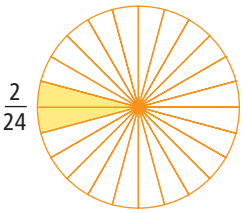
6

Introduction to Fraction Operations

On average, teens in Canada spend about 2 h a day watching TV. There are 24 h in a day. That means many teens watch TV for 2 out of 24 h.

This amount can be shown as $\frac{2}{24}$ in a diagram.



How much of your day do you spend watching TV?

What You Will Learn

- to determine if a number is divisible by 2, 3, 4, 5, 6, 8, 9, 10
- to show why a number cannot be divided by 0
- to write fractions in lowest terms
- to add and subtract fractions with like denominators

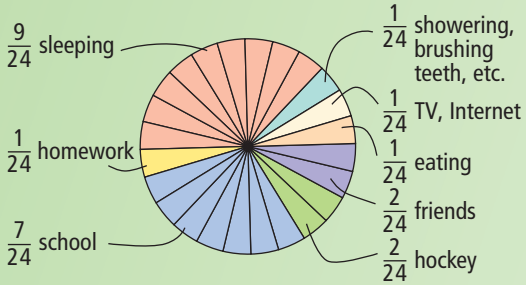
Key Words

divisible
common factor
lowest terms

MATH LINK

The diagram shows the fraction of time Joseph spends on all the things he does during a 24-h day.

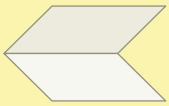
What fraction of the day do you spend playing sports, in school, or sleeping? In this chapter, you will create your own diagram showing all the things you do in a day.



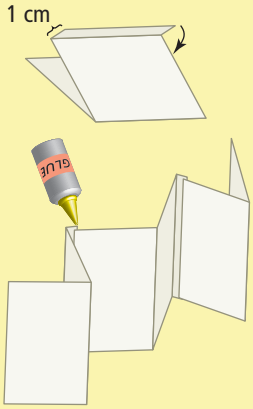
FOLDABLES™
Study Tool

Make the following Foldable to organize what you learn in Chapter 6.

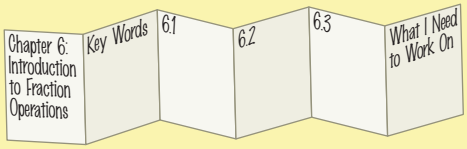
Step 1 Collect three sheets of paper. Fold each sheet of paper in half as shown.



Step 2 Fold a 1-cm tab along the edge of two of the folded sheets of paper. Glue the papers together along the tabs.



Step 3 Label the sections made by each fold.



Literacy Link

As you work through Chapter 6, make notes on the appropriate fold. Include information about the key words, examples, and key ideas.

6.1 Divisibility

Focus on...

After this lesson, you will be able to...

- determine if a number can be divided evenly by 2, 3, 4, 5, 6, 8, 9, 10
- show why a number is not divisible by 0
- find the factors of a number using divisibility rules
- write a fraction in lowest terms using common factors

It's the first day of summer camp. The campers have been divided into 9 groups. Stacy, the camp leader, has a box of 207 "Fun Times Nature Camp" T-shirts. In her head, Stacy quickly figures out that she will be able to divide the 207 T-shirts equally among the 9 groups. How did she do this?

Explore the Math

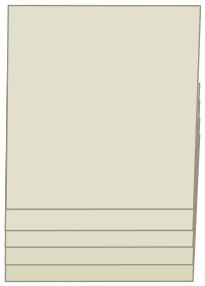
Materials

- number charts
- coloured pencils
- counters or coins

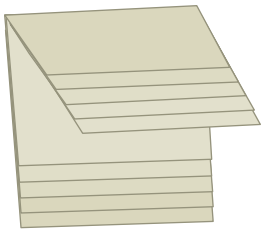
FOLDABLES™ Study Tool

What are the divisibility rules for 2, 3, 4, 5, 6, 8, 9, and 10?

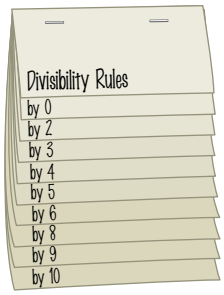
1. Make the following Foldable to organize what you learn in this Explore the Math.
   a) Use five sheets of paper. Put them in a pile so they overlap by 1.5 cm. Keep the edges straight.



b) Fold the top edge of the paper. Stop 1.5 cm from the bottom edge. Staple together along the fold.



c) Label the tabs.



Part 1: Divisibility Rules for 2, 5, and 10

2. Use a chart of the numbers 21 to 120.

a) Colour each number that is **divisible** by 2 yellow.

b) Circle each number that is divisible by 5.

c) Put an X through each number that is divisible by 10.

21	22	23	24	25	26	27	28	29	~~30~~
31	32	33	34	35	36	37	38	39	~~40~~

divisible

- when a number can be divided by another number, with no remainder

3. a) The yellow numbers are divisible by 2. Look at the last digit of each yellow number. Are these digits even or odd?

b) The circled numbers are divisible by 5. Look at the last digit of each circled number. What do you notice?

c) The numbers with an X are divisible by 10. Look at the last digit of each number with an X. What do you notice?

d) Look at the numbers divisible by 10. What other numbers are they divisible by?

Literacy Link

Even and Odd

Even numbers are 0, 2, 4, 6, 8, and so on.

Odd numbers are 1, 3, 5, 7, 9, and so on.

