Math 9: 5.1 The Language of Mathematics

3. Give two examples of a polynomial that satisfies all statements.
   • consists of two terms
   • contains two variables
   • has degree 2
   • one term is of degree 1 and has a coefficient of 1

4. When is it acceptable not to write the 1 in an algebraic expression?
   When must you write the 1? Give examples.

Practise
For help with #5 to #7, refer to Example 1 on page 176.
5. For each expression, identify the number of terms and whether the expression is a monomial, binomial, trinomial, or polynomial.
   a) $3x^2 - 5x - 7$
   b) $-11a$
   c) $c^2 + cf + df - f^2$
   d) 8

6. What is the number of terms and what is a name for each expression?
   a) $n$
   b) $6 + 4x - x^2$
   c) 0
   d) $p^2 + 3pq$

7. Refer to the polynomials below to answer each question.
   
   For help with #8 to #10, refer to Example 2 on pages 176–177.

8. For each polynomial, what is the degree and number of terms?
   a) $4 - b$
   b) $fg + 2g$
   c) $8x^2 - xy - y^4$

9. State the degree and number of terms for each polynomial.
   a) $3xy + 1$
   b) $11k^2 + 7k - 5$
   c) 6

10. Refer to the polynomials below to answer each question.

   
   For help with #11 to #14, refer to Example 3 on page 177.

11. What expression is represented by each set of algebra tiles?

12. Write the expression represented by each set of algebra tiles.

13. Model each polynomial.
   a) $x^2 + x - 1$
   b) $3x + 2$
   c) $-2x$

14. Use a model to represent each polynomial.
   a) $-x^2 + 3$
   b) $2x^2 - 3x$
   c) $8$

Apply
15. Represent each of the following with a diagram and an expression.

   - binomial
   - monomial of degree 1
   - monomial of degree 2 with a coefficient of 9
   - polynomial with four terms that is of degree 2

16. Use your knowledge of algebra tiles to answer the following questions.
   a) How are the dimensions of a 1-tile and an x-tile related?
   b) The rectangle shown was formed using an x^2-tile and three x-tiles. What is an expression for the length of the rectangle?

17. Write an algebraic expression for each of the following.
   a) the product of 6 and x
   b) the sum of 2x and 3
   c) the length of the rectangle below, which is made from algebra tiles

18. Make a model of an algebraic expression that includes at least one x^2-tile, at least two x-tiles, and two 1-tiles. Use materials or a diagram. Then, use symbols to show your expression. What type of polynomial is it?

19. For the polynomial $6x^2 - 5$, state the following.
   a) number of terms
   b) coefficient of the first term
   c) number of variables
   d) degree of polynomial
   e) constant term

20. Let $x^2$ represent x, $x$ represent 1, and $-1$ represent negative quantities. The diagrams shown.
   a) What is an expression for the polynomial shown?
   b) Make up a trinomial. Draw diagrams to represent your trinomial.

21. Write each statement as an algebraic expression. Include what your variables represent.
   a) Eight and a number are added together.
   b) Omar has some money in his wallet. How much money does he have after a friend gives him $5?
   c) A page is 4 cm longer than its width. The product of a number and 5 is increased by 2.
   d) The result of 3 times the number of people decreased by 21.
   a) $3x + 5$
   b) $10 - x$

22. Describe a situation that could be modelled by each given polynomial.
   a) $3x + 5$
   b) $10 - x$

A~B: #2-4, 7, 9, 10, 12, 13, 17-19, 21-26 (15, 27-31)*
C+~C-: #2-5, 7, 8, 12, 13, 15, 17, 20, 23
Math 9: 5.1 The Language of Mathematics

23. Marion gives French lessons in the evening. She charges $20 for adults and $15 for children. The expression $20a + 15c$ represents her earnings.
   a) What do the variables $a$ and $c$ represent?
   b) How much does Marion make if she gives lessons to four adults and nine children? Show your work.
   c) Write a new expression for Marion’s earnings if she charges $3 more for adults and $2 more for children.

24. Tickets for a school concert are $10 for adults and $5 for students. Write an expression that shows the total income for the school concert. Tell what your variables represent.

25. A hockey league awards teams two points for a win, one point for a shoot-out loss, and no points for a loss in regulation time.
   a) Write an algebraic expression to represent the total points for a hockey team.
   b) What variable(s) did you use? Indicate what each variable represents.
   c) In the first 20 games of the season, Team A had 12 wins and 4 shoot-out losses. How many losses in regulation time did the team have?
   d) What were the total points for Team A?
   e) Team A was tied with Team B after 20 games. However, Team B had a different record than Team A. Show two possible records for Team B. Use your expression to show that the two hockey teams had the same number of total points.

26. A banquet hall can be rented for parties. An expression for the rental cost is $5n + 75$, where $n$ is the number of people.
   a) What type of polynomial is $5n + 75$, and what is its degree?
   b) What could the numbers 5 and 75 represent?
   c) How much does it cost to rent the banquet hall for 150 people?

Extend

27. On a true/false test, there is a penalty for incorrect answers. Miranda’s teacher advises the students not to guess at any of the 25 questions. The teacher awards 2 points for a correct answer, −1 point for a wrong answer, and 0 points if the question is not answered.
   a) Write a polynomial to represent a student’s score on this test.
   b) What are the maximum and minimum scores possible on this test? Explain.
   c) What are all of the possible scores if Miranda got 20 questions correct? Explain.

28. What is the degree of $xy - abx + cdy - qr + prq$?
   a) If $x$, $y$, and $z$ are variables and $a$, $b$, $c$, $d$, $p$, $q$, and $r$ are coefficients?

29. Ricardo draws the following rectangle with dimensions in metres.
   a) What is an expression for the perimeter of the rectangle?
   b) Write an equation showing how the length and width of the diagram would be related if the dimensions given were for a square.
   c) Solve your equation in part b) to find the value of $x$. Show your work.

30. Create a polynomial satisfying the following conditions:
   a) contains three variables
   b) has three terms
   c) is of degree 2
   d) has a constant term, 3

31. Deidra is training for a triathlon. From her training, she knows that she can swim at 1.3 km/h, cycle at 28 km/h, and run at 12 km/h.
   a) Write the formula distance ($d$) = speed ($s$) x time ($t$) using variables of your choice for speed and time. Tell what each variable represents.
   b) What could the numbers 5 and 75 represent?
   c) How much does it cost to rent the banquet hall for 150 people?

