3.1 Build Algebraic Models Using Concrete Materials

Principles of Mathematics 9, pages 104–109

A

1. Use algebra tiles to represent each area.

  a) 4 square units

  b) 9 square units

  c) $2x^2$ square units

  d) $4x^2$ square units

2. Use tiles to model each algebraic expression.

  a) $x^2 + 5x$

  b) $3x^2 - 4x$

  c) $2x^2 + 3x + 4$

  d) $x^2 - 5x - 3$

3. Write the algebraic expression represented by each model.

  a)

  b)

  c)

  d)

4. Each unit tile represents 1 m that Jacinth walked on a hike. Find each distance.

  a)

  b)

  c)

  d)

  e)

B

5. a) Build an area model to represent a square with length and width both equal to 5 cm. Sketch the model and label the length and width.

  b) What is the area? Write this as a power.

6. a) Build a volume model to represent a cube with length, width, and height all equal to 3 cm. Sketch the model and label the length, width, and height..

  b) What is the volume? Write this as a power.

7. a) Build a volume model to represent a cube with length, width, and height all equal to 5 cm. Sketch the model and label the length, width, and height.

  b) What is the volume? Write this as a power.

  c) Write an expression for the area of one face as a power. Evaluate the area of one face.

8. The area of one face of a cube is 64 cm^2.

   a) What side length of the cube would give this area?

   b) Determine the volume of the cube. Write this as a power.

9. **a)** A cube has a volume of 125 cm^3. Find the total surface area of all six faces.

   b) A cube has a volume of 343 cm^3. Find the total surface area of all six faces.

10. The total surface area of all six faces of a cube is 96 cm^2.

   a) Determine the area of one face of the cube.

   b) What side length of the cube would give this area?

   c) Determine the volume of the cube. Write this as a power.

11. Use tiles to build an area model that has length and width as indicated.

   a) length = x, width = $x + 2$

   b) length = $x + 1$, width = $x + 3$

   c) length = $x + 4$, width = x

   d) length = $x + 2$, width = $x + 3$

C

12. Two cubes have a total volume of 72 cm^3. Both cubes have whole-number side lengths.

   a) Find the side length of each cube.

   b) Find the total surface area of both cubes.

13. What is the final digit in the number 2687^{398}? Hint: First compute 7^1, 7^2, 7^3, 7^4, 7^5, ..., until you see a pattern. Why are the final digits of these numbers the same as the final digits of 2687^1, 2687^2, 2687^3, ...?

3.2 Work With Exponents
Principles of Mathematics 9, **pages 110–118**

A

1. Write each as a power.
  a) $5 \times 5 \times 5 \times 5 \times 5 \times 5$
  b) $(-3) \times (-3) \times (-3) \times (-3)$
  c) $2.03 \times 2.03 \times 2.03 \times 2.03 \times 2.03$
  d) $\left(-\dfrac{2}{3}\right) \times \left(-\dfrac{2}{3}\right) \times \left(-\dfrac{2}{3}\right)$

2. Write each power in expanded form.
  a) 2^4 **b)** $(-4)^5$
  c) 0.7^3 **d)** $\left(-\dfrac{3}{4}\right)^2$

3. Evaluate.
  a) 2^3
  b) $(-4)^2$
  c) -4^2
  d) $(-6)^3$
  e) $\left(\dfrac{3}{4}\right)^4$

4. Evaluate.
  a) $\left(-\dfrac{2}{3}\right)^3$
  b) 2.3^3
  c) 1^5
  d) $(-1)^{99}$
  e) -1^{28}

5. Evaluate. Remember to use the correct order of operations.
  a) $2^3 + 2^4$ **b)** $4^5 - 4^3$
  c) $4^2 \times 2^4$ **d)** $2^6 \div 4^3$

6. Evaluate. Remember to use the correct order of operations.
  a) $2^4 + 2^2 - 2^3$
  b) $2^4 - 2^2 + 2^3$
  c) $(5^2 - 3^2) + (5^2 - 3^2)$
  d) $\left(\dfrac{3}{4}\right)^2 \times \left(-\dfrac{2}{3}\right)^3$
  e) $30(2)^3$
  f) $-5(-3)^2$

7. Substitute the given values into each expression. Then, evaluate the expression. Round your answers to the nearest tenth where necessary.
  a) $5a^2$; $a = 3$
  b) πr^2; $r = 2.5$
  c) $c^2 - b^2$; $b = 5$, $c = 13$
  d) $\dfrac{1}{3}\pi r^2 h$; $r = 6$, $h = 4$
  e) $4\pi r^2$; $r = 1.2$
  f) $x^2 - 3x - 10$; $x = -2$

B

8. a) Evaluate each power.
  3^1 3^2 3^3 3^4 3^5 3^6
  b) Examine the final digit of each of your answers. What pattern do you notice?
  c) Use the pattern that you found in part b) to determine the final digit in the number 3243^{3243}.