Reflect on Your Findings

4. a) Describe a divisibility rule for 2.

b) Describe a divisibility rule for 5.

c) Describe a divisibility rule for 10.

d) Add your rules to the Foldable you created in #1. Include examples.

Part 2: Divisibility Rules for 4 and 8

5. Use a chart of the numbers 1044 to 1143.

a) Colour each number that is divisible by 4 yellow.

b) Circle each number that is divisible by 8.

1044	1045	1046	1047	1048	1049	1050	1051	1052	1053
1054	1055	1056	1057	1058	1059	1060	1061	1062	1063

For example, the number formed by the last two digits of 1044 is 44.

6. a) The yellow numbers are all divisible by 4. Look at the last two digits of one of these numbers. What is the number formed by these two digits? Divide it by 2.

b) Is the quotient odd or even? If it is even, divide by 2 again.

c) Is the quotient a whole number or a decimal number?

d) Choose another yellow number. Divide by 2 twice. Is the final quotient a whole number or a decimal number?

e) Choose a number that is not yellow. Divide by 2 twice. Is the final quotient a whole number or a decimal number?

Literacy Link

Quotient

A quotient is the result of a division In $12 \div 2 = 6$, the quotient is 6.

7. a) The circled numbers are divisible by 8. Choose one circled number. Divide it by 2.

b) Is the quotient odd or even? If it is even, divide by 2 again.

c) Is the quotient odd or even? If it is even, divide by 2 again.

d) Is the quotient a whole number or a decimal number?

e) Choose another circled number. Divide by 2 three times. Is the final quotient a whole number or a decimal number?

f) Choose a number that is not circled. Divide by 2 three times. Is the final quotient a whole number or a decimal number?

Reflect on Your Findings

8. a) Describe a divisibility rule for 4.

b) Describe a divisibility rule for 8.

c) Add your rules to the Foldable you created in #1. Include examples.

Part 3: Divisibility Rules for 3, 6, and 9

9. Use a chart of the numbers 0 to 99.

a) Colour each number that is divisible by 3 yellow.

b) Circle each number that is divisible by 9.

c) Put an X through each number that is divisible by 6.

0	1	2	3	4	5	6	7	8	9
10	11	12	13	14	15	16	17	18	19

10. **a)** The yellow numbers are divisible by 3. Calculate the sum of the digits of a few of these numbers. Continue to calculate the sum of the digits until you get a one-digit number. What number other than 1 is each sum divisible by?

b) The circled numbers are divisible by 9. Calculate the sum of the digits of a few of these numbers. What is the largest single-digit number that each sum is divisible by? Look at the chart. What other number are these numbers divisible by, other than 1?

c) Put a vertical blue line | through the numbers that are divisible by 2. The numbers with an X are divisible by 6. What other two numbers are the numbers with an X divisible by?

For example, this is what you do for 93:
$9 + 3 = 12$
$1 + 2 = 3$

Reflect on Your Findings

11. **a)** Describe a divisibility rule for 3.

b) Describe a divisibility rule for 6.

c) Describe a divisibility rule for 9.

d) Add your rules to the Foldable you created in #1. Include examples.

Part 4: Divisibility by 0

12. Use six counters or coins.

a) Divide your counters into groups of 3. How many groups do you get?

b) Divide your counters into groups of 2. How many groups do you get?

c) Divide your counters into groups of 1. How many groups do you get?

d) Divide your counters into groups of 0. Can you describe how many groups you get? Explain.

Strategies
Look for a Pattern
Refer to page xvii.

13. Copy and fill in the blanks.

a) $3 \times \square = 12 \quad 12 \div 3 = \square$

b) $2 \times \square = 12 \quad 12 \div 2 = \square$

c) $1 \times \square = 12 \quad 12 \div 1 = \square$

d) $0 \times \square = 12 \quad 12 \div 0 = \square$

Reflect on Your Findings

14. Describe what you learned about divisibility by 0.

WWW Web Link
For more information about the number zero, go to www.mathlinks7.ca and follow the links.

Example 1: Use Divisibility Rules to Sort Numbers

a) Sort the numbers according to divisibility by 6 and 9.
30 79 162 3996 23 517 31 974

b) If a number is divisible by both 6 and 9, what is the smallest number other than 1 that it is also divisible by? How do you know?

Solution

a) Check for divisibility by 6. Is the number divisible by both 2 and 3? Check for divisibility by 9. Is the sum of the digits divisible by 9? Use an organizer such as a Carroll diagram or Venn diagram.

Literacy Link

Carroll Diagram

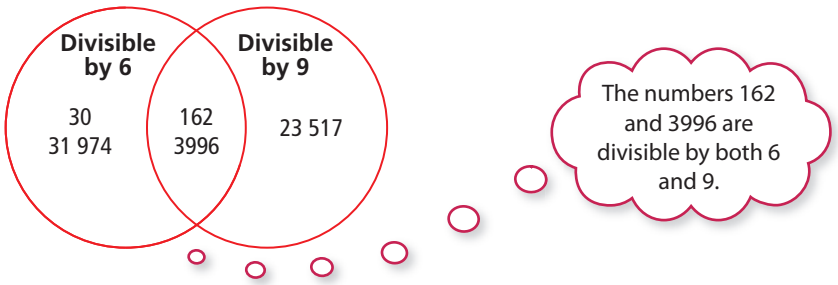
A Carroll diagram is a table that shows how numbers are the same and different.

