



# 6th Grade Math

A Colorful Adventure in Numbers & Shapes!

*By Arieyanna Jefferson*

# Final Reflections

As I reach the end of this book, I want to take a moment to reflect on everything I've learned and experienced while exploring 6th grade math, especially decimals. Math is not just about numbers and calculations—it's about building skills that will stay with us for life.

Throughout this book, you've found practice tests, review questions, and helpful Q&A sections, all focused on decimals and the important concepts we learn in 6th grade. My hope is that by working through these pages, you've gained confidence in your abilities and discovered new ways to think about numbers.

Learning about decimals is much more than just moving a point left or right. It's about understanding parts of a whole, making sense of measurements, and solving real-world problems. Every practice test and question in this book was designed to help you master these ideas step by step. I want you to remember that making mistakes is a part of learning—what matters is that you keep trying and never give up.

## A Special Thank You

I am incredibly grateful to Dr. Whu for teaching me how to use the AI app Poe to my greatest advantage. When I first started, I never realized how helpful AI could be in solving math problems, checking my work, and even giving me new ways to approach tough questions. Dr. Whu's patience and encouragement helped me see that technology isn't just a tool—it's a life skill that can open up so many opportunities for learning and growth.

Using Poe has made me more independent and confident in my math studies. It's a skill I'm proud to have, and one I know I will continue to use for many years to come. I truly appreciate Dr. Whu for showing me how to use AI in such a positive and meaningful way. Thank you, Dr. Whu, for your guidance and support. You have made a real difference in my learning journey.

As you close this book, I hope you feel proud of all the hard work you've put into learning decimals and 6th grade math. Remember, the skills you build now are the foundation for everything you will learn in the future. Keep practicing, stay curious, and never be afraid to ask questions. Math is a journey, and every step you take brings you closer to understanding the world in new and exciting ways.

Thank you for reading this book. I wish you all the best in your studies and beyond!



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The book is also available online at

<https://www.backupspirit.com/camp/2025/completion/ArieyannaJefferson.html>

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# Fractions, Ratios, and Proportions Mastery

Understand, Practice, and Test Your Skills!

Concepts

Examples

Pre-Test

Q & A

Post-Test

## Core Concepts Explained

- **Improper Fraction:** A fraction where the numerator is equal to or larger than the denominator (e.g.,  $\frac{7}{4}$ ).
- **Mixed Number:** A whole number and a fraction combined (e.g.,  $1\frac{3}{4}$ ).
- **Like Denominators:** Fractions that have the same bottom number (denominator).
- **Unlike Denominators:** Fractions with different denominators.
- **Reciprocal:** Flip the numerator and denominator (e.g., reciprocal of  $\frac{2}{3}$  is  $\frac{3}{2}$ ).
- **Estimating:** Rounding fractions to 0,  $\frac{1}{2}$ , or 1 to estimate sums or differences.
- **Ratio:** Comparison of two numbers using division, written as 3:2 or  $\frac{3}{2}$ .
- **Rate:** A type of ratio comparing quantities with different units (e.g., miles/hour).
- **Proportion:** An equation showing two ratios are equivalent.
- **Cross Multiplying:** In a proportion  $\frac{a}{b} = \frac{c}{d}$ , cross multiply:  $ad = bc$ .
- **Ratio Table:** A table of equivalent ratios, useful for scaling up/down.

## Key Fraction Operations

1. **To change an improper fraction to a mixed number:** Divide numerator by denominator, the quotient is the whole number, remainder is the new numerator.
2. **To change a mixed number to an improper fraction:** Multiply the whole number by denominator, add numerator, put over original denominator.
3. **Adding/Subtracting like denominators:** Add/subtract numerators, keep denominator.
4. **Adding/Subtracting unlike denominators:** Find LCD, convert both, then add/subtract.
5. **Multiplying fractions:** Multiply numerators, multiply denominators, reduce if possible.
6. **Dividing fractions:** Multiply by reciprocal of divisor.

## Worked Examples

### Changing Improper Fractions to Mixed Numbers

Example:  $1\frac{1}{4} = 2\frac{3}{4}$

$11 \div 4 = 2$  remainder 3, so answer is  $2\frac{3}{4}$

### Changing Mixed Numbers to Improper Fractions

Example:  $2 \frac{2}{5} = (2 \times 5 + 2) / 5 = \frac{12}{5}$

### Adding Fractions with Like Denominators

Example:  $\frac{3}{8} + \frac{4}{8} = \frac{7}{8}$

### Subtracting Fractions with Like Denominators

Example:  $\frac{5}{9} - \frac{2}{9} = \frac{3}{9} = \frac{1}{3}$  (simplified)

### Adding Fractions with Unlike Denominators

Example:  $\frac{1}{4} + \frac{1}{6} = \frac{3}{12} + \frac{2}{12} = \frac{5}{12}$

### Multiplying Fractions

Example:  $\frac{3}{5} \times \frac{2}{7} = \frac{6}{35}$

### Dividing Fractions

Example:  $\frac{4}{5} \div \frac{2}{3} = \frac{4}{5} \times \frac{3}{2} = \frac{12}{10} = \frac{6}{5}$

### Ratio Table

Example: If 2 apples cost \$6, how much for 5 apples?

$$2 : 6 = 5 : x \rightarrow x = (5 \times 6) / 2 = \$15$$

### Proportion with Cross-Multiplying

Example:  $\frac{3}{4} = \frac{x}{8}$

$$3 \times 8 = 4 \times x \Rightarrow x = 6$$

## Pre-Test: Check Your Understanding!

1. What is  $\frac{9}{4}$  as a mixed number?

- $1 \frac{5}{4}$
- $2 \frac{1}{4}$
- $2 \frac{3}{4}$
- $3 \frac{1}{4}$

2. Convert  $3\frac{1}{2}$  to an improper fraction.

- $\frac{7}{2}$
- $\frac{8}{2}$
- $\frac{5}{2}$
- $\frac{6}{2}$

3.  $\frac{3}{8} + \frac{2}{8} = ?$

- $\frac{5}{16}$
- $\frac{5}{8}$
- $\frac{6}{8}$
- $\frac{1}{8}$

4.  $\frac{5}{9} - \frac{4}{9} = ?$

- $\frac{1}{9}$
- $\frac{1}{5}$
- $\frac{9}{1}$
- $\frac{4}{5}$

5. What is the reciprocal of  $\frac{3}{5}$ ?

- $\frac{5}{3}$
- $\frac{3}{5}$
- $\frac{2}{3}$
- $\frac{3}{2}$

Submit Answers

## Questions & Answers

*"What is the difference between a fraction and a ratio?"*

A fraction compares a part to a whole, while a ratio compares two quantities (parts to parts or part to whole).

*"How do I find a common denominator?"*

Find the least common multiple (LCM) of the denominators and rewrite each fraction with that denominator.

*"When dividing by a fraction, why do we multiply by its reciprocal?"*

Dividing by a number is the same as multiplying by its reciprocal, so this converts division into multiplication.

*"What does it mean to reduce a fraction?"*

To write the fraction in lowest terms by dividing numerator and denominator by their greatest common factor (GCF).

*"How do I estimate a sum or difference of mixed numbers?"*

Round each mixed number to the nearest whole number or half, then add or subtract.

## Post-Test: Demonstrate Your Mastery!

1. What is  $13/5$  as a mixed number?

- $2 \frac{3}{5}$
- $2 \frac{5}{3}$
- $3 \frac{2}{5}$
- $1 \frac{8}{5}$

2. Convert  $4 \frac{2}{3}$  to an improper fraction.

- $14/3$
- $12/3$
- $11/3$
- $9/2$

3.  $7/10 + 1/10 = ?$

- $8/10$
- $7/20$
- $6/10$
- $8/20$

4.  $6/7 - 2/7 = ?$

- $4/7$
- $8/7$
- $1/7$
- $6/9$

5. What is the reciprocal of  $\frac{4}{9}$ ?

- $\frac{9}{4}$
- $\frac{4}{9}$
- $\frac{2}{3}$
- $\frac{3}{2}$

Submit Answers

# Part 2: Arithmetic of Fractions

Fractions, Ratios, Proportions, and More

Concepts

Examples

Pre-Test

Q & A

Post-Test

## Key Concepts

- **Improper Fractions & Mixed Numbers:** An improper fraction has a numerator equal to or larger than the denominator. A mixed number combines a whole number and a fraction.
- **Adding & Subtracting Fractions:** Add/subtract numerators if denominators are the same. Find a common denominator if not.
- **Mixed Numbers:** Add or subtract whole parts and fractional parts, using common denominators if needed.
- **Estimating:** Round fractions or mixed numbers to estimate sums/differences.
- **Multiplying Fractions:** Multiply numerators, multiply denominators, reduce if needed. Multiply mixed numbers by converting to improper fractions first.
- **Reciprocals:** Flip numerator and denominator. Used in dividing fractions.
- **Dividing Fractions:** Multiply by the reciprocal of the divisor.
- **Ratios:** Compare two numbers, written as a:b, a/b, or "a to b".
- **Proportions:** Two equal ratios. Use cross-multiplying to solve.
- **Ratio Tables & Rates:** Show equivalent ratios or compare two quantities with different units (rate).
- **Problem Solving:** Use the above methods to solve real-world problems involving fractions, ratios, and rates.

## Concepts to Focus On

1. Finding common denominators
2. Reducing fractions
3. Recognizing and working with ratios and proportions
4. Converting between improper fractions and mixed numbers
5. Applying operations to mixed numbers and fractions

## Worked Examples

### Improper Fraction to Mixed Number

Example:  $11/4 = 2 \frac{3}{4}$

$11 \div 4 = 2$  remainder 3; so,  $2 \frac{3}{4}$

### Mixed Number to Improper Fraction

Example:  $2 \frac{2}{5} = (2 \times 5 + 2) / 5 = \frac{12}{5}$

### Adding Fractions with Like Denominators

Example:  $\frac{3}{8} + \frac{4}{8} = \frac{7}{8}$

### Subtracting Fractions with Like Denominators

Example:  $\frac{5}{9} - \frac{2}{9} = \frac{3}{9} = \frac{1}{3}$

### Adding Fractions with Unlike Denominators

Example:  $\frac{1}{4} + \frac{1}{6} = \frac{3}{12} + \frac{2}{12} = \frac{5}{12}$

### Adding Mixed Numbers with Unlike Denominators

Example:  $2 \frac{1}{3} + 1 \frac{1}{6} = 3 \frac{1}{2}$

### Estimating Sums of Mixed Numbers

Example:  $2 \frac{3}{4} + 3 \frac{1}{4} \approx 3 + 3 = 6$

### Multiplying Fractions and Whole Numbers

Example:  $3 \times \frac{2}{5} = \frac{6}{5} = 1 \frac{1}{5}$

### Multiplying Fractions: Reciprocals

Example: Reciprocal of  $\frac{3}{4}$  is  $\frac{4}{3}$

### Dividing Fractions by Whole Numbers

Example:  $\frac{3}{5} \div 2 = \frac{3}{5} \times \frac{1}{2} = \frac{3}{10}$

### Ratios and Proportions

Example: If 2 apples cost \$6, how much for 5 apples?