9. Staphylococcus aureus is a type of bacteria that can cause dangerous health problems. It doubles every 60 min. The initial population of a sample of Staphylococcus aureus is 200.

a) Copy and complete the table.

Time (min)	Population of Staphylococcus aureus
0	200
60	400
120	
180	
240	

b) Construct a graph of population versus time. Use a smooth curve to connect the points. Describe the shape of the graph.

c) What will the population be after
- 12 h?   • 1 day?

10. Bronchial pneumonia can be caused by the bacterium Streptococcus pneumoniae. The doubling time of Streptococcus pneumoniae is 20 min.

a) Copy and complete the table.

Time (min)	Population of Streptococcus pneumoniae
0	100
20	200
40	400
60	
80	
100	

b) Construct a graph of population versus time. Use a smooth curve to connect the points. Describe the shape of the graph.

C

11. The radius of a hydrogen atom is 0.000 000 6 mm. This number can be written in scientific notation as 6.0×10^{-7}.

a) How many hydrogen atoms placed in a row will make 3 mm?

b) How many balls, each with a diameter of 60 cm, placed in a row would have a length of 3000 km?

12. Iodine-131 is a radioactive isotope of iodine that is used in a sodium salt to diagnose thyroid disease. The half-life of Iodine-131 is 8 days, which means that it takes 8 days for the sample to decay to half its original amount.

a) Suppose you started with a 200-mg sample of Iodine-131. Copy and complete the table.

Number of Half-Life Periods	Time (days)	Amount of Iodine-131 Remaining (mg)
0	0	200
1	8	$200\left(\dfrac{1}{2}\right)^{1} = 100$
2	16	
3		
4		

b) Construct a graph of the amount, in milligrams, of Iodine-131 remaining versus time, in days. Describe the shape of the graph.

c) Approximately how much Iodine-131 will remain after 48 days?

d) How long will it take until only 1 mg of Iodine-131 remains?