	Divisible by 9	**Not Divisible by 9**
Divisible by 6	162 3996	30 31 974
Not Divisible by 6	23 517	79

Literacy Link

Venn Diagram

A Venn diagram shows relationships between groups of numbers.



b) Since 6 is divisible by 3, and 9 is divisible by 3, any number divisible by both 6 and 9 will also be divisible by 3.

The numbers 162 and 3996 are both divisible by 6 and 9, so they will also be divisible by 3.

Check:
$162 \div 3 = 54$
$3996 \div 3 = 1332$

Show You Know

a) Sort the numbers according to divisibility by 4 and 5.
93 540 955 8060 67 982 84 430

b) If a number is divisible by 4 and 5, what other number is it divisible by? How do you know?

Example 2: Use Divisibility Rules to Determine Factors

a) What are the factors of 24?

b) What are the factors of 32?

c) What are the **common factors** of 24 and 32?

d) What is the greatest common factor of 24 and 32?

common factor

- a number that two or more numbers are divisible by
- 4 is a common factor of 8 and 12

Solution

a) Use divisibility rules to determine the factors.

24 is divisible by 1. $1 \times 24 = 24$

24 is divisible by 2 because it is even. $2 \times 12 = 24$

24 is divisible by 3 because the sum of the digits, $2 + 4 = 6$, is divisible by 3. $3 \times 8 = 24$

24 is divisible by 4 because the number formed by the two digits is divisible by 2 at least twice. $4 \times 6 = 24$

The factors of 24 are 1, 2, 3, 4, 6, 8, 12, and 24.

All numbers are divisible by 1.

Literacy Link

The greatest common factor is the largest number that both numbers are divisible by.

b) Use divisibility rules to determine the factors.

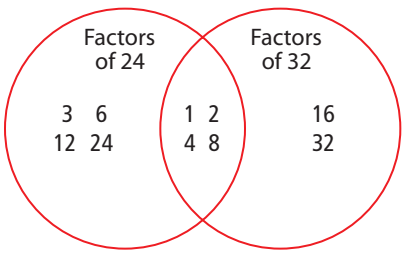
32 is divisible by 1. $1 \times 32 = 32$

32 is divisible by 2 because it is even. $2 \times 16 = 32$

32 is divisible by 4 because the number formed by the two digits is divisible by 2 at least twice. $4 \times 8 = 32$

The factors of 32 are 1, 2, 4, 8, 16, and 32.

c)



The common factors of 24 and 32 are 1, 2, 4, and 8.

d) The greatest common factor of 24 and 32 is 8.

Show You Know

a) What are the factors of 30?

b) What are the factors of 18?

c) What are the common factors of 30 and 18?

d) What is the greatest common factor of 30 and 18?

WWW Web Link

To learn more about factoring and Venn diagrams, go to www.mathlinks7.ca and follow the links.

Example 3: Use Divisibility Rules to Write a Fraction in Lowest Terms

lowest terms

- a fraction is in lowest terms when the numerator and denominator of the fraction have no common factors other than 1

Write $\frac{12}{42}$ in **lowest terms**.

Solution

Method 1: Divide by Common Factors

Use divisibility rules to determine common factors.

12 is divisible by 2 because it is even.

42 is divisible by 2 because it is even.

Divide the numerator and denominator by the common factor 2.

$$\frac{12}{42} \overset{\div 2}{=} \frac{6}{21}$$

Keep dividing by common factors until the only common factor is 1. Can you divide again?

6 is divisible by 3.

21 is divisible by 3 because the sum of the digits, $2 + 1 = 3$, is divisible by 3.

Divide by the common factor 3.

$$\frac{6}{21} \overset{\div 3}{=} \frac{2}{7}$$

Can you divide again?

Stop dividing when the only common factor is 1.

There are no common factors for 2 and 7 other than 1.

$\frac{12}{42} = \frac{2}{7}$

So, $\frac{12}{42}$ can be written in lowest terms as $\frac{2}{7}$.

Method 2: Divide by the Greatest Common Factor

Use divisibility rules to determine the factors of 12:

12 is divisible by 1.	$1 \times 12 = 12$
12 is divisible by 2 because it is even.	$2 \times 6 = 12$
12 is divisible by 3 because the sum of the digits, $1 + 2 = 3$, is divisible by 3.	$3 \times 4 = 12$

The factors of 12 are 1, 2, 3, 4, 6, and 12.

You do not need to divide by 4, 6, and 12 because the multiplication shows that they are factors of 12.

Use divisibility rules to determine the factors of 42:

42 is divisible by 1.	$1 \times 42 = 42$
42 is divisible by 2 because it is even.	$2 \times 21 = 42$
42 is divisible by 3 because the sum of the digits, $4 + 2 = 6$, is divisible by 3.	$3 \times 14 = 42$
42 is divisible by 6 because it is divisible by 2 and 3.	$6 \times 7 = 42$

The factors of 42 are 1, 2, 3, 6, 7, 14, 21, and 42.

The common factors of 12 and 42 are 1, 2, 3, and ⑥.

The greatest common factor is 6.

Write $\frac{12}{42}$ in lowest terms by dividing the numerator and denominator by 6.

$$\frac{12}{42} \overset{\div 6}{=} \frac{2}{7}$$

So, $\frac{12}{42}$ can be written in lowest terms as $\frac{2}{7}$.