Extend

32. A triathlon includes a 1.5-km swim, a 40-km cycle, and a 10-km run. How long will it take Deidra to complete this triathlon? What assumptions are you making?

33. If Deidra could maintain the same speeds, how long would it take her to complete a triathlon that is a 3.8-km swim, 180-km cycle, and 42.2-km run?

34. Create a polynomial satisfying the following conditions:
   a) contains three variables
   b) has three terms
   c) is of degree 2
   d) has a constant term, 3

35. Create a polynomial satisfying the following conditions:
   a) contains three variables
   b) has three terms
   c) is of degree 2
   d) has a constant term, 3

36. Write a trinomial to model Deidra’s total time for a triathlon.

37. A triathlon includes a 1.5-km swim, a 40-km cycle, and a 10-km run. How long will it take Deidra to complete this triathlon? What assumptions are you making?

38. If Deidra could maintain the same speeds, how long would it take her to complete a triathlon that is a 3.8-km swim, 180-km cycle, and 42.2-km run?

39. Write a trinomial to model Deidra’s total time for a triathlon.

40. A triathlon includes a 1.5-km swim, a 40-km cycle, and a 10-km run. How long will it take Deidra to complete this triathlon? What assumptions are you making?

41. If Deidra could maintain the same speeds, how long would it take her to complete a triathlon that is a 3.8-km swim, 180-km cycle, and 42.2-km run?

Web Link

The Ironman Canada Triathlon in Penticton, B.C., involves a 3.8-km swim, 180-km cycle, and 42.2-km run. The times of recent winners are impressive. Top men’s times are around 8 h, ... 9 h. For information about the Ironman Canada Triathlon and about the history of the Ironman competition, go to www.mathlinks9.ca and follow the links.

Math Link

You want to be a contestant on a game show. In order to get on the show, you must show how to spend exactly $100 by choosing from the items shown.

You may purchase some or all of the six items, and as many of a single item as necessary.

a) Find at least six answers that would get you on the game show.

b) Write an algebraic expression for one of your combinations in part a). What is an equation for this same combination?

c) Is it possible to spend $100 choosing all different items? Explain.
Math 9: 5.2 Equivalent Expressions

Check Your Understanding

Communicate the Ideas

1. Using models, show how you know that $x - 5s$ combines to give $-4s$.

2. Jean claimed that $3m^2 + 4m$ could be combined to give $7m^3$. Do you agree? Explain with diagrams.

3. Most people would agree that 2 cats + 5 cats = 7 cats and 7 cats - 2 cats = 5 cats. Use this information to support an argument for combining like terms and for being unable to combine unlike terms in algebra. Use examples with two different animals and two different variables.

4. Does a number in front of a variable affect whether or not you have like terms? Explain using examples.

Practise

For help with #5 to #7, refer to Example 1 on page 184.

5. What is the value of the coefficient and the number of variables for each term?
   a) $-3z^2$
   b) $k$
   c) 43

6. Determine the value of the coefficient and the number of variables for each term.
   a) $4d$
   b) $-3t$
   c) $-8f^2$

7. Use the following monomial expressions to answer the questions below:
   \[
   \begin{array}{c|c|c|c}
   \text{Term} & \text{Coefficient} & \text{Variable(s)} & \text{Variable’s Exponent} \\
   \hline
   -x^2y & -1 & x, y & 2 \text{ for } x, 1 \text{ for } y
   \end{array}
   \]
   a) Which have a coefficient of 1?
   b) Which have two variables?
   c) Which have only one variable with an exponent of 1?
   d) Which have a coefficient of $-1$?

For help with #8 and #9, refer to Example 2 on page 184.

8. Identify the like terms in each group.
   a) $2a + 5 - 7.1a + 9b - c$
   b) $3m - 2ab + \frac{5}{2}m - 2ad + m^2$
   c) $-1.9 + 6p^2 + 5 - 2p - p^3$

For help with #10 to #12, refer to Example 3 on page 185.

9. Which terms are like terms in each group?
   a) $-2k \quad 9 \quad 104k \quad 104f \quad -f^2$
   b) $\frac{1}{2}ab \quad 0.5a \quad -4b \quad ab^2 \quad ab$
   c) $-5 \quad 13d^2 \quad 5 \quad -10d \quad d$

10. Collect like terms.
    a) $3x - 2x^2 + x - 2x^2$
    b) $-4 - 2w^2 - 3n + 3 + 2n^2$
    c) $2q - 4q^2 - 2 + 3q^2 + 2 - 3q$
    d) $-4c + 3 + 5c - 7$
    e) $b^2 - 3h + 4h^2 + 2h$
    f) $3j - 5 + 2j^2 - 1 + 2j - 3j^2$

11. Simplify by collecting like terms.
    a) $2d - 3d^2 + d^2 - 5d$
    b) $y^2 + 2y - 2y^2 + y$
    c) $-p + 4p^2 + 3 - 3p^2 - 5 + 2p$
    d) $m - 4 + 6 + 3m$
    e) $q^2 - 3q + 2q^2 - q$
    f) $5w - 3 + w^2 - 2w - 4w^2 - 1$
12. Which expressions are equivalent to the simplified expression \(-3x^2 + x - 4\)?
   a) \(-4 + 3x + x\)
b) \(x - 4 - 3x^2\)
   c) \(x^2 + 2 - 4x^2 + 3x - 6 - 2x\)
   d) \(-3 - 5x^2 + x + 1 + 2x^2\)
   e) \(2x - 2 + x^2 - x - 4x^2 - 2\)
   f) \(-4 + 3x - x^2 - 5 + 5x^2 + 4x - 6x^2\)

13. Jessica and Taz are working on a measurement problem. Their calculations involve combining Jessica’s measurement of 2 m and 32 cm with Taz’s measurement of 1 m and 63 cm. Jessica claims you find the answer just like in algebra. Do you agree? Explain.

