I. Lesson Overview

Lesson Title:	Applications of Indices in Real-Life Situations
Strand:	Numbers and Algebra
Sub-Strand:	Indices and Logarithms
Grade Level:	10
Estimated Duration:	40 minutes

Key Inquiry Question

How do we use real numbers in day-to-day activities?

II. Learning Objectives & Standards

Learning Objectives

Upon completion of this lesson, students will be able to:

1. **Know (Conceptual Understanding):** Understand how indices model real-world phenomena such as population growth, compound interest, bacterial growth, and decay.
2. **Do (Procedural Skill):** Apply exponential growth and decay formulas using indices to solve practical problems.
3. **Apply (Application/Problem-Solving):** Interpret and solve real-life problems involving doubling, tripling, and other exponential patterns using index notation.

Curriculum Alignment

Strand:	Indices and Logarithms
Sub-Strand:	Indices
Specific Learning Outcome:	Applications of Indices in Real-Life Situations.

III. Materials & Resources

Textbooks:	CBC Grade 10 Mathematics Learner's Book CBC Grade 10 Mathematics Teacher's Book

IV. Lesson Procedure

Phase 1: Problem-Solving and Discovery / Engage & Explore (15 minutes)

Objective: To explore how indices appear in everyday situations and activate prior knowledge about exponential patterns.

Anchor Activity: Real-Life Index Exploration

Work in Groups:

Each group receives a different real-life scenario card. Analyze the pattern and express it using indices.

Scenario Cards:

Group 1 - Population Growth:

A town has 10,000 people. The population doubles every 15 years. How many people will there be in 45 years?

Group 2 - Bacterial Growth:

A scientist places 100 bacteria in a dish. They triple every 4 hours. How many bacteria after 12 hours?

Group 3 - Investment:

You invest Ksh 5,000 in a savings account that doubles every 7 years. What is the value after 21 years?

Group 4 - Medicine Decay:

A 160 mg medicine dose reduces to half every 3 hours. How much remains after 9 hours?

Discussion Questions for Groups:

- What pattern do you notice? (doubling, tripling, halving)
- How many times does the pattern repeat?
- Can you write this using powers/indices?
- What is the base number? What is the exponent?

Teacher's Role: The teacher circulates among groups, asking probing questions (e.g., "What multiplier are you using?", "How does the exponent relate to time?"). The teacher surfaces student thinking and uses their solutions to bridge to formal instruction on exponential models.

Phase 2: Structured Instruction / Explain (10 minutes)

Objective: To formalize the exponential growth and decay models using indices.

Key Takeaways:

Exponential Growth Model:

When a quantity grows by a constant factor over equal time intervals:

$P = P_0 \times r^n$

Where:

• P = Final amount

• P_0 = Initial amount

• r = Growth factor (multiplier)

• n = Number of time periods

Common Growth Patterns:

Pattern	Growth Factor (r)	Example
Doubling	2	Population doubles every 10 years
Tripling	3	Bacteria triple every 5 hours
Halving (Decay)	1/2 or 0.5	Medicine reduces by half every 6 hours
Compound Interest	1 + rate	1.05 for 5% annual interest

Finding the Exponent (n):

The exponent represents how many times the pattern repeats:

n = Total time ÷ Time for one cycle

Example: If population doubles every 10 years, after 30 years: $n = 30 \div 10 = 3$

Addressing Misconceptions: "Remember: The exponent is NOT the total time—it's the NUMBER OF CYCLES. Also, decay uses fractions (like 1/2) as the base, not negative exponents in this context."

Phase 3: Practice and Application / Elaborate (15 minutes)

Objective: To apply exponential models to solve real-world problems.

Worked Example 1: Population Growth

Kakamega town's population doubles every 10 years. If the population today is 50,000 people, what will the population be in 30 years?

Solution:

Step 1: Identify the values

• P_0 = 50,000 (initial population)

• $r = 2$ (doubles)

• Time = 30 years, Cycle = 10 years

• $n = 30 \div 10 = 3$

Step 2: Apply the formula

$P = P_0 \times r^n$

$P = 50{,}000 \times 2^3$

$P = 50{,}000 \times 8$

$P = 400{,}000$ people

Worked Example 2: Community Population Growth

A small community has an initial population of 1,050 people. The population grows each year by a factor of 53/50. Calculate the population after 3 years.