Show You Know

Write each fraction in lowest terms.

a) $\frac{20}{24}$ **b)** $\frac{12}{18}$

Key Ideas

Divisibility Rules

A number is divisible by . . .	If . . .
2	the last digit is even (0, 2, 4, 6, or 8)
3	the sum of the digits is divisible by 3
4	the number formed by the last two digits is divisible by 2 at least twice
5	the last digit is 0 or 5
6	the number is divisible by both 2 and 3
8	the number is divisible by 2 at least three times
9	the sum of the digits is divisible by 9
10	the last digit is 0

- Numbers cannot be divided by 0.
- You can use the divisibility rules to find factors of a number.
- You can write fractions in lowest terms by dividing the numerator and the denominator by common factors until the only common factor is 1.

Communicate the Ideas

1. a) Why is a number that is divisible by 6 also divisible by 2 and 3?

b) A number is divisible by 10. What other numbers is the number divisible by? How do you know?

2. a) Explain one method for determining the greatest common factor of 36 and 20.

b) Share your answer with a partner.

3. Simone wrote $\frac{18}{30}$ in lowest terms as $\frac{6}{10}$.

a) Is she finished yet? Explain.

b) Show a method for writing $\frac{18}{30}$ in lowest terms.

4. Explain what you know about divisibility by 0. Include an example in your explanation.

Practise

For help with #5 to #8, refer to Example 1 on page 202.

5. Which of the following numbers are divisible by 5? Explain how you know.

1010 554 605 902 900 325

6. Which of the following numbers are divisible by 4? Explain how you know.

124 330 3048 678 982 1432

7. **a)** Use a diagram or table to sort the numbers according to divisibility by 4 and 8.

312 330 148 164 264 13 824

b) If a number is divisible by 4 and 8, what is the smallest number other than 1 that it is also divisible by? How do you know?

8. **a)** Using a diagram or table, sort the numbers based on divisibility by 6 and 10.

5832 35 010 243 9810 31 990

b) If a number is divisible by 6 and 10, what is the smallest number other than 1 that it is also divisible by? How do you know?

For help with #9 to #14, refer to Example 2 on page 203.

9. Use the divisibility rules to list the factors of the following numbers.

a) 36 **b)** 15 **c)** 28

10. What are the factors of these numbers?

a) 18 **b)** 54 **c)** 72

11. Use the divisibility rules to determine the common factors for each pair of numbers.

a) 3 and 6

b) 4 and 8

c) 6 and 12

12. What are the common factors for each pair of numbers?

a) 5 and 10

b) 4 and 12

c) 24 and 15

13. **a)** Use the divisibility rules to determine the common factors of 16 and 20. Include a Venn diagram as part of your answer.

b) What is the greatest common factor of 16 and 20?

14. **a)** What are the common factors of 10 and 30? Include a Venn diagram with your answer.

b) Identify the greatest common factor of 10 and 30.

For help with #15 and #16, refer to Example 3 on pages 204–205.

15. Write the following fractions in lowest terms.

a) $\frac{15}{20}$ **b)** $\frac{6}{18}$ **c)** $\frac{10}{16}$

d) $\frac{9}{12}$ **e)** $\frac{4}{10}$ **f)** $\frac{9}{15}$

16. Write each fraction in lowest terms.

a) $\frac{12}{16}$ **b)** $\frac{6}{12}$ **c)** $\frac{8}{20}$

d) $\frac{14}{24}$ **e)** $\frac{5}{10}$ **f)** $\frac{12}{15}$

Apply

17. A shipment of flowers has arrived at Mr. Greenthumb's nursery. He has to sort them into groups.

Flower	Number in Shipment
A daisies	336
B roses	120
C pansies	244
D marigolds	118
E lilies	321

a) Which flowers can he divide into groups of 2?

b) Which flowers can he divide into groups of 3?

c) What is a quick way for Mr. Greenthumb to know which flowers he can divide into groups of 6? Explain.

18. **a)** Write a five-digit number that is divisible by 3 and 5.

b) Write a seven-digit number that is divisible by 6.

19. A grocery store sells apples in bags of 8 only. Using divisibility rules, determine if you can buy exactly

a) 116 apples

b) 168 apples

c) 194 apples

20. Anita says that if 6, 10, and 15 are factors of a number, that means 2, 3, and 5 are also factors. Is she correct? Explain how you know.

21. Matthew finds the divisibility rule for 9 difficult to use. Is there a way of making this rule easier to use? Explain.

22. Amouyuk's class and Iblauk's class are going on a trip. There are 30 students in Amouyuk's class and 24 in Iblauk's class. There will be an equal number of students from Amouyuk's class and an equal number from Iblauk's class in each komatik, and no more than 10 students in each.

Komatik, or Sled

a) How many students will travel in each komatik?

b) How many komatiks will be needed?

23. There were 12 ripe peaches on a tree. Four children shared them equally. When 12 more peaches were ripe, no children came to pick them. Can the peaches be shared among 0 children? Use this example to explain divisibility by 0.

24. Andrea is the head of the local baseball league. She plans to divide the bats and balls equally among as many teams as she can. There are 16 bats and 40 balls. What is the greatest number of teams she can divide them among? Use a diagram or a table to help you determine the answer.

Extend

25. Adam and Kayla are going to fill their little sister's pool. It holds 616 L of water.

a) Which of the following containers can they use to fill the pool exactly to 616 L without having any water left over?

A 9-L wheelbarrow

B 8-L barrel

C 6-L bucket

D 2-L jug and a 5-L pail

b) For the containers they can use, how many of each container would they need?

26. A parallelogram has an area of 48 cm^2 and a rectangle has an area of 64 cm^2. They have the same base.

a) What is the least possible height the parallelogram could have?

b) What is the least possible height the rectangle could have?

