

Topic 1

Expressions

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I. Order of Operations and Simplifying Numeric Expressions

A. Simplify each expression.

1. $20 - 5 \times 3 + 4 \div 4$

2. $14 \times 2 - 12 \div 2 \div 2 + 4$

3. $3 \times 9 - (9 + 0) \div 3 \times 9$

4. $5 + 10 \div 2 - 6 \times 1$

5. $6 - 4 \div 2 + 5 \times 3$

6. $25 \times 6 - 3 - 4 \div 2$

7. $8 + 7 \times 2 - 15 \div 5$

8. $24 \div 6 + 3 \times 3 - 7$

9. $18 - 2 \times 4 \times 2 + 10 \div 2$

10. $9 \div 3 - 1 + 8 \times 7 - 16$

11. $10 + 18 \div 3 \div 2 - 3 \times 4$

12. $36 \div 12 + 9 \times 3 - 12$

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B. Simplify each expression using the Order of Operations.

1. $4 + 3 \div 1 - 2 \times 3$

2. $5 \times 3 - 8 + 10 \div 2$

3. $5 + 2 \times 3 - 8 \div 4$

4. $15 - 12 \div 6 \div 2 \times 4 + 7$

5. $5 - 8 \div 4 + 2 \times 7$

6. $1 + 3 \times (4 - 1) + 6 \div 2$

7. $4 + 3 \times 5 - 12$

8. $56 \div 8 + 3 \times 6$

9. $13 + 9 \times 2 - 14 \div 2$

10. $9 \times 8 - 29 + 30 \div 15 - 15$

11. $36 \div (12 - 8) + 2 \times 5$

12. $18 + 4 \div 4 - 2 \times (3 + 1)$

C. Write each exponent expression as a product of factors.

1. 5^2

2. 7^3

3. 4^5

4. 3^2

5. 2^9

6. 8^3

7. 6^4

8. 9^7

9. 1^6

10. 10^3

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D. Simplify each numeric expression.

1. $4^2 \cdot 3$

2. $3^3 - 14 \div 2 + 5$

3. $17 - 2^3$

4. $144 \div 6^2 \cdot 8 + 2^2$

5. $32 \div 4^2$

6. $2^4 - 3 \cdot 5 + 9$

7. $9 + 5^2 - 2 \cdot 3^2$

8. $11^2 - 7 \cdot 6 - 4^3 \div 2$

9. $(4 + 3) \cdot 5$

10. $((3 \cdot 4^2) + 2) \div 5$

11. $(13 - 8)^2$

12. $(2^3 + 13) \div (12 - 9)$

13. $29 - (2^2 + 7)$

14. $((5 \cdot 7) - (8 \cdot 4))^3 - 10$

15. $40 \div (11 - 9)^2$

16. $7^2 + ((46 - 7 \cdot 2) \div 2^3)^2$

II. Evaluating Multi-Step Expressions

A. Evaluate the expression for the variable to solve each problem.

1. A frame maker is hired by an art museum to make a special frame for a large, rectangular painting. The painting is 3 times as long as it is tall. The expression $2(x + 3x)$ represents the perimeter of the painting, where x represents the length of the short side of the painting in feet.
2. You purchased two solar panels that have the same width but different heights. One panel has a height of 5.6 feet and the other panel has a height of 7.2 feet. To calculate the area that both panels will cover, you use the formula $5.6w + 7.2w$, where w is the width of each panel in feet.

What is the total feet of framing needed if the short side of the painting measures 2.6 feet?

How much area will both panels cover if they are each two feet wide?

3. Pearl wants to determine the average number of goals she scored her first five field hockey games of the season. She scored 2 goals in the first game, 3 goals in the second, and 5 goals in the third. She can't remember how many goals she scored in the fourth and fifth games but she does remember that she scored the same number of times in each of those games. The expression $\frac{2 + 3 + 5 + x + x}{5}$ will determine the average number of goals she scored, where x is the number of goals she scored in each of the fourth and fifth games.
4. Alice sells slices of pie and cheesecake at her bakery, for \$3.90 per slice. During the lunch rush, she sold all of the slices from the ten cheesecakes she had on display and five slices of pie. The expression $3.9(10s + 5)$ represents the amount of money she earns during the lunch rush in dollars, where s is the number of slices in a cheesecake.

If each cheesecake was cut into 10 slices, how much money did she earn?

If Pearl scored 2 goals in each of the fourth and fifth games, what was her average number of goals per game?

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5. Alicia, a graphic designer, is designing a new logo for a company. The logo will contain a square and a triangle. The triangle's base and height will be the same length as the side of the square. Alicia wants to use fabric to create the shapes to use during her presentation to the company. The expression $s \cdot s + 0.5s \cdot s$ represents the number of square inches of fabric she will need to create the logo, where s is the length of the side of the square in inches.