13. Write each number in scientific notation.

a) 34 500 000 000

b) 0.000 000 005 12

3.3 Discover the Exponent Laws
Principles of Mathematics 9, pages 119–129

A

1. Apply the product rule to write each as a single power. Then, evaluate the expression.

a) $4^3 \times 4^2$

b) $(-2)^2 \times (-2)^4$

c) $2.5^3 \times 2.5^3$

d) $(-1)^{15} \times (-1)^{25}$

e) $\left(\dfrac{2}{3}\right)^4 \times \left(\dfrac{2}{3}\right)^3$

f) $\left(-\dfrac{3}{5}\right)^2 \times \left(-\dfrac{3}{5}\right)^3$

2. Apply the quotient rule to write each as a single power. Then, evaluate the expression.

a) $8^5 \div 8^3$

b) $(-5)^4 \div (-5)$

c) $3.2^5 \div 3.2^2$

d) $(-1)^{35} \div (-1)^{20}$

e) $\left(\dfrac{3}{4}\right)^6 \div \left(\dfrac{3}{4}\right)^3$

f) $\left(-\dfrac{2}{5}\right)^5 \div \left(-\dfrac{2}{5}\right)^3$

3. Apply the power rule to write each as a single power. Then, evaluate the expression.

a) $(5^3)^2$

b) $(-4^3)^2$

c) $(0.2^2)^3$

d) $(-1^6)^3$

e) $\left[\left(\dfrac{1}{5}\right)^2\right]^2$

f) $\left[\left(-\dfrac{5}{6}\right)^3\right]^2$

4. Simplify using the exponent laws. Then, evaluate.

a) $3^2 \times 3^4 \times 3^1$

b) $4^5 \div 4^2 \div 4$

c) $(2^3)^2 \times (2^2)^3$

d) $(2^6)^3 \div (2^4)^4$

5. Simplify using the exponent laws. Then, evaluate.

a) $3^5 \times 3^2 \div 3^4$

b) $4^6 \div 4^3 \times 4^2$

c) $\dfrac{0.2^4 \times 0.2^3}{(0.2^2)^2}$

d) $\dfrac{(-3)^5 \div (-3)^2}{(-3)^2}$

e) $(6^2)^5 \times (6^3)^5 \div (6^5)^3$

f) $[(-5)^2]^3 \div (-5)^4 \times (-5)^2$

6. Simplify.

a) $x^5 \times x^3$

b) $y^8 \div y^6$

c) $(m^4)^3$

d) $(d^2)^4$

e) $a^3 b \times a b^3$

f) $c^5 d^4 \div c d$

B

7. Simplify.

a) $3x^3 y^2 \times 5x^4 y^3$

b) $8a^5 b^3 \div 4ab^2$

c) $(2m^3 n^2)^4 \div (-4mn)^2$

d) $(-c^3)^2 \times (-2c)^3$

8. Simplify.

a) $\dfrac{3d^4 m^3 \times 8d^2 m^5}{2d^2 m^2 \times 6d^3 m^2}$

b) $\dfrac{2g^2 h^3 \times (-3g^2 h^2)^2}{3gh \times 6g^2 h^2}$

c) $\dfrac{33x^5 y^7 \div 11xy^2}{12x^5 y^3 \div 4x^2 y^2}$

9. Consider the expression $\dfrac{3x^3 y \times 6xy^3}{(-3xy)^2}$.

   a) Substitute $x = -1$ and $y = 2$ into the expression. Then, evaluate the expression.

   b) Simplify the original expression using the exponent laws. Then, substitute the given values and evaluate the expression.

   c) Describe the advantages and disadvantages of each method.

10. The probability of tossing tails with a standard coin is $\dfrac{1}{2}$, because it is one of two possible outcomes. The probability of tossing four tails in a row is

   $\left(\dfrac{1}{2}\right)^4$ or $\dfrac{1}{16}$.

   a) What is the probability of tossing
   - 9 tails in a row?
   - 12 tails in a row?

   b) Write each answer in part a) as a power of a power.

11. a) What is the probability of rolling a 5 with a standard number cube?

   b) What is the probability of rolling five 5s in a row with a standard number cube?

   c) What is the probability of rolling a prime number with a standard number cube?

   d) What is the probability of not rolling a 2 with a standard number cube?

12. A triangular pyramid has the numbers 1, 2, 3, and 4 on its sides.

   a) What is the probability of rolling a 3?

   b) What is the probability of rolling four 3s in a row? Write as a power. Then, evaluate the expression.

   c) What is the probability of rolling seven 3s in a row? Write as a power. Then, evaluate the expression.

C

13. Evaluate each of the following. Express each answer in scientific notation and then in standard notation.

   a) $4 \times 10^4 \times 2 \times 10^3$

   b) $1.4 \times 10^3 \times 5 \times 10^2$

   c) $(8 \times 10^9) \div (4 \times 10^5)$

   d) $(4.6 \times 10^{11}) \div (2 \times 10^9)$

14. If $x^3 = \dfrac{1}{8}$, place the following values in order from least to greatest:

   $x, x^2, \dfrac{1}{x}, \dfrac{1}{x^2}$

15. a) Predict the screen output of your scientific or graphing calculator when you enter the following calculations: $(4 \times 10^9) \div (8 \times 10^5)$.

   b) Is the answer what you predicted? Explain the answer that the calculator provided.

3.4 Communicate With Algebra
Principles of Mathematics 9, pages 130–139

A

1. Identify the coefficient and the variable part of each term.

   a) $3x$

   b) $-5y$

   c) dm

   d) $-4ab$

2. Identify the coefficient and the variable part of each term.

   a) $-w^3y^2$

   b) $-0.2e^5f$

   c) $\dfrac{2}{3}x^5$

   d) $-\dfrac{3}{8}y^4$

3. Classify each polynomial by the number of terms.

   a) $4x^3$

   b) $-5ab + c$

   c) $7a^6 + b^5 - 10$

   d) $-3m^7 n^4$

   e) $x^2 - 3x + 4$

   f) $x^2 - y$

4. State the degree of each term.

   a) $6x$

   b) $-5x^3$

   c) $7y$

   d) u^5v^3

   e) $0.4m^3n$

   f) $\dfrac{2}{3}x^3y^5$

   g) 5

   h) -3

5. State the degree of each polynomial.

   a) $2x + 5$

   b) $a^2 - 3a - 5$

   c) $d + 3e^3$

   d) $m^4n^3 - 6m^5n^4$

   e) $3xy + \dfrac{1}{2}x^3y^2$

   f) $4x^2y^3 - \dfrac{2}{5}x^5y^3$

6. A soccer team earns 2 points for a win and 1 point for a tie. Let w represent the number of wins and t represent the number of ties. Write an expression that describes the team's total points.