27. George is arranging sandwiches on a tray for a class party. If he arranges the sandwiches in rows of 2, 3, 4, 5, or 6 he always has exactly one sandwich left over each time. What is the smallest number of sandwiches that he could have?

28. What is the smallest number you must add to each of the following numbers so that the sum is divisible by 3?

a) 24 683 + ■ **b)** 502 + ■

c) 5439 + ■

MATH LINK

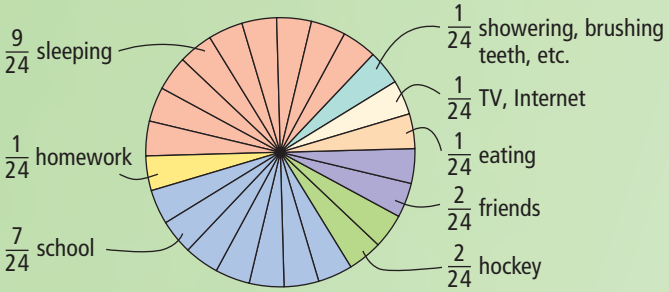
The diagram shows the fraction of time Joseph spends on all his activities during a 24-h day.

a) Use the divisibility rules to find the factors of 24.

b) Use the factors of 24 to help you write the fractions in the diagram in lowest terms.

c) Are there fractions that you could not rewrite in lowest terms? Which ones? Why?

d) How would you change the diagram now that you have written the fractions in lowest terms? Explain.

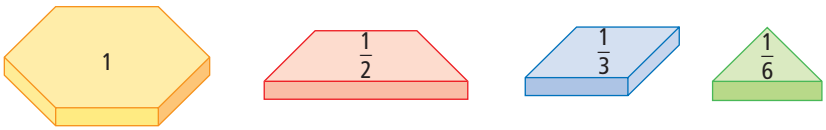


6.2 Add Fractions With Like Denominators

Focus on...

After this lesson, you will be able to...

- ❑ add fractions with like denominators using models, diagrams, and addition statements



Kendra used pattern blocks to show 1 in several different ways.

How can she use pattern blocks to add fractions?

Explore the Math

Materials

- pattern blocks

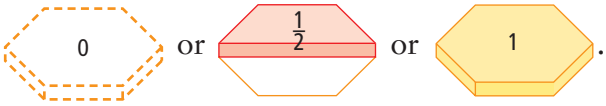
How can you use pattern blocks to estimate sums and add fractions?

1. Use pattern blocks to show $\frac{1}{3} + \frac{1}{3}$.

To compare, use the pattern blocks that represent $\frac{1}{2}$ and 1.

2. a) Compare the blocks that show $\frac{1}{3} + \frac{1}{3}$ to 0, $\frac{1}{2}$, and 1.

b) Estimate whether $\frac{1}{3} + \frac{1}{3}$ is closest to



.

3. What is the answer to $\frac{1}{3} + \frac{1}{3}$?

Reflect on Your Findings

4. a) How do models such as pattern blocks help you to estimate sums of fractions?

b) How do models such as pattern blocks help you to add fractions?

Example 1: Add Fractions Using Models

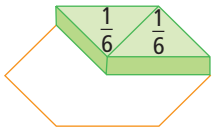
Add using models. Write the answer in lowest terms.

$\frac{1}{6} + \frac{1}{6}$

Solution

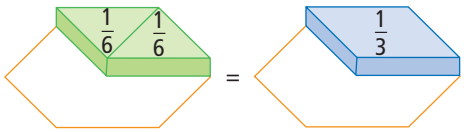
Method 1: Use Pattern Blocks

$\frac{1}{6} + \frac{1}{6} = \frac{2}{6}$



Write $\frac{2}{6}$ in lowest terms.

$\frac{2}{6} = \frac{1}{3}$

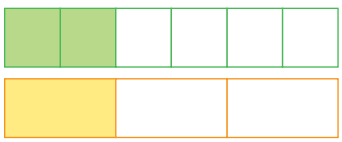


Method 2: Use Fraction Strips

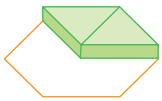
$\frac{1}{6} + \frac{1}{6} = \frac{2}{6}$

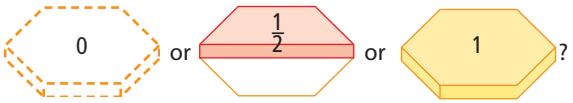
Write $\frac{2}{6}$ in lowest terms.

$\frac{2}{6} = \frac{1}{3}$



You can estimate the answer.

Is  closest to



It is closest to $\frac{1}{2}$.

Each time you write a fraction in lowest terms, you are writing an equivalent fraction.

Show You Know

Add using models. Write your answer in lowest terms.

a) $\frac{1}{4} + \frac{1}{4}$ **b)** $\frac{2}{3} + \frac{1}{3}$

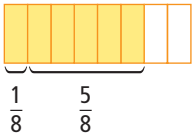
Example 2: Add Fractions Using a Diagram

Add using a diagram. Write the answer in lowest terms.

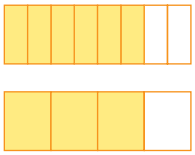
$\frac{1}{8} + \frac{5}{8}$

Solution

$\frac{1}{8} + \frac{5}{8} = \frac{6}{8}$



Write $\frac{6}{8}$ in lowest terms.



