

Pennsylvania Keystone Grade 9 Math Made Easy

Study Guide with Key Concepts, Review & Practice

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YOUR ALGEBRA 1 STUDY GUIDE

Math Made Easy

Key Concepts • Worked Examples • Practice with Answers

Algebra 1 is the foundation of all higher mathematics. This study guide covers every key concept you need — from real numbers and exponents through linear and quadratic functions, systems of equations, polynomials, exponential models, and data analysis.

Each topic is explained simply, backed by worked examples, and followed by focused practice with a full answer key. Use it to learn new ideas, review before a test, or fill in gaps any time.

 **37 Topics Across 9 Chapters**

Real numbers, linear equations, functions, systems, polynomials, quadratics, exponentials, and statistics — every Algebra 1 standard.

 **Clear Explanations & Worked Examples**

Every concept is broken down step by step with real examples so you understand the why, not just the how.

 **Practice with Every Topic**

Short, focused problem sets after each lesson let you test your understanding immediately.

 **Complete Answer Key**

Every practice problem has a detailed answer and explanation in the back of the book.

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How to Use This Study Guide

Four steps to master every topic.

1

Read the Concept Box

Each topic starts with a clear explanation of the key idea or formula. Read it carefully — this is the foundation for everything that follows. Underline anything you want to remember.

2

Study the Worked Examples

Worked examples show you exactly how to apply the concept step by step. Cover the solution, try it yourself first, then compare. That one extra effort makes the method stick.

3

Solve the Practice Problems

After each explanation, a short set of problems tests your understanding. Work them on paper — writing out every step is the fastest way to learn.

4

Check Answers and Fix Mistakes

Flip to the Answer Key and mark your work. For any mistake, re-read the explanation and try again. Mistakes show you exactly where to focus next.



Study Plan Ideas

- **Daily:** One topic per day (15–25 minutes).
- **Weekly:** Review the week's concepts each Friday.
- **Before a test:** Re-do any problems you got wrong.



Tips for Parents & Teachers

- Use the guide alongside classroom lessons for extra support.
- Review mistakes together — focus on understanding, not just answers.
- Praise effort and persistence over speed or scores.

Algebra Quick Reference

Key formulas and facts for Algebra 1 – tear out or bookmark this page.

Exponent Rules

$$a^m \cdot a^n = a^{m+n}$$

$$\frac{a^m}{a^n} = a^{m-n}$$

$$(a^m)^n = a^{mn}$$

$$a^0 = 1 \quad (a \neq 0)$$

$$a^{-n} = \frac{1}{a^n}$$

Systems of Equations

Substitution: Solve one equation for a variable, plug into the other.

Elimination: Add/subtract equations to cancel a variable.

One solution: lines cross

No solution: parallel lines

Infinite: same line

Slope & Linear Equations

$$\text{Slope: } m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{\text{rise}}{\text{run}}$$

$$\text{Slope-intercept: } y = mx + b$$

$$\text{Point-slope: } y - y_1 = m(x - x_1)$$

$$\text{Standard: } Ax + By = C$$

Parallel: same slope

$$\text{Perpendicular: } m_1 \cdot m_2 = -1$$

Functions

A function maps each input to exactly one output.

$f(x)$ means "the output for input x "

Domain: set of all inputs

Range: set of all outputs

Vertical line test: if a vertical line hits the graph twice, it's not a function.

Algebra Quick Reference

Continued

Factoring Polynomials

GCF first, always.

$$a^2 - b^2 = (a + b)(a - b)$$

$$a^2 + 2ab + b^2 = (a + b)^2$$

$$a^2 - 2ab + b^2 = (a - b)^2$$

$$x^2 + bx + c = (x + p)(x + q)$$

where $p + q = b$ and $pq = c$

Quadratic Functions

Standard: $f(x) = ax^2 + bx + c$

Vertex: $f(x) = a(x - h)^2 + k$

Axis of symmetry: $x = -\frac{b}{2a}$

Vertex: $\left(-\frac{b}{2a}, f\left(-\frac{b}{2a}\right)\right)$

$a > 0$: opens up $a < 0$: opens down

Quadratic Formula

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Discriminant: $\Delta = b^2 - 4ac$