B

7. The students at Northdale High School sell coupon books to raise money for a school trip. The school receives 45% of the money paid for the coupon books.

a) Choose a variable to represent the money paid for the coupon books.

b) Using your variable from part a), write the expression for the amount of money the school will receive.

c) Shannon sold one coupon book to her grandmother for $20. Calculate the amount of money the school receives on this sale.

d) The sum of all coupon book orders was $14 000. Use your formula to calculate how much the school will receive for this fundraiser.

8. In a basketball game, each player on the team receives 2 points for a basket and 1 point for a free throw.

a) Write an expression to represent a player's total score for the game.

b) In the game, Mohamed scored six baskets and five free throws. Use your expression to find Mohamed's total score.

9. On a multiple-choice test, you earn 1 point for each correct answer and lose 2 points for each incorrect answer.

a) Write an expression for a student's total score.

b) Tim answered 22 questions correctly and 3 incorrectly. Find Tim's score.

10. Elizabeth has a summer job at a camera store. She earns a $10 bonus for each gold membership and a $5 bonus for each silver membership.

a) Write a polynomial expression that describes Elizabeth's total bonus.

b) Identify the variable and the coefficient of each term and explain what they mean.

c) How much will Elizabeth's bonus be if she sells 20 gold memberships and 30 silver memberships?

11. A theatre charges $80 for orchestra seats, $50 for dress circle seats, and $25 for balcony seats.

a) Write an expression that describes the total earnings from seat sales.

b) Identify the variable and the coefficient of each term and explain what they mean.

c) How much will the theatre earn if it sells 100 orchestra seats, 200 dress circle seats, and 150 balcony seats?

d) How much with the theatre earn if it sells 80 orchestra seats, 250 dress circle seats, and 200 balcony seats?

C

12. Protect-a-Boat Insurance Company charges $400 for liability, plus 15% of the value of the boat, plus $200 per passenger.

a) Write an expression to model the insurance cost.

b) Find the cost of insurance for a $120 000 boat that can carry 60 passengers.

13. Judy is training for an Ironman triathlon race. During her training program, she finds that she can swim at 1.5 km/h, cycle at 30 km/h, and run at 12 km/h. To estimate her time for an upcoming race, Judy rearranges the formula distance = speed × time to find that

$$\text{time} = \frac{\text{distance}}{\text{speed}}.$$

a) Choose a variable to represent the distance travelled for each part of the race. For example, choose c for cycle.

b) Copy and complete the table. The second row is done for you.

Part of the Race	Speed (km/h)	Distance (km)	Time (h)
swim			
cycle	30	c	$\dfrac{c}{30}$
run			

c) Write a trinomial to model Judy's time.

d) The upcoming Ironman race is a triathlon composed of a 3.8-km swim, a 180.2-km cycle, and a full marathon run of 42.2 km. Using your expression from part c), calculate how long it will take Judy to finish the race.

3.5 Collect Like Terms
Principles of Mathematics 9, pages 144–153

A

1. Classify each pair of terms as either like or unlike.

a) $5x$ and $-4x$

b) $4a$ and $4b$

c) $-x^3$ and $-3x$

d) $5m^2$ and $4m^2$

e) $4xy$ and $3yx$

f) $4a^2b$ and $-3ab^2$

2. Write two like terms for each.

a) $10d$

b) $-m$

c) $5a^2$

d) $-4ab$

e) $4x^2y^2$

f) 8

3. Copy the two columns of terms into your notebook. Connect each term in the first column with the like term in the second column.

