

Participant Resource Guide

Shop Math

September 2026



Course Outline

Module 1: Basic Operations

- Module 2: Fractions
- Module 3: Decimals
- Module 4: Measurements



U.S. Department of Transportation
Federal Transit Administration

A program of the Federal Transit Administration administered by the International Transportation Learning Center

Course: Shop Math

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Shop Math – Basic Operations

Objectives

- Demonstrate the ability to solve mathematics problems involving whole numbers.
- Choose the correct operation based on a given problem.
- Use the order of operations to solve problems accurately.

Key Terms

- Addition
- Basic operations
- Division
- Equation
- Exponents
- Multiplication
- Order of Operations
- Parentheses
- Solution
- Subtraction



Participant Resource Guide

Basic Operations

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Basic Operations
Shop Math
Transit Core Competencies Curriculum (TC3)

**U.S. Department of Transportation
Federal Transit Administration**
A program of the Federal Transit Administration administered by the International Transportation Learning Center

Objectives

- Demonstrate the ability to solve mathematics problems involving whole numbers.
- Choose the correct operation based on a given problem.
- Use the order of operations to solve problems accurately.

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Agenda

- Welcome and Warm Up
- 1.1 – Basic Operations
- 1.2 – Order of Operations
- Quiz and Wrap Up



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Warm Up

Scenario: During a busy shift, Chris and Elena need to estimate how long a job will take before the next train arrives. The job requires 5 minutes of prep time, and each component takes 4 minutes to install. There are 6 components total. The next train arrives in 30 minutes.

Discuss:

- How could the wrong estimate impact service or safety?
- Which math operations do they need?
- Why did they get different answers?



Elena 29 minutes
 $5 + (4 \times 6)$
 $5 + 24$
29 min.

Chris 54 minutes
 $5 + (4 \times 6)$
 9×6
54 min.

Notes:

- Here is our scenario: During a busy shift, two technicians, Chris and Elena, need to estimate how long a job will take before the next train arrives. The job requires 5 minutes of prep time, and each component takes 4 minutes to install. There are 6 components total. The next train arrives in 30 minutes.
 - How could the wrong estimate impact service or safety?
 - Which math operation are needed for this equation? Do they need to add, subtract, multiply, or divide?
 - Why did they get different answers?
 - As you can see, simple mistakes can have real-world consequences.
 - In our lesson today, we'll review basic math operations and the correct order of operations for solving equations. We will return to Elena and Chris shortly.
-
-
-
-
-

Key Terms

Equation - An equation is a mathematical statement that shows two values are equal, using an equals sign (=).

Solution - A solution is the correct answer to an equation.