$\Delta > 0$: two real solutions

$\Delta = 0$: one real solution

$\Delta < 0$: no real solutions

Exponential Functions

$$f(x) = a \cdot b^x$$

a = initial value (y-intercept)

$b > 1$: growth $0 < b < 1$: decay

Growth rate: $r = b - 1$






Arithmetic seq: $a_n = a_1 + (n - 1)d$

Geometric seq: $a_n = a_1 \cdot r^{n-1}$

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CHAPTER

1

Foundations of Algebra

★ What's Inside ★

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★ 1.1 Classifying Real Numbers ★

🎯 Learning Goals

- Classify numbers as natural, whole, integer, rational, or irrational
- Know that rational decimals terminate or repeat

🎓 Number Subsets

Every number you use belongs to at least one of these groups:

- **Natural numbers:** $1, 2, 3, \dots$ (counting numbers)
- **Whole numbers:** $0, 1, 2, 3, \dots$ (naturals plus zero)
- **Integers:** $\dots, -2, -1, 0, 1, 2, \dots$ (whole numbers and negatives)
- **Rational numbers:** any number that equals $\frac{a}{b}$ where a, b are integers and $b \neq 0$
- **Irrational numbers:** decimals that never end and never repeat ($\sqrt{2}, \pi$)

These sets nest like rings. $\text{Natural} \subset \text{Whole} \subset \text{Integer} \subset \text{Rational}$. Rational and Irrational together make the **real numbers**.

✏️ Classifying Numbers

Place each number in all groups that fit.

1. 7 — Natural, Whole, Integer, Rational ($\frac{7}{1}$), Real
2. 0 — Whole, Integer, Rational ($\frac{0}{1}$), Real
3. -3 — Integer, Rational ($\frac{-3}{1}$), Real
4. $\frac{2}{5} = 0.4$ — Rational (terminates), Real
5. $\sqrt{3} = 1.7320\dots$ — Irrational (never repeats), Real



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“ Every integer is rational! Just write it over 1. For example, $-5 = \frac{-5}{1}$. ”

Rational Numbers

- Written as $\frac{a}{b}$, $b \neq 0$
- Decimals terminate or repeat
- Examples: $\frac{3}{4}$, -2 , $0.\bar{6}$

Irrational Numbers

- Cannot be written as $\frac{a}{b}$
- Decimals never terminate or repeat
- Examples: $\sqrt{2}$, π , $\sqrt{10}$

Classifying Real Numbers

1. Classify -12 : natural, whole, integer, rational, or irrational?
2. Is $\sqrt{25}$ rational or irrational?
3. Is $\sqrt{7}$ rational or irrational?
4. Write $0.\bar{3}$ as a fraction.
5. All whole numbers are integers.

True False



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CHAPTER

2

Introduction to Functions

★ What's Inside ★

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★ 2.1 What Is a Function? ★

🎯 Learning Goals

- Decide whether a relation is a function
- Use the vertical line test on graphs

🎓 What Is a Function?

A **relation** is any set of ordered pairs (x, y) .

A **function** is a special relation where every input (x) gives exactly one output (y) . No x -value may repeat with a different y -value.

Think of a vending machine. Press button **A3**, you always get the same snack. If one button gave a random item each time, that machine would not be a function!

Ways to show a relation: ordered pairs, table, graph, mapping diagram, or equation.

✏️ Checking a Table

Is this relation a function?

x	1	2	3	1
y	5	8	10	7

The input $x = 1$ maps to both 5 and 7. One input gives two outputs, so this is **not a function**.



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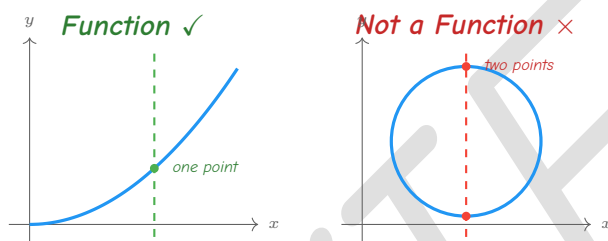


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The Vertical Line Test

- 1 Draw or look at the graph of the relation.
- 2 Imagine sliding a vertical line across the graph from left to right.
- 3 If the vertical line ever hits the graph in **two or more points** at the same time, it is **not** a function.
- 4 If every vertical line hits at most one point, it **is** a function.