$5x$	$-3a^2b^2$
$-3mn$	$2x^3$
8	$-3x$
$4a^5$	-5
$-2x^3$	$5mn$
$6a^2b^2$	$7a^5$

4. Simplify by collecting like terms.

a) $5x + 2 + 3x + 4$

b) $4y + 5 - 2y - 3$

c) $4m - 3 - m + 4$

d) $6n - 4 - 5n - 2$

e) $3x^2 + 5 + 2x^2 + 4$

f) $7a + 3b - 4a - 5b$

5. Simplify.

a) $3x^2 + 5x + 4x^2 + 2x$

b) $5a - 1 + 3 - 2a - 4 - a$

c) $4m^2 + 3m + 2 - 2m^2 - 5m - 3$

d) $5w^3 + 4w^2 - 3w - w^3 + 2w^2 + 2w$

6. Simplify.

a) $3a^2 - 2ab - 2b^2 - 2a^2 - ab + b^2$

b) $2m^3n^2 + 3m^2n^3 - m^3n^2 - 2m^2n^3$

c) $-4x^2y + 5x - 3 - 3x^2y - 8x + 5$

d) $5r^4 + 3r^2 - 4 + 2r^4 - 2r^2 + 1$

B

7. The length of a rectangular garden is five times its width.

a) Write an expression for the perimeter of the garden.

b) Find the perimeter if the garden is 20 m wide.

c) Find the length and width if the perimeter is 180 m.

d) Write an expression for the area of the garden.

e) Find the area if the garden is 30 m wide.

f) Find the length and width if the area is 500 m^2.

8. Use algebra tiles, virtual algebra tiles, or a diagram to model and simplify each expression.

a) $2x + 3 + 4x + 1$

b) $5y + 2 - 3y - 1$

c) $2c^2 + 3c + 4c^2 - 4c$

9. A square has an unknown side length, x.

   a) Write a simplified expression for its perimeter.

   b) Write a simplified expression for its area.

   c) If the area of the square is 25 m^2, find the perimeter of the square.

10. Kathe's Kitchen Stores estimates its profits at its five stores for the next x months as follows.

Store	Profit ($)
North End	$1500x - 3200$
South End	$1300x - 900$
West End	$2150x - 1100$
East End	$1700x - 5000$
Central	$1850x - 800$

   a) Copy the table, and add a column titled **Profit (or Loss) After 2 Months ($)**. Complete the table and find the sum of the profits (or losses).

   b) Write a polynomial representing the total profit (or loss) at all five stores.

   c) Use your polynomial from part b) to calculate the sum of the profits (or losses) from all five stores after 2 months. Compare this to your answer from part a).

   d) Calculate the total profit (or loss) after 1 year.

11. A regular pentagon has an unknown side length, x. Write a simplified expression for its perimeter.

C

12. John simplified the following expression:

$$x^2 + 3x + x^2 + 2x$$
$$= x^4 + 6x^2$$

   a) Describe the error that John made.

   b) How can you convince John that these two expressions are not equal?

   c) Simplify the expression properly. How can you convince John that your answer is correct?

13. When asked his birth year, the 19th-century British mathematician Augustus De Morgan said that he was x years old in the year x^2. In what year was he born?

3.6 Add and Subtract Polynomials
Principles of Mathematics 9, pages 154–159

A

1. Simplify by removing brackets and collecting like terms.

a) $(3x + 2) + (5x + 3)$

b) $(7m - 5) + (3m + 4)$

c) $(-3n + 5) + (n - 4)$

d) $(3k + 2) + (5k + 4) + (2k + 3)$

e) $(6r + 5) + (4r - 1) + (3r - 2)$

2. Simplify by adding the opposite polynomial.

a) $(3x + 5) - (2x + 3)$

b) $(7m + 4) - (3m + 3)$

c) $(5s - 2) - (3s + 5)$

d) $(4d - 5) - (2d - 3)$

e) $(3r + 7) - (2r - 5)$

f) $(6t - 5) - (3t + 7)$

3. Simplify.

a) $(3x + 5) + (4x - 3)$

b) $(5y - 4) + (7y - 3)$

c) $(4p^2 + 8p + 2) + (2p^2 - 3p - 4)$

d) $(6m^2 - 5mn - 5n^2) - (m^2 + mn - 4n^2)$

e) $(4a + 5b) + (2a - 3b) - (3a - b)$

f) $(3p^2 - 2p) + (3p + 5q) - (2q - 2p^2)$

B

4. A soccer team gives each player a bonus on top of his or her base salary for every goal the player scores. Data for some of the team's players are given.

Player	Base Salary ($1000s)	Goals
Gerros	60	70
Makaros	50	20
Smith	70	80

a) Find a simplified expression for the total earnings for these three players if b represents the bonus, in dollars.

b) Find the total earnings for these three players when $b = \$300$.

