

# Massachusetts MCAS Grade 9 Math Step by Step

*A Beginner Friendly Guide to Learning Math*

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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



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



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**Rational Numbers**

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

**Irrational Numbers**

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

 **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  $0.\overline{3}$  as a fraction.
5. All whole numbers are integers.

True  False 

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CHAPTER

2

# Introduction to Functions

## ★ What's Inside ★

2.1 What Is a Function? .....	5
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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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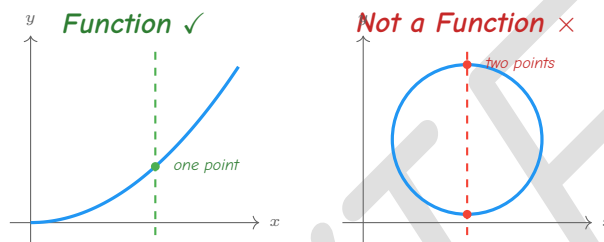


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## The Vertical Line Test

- 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.

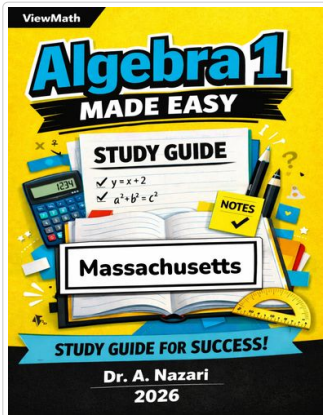


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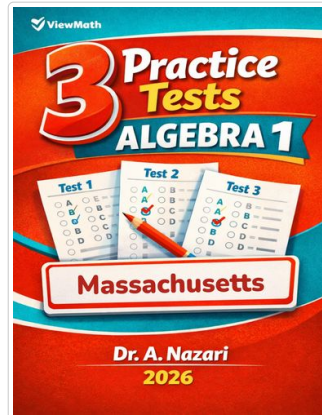
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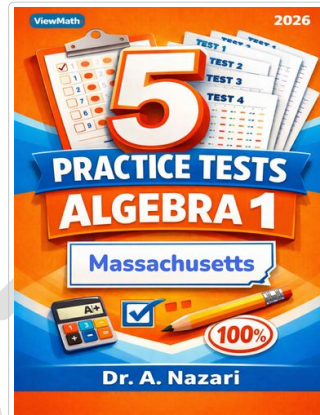
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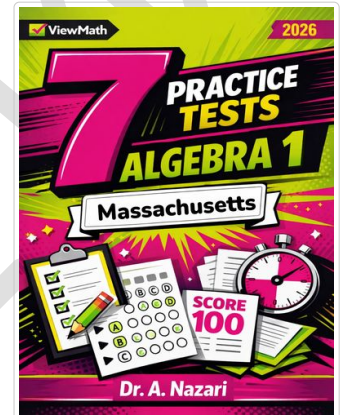
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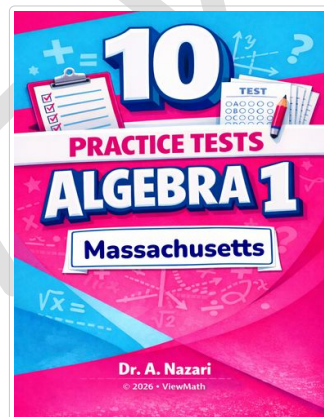
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7 Practice Tests



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10 Practice Tests



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