If a side of the square is 9.7 inches long, how many square inches of fabric will Alicia need?

7. Brandon and Rey are both hired to work at the school fun fair. The school pays Brandon \$6.80 per hour to work outside and Rey \$8.30 per hour to work inside. To calculate how much the school owed them, they used the formula $6.8h + 8.3h$, where h is the number of hours they worked.

If they both worked 6 hours, how much did they earn together?

6. Malik is building a new chicken coop for his backyard. The side of the coop is in the shape of a trapezoid, where the lower base of the trapezoid is 7 feet long, and the upper base of the trapezoid is 5 feet long. The expression $\frac{1}{2}h(7 + 5)$ will determine the number of square feet of wood he will need for the side of the coop, where h is the height of the side of the coop in feet.

If Malik wants the side of the chicken coop to be 5.2 feet tall, how many square feet of wood will he need?

8. To save up for veterinary school, you start your own animal care business. You will help owners by doing just about anything for their dogs, including feed, walk, bathe, and board them. However, your love is to train the dogs. You have a few expenses like dog treats and pooper-scooper bags that total about \$1.10 per session. Each customer pays you \$7.40 per session. To calculate how much you make in a week of training, you use the formula $7.4d - 1.1d$, where d is the number of dog-training sessions you have.

How much do you make if you have 6 sessions in a week?

- 9.** In the year 2150, a colony is started on the Moon. The colony first creates 9.7 square miles of farmland. After that, the colony adds 3.3 square miles of new farmland per year. Each year the colony also converts 1 square mile of the original farmland to green space to produce more oxygen for the colony. The expression $9.7 + 3.3y - y$ represents the Moon colony's farmland in square miles, where y represents the number of years.

How many total square miles of farmland will the Moon colony have after 10 years?

- 10.** A strong push-off adds momentum to a bobsled and over the entire run adds 7.9 yards to the distance the sled travels in a given time. The rest of the sled's speed is contributed by the force of gravity. A certain sled travels at a speed of 5.4 yards per second after the push-off. The bobsled's average speed is given by the total distance divided by the run's time. The expression $\frac{7.9 + 5.4t}{t}$ represents the average speed for the sled in yards per second, where t represents the number of seconds into the run.

What is the sled's average speed, in yards per second, 6 seconds into the run?

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III. Evaluating Expressions with Multiple Variables

A. Evaluate the expression for the variables to solve each problem.

1. Seth went to Leonard's Laughs to purchase funny items to use at a birthday party. He decided to get 2 packs of Googly Eyes, 3 pairs of Creepy Glasses, and 1 bag of Fake Ants. The expression $m - (2a + 3b + c)$ represents the amount of money in dollars Seth will have left after his purchases, where m represents the amount of money he gives the cashier in dollars, a represents the cost of a pack of Googly Eyes in dollars, b represents the cost of a pair of Creepy Glasses in dollars, and c represents the cost of a bag of Fake Ants in dollars.
2. A museum gift shop sells popcorn in containers shaped like the great Pyramid at Giza. The expression $\frac{1}{3}Bh$ represents the volume of a pyramid in cubic inches, where B represents the area of the base of the pyramid in square inches and h represents the height of the pyramid in inches.

What is the volume of a pyramid container if the area of its base is 100 square inches and its height is 5 inches?

How much will Seth have left if he gives the cashier \$9, the Googly Eyes are \$0.80 per pack, the Creepy Glasses are \$1.30 per pair, and the Fake Ants are \$2.50 a bag?

- 3.** In basketball, players can score 3-pointers by successfully shooting a basket from outside the three-point line. Players can score 2-points by successfully shooting a basket from inside the three-point line. The expression $3x + 2y$ represents the number of points a player scores where x is the number of successful baskets from outside the three-point line and y is the number of successful baskets from inside the three-point line.
- 4.** Admission to a museum is \$7.10 per adult and \$4.80 per child. The expression $7.1a + 4.8c$ represents the total cost in dollars for admission for a adults and c children.

If Oscar successfully made 5 shots from outside of the three-point line and 9 shots from inside of the three-point line, how many points did he score for his team?

If 6 adults and 6 children attend the museum, what is the total cost?

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5. In California, when customers return empty glass and plastic bottles or jars to redemption centers, they are refunded money. Customers are refunded 5 cents on bottles that hold less than 24 ounces and 10 cents on bottles that hold at least 24 ounces. The expression $5s + 10m$ represents the total refund in cents when s is the number of less than 24-ounce bottles returned and m is the number of at least 24-ounce bottles returned.