5. Winson is building a dock at his cottage. The length of the dock is twice the width, plus 3 m.

a) Draw a diagram of the dock and label the width and length with algebraic expressions.

b) Find a simplified algebraic expression for the perimeter of the dock.

c) Find an algebraic expression for the area of the dock.

d) If the width of the dock is 2 m, find the perimeter and area of the dock.

6. A group of employees at a shoe store are paid a yearly salary according to the following rate, where n is the amount of sales.

Employee	Fixed Yearly Salary ($)	Commission
Susan	40 000	$0.10n$
Kelvin	35 000	$0.20n$
Jean	25 000	$0.14n$
Luxana	20 000	$0.16n$

a) Write a simplified expression for the total amount paid to the group of employees.

**b)** This table shows the sales achievement levels for the company.

Status	Sales ($)
Silver	50 000
Gold	75 000
Platinum	100 000

Determine the total annual salary for the group if their sales achievement level

• reaches silver status

• reaches gold status

• reaches platinum status

c) Which employee makes the highest salary at each achievement level?

7. Copy and complete the addition cascade.
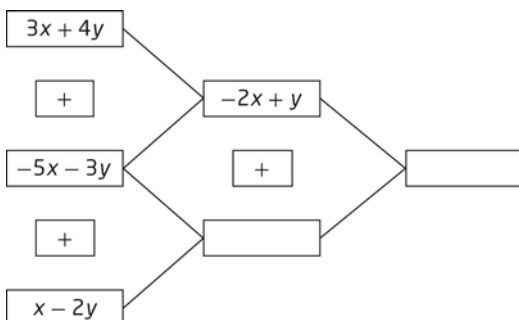
8. Copy and complete the subtraction cascade.
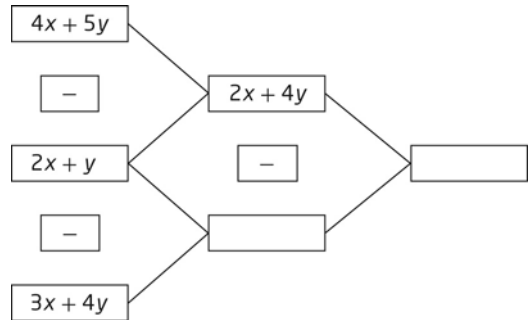
C

9. A women's hockey team gives players a bonus on top of their base salary for every goal and for every assist they score. Data for some of the team's players are given.

Player	Base Salary ($1000s)	Goals	Assists
Cruz	80	35	25
Gortan	60	20	18
McKinnon	100	42	30

a) Write an algebraic expression for the earnings of each of these three players, where g represents the bonus for goals and a represents the bonus for assists.

b) Find a simplified expression for the total earnings for these three players.

c) Find the total earnings for these three players if $g = 200$ and $a = 100$.

10. A group of employees at a store are paid a weekly salary and a commission of 5% of their total weekly sales. The sales for last week are listed in the table.

Employee	Fixed Weekly Salary ($)	Total Sales ($)
Jack	700	10 000
Yaling	650	8 000
Stacia	800	6 500
Meisrain	900	8 500
Janet	1000	5 000

a) Determine the weekly earnings for each employee.

b) Find a simplified expression for the total amount paid to the group of employees, if c represents the commission, expressed as a decimal.

3.7 The Distributive Property
Principles of Mathematics 9, pages 160–169

A

1. Expand, using the distributive property.
- **a)** $3(x + 2)$
- **b)** $4(x - 5)$
- **c)** $-2(x + 4)$
- **d)** $-5(x - 4)$

2. Expand, using the distributive property.
- **a)** $4(2a + 3)$
- **b)** $6(3b - 4)$
- **c)** $-(6m + 5)$
- **d)** $-(4r - 3)$

3. Expand.
- **a)** $x(x + 4)$
- **b)** $a(a - 5)$
- **c)** $z(-z + 3)$
- **d)** $b(-2b + 1)$

4. Expand.
- **a)** $-w(3w + 5)$
- **b)** $-m(3m - 2)$
- **c)** $4q(3q + 7)$
- **d)** $-7d(-2d - 5)$

5. Expand, using the distributive property.
- **a)** $(m + 2) \times 3$
- **b)** $(d - 3) \times 5$
- **c)** $(3h + 5) \times (-2)$
- **d)** $(4r - 1) \times (-3)$

6. Expand, using the distributive property.
- **a)** $(q - 4) \times 5$
- **b)** $(b - 6) \times 7$
- **c)** $(5t + 7) \times (-4)$
- **d)** $(7c - 3) \times (-5)$