*Both sides of the equation
have the same value*

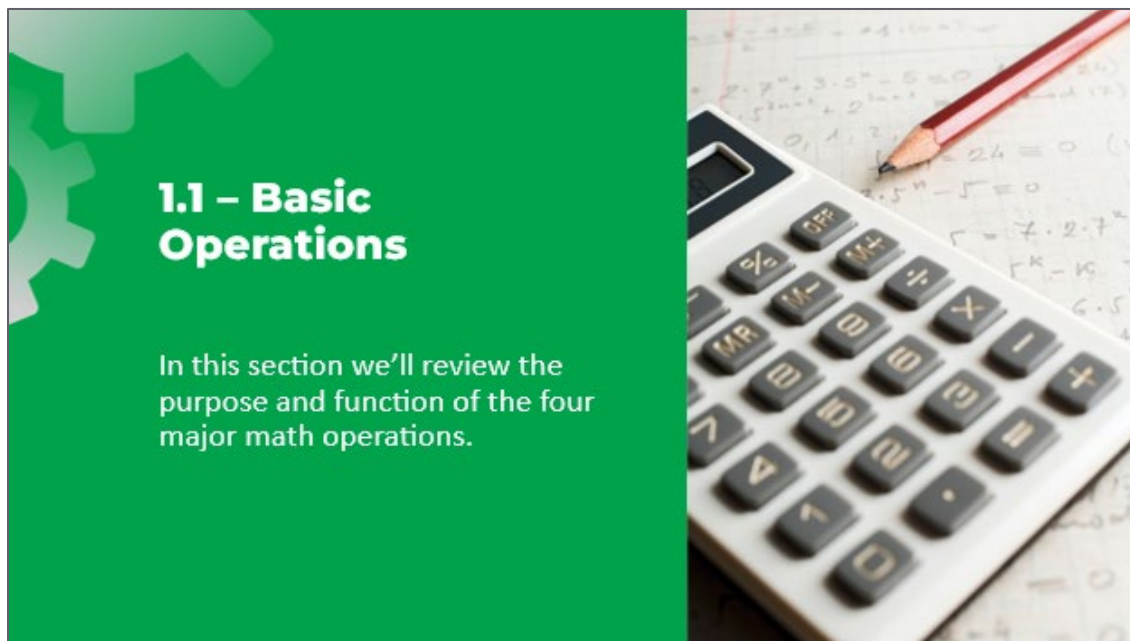
$$8 + 4 = 12$$

*The value that makes the
equation true*



Notes:

- As we dive deeper into our lesson topic, you will hear the following terms frequently.
- An **equation** is a mathematical statement that shows two values are equal, using an equal sign (=). Both sides of the equation have the same value. We have 12 on the left and 12 on the right of the equal sign.
- A **solution** is the correct answer to an equation. A solution is the value that makes the equation true. In this case, 12.



Notes:

- In this section we'll review the purpose and function of the four major math operations.

Basic operations are the four fundamental ways we work with numbers. They include **addition**, **subtraction**, **multiplication**, and **division**.



Notes:

- Basic operations are the four fundamental ways we work with numbers.
- There are four basic operations in math: addition, subtraction, multiplication, and division.
- Think of these as the foundational building blocks of math.

Basic Operations



Addition is combining values to find a total.

**5,000**
Morning steps

+

3,500
Afternoon steps

=

8,500
Total steps







Notes:

- **Addition (+):** Addition is combining values to find a total.
- For example, you add the number of steps you walked in the morning and the evening to get your total for the day.

Basic Operations



Subtraction is finding the difference between values.

 **\$475**
Before groceries

 **\$150**
After groceries

= \$325
Remaining money



Notes:

- **Subtraction (-):** Subtraction is finding the difference between values or what's left over.
- A common example is checking how much money you have left after buying groceries.

Basic Operations



Multiplication is a shortcut for repeated addition.

 \$5
Lunch



 7
Days a week

=

\$35
Cost per week







Notes:

- **Multiplication (x):** Multiplication is a shortcut for repeated addition.
- Instead of adding \$5 for lunch each day over 7 days, you multiply 5×7 to find the total cost for the week.

Basic Operations



Division is used for splitting a value into equal parts or groups.



$18 \div$ = $\frac{1}{8}$ of a pizza per person

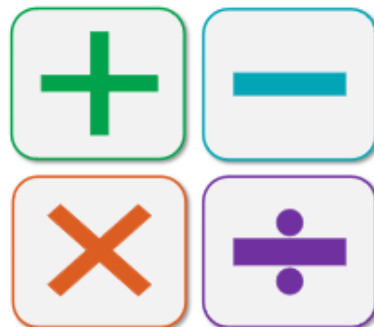


Notes:

- **Division** is used for splitting a value into equal parts or groups.
- For instance, you divide one pizza into 8 slices, so everyone gets an equal share.

Choosing the Right Operation

- Problems won't always tell you which operation to use
- Workers must decide based on the situation
- **Ask Yourself:**
 - What am I trying to find?
 - Am I combining, comparing, grouping, or splitting?



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Notes:

- In real-world work environments, problems don't come labeled as addition, subtraction, multiplication, or division. It's up to you to figure out which operation makes sense based on the situation.
- A good starting point is to ask yourself:
 1. What am I trying to find?
 2. Am I combining amounts, finding a difference, working with equal groups, or splitting something evenly?
- The math itself may be simple, but choosing the correct operation is where mistakes often happen.
- If the wrong operation is used, the final answer will be incorrect—even if the math is done correctly.
- This is why understanding the situation is just as important as knowing how to calculate.
- Let's do some practice problems to get a feel for choosing the correct operation.