“ A function is like a rule: one question, one answer. If one input gives two answers, it breaks the rule! ”



TIP

In a mapping diagram, each input arrow must point to exactly one output. An input with two arrows means it is not a function.

What Is a Function?

1. A relation has the pairs $(2, 4)$, $(3, 6)$, $(4, 8)$, $(5, 10)$. Is it a function?
2. A relation has the pairs $(1, 3)$, $(2, 5)$, $(1, 7)$. Is it a function?
3. A circle is drawn on a coordinate plane. Does it pass the vertical line test?
4. Every function is a relation. True False
5. A mapping diagram shows $3 \rightarrow 9$, $4 \rightarrow 16$, $5 \rightarrow 25$. Is it a function?



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Answer Key



Answer Key

Try each problem on your own first, then check your work here.

Chapter 1

> Section 1.1

1 Integer, Rational

2 Rational

3 Irrational

4 $\frac{1}{3}$

5 True

Explanations

1 -12 is negative, so not natural or whole. It is an integer. Since $-12 = \frac{-12}{1}$, it is also rational.

2 $\sqrt{25} = 5$, a whole number. Every integer is rational: $5 = \frac{5}{1}$.

3 7 is not a perfect square. So $\sqrt{7}$ is a non-repeating, non-terminating decimal.

4 $0.\overline{3} = 0.333\dots$. The repeating decimal equals $\frac{1}{3}$, which is rational.

Chapter 2



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[> Section 2.1](#)

1 Yes

2 No

3 No

4 True

5 Yes

 Explanations

1 Each input appears only once. Every x -value maps to exactly one y -value, so it is a function.

2 The input $x = 1$ maps to both 3 and 7. One input gives two outputs, so it is not a function.

3 A vertical line through the middle of a circle hits it at two points. So a circle is not a function.

5 Each input maps to exactly one output. No input is repeated, so it is a function.



Well done checking your answers!

Keep practicing to strengthen your skills.



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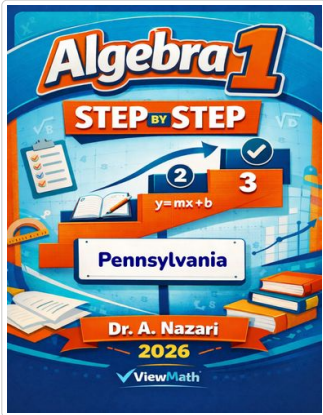


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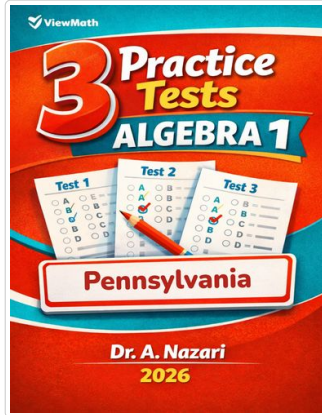
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Step-by-Step



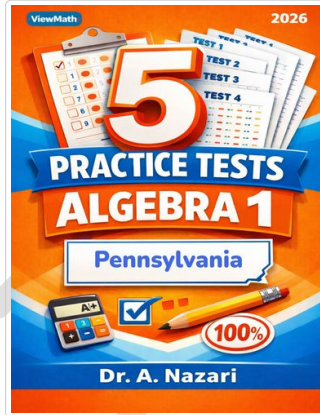
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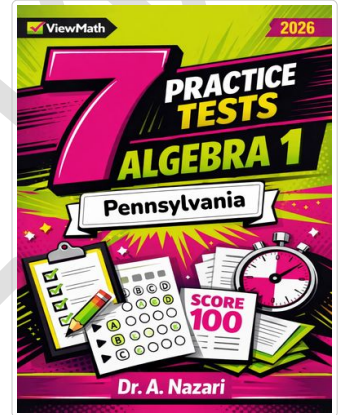
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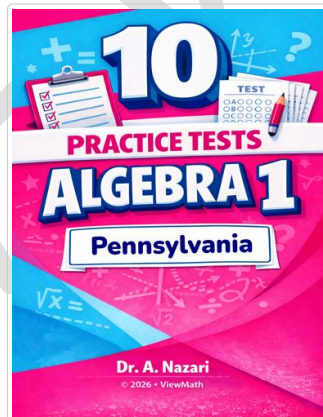
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7 Practice Tests



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10 Practice Tests



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