$2:6 = 5:x \rightarrow x = (5 \times 6) / 2 = \$15$

### Ratio Table

Example:

## Apples Cost

2	6
4	12
6	18

## Pre-Test: Check Your Understanding!

1. What is  $17/5$  as a mixed number?

- $3 \frac{2}{5}$
- $2 \frac{3}{5}$
- $3 \frac{3}{5}$
- $2 \frac{2}{5}$

2. Convert  $2 \frac{1}{3}$  to an improper fraction:

- $7/3$
- $5/3$
- $6/3$
- $4/3$

3.  $3/8 + 4/8 = ?$

- $5/8$
- $7/8$
- $6/8$
- $3/16$

4.  $5/9 - 2/9 = ?$

- $3/9$
- $7/9$
- $3/7$
- $2/7$

5.  $1/4 + 1/6 = ?$

- $2/10$
- $5/12$
- $3/12$
- $1/10$

6.  $5/6 - 1/4 = ?$

- $4/24$

$\frac{7}{12}$

$\frac{6}{12}$

$\frac{2}{12}$

7.  $2\frac{1}{3} + 1\frac{1}{6} = ?$

$3\frac{1}{2}$

$2\frac{3}{6}$

$4\frac{1}{2}$

$2\frac{1}{2}$

8.  $3\frac{3}{4} - 1\frac{1}{2} = ?$

$2\frac{1}{4}$

$2\frac{1}{2}$

$2\frac{1}{8}$

$1\frac{1}{4}$

9. Estimate:  $2\frac{3}{4} + 3\frac{1}{4}$

5

6

7

4

10.  $3 \times \frac{2}{5} = ?$

$\frac{5}{2}$

$\frac{6}{5}$

$\frac{3}{5}$

$\frac{2}{15}$

11. The reciprocal of  $\frac{3}{4}$  is:

$\frac{4}{3}$

$\frac{3}{4}$

$\frac{7}{4}$

$\frac{3}{7}$

12. Reduce  $\frac{8}{12}$  to lowest terms:

$\frac{2}{3}$

$\frac{4}{6}$

$\frac{6}{8}$

$\frac{1}{2}$

13.  $\frac{3}{5} \div 2 = ?$

$\frac{3}{10}$

- $\frac{6}{5}$
- $\frac{3}{7}$
- $\frac{3}{12}$

14.  $4 \div \frac{2}{3} = ?$

- $\frac{6}{2}$
- $\frac{4}{3}$
- 6
- $\frac{8}{3}$

15.  $\frac{5}{8} \div \frac{1}{4} = ?$

- $\frac{5}{2}$
- $\frac{5}{32}$
- $\frac{5}{4}$
- $\frac{8}{5}$

16.  $2\frac{1}{2} \div \frac{1}{2} = ?$

- 5
- 3
- $\frac{5}{2}$
- $\frac{3}{2}$

17. The ratio of 8 to 2 is:

- 2:8
- 1:4
- 4:1
- 8:4

18. Which is true for the proportion  $\frac{3}{4} = \frac{x}{8}$ ?

- $3 \times 8 = 4 \times x$
- $3 \times 4 = 8 \times x$
- $3 \times x = 4 \times 8$
- $x = 6$

19. If 2 apples cost \$6, how much for 7 apples?

- 14
- 18
- 21
- 7

20. If a car travels 180 miles in 3 hours, what is the rate?

- 60 miles/hr
- 90 miles/hr
- 30 miles/hr
- 45 miles/hr

21. If 5 pencils cost \$2, what is the cost of 15 pencils?

- \$4
- \$6
- \$8
- \$10

22. [Practice] Convert  $2\frac{1}{3}$  to an improper fraction:

- $\frac{7}{3}$
- $\frac{5}{3}$
- $\frac{6}{3}$
- $\frac{4}{3}$

23. [Practice]  $\frac{3}{8} + \frac{4}{8} = ?$

- $\frac{5}{8}$
- $\frac{7}{8}$
- $\frac{6}{8}$
- $\frac{3}{16}$

24. [Practice]  $\frac{5}{9} - \frac{2}{9} = ?$

- $\frac{3}{9}$
- $\frac{7}{9}$
- $\frac{3}{7}$
- $\frac{2}{7}$

25. [Practice]  $\frac{1}{4} + \frac{1}{6} = ?$

- $\frac{2}{10}$
- $\frac{5}{12}$
- $\frac{3}{12}$
- $\frac{1}{10}$

26. [Practice]  $\frac{5}{6} - \frac{1}{4} = ?$

- $\frac{4}{24}$
- $\frac{7}{12}$
- $\frac{6}{12}$
- $\frac{2}{12}$

27. [Practice]  $2\frac{1}{3} + 1\frac{1}{6} = ?$

- $3\frac{1}{2}$
- $2\frac{3}{6}$
- $4\frac{1}{2}$
- $2\frac{1}{2}$

28. [Practice]  $3\frac{3}{4} - 1\frac{1}{2} = ?$

- $2\frac{1}{4}$
- $2\frac{1}{2}$
- $2\frac{1}{8}$
- $1\frac{1}{4}$

29. [Practice] Estimate:  $2\frac{3}{4} + 3\frac{1}{4}$

- 5
- 6
- 7
- 4

30. [Practice]  $3 \times \frac{2}{5} = ?$

- $\frac{5}{2}$
- $\frac{6}{5}$
- $\frac{3}{5}$
- $\frac{2}{15}$

31. [Practice] The reciprocal of  $\frac{3}{4}$  is:

- $\frac{4}{3}$
- $\frac{3}{4}$
- $\frac{7}{4}$
- $\frac{3}{7}$

32. [Practice] Reduce  $\frac{8}{12}$  to lowest terms:

- $\frac{2}{3}$
- $\frac{4}{6}$
- $\frac{6}{8}$
- $\frac{1}{2}$

33. [Practice]  $\frac{3}{5} \div 2 = ?$

- $\frac{3}{10}$
- $\frac{6}{5}$
- $\frac{3}{7}$
- $\frac{3}{12}$

34. [Practice]  $4 \div \frac{2}{3} = ?$

- $\frac{6}{2}$
- $\frac{4}{3}$
- 6
- $\frac{8}{3}$

35. [Practice]  $\frac{5}{8} \div \frac{1}{4} = ?$

- $5/2$
- $5/32$
- $5/4$
- $8/5$

36. [Practice]  $2 \frac{1}{2} \div \frac{1}{2} = ?$

- 5
- 3
- $5/2$
- $3/2$

37. [Practice] The ratio of 8 to 2 is:

- 2:8
- 1:4
- 4:1
- 8:4

38. [Practice] Which is true for the proportion  $3/4 = x/8$ ?

- $3 \times 8 = 4 \times x$
- $3 \times 4 = 8 \times x$
- $3 \times x = 4 \times 8$
- $x = 6$

39. [Practice] If 2 apples cost \$6, how much for 7 apples?

- 14
- 18
- 21
- 7

40. [Practice] If a car travels 180 miles in 3 hours, what is the rate?

- 60 miles/hr
- 90 miles/hr
- 30 miles/hr
- 45 miles/hr

Submit Answers

## Questions & Answers From Your Pre-Test

### Post-Test: Demonstrate Your Mastery!

1. What is  $17/5$  as a mixed number?

$3 \frac{2}{5}$

$2 \frac{3}{5}$

$3 \frac{3}{5}$

$2 \frac{2}{5}$

2. Convert  $2 \frac{1}{3}$  to an improper fraction:

$\frac{7}{3}$

$\frac{5}{3}$

$\frac{6}{3}$

$\frac{4}{3}$

3.  $\frac{3}{8} + \frac{4}{8} = ?$

$\frac{5}{8}$

$\frac{7}{8}$

$\frac{6}{8}$

$\frac{3}{16}$

4.  $\frac{5}{9} - \frac{2}{9} = ?$

$\frac{3}{9}$

$\frac{7}{9}$

$\frac{3}{7}$

$\frac{2}{7}$

5.  $\frac{1}{4} + \frac{1}{6} = ?$

$\frac{2}{10}$

$\frac{5}{12}$

$\frac{3}{12}$

$\frac{1}{10}$

6.  $\frac{5}{6} - \frac{1}{4} = ?$

$\frac{4}{24}$

$\frac{7}{12}$

$\frac{6}{12}$

$\frac{2}{12}$

7.  $2 \frac{1}{3} + 1 \frac{1}{6} = ?$

$3 \frac{1}{2}$

$2 \frac{3}{6}$

$4 \frac{1}{2}$

$2 \frac{1}{2}$

8.  $3\frac{3}{4} - 1\frac{1}{2} = ?$

- $2\frac{1}{4}$
- $2\frac{1}{2}$
- $2\frac{1}{8}$
- $1\frac{1}{4}$

9. Estimate:  $2\frac{3}{4} + 3\frac{1}{4}$

- 5
- 6
- 7
- 4

10.  $3 \times \frac{2}{5} = ?$

- $\frac{5}{2}$
- $\frac{6}{5}$
- $\frac{3}{5}$
- $\frac{2}{15}$

11. The reciprocal of  $\frac{3}{4}$  is:

- $\frac{4}{3}$
- $\frac{3}{4}$
- $\frac{7}{4}$
- $\frac{3}{7}$

12. Reduce  $\frac{8}{12}$  to lowest terms:

- $\frac{2}{3}$
- $\frac{4}{6}$
- $\frac{6}{8}$
- $\frac{1}{2}$

13.  $\frac{3}{5} \div 2 = ?$

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21. If 5 pencils cost \$2, what is the cost of 15 pencils?