Choose, Solve, Explain

A technician installs 6 sensors in the morning and 9 sensors in the afternoon. How many sensors were installed in total?

1. Which operation do we need to use?
2. Explain your choice.
3. What is the solution?



Addition

$$6 + 9 =$$

15

Choose, Solve, Explain

A crew has 36 inspection tasks to complete. There are 6 technicians on the team. How many tasks should each worker have to distribute work evenly?

1. Which operation do we need to use?
2. Explain your choice.
3. What is the solution?



Division

$$36 \div 6 =$$

16

Choose, Solve, Explain

A technician starts with 30 bolts. They use 4 bolts per panel on 5 panels. How many bolts are left on the job?

- 1. Which operation **s** do we need to use?
- 2. Explain your choice.
- 3. What is the solution?



Multiplication



Subtraction

$4 \times 5 =$

Choose, Solve, Explain

A technician is working on 4 vehicles. Each vehicle needs 3 filters. The technician wants to bring 5 extra filters just in case. How many filters does the technician need?

- 1. Which operation do we need to use?
- 2. Explain your choice.
- 3. What is the solution?

×

Multiplication

+

Addition

4 x 3 =

Activity: Choosing the Right Operation



Directions: For each problem, (1) identify which operation(s) should be used and (2) solve the problem.

Use the words addition, subtraction, multiplication, or division to help you choose the correct operation.

Activity

Choosing the Right Operation

Directions: For each problem, (1) identify which operation(s) should be used and (2) solve the problem. Use words like combine, left, groups, or left to help you choose the correct operation.

Read to Help Operation:

1. A technician made 7 repairs in the morning and 8 in the afternoon.
• Which operation do you need to use to solve the equation?
• How many repairs were completed in total?
2. A technician has 30 feet of wire and uses it to make 5 equal coils.
• Which operation do you need to use to solve the equation?
• How long is each coil?
3. A storage bin holds 40 tools, and 25 are used.
• Which operation do you need to use to solve the equation?
• How many tools remain?
4. Each vehicle requires 5 filters. There are 6 vehicles.
• Which operation do you need to use to solve the equation?
• How many filters are needed?
5. A technician has 15 parts and needs 12 more.
• Which operation do you need to use to solve the equation?
• How many parts do they have now?
6. A repair has 12 steps to complete and 4 technicians.
• Which operation do you need to use to solve the equation?
• How many steps does each technician complete?
7. A technician starts with 25 tools and uses 10 during a shift.
• Which operation do you need to use to solve the equation?
• How many tools are left?

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Activity

Choosing the Right Operation

Directions: For each problem, **(1)** identify which operation(s) should be used and **(2)** solve the problem. Use the words addition, subtraction, multiplication, or division to help you choose the correct operation.

Part 1: Single Operation

1. A technician installs 7 sensors in the morning and 8 in the afternoon.
 - Which operation do you need to use to solve the equation? _____
 - How many sensors were installed in total?

2. A technician has 24 feet of wire and cuts it into 6 equal pieces.
 - Which operation do you need to use to solve the equation? _____
 - How long is each piece?

3. A storage bin holds 40 bolts, and 18 are used.
 - Which operation do you need to use to solve the equation? _____
 - How many bolts remain?

4. Each vehicle requires 5 filters. There are 6 vehicles.
 - Which operation do you need to use to solve the equation? _____
 - How many filters are needed?

5. A technician has 15 parts and receives 10 more.
 - Which operation do you need to use to solve the equation? _____
 - How many parts do they have now?

6. A team has 32 tasks to complete and 4 technicians.
 - Which operation do you need to use to solve the equation? _____
 - How many tasks does each technician complete?

7. A technician starts with 25 fuses and uses 11 during a shift.
 - Which operation do you need to use to solve the equation? _____
 - How many fuses are left?