If Ethan returns 5 bottles that hold less than 24 ounces and 10 bottles that hold more than 24 ounces, what will be his total refund?

6. A few homeowners with overgrown woods in their back yards were asked to donate some of their smaller trees for transplanting in a local community area. The contributing homeowners live in Berkshire and Roxbury. The community area already has ten trees. The expression $ax + by + 10$ represents the total number of trees the community area will have after transplanting, where a represents the number of contributing homeowners in Berkshire, x represents the number of trees donated per homeowner in Berkshire, b represents the number of contributing homeowners in Roxbury, and y represents the number of trees donated per homeowner in Roxbury.

How many trees will the community area have after transplanting six trees from each of seven homeowners in Berkshire and three trees from each of seven homeowners in Roxbury?

7. A city planning committee recycles used tires to create walking paths in city parks. Tire manufacturers donated several tons of scrap tire material from a warehouse location. Tire service companies contributed 2.7 times the amount that the manufacturers donated. The planners also collected donations from local citizens. Junkyards donated about 2.7 fewer tons of tires than the citizens. The expression $w + 2.7w + c + (c - 2.1)$ represents the total tons of tires collected, where w represents the tons of tires at the warehouse location, and c represents the tons of tires donated by the citizens.

How many tons of tires were collected if there were 7.1 tons of tires in the warehouse location and 7.1 tons of tires donated by citizens?

8. Each of the last 2 years, Orpheus lost his phone x times and his eReader y times. This year he lost his new tablet z times, and the year is not even over yet. The total number of times he lost his stuff can be shown as $2(x + y) + z$.

If he lost his phone twice each year, his eReader twice each year, and his tablet 6 times already, how many times has Orpheus lost his stuff?

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9. For a new Native American Museum, an architect designs a building in the shape of a cone. The expression $1.1(r \cdot rh)$ represents the estimated volume of the building in cubic meters, where r represents the radius of the building in meters and h represents the building's height in meters.

What is the estimated volume of the building in cubic meters if its radius is 7.5 meters and its height is 10.1 meters?

10. Mako's basketball team made several two-point baskets, three-point baskets, and free-throw baskets during the first quarter of Friday night's game. The expression $2x + 3y + z$ represents the total points earned during the first quarter, where x represents the number of two-point baskets, y represents the number of three-point baskets, and z represents the number of free-throw baskets.

How many points did Mako's team earn during the first quarter of Friday night's game if there were three two-point baskets, three three-point baskets, and six free-throw baskets?

IV. Modeling Equivalent Algebraic Expressions

A. Write an algebraic expression to represent each model.

1.



2.



3.



4.



5.



6.



B. Write an algebraic expression to represent each model. Then, if possible, combine like terms to simplify the expression.

1.



2.



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3.



4.



5.



6.



V. Exploring the Distributive Property with Algebraic Expressions

A. Write a multiplication expression to represent each model.

1.



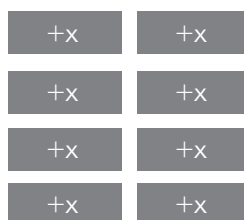
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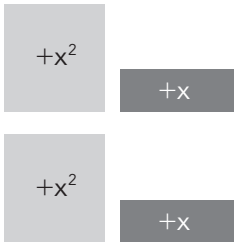
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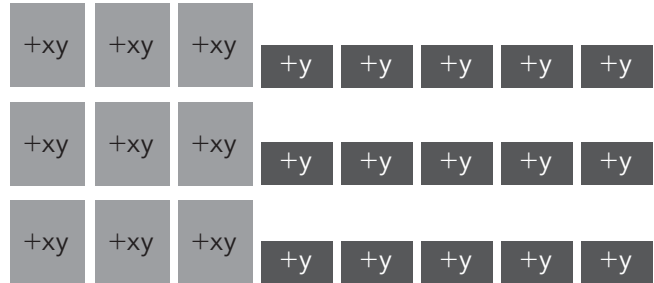
4.



5.



6.