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- \$8
- \$10

22. [Practice] Convert  $2\frac{1}{3}$  to an improper fraction:

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- $\frac{4}{3}$

23. [Practice]  $\frac{3}{8} + \frac{4}{8} = ?$

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- $\frac{2}{7}$

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- $\frac{3}{12}$
- $\frac{1}{10}$

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- $\frac{7}{12}$
- $\frac{6}{12}$
- $\frac{2}{12}$

27. [Practice]  $2\frac{1}{3} + 1\frac{1}{6} = ?$

- $3\frac{1}{2}$
- $2\frac{3}{6}$
- $4\frac{1}{2}$
- $2\frac{1}{2}$

28. [Practice]  $3\frac{3}{4} - 1\frac{1}{2} = ?$

- $2\frac{1}{4}$
- $2\frac{1}{2}$
- $2\frac{1}{8}$
- $1\frac{1}{4}$

29. [Practice] Estimate:  $2\frac{3}{4} + 3\frac{1}{4}$

- 5
- 6
- 7
- 4

30. [Practice]  $3 \times \frac{2}{5} = ?$

- $\frac{5}{2}$
- $\frac{6}{5}$
- $\frac{3}{5}$
- $\frac{2}{15}$

31. [Practice] The reciprocal of  $\frac{3}{4}$  is:

- $\frac{4}{3}$
- $\frac{3}{4}$
- $\frac{7}{4}$
- $\frac{3}{7}$

32. [Practice] Reduce  $\frac{8}{12}$  to lowest terms:

- $\frac{2}{3}$
- $\frac{4}{6}$
- $\frac{6}{8}$
- $\frac{1}{2}$

33. [Practice]  $\frac{3}{5} \div 2 = ?$

- $\frac{3}{10}$
- $\frac{6}{5}$
- $\frac{3}{7}$
- $\frac{3}{12}$

34. [Practice]  $4 \div \frac{2}{3} = ?$

- $\frac{6}{2}$
- $\frac{4}{3}$
- 6
- $\frac{8}{3}$

35. [Practice]  $\frac{5}{8} \div \frac{1}{4} = ?$

- $\frac{5}{2}$
- $\frac{5}{32}$
- $\frac{5}{4}$
- $\frac{8}{5}$

36. [Practice]  $2 \frac{1}{2} \div \frac{1}{2} = ?$

- 5
- 3
- $\frac{5}{2}$
- $\frac{3}{2}$

37. [Practice] The ratio of 8 to 2 is:

- 2:8
- 1:4
- 4:1
- 8:4

38. [Practice] Which is true for the proportion  $\frac{3}{4} = \frac{x}{8}$ ?

- $3 \times 8 = 4 \times x$
- $3 \times 4 = 8 \times x$
- $3 \times x = 4 \times 8$
- $x = 6$

39. [Practice] If 2 apples cost \$6, how much for 7 apples?

- 14
- 18
- 21
- 7

40. [Practice] If a car travels 180 miles in 3 hours, what is the rate?

- 60 miles/hr
- 90 miles/hr
- 30 miles/hr
- 45 miles/hr

Submit Answers

# Decimals, Fractions, and Percents Mastery

Your complete guide to understanding, converting, and calculating with decimals, fractions, and percents.

## Chapter 1: Key Concepts

- **Place Value:** Each digit in a number has a position, or place, which determines its value (e.g., tenths, hundredths, thousandths).
- **Decimals:** Numbers that have a whole part and a fractional part separated by a decimal point.
- **Fractions:** Represent parts of a whole, written as one number over another (numerator/denominator).
- **Rounding:** Simplifying a number while keeping its value close to the original number (e.g., rounding 3.76 to 3.8).
- **Percents:** Means "per hundred"; a way to express numbers as parts of 100.
- **Estimating:** Finding a number that is close enough to the right answer, usually by rounding.
- **Operations:** Addition, subtraction, multiplication, and division can be performed with decimals, fractions, and percents, following similar rules as for whole numbers but paying attention to decimal points and denominators.

## Chapter 2: Topics

1. **Decimal Place Value and Rounding**
2. **Changing Fractions to Decimals**
3. **Changing Decimals to Fractions**
4. **Comparing and Ordering Decimals**
5. **Adding Decimals**
6. **Subtracting Decimals**
7. **Adding and Subtracting Money**
8. **Estimating Decimal Sums and Differences**
9. **Multiplying Decimals**
10. **Multiplying Money**
11. **Estimating Decimal Products**
12. **Dividing Decimals by Whole Numbers**
13. **Dividing Whole Numbers by Decimals**
14. **Dividing Decimals by Decimals**
15. **Dividing Money**
16. **Estimating Decimal Quotients**
17. **Understanding Percent**
18. **Percents and Fractions**

## Chapter 3: Examples

### 1. Decimal Place Value and Rounding

Number: **3.476**

- 3 is in the ones place
- 4 is in the tenths place
- 7 is in the hundredths place
- 6 is in the thousandths place

Round 3.476 to the nearest hundredth: **3.48**

### 2. Changing Fractions to Decimals

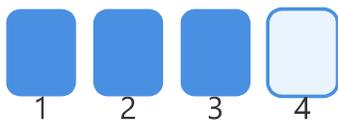
$$3/4 = 0.75$$

How does  $3/4 = 0.75$ ?

1. **Divide the numerator by the denominator:**

$$3 \div 4 = 0.75$$

2. **Think of it in money:** If you have 3 out of 4 quarters, you have 75 cents, or \$0.75.



**3 out of 4 parts are shaded.**

Fraction:  $3/4$  → Decimal: **0.75**

3. **Visualize it:** Imagine a chocolate bar split into 4 equal pieces. If you eat 3 pieces, you've eaten  $3/4$  of the bar, or 0.75 of the whole.

### 3. Changing Decimals to Fractions

$$0.6 = 6/10 = 3/5 \text{ (write as 6 over 10, then simplify)}$$

### 4. Comparing and Ordering Decimals

Order: 0.56, 0.605, 0.65 (from least to greatest)

### 5. Adding Decimals

$$1.25 + 3.7 = 4.95$$

How do you add  $1.25 + 2.7$ ?

1. **Line up the decimal points:**

$$\begin{array}{r} 1.25 \\ + 2.70 \end{array}$$

2. **Add zeros if needed to make the same number of decimal places.**

(2.7 becomes 2.70)

3. **Add from right to left, just like whole numbers, keeping the decimal point in line.**

Line up decimals!

$$\begin{array}{r} 1.25 \\ +2.70 \\ \hline 3.95 \end{array}$$

**Always line up the decimal points.**

Add as usual, then bring the decimal point straight down.

$$1.25 + 2.70 = 3.95$$

4. **Write the answer with the decimal point in the same place:**

$$3.95$$

## 6. Subtracting Decimals

$$5.6 - 2.48 = 3.12$$

## 7. Adding and Subtracting Money

$$\$4.20 + \$1.35 = \$5.55$$

$$\$7.00 - \$2.75 = \$4.25$$

## 8. Estimating Decimal Sums and Differences

$$4.67 + 2.19 \approx 5 + 2 = 7$$

## 9. Multiplying Decimals

$$0.7 \times 0.3 = 0.21$$

How do you multiply  $0.7 \times 0.3$ ?

1. **Ignore the decimals for now and multiply as whole numbers:**

$$7 \times 3 = 21$$

2. **Count the total decimal places:**

- 0.7 has 1 decimal place

- 0.3 has 1 decimal place

- Total: **2 decimal places**

3. **Place the decimal in the product:**

Start at the right and count 2 places to the left:

$$21 \rightarrow 0.21$$



The overlap (darkest rectangle) is **0.21** of the whole box.

$$0.7 \times 0.3 = 0.21$$

4. So,  $0.7 \times 0.3 = 0.21$

(21, with two decimal places)

## 10. Multiplying Money

$$\$5.25 \times 3 = \$15.75$$

## 11. Estimating Decimal Products

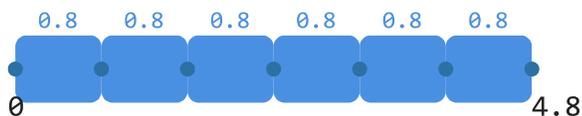
$$3.6 \times 2.1 \approx 4 \times 2 = 8$$

## 12. Dividing Decimals by Whole Numbers

$$4.8 \div 6 = 0.8$$

How do you divide  $4.8 \div 6$ ?

1. Write 4.8 as a decimal: 4.8
2. Think: "How many times does 6 fit into 4.8?"
3. Divide as you would with whole numbers, then place the decimal:  
Ignore the decimal for a moment:  $48 \div 6 = 8$ .  
Since there is one decimal place in 4.8, the answer is 0.8.



Splitting 4.8 into 6 equal parts gives six "0.8" segments.

$$4.8 \div 6 = 0.8$$

4. So, each share is 0.8.

$$4.8 \div 6 = 0.8$$

## 13. Dividing Whole Numbers by Decimals

$$8 \div 0.4 = 20$$

## 14. Dividing Decimals by Decimals

$$0.81 \div 0.09 = 9$$

## How do you divide $0.81 \div 0.09$ ?

### 1. Understand what this means:

How many times does  $0.09$  fit into  $0.81$ ?

### 2. Move the decimal point in both numbers to make the divisor a whole number:

$0.81 \div 0.09$  becomes  $81 \div 9$  (move decimal two places right for both)

### 3. Now, divide:

$$81 \div 9 = 9$$



There are 9 segments of 0.09 in 0.81.

$$0.81 \div 0.09 = 9$$

### 4. So, $0.81 \div 0.09 = 9$ .

There are 9 groups of 0.09 in 0.81.

## 15. Dividing Money

$$\$12.00 \div 4 = \$3.00$$

## 16. Estimating Decimal Quotients

$$9.2 \div 2.1 \approx 9 \div 2 = 4.5$$

## 17. Understanding Percent

80% means 80 out of 100, or **0.80**

## 18. Percents and Fractions

$$25\% = \frac{25}{100} = \frac{1}{4}$$

### How do you simplify $\frac{25}{100}$ to $\frac{1}{4}$ ?

#### 1. Find the greatest common factor (GCF):

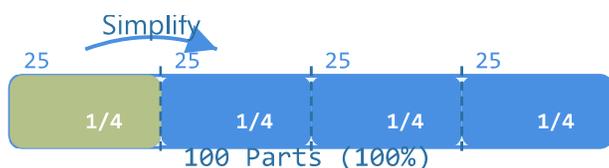
Both 25 and 100 can be divided by 25.