Shop Math – Basic Operations

8. A technician installs 3 cables per system across 8 systems.
- Which operation do you need to use to solve the equation? _____
 - How many cables are installed in total?
9. A worker completes 12 inspections on Monday and 9 on Tuesday.
- Which operation do you need to use to solve the equation? _____
 - What is the total number of inspections completed?
10. A worker has 50 screws and uses 20.
- Which operation do you need to use to solve the equation? _____
 - How many screws remain?

Part 2: Multi-Step Operation

11. A technician works on 4 vehicles. Each vehicle needs 3 sensors, and the technician brings 6 extra sensors.
- Which operation(s) do you need to use? _____
 - How many sensors are needed in total?
12. A worker starts with 40 bolts. They use 5 bolts per panel on 6 panels.
- Which operation(s) do you need to use? _____
 - How many bolts are left?
13. A technician installs 2 cables per unit on 7 units, then installs 5 additional cables.
- Which operation(s) do you need to use? _____
 - How many cables were installed in total?
14. A crew has 36 inspection tasks and completes 6 tasks before lunch. The remaining tasks are split evenly among 5 technicians.
- Which operation do you need to use? _____
 - How many tasks are assigned to each technician?
15. A technician has 48 feet of wire. They cut it into 8 equal pieces, then use 3 of those pieces.
- Which operation(s) do you need to use? _____
 - How many feet of wire were used?

Summary and What's Next

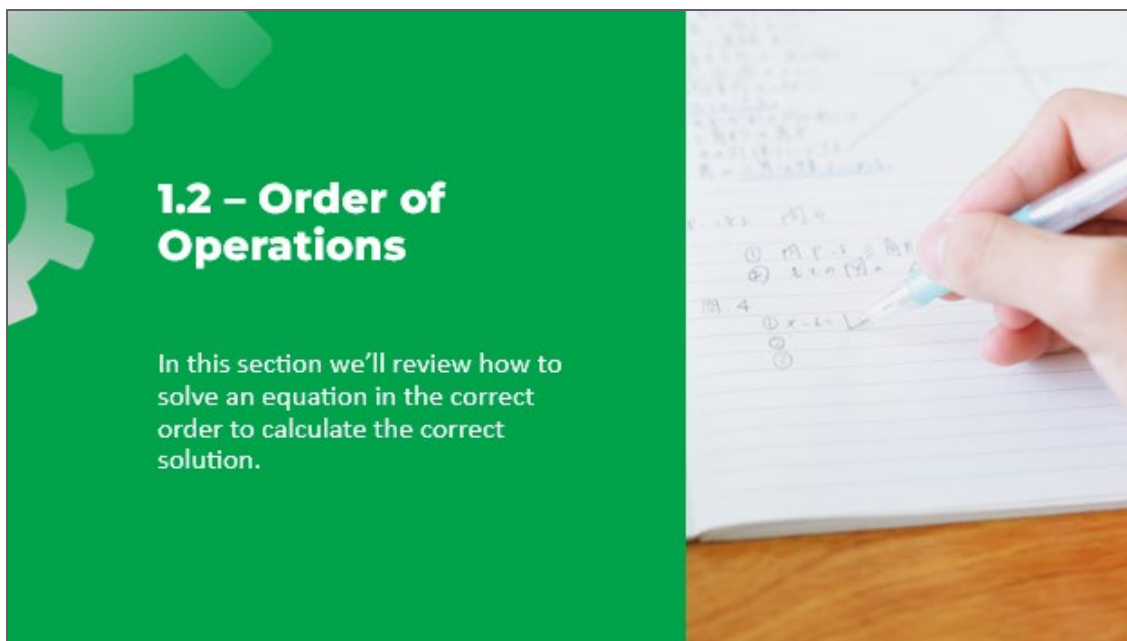
- Solving equations accurately is essential for a safe and efficient workplace.
- Addition, subtraction, multiplication, and division are the four fundamental ways we work with numbers.
- Workers must be familiar with these operations so they can choose which operations they need in real-work scenarios.

Next, we'll learn about how to solve more complex equations in the correct order.