7. Expand.
- **a)** $3(x^2 + 5x + 4)$
- **b)** $5(x^2 - 3x + 2)$
- **c)** $4m(m^2 + 3m + 5)$
- **d)** $5a(a^2 + a - 4)$
- **e)** $(x^2 + 7x + 3)(3)$

8. Expand.
- **a)** $(x^2 + x - 1)(-4)$
- **b)** $(a^2 - a + 4)(5)$
- **c)** $(r^2 + r - 5)(-1)$
- **d)** $5[x + 3(x + 2)]$
- **e)** $-4[5(b - 3) - b]$

B

9. Expand and simplify.
- **a)** $5(x + 4) + 3(x - 6)$
- **b)** $3(a - 5) - 2(a + 4)$
- **c)** $0.3(c + 2) + 0.5(2c - 5)$
- **d)** $-4(4d - 3) - 2(3d + 4)$
- **e)** $3k(k + 5) + 4k(k - 3)$

10. An electrician charges $75 per visit plus $25/h for house calls.
- **a)** Write an algebraic expression that describes the service charge for one household visit.
- **b)** Use your expression to find the total service charge for a 3.5-h repair job.
- **c)** Suppose all charges are double for evenings, weekends, and holidays. Write a simplified expression for these service charges.
- **d)** Use your simplified expression from part c) to calculate the cost for a 3.5-h repair job on the weekend. Does this answer make sense?

11. Expand and simplify.

   a) $-0.4h(3h - 2) - 0.3h(2h + 3)$

   b) $3(a + 2) + 5(a - 3) - 2(a + 4)$

   c) $4(r - 3) - 3(r + 2) + 2(r - 5)$

   d) $3a(2a + 3) + 4(a^2 + 2a - 4)$

   e) $5g(2g - 3) - 3(2g^2 - 4g + 3)$

12. A room has dimensions as shown.

$3x$

$4x + 3$
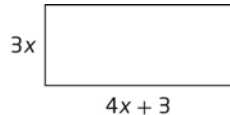
   a) Find a simplified expression for the perimeter.

   b) Find a simplified expression for the area.

   c) Repeat parts a) and b) if both the length and width are doubled.

   d) Has this doubled the perimeter? Justify your answer.

   e) Has this doubled the area? Justify your answer.

13. The formula for the surface area of a rectangular prism is
$SA = 2(lw + hw + lh)$. Apply the distributive property to write this formula in another way.

14. Expand and simplify.

   a) $\dfrac{1}{4}(8x + 3) + \dfrac{1}{3}(6x + 2)$

   b) $\dfrac{1}{5}(-5a + 2b) - \dfrac{3}{4}(4a - b)$

   c) $\dfrac{2}{3}(3m + 5) + \dfrac{2}{5}(5m - 4)$

   d) $\dfrac{1}{2}(6a - 5c) - \dfrac{1}{3}(6a + 4c)$

C

15. Expand and simplify.

   a) $3x[x + 4(x + 2)]$

   b) $4m[3m - 2(m - 5)]$

   c) $2a[3a(a + 4)] - a(2a - 3)]$

   d) $4[3 - 2(b + 1)] + 3[4 - 2(b + 1)]$

   e) $-2[4 - (y - 4)] - 3[2 + (y - 3)]$

   f) $-3[2c + (c + 3)] + 2[3c - (c - 2)]$

16. Expand and simplify.

   a) $(x + 3)(x + 4)$

   b) $(a + 5)(a + 6)$

   c) $(b + 7)(b + 3)$

   d) $(w + 2)(w + 8)$

   e) $(d + 5)(d - 2)$

17. Expand and simplify.

   a) $(z + 3)(z - 6)$

   b) $(m - 4)(m + 5)$

   c) $(y - 5)(y + 3)$

   d) $(h - 4)(h - 8)$

   e) $(p - 3)(p - 3)$

18. Expand and simplify.

   a) $(x + 2)(x^2 + 3x + 4)$

   b) $(y + 3)(y^2 - 4y - 5)$

Chapter 3 Review
Principles of Mathematics 9, **pages 174–175**

1. Use algebra tiles to build a model for each situation. Write an algebraic expression to represent the model.
   a) Sheila swam 5 km.
   b) Ursula walked an unknown distance, three times.
   c) Tasnia drove 5 km plus an unknown distance.
   d) Susu read a book twice.