#### 2. Divide the top and bottom by 25:

$$25 \div 25 = 1$$

$$100 \div 25 = 4$$

#### 3. You get: $\frac{1}{4}$



**25 out of 100 is the same as 1 out of 4 equal parts.**

$$25/100 = 1/4$$

**4. So, 25/100 simplifies to 1/4.**

## 19. Percents and Decimals

$$7\% = \mathbf{0.07}$$

## 20. Multiplying Percents and Fractions

$$50\% \text{ of } 3/4 = 0.5 \times 0.75 = \mathbf{0.375}$$

## Chapter 4: Pre-Test (40 Questions)

1. What is the value of the digit 7 in 14.673?

- 7
  - 7 tenths
  - 7 thousandths
  - 7 hundredths
- 

2. Round 5.348 to the nearest tenth.

- 5.35
  - 5.3
  - 5.4
  - 5.5
- 

3. Change  $2/5$  to a decimal.

- 0.25
  - 0.5
  - 0.2
  - 0.4
- 

4. Write 0.85 as a fraction in simplest form.

- $17/20$
- $85/100$

8/10

5/6

---

5. Which is greater: 0.507 or 0.57?

0.507

They are equal

0.57

Cannot compare

---

6. Order the following from least to greatest: 0.5, 0.25, 0.75

Concepts

Topics

Examples

Pre-Test

Q & A

Post-Test

---

0.25, 0.75, 0.5

0.25, 0.5, 0.75

---

7. Add:  $1.56 + 2.4$

3.16

3.96

4.06

4.16

---

8. Subtract:  $8.32 - 5.7$

2.72

2.82

2.62

3.62

---

9. Add:  $\$2.35 + \$4.60$

\$6.95

\$7.05

\$7.15

\$6.85

---

10. Subtract:  $\$10.00 - \$3.99$

- \$6.11
  - \$6.01
  - \$7.01
  - \$7.11
- 

11. Estimate:  $7.9 + 2.2$

- 9
  - 10
  - 10
  - 11
- 

12. Estimate:  $5.6 - 2.1$

- 4
  - 3
  - 2
  - 5
- 

13. Multiply:  $0.6 \times 0.7$

- 0.13
  - 0.42
  - 0.47
  - 0.21
- 

14. Multiply:  $\$4.25 \times 2$

- \$6.25
  - \$7.25
  - \$8.50
  - \$9.50
- 

15. Estimate:  $6.2 \times 1.9$

- 6

10

12

12

---

**16.** Divide:  $3.6 \div 4$

0.9

1.2

1.4

0.8

---

**17.** Divide:  $6 \div 0.2$

3

12

30

120

---

**18.** Divide:  $0.9 \div 0.3$

0.3

0.6

0.9

3

---

**19.** Divide:  $\$8.40 \div 7$

\$1.20

\$1.20

\$1.40

\$1.12

---

**20.** Estimate:  $10.5 \div 2.1$

2

3

5

12

---

**21.** What is 35% as a decimal?

- 0.35
  - 3.5
  - 0.0035
  - 0.035
- 

**22.** Express 75% as a fraction in simplest form.

- $\frac{3}{5}$
  - $\frac{3}{4}$
  - $\frac{1}{3}$
  - $\frac{1}{4}$
- 

**23.** Express 0.12 as a percent.

- 1.2%
  - 12%
  - 12%
  - 0.12%
- 

**24.** What is 20% of 50?

- 2
  - 5
  - 20
  - 10
- 

**25.** Write 0.375 as a fraction.

- $\frac{3}{8}$
  - $\frac{3}{8}$
  - $\frac{8}{25}$
  - $\frac{37}{100}$
-

26. Round 4.987 to the nearest hundredth.

- 4.9
  - 4.98
  - 4.99
  - 5.0
- 

27. Change  $7/10$  to a decimal.

- 0.17
  - 0.7
  - 0.77
  - 0.07
- 

28. Which is smaller: 0.3 or 0.29?

- 0.3
  - 0.29
  - They are equal
  - Cannot tell
- 

29. Add:  $3.25 + 8.9$

- 11.05
  - 12.05
  - 12.15
  - 13.15
- 

30. Subtract:  $9.7 - 3.36$

- 6.34
  - 6.44
  - 5.34
  - 5.44
- 

31. Add:  $\$3.45 + \$2.78$

- \$6.13

\$5.13

\$5.23

\$6.23

---

**32.** Subtract:  $\$5.00 - \$1.65$

\$3.35

\$3.45

\$3.25

\$4.35

---

**33.** Estimate:  $3.9 + 4.1$

7

8

9

6

---

**34.** Estimate:  $8.2 - 2.7$

7

5

5

6

---

**35.** Multiply:  $0.5 \times 0.9$

0.45

0.95

0.5

0.9

---

**36.** Multiply:  $\$6.15 \times 3$

\$18.35

\$19.45

\$18.45

\$19.35

---

**37.** Estimate:  $2.4 \times 3.7$

- 5
  - 9
  - 7
  - 10
- 

**38.** Divide:  $2.7 \div 3$

- 1.8
  - 0.9
  - 0.3
  - 1.7
- 

**39.** Divide:  $12 \div 0.4$

- 3
  - 30
  - 30
  - 48
- 

**40.** Divide:  $0.45 \div 0.05$

- 0.9
- 9
- 0.5
- 9

Submit

*Try to answer all questions before checking the Q & A or Examples chapters.*

## Chapter 5: Questions and Answers

## Chapter 6: Post-Test (40 Questions)

1. What is the value of the digit 3 in 8.236?

- 3 tenths
  - 3 hundredths
  - 3 thousandths
  - 3 hundredths
- 

2. Round 2.697 to the nearest tenth.

- 2.7
  - 2.6
  - 2.69
  - 2.68
- 

3. Change  $\frac{5}{8}$  to a decimal.

- 0.6250
  - 0.625
  - 0.58
  - 0.75
- 

4. Write 0.45 as a fraction in simplest form.

- $\frac{45}{10}$
  - $\frac{9}{20}$
  - $\frac{45}{100}$
  - $\frac{9}{20}$
- 

5. Which is greater: 0.439 or 0.493?

- 0.439
- 0.493
- They are equal

Cannot tell

---

6. Order the following from least to greatest: 0.9, 0.4, 0.75

0.4, 0.9, 0.75

0.75, 0.4, 0.9

0.4, 0.75, 0.9

0.9, 0.4, 0.75

---

7. Add:  $2.45 + 3.6$

5.95

6.05

5.85

6.05

---

8. Subtract:  $6.84 - 2.3$

4.44

4.54

4.64

4.74

---

9. Add:  $\$5.75 + \$3.20$

\$8.85

\$9.05

\$8.95

\$7.95

---

10. Subtract:  $\$9.50 - \$1.95$

\$7.55

\$7.65

\$7.45

\$8.55

---

11. Estimate:  $8.1 + 1.6$

- 10
  - 10
  - 9
  - 8
- 

12. Estimate:  $7.4 - 4.2$

- 4
  - 3
  - 5
  - 6
- 

13. Multiply:  $0.8 \times 0.5$

- 0.3
  - 0.4
  - 0.5
  - 0.08
- 

14. Multiply:  $\$7.30 \times 2$

- \$13.60
  - \$14.60
  - \$14.60
  - \$15.60
- 

15. Estimate:  $4.7 \times 1.8$

- 9
  - 8
  - 5
  - 6
- 

16. Divide:  $5.4 \div 6$

- 0.7

- 0.9
  - 0.8
  - 0.6
- 

**17.** Divide:  $10 \div 0.5$

- 2
  - 5
  - 20
  - 50
- 

**18.** Divide:  $0.81 \div 0.09$

- 0.09
  - 0.9
  - 9
  - 9
- 

**19.** Divide:  $\$15.00 \div 5$

- \$3.00
  - \$3.50
  - \$2.50
  - \$5.00
- 

**20.** Estimate:  $12.6 \div 3.1$

- 6
  - 4
  - 5
  - 3
- 

**21.** What is 12% as a decimal?

- 0.12
- 1.2
- 0.012

12

---

**22.** Express 60% as a fraction in simplest form.

$\frac{3}{5}$

$\frac{3}{5}$

$\frac{2}{3}$

$\frac{6}{10}$

---

**23.** Express 0.45 as a percent.

45

0.45%

45%

4.5%

---

**24.** What is 30% of 60?

18

20

30

15

---

**25.** Write 0.625 as a fraction.

$\frac{5}{8}$

$\frac{5}{8}$

$\frac{8}{13}$

$\frac{62}{100}$

---

**26.** Round 8.994 to the nearest hundredth.

8.99

8.98

9.00

8.90

---

27. Change  $\frac{3}{8}$  to a decimal.

- 0.38
  - 0.375
  - 0.33
  - 0.3
- 

28. Which is smaller: 0.4 or 0.38?

- 0.4
  - 0.38
  - They are equal
  - Cannot tell
- 

29. Add:  $4.75 + 7.2$

- 11.85
  - 12.15
  - 11.95
  - 12.05
- 

30. Subtract:  $11.5 - 6.23$

- 5.37
  - 5.27
  - 4.27
  - 5.73
- 

31. Add:  $\$2.95 + \$5.08$

- \$7.95
  - \$7.85
  - \$8.03
  - \$8.03
- 

32. Subtract:  $\$8.00 - \$3.15$

- \$4.85

\$4.75

\$5.15

\$4.65

---

**33.** Estimate:  $6.1 + 2.8$

7

9

9

8

---

**34.** Estimate:  $9.2 - 4.6$

5

4

3

6

---

**35.** Multiply:  $0.2 \times 0.7$

0.14

0.14

0.07

1.4

---

**36.** Multiply:  $\$3.45 \times 4$

\$12.60

\$13.80

\$13.80

\$14.80

---

**37.** Estimate:  $5.9 \times 2.2$

10

12

11

13

---

**38.** Divide:  $8.4 \div 7$

1.2

1.3

1.2

1.0

---

**39.** Divide:  $14 \div 0.7$

2

20

7

20

---

**40.** Divide:  $0.28 \div 0.07$

0.4

4

0.07

4

Submit

*Take this post-test after studying the chapters above. Check your answers in the Q & A or Examples chapters if needed.*

