I. Lesson Overview

Lesson Title:	Laws of Indices
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 the five laws of indices: Product Law, Quotient Law, Power of a Power Law, Power of a Product Law, and Fractional Powers.
2. **Do (Procedural Skill):** Apply the laws of indices to simplify expressions involving powers with the same base.
3. **Apply (Application/Problem-Solving):** Use the laws of indices to solve real-world problems involving exponential quantities.

Curriculum Alignment

Strand:	Indices and Logarithms
Sub-Strand:	Indices
Specific Learning Outcome:	Applying the laws of indices.

III. Materials & Resources

Textbooks:	CBC Grade 10 Mathematics Learner's Book CBC Grade 10 Mathematics Teacher's Book
Materials:	Pen, notebook, flashcards with index questions (optional)

IV. Lesson Procedure

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

Objective: To activate prior knowledge about index notation and explore patterns when combining powers.

Materials Required: Pen and notebook for each student; flashcards or board with index questions.

Anchor Activity: Index Question Challenge

4. Group Formation: Form groups of three students.
5. Question Distribution: Each group gets a set of index questions (on flashcards or written on the board).
6. Recording: Write the question in your notebook.
7. Simplification: Simplify each expression using any patterns or laws of indices you can identify.
8. Presentation: Each group presents their work to the class, explaining their reasoning.

Sample Questions for Groups:

- Group 1: Simplify $2^3 \times 2^4$
- Group 2: Simplify $5^7 \div 5^3$
- Group 3: Simplify $(3^2)^3$
- Group 4: Simplify $(2 \times 5)^3$
- Group 5: Simplify $8^{(1/3)}$

Teacher's Role: The teacher circulates among the groups, observing how students approach simplification. The teacher asks probing questions (e.g., "What pattern do you see?", "How did you get that answer?", "Can you write out the multiplication to check?"). The teacher uses student discoveries to bridge to formal instruction on the laws of indices.

Phase 2: Structured Instruction / Explain (10 minutes)

Objective: To formalize the five laws of indices and connect them to student discoveries.

Key Takeaways - The Five Laws of Indices:

a) Product Law

When multiplying numbers with the same base, ADD their powers.

Formula: $a^m \times a^n = a^{m+n}$

Example: $3^2 \times 3^4 = 3^{2+4} = 3^6$

b) Quotient Law

When dividing numbers with the same base, SUBTRACT their powers.

Formula: $a^m \div a^n = a^{m-n}$

Example: $5^7 \div 5^3 = 5^{7-3} = 5^4$

c) Power of a Power Law

When raising a power to another power, MULTIPLY the powers.

Formula: $(a^m)^n = a^{m \times n}$

Example: $(3^2)^3 = 3^{2 \times 3} = 3^6$

d) Power of a Product Law

When raising a product to a power, apply the power to ALL factors inside the bracket.

Formula: $(ab)^n = a^n \times b^n$

Example: $(2 \times 3)^3 = 2^3 \times 3^3 = 8 \times 27 = 216$

e) Fractional Powers

A fractional power represents a root.

Formula: $a^{\wedge}(m/n) = \sqrt[n]{a^m}$

Example: $8^{\wedge}(1/3) = \sqrt[3]{8} = 2$

Addressing Misconceptions: "Remember: These laws only work when the BASES are the same. You cannot use the product law on $2^3 \times 3^4$ because the bases (2 and 3) are different."

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

Objective: To apply the laws of indices to simplify expressions and solve real-world problems.

Varied Problems:

1. Direct Application:

Solve: $8^{\wedge}(1/3)$

Solution: $8^{\wedge}(1/3) = \sqrt[3]{8} = 2$

Alternative: $8 = 2^3$, so $8^{\wedge}(1/3) = (2^3)^{\wedge}(1/3) = 2^{\wedge}(3 \times 1/3) = 2^1 = 2$

2. Word Problem:

The Agriculture Club is making mango juice. Each jar needs 5^1 mangoes. The group makes 5^1 jars of mango juice. How many mangoes are needed in total? Write your answer as a single power.

Solution: Total mangoes = $5^1 \times 5^1 = 5^{(1+1)} = 5^2 = 25$ mangoes

Teacher's Role: The teacher monitors students, helping them identify which law applies to each problem and ensuring they understand when bases must match.

Phase 4: Assessment / Evaluate (Exit Ticket)

Objective: To formatively assess individual student understanding of the laws of indices.

Exit Ticket Questions:

1. Use the laws of indices to simplify:

   a) $a^9 \times a^8 \div a^5$

   b) $m^{10} \times m^{-6} \div m^{-5}$

2. Watamuu Comprehensive School is buying blocks of writing paper. Each block contains 7^2 sheets. The school buys 7^1 blocks. The sheets are packed into bundles of 7^1 sheets each. How many bundles are formed? Write your answer as a single power.

3. Mr. Gitonga divides his field (area 5^8 m^2) into smaller plots of 5^3 m^2 each. How many plots does he get? Express using indices.

4. Mkurugenzi Company investment was worth 4^5 shillings initially. After two years, it was multiplied by 4^3. Express the total value using indices.

Answer Key:

1a) $a^9 \times a^8 \div a^5 = a^{(9+8-5)} = a^{12}$

1b) $m^{10} \times m^{-6} \div m^{-5} = m^{(10+(-6)-(-5))} = m^{(10-6+5)} = m^9$

2. Total sheets = $7^2 \times 7^1 = 7^3$. Bundles = $7^3 \div 7^1 = 7^2$ bundles

3. Number of plots = $5^8 \div 5^3 = 5^5$ plots

4. Total value = $4^5 \times 4^3 = 4^8$ shillings

V. Differentiation

Student Group	Strategy & Activity
Struggling Learners (Support)	Scaffolding: Provide a reference card with all five laws. Start with numerical examples before variables. Allow students to expand powers to verify (e.g., $2^3 \times 2^2 = 2 \times 2 \times 2 \times 2 \times 2 =$

	2⁵). Work with this group during the anchor task.
On-Level Learners (Core)	The core lesson activities as described above.
Advanced Learners (Challenge)	Extension Activity: A carpenter builds square tables. The first has an area 3^2 m². Each new table is twice the length of the previous. a) Express areas of 2nd and 3rd tables in index form. b) Find the total area of the first three tables. c) What is the area of the 5th table?

Extension Activity Solutions:

Carpenter's Tables Problem:

• First table area: 3^2 m²

• Second table: length doubled → area = $(2×3)^2 = 2^2 × 3^2 = 4 × 9 = 36$ m² $= 6^2$ m²

• Third table: length doubled again → area = $(2×6)^2 = 12^2 = 144$ m²

• Total area of first three: 9 + 36 + 144 = 189 m²

• Fifth table: Following the pattern, area = $3^2 × 4^4 = 9 × 256 = 2304$ m²

VI. Assessment

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

Checkpoint Integration

Pre-class Preparation list:

1. Test internet connectivity and access to https://innodems.github.io/CBC-Grade-10-Maths/
2. Ensure all student devices can access the digital textbook
3. Pre-load the checkpoint page on the teacher's display device
4. Have backup printed worksheets in case of technical issues

5. Arrange seating for pair work and station rotations

Checkpoint protocol for Learners:

1. Click "Show new example question" to load the problem
2. Solve the displayed question
3. Click "submit" to check your answer
4. If incorrect, carefully read the feedback and analyse the error before trying a new question. The immediate feedback from checkpoint submissions allows students to identify and correct errors in real-time.
5. Complete at least 5 questions before rotating
6. Pair students strategically so stronger learners can explain reasoning to peers.

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?