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Notes:

- Solving equations accurately is important for working safely and efficiently on the job.
- Even small mistakes in math can lead to bigger problems like delays, incorrect materials, or safety risks.
- You reviewed the four basic operations: addition, subtraction, multiplication, and division. These are the main ways we work with numbers in everyday tasks.
- It's not just about knowing how to do the math. It's also about knowing which operation to use based on the situation.
 - On the job, no one tells you which operation to use—you have to figure that out.
 - Being comfortable with these operations helps you make better decisions and avoid mistakes.
- Next, you'll build on this by learning how to solve more complex equations using the correct order of operations.



Notes:

- In this section we'll review how to solve an equation in the correct order to calculate the correct solution.

Order of Operations

The **order of operations** is a set of rules that tells us what math operation to do first in an expression with **multiple** operations.

Elena 29 minutes

$$\begin{aligned} &5 + (4 \times 6) \\ &5 + 24 \\ &29 \text{ min.} \end{aligned}$$



Chris 54 minutes

$$\begin{aligned} &5 + (4 \times 6) \\ &9 \times 6 \\ &54 \text{ min.} \end{aligned}$$

Notes:

- Have you ever tried to solve a math problem, where you didn't know where to start or what to do next?
 - Think back to Elena and Chris from our warm up.
 - They both solved the same equation, but they solved it in a different order and got different answers.
- The **order of operations** is a set of rules that tells us what math operation to do first in an expression with multiple operations like addition, subtraction, multiplication, and division.
- Let's take a closer look at the order of operations so we can determine whether Elena or Chris solved the equation correctly.

PEMDAS is an acronym that reminds us of the sequence of steps to follow when solving mathematical expressions with multiple operations.

It stands for **parentheses**, **exponents**, **multiplication**, **division**, **addition**, and **subtraction**.



Notes:

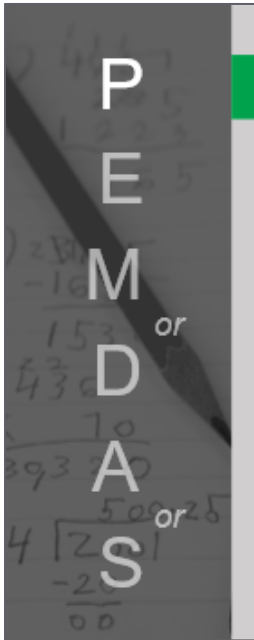
- PEMDAS is an acronym that reminds us of the sequence of steps to follow when solving mathematical expressions with multiple operations.
- It stands for parentheses, exponents, division, addition, and subtraction.

PEMDAS: Order of Operations

Have you ever wondered which math operation comes first in a problem? The **order of operations** is a set of rules that tells us what to do first in an expression with multiple operations, like addition, subtraction, multiplication, and division.

PEMDAS is an acronym showing the order to follow when solving mathematical expressions with multiple operations: Parentheses first, then Exponents, followed by Multiplication and Division (from left to right), and finally Addition and Subtraction (from left to right).

P E M D A S	Parentheses is the first step to the order of operations, so we have to solve anything in () before moving to the next step.	$10 + 6^2 \div 3 \times (8 - 4)$
	Exponents is the second step in the order of operations. Exponents show how many times a number is multiplied by itself. For instance, 5^2 is 5×5 .	$10 + 6^2 \div 3 \times 4$ $10 + 36 \div 3 \times 4$ $10 + 12 \times 4$
	The third step in the order of operations is multiplication OR division . They are prioritized or equally and are performed <u>from left to right</u> .	$10 + 48$ 58
	The fourth step in the order of operations is addition OR subtraction . They are prioritized or equally and are performed <u>from left to right</u> .	

A vertical graphic on the left side of the slide. It features the letters P, E, M, D, A, S stacked vertically. To the right of the letters are the words 'or' and 'or' between the M/D and A/S pairs. The background is dark with faint, light-colored mathematical calculations and a pencil graphic.

Parentheses

- The first step to the order of operations
- We must solve anything in () before moving on.

