Step by step guide: Expressing Numbers in Index Form

Grade 10 Mathematics | 40-Minute Lesson

Before Class Begins

Preparation Checklist:

- Prepare one A4 sheet of paper per student
- Arrange students into groups of 2-3
- Prepare exit tickets for distribution
- Set timer for phase transitions
- Write the index notation format on the board (covered until Phase 2): a^n
- Prepare a sample table for recording paper folding observations

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

Opening (2 minutes)

[SAY]:

"Good morning/afternoon, class! Today we're going to discover a powerful way to write numbers—using index notation, also called powers or exponents. This is a skill that's used everywhere, from science to computing."

[SAY]:

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

Anchor Activity Introduction (2 minutes)

[DISTRIBUTE paper sheets]

[SAY]:

"Everyone has a piece of paper. This paper is about 0.1 mm thick. We're going to fold it and discover something amazing about numbers!"

[ASK]:

"If you fold this paper in half, how many layers will you have?"

[WAIT for response]: "Two!"

Group Work Instructions (1 minute)

[SAY - Read slowly and clearly]:

"In your groups, I want you to:
Step 1: Fold your paper in half once and count the layers
Step 2: Fold it in half again and count the layers
Step 3: Keep folding and record your observations in a table
Step 4: Look for a pattern in the number of layers
Step 5: Try to express the number of layers using powers of 2

You have 10 minutes. Begin!"

Circulation and Probing (8 minutes)

[DO]: Walk around the room, observing how students count layers and record data.

[ASK probing questions as you circulate]:

- "How many layers do you have after 3 folds?"
- "What pattern do you see in the numbers?"
- "How does the number of layers change with each fold?"
- "Can you predict the number of layers after 6 folds without folding?"
- "How would you write 8 as a power of 2?"

[OBSERVE]: Note which groups recognize the doubling pattern and can express it as powers of 2.

[TIME CHECK]: At 8 minutes, announce: "Two more minutes to complete your tables!"

Group Sharing (2 minutes)

[SAY]:

"Time's up! Let's hear from some groups. [Group name], what pattern did you notice?"

[Expected answer]: "The number of layers doubles each time."

[ASK]:

"[Group name], how did you express 8 layers using powers?"

[Expected answer]: "$2 \times 2 \times 2 = 2^3$"

[TRANSITION]:

"Excellent! You've discovered index notation. Let me formalize what you found."

PHASE 2: Structured Instruction (10 Minutes)

Introducing Index Notation (4 minutes)

[SAY]:

"What you discovered is called INDEX NOTATION or EXPONENTIAL FORM."

[WRITE on board]:

Index Notation: a^n

[SAY while pointing to each part]:

"In a^n:
• a is called the BASE—the number being multiplied
• n is called the EXPONENT, INDEX, or POWER—the number of times the base is multiplied by itself"

[SAY]:

"Let's connect this to your paper folding:
• 2 layers = 2^1 (2 to the power of 1)
• 4 layers = $2 \times 2 = 2^2$ (2 squared)
• 8 layers = $2 \times 2 \times 2 = 2^3$ (2 cubed)
• 16 layers = $2 \times 2 \times 2 \times 2 = 2^4$ (2 to the power of 4)"

Working Through Examples (4 minutes)

[SAY]:

"Let's practice expressing numbers in index form."

[WRITE]: "$a \times a = a^2$" (a squared)

[WRITE]: "$8 = 2 \times 2 \times 2 = 2^3$" (2 cubed)

[WRITE]: "$625 = 5 \times 5 \times 5 \times 5 = 5^4$" (5 to the power of 4)

[WRITE]: "$1000 = 10 \times 10 \times 10 = 10^3$" (10 cubed)

Addressing Misconceptions (2 minutes)

[SAY - IMPORTANT]:

"Be careful! The exponent tells us how many times to MULTIPLY, not ADD.

$2^3 = 2 \times 2 \times 2 = 8$ ✓
$2^3 \neq 2 + 2 + 2 = 6$ ✗ "

[ASK]:

"What is 3^4?"

[WAIT, then confirm]:

"$3^4 = 3 \times 3 \times 3 \times 3 = 81$, NOT $3 \times 4 = 12$!"

[TRANSITION]:

"Now let's practice expressing more numbers in index form!"

PHASE 3: Practice and Application (15 Minutes)

Guided Practice (5 minutes)

[SAY]:

"Let's work through some problems together. Express these numbers in index form."

[ASK]: "Express 81 in index form."

[Expected answer]: "3^4 because $3 \times 3 \times 3 \times 3 = 81$"

[ASK]: "Express 64 in index form."

[Expected answer]: "2^6 because $2 \times 2 \times 2 \times 2 \times 2 \times 2 = 64$, OR 4^3 because $4 \times 4 \times 4 = 64$"

[ASK]: "Express 1000000 in index form."

[Expected answer]: "10^6 because $10 \times 10 \times 10 \times 10 \times 10 \times 10 = 1{,}000{,}000$"

Partner Practice (7 minutes)

[SAY]:

"Now work with your partner. Express these numbers in index form:
a) 729
b) 243
c) 256
d) 10000"

[GIVE 5 minutes, then review]:

"Let's check:
a) 729 = 3^6 (or 9^3 or 27^2)
b) 243 = 3^5
c) 256 = 2^8 (or 4^4 or 16^2)
d) 10000 = 10^4"

Quick Application (3 minutes)

[SAY]:

"Quick question: A computer stores data in bytes. If a file is 1024 bytes, express 1024 as a power of 2."

[WAIT, then reveal]:

"1024 = 2^{10} ($2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 = 1024$)"

[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. Write the number 729 in index form. (Your answer should be written as a^b)

2. A school computer server saves files in blocks. Each unit file is 3 MB. The total saved size is 243 MB. Write 243 in index form using base 3."

[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 to express numbers in index form. Remember: a^n means the base a is multiplied by itself n times. This notation is used throughout mathematics and science."

[ASK]:

"Thinking back to our paper folding—if you could fold a paper 42 times, it would reach the moon! That's the power of exponential growth. Where else do you see exponential patterns?"

[ACCEPT responses - examples: population growth, compound interest, computer memory]

[SAY]:

"Great work today! For homework, express the numbers 32, 125, 216, and 512 in index form."

Differentiation Notes

For Struggling Learners:

- Provide a multiplication chart to help identify repeated factors
- Start with small bases (2, 3, 5) and small exponents
- Use visual aids showing the paper folding pattern
- Allow use of calculators to verify answers

For Advanced Learners:

[GIVE these extensions]:

- Find numbers that can be expressed in multiple index forms (e.g., $64 = 2^6 = 4^3 = 8^2$)
- Calculate: If you could fold a paper 50 times, how thick would it be? ($2^{50} \times 0.1$ mm)
- Research real-world applications of exponential growth

Answer Key

Exit Ticket Answers:

1. 729 in index form: 3^6 (since $3 \times 3 \times 3 \times 3 \times 3 \times 3 = 729$)

Alternative answers: 9^3 or 27^2

2. 243 in index form (base 3): 3^5 (since $3 \times 3 \times 3 \times 3 \times 3 = 243$)

Paper Folding Reference Table:

Folds	Layers	Index Form

1	2	2^1
2	4	2^2
3	8	2^3
4	16	2^4
5	32	2^5

Post-Lesson Reflection Prompts

1. What went well? Did the paper folding activity engage students?

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

3. Student Understanding: What did the exit tickets reveal about understanding base vs exponent?

4. Next Steps: Which students confused multiplication with addition in exponents?