# Laws and Properties of Arithmetic and Equations

Exponents, Notation, Order, Properties, and Solving

Concepts

Examples

Pre-Test

Q & A

Post-Test

## Key Concepts

- **Exponents:** Repeated multiplication (e.g.  $2^4 = 2 \times 2 \times 2 \times 2 = 16$ ).
- **Scientific Notation:** Writing numbers as a product of a decimal 1–10 and a power of ten. Example:  $3,500 = 3.5 \times 10^3$ .
- **Order of Operations:** PEMDAS: Parentheses, Exponents, Multiplication/Division (left to right), Addition/Subtraction (left to right).
- **Commutative Property:** Order doesn't matter for addition/multiplication.  $a+b = b+a$ ;  $ab = ba$ .
- **Associative Property:** Grouping doesn't matter for addition/multiplication.  $(a+b)+c = a+(b+c)$ .
- **Distributive Property:**  $a(b+c) = ab + ac$ .
- **Identity Property:**  $a+0=a$ ;  $a \times 1=a$ .
- **Zero Property:**  $a \times 0=0$ .
- **Equality Properties:** If  $a=b$ , then  $a+c=b+c$ ,  $a-c=b-c$ ,  $a \times c=b \times c$ , and if  $c \neq 0$ ,  $a/c=b/c$ .
- **Factors:** Numbers that multiply to give another number (e.g. factors of 6: 1,2,3,6).
- **Multiples:** Products of a number and integers (e.g. multiples of 4: 4,8,12,...).
- **Variable Expressions:** Expressions with variables (e.g.  $2x+3$ ).
- **Solving Equations:** Finding variable values. Use inverse operations (add/subtract/multiply/divide).
- **Inequalities:** Mathematical sentences using  $<$ ,  $>$ ,  $\leq$ ,  $\geq$ . Example:  $x > 5$ .
- **Solving by Substitution:** Replace a variable with a number or another expression to check or solve.

## Concepts to Focus On

1. Order of operations and applying properties
2. Translating and simplifying variable expressions
3. Solving basic equations and inequalities
4. Working with exponents and scientific notation
5. Recognizing and using factors and multiples

## Worked Examples

### Exponents

Example:  $3^2 = 3 \times 3 = 9$

## Scientific Notation

Example:  $45,000 = 4.5 \times 10^4$

## Order of Operations

Example:  $2 + 3 \times 4 = 2 + 12 = 14$

## Commutative Property

Example:  $5 + 7 = 7 + 5$ ;  $3 \times 8 = 8 \times 3$

## Associative Property

Example:  $(2 + 3) + 4 = 2 + (3 + 4) = 9$

## Distributive Property

Example:  $2(3 + 5) = 2 \times 3 + 2 \times 5 = 6 + 10 = 16$

## Identity and Zero Properties

Example:  $7 + 0 = 7$  (identity),  $9 \times 0 = 0$  (zero)

## Factors and Multiples

Example: Factors of 12: 1, 2, 3, 4, 6, 12; Multiples of 3: 3, 6, 9, 12, ...

## Variable Expressions

Example: If  $x = 4$ , then  $2x + 1 = 2 \times 4 + 1 = 9$

## Solving Equations by Addition

Example:  $x - 5 = 7 \rightarrow x = 12$

## Solving Equations by Multiplication

Example:  $3x = 21 \rightarrow x = 7$

## Inequalities

Example:  $x + 2 < 7 \rightarrow x < 5$

## Solving by Substitution

## Pre-Test: Check Your Understanding!

1. What is  $2^5$ ?

- 7
- 10
- 25
- 32

2. What is  $10^3$ ?

- 1,000
- 100
- 10
- 10,000

3. Write 4,200,000 in scientific notation.

- $4.2 \times 10^6$
- $4.2 \times 10^5$
- $42 \times 10^5$
- $0.42 \times 10^7$

4. Which is  $8.3 \times 10^3$  in standard form?

- 830
- 8,300
- 83,000
- 830,000

5. Evaluate:  $3 + 4 \times 2$

- 14
- 11
- 10
- 7

6. Evaluate:  $(5 + 3) \times 2$

- 16
- 13
- 10
- 8

7. Evaluate:  $12 \div 3 \times 2$

- 2
- 4
- 8
- 6

8. What is the value of  $9 - 3 \times 2$ ?

- 3
- 0
- 12
- 6

9. Which shows the commutative property of addition?

- $a + b = b + a$
- $a + (b + c) = (a + b) + c$
- $a(b + c) = ab + ac$
- $a \times 1 = a$

10. Which shows the associative property of multiplication?

- $a \times b = b \times a$
- $a \times (b \times c) = (a \times b) \times c$
- $a(b + c) = ab + ac$
- $a \times 0 = 0$

11. Which is the distributive property?

- $a + b = b + a$
- $a \times (b + c) = ab + ac$
- $a + 0 = a$
- $a \times 1 = a$

12. What is the additive identity?

- 0
- 1
- a
- 1

13. What is the multiplicative identity?

- 0
- 1
- a
- 1

14. What is  $a \times 0$  for any a?

- a
- 0
- 1
- $a + 0$

15. If  $a = b$ , then  $a + c = b + c$ . This is:

- Substitution property
- Equality property
- Zero property
- Distributive property

16. Which is a factor of 18?

- 5
- 6
- 9
- Both 6 and 9

17. Which is a multiple of 7?

- 14
- 21
- 28
- All of these

18. Which number is not a factor of 24?

- 3
- 4
- 5
- 6

19. Which number is a multiple of 9?

- 8
- 12
- 18
- 20

20. What is the value of  $2x + 3$  when  $x = 4$ ?

- 7
- 8
- 11
- 13

21. If  $y = 5$ , what is  $y^2$ ?

- 10
- 25
- 15
- 20

22. If  $z = 3$ , what is  $4z - 2$ ?

- 10
- 12
- 9
- 8

23. Which is a variable expression?

- $2 + 3$
- $x + 4$
- $7 \times 5$
- $10 - 2$

24. Solve:  $x + 5 = 12$

- 5
- 7
- 12
- 17

25. Solve:  $y - 3 = 10$

- 7
- 10

- 13
- 3

26. If  $x - 2 = 6$ , what is  $x$ ?

- 4
- 6
- 8
- 2

27. If  $a + 9 = 15$ , then  $a = ?$

- 6
- 7
- 24
- 5

28. Solve:  $5x = 30$

- 6
- 5
- 25
- 35

29. Solve:  $x / 4 = 3$

- 1
- 7
- 12
- 15

30. If  $2y = 20$ , what is  $y$ ?

- 10
- 20
- 8
- 18

31. If  $b / 2 = 5$ , then  $b = ?$

- 10
- 5
- 7
- 3

32. Which shows ' $x$  is less than 5'?

- $x > 5$
- $x \geq 5$
- $x < 5$
- $x = 5$

33. If  $x + 3 > 7$ ,  $x > ?$

- 3
- 4
- 5
- 6

34. If  $y - 2 \leq 8$ ,  $y \leq ?$

- 10
- 6
- 8
- 2

35. Which is true if  $10 > x$ ?

- $x > 10$
- $x < 10$
- $x = 10$
- $x \geq 10$

36. If  $x = 2$ , what is the value of  $3x + 1$ ?

- 5
- 6
- 7
- 8

37. If  $y = 4$ , is  $y + 2 > 6$ ?

- Yes, because  $4+2=6$
- Yes, because  $4+2=7$
- No, because  $4+2=5$
- No, because  $4+2=6$

38. If  $z = 3$ , does  $2z = 6$ ?

- Yes, because  $2 \times 3 = 6$
- No, because  $2 \times 3 = 5$
- No, because  $2 \times 3 = 3$
- Yes, because  $2 + 3 = 5$

39. If  $a = 5$ , what is  $a^2 - a$ ?

- 0
- 20
- 25
- 15

40. [Practice] What is the value of  $2x + 3$  when  $x = 4$ ?

- 7
- 8
- 11
- 13

Submit Answers

**Questions & Answers From Your Pre-Test**

**Post-Test: Demonstrate Your Mastery!**

1. What is  $2^5$ ?

- 7
- 10
- 25
- 32

2. What is  $10^3$ ?

- 1,000
- 100
- 10
- 10,000

3. Write 4,200,000 in scientific notation.

- $4.2 \times 10^6$
- $4.2 \times 10^5$
- $42 \times 10^5$
- $0.42 \times 10^7$

4. Which is  $8.3 \times 10^3$  in standard form?

- 830
- 8,300
- 83,000
- 830,000

5. Evaluate:  $3 + 4 \times 2$

- 14
- 11
- 10
- 7

6. Evaluate:  $(5 + 3) \times 2$

- 16
- 13
- 10
- 8

7. Evaluate:  $12 \div 3 \times 2$

- 2
- 4
- 8
- 6

8. What is the value of  $9 - 3 \times 2$ ?

- 3
- 0
- 12
- 6

9. Which shows the commutative property of addition?

- $a + b = b + a$

- $a + (b + c) = (a + b) + c$
- $a(b + c) = ab + ac$
- $a \times 1 = a$

10. Which shows the associative property of multiplication?

- $a \times b = b \times a$
- $a \times (b \times c) = (a \times b) \times c$
- $a(b + c) = ab + ac$
- $a \times 0 = 0$

11. Which is the distributive property?

- $a + b = b + a$
- $a \times (b + c) = ab + ac$
- $a + 0 = a$
- $a \times 1 = a$

12. What is the additive identity?

- 0
- 1
- a
- 1

13. What is the multiplicative identity?

- 0
- 1
- a
- 1

14. What is  $a \times 0$  for any a?

- a
- 0
- 1
- $a + 0$

15. If  $a = b$ , then  $a + c = b + c$ . This is:

- Substitution property
- Equality property
- Zero property
- Distributive property

