the room and clear up any misconceptions.
6. Ask one pupil to come to the board and solve the problem while the rest of the class check their work in their exercise books.
Answers: $\frac{3 \text{ workers}}{f} = \frac{8 \text{ days}}{4 \text{ days}}$ $\frac{3 \text{ workers}}{f} = \frac{4 \text{ days}}{8 \text{ days}}$ \rightarrow
 $3 \text{ workers} \times 8 \text{ days} = f \times 4 \text{ days}$
 $24 = 4f$
 $f = 6$
7. Make sure pupils understand that this means they need 6 workers in total, so they need 3 friends to join them.

Independent Practice (10 minutes)

1. Write the following problem on the board:
Abel is traveling to Freetown. If he drives at the rate of 60 kph it will take him 2 hours. How much faster would he get to Freetown if he drove at the rate of 80 kph?
2. **Say:** Use the letter h to represent the unknown number of hours you are solving for.
3. Ask pupils to solve the problem individually.
4. Ask pupils to solve the problem in their exercise books.
5. Move around the room and clear up any misconceptions. Make sure pupils notice that the question asks how much faster he would get there.
6. **Say:** Once we find out how long it would take Abel to get to Freetown traveling at 80 kph, we need to find the difference between the two lengths of time.
7. Ask a pupil to come to the board and solve the problem, while the rest of the class checks their work in their exercise books.

Answers: $\frac{2 \text{ hr}}{h} = \frac{60 \text{ kph}}{80 \text{ kph}}$ $\frac{2 \text{ hr}}{h} = \frac{80 \text{ kph}}{60 \text{ kph}}$

$$2 \text{ hr} \times 60 \text{ kph} = h \times 80 \text{ kph}$$




$$120 = 80h$$

$h = 1.5 \text{ hours}$; He would arrive 30 minutes sooner.

Closing (4 minutes)

1. Allow pupils to choose: either writing their own story problem, or brainstorming situations in everyday life when they could calculate an indirect proportion.
2. Allow 1-2 pupils to share with the class, as time allows. (Example answers: pupils could discuss sharing work, accomplishing tasks together, sharing food, etc.)

Lesson Title: Practice with Proportion	Theme: Everyday Arithmetic	
Lesson Number: M-08-055	Class/Level: JSS 2	Time: 35 minutes

	Learning Outcomes By the end of the lesson, pupils will be able to solve number and story problems with direct and indirect proportion.		Teaching Aids None		Preparation None
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Opening (3 minutes)

- Ask pupils to answer the following questions in their own words:
 - What is a direct proportion?
 - What is an indirect proportion?
- Allow pupils to discuss with their neighbours.
- Ask 2 pupils to share their answers and ask any questions. (Answers: a) Both ratios move in the same direction, they either both increase or both decrease. b) The ratios move in opposite directions, either one decreases and the other increases or vice versa.)
- Say:** Today we will learn to solve story problems involving direct and indirect proportions.

Introduction to the New Material (11 minutes)

- Write the following problem on the board:
There are 3 cooks at the school who prepare 250 school meals in 50 minutes every day. The principal wants to shorten the time it takes to prepare the meals by hiring more cooks. How many cooks would the school need to prepare the meal in 30 minutes, assuming they all work at the same rate?
- Ask:** Is this a direct or indirect proportion? (Answer: indirect, the time for the meal will go down, while the number of cooks will increase)
- Say:** Let us set up ratios for the question.
- Ask pupils to write the proportions as fractions.
- Say:** Let c represent the unknown number of cooks.
- Write on the board: $\frac{50 \text{ min.}}{30 \text{ min.}} = \frac{3 \text{ cooks}}{c}$
- Ask:** What do we need to do with the ratios now? (Answer: Flip one of them upside down)
- Write on the board: $\frac{50 \text{ min.}}{30 \text{ min.}} = \frac{c}{3 \text{ cooks}}$
- Ask:** How do we solve for c ? (Answer: Cross-multiply and solve)
- Say:** Let us cross-multiply the means and extremes of the proportions.
- Ask pupils to call out the steps of what to multiply while you do so on the board, and solve the problem in their exercise books.
- Write on the board:

$$50 \text{ min.} \times 3 \text{ cooks} = 30 \text{ min.} \times c$$

$$150 = 30c$$

$$\frac{150}{30} = \frac{30c}{30}$$

$$5 = c$$
- Say:** The school would need 5 cooks to prepare the meal in 30 minutes.

Guided Practice (7 minutes)

1. Write the following problem on the board:
Jebbeh is drawing a scale map of her community. She measured the distance she walks from her home to the school every day at 2 km. The scale on her map is 1 cm = 25 m. How long should the distance be on her map?
2. **Say:** Use the letter d to represent the unknown distance.
3. **Ask:** Is this a direct or indirect proportion? (Answer: Direct; as the distance in Jebbeh's community increases, the distance on the map increases.)
4. Ask pupils to work in pairs.
5. Ask pupils to solve the problem in their exercise books.
6. Move around the room and clear up any misconceptions. Remind pupils that they need to convert the units between km. and m. If needed write $1 \text{ km} = 1000 \text{ m}$. on the board
7. Ask one pupil to come to the board and solve the problem while the rest of the class check their work in their exercise books. (Answers: $\frac{1 \text{ cm}}{25 \text{ cm}} = \frac{d}{2,000 \text{ m}}$; $2,000 = 25d$; $d = 80 \text{ cm}$)

Independent Practice (10 minutes)

1. Write the following two questions on the board:
Abraham is leaving for the airport. If he were to take a bus it would travel at 45 kph. He would arrive in 55 minutes. If he were to take a car it would travel at 60 kph. He only wants to pay the extra expense of a taxi if it will give him much more time at the airport. Will taking a taxi be fast enough to get him to the airport in less than 30 minutes?
2. **Say:** Use the letter m to equal the time you are solving for.
3. **Ask:** Is this a direct or indirect proportion? (Answer: Indirect, as the rate of travel increases, the length of time decreases)
4. Ask pupils to solve the problem individually.
5. Ask pupils to solve the problem in their exercise books.
6. Move around the room and clear up any misconceptions.
7. Ask a pupil to come to the board and solve the problem, while the rest of the class check their work in their exercise books.

$$\text{Answers: } \frac{55 \text{ minutes.}}{m} = \frac{45 \text{ kph} \cdot 55 \text{ minutes}}{60 \text{ kph} \cdot m} = \frac{60 \text{ kph}}{45 \text{ kph}}$$

$$55 \text{ minutes} \times 45 \text{ kph} = m \times 60 \text{ kph}$$

$$2,475 = 60 m$$

$$m = 41.25 \text{ minutes; he would not arrive in under 30 minutes.}$$

Closing (4 minutes)

1. Write the following scenarios on the board and ask pupils to determine if they would be directly or indirectly proportional.
 - a) 5 people cleaning faster than 4 people
 - b) Two business partners fairly dividing their money based on their investments
 - c) Getting paid based on the number of hours worked
2. Allow pupils to discuss with their neighbours.
3. Ask 3 volunteers from different corners of the class to share the correct answers. (Answers: a) indirect; b) direct; c) direct.

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