GENERAL

# math 120 review sheet exponential and logarithmic functions

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## Math 120 Review Sheet: Exponential and Logarithmic Functions

Welcome to your comprehensive math 120 review sheet focused on exponential and logarithmic functions. Whether you're preparing for a mid term, a final exam, or simply want to strengthen your understanding of these powerful concepts, this guide is designed to walk you through every key idea, property, and application in a clear, organized, and engaging way. By the end, you'll be ready to tackle any problem involving exponentials or logs with confidence.

### Why Exponential and Logarithmic Functions Matter

Exponential and logarithmic functions appear in many real world contexts—population growth, radioactive decay, interest calculations, and even the Richter scale for earthquakes. In a college algebra course like Math 120, mastering these functions equips you with the tools to solve complex equations, model natural phenomena, and transition smoothly into higher level math courses.

Our review sheet is structured to mirror the typical flow of a math 120 curriculum: from foundational definitions to advanced applications. We'll cover:

- Key definitions and notation
- Properties of exponential and logarithmic functions
- Graphing techniques and transformations
- Solving equations and inequalities
- Applications in real world scenarios
- Practice problems with step by step solutions
- Effective study strategies

Let's dive in and unlock the full potential of exponential and logarithmic functions.

## 1. Exponential Functions: Foundations

### 1.1 Definition and Basic Notation

An **exponential function** has the form **f(x) = a<sup>x</sup>**, where **a** is a positive real constant called the **base**, and **x** is the exponent. The most common bases are **2**, **10**, and the natural constant **e "H 2.71828**

Key points:

- The base must be positive and not equal to 1.
- When a > 1, the function grows rapidly.
- When 0 , the function decays toward 0.

### 1.2 Fundamental Properties

Exponential functions obey several algebraic rules that simplify calculations:

1. Product Rule: ax · ay = ax + y
2. Quotient Rule: ax / ay = ax – y

3. Power Rule:  (ax)n = anx
4. Zero Exponent:  a0 = 1
5. Negative Exponent:  a–n = 1 / an

### 1.3 Graphing Exponential Functions

Graphing **f(x) = a<sup>x</sup>** involves understanding its key features:

- Domain: All real numbers.
- Range: (0, " ) for positive bases.
- Horizontal Asymptote: y = 0 (the x  axis).
- Intercepts:

  y  intercept at (0, 1) because a0 = 1.
- No x  intercept because the function never reaches zero.
- If a > 1, the graph rises steeply to the right.
- If 0

### 1.4 Transformations of Exponential Functions

Adding or multiplying by constants shifts or stretches the graph. For **f(x) = a<sup>bx + c</sup> + d**, the transformations are:

- Horizontal Shift: c/b units left if c is negative, right if c is positive.
- Vertical Shift: d units up if d is positive, down if d is negative.
- Vertical Stretch/Compression: factor b (|b| > 1 stretches, |b|
- Reflection: if b is negative, reflect across the x  axis.

### 1.5 Solving Exponential Equations

When faced with equations like **3<sup>x</sup> = 81**, use properties of exponents to isolate **x**:

1. Rewrite both sides with the same base: 81 = 34.
2. Set exponents equal: x = 4.

For equations that don't share a common base, you may need to take logarithms (see next section).

## 2. Logarithmic Functions: The Inverse of Exponentials

### 2.1 Definition and Notation

A **logarithmic function** is the inverse of an exponential function. For a base **a > 0, a "`,1** the logarithm is written as **log<sub>a</sub>(x)** and satisfies:

$$ a^{\\,\\text{log}_a(x)} = x \\quad \\text{and} \\quad \\text{log}_a(a^x) = x $$

Common logarithms:

- Common Logarithm: base 10, written as log(x).
- Natural Logarithm: base e, written as ln(x).

### 2.2 Fundamental Properties

Logarithms share analogous rules to exponentials:

1. Product Rule: loga(xy) = loga(x) + loga(y)
2. Quotient Rule: loga(x/y) = loga(x) – loga(y)

3. Power Rule: loga(xn) = n·loga(x)
4. Change of Base: loga(x) = ln(x) / ln(a) (or log10(x) / log10(a)).

### 2.3 Graphing Logarithmic Functions

Key features of **g(x) = log<sub>a</sub>(x)**:

- Domain: x > 0.
- Range: All real numbers.
- Vertical Asymptote: x = 0.
- Intercepts:

  y  intercept at (1, 0) because loga(1) = 0.
- No x  intercept unless the function is shifted.

### 2.4 Solving Logarithmic Equations

To solve equations like **log<sub>2</sub>(x) = 5**, exponentiate both sides:

1. Rewrite as 25 = x.
2. Compute: x = 32.

For more complex equations, apply logarithmic properties to combine terms before solving.

## 3. Bridging Exponentials and Logarithms

### 3.1 Inverse Relationship

Because exponentials and logarithms are inverses, solving one often involves the other. For example, to solve **e<sup>3x</sup> = 5**, take the natural log of both sides:

1. ln(e3x) = ln(5)
2. Use the power rule: 3x = ln(5)
3. Isolate x: x = ln(5) / 3

### 3.2 Change of Base Formula

When calculators only provide **log** (base 10) and **ln** (base e), you can convert any logarithm:

$$ \\text{log}_a(b) = \\frac{\\log(b)}{\\log(a)} \\quad \\text{or} \\quad \\frac{\\ln(b)}{\\ln(a)} $$

This is especially useful when solving equations with non  standard bases.

### 3.3 Common Real  World Models

1. **Compound Interest:** A principal P grows to A after t years with interest rate r compounded n times per year: **A = P(1 + r/n)^{nt}**.

2. **Radioactive Decay:** The remaining quantity Q after time t: **Q = Q<sub>0</sub>e^{–kt}**, where k is the decay constant.

3. **Population Growth:** Exponential model: **N(t) = N<sub>0</sub>e^{rt}**.

4. pH

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