16. Which is a factor of 18?

- 5
- 6
- 9
- Both 6 and 9

17. Which is a multiple of 7?

- 14
- 21
- 28
- All of these

18. Which number is not a factor of 24?

- 3
- 4
- 5
- 6

19. Which number is a multiple of 9?

- 8
- 12
- 18
- 20

20. What is the value of  $2x + 3$  when  $x = 4$ ?

- 7
- 8
- 11
- 13

21. If  $y = 5$ , what is  $y^2$ ?

- 10
- 25
- 15
- 20

22. If  $z = 3$ , what is  $4z - 2$ ?

- 10
- 12
- 9
- 8

23. Which is a variable expression?

- $2 + 3$
- $x + 4$
- $7 \times 5$
- $10 - 2$

24. Solve:  $x + 5 = 12$

- 5
- 7
- 12
- 17

25. Solve:  $y - 3 = 10$

- 7
- 10
- 13
- 3

26. If  $x - 2 = 6$ , what is  $x$ ?

- 4
- 6
- 8

2

27. If  $a + 9 = 15$ , then  $a = ?$

6

7

24

5

28. Solve:  $5x = 30$

6

5

25

35

29. Solve:  $x / 4 = 3$

1

7

12

15

30. If  $2y = 20$ , what is  $y$ ?

10

20

8

18

31. If  $b / 2 = 5$ , then  $b = ?$

10

5

7

3

32. Which shows ' $x$  is less than 5'?

$x > 5$

$x \geq 5$

$x < 5$

$x = 5$

33. If  $x + 3 > 7$ ,  $x > ?$

3

4

5

6

34. If  $y - 2 \leq 8$ ,  $y \leq ?$

10

6

8

2

35. Which is true if  $10 > x$ ?

$x > 10$

- $x < 10$
- $x = 10$
- $x \geq 10$

36. If  $x = 2$ , what is the value of  $3x + 1$ ?

- 5
- 6
- 7
- 8

37. If  $y = 4$ , is  $y + 2 > 6$ ?

- Yes, because  $4+2=6$
- Yes, because  $4+2=7$
- No, because  $4+2=5$
- No, because  $4+2=6$

38. If  $z = 3$ , does  $2z = 6$ ?

- Yes, because  $2 \times 3 = 6$
- No, because  $2 \times 3 = 5$
- No, because  $2 \times 3 = 3$
- Yes, because  $2 + 3 = 5$

39. If  $a = 5$ , what is  $a^2 - a$ ?

- 0
- 20
- 25
- 15

40. [Practice] What is the value of  $2x + 3$  when  $x = 4$ ?

- 7
- 8
- 11
- 13

Submit Answers

# Measurement Mastery: Customary & Metric Units

Understand, Practice, and Test Your Skills!

Concepts

Examples

Pre-Test

Q & A

Post-Test

## Key Concepts Explained

- **Customary Units of Length:** Inch (in), foot (ft), yard (yd), mile (mi).
- **Customary Units of Liquid Volume:** Teaspoon (tsp), tablespoon (tbsp), fluid ounce (fl oz), cup (c), pint (pt), quart (qt), gallon (gal).
- **Customary Units of Weight:** Ounce (oz), pound (lb), ton.
- **Perimeter:** The distance around a 2D shape. For a rectangle:  $P = 2(l + w)$ .
- **Area:** The space inside a 2D shape. For a rectangle:  $A = l \times w$ .
- **Volume of a Solid:** The space inside a 3D object. For a rectangular prism:  $V = l \times w \times h$ .
- **Time:** Units include second (s), minute (min), hour (h), day, week, month, year.
- **Temperature:** Measured in degrees Fahrenheit ( $^{\circ}\text{F}$ ) in customary, Celsius ( $^{\circ}\text{C}$ ) in metric.
- **Metric Units of Length:** Millimeter (mm), centimeter (cm), meter (m), kilometer (km).
- **Metric Units of Liquid Volume:** Milliliter (mL), liter (L).
- **Metric Units of Mass:** Milligram (mg), gram (g), kilogram (kg).
- **Perimeter, Area, and Volume in Metric:** Use metric units for all formulas.
- **Customary to Metric:** Use conversion factors, e.g., 1 inch  $\approx$  2.54 cm.
- **Metric to Customary:** Use conversion factors in the other direction, e.g., 1 cm  $\approx$  0.39 in.

## My Preference for Concepts to Focus On:

1. Understanding conversion between units
2. Calculating perimeter, area, and volume
3. Knowing when to use which measurement unit
4. Estimating measurements

## Worked Examples

### Customary Length:

Example: 3 feet = 36 inches (since 1 foot = 12 inches;  $3 \times 12 = 36$ )

### Customary Liquid Volume:

Example: 2 quarts = 8 cups (since 1 quart = 4 cups;  $2 \times 4 = 8$ )

**Customary Weight:**

Example: 16 ounces = 1 pound

**Perimeter:**

Example: Rectangle with  $l = 5$  in,  $w = 3$  in

$$P = 2(5 + 3) = 2(8) = 16 \text{ in}$$

**Area:**

Example: Rectangle with  $l = 7$  cm,  $w = 2$  cm

$$A = 7 \times 2 = 14 \text{ cm}^2$$

**Volume:**

Example: Rectangular prism:  $l = 4$  m,  $w = 3$  m,  $h = 2$  m

$$V = 4 \times 3 \times 2 = 24 \text{ m}^3$$

**Time:**

Example: 2 hours 30 minutes = 150 minutes ( $2 \times 60 + 30$ )

**Temperature:**

Example:  $68^\circ\text{F}$  to Celsius:  $(68 - 32) \times 5/9 \approx 20^\circ\text{C}$

**Metric Length:**

Example: 1000 meters = 1 kilometer

**Metric Liquid Volume:**

Example: 250 mL = 0.25 L

**Metric Mass:**

Example: 1000 g = 1 kg

**Customary to Metric Conversion:**

Example: 10 inches  $\times 2.54 = 25.4$  cm

**Metric to Customary Conversion:**

Example: 100 cm  $\times 0.39 \approx 39$  inches

# Pre-Test: Check Your Understanding!

1. How many inches are in 2 feet?

- 24
- 12
- 36
- 18

2. How many feet are in 1 yard?

- 2
- 3
- 4
- 6

3. How many yards are in a mile?

- 1,760
- 5,280
- 3,600
- 528

4. How many inches are in a foot?

- 10
- 12
- 14
- 16

5. How many cups are in a quart?

- 2
- 4
- 8
- 16

6. How many pints are in a gallon?

- 4
- 6
- 8
- 2

7. How many tablespoons in 1 cup?

- 8
- 12
- 16
- 32

8. How many quarts in 1 gallon?

- 2
- 3
- 4
- 6

9. How many ounces in a pound?

- 14
- 16
- 20
- 18

10. How many pounds in a ton?

- 500
- 1000
- 2000
- 2500

11. What is the perimeter of a rectangle with  $l = 4$ ,  $w = 6$ ?

- 20
- 24
- 16
- 18

12. What is the area of a rectangle with  $l = 5$ ,  $w = 8$ ?

- 40
- 13
- 25
- 30

13. What is the volume of a box:  $l = 2\text{m}$ ,  $w = 3\text{m}$ ,  $h = 4\text{m}$ ?

- 24
- 9
- 12
- 8

14. How many minutes in 3 hours?

- 120
- 90
- 180
- 60

15. How many seconds in 5 minutes?

- 300
- 60
- 120
- 180

16. What is freezing point of water in Fahrenheit?

- $32^{\circ}\text{F}$
- $0^{\circ}\text{F}$
- $100^{\circ}\text{F}$
- $212^{\circ}\text{F}$

17. How many millimeters in a centimeter?

- 1
- 10
- 100

1000

18. How many centimeters in a meter?

10

100

1000

1

19. How many kilometers in 1,000 meters?

0.1

1

10

100

20. How many milliliters in a liter?

10

100

1000

10000

21. How many liters in 2,500 mL?

0.25

2.5

25

250

22. How many grams in a kilogram?

100

1000

10,000

10

23. How many milligrams in a gram?

10

100

1,000

10,000

24. Perimeter of rectangle:  $l=8\text{cm}$ ,  $w=7\text{cm}$ ?

15cm

30cm

22cm

28cm

25. Area of rectangle:  $l=4\text{m}$ ,  $w=5\text{m}$ ?

$9\text{m}^2$

$20\text{m}^2$

$16\text{m}^2$

$25\text{m}^2$

26. Volume of box:  $l=3\text{cm}$ ,  $w=4\text{cm}$ ,  $h=5\text{cm}$ ?

$60\text{cm}^3$

- 12cm<sup>3</sup>
- 30cm<sup>3</sup>
- 24cm<sup>3</sup>

27. Convert 10 inches to centimeters (1 in = 2.54 cm)

- 12.54
- 20.54
- 25.4
- 254

28. Convert 5 miles to kilometers (1 mi  $\approx$  1.61 km)

- 8.05
- 16.1
- 0.805
- 80.5

29. Convert 100 centimeters to inches (1 cm  $\approx$  0.39 in)

- 39
- 3.9
- 390
- 9.3

30. Convert 2 liters to quarts (1 L  $\approx$  1.06 qt)

- 1.06
- 2.12
- 3.18
- 4.24

31. Which is heavier: 1 pound or 1 kilogram?

- 1 pound
- 1 kilogram
- Same
- Cannot tell

32. Which is longer: 1 yard or 1 meter?

- 1 yard
- 1 meter
- Same
- Cannot tell

33. Which is larger: 1 gallon or 1 liter?

- 1 gallon
- 1 liter
- Same
- Cannot tell

34. Which is greater: 100°F or 100°C?

- 100°F
- 100°C
- Same
- Cannot tell

35. How many hours in 3 days?
- 24
  - 72
  - 36
  - 48
36. How many minutes in half an hour?
- 15
  - 30
  - 60
  - 90
37. How many quarts in 2 gallons?
- 2
  - 4
  - 6
  - 8
38. How many meters in 0.5 kilometers?
- 5
  - 50
  - 500
  - 5000
39. What is the area of a square with side 9cm?
- $9\text{cm}^2$
  - $18\text{cm}^2$
  - $36\text{cm}^2$
  - $81\text{cm}^2$
40. What is the perimeter of a square with side 6m?
- 12m
  - 18m
  - 24m
  - 36m
41. How many grams in 3 kilograms?
- 3
  - 30
  - 300
  - 3000

Submit Answers

## Questions & Answers

*"What is the difference between weight and mass?"*

Weight is the force of gravity on an object (measured in pounds or newtons), while mass is the amount of matter in an object (measured in grams or kilograms).

*"How do you convert inches to centimeters?"*

Multiply inches by 2.54 to get centimeters.

*"How do you find the perimeter of a rectangle?"*

Add all sides or use the formula:  $P = 2(l + w)$ .

*"What is a liter?"*

A metric unit of liquid volume.  $1 \text{ L} = 1000 \text{ mL}$ .

*"What are the main metric units for measuring length?"*

Millimeter (mm), centimeter (cm), meter (m), kilometer (km).