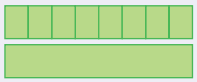
$\frac{6}{8} = \frac{3}{4}$

Literacy Link

Fractions Equivalent to 1

If the numerator and denominator are the same number, the fraction equals 1.

$\frac{8}{8} = 1$



Show You Know

Add. Write your answer in lowest terms.

a) $\frac{2}{5} + \frac{1}{5}$ **b)** $\frac{1}{10} + \frac{9}{10}$

Example 3: Add Fractions Using an Addition Statement

Add. Write the answer in lowest terms.

$\frac{7}{10} + \frac{1}{10}$

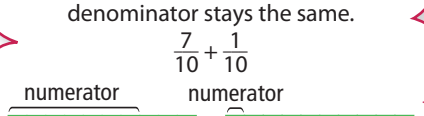
Solution

$\frac{7}{10} + \frac{1}{10} = \frac{7 + 1}{10}$

$= \frac{8}{10}$

When you add fractions with like denominators, you add the numerators to get the sum of the parts. The denominator stays the same.

$\frac{7}{10} + \frac{1}{10}$



Write $\frac{8}{10}$ in lowest terms.

$\frac{8}{10} \overset{\div 2}{=} \frac{4}{5}$

2 is a factor of both 8 and 10.

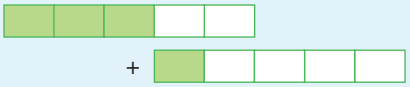
Show You Know

Add. Write your answer in lowest terms.

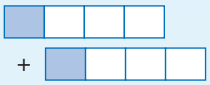
a) $\frac{5}{12} + \frac{1}{12}$ **b)** $\frac{4}{9} + \frac{2}{9}$

Key Ideas

- When adding fractions using models or diagrams, use parts of the whole that are of equal size.

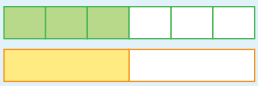


$\frac{3}{5} + \frac{1}{5}$



$\frac{1}{4} + \frac{1}{4}$

- To estimate the sum of two fractions, compare fractions to 0, $\frac{1}{2}$, or 1.
- To add fractions with like denominators, add the numerators. The denominator stays the same.
- You can use models, diagrams, or factors to help you write your answer in lowest terms.



$\frac{3}{6} = \frac{1}{2}$

$\frac{2}{4} = \frac{1}{2}$

$\frac{6}{15} \overset{\div 3}{=} \frac{2}{5}$

Communicate the Ideas

1. a) Show how you would model $\frac{5}{6} + \frac{1}{6}$.

b) Discuss your model with a partner. Are your models the same? If they are, discuss another model you could have used.

2. a) Add: $\frac{3}{8} + \frac{1}{8}$.

b) When you added, what did you do with the numerators of the two fractions?

c) What did you do with the denominators of the two fractions?

d) Explain why you added in this way. Use diagrams as part of your answer.

3. How could you write your answer for #2 in lowest terms? Explain what you did.

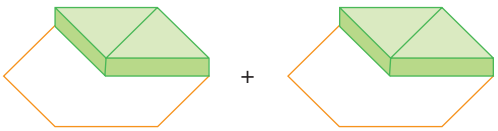
4. Describe a situation when it might be better not to put a fraction in lowest terms.

Practise

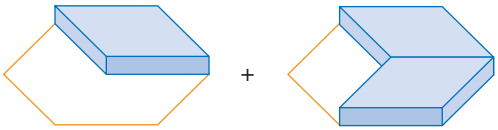
For help with #5 and #6, refer to Example 1 on page 211.

5. Write each addition statement shown by the pattern blocks. Estimate the answer, and then add.

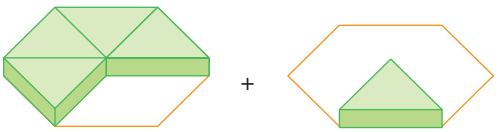
a)



b)



c)



6. Write each addition statment shown by the fraction strips. Estimate the answer, and then add.

a)

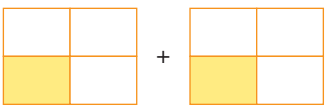
b)

c)

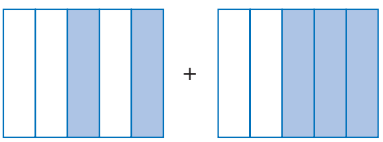
For help with #7 and #8, refer to Example 2 on page 212.

7. Write each addition statement shown by the diagrams. Then add. Write your answer in lowest terms.

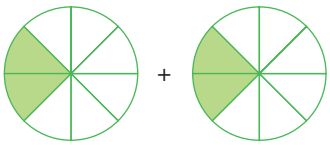
a)



b)

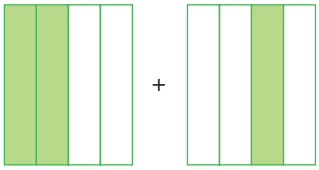


c)

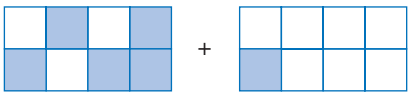


8. Write each addition statement shown by the diagrams. Then add. Write your answer in lowest terms.

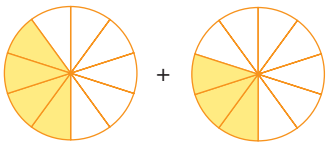
a)



b)



c)



For help with #9 and #10, refer to Example 3 on page 212.

