Step by step guide: Laws of Indices

Grade 10 Mathematics | 40-Minute Lesson

Before Class Begins

Preparation Checklist:

- Prepare flashcards with index questions OR write questions on the board
- Arrange students into groups of three
- Prepare exit tickets for distribution
- Set timer for phase transitions
- Write the five laws on the board (covered until Phase 2)
- Ensure each student has pen and notebook

PHASE 1: Problem-Solving and Discovery (15 Minutes)

Opening (2 minutes)

[SAY]:

"Good morning/afternoon, class! In our previous lesson, we learned how to express numbers in index form. Today, we're going to discover the LAWS that govern how we work with indices. These laws are powerful tools that make complex calculations simple."

[SAY]:

"Here's our key question: How do we use real numbers in day-to-day activities? Let's explore this through a group challenge."

Anchor Activity Introduction (2 minutes)

[SAY]:

"Today you're going to work in groups to discover patterns when we combine powers. Each group will get a different question to simplify."

[ASSIGN groups and distribute questions]:

- 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)

Group Work Instructions (1 minute)

[SAY - Read slowly and clearly]:

"In your groups:
Step 1: Write your question in your notebook
Step 2: Try to simplify it—you can expand the powers to help you see patterns
Step 3: Discuss what pattern or rule you discovered
Step 4: Prepare to present your work to the class

You have 8 minutes. Begin!"

Circulation and Probing (6 minutes)

[DO]: Walk around the room, observing how students approach simplification.

[ASK probing questions as you circulate]:

- "Can you expand $2^3 \times 2^4$ to see what's happening?"
- "How many 2s are you multiplying altogether?"
- "What pattern do you notice with the exponents?"
- "Why do you think that rule works?"
- "What happens to the bases? Do they change?"

[HINT for struggling groups]: "Try writing out all the multiplications. For example, $2^3 = 2 \times 2 \times 2$."

[TIME CHECK]: At 6 minutes, announce: "Two more minutes to prepare your presentations!"

Group Presentations (4 minutes)

[SAY]:

"Time's up! Let's hear from each group. Keep your presentation brief—show your work and explain the pattern you found."

[CALL each group to present - about 45 seconds each]:

Group 1: $2^3 \times 2^4 = 2{\times}2{\times}2 \times 2{\times}2{\times}2{\times}2 = 2^7 \rightarrow$ When multiplying, we ADD the powers

Group 2: $5^7 \div 5^3 = 5^4 \rightarrow$ When dividing, we SUBTRACT the powers

Group 3: $(3^2)^3 = 3^6 \rightarrow$ When raising a power to a power, we MULTIPLY

Group 4: $(2{\times}5)^3 = 2^3 \times 5^3 = 8 \times 125 = 1000 \rightarrow$ The power applies to ALL factors

Group 5: 8^(1/3) = 2 → Fractional powers are ROOTS

[TRANSITION]:

"Excellent work! You've discovered the five laws of indices. Let me formalize these."

PHASE 2: Structured Instruction (10 Minutes)

The Five Laws of Indices (8 minutes)

[SAY]:

"Let me now present the five laws of indices formally. These are the rules you discovered!"

[WRITE and SAY - Law 1]:

"LAW 1: PRODUCT LAW
When multiplying numbers with the same base, ADD their powers.
$a^m \times a^n = a^{m+n}$
Example: $3^2 \times 3^4 = 3^{2+4} = 3^6$"

[WRITE and SAY - Law 2]:

"LAW 2: QUOTIENT LAW
When dividing numbers with the same base, SUBTRACT their powers.
$a^m \div a^n = a^{m-n}$
Example: $5^7 \div 5^3 = 5^{7-3} = 5^4$"

[WRITE and SAY - Law 3]:

"LAW 3: POWER OF A POWER LAW
When raising a power to another power, MULTIPLY the powers.
$(a^m)^n = a^{mxn}$
Example: $(3^2)^3 = 3^{2x3} = 3^6$"