14. Describe a real-life situation that could be represented by each expression.
   a) \(m - 3\)
   b) \(2p + 5\)

15. For each of the following polynomials, write an equivalent expression with six terms.
   a) \(2p^2 - 3p + 2\)
   b) \(-3x^2 + 5x - 4\)
   c) \(4r^2 - 2r^2 - 3qr\)

16. Write an expression for the perimeter of each figure. Then, combine like terms if possible.
   a)
   ![Figure A]
   b)
   ![Figure B]

17. a) Draw a figure with a perimeter that is represented by \((3x + 3) + (3x - 2) + (x + 6)\), where each value in parentheses represents the length of one side.
   b) Simplify the expression for the perimeter.

18. A student council decides to raise money by organizing a dance. The cost of a band is $700. The student council decides to sell tickets at $5 each.
   a) Write an expression for the profit that the student council would make. What does your variable represent?
   b) If 230 students pay to attend the dance, what is the profit?
   c) Estimate, then calculate, the minimum number of students who will need to buy tickets for the student council to make a profit.

19. A heating company charges $60 per hour plus $54 for a service call. Let \(n\) be the number of hours the technician works at your house.
   a) What expression represents the total cost of the job?
   b) What is the cost for a job requiring 2 h?
   c) The company charges half as much for a second technician. Write an expression showing the total cost if two technicians install a new furnace. Simplify your expression by combining like terms.

20. A publisher makes books for a number of distributors. For one book, the charge to the distributor is represented by a fixed cost of $3000 plus $16 per book.
   a) Write an expression for the cost that a distributor is charged for \(b\) copies of this book.
   b) How much do 600 books cost?
   c) What is the cost per book if 600 are ordered?
   d) What is the cost per book if 1000 are ordered?

21. Raj was told to write an expression equivalent to \(3x - 8 + 3x + 9\).
   \(3x - 8 - 3x + 9\)
   \(3x - 8 + 9\)
   \(3x - 8 + 9\)
   \(3x - 8 + 9\)
   a) What errors did he make?
   b) Show the correct response.

22. The diagram represents a piece of string.
   a) What is an expression for the total length of the string?
   b) Combine like terms to get the simplest expression possible for the length of the string.

23. When would the expressions \(x + y + 3\) and \(x + w + 3\) be equal? How do you know?

24. A department store marks up wholesale prices 40% to get its retail or selling price.
   a) Complete the following table. The first row has been done for you.

<table>
<thead>
<tr>
<th>Wholesale Price ($)</th>
<th>Expression For Retail Price</th>
<th>Retail Price ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.00</td>
<td>(8 + (0.4)(8))</td>
<td>11.20</td>
</tr>
<tr>
<td>12.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

25. Zip Publishers will print posters for fundraising events for an initial cost of $100 plus $2 per poster. Henry’s Printers charges $150 plus $1 per poster.
   a) Write an expression for the total cost for any number of posters.
   b) What is the cost of 125 posters from each company?
   c) What is the total cost if you print 200 posters at each company? Show two different ways to find the answer.

Math Link
Refer to the Math Link for section 5.1 on page 182. Represent each item with a variable:
\(a = \text{blender}\)
\(b = \text{watch}\)
\(c = \text{book}\)
\(d = \text{soccer ball}\)
\(e = \text{drum}\)
\(f = \text{coffeemaker}\)

a) Rewrite all your combinations that add to $100, using the letters a to f. Arrange each combination in alphabetical order. For example, \(a + e + d + 3c\) would be written as \(a + 3c + d + e\).

b) The example in part a) can be used to find other combinations. Notice that \(e\) has a value of $40. What other items from the list have a value of $40? By substituting into \(e\) the letter or letters that combine to a total value of $40, you arrive at another answer. Do not forget to combine like terms and arrange each expression in alphabetical order. What other combinations can you find using substitution?

c) If you were asked to find combinations of the items that add to $101, how could you use algebra to help you? Give two ways that algebra could help you.
Math 9: 5.3 Adding & Subtracting Polynomials

Key Ideas

- You can add or subtract polynomials. You can use models to help simplify the expression.

\[
(2x^2 - 3x) + (x^2 + x + 4)
\]

Group like terms. Remove any zero pairs.

\[
(2x^2 - 3x) + (x^2 + x + 4) = 3x^2 - 2x + 4
\]

- The opposite of a polynomial is found by taking the opposite of each of its terms.

The opposite of \(-3x^2 + x + 1\) is \(3x^2 - x - 1\).

- To subtract a polynomial, you can add the opposite terms.

\[
(6x^3 - 3x + 4) - (x^2 - 3x + 2)
\]

\[
= 6x^3 - x^2 + 3x + 2
\]

\[
= 5x^3 + 0x + 2
\]

\[
= 5x^3 + 2
\]

Check Your Understanding

Communicate the Ideas

1. Jeanette and Tim find the answer to \((3x^2 - 5x) - (4 - 2x)\). Jeanette claims the simplified answer has three terms. Tim says it has only two terms. Who is correct? How do you know?

2. What is the opposite of \(-x^2 + 2x - 3\)? Use diagrams and then use symbols to determine the answer. Which method do you prefer? Why?

3. Identify any errors in Mei’s work and correct them.

\[
(-2x^2 + 7) - (3x^2 + x - 5)
\]

\[
= (-2x^2 + 7) + (-3x^2 - x + 5)
\]

\[
= -2x^2 - 3x^2 - x + 7 + 5
\]

\[
= 5x^2 - x + 12
\]

4. Create a situation in which the polynomials \(3x + 2\) and \(5x - 1\) are involved. In your situation, what does \((3x + 2) + (5x - 1)\) represent?

Practise

For help with #5 to #7, refer to Example 1 on page 191.

5. Which addition statement does the diagram model?

\[
A (2x^2 - 3x) + (3x + x - 12)
\]

\[
B (-2x^2 + 3x) + (3x^2 + x)
\]

\[
C (-2x^2 + 3x) + (3x^2 - x)
\]

6. Add the polynomials.

a) \((3x - 4) + (2x - 3)\)

b) \((-a^2 - 3a + 2) + (-4a^2 + 2a)\)

c) \((5p + 5) + (5p - 5)\)

d) \((2y^2 - 15) + (6y + 9)\)

7. Perform the indicated operation and simplify by combining like terms.

a) \((-3x + 4) + (6x)\)

b) \((3n - 4) + (7 - 4n)\)

c) \((2b^2 - 3) + (-b^2 + 2)\)

d) \((5a^2 - 3a + 2) + (-4a^2 + 2a - 3)\)

For help with #8 to #12, refer to Example 2 on pages 192-193.