9. What is the sum of each fraction statement? Write each answer in lowest terms.

a) $\frac{1}{6} + \frac{1}{6}$

b) $\frac{1}{4} + \frac{1}{4}$

c) $\frac{3}{5} + \frac{1}{5}$

d) $\frac{5}{12} + \frac{1}{12}$

e) $\frac{3}{10} + \frac{7}{10}$

f) $\frac{2}{9} + \frac{1}{9}$

10. Determine the sum of each fraction statement. Write each answer in lowest terms.

a) $\frac{1}{7} + \frac{2}{7}$

b) $\frac{5}{12} + \frac{5}{12}$

c) $\frac{1}{3} + \frac{1}{3}$

d) $\frac{4}{9} + \frac{2}{9}$

e) $\frac{1}{4} + \frac{3}{4}$

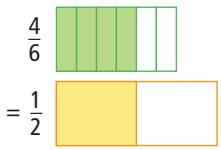
f) $\frac{7}{15} + \frac{2}{15}$

Apply

11. Carl and Mark shovelled the snow from Mark's driveway.

Did the boys shovel the whole driveway? Explain how you know.

12. Jamal's answer for $\frac{1}{6} + \frac{3}{6}$ was $\frac{4}{6}$. He used this method to write $\frac{4}{6}$ in lowest terms:



a) Was Jamal's method correct? Explain.

b) If not, use diagrams to show what Jamal should have done.

13. Suzanne answered $\frac{1}{10} + \frac{3}{10}$ this way:

$\frac{1}{10} + \frac{3}{10} = \frac{4}{20}$

a) Is Suzanne correct?

b) If not, what is the correct answer?

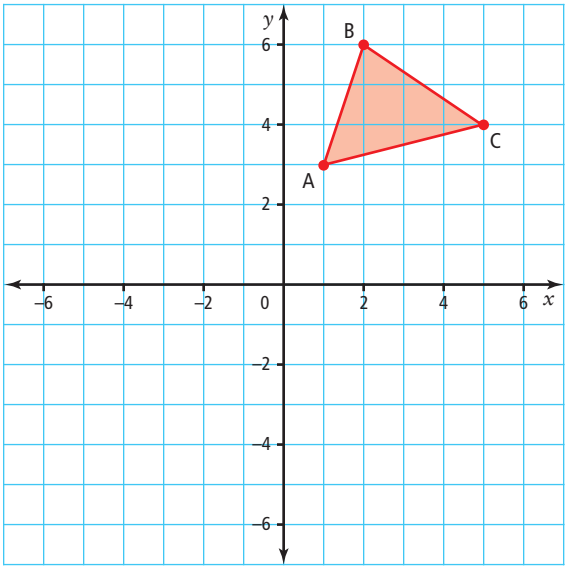
14. Faith and Lucy made bannock for lunch. Faith cooked $\frac{5}{8}$ of the batter. Lucy cooked $\frac{1}{8}$. Did they use it all up? Show your work.

Did You Know?

Bannock is a flat, round bread made by Métis and many Western Canadian Aboriginal peoples. It originated in Scotland.

Extend

15. Draw $\triangle ABC$ on a coordinate grid.



a) The triangle is rotated $\frac{1}{4}$ turn clockwise about the origin. Draw $\triangle A'B'C'$.

b) The triangle is rotated another $\frac{1}{4}$ turn clockwise. Draw $\triangle A''B''C''$.

c) Use an addition statement to show how to determine the total turn.

16. Each performance in the dance recital was $\frac{1}{4}$ h long. There were 3 performances.

How long was the recital? Include a diagram with your answer.

17. a) Draw a diagram to show $\frac{1}{8} + \frac{1}{8} + \frac{3}{8}$.

b) Draw a diagram to show $\frac{5}{12} + \frac{1}{12} + \frac{1}{12}$.

c) Which sum is larger? How do you know?

18. Dakota has one bag of beads. She is going to make three different necklaces. For the first necklace, she needs $\frac{3}{8}$ of a bag of beads. For the second, she needs $\frac{1}{8}$ of a bag of beads. For the third, she needs $\frac{5}{8}$ of a bag.

a) What fraction of a bag of beads does she need?

b) Does she have enough? Explain.

MATH LINK

During an average weekday, how many hours do you spend doing all the things you do?

a) Draw a table and fill it in to show your results. You might begin like this:

Activities	Amount of Time	Fraction of 24-Hour Day
sleeping	■ h	$\frac{■}{24}$
going to school	■ h	$\frac{■}{24}$
doing after-school activities	■ h	$\frac{■}{24}$

- Each activity must be described in hours: 1 h, 2 h, 3 h, and so on. If an activity takes only part of an hour, group it together with other shorter activities. For example, if you watch TV for 30 min, listen to music for 15 min, and talk on the phone for 15 min, this adds up to 60 min, or 1 h.
- Show each amount of time as a fraction of a 24-h day. For example, if you spend 2 h doing homework out of 24 h, that is $\frac{2}{24}$.

b) Once you are finished, add all of the fractions.

c) What should the fractions add up to? Why? If the fractions do not add up correctly, look at your list of activities again. See what you might have missed or what times you need to fix.

6.3 Subtract Fractions With Like Denominators

Focus on...

After this lesson, you will be able to...

- subtract fractions with like denominators using models, diagrams, and subtraction statements

Molly is participating in a marathon to raise money for charity. She has $\frac{2}{3}$ of the way to go. After she completes another $\frac{1}{3}$ of the marathon, how much of the marathon will be left?

