CHAPTER 0 PROJECT

Lab Measurements and Dosage Calculations

You are a first-year lab assistant in your university's biology department. The lab runs experiments that require precise measurements, unit conversions, dilution calculations, and dosage formulas. Before you can work independently, you must demonstrate fluency with the fundamental algebra skills that underpin laboratory science. Throughout this project, you will use real numbers, algebraic expressions, exponent rules, radicals, rational exponents, and polynomial factoring to solve practical lab problems.

1. The lab's freezer log records temperature readings throughout the day: −18.4°C, −17.9°C, −19.1°C, −18.6°C, −20.0°C. Calculate the average temperature.

2. A lab protocol calls for preparing a solution using two reagents. Reagent A costs $(4.50m + 12)$ dollars for m milliliters, and Reagent B costs $(3.25n + 8)$ dollars for n milliliters. Write and simplify an expression for the total cost of using m mL of A and n mL of B. If you need 20 mL of A and 35 mL of B, calculate the total cost.

3. A bacterial culture triples every hour. Starting with 200 bacteria, the population after h hours is $200 \cdot 3^h$. Calculate the population when $h = 0$, 2, 4, and 6.

4. The lab measures the diameter of circular cell samples under a microscope. One sample has an area of 50 square micrometers (μm²). Since $A = \pi r^2$, the radius is $r = \sqrt{\frac{A}{\pi}} = \sqrt{\frac{50}{\pi}}$.

a. Separate $\sqrt{\frac{50}{\pi}}$, simplify $\sqrt{50}$ by factoring out a perfect square, and rewrite $\frac{\sqrt{50}}{\sqrt{\pi}}$.

b. Approximate the radius to two decimal places.

c. A second sample has area 72 μm². Simplify $\sqrt{\frac{72}{\pi}}$ like we did with $\sqrt{\frac{50}{\pi}}$ and approximate the radius. By approximately what factor is the second radius larger than the first?

5. The lab uses the expression $\sqrt{200}+3\sqrt{18}-2\sqrt{50}$ to calculate a combined measurement across three tissue samples (in µm). Simplify each radical term, then combine like terms. Express the result as a single term with a simplified radical.

6. Drug dosage formulas often use rational exponents. A pediatric dosage model estimates the appropriate dose (in mg) as: $12w^{\frac{2}{3}}$ where w is the child's body weight in kilograms.

a. Rewrite the dosage $12w^{\frac{2}{3}}$ using radical notation.

b. Find the dosage when $w = 8$ kg and when $w = 27$ kg. Show how to compute $8^{\frac{2}{3}}$ and $27^{\frac{2}{3}}$ step by step using radical form.

7. The concentration of a drug (in mg/L) at various times during a trial is modeled by the polynomial: $-0.5t^2+6t+2$ where t is hours after administration.

a. Find the concentration of the drug when $t = 0$, 4, 8, and 12.

b. At which time is the concentration highest among these values?

c. Describe the trend.

8. The lab models the area of a rectangular growth plate as $x(24 - x)$, where x is the width in millimeters and $(24 - x)$ is the length.

a. Expand the expression for the area.

b. Find the area of the rectangular growth plate when the width $x = 6$, 10, and 12. Which width gives the largest area?

c. Explain why the width of the growth plate cannot be 0 mm or 24 mm.

9. The lab needs to factor several expressions that arise in chemistry and biology formulas. Factor each completely:

a. $4x^2 - 25$

b. $x^2 - 10x + 21$

c. $6x^2 + 11x - 10$

For each, state which factoring technique you used (difference of squares, trial and error, grouping, etc.).

10. A senior lab member tells you: "You don't need algebra in the lab. Just follow the protocol step by step." Using specific examples from this project, explain why fundamental algebra skills are essential for a lab assistant. Address at least three skills. Then identify one situation from this project where blindly following a calculator's decimal output would be less informative than understanding the algebraic form of the answer.