8. What is the opposite of the expression represented by each diagram? Express your answer using both diagrams and symbols.

9. Let \(\square\) represent \(x^2\), \(\square\) represent \(x\), and \(\blacksquare\) represent 1. The same diagrams in yellow represent negative quantities. Determine the opposite of the expression represented by each diagram. Use both diagrams and symbols to express your answer.

10. What is the opposite of each expression?

a) \(-9x\)

b) \(5d + 6\)

d) \(-2x^2 + 3x - 5\)

11. What is the opposite of each expression?

a) \(3x - 7\)

b) \(4y^2 - 4x + 2.5\)

c) \(x^2 + 8r - 1\)

12. Which of the following represents the opposite of \(2x^2 - x^2\)?

A \(-2x^2 - x\)

B \(2x^2 + x\)

C \(-2x^2 + x\)

D \(2x^2 + x\)
Math 9: 5.3 Adding & Subtracting Polynomials

For help with #13 to #15, refer to Example 3 on page 194.

13. Draw a diagram to model the subtraction statement \((-3x^2 + 4x) - (-2x^2 - x)\).

   a) \((2x - 3) - (5x - 1)\)
   b) \((-3b^2 - 5b) - (2b^2 + 4b)\)
   c) \((5 - 6u) - (-2 - 3u)\)
   d) \((m + 7) - (m^2 + 7)\)

15. Subtract.
   a) \((8c - 3) - (-5c)\)
   b) \((-3r^2 - 5r - 2) - (r^2 - 2r + 4)\)
   c) \((y^2 - 5y) - (2y - y^2)\)
   d) \((6y^2 - 4y + 3) - (-2y^2 - 5)\)

Apply

16. A triangle has the dimensions shown.

   ![](image)

   a) What does \((x - 3) + (3x - 2) + (2x + 5)\) represent?
   b) Simplify the expression in part a).
   c) If \(x\) has a value of 5, what is the perimeter of the triangle? Did you use the expression in part a) or part b) to find this answer? Why?

17. Complete the addition pyramid. Find the value in any box by adding the expressions in the two boxes immediately below it.

   ![](image)

18. In Langley, British Columbia, you can rent a backhoe for $399 per day and a bulldozer for $550 per day. It costs $160, round trip to move each piece of equipment back and forth to the job site.
   a) Write an expression for the total cost of renting the backhoe, before tax. Include transportation to and from the job site.
   b) What does your variable represent?
   c) Write an expression for the total cost of renting and moving the bulldozer? Use the same variable as in part a).
   d) What is an expression for the difference in cost between renting the backhoe and the bulldozer? Give your answer in its simplest form.

19. Consider the addition pyramid shown below.

   ![](image)

   a) Write an expression for box C. Do not simplify.
   b) Show how you can find the value for boxes A and B. Simplify your answers.

20. The cost to print \(n\) copies of a book is 15\(n\) + 2000 dollars. The cost to ship \(n\) copies of the book is 2\(n\) + 150 dollars.
   a) What is an expression for the total cost to print and ship \(n\) copies of the book?
   b) What is the actual cost to print and ship 600 copies of the book?
   c) What does \((15n + 2000) - (2n + 150)\) represent? Find a simpler expression for this subtraction statement.

21. Describe any errors in Jorge’s work and how you would correct each one.

   a) \((4p^2 - p + 3) - (p^2 + 3p - 2)\)
   b) \((4p^2 - p - 3 - p^2 - 3p - 2)\)
   c) \((4p^2 - p - 3 + p - 3p + 5 - 2)\)
   d) \((4t^2 - t - 1)\)

22. Simplify by combining like terms.

   a) \((6x - 7) + (3x - 1) + (x - 4)\)
   b) \((3a^2 - 4a) + (3a - 5) - (a^2 - 1)\)
   c) \((4t^2 - t + 6) - (t^2 + 2t - 4) + (2t^2 - 3t - 1)\)
   d) \((2x - 1.8) - (3.4x - 2.1) - (0.9x - 0.1)\)

23. Replace each question mark with algebra tiles to make a true statement.

   a) \((-x + 5) + (3x - 2)\)
   b) \((4t - 3)\)

24. The perimeter of the triangle shown is 12\(x^2 + 6x\), in metres. Find a polynomial representing the missing side length.

   ![](image)

25. Your student council plans to thank 25 students and staff who have made special contributions to the school. Wooden plaques cost $17.95. It costs $0.12 per letter to engrave a message on the plaque. All costs are before tax.
   a) Write an expression for the cost of buying and engraving 25 plaques with an unknown number of letters.
   b) Write an expression for the cost of engraving 25 plaques with the following message and the name of your school.
   Thank you for your generous support.
   c) Write an expression for the cost of engraving the plaques.
   d) Show how to use the addition of polynomials to find the cost of 50 plaques if each plaque has the same number of letters and numbers.

Extend

26. Kiesha’s dad is a Haisla artist. He makes his own prints and sells them on the Internet. He will ship the prints to purchasers anywhere in Canada. For large prints, he charges $30 to ship one print plus $7 for each additional print. For small prints, he charges $20 for one print plus $5 for each additional print.
   a) How much does her dad charge to ship two large prints?
   b) How much does he charge to ship four small prints?
   c) Write an expression to show how much he charges to ship an unknown number of large and small prints.
27. The length of the picture shown is 15 cm more than its width. The picture frame has a width of 4 cm. What is the minimum length of material needed to make the frame for this picture? Give your answer as a simplified expression.

28. A small manufacturer makes air quality monitoring kits for home use. The revenue, in dollars, from the sale of \( n \) kits can be shown by \(-n^2 + 3600n\). The cost, in dollars, to make \( n \) kits is represented by \(-3n^2 + 8600\). The manufacturer makes a profit if the cost subtracted from the revenue is positive.
   a) Write an expression to find the profit. Simplify your answer.
   b) Estimate and then calculate if the manufacturer will make a profit or suffer a loss after selling 20 test kits. Explain.