2. a) Build a volume model to represent a cube with side length 4 cm. Sketch the model and label the length, width, and height.
   b) What is the volume of the cube? Write this as a power.
   c) Write an expression for the area of one face of the cube as a power. Evaluate the area of one face.
   d) Write an expression for the surface area of the cube. Evaluate the surface area of the cube.

3. Evaluate.
   a) 5^3
   b) $(-2)^6$
   c) $\left(\dfrac{3}{4}\right)^3$
   d) 1.06^5

4. Write as a single power. Then, evaluate the expression.
   a) $3^2 \times 3^3 \times 3$
   b) $5^6 \div 5 \div 5^2$
   c) $4^6 \div 4^5 \times 4^2$
   d) $2^3 \times 2^5 \div 2^4$
   e) $[(-3)^2]^3$
   f) $\dfrac{(5^4)^3}{5^5 \times 5^4}$

5. E. coli is a type of bacteria that can cause dangerous health problems. It doubles every 20 min. The initial population of a sample of E. coli is 400.
   a) Copy and complete this table.

Time (min)	Population of E. coli
0	400
20	800
40	
60	
80	
100	
120	

   b) Construct a graph of population versus time. Use a smooth curve to connect the points. Describe the shape of the graph.
   c) What will the population be after
   • 5 h?   • 8 h?

6. Simplify.
   a) $a^5b^4 \times a^3b^2$
   b) $\dfrac{d^6 \times d^5}{d^7}$
   c) $\dfrac{m^{10}}{m^3 \times m^5}$
   d) $\dfrac{(y^6)^3}{(y^5)^2}$

7. Identify the coefficient and variable part of each term.
   a) $6x$
   b) $-5y$
   c) 7
   d) $4a^5b^3$
   e) dm
   f) $\dfrac{2}{3}x^2y^3$

8. In a hockey tournament, teams are awarded 4 points for a win and 2 points for an overtime win.

   a) Write an expression that describes the number of points a team has.

   b) Use your expression to find the number of points earned by a team that has five wins and two overtime wins.

9. State the degree of each term.

   a) $5x^4$

   b) $-7m^5$

   c) a^3b^2c

   d) 5

10. State the degree of each polynomial.

   a) $5x + 4$

   b) $3y^4 - 2$

   c) $5m^2 + 3m + 6$

   d) $6a^3 - 5a^2 + 4a - 3$

11. Classify each pair of terms as either like or unlike.

   a) $3x$ and $-7x$

   b) $4y$ and $5z$

   c) $4ab$ and $-2ab$

   d) $3x^2y$ and $4xy^2$

   e) $5xy$ and $3yx$

   f) $5m^2$ and $8m^2$

12. Identify the like terms in each set.

   a) $5a^2$, $-3b$, $2d$, $6x^2$, $7b^3$, $-5x^2$, $4a$, $6c$

   b) $6y^2$, $5y^2$, $-4y^3$, 3, $-4y^2$, $-2y^3$

13. Simplify by collecting like terms.

   a) $3x + 5y + 4x + 6y$

   b) $5d + 3m - 4d - 5m$

   c) $2a^2 - 5a + 3 - a^2 + 2a - 6$

   d) $3w^2 + 2wy - y^2 - 2w^2 - 2wy + 4y^2$

   e) $4d - 8e - 6f + 3d + 5e - 10f$

   f) $6a^3 - 4ab + 5b^2 - 3 + 5a^3 - 3ab$

14. Simplify.

   a) $(5x + 3) + (6x - 4)$

   b) $(4y - 3) + (5y - 2)$

   c) $(3p^2 + 5p + 4) + (7p^2 - 4p - 3)$

   d) $(4m^2 - 3mn - 2n^2) - (m^2 + mn - 5n^2)$

   e) $(6a + 8b) + (3a - 4b) - (5a - 3b)$

15. A rectangular cake has dimensions $4x$ by $3x + 2$. Find a simplified expression for its perimeter.

16. Expand.

   a) $5(x + 2)$

   b) $-4(y - 3)$

   c) $2m(3m + 4)$

   d) $-4g(2g - 3)$

17. Expand and simplify.

   a) $4(2x + 3y) + 5(3x + 6y)$

   b) $3(4y - 2w) - 3(2y + 1)$

   c) $4(3a + 2b) + 3(2a - 3b) - (a + 2b)$

   d) $-4[3 - 2(c + 5) - 4c]$