I. Lesson Overview

Lesson Title:	Exploring Logarithms in Real-Life Applications
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 logarithms are applied in various real-world fields including science, engineering, finance, and measurement scales.
2. **Do (Procedural Skill):** Apply logarithmic formulas to solve problems involving pH, earthquake intensity, population growth, and compound calculations.
3. **Apply (Application/Problem-Solving):** Analyze real-world scenarios and select appropriate logarithmic methods to find solutions.

Curriculum Alignment

Strand:	Numbers and Algebra
Sub-Strand:	Indices and Logarithms
Specific Learning Outcome:	Exploring Logarithms in Real-Life Applications.

III. Materials & Resources

Textbooks:	CBC Grade 10 Mathematics Learner's Book CBC Grade 10 Mathematics Teacher's Book
Equipment:	Scientific calculators, Logarithm tables
Visual Aids:	Charts showing pH scale, Richter scale, and population growth graphs

IV. Lesson Procedure

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

Objective: To explore real-world applications of logarithms through individual research and group discussion.

Anchor Activity: Exploring Logarithms in Different Fields

At an individual level, explore how logarithms are used in different fields:

Research Areas:

- Engineering: Signal processing, decibel measurements, circuit analysis
- Finance: Compound interest, investment growth, loan calculations
- Science: pH scale in chemistry, radioactive decay, population biology
- Geology: Richter scale for earthquake measurement
- Astronomy: Stellar magnitude and brightness
- Medicine: Drug concentration decay in the body

Individual Research Task (8 minutes):

1. Choose ONE field that interests you

2. Find at least ONE specific example of how logarithms are used

3. Write down the formula or application

4. Be prepared to share with your group

Group Discussion (5 minutes):

Share your findings with your group and discuss:

- What common patterns do you see across different applications?
- Why do you think logarithms are useful for these applications?
- How do logarithms help us work with very large or very small numbers?

Teacher's Role: The teacher circulates among students, guiding research and asking probing questions (e.g., "Why do you think scientists use logarithms for the pH scale?", "What happens when numbers get very large?"). The teacher collects interesting findings to share during instruction.

Phase 2: Structured Instruction / Explain (10 minutes)

Objective: To formalize the key real-life applications of logarithms.

Key Takeaways:

Why Do We Use Logarithms in Real Life?

Logarithms help us:

• Compress large ranges of numbers into manageable scales

• Solve exponential equations (find unknown exponents)

• Model phenomena that grow or decay exponentially

• Simplify multiplication and division into addition and subtraction

Key Real-Life Applications:

Application	Formula	What It Measures
pH Scale (Chemistry)	$pH = -\log[H^+]$	Acidity/alkalinity of solutions
Richter Scale (Geology)	$R = \log(I/I_0)$	Earthquake intensity
Decibel Scale (Sound)	$dB = 10 \log(I/I_0)$	Sound intensity
Population Growth	$P = P_0e^{rt}$	Exponential population change

Important Properties for Applications:

• $\log(ab) = \log(a) + \log(b)$ — useful for compound calculations

• $\log(a/b) = \log(a) - \log(b)$ — useful for ratio comparisons

• $\log(a^n) = n \cdot \log(a)$ — useful for exponential problems

• $\log(\sqrt{a}) = ½ \cdot \log(a)$ — useful for root calculations

Addressing Misconceptions: "Remember: The negative sign in $pH = -\log[H^+]$ is part of the formula, not the answer. Also, each unit increase on the Richter scale represents a 10-fold increase in intensity!"

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

Objective: To apply logarithmic formulas to solve real-world problems.

Problem 1: pH Calculation

The pH scale in chemistry is based on logarithms. Given that $pH = -\log[H^+]$, determine the pH of a solution where $[H^+] = 3.2 \times 10^{-4}$.

Solution:

$pH = -\log[H^+]$

$pH = -\log(3.2 \times 10^{-4})$

$pH = -[\log(3.2) + \log(10^{-4})]$

$pH = -[0.5051 + (-4)]$

$pH = -[0.5051 - 4]$

$pH = -(-3.4949)$

pH ≈ 3.49 (acidic solution)

Problem 2: Richter Scale

The Richter scale measures earthquake intensity using $R = \log(I/I_0)$, where I is the intensity and I_0 is the reference intensity. If an earthquake is 1000 times more intense than the reference, what is its magnitude?