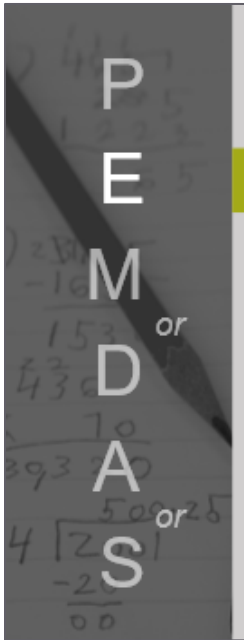
Example:

$$10 + 6^2 \div 3 \times (8 - 4)$$
$$10 + 6^2 \div 3 \times 4$$

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Notes:

- Parentheses is the first step to the order of operations, so we have to solve anything in () before moving to the next step.
- Sometimes people call these “brackets” instead of parentheses – they mean the same thing.
- Take a look at the example equation.
 - What do we need to do first?

A vertical graphic on the left side of the slide. It features the letters P, E, M, D, A, S stacked vertically. To the right of the letters are the words 'or' and 'or' between M and D, and between A and S. The background is dark with faint, light-colored mathematical calculations and a pencil graphic.

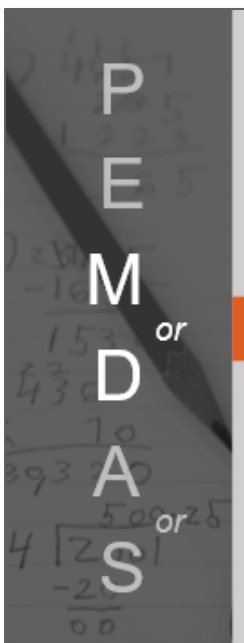
Exponents

- The second step to the order of operations
- Shows how many times a number is multiplied by itself
 - 5^2 is $5 \times 5 =$
 - 4^3 is $4 \times 4 \times 4 =$
 - 2^4 is $=$

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Notes:

- The second step in the order of operations is **exponents**.
 - Exponents show how many times a number is multiplied by itself.
 - For instance, 5^2 is 5×5 . What does 5×5 equal?
 - Take a look at 4^3 which would represent $4 \times 4 \times 4$. What does 4^3 equal?
 - What equation does 2^4 represent? What is the solution to 2^4 ?
 - Take a look at the example equation. What do we need to do second?
-
-
-
-
-



**Multiplication
or Division**

- The third step to the order of operations
- They are prioritized equally and are performed from **left to right**

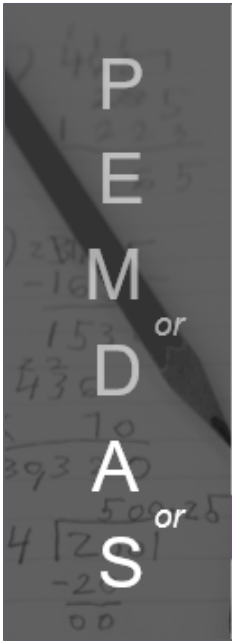
Example:

$$10 + 6^2 \div 3 \times (8 - 4)$$
$$10 + 6^2 \div 3 \times 4$$
$$10 + 36 \div 3 \times 4$$
$$10 + 12 \times 4$$
$$10 + 48$$

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Notes:

- The third step in the order of operations is **multiplication OR division**.
 - Depending on the equation, you may have EITHER or BOTH of these operations.
 - They are prioritized equally and are performed from **left to right**.
 - Take a look at the example equation.
 - If we are reading from left to right, what equation do we need to solve first? What is the solution?
 - Remember that multiplication and division go together, so were not done yet.
 - What do we need to solve next?
 - What is the solution?
-
-
-
-
-

A vertical graphic on the left side of the slide showing the letters P, E, M, D, A, S stacked vertically. The letters M and D are separated by the word 'or', and A and S are also separated by the word 'or'. The background of the graphic shows faint mathematical calculations.