Solution:

$P(t) = P_0 \times g^t$

$P(3) = 1{,}050 \times (53/50)^3$

$P(3) = 1{,}050 \times (148877/125000)$

$P(3) \approx 1{,}250.6$ people

Worked Example 3: Investment Growth

A school STEM club invests Ksh 1,100 in a project account. The money grows by a factor of 11/10 each year. Calculate the value after 3 years.

Solution:

$A = P \times r^n$

$A = 1{,}100 \times (11/10)^3$

$A = 1{,}100 \times (1331/1000)$

$A = 1{,}464.10$ Ksh

Teacher's Role: The teacher emphasizes identifying the growth factor and calculating the correct exponent based on time periods.

Phase 4: Assessment / Evaluate (Exit Ticket)

Objective: To formatively assess individual student understanding.

Exit Ticket Questions:

1. The Science Club places 1,000 bacteria in a petri dish. The bacteria triple every 5 hours.

   a) How many bacteria will be present after 10 hours?

   b) How many bacteria will be present after 20 hours?

   c) How long will it take for the bacteria to reach 243,000?

2. A principal planted 3 trees in the first week. Each week, the number of trees planted triples.

   a) How many trees will be planted by the 5th week?

   b) How long will it take to plant at least 2,000 trees?

3. Upendo Bank offers compound interest where an investment grows by a factor of 1.05 per year. A person invests Ksh 50,000.

   a) Write an index notation for the amount after 10 years.

   b) Find the total amount after 10 years.

Answer Key:

1a) After 10 hours ($n = 10 \div 5 = 2$): $1{,}000 \times 3^2 = 1{,}000 \times 9 = 9{,}000$ bacteria

1b) After 20 hours ($n = 20 \div 5 = 4$): $1{,}000 \times 3^4 = 1{,}000 \times 81 = 81{,}000$ bacteria

1c) $243{,}000 = 1{,}000 \times 3^n \rightarrow 243 = 3^n \rightarrow 3^5 = 243 \rightarrow n = 5$ cycles $\rightarrow 5 \times 5 = 25$ hours

2a) Week 5: $3 \times 3^4 = 3 \times 81 = 243$ trees (or $3^5 = 243$)

2b) $3 \times 3^n \geq 2{,}000 \rightarrow 3^{n+1} \geq 2{,}000 \rightarrow 3^7 = 2{,}187 \geq 2{,}000 \rightarrow$ Week 7

3a) $A = 50{,}000 \times (1.05)^{10}$

3b) $A = 50{,}000 \times 1.6289 \approx$ Ksh 81,445

V. Differentiation

Student Group	Strategy & Activity
Struggling Learners (Support)	Scaffolding: Provide formula cards with $P = P_0 \times r^n$. Use tables to show step-by-step growth.

	Start with simple doubling patterns. Allow calculator use for calculations.
On-Level Learners (Core)	The core lesson activities as described above.
Advanced Learners (Challenge)	Extension Activity: 1) A doctor prescribes medicine that reduces to 1/4 every 6 hours. Express the remaining amount after 18 hours in index form. If the initial dose was 200 mg, calculate the amount left. 2) Sound intensity: If a jet engine is 10^6 times louder than a whisper and a conversation is 10^2 times louder than a whisper, how many times louder is a jet engine than a conversation?

Extension Activity Solutions:

Medicine Decay Problem:

• After 18 hours (n = 18÷6 = 3): Amount = $200 \times (1/4)^3$

• = 200 × (1/64) = 3.125 mg

Sound Intensity Problem:

• Jet engine vs whisper: 10^6

• Conversation vs whisper: 10^2

• Jet engine vs conversation: $10^6 \div 10^2 = 10^{6-2} = 10^4$ = 10,000 times louder

VI. Assessment

Type	Method	Purpose
Formative (During Lesson)	- Observation during group scenarios - Questioning during exploration - Exit Ticket	To monitor progress and adjust instruction.
Summative (After Lesson)	- Homework assignment - Future quiz/test questions	To evaluate mastery of learning objectives.

Teacher's Role: Collect and review the exit tickets to gauge student understanding and identify any common misconceptions that need to be addressed in the next lesson.

VII. Teacher Reflection

To be completed after the lesson.

1. What went well?

2. What would I change?

3. Student Understanding: What did the exit tickets reveal?

4. Next Steps: Based on assessment data, what is the plan for the next lesson?