Solution:

Given: $I = 1000 \times I_0$, so $I/I_0 = 1000$

$R = \log(I/I_0)$

$R = \log(1000)$

$R = \log(10^3)$

$R = 3$

Magnitude = 3.0 on the Richter scale

Problem 3: Using Logarithm Tables for Compound Calculation

Use logarithm tables to evaluate $\sqrt{[(6.28 \times 42.5) / 9.81]}$

Solution:

Let $x = \sqrt{[(6.28 \times 42.5) / 9.81]}$

$\log(x) = ½ \times \log[(6.28 \times 42.5) / 9.81]$

$\log(x) = ½ \times [\log(6.28) + \log(42.5) - \log(9.81)]$

$\log(x) = ½ \times [0.7980 + 1.6284 - 0.9917]$

$\log(x) = ½ \times 1.4347$

$\log(x) = 0.7174$

$x = \text{antilog}(0.7174)$

$x \approx 5.22$

Problem 4: Population Growth

A country's population grows according to $P = P_0e^{rt}$. If the population doubles in 10 years at a growth rate of 5% per year, verify this relationship.

Solution:

For doubling: $P = 2P_0$

$2P_0 = P_0e^{rt}$

$2 = e^{rt}$

$\ln(2) = rt$

$t = \ln(2)/r = 0.693/0.05$

$t \approx 13.86$ years (at 5% growth rate)

Note: The actual doubling time at 5% is about 14 years, not 10 years. For doubling in 10 years, the growth rate would need to be about 6.93%.

Teacher's Role: The teacher monitors students, helping them connect the formulas to real-world meaning and emphasizing units and context.

Phase 4: Assessment / Evaluate (Exit Ticket)

Objective: To formatively assess individual student understanding.

Exit Ticket Questions:

1. Research and describe two real-life applications of logarithms. Present your findings to the class.

2. The pH scale in chemistry is based on logarithms. Given that $pH = -\log[H^+]$, determine the pH of a solution where $[H^+] = 3.2 \times 10^{-4}$.

3. The Richter scale measures earthquake intensity using $R = \log(I/I_0)$. If an earthquake is 1000 times more intense than the reference, what is its magnitude on the Richter scale?

4. Use logarithm tables to evaluate $\sqrt{[(6.28 \times 42.5) / 9.81]}$.

5. A country's population grows exponentially according to $P = P_0e^{rt}$. Solve for t if a population doubles at a growth rate of 5% per year.

Answer Key:

1. Examples include: pH scale (chemistry), Richter scale (earthquakes), decibel scale (sound), compound interest (finance), radioactive decay (physics), stellar magnitude (astronomy).

2. $pH = -\log(3.2 \times 10^{-4}) = -[\log(3.2) + \log(10^{-4})] = -[0.5051 - 4] = 3.49$

3. $R = \log(1000) = \log(10^3) = 3.0$

4. $\log(x) = \frac{1}{2}[\log(6.28) + \log(42.5) - \log(9.81)] = \frac{1}{2}[0.7980 + 1.6284 - 0.9917] = 0.7174$; $x \approx 5.22$

5. $2 = e^{rt} \rightarrow \ln(2) = rt \rightarrow t = \ln(2)/0.05 = 0.693/0.05 \approx 13.86$ years

V. Differentiation

Student Group	Strategy & Activity
Struggling Learners (Support)	Scaffolding: Provide formula cards with examples. Focus on one application (pH or Richter). Use calculators for verification. Pair with stronger students during research.
On-Level Learners (Core)	The core lesson activities as described above.
Advanced Learners (Challenge)	Extension Activity: 1) Research the decibel scale: If normal conversation is 60 dB and a rock concert is 120 dB, how many times more intense is the concert? 2) The half-life of a radioactive substance is given by $t_1/_2 = \ln(2)/\lambda$. If a substance has a half-life of 5 years, find its decay constant λ. 3) Create your own real-world problem using logarithms.

Extension Activity Solutions:

1. Decibel Problem:

120 dB − 60 dB = 60 dB difference

$60 = 10 \log(I_2/I_1)$

$6 = \log(I_2/I_1)$

$I_2/I_1 = 10^6 = 1,000,000$ times more intense

2. Half-life Problem:

$t_1/_2 = \ln(2)/\lambda$

$5 = 0.693/\lambda$

$\lambda = 0.693/5 = 0.1386$ per year

VI. Assessment

Type	Method	Purpose
Formative (During Lesson)	- Observation during research - Questioning during discussion - Exit Ticket	To monitor progress and adjust instruction.
Summative (After Lesson)	- Research presentation - Problem-solving assignment	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: Could students connect logarithms to real-world applications?

4. Next Steps: Which applications need more practice?