Addition or Subtraction

- The fourth step to the order of operations
- They are prioritized equally and are performed from **left to right**

Example:

$$10 + 6^2 \div 3 \times (8 - 4)$$
$$10 + 6^2 \div 3 \times 4$$
$$10 + 36 \div 3 \times 4$$
$$10 + 12 \times 4$$
$$10 + 48$$
$$58$$

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Notes:

- The fourth step in the order of operations is **addition OR subtraction**.
- Depending on the equation, you may have EITHER or BOTH of these operations.
- They are prioritized equally and are performed from **left to right**.
- Take a look at the example equation.
- If we are reading from left to right, what equation do we need to solve next? What is the solution?
 - Remember that addition and subtraction go together.
- We don't have any subtraction left in this equation, which means we have found the solution.

Common Mistakes

- Not following the correct order
 - Always follow P, E, M/D, A/S
- Not reading from left to right
 - When it comes to M/D and A/S, always do which ever operation comes first

What comes first?

$$8 - 2 + 3$$

What comes first?

$$6 \div 2 \times 3$$

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Notes:

- When it comes to the order of operations, there are a few common mistakes we need to watch out for.
- One common mistake is not following the correct order.
- **Always follow this order: parentheses, exponents, multiplication/division, and addition/subtraction.**
- People often forget to **read the equation from LEFT to RIGHT**, like you're reading a book.
- This matters most when it comes to multiplication/division and addition/subtraction because they occur at the same time.
- Take a look at these examples.
 - If we read from left to right in the first example, what comes first – addition or subtraction?
 - If we read from left to right in the second example, what comes first – multiplication or division?
 - If we don't read from left to right, we will not get the right solution.

Which worker has the correct answer?

Elena 29 minutes

$$5 + (4 \times 6)$$

$$5 + 24$$

29 min.



Chris 54 minutes

$$5 + (4 \times 6)$$

$$9 \times 6$$

54 min.

Elena has the correct answer.

Elena 29 minutes

$$5 + (4 \times 6)$$
$$5 + 24$$

29 min.

*Parentheses
come first in
PEMDAS.*



Notes:

- Have you ever tried to solve a math problem, where you didn't know where to start or what to do next?
 - Think back to Elena and Chris from our warm up. They both solved the same equation, but they solved it in a different order, so they got different answers.
- The **order of operations** is a set of rules that tells us what math operation to do first in an expression with multiple operations like addition, subtraction, multiplication, and division.
- Let's take a closer look at the order of operations so we can determine whether Elena or Chris solved the equation correctly.

Activity: Order of Operation Practice



Directions: Solve each problem using the correct order of operations. Show your work.

- **Part 1:** Equation Practice
- **Part 2:** Word Problem Practice

Activity

Order of Operation Practice

Solve each problem using the correct order of operations. Show your work.

Part 1: Equation Practice

1. $10 + 5 - 8 =$ _____	6. $80 - 20 + 5 =$ _____
2. $30 + 10 + 5 =$ _____	7. $10 + 5 + 5 + 8 =$ _____
3. $10 + 5 + 5 =$ _____	8. $40 - 20 + 5 + 5 =$ _____
4. $5 + 5 + 5 =$ _____	9. $10 + 5 + 5 + 5 =$ _____
5. $5 + 5 + 5 =$ _____	10. $80 - 40 + 5 + 5 =$ _____
6. $10 + 5 + 5 =$ _____	
7. $10 + 5 + 5 =$ _____	

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Order of Operation Practice

Directions: Solve each problem using the correct order of operations. Show your work.

Part 1: Equation Practice

1. $14 + 9 - 6 =$ _____

8. $30 - (6 \times 3) =$ _____

2. $30 - 12 + 5 =$ _____

9. $(15 + 5) \div 5 \times 4 =$ _____

3. $16 \div 4 \times 3 =$ _____

10. $40 - (8 + 2) \times 3 =$ _____

5. $9 + 5 \times 4 =$ _____

11. $12 + 3^2 \times 2 =$ _____

6. $25 - 3 \times 5 =$ _____

12. $20 - 8 \div 4 \times (3 + 1) =$ _____

7. $(9 + 7) \times 2 =$ _____

Part 2: Word Problem Practice

13. A technician installs 3 sensors on each of 6 vehicles, then installs 4 additional sensors.
What is the total number of sensors installed? _____

14. A worker has 50 bolts. They use 5 bolts per panel on 6 panels.
How many bolts are left? _____
Hint – This equation has parentheses.