*"How do you convert Fahrenheit to Celsius?"*

Subtract 32, then multiply by  $5/9$ .

## Post-Test: Demonstrate Your Mastery!

1. How many inches are in 2 feet?

- 24
- 12
- 36
- 18

2. How many feet are in 1 yard?

- 2
- 3
- 4
- 6

3. How many yards are in a mile?

- 1,760
- 5,280
- 3,600
- 528

4. How many inches are in a foot?

- 10
- 12
- 14
- 16

5. How many cups are in a quart?

- 2
- 4
- 8
- 16

6. How many pints are in a gallon?

- 4
- 6
- 8
- 2

7. How many tablespoons in 1 cup?

- 8
- 12
- 16
- 32

8. How many quarts in 1 gallon?

- 2
- 3
- 4
- 6

9. How many ounces in a pound?

- 14
- 16
- 20
- 18

10. How many pounds in a ton?

- 500
- 1000
- 2000
- 2500

11. What is the perimeter of a rectangle with  $l = 4$ ,  $w = 6$ ?

- 20
- 24
- 16
- 18

12. What is the area of a rectangle with  $l = 5$ ,  $w = 8$ ?

- 40
- 13
- 25
- 30

13. What is the volume of a box:  $l = 2\text{m}$ ,  $w = 3\text{m}$ ,  $h = 4\text{m}$ ?

- 24
- 9
- 12
- 8

14. How many minutes in 3 hours?

- 120
- 90
- 180
- 60

15. How many seconds in 5 minutes?

- 300
- 60
- 120
- 180

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- $0^{\circ}\text{F}$
- $100^{\circ}\text{F}$
- $212^{\circ}\text{F}$

17. How many millimeters in a centimeter?

- 1
- 10
- 100
- 1000

18. How many centimeters in a meter?

- 10
- 100
- 1000
- 1

19. How many kilometers in 1,000 meters?

- 0.1
- 1
- 10
- 100

20. How many milliliters in a liter?

- 10
- 100
- 1000
- 10000

21. How many liters in 2,500 mL?

- 0.25
- 2.5

- 25
- 250

22. How many grams in a kilogram?

- 100
- 1000
- 10,000
- 10

23. How many milligrams in a gram?

- 10
- 100
- 1,000
- 10,000

24. Perimeter of rectangle:  $l=8\text{cm}$ ,  $w=7\text{cm}$ ?

- 15cm
- 30cm
- 22cm
- 28cm

25. Area of rectangle:  $l=4\text{m}$ ,  $w=5\text{m}$ ?

- $9\text{m}^2$
- $20\text{m}^2$
- $16\text{m}^2$
- $25\text{m}^2$

26. Volume of box:  $l=3\text{cm}$ ,  $w=4\text{cm}$ ,  $h=5\text{cm}$ ?

- $60\text{cm}^3$
- $12\text{cm}^3$
- $30\text{cm}^3$
- $24\text{cm}^3$

27. Convert 10 inches to centimeters (1 in = 2.54 cm)

- 12.54
- 20.54
- 25.4
- 254

28. Convert 5 miles to kilometers (1 mi  $\approx$  1.61 km)

- 8.05
- 16.1
- 0.805
- 80.5

29. Convert 100 centimeters to inches (1 cm  $\approx$  0.39 in)

- 39
- 3.9
- 390
- 9.3

30. Convert 2 liters to quarts (1 L  $\approx$  1.06 qt)

- 1.06
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- 1 kilogram
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- Same
- Cannot tell

33. Which is larger: 1 gallon or 1 liter?

- 1 gallon
- 1 liter
- Same
- Cannot tell

34. Which is greater:  $100^{\circ}\text{F}$  or  $100^{\circ}\text{C}$ ?

- $100^{\circ}\text{F}$
- $100^{\circ}\text{C}$
- Same
- Cannot tell

35. How many hours in 3 days?

- 24
- 72
- 36
- 48

36. How many minutes in half an hour?

- 15
- 30
- 60
- 90

37. How many quarts in 2 gallons?

- 2
- 4
- 6
- 8

38. How many meters in 0.5 kilometers?

- 5
- 50
- 500
- 5000

39. What is the area of a square with side 9cm?

- 9cm<sup>2</sup>
- 18cm<sup>2</sup>
- 36cm<sup>2</sup>
- 81cm<sup>2</sup>

40. What is the perimeter of a square with side 6m?

- 12m
- 18m
- 24m
- 36m

41. How many grams in 3 kilograms?

- 3
- 30
- 300
- 3000

Submit Answers

# Geometry Fundamentals

Points, Lines, Angles, Polygons, Solids, and Graphing

Concepts

Examples

Pre-Test

Q & A

Post-Test

## Key Concepts Explained

- **Points and Lines:** A point marks a position in space. A line is a straight path extending in both directions with no endpoints.
- **Line Segments and Rays:** A line segment has two endpoints. A ray starts at an endpoint and goes forever in one direction.
- **Measuring Angles:** Angles are measured in degrees ( $^{\circ}$ ). A protractor is used to measure angles.
- **Types of Angles:**
  - Acute: less than  $90^{\circ}$
  - Right: exactly  $90^{\circ}$
  - Obtuse: more than  $90^{\circ}$  but less than  $180^{\circ}$
  - Straight: exactly  $180^{\circ}$
  - Reflex: more than  $180^{\circ}$
- **Triangles:** 3-sided polygons, classified by sides (equilateral, isosceles, scalene) and angles (acute, right, obtuse).
- **Quadrilaterals:** 4-sided polygons, such as squares, rectangles, parallelograms, trapezoids, and rhombuses.
- **Polygons:** Closed figures with straight sides. Named by number of sides (pentagon = 5, hexagon = 6, etc.).
- **Circles:** Set of all points equidistant from a center. Key terms: radius, diameter, circumference.
- **Solid Figures:** 3D objects such as cubes, prisms, pyramids, spheres, cones, and cylinders.
- **Surface Area:** The total area of all surfaces of a 3D object.
- **Graphing Figures:** Placing points, lines, and shapes on a coordinate grid (x, y axes).

## Concepts I Recommend Focusing On

1. How to identify and draw geometric figures
2. How to classify triangles and quadrilaterals
3. How to measure and estimate angles
4. How to calculate area, perimeter, and surface area
5. How to interpret and create coordinate graphs

## Worked Examples

## Identifying a Ray vs. Line Segment

Example:

$AB\rightarrow$  is a ray (starts at A, passes through B, continues forever);

CD is a line segment (from C to D only).

## Measuring Angles

Example: If an angle opens  $\frac{1}{4}$  of a circle, its measure is  $90^\circ$  (a right angle).

## Types of Angles

Example:  $120^\circ$  is obtuse;  $85^\circ$  is acute;  $90^\circ$  is right.

## Classifying Triangles

Example: A triangle with sides 5 cm, 5 cm, 8 cm is isosceles.

## Quadrilaterals

Example: A rectangle is a quadrilateral with 4 right angles and opposite sides equal.

## Polygons

Example: A hexagon has 6 sides; a pentagon has 5 sides.

## Circles

Example: The radius is half the diameter. Circumference =  $2\pi r$ .

## Surface Area of a Cube

Example: For side length 4 cm, surface area =  $6 \times 4 \times 4 = 96 \text{ cm}^2$ .

## Graphing Figures

Example: Plotting (2,3), (2,7), (6,7), (6,3) on a grid forms a rectangle.

# Pre-Test: Check Your Understanding!

1. What is a point?

- A location in space with no size
- A line with two endpoints
- A straight path that goes forever in both directions
- A part of a circle

2. Which is a line segment?

- AB←
- AB→
- AB
- AB with two endpoints

3. Which figure goes on forever in one direction from an endpoint?

- Line segment
- Ray
- Circle
- Polygon

4. How many points are needed to define a line?

- 1
- 2
- 3
- 4

5. Which tool is used to measure angles?

- Ruler
- Protractor
- Compass
- Scale

6. What is the measure of a right angle?

- 45°
- 60°
- 90°
- 180°

7. An angle measuring more than 90° but less than 180° is called:

- Acute angle
- Obtuse angle
- Right angle
- Reflex angle

8. An angle of 180° is called a:

- Acute angle
- Straight angle
- Right angle
- Obtuse angle

9. An angle less than 90° is called:

- Acute angle
- Right angle
- Obtuse angle
- Straight angle

10. An angle more than 180° is a:

- Acute angle
- Obtuse angle

- Reflex angle
- Right angle

11. A triangle with all sides equal is called:

- Isosceles
- Scalene
- Equilateral
- Right

12. Which triangle has one right angle?

- Scalene triangle
- Right triangle
- Equilateral triangle
- Obtuse triangle

13. A triangle with sides 3 cm, 4 cm, 5 cm is:

- Equilateral
- Isosceles
- Scalene
- Right

14. The sum of the angles in any triangle is:

- $90^\circ$
- $180^\circ$
- $270^\circ$
- $360^\circ$

15. How many sides does a quadrilateral have?

- 3
- 4
- 5
- 6

16. A parallelogram with four right angles is a:

- Rhombus
- Rectangle
- Square
- Trapezoid

17. A square is a special case of a:

- Rectangle and Rhombus
- Trapezoid
- Pentagon
- Circle

18. A quadrilateral with only one pair of parallel sides is a:

- Rectangle
- Trapezoid
- Rhombus
- Square

19. A polygon with 5 sides is called a:

- Pentagon
- Hexagon
- Octagon
- Quadrilateral

20. A polygon must have at least how many sides?

- 2
- 3
- 4
- 5

21. A closed figure with straight sides is called a:

- Polygon
- Circle
- Ray
- Angle

22. A hexagon has how many sides?

- 5
- 6
- 7
- 8

23. The distance from the center of a circle to any point on the circle is the:

- Diameter
- Radius
- Chord
- Circumference

24. A line passing through the center of a circle, touching two points on the edge, is called:

- Radius
- Diameter
- Chord
- Tangent

25. Circumference of a circle is:

- Distance across circle
- Distance around the circle
- Area of the circle
- Another name for radius