29. Simplify \((2x + 4x + 6x + 8x + \ldots + 2006x + 2008x) - (x + 3x + 5x + 7x + \ldots + 2005x + 2007x)\).

30. Mary is sewing two wall hangings. The length of one wall hanging is 36 cm greater than its width. The length of the other wall hanging is 15 cm greater than its width. Each of them has the same width. She is going to add a trim strip around each wall hanging. What is the total minimum length of trim she will need for both wall hangings?
Key Ideas

• You can represent the multiplication and division of monomials using a model.

\((2x)(-3x)\)

There are 6 negative \(x^2\)-tiles.

\((2x)(-3x) = -6x^2\)

\[8xy\]

The unknown side length of the rectangle is made up of 4 positive \(y\)-tiles.

\[\frac{8xy}{2x} = 4y\]

• To multiply monomials algebraically, you can multiply the numerical coefficients and use the exponent rules to multiply the variables.

• To divide monomials algebraically, you can divide the numerical coefficients and use the exponent rules to divide the variables.

Check Your Understanding

Communicate the Ideas

1. Explain to a partner at least two ways you could find the product of \((3x)\) and \((5x)\).

2. Laurie used the following method to divide \(16x^7\) by \(2n\).

\[\frac{16x^7}{2n} = \left( \frac{16}{2} \right) x^7 \left( \frac{1}{n} \right) = 8x^7 \frac{1}{n}\]

Does Laurie’s method have any errors? If so, what are her errors and what is the correct solution?
11. Write the division statement represented by each set of algebra tiles.
   a)  
   b)  
   c)  

12. Determine the division statement shown by each set of algebra tiles.
   a)  
   b)  
   c)  

13. Model and complete each division.
   a)  \( \frac{8x^2}{2x} \)  
   b)  \( \frac{5xy}{5y} \)  
   c)  \( -\frac{12x^2}{4x} \)  
   d)  \( \frac{2x^2}{-x} \)  

14. Model and complete each division.
   a)  \( \frac{15x^2}{3x} \)  
   b)  \( \frac{10y}{2x} \)  
   c)  \( \frac{12x^2}{-3x} \)  
   d)  \( \frac{-9x^3}{-3x} \)  

15. Find the quotient of each pair of monomials.
   a)  \( \frac{7x^2}{x} \)  
   b)  \( \frac{-5st}{5x} \)  
   c)  \( \frac{125t}{5} \)  
   d)  \( \frac{-8m}{-2m} \)  
   e)  \( \frac{81r^2}{3rs} \)  
   f)  \( \frac{4.5p^2}{-3p} \)  

   a)  \( \frac{12.4x^2}{x} \)  
   b)  \( -15r \div (-4r) \)  
   c)  \( \frac{0.64t^2}{0.2t^2} \)  
   d)  \( -18pn \div 3n \)  
   e)  \( k \div 4k \)  
   f)  \( \frac{2x^2}{3} \div 2x \)  

17. Find an expression for the area of each figure.
   a)  
   b)  
   c)  

18. What is the missing dimension in each figure?
   a)  
   b)  
   c)  

19. The area of a rectangle is 72\(d^2\) and its length is 20\(d\). What is an expression for its width?

20. Claire wants to build a patio outside her café. The rectangular space outside of Claire’s café is three times as long as it is wide. The area of the space is 48 m\(^2\). Claire would like to build a patio with dimensions 3.5 m by 12.5 m in this space. Will it fit? Explain.

21. The diagram shows that \(x\) is the radius of the large circle and the diameter of the small circle. Write the ratio of the area of the large circle to the area of the small circle. Simplify the expression.

22. A circle is inscribed in a square as shown.
   In terms of the radius, \(r\), determine each of the following ratios.
   a)  the area of the square to the area of the circle
   b)  the perimeter of the square to the circumference of the circle

23. Jonasie and Elisa are taking two tourists on a trip to photograph caribou. The visitors will be travelling by dogsled. The dogsled’s length is 4 times its width. The sled has a rectangular base area of 3.2 m\(^2\). The equipment to be loaded on the sled measures 0.8 m wide by 3.5 m long. Will the equipment fit on the sled as it is presently packed? Explain your answer.
Math 9: 7.2 Multiplying Polynomials by Monomials

Key Ideas

- You can represent the multiplication of a polynomial by a monomial using models.
  - area model
    \[2x + 2\]
    \[2x\]
    \[3x\]
    \[A_1 = 6x^2\]
    \[A_2 = 6x\]
    \[(3x)(2x + 2)\]
The product is represented by \(A_1 + A_2\):
\[(3x)(2x + 2) = 6x^2 + 6x\]

- algebra tiles
  - (2x)(−2x + 3)
    There are 4 negative \(x^2\)-tiles and 6 positive \(x\)-tiles.
    \[(2x)(−2x + 3) = −4x^2 + 6x\]

- To multiply a polynomial by a monomial algebraically, you can expand the expression using the distributive property. Multiply each term of the polynomial by the monomial.
  \[= (−1.2x)(2x − 7)\]
  \[= (−1.2x)(3x) − (−1.2x)(7)\]
  \[= −3.6x^2 + 8.4x\]

Check Your Understanding

Communicate the Ideas

1. Describe two methods you could use to multiply polynomials by monomials.

2. Sara is going to simplify the expression \((3x)(2x + 4)\). Can she add the terms in the brackets and then multiply? Explain.

3. Mahmoud used the following method to expand the expression \((5x)(2x + 1)\).
\[(5x)(2x + 1) = 10x^2 + 1\]
   a) Show that Mahmoud's solution is incorrect.
   b) How would you correct his solution?

Practise

For help with #4 to #7, refer to Example 1 on page 266.

4. What multiplication statement is represented by each area model?

5. Determine the multiplication statement shown by each area model.

6. Expand each expression using an area model.
   a) \((3.2r + 1)(4r)\)
   b) \(\left(\frac{1}{2}x\right)(3x + 6)\)

7. Use an area model to expand each expression.
   a) \((2x)(4x + 2)\)
   b) \((6k + 2)(4.5\hat{k})\)

For help with #8 to #11, refer to Example 2 on pages 266-267.