15. A technician has 56 feet of wire and cuts it into 7 equal pieces, then uses 3 pieces.
How many feet of wire were used? _____

16. A job requires 4 hours per unit for 3 units, plus 3 hours of setup time.
What is the total time required? _____

17. A crew completes 4 inspections per vehicle on 7 vehicles, then completes 6 additional inspections.
What is the total number of inspections completed? _____

Knowledge Check



Q: What are the basic operations?

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Knowledge Check



Q: Which operations does the technician need to use in this scenario: A technician installs 3 sensors on each of 5 vehicles, then installs 4 additional sensors.

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Knowledge Check



Q: Why does the order of operations exist?

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Knowledge Check



Q: What is the solution to this equation?

$$18 - 6 \div 3 \times (2 + 4)$$

(A). 6

(B). 12

(C). 30

(D). 24

35

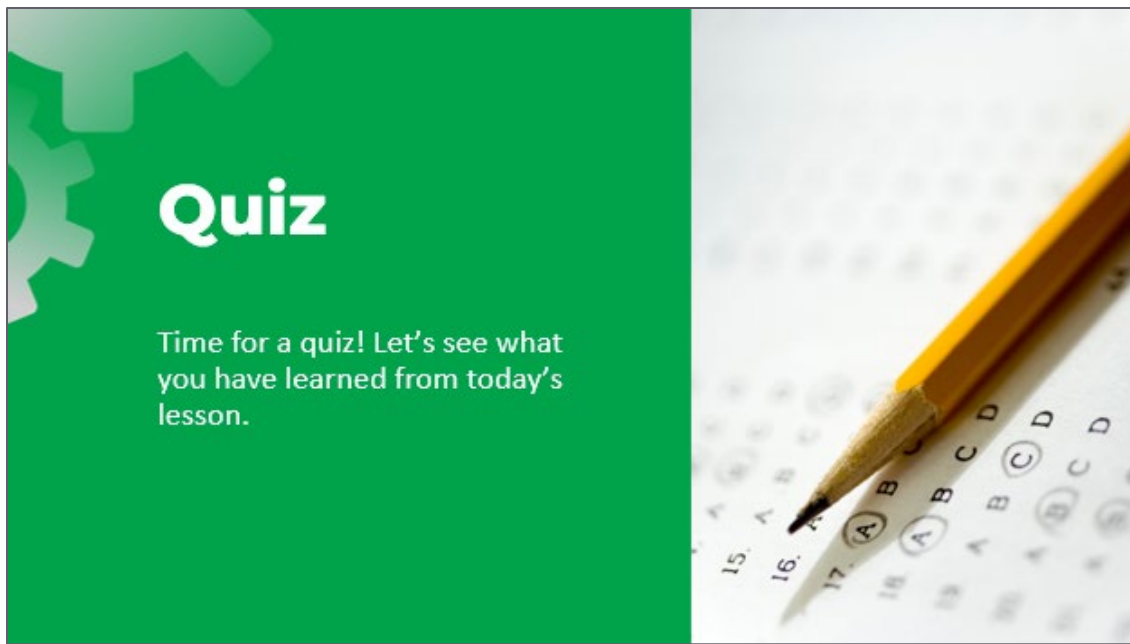
Knowledge Check



A technician solves the following equation: $12 \div 3 \times 2$. They write their answer as 2.

Q: Why did this person get the wrong answer?

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Notes:

- Time for a quiz! Let's see what you have retained from today's lesson.

Revisiting Objectives

- Demonstrate the ability to solve mathematics problems involving whole numbers.
 - Choose the correct operation based on a given problem.
 - Use the order of operations to solve problems accurately.

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Notes:

- If you were explaining today's objectives to someone else, how would you summarize what they mean and why they matter?
- Which of today's objectives do you feel most confident about? Which were most challenging?
 - Explain your reasoning.
- Can you give an example of how you could apply one of today's objectives in a real-world situation?