[WRITE and SAY - Law 4]:

"LAW 4: POWER OF A PRODUCT LAW
When raising a product to a power, apply the power to ALL factors.
$(ab)^n = a^n \times b^n$
Example: $(2 \times 3)^3 = 2^3 \times 3^3 = 8 \times 27 = 216$"

[WRITE and SAY - Law 5]:

"LAW 5: FRACTIONAL POWERS
A fractional power represents a root.
a^(1/n) = $\sqrt[n]{a}$
Example: 8^(1/3) = $\sqrt[3]{8} = 2$"

Key Reminder (2 minutes)

[SAY - IMPORTANT]:

"CRITICAL POINT: These laws only work when the BASES are the SAME!

✓ *$2^3 \times 2^4 = 2^7$ (same base: 2)*
✗ *$2^3 \times 3^4$ cannot be simplified using the product law (different bases)"*

[TRANSITION]:

"Now let's practice applying these laws!"

PHASE 3: Practice and Application (15 Minutes)

Guided Practice (5 minutes)

[SAY]:

"Let's work through some problems together."

[ASK]:

"Simplify: 8^(1/3)"

[WORK through solution]:

"8^(1/3) = $\sqrt[3]{8} = 2$
OR: $8 = 2^3$, so 8^(1/3) = $(2^3)^{(1/3)} = 2^{(3\times1/3)} = 2^1 = 2$"

Word Problem (5 minutes)

[READ the problem]:

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

[GIVE 2 minutes, then solve]:

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

Partner Practice (5 minutes)

[SAY]:

"Work with your partner. Simplify:
a) $a^9 \times a^8 \div a^5$
b) $m^{10} \times m^{-6} \div m^{-5}$"

[GIVE 3 minutes, then review]:

"a) $a^9 \times a^8 \div a^5 = a^{(9+8-5)} = a^{12}$
b) $m^{10} \times m^{-6} \div m^{-5} = m^{(10-6+5)} = m^9$"

[TRANSITION]:

"Now I want to see what each of you has learned."

PHASE 4: Assessment / Checkpoint (8 Minutes)

Independent Work (5 minutes)

[DISPLAY questions]:

"1. Mr. Gitonga's field has area 5^8 m². Each plot is 5^3 m². How many plots? Express using indices.

2. An investment worth 4^5 shillings was multiplied by 4^3 after two years. Express the total value using indices."

[SAY]:

"You have 5 minutes. Begin."

Collection and Closure (2 minutes)

[SAY]:

"Time's up. Please pass your exit tickets forward."

[COLLECT all tickets]

[SAY]:

"Today you learned the five laws of indices:
• Product Law: ADD powers when multiplying
• Quotient Law: SUBTRACT powers when dividing
• Power of a Power: MULTIPLY powers

• *Power of a Product: Apply power to ALL factors*
• *Fractional Powers: Represent ROOTS"*

[SAY]:

"Great work today! For homework, complete the remaining problems from the exit ticket."

Differentiation Notes

For Struggling Learners:

- Provide a reference card with all five laws
- Start with numerical examples before variables
- Allow students to expand powers to verify
- Use color coding: one color for bases, another for exponents

For Advanced Learners:

[GIVE this extension - Carpenter's Tables]:

"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?"

Answer Key

Exit Ticket Answers:

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

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

Additional Assessment Answers:

$a^9 \times a^8 \div a^5 = a^{12}$

$m^{10} \times m^{-6} \div m^{-5} = m^9$

Paper bundles: $7^2 \times 7^1 \div 7^1 = 7^2$ bundles

Library books: $2^6 + 2^4$ (cannot simplify further with index laws—different operation)

Post-Lesson Reflection Prompts

1. What went well? Did the group presentations help students understand the laws?

2. What would I change? Was enough time given for discovery?

3. Student Understanding: Which law did students struggle with most?

4. Next Steps: Do students need more practice with negative exponents?