8. What multiplication statement is represented by the algebra tiles?
Math 9: 7.2 Multiplying Polynomials by Monomials

10. Expand each expression, using algebra tiles.
   a) \((x - 5)(3x)\)  
   b) \((2x)(-2x + 3)\)

11. Use algebra tiles to expand each expression.
   a) \((4x + 2)(-3x)\)  
   b) \((-4x)(3x - 1)\)

For help with #12 and #13, refer to Example 3 on page 267.

12. Expand using the distributive property.
   a) \((2y)(3x - 1)\)
   b) \((3p)(2p - 0.8)\)
   c) \((0.5m)(7 - 12n)\)
   d) \((\frac{1}{2}r - 2)(-r)\)
   e) \((2n - 7)(8.2)\)
   f) \((3x)(x + 2y + 4)\)

   a) \((4)(2x - 3)\)
   b) \((-1.2w)(3w - 7)\)
   c) \((6x)(4 - 2.4x)\)
   d) \((\frac{3}{4}v + 7)(-1)\)
   e) \((3 - 9y)(y)\)
   f) \((-8u - 7b - 2)(8a)\)

Apply

14. A rectangular Kwakiutl button blanket has a width of \(3x\) and a length of \(4x - 3\).
   a) What is an expanded expression for the area of the blanket?
   b) What is a simplified expression for the perimeter of the blanket?

15. Lee has decided to build a shed on a square concrete slab. The shed has the same width, \(w\), as the slab. Its length is 2 m shorter than the width of the slab.
   a) What is an expression for the area of the slab?
   b) If the width, \(w\), of the slab is 4 m, what is the area of the shed?

16. The basketball court for the Jeux de la Francophonie is 5.5 m longer than 1.5 times the width.
   a) What is an expression for the area of the basketball court?
   b) If the length is 28 m, what is the area of the basketball court?

Did You Know?
The Jeux de la Francophonie are games for French-speaking people. They are held every four years in different locations around the world. The games include sports and artistic events. Canada is represented by three teams: Quebec, New Brunswick, and a third team representing the rest of Canada.

17. A rectangular field is \((4x + 2)\) m long. The width of the field is 2 m shorter than the length. What is an expression for the area of the field?

18. A rectangular skateboard park is \((3x)\) m long. Its width is 4 m less than the length.
   a) What is an expression for the area of the park?
   b) If \(x = 15\), what is the area of the park?

Extend

19. A rectangular packing crate has the dimensions shown, in metres.
   a) What is an expression for the total surface area of the crate?
   b) What is an expression for the volume of the crate?

20. The surface area, \(SA\), of a cylinder is \(SA = 2\pi r^2 + 2\pi rh\), where \(r\) is the radius and \(h\) is the height. The formula for the volume, \(V\), of a cylinder is \(V = \pi r^2h\). What is the surface area of a cylinder that has a height of 5 cm and a volume of \(80\pi\) cm³?

21. A rectangular measuring \((12n)\) m by \(8\) m has a square of side length \(2\) m cut out in the four corners. The cut-out shape forms an open box when the four corners are folded and taped.
   a) Draw the box and label its dimensions.
   b) What is the surface area of this open box?
   c) What is the capacity of this box?

Math Link

You are drawing up plans for a landscape design. You are going to include one of the following design elements, which will be in the shape of a rectangle:
- swimming pool
- concrete patio
- hockey rink
- beach volleyball pit

The rectangular shape is 2 m longer than twice the width. You must choose an appropriate depth for your design element.
   a) Create a formula for calculating the volume of material needed to fill your design element.
   b) Use your formula to calculate the volume of material needed for widths of 2 m, 3 m, 4 m, and 5 m. Which width would you prefer for your design element? Why?
Math 9: 7.3 Dividing Polynomials by Monomials

Check Your Understanding

Communicate the Ideas

1. Explain how you would perform the following division: \( \frac{3x^2 + 6x}{2x} \).

2. Anita used the following method to simplify an expression:
   a) Show that Anita’s solution is incorrect.
   b) How would you correct her solution?

3. Use a model to show a polynomial division statement with a quotient of \( 3x + 2 \).

Practise

4. What division statement is represented by the algebra tiles? Determine the quotient.
   a) 
   b) 
   c) 

5. Determine the division statement represented by the algebra tiles and give the quotient.
   a) 
   b) 
   c) 

6. Divide each expression, using a model.
   a) \( \frac{5x^2 - 10x}{5x} \)
   b) \( \frac{4x^2 + 12x}{2x} \)

7. Use a model to divide each expression.
   a) \( \frac{-8x^2 - 4x}{-2x} \)
   b) \( \frac{-3x^2 + 5x}{-x} \)

For help with #8 and #9, refer to Example 2 on page 274.

8. Divide.
   a) \( \frac{2y^2 + 4.2y}{2y} \)
   b) \( \frac{12m^2 - 6.2m + 24}{2} \)
   c) \( \frac{-18y^3 - 6y}{-6y} \)
   d) \( \frac{3cv - 2.7c}{3c} \)

9. Determine each quotient.
   a) \( \frac{9x^2 + 3.6x}{3x} \)
   b) \( \frac{2x^2 + 8xy}{3x} \)
   c) \( \frac{-x^2 - 1.5st}{5x} \)
   d) \( \frac{-14w^2 - 7w + 0.5}{0.5} \)

Apply

10. A dump truck holds 10 m\(^3\) of soil. You are filling a rectangular space in a yard with the dimensions of \((2x + 3)\) by \(5x\) by 2, in metres. What polynomial expression represents the number of truck loads of soil you will need?

11. A rectangular fish tank has the dimensions shown, in metres. The volume of the tank can be represented by \(7.5w^2 - 3w\).

   a) What polynomial expression represents the area of the base of the tank?
   b) What polynomial expression represents the length of the tank?
   c) What is the length of the tank if the width is 0.6 m? What is the volume of the tank?

12. For their Valentine’s Day dance, the grade 9 students want to decorate the end wall of the gym with red poster paper. The area of the wall is given by the polynomial \(45x^2 + 20x\). One sheet of poster paper covers an area given by the monomial \(5x\). What polynomial expression represents the number of sheets of paper the students will need to cover the wall?

