Step by step guide: Multiplying and Dividing Logarithms

Grade 10 Mathematics | 40-Minute Lesson

Before Class Begins

Preparation Checklist:

- Distribute logarithm tables and antilogarithm tables to each student or pair
- Ensure scientific calculators are available for verification
- Display the four laws of logarithms on the board
- Prepare exit tickets for distribution
- Set timer for phase transitions

[WRITE on board before class]:

"LAWS OF LOGARITHMS:
1. $\log(a \times b) = \log(a) + \log(b)$
2. $\log(a \div b) = \log(a) - \log(b)$
3. $\log(a^b) = b \times \log(a)$
4. $\log(\sqrt[n]{a}) = (1/n) \times \log(a)$"

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

Opening (2 minutes)

[SAY]:

"Good morning/afternoon, class! Before calculators existed, how do you think scientists and engineers performed complex calculations like 236.5 × 42.8 or finding cube roots?"

[WAIT for responses]

[SAY]:

"They used LOGARITHMS! Today we'll discover how logarithms turn difficult calculations into simple ones."

Anchor Activity Introduction (3 minutes)

[SAY]:

"In your groups, I want you to try a challenge.

Part A: Without a calculator, try to compute:
• 236.5 × 42.8
• 528.6 ÷ 24.7
• The cube root of 524.8

Part B: Now use your logarithm tables. Find log(236.5) and log(42.8). What happens when you ADD them and find the antilog?"

Group Work (7 minutes)

[SAY]:

"You have 6 minutes to explore. Discuss with your group:
- How does adding logarithms relate to multiplication?
- How does subtracting relate to division?
- What about powers and roots?

Begin!"

[DO]: Walk around the room, observing group discussions.

[ASK probing questions as you circulate]:

- "What did you get when you added log(236.5) + log(42.8)?"
- "What's the antilog of that sum? Does it match 236.5 × 42.8?"
- "For the cube root, what operation did you try on the logarithm?"
- "Why do you think adding logs gives multiplication?"

[TIME CHECK]: At 5 minutes, announce: "One more minute!"

Class Discussion (3 minutes)

[SAY]:

"Let's share discoveries. What did you find when you added log(236.5) + log(42.8)?"

[Expected answer]: "2.3741 + 1.6318 = 4.0059, and antilog gives about 10,160!"

[ASK]:

"And 236.5 × 42.8 = ?"

[Expected answer]: "About 10,160! It matches!"

[TRANSITION]:

"Excellent! You've discovered the power of logarithms. Let me formalize these laws."

PHASE 2: Structured Instruction (10 Minutes)

The Four Laws (6 minutes)
[SAY]:

"Logarithms help simplify calculations. Here are the four laws you discovered:"

[WRITE and explain each]:

"LAW 1 - MULTIPLICATION:
$\log(a \times b) = \log(a) + \log(b)$
To multiply: ADD the logarithms, then find antilog

LAW 2 - DIVISION:
$\log(a \div b) = \log(a) - \log(b)$
To divide: SUBTRACT the logarithms, then find antilog

LAW 3 - POWERS:
$\log(a^b) = b \times \log(a)$
To find a power: MULTIPLY the logarithm by the exponent

LAW 4 - ROOTS:
$\log(\sqrt[n]{a}) = (1/n) \times \log(a)$
To find a root: DIVIDE the logarithm by the root index"

The Process (2 minutes)
[SAY]:

"The general process is always THREE steps:

Step 1: Find log of each number from tables
Step 2: Apply the appropriate operation (+, -, ×, ÷)
Step 3: Find antilog of the result"

Misconception Alert (2 minutes)
[SAY - IMPORTANT]:

"CAUTION! A common mistake: log(a + b) is NOT equal to log(a) + log(b)!

The laws ONLY work for:
• Multiplication → add logs
• Division → subtract logs
• Powers → multiply log
• Roots → divide log

NOT for addition or subtraction of numbers!"

[TRANSITION]:

"Now let's practice using these laws!"

PHASE 3: Practice and Application (15 Minutes)

Worked Example 1: Multiplication (3 minutes)
[SAY]:

"Let's find 236.5 × 42.8 using logarithm tables."