26. If the diameter of a circle is 10, what is the radius?

- 5
- 10
- 15
- 20

27. How many faces does a cube have?

- 4
- 5
- 6
- 8

28. A solid figure with a circular base and one vertex is a:

- Sphere
- Cylinder
- Cone
- Cube

29. A sphere has how many faces?

- 0
- 1
- 2
- 3

30. A rectangular prism has how many edges?

- 8
- 10
- 12
- 6

31. The surface area of a cube with side 3 units is:

- 9
- 18
- 27
- 54

32. Which units are used for surface area?

- cm
- $\text{cm}^2$
- $\text{cm}^3$
- m

33. The sum of the areas of all faces of a solid figure is the:

- Volume
- Surface area
- Perimeter
- Radius

34. What is the surface area of a rectangular prism  $2 \times 3 \times 4$  units?

- 24
- 36
- 52
- 48

35. Which pair is a coordinate on a plane?

- (x, y)
- (l, w)
- (a, b, c)
- (h, k, l)

36. The horizontal axis on a graph is called:

- y-axis
- x-axis

- z-axis
- t-axis

37. What shape is formed by points  $(0,0)$ ,  $(0,3)$ ,  $(3,3)$ ,  $(3,0)$ ?

- Triangle
- Rectangle
- Circle
- Hexagon

38. What is the y-coordinate of the point  $(4,7)$ ?

- 4
- 7
- 11
- 3

Submit Answers

## Questions & Answers From Your Pre-Test

### Post-Test: Demonstrate Your Mastery!

1. What is a point?

- A location in space with no size
- A line with two endpoints
- A straight path that goes forever in both directions
- A part of a circle

2. Which is a line segment?

- $AB\leftarrow$
- $AB\rightarrow$
- $AB$
- $AB$  with two endpoints

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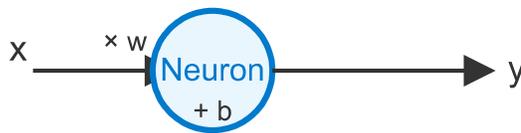
Submit Answers



# Train a Single Neuron: Linear Regression Demo

## 1. Introduction to Linear Regression

Linear regression is a foundational technique in machine learning used to model the relationship between a dependent variable ( $y$ ) and one independent variable ( $x$ ). The goal is to find the best-fitting straight line, which is mathematically expressed as  $y = wx + b$ , where  $w$  is the weight (slope) and  $b$  is the bias (intercept).



*Diagram: Single neuron for linear regression. Input  $x$  is multiplied by weight  $w$ , bias  $b$  is added, and the output is  $y$ .*

**Example:** Suppose you want to predict the price of a slice of pizza ( $y$ ) by its size in inches ( $x$ ). If every extra inch adds \$2, and a plain slice (0 inches) costs \$1, the model is:

$$y = 2x + 1$$

So, a 4-inch slice ( $x=4$ ) would cost  $y = 2 \times 4 + 1 = 9$  dollars.

## 2. Train a Single Neuron for Linear Regression

In this section, we use TensorFlow.js to train a single neuron (with just one input and one output) to learn the relationship between  $x$  and  $y$  as described above.

Train Model

## 3. Discussion: TensorFlow.js for JavaScript

[TensorFlow.js](#) is an open-source library that enables you to define, train, and run machine learning models directly in your browser or in a JavaScript environment such as Node.js. It supports both training from scratch and running pre-trained models and leverages GPU acceleration for efficient computation.

- **In-browser ML:** No server needed; everything runs on your device.
- **Interactivity:** You can build live, interactive demos.
- **Privacy:** Data can stay on the user's machine.
- **Hardware acceleration:** Uses WebGL for faster computation.

In this demo, TensorFlow.js powers the training and prediction process right in your browser!

# Convolutional Neural Networks in JavaScript

## Introduction to Convolutional Neural Networks (CNN)

Convolutional Neural Networks (CNNs) are a specialized type of deep learning model particularly effective at processing data that has a grid-like topology, such as images. CNNs are composed of layers that automatically and adaptively learn spatial hierarchies of features, making them highly effective for image recognition, object detection, and similar tasks.

### How to Train a CNN

- **Data Preparation:** Collect and preprocess your dataset (e.g., normalizing images, resizing).
- **Model Architecture:** Define a CNN architecture with convolutional, pooling, and fully connected layers.
- **Compilation:** Set the loss function, optimizer, and metrics for training.
- **Training:** Feed the training data into the network and adjust the model's parameters using backpropagation.
- **Evaluation:** Assess the model's performance on validation or test datasets.
- **Inference:** Use the trained model to make predictions on new data.

## TensorFlow.js for CNNs and Training

[TensorFlow.js](#) is an open-source library that allows you to define, train, and run machine learning models directly in the browser and in Node.js environments. This makes it possible to create, train, and deploy CNNs using JavaScript, leveraging GPU acceleration where available.

### Key Features of TensorFlow.js for CNNs

- **Layer API:** Enables building sequential and functional neural network architectures, including convolutional layers like `tf.layers.conv2d`.
- **Training Support:** Provides utilities to compile models, specify loss functions, optimizers (such as Adam), and fit models using `model.fit()`.
- **GPU Acceleration:** Uses WebGL for efficient computation in the browser.
- **Data Handling:** Offers APIs for loading and manipulating image and tensor data.

### Example: Creating a CNN in TensorFlow.js

```
// Basic CNN in TensorFlow.js
const model = tf.sequential();
model.add(tf.layers.conv2d({
  inputShape: [28, 28, 1],
  filters: 32,
  kernelSize: 3,
  activation: 'relu'
}));
model.add(tf.layers.maxPooling2d({poolSize: 2, strides: 2}));
model.add(tf.layers.flatten());
model.add(tf.layers.dense({units: 64, activation: 'relu'}));
model.add(tf.layers.dense({units: 10, activation: 'softmax'}));

model.compile({
```

```
optimizer: 'adam',  
loss: 'categoricalCrossentropy',  
metrics: ['accuracy']  
});
```

With TensorFlow.js, you can train this network on image data directly in the browser, making deep learning accessible to web developers.

## Libraries for Defining, Training, and Visualizing Models

Several JavaScript libraries are essential for building, training, and visualizing neural network models in the browser:

- **TensorFlow.js** – *Model Definition & Training*: This is the main library for creating and training neural networks, including CNNs, directly in JavaScript.
- **tfjs-vis** – *Visualization*: This library provides utilities to visualize model layers, training progress, metrics, and more, directly in the browser.

These libraries make it possible to build, train, and visualize deep learning models interactively within a web page.

Run

## Discussion: The MNIST Dataset and Labels

The MNIST dataset is a well-known collection of handwritten digits used for training and evaluating image processing systems. It consists of 28x28 pixel grayscale images of digits (0–9). Each image is paired with a label that indicates which digit it represents.

- **Images**: Downloaded from [mnist\\_images.png](#). This file is a large sprite image containing 70,000 digits (each of size 28x28), stacked vertically.
- **Labels**: Downloaded from [mnist\\_labels\\_uint8](#). This file contains one byte (an integer from 0 to 9) for each image in the sprite, describing which digit appears in each image.

Before using this data in a model, the images and labels must be extracted and organized. Each image will be converted into a flat array of pixel values (normalized between 0 and 1), and each label will be stored as an integer. The cleaned dataset is made easily accessible in the browser as `cleanedData` for further experiments.

Load Dataset

## Visualizing the Cleaned MNIST Dataset

After loading and preprocessing the MNIST data, it's helpful to visualize some samples to confirm that the images and labels are correct. Below, you can display a selection of random handwritten digit images from `cleanedData` along with their corresponding labels.

Show Samples

# Splitting the Dataset into Training and Testing Sets

Before building or evaluating a machine learning model, it's important to split the dataset into two separate parts: a **training set** (used to train the model) and a **testing set** (used to evaluate model performance on unseen data). A common practice is to use 80% of the data for training and 20% for testing. This helps ensure fair and unbiased evaluation of your model.

Click the button below to perform the split. After splitting, you can access the sets with `trainingSet` and `testingSet` in your scripts.

Split the dataset

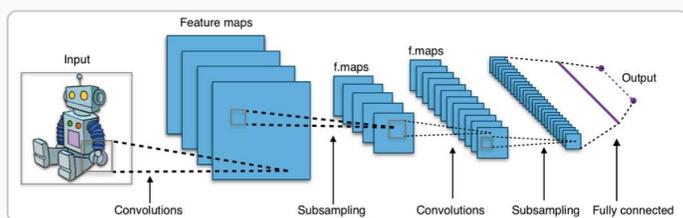
## Defining a Convolutional Neural Network (CNN) Model

Convolutional Neural Networks (CNNs) are specialized for processing images. With the button below, you can programmatically define a simple CNN architecture in JavaScript, ready for training on the MNIST dataset. After creation, the layer configuration will be displayed.

Define CNN Model

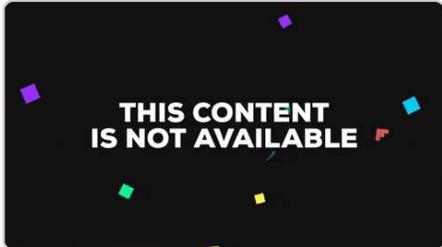
## Understanding the CNN Architecture

A Convolutional Neural Network (CNN) uses a series of layers to extract patterns from image data and perform classification. Here's a visual explanation of how it works:



- **Input layer:** Takes a 28x28 grayscale image.
- **Convolutional layers:** Scan the image to extract local features (edges, blobs, etc.).
- **Pooling layers:** Reduce the spatial size, focusing on the most important features.
- **Flatten layer:** Converts the 2D feature maps into a 1D vector.
- **Dense (fully connected) layers:** Combine the extracted features to make the final decision.
- **Output layer:** Uses `softmax` to predict the probability of each digit (0-9).

Image source: Wikimedia Commons ([Typical\\_cnn.png](#))



In this animation, you can see how filters slide across the image, producing feature maps that capture patterns useful for recognizing digits.

## Training the CNN Model

After defining and understanding your CNN model, the next step is to train it using your training dataset. Training involves feeding your model many labeled examples so it can learn to recognize digit patterns. As training progresses, you can monitor the accuracy and loss to see how well the model is learning.

Train the Model

## Understanding the Confusion Matrix

A **confusion matrix** is a table that visualizes the performance of a classification model by showing how many predictions were correct and where errors occurred. Each row corresponds to the **actual** class, and each column to the **predicted** class. The diagonal values represent correct predictions, while off-diagonal values indicate misclassifications.

- **High diagonal values** mean good performance.
- **Non-zero off-diagonal values** show specific mistakes (e.g., confusing '3' with '5').

Confusion Matrix