13. A rectangle has an area of \(9x^2 - 3x\) square units. The width of the rectangle is \(3x\) units. What is the length?
You are designing a park that includes a large parking lot that will be covered with gravel.

a) Design two different-shaped parking lots using any single shape or combination of regular shapes. Include the dimensions on a drawing of each parking lot design. Note that you will need to be able to calculate the area of your parking lots. Each area should be a different shape. Make them no less than 200 m² and no greater than 650 m².

b) A truck with dimensions similar to those shown in the picture will deliver the gravel. Write an expression for the approximate area that a single load of gravel will cover to a depth of 5 cm.

c) There are three sizes of trucks that can deliver the gravel. The widths are 1.5 m, 2 m, and 3 m. Approximately how many truckloads would it take for each truck size to deliver the required amount of gravel for each of your parking lots? You will cover each parking lot to a depth of 5 cm. Show your work.

d) Which truck size do you think would be the most efficient to use for each of your parking lots? Explain your reasoning.

14. The formula used to predict the distance an object falls is \( d = 4.9t^2 + vt \). In the formula, \( d \) is the distance, in metres, \( t \) is the time, in seconds, and \( v \) is the starting velocity of the object, in metres per second.

a) The average speed of a falling object is calculated as \( s = \frac{d}{t} \), where \( s \) is the average speed, in metres per second. Use this information to develop a formula for the average speed of a falling object in terms of \( t \) and \( v \).

b) What is the average speed of an object that falls for 5 s, if it starts from a resting position?

15. Divide.

a) \( \frac{3.6g^2 + 0.93g}{0.3g} \)

b) \( \frac{2}{3} b^2 - \frac{1}{2} ab + \frac{1}{3} b \)

c) \( -4.8x^2 + 3.6x - 0.4 \)

16. Two rectangles have common sides with a right triangle, as shown. The areas and widths of the rectangles are shown. What is a simplified expression for the area of the triangle?

17. What is the ratio of the area of the shaded rectangle to the area of the large rectangle?

18. If a rectangle has length \( 2xy \) and area \( 12x^2y + 6xy^2 \), what is its perimeter?
16. Explain how you can tell like terms by looking at them. Give four different sets of examples with at least three like terms in each set.

17. The following diagrams represent terms in an expression. Draw a new diagram with like terms together and write an expression for the simplified answer.

18. Use materials or diagrams to model each expression and show how to combine like terms. What is the simplified expression?

19. Combine like terms.
   a) \(4a + 3 + 9a + 1\)
   b) \(2b^2 - 3b - 4b^2 + 8b\)
   c) \(1 - c + 4 + 2c - 3 + 6c\)

20. Draw a shape with a perimeter represented by \((4x) + (3x - 1) + (x + 3) + (x - 2)\), where each quantity in parentheses represents the length of a side. Find a simpler expression for the perimeter by combining like terms.

21. Kara and Jasmine go to Splash-o-rama water park. The entrance fee is $20.00. Kara rents a locker for $1.50 per hour. Jasmine rents a tube for $3.00 per hour.
   a) What is an expression that represents the cost for Kara?
   b) What is an expression that represents the cost for Jasmine?
   c) What is a simplified expression for the total cost for both Kara and Jasmine to stay at the water park together for any number of hours?

22. a) Simplify each of the algebraic expressions.
   \((4x - 3) + (x - 1)\)  \((4x - 3) - (x - 1)\)
   b) How are the processes similar? How are they different?

23. Is \(2x^2 - 3x\) the opposite of \(3x - 2x^2\)?
   Show how you know.

24. For each of the following expressions, what is the opposite?
   a) \(-3\)
   b) \(7 - a\)
   c) \(x^2 - 2x + 4\)
   Which method do you prefer? Why?

25. a) Model each expression.
   \(1 - v\)  \(3y^2 - 2x + 1\)

   a) \((-p + 7) + (4p - 5)\)
   b) \((a^2 - a - 2) - (5 - 3a^2 + 6a)\)

27. Complete the subtraction pyramid. Find the value in any box by subtracting the two expressions in the boxes immediately below it. Subtract in order from left to right.

28. An end-of-year class party has a fixed cost of $140 to cover printing, decorations, and awards. In addition, it costs $12 to feed each person who attends.
   a) What is an expression for the total cost of the party? What does your variable represent?
   b) Create a short scenario to generate an addition or subtraction question with polynomials. Simplify by combining like terms.
12. Write an expression to represent what the diagrams show. Then, simplify.

\[ \text{expression} \]

13. Simplify. Use models for at least one of the expressions. Show your work.
   a) \((2x^2 - 8x + 1) + (9x^2 + 4x - 1)\)
   b) \((4 - 6x) - (3 - 8x)\)

Extended Response

14. The number of peanuts two squirrels bury can be represented by \(4n - 7\) and \(5n - 1\), respectively.
   a) Write and simplify an expression for the number of peanuts both squirrels bury.
   b) What could the expression \((5n - 1) - (4n + 7)\) represent?
   c) What is a simpler expression for \((5n - 1) - (4n + 7)\)?

15. The cost for a birthday party at Big Fun Bowling is $100 for up to ten children, plus $5 per pair of bowling shoes. To rent the party room, the cost is $20, plus $4 per child for pizza.
   a) What is an expression for the cost of bowling for up to ten children?
   b) What is an expression for the cost of pizza in the party room for up to ten children?
   c) What is a simplified expression for the total cost of up to ten children going bowling and having pizza in the party room?
   d) Estimate, then calculate, the cost of nine children going bowling and having pizza in the party room.

Math Link: Wrap It Up!

You are an illusionist who is about to amaze your audience with a number trick. However, before you try the trick, you need to know how it works.

**Guess a Number**

**Step 1** Tell someone to write down a three-digit number with no repeating digits. During the entire trick, do not look at what the person writes.

**Step 2** Have the person arrange the digits in decreasing order.

**Step 3** Ask the person to circle one number in the difference.

**Step 4** Tell the person to subtract the number in step 3 from the number in step 2.

**Step 5** Ask the person to arrange the same three digits in increasing order.

**Step 6** Ask what the other two digits are. Identify the digit that was circled.

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Chapter 7 Review

Key Words
For #1 to #4, match the polynomial in Column A with an equivalent polynomial in Column B. Polynomials in Column B may be used more than once or not at all.