B. Write an equivalent expression for each without grouping symbols.

1. $4(2x)$

2. $3(5x + 2)$

3. $10(x + 1)$

4. $5(2y)$

5. $2(x^2 + x)$

6. $2(3xy + 5y)$

7. $6(8xy)$

8. $7(2y + 3)$

9. $8(3xy + 5y)$

10. $5(2y^2 + 7)$

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11. $3(4x + 9y)$

12. $2(x^2 + 8xy + y^2)$

C. Write each expression as a product of two expressions.

1. $4x + 2$

2. $12x + 8$

3. $10 + 15x$

4. $12 + 9x$

5. $18x + 12$

6. $32 + 20x$

7. $54 + 24x$

8. $36x + 21$

9. $3x + 30$

10. $88 + 55x$

11. $25x + 100$

12. $16 + 48x$

VI. Simplifying Algebraic Expressions

A. Simplify each expression completely.

1. $7 \times 3 + 6x \div 2 + 8$

2. $4 \times 3x + 5 \div 1 - x$

3. $3 + 6(3x + 3)$

4. $7x + 6 \div 6 + 2x$

5. $6x + 3 \div 8 - 4x$

6. $4x(4 + 3)$

7. $2x \cdot 4 + 4x \cdot 5$

8. $3x + 5x(5 - 5)$

9. $2 + 8(9 + 4x)$

10. $9x \cdot 2 + 5 \div 3 - 9x$

11. $2 \times 7 + 3x \div 8 + 8$

12. $3(5x - 2x \cdot 2)$

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VII. Patterns and One-Step Expressions

A. Solve each problem.

1. The amount of time that a United States \$1 bill stays in circulation is called its lifespan. The average lifespan of a \$1 bill is 21 months.

Complete the table. Then define a variable for the time that a \$1 bill has been in circulation and use this variable to write an expression for the time remaining in its lifespan.

Time in Circulation (months)	Time Remaining in Lifespan (months)
9	
15	
20	

3. Matthew feeds his horse 10 pounds of hay per day.

Complete the table. Then define a variable for the time Matthew feeds his horse and use this variable to write an expression for the amount of hay fed to Matthew's horse.

Time Feeding Horse (days)	Hay Feed to Horse (pounds)
3	
7	
23	

2. Enrique is an aspiring painter, and he currently has 14 paintings in his art gallery. He creates 1 new painting every month to add to his collection.

Complete the table. Then define a variable for the amount of time Enrique paints and use this variable to write an expression for the number of paintings in his collection.

Time Painting (months)	Number of Paintings
6	
9	
10	

4. Part of your job at Felix's Shoe Store is organizing deliveries. You notice a strange pattern that the number of boxes of shoes delivered for a particular shoe size is 8 more than the shoe size.

Complete the table. Then define a variable for the shoe size and use this variable to write an expression for the number of boxes.

Shoe Size	Number of Boxes
5	
9	
11	

5. The Springfield Football League needs to order new jerseys. They order seven more medium-sized jerseys than large-sized jerseys.

Complete the table. Then define a variable for the number of large jerseys and use this variable to write an expression for the number of medium jerseys.

Large Jerseys	Medium Jerseys
7	
10	
15	

6. Shane won a gift card for music downloads from a raffle drawing. He allows his brother to download 3 songs using his gift card.

Complete the table. Then define a variable for the number of songs initially on the gift card and use his variable to write an expression for the number of songs left on the gift card.

Songs on Gift Card	Songs Left
19	
17	
12	

7. The NCAA allows each Division I school to offer 12 softball scholarships per year.

Complete the table. Then define a variable for the number of schools and use this variable to write an expression for the number of scholarships.

Number of Schools	Number of Scholarships
6	
8	
13	

8. A small wind farm opens to create energy starting with 15 wind turbines. Each month they add another turbine.

Complete the table. Then define a variable for the time adding wind turbines and use this variable to write an expression for the number of turbines.

Time Adding Turbines (months)	Number of Turbines
12	
24	
48	

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- 9.** Emilia is excited because she just scored a cleaning job at the local motel. She will be working five days a week, and there are twenty-five rooms to be dusted, mopped, and vacuumed each day.

Complete the table. Then define a variable for the time Emilia works and use this variable to write an expression for the number of rooms cleaned.

Time Worked (days)	Rooms Cleaned
5	
30	
40	

- 11.** Wetlands help filter water and provide homes to many species. The Pine Barrens of New Jersey are protected wetlands. A section of the Pine Barrens has 43 inches of water on it when it starts to rain. The rain adds 1 inch of water to the wetlands every day.

Complete the table. Then define a variable for the amount of time it rains and use this variable to write an expression for the depth of the water.

Time Raining (days)	Depth of Water (inches)
7	
14	
21	

- 10.** Belita and Lucy are going shopping with the money they earned babysitting. Lucy has \$14 less than Belita to spend.

Complete the table. Then define a variable for Belita's money and use this variable to write an expression for Lucy's money.

Belita's Money (dollars)	Lucy's Money (dollars)
75	
68	
54	

- 12.** Many people invest in stocks so they can get income from their investment when they are older. Blue chip companies are generally safer stock investments than others because they maintain stable and reliable growth over time. Dontrell wants to invest in a blue chip company. Each share costs \$21.

Complete the table. Then define a variable for the number of shares and use this variable to write an expression for the cost of the shares.

Number of Shares	Cost (dollars)
6	
10	
13	