[WRITE step by step]:

"Step 1: Find logarithms from tables
  log(236.5) = 2.3741
  log(42.8) = 1.6318

Step 2: ADD the logarithms (multiplication law)
  2.3741 + 1.6318 = 4.0059

Step 3: Find antilogarithm
  antilog(4.0059) ≈ 10,160

Therefore: 236.5 × 42.8 ≈ 10,160"

Worked Example 2: Division (3 minutes)
[SAY]:

"Now let's find 528.6 ÷ 24.7"

[WRITE step by step]:

"Step 1: Find logarithms
  log(528.6) = 2.7233
  log(24.7) = 1.3927

Step 2: SUBTRACT the logarithms (division law)
  2.7233 - 1.3927 = 1.3306

Step 3: Find antilogarithm
  antilog(1.3306) ≈ 21.4

Therefore: 528.6 ÷ 24.7 ≈ 21.4"

Worked Example 3: Cube Root (3 minutes)
[SAY]:

"Finally, let's find $\sqrt[3]{524.8}$"

[WRITE step by step]:

"Step 1: Find logarithm
  log(524.8) = 2.7200

Step 2: DIVIDE by 3 (cube root law)
  2.7200 ÷ 3 = 0.9067

Step 3: Find antilogarithm
  antilog(0.9067) ≈ 8.1

Therefore: $\sqrt[3]{524.8}$ ≈ 8.1"

Guided Practice (4 minutes)
[SAY]:

"Try these with your partner:
1. Find 345.6 × 78.9
2. Find $\sqrt{82.6}$"

[GIVE 3 minutes, then review]:

"1. 345.6 × 78.9:
  log(345.6) = 2.5386, log(78.9) = 1.8971
  Sum = 4.4357, antilog ≈ 27,268

2. $\sqrt{82.6}$:

log(82.6) = 1.9170
Divide by 2: 0.9585
antilog ≈ 9.09"

[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. Use logarithms to find: 652.3 ÷ 12.7
2. Use logarithms to find: $\sqrt[3]{658.4}$"

[SAY]:

"You have 5 minutes. Show all three steps. Begin."

Collection and Closure (2 minutes)
[SAY]:

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

[COLLECT all tickets]

[SAY]:

"Today you learned how logarithms simplify calculations:

• To MULTIPLY: ADD logarithms
• To DIVIDE: SUBTRACT logarithms
• To find POWERS: MULTIPLY the logarithm
• To find ROOTS: DIVIDE the logarithm

Always follow the three steps: find logs, apply operation, find antilog.

Great work today!"

Differentiation Notes
For Struggling Learners:

- Provide step-by-step calculation templates
- Use color coding: log values (blue), operations (green), antilog (red)
- Allow calculator verification of final answers
- Focus on single operations before combining

For Advanced Learners:

[GIVE these extensions]:

- Evaluate: $\sqrt{(4.56 \times 12.3) \div 24.7}$
- Evaluate: $\sqrt[4]{(8462 \times 23.7) \div 673}$
- Prove: $\log(\sqrt{a} \times \sqrt[3]{b}) = \tfrac{1}{2}\log(a) + \tfrac{1}{3}\log(b)$

Answer Key

Exit Ticket Answers:

1. 652.3 ÷ 12.7:

log(652.3) = 2.8144, log(12.7) = 1.1038

2.8144 - 1.1038 = 1.7106

antilog(1.7106) ≈ 51.4

2. $\sqrt[3]{658.4}$:

log(658.4) = 2.8185

2.8185 ÷ 3 = 0.9395

antilog(0.9395) ≈ 8.70

Practice Problems Answers:

Multiplication:

345.6 × 78.9 ≈ 27,268

6284 × 92.5 ≈ 581,270

0.0482 × 53.7 ≈ 2.588

Division:

652.3 ÷ 12.7 ≈ 51.4

0.0854 ÷ 3.42 ≈ 0.0250

4312 ÷ 58.3 ≈ 74.0

Powers:

$(78.5)^3 ≈ 484,000$

$(254.6)^4 ≈ 4.20 × 10^9$

$(12.75)^{2.5} ≈ 580$

Roots:

$\sqrt[3]{658.4} ≈ 8.70$

$\sqrt{82.6} ≈ 9.09$

$\sqrt[4]{3126} ≈ 7.48$

Word Problems:

Square field (Area = 18,432 m²): Side ≈ 135.8 m

Cube (Volume = 79,507 cm³): Side ≈ 43.0 cm

Post-Lesson Reflection Prompts

1. What went well? Did students discover the laws through exploration?

2. What would I change? Was the table reading clear?

3. Student Understanding: Could students apply the correct law for each operation?

4. Next Steps: Which students need more practice with specific operations?