<table>
<thead>
<tr>
<th>Column A</th>
<th>Column B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. $8xy$</td>
<td>A $4xy - 2x$</td>
</tr>
<tr>
<td>2. $12x^2 - 6x$</td>
<td>B $4x^2 - 2x$</td>
</tr>
<tr>
<td>3. $(-2x + 1)(-2x)$</td>
<td>C $4y$</td>
</tr>
<tr>
<td>4. $12xy - 6x$</td>
<td>D $2x^2 - 2x$</td>
</tr>
<tr>
<td>5. $12xy - 3x$</td>
<td>E $4xy$</td>
</tr>
<tr>
<td>6. $4x - 2$</td>
<td>F $4x - 2$</td>
</tr>
</tbody>
</table>

### 7.1 Multiplying and Dividing Monomials, pages 254–263

5. Use a model to complete each monomial multiplication statement.
   a) $(3x)(5x)$
   b) $(4x)(-5y)$

6. Find each product.
   a) $(-3.2x)(-2.7y)$
   b) $\left(\frac{5}{2}a\right)(-14a)$

7. Use a model to complete each monomial division statement.
   a) $\frac{6x^2}{2x}$
   b) $15a^2 \div (-3a)$

8. Determine each quotient.
   a) $-4.8x^2$
   b) $2xy \div 2x$

9. A rectangle is four times as long as it is wide. If the area of the rectangle is 1600 cm², what are its dimensions?

### 7.2 Multiplying Polynomials by Monomials, pages 264–271

11. What polynomial multiplication statement is represented by each area model?
   a) $1.3y 
   b) 1.2f$

12. What polynomial multiplication statement is represented by the algebra tiles?

### 7.3 Dividing Polynomials by Monomials, pages 272–277

15. Determine the division statement represented by the algebra tiles. Give the quotient.
   a) $\frac{3}{2}$
   b) $2$

   a) $12x^2 - 2n$
   b) $15x - 3x^3$

18. A rectangular wall has a circular window. The area of the wall can be represented by $32x^2 + 16x$. The length of the wall is $8x$. The diameter of the circular window has a measurement that is half the width of the wall. What is the radius of the window written as an expression in terms of $x$?

19. Naullaq is cutting ice blocks from the lake for her mother’s drinking water tank. The cylindrical tank has a volume of $4x^2\pi$. Once each block has melted, it will have a volume of $3x^2$. How many blocks does she need to cut so that her mother’s tank will be filled when the ice melts? Give your answer to the nearest whole block. Explain your answer.

Use the $\pi$ key on your calculator.

### Chapter 7 Review

10. A square is inscribed in a circle with radius $r$ as shown. What is the ratio of the area of the square to the area of the circle?

13. Expand.
   a) $(20x)(2.3x - 1.4)$
   b) $\left(\frac{7}{3}r\right)(r - \frac{3}{4})$

14. The length of a piece of rectangular cardboard in centimetres is $6x + 3$. The width is 1 cm less than $\frac{1}{3}$ of the length. What is an expression for the area of the cardboard?

17. A triangle has an area represented by $3x^2 + 6x$. If the base of the triangle is $3x$, what is the height?

18. A triangle has an area represented by $3x^2 + 6x$. If the base of the triangle is $3x$, what is the height?

19. Naullaq is cutting ice blocks from the lake for her mother’s drinking water tank. The cylindrical tank has a volume of $4x^2\pi$. Once each block has melted, it will have a volume of $3x^2$. How many blocks does she need to cut so that her mother’s tank will be filled when the ice melts? Give your answer to the nearest whole block. Explain your answer.

Use the $\pi$ key on your calculator.
Chapter 7 Practice Test

For #1 to #6, select the best answer.

1. Which monomial multiplication statement is represented by the algebra tiles?

- A \((3x)(-2x) = -6x^2\)
- B \((2x)(-3x) = -6x^2\)
- C \((2x)(3x) = 6x^2\)
- D \((-2x)(-3x) = 6x^2\)

2. What is the product of 3y and 2.7y?

- A 0.9y
- B 8.1y
- C 0.9y²
- D 8.1y²

3. Which monomial division statement is represented by the algebra tiles?

- A \(-3x - 2\)
- B \(-3y + 2\)
- C \(3y - 2\)
- D \(3y + 2\)

4. Which is equivalent to \(-27q^2 ÷ 9q^2\)?

- A \(3q^2\)
- B \(3q\)
- C \(-3q\)
- D \(-3q^2\)

5. Which is equivalent to \(\frac{\frac{2}{3}}{3 - 6}\)?

- A \(-2x^2 - 4x\)
- B \(-2x - 4\)
- C \(2x - 4\)
- D \(2x^2 - 4x\)

6. Calculate \(\frac{1.5y^2 - 10y}{-5y}\).

- A \(-3y - 2\)
- B \(-3y + 2\)
- C \(3y - 2\)
- D \(3y + 2\)

Complete the statements in #7 and #8.

7. The expression \(-\frac{24x^4 + 8x^2}{4x}\) is equivalent to _______.

8. A polynomial multiplication expression that is equivalent to \(24d^2 - 12d\) is _______.

Short Answer

For #9 to #11, show all of the steps in your solutions.

9. Calculate \((2x)(4y)\).

10. What is the product of \(12h\) and \(-\frac{3}{4}h + 2\)?

11. Simplify \(\frac{2x^2 + 3x}{-3x}\).

12. Paula is building a rectangular patio. It will have a square flower bed in the middle. The rest will have paving stones. The patio will have a length of \(4x\) and a width of \(3.1x\). The area of the flower bed will be \(3.5x^2\). What area of the patio will need paving stones?

Math Link: Wrap It Up!

You have been hired to create a landscape design for a park. The park is rectangular and covers an area of 500,000 m². The park includes the following features:
- A play area covered with bark mulch
- A sand area for playing beach volleyball
- A wading pool

The features in your design include the following shapes:
- A circular area
- A rectangular area
- A parallelogram-shaped area with the base three times the height

The features of your park have varying depths. Include the following in your design:
- a scale drawing showing the layout of each of the required features
- a list showing the area of each feature and the volume of each material (mulch, sand, and water) required to complete the park
- a polynomial expression for the area and volume of each feature, using a variable for one of the dimensions