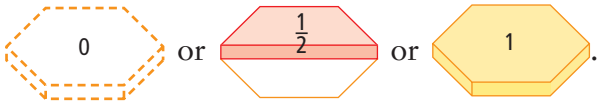
Explore the Math

Materials

- pattern blocks

How can you use pattern blocks to estimate differences and subtract fractions?

1. Use two identical pattern blocks to represent $\frac{2}{3}$.
2. Remove a pattern block to show $\frac{2}{3} - \frac{1}{3}$.
3. Estimate whether $\frac{2}{3} - \frac{1}{3}$ is closest to



.

4. What is the answer to $\frac{2}{3} - \frac{1}{3}$?

Reflect on Your Findings

5. a) How do models such as pattern blocks help you to estimate a difference between two fractions?
   b) How do models such as pattern blocks help you to subtract fractions?

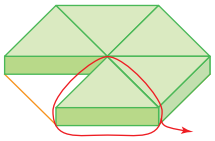
Example 1: Subtract Fractions Using Models

Subtract $\frac{5}{6} - \frac{1}{6}$ using models. Write the answer in lowest terms.

Solution

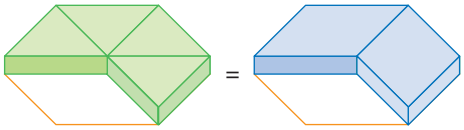
Method 1: Use Pattern Blocks

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



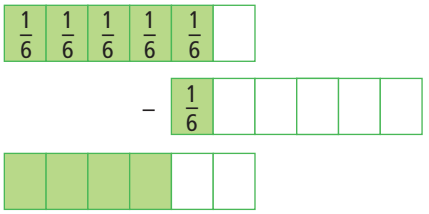
Write $\frac{4}{6}$ in lowest terms.

$\frac{4}{6} = \frac{2}{3}$



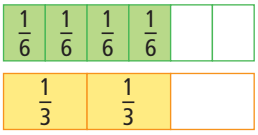
Method 2: Use Fraction Strips

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



Write $\frac{4}{6}$ in lowest terms.

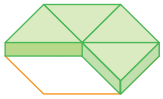
$\frac{4}{6} = \frac{2}{3}$



ME

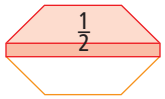
You can estimate the answer.

Is

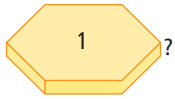


closest to

or



or



?

It is closest to $\frac{1}{2}$.

Show You Know

Subtract using models. Write your answers in lowest terms.

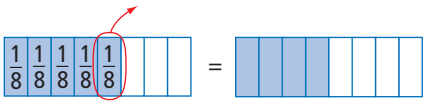
a) $\frac{3}{4} - \frac{1}{4}$ **b)** $\frac{1}{3} - \frac{1}{3}$

Example 2: Subtract Fractions Using Diagrams

Subtract $\frac{5}{8} - \frac{1}{8}$ using diagrams. Write the answer in lowest terms.

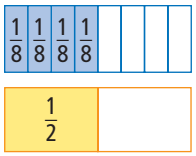
Solution

$\frac{5}{8} - \frac{1}{8} = \frac{4}{8}$



Write $\frac{4}{8}$ in lowest terms.

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



Show You Know

Subtract using diagrams. Write your answers in lowest terms.

a) $\frac{4}{5} - \frac{1}{5}$ **b)** $\frac{5}{8} - \frac{3}{8}$

Example 3: Subtract Fractions Using a Subtraction Statement

Subtract $\frac{11}{12} - \frac{7}{12}$. Write the answer in lowest terms.

Solution

$$\frac{11}{12} - \frac{7}{12} = \frac{11 - 7}{12}$$ Subtract the numerators. The denominator stays the same.

$$= \frac{4}{12}$$

Write $\frac{4}{12}$ in lowest terms.

$$\frac{4}{12} \overset{\div 4}{=} \frac{1}{3}$$

4 is a factor of both 4 and 12.

Show You Know

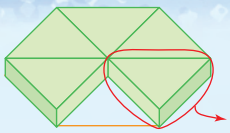
Subtract. Write your answers in lowest terms.

a) $\frac{7}{10} - \frac{3}{10}$ **b)** $1 - \frac{1}{9}$

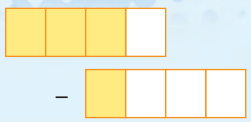
You can change 1 to a fraction to help you subtract. How many ninths are there in 1?

Key Ideas

- When subtracting fractions using models or diagrams, remove parts of the whole that are of equal size.
- To estimate a difference, compare fractions to 0, $\frac{1}{2}$, or 1.
- To subtract fractions with like denominators, subtract the numerators. The denominator stays the same.
- You can use models, diagrams, or factors to help you write your answer in lowest terms.



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



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

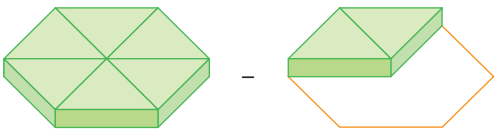
Communicate the Ideas

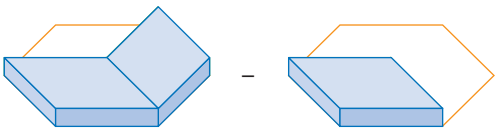
1. Describe how you could use pattern blocks to estimate $\frac{5}{6} - \frac{3}{6}$.
2. Describe how you could use models or diagrams to answer $\frac{2}{5} - \frac{1}{5}$. Explain why you chose the method you did.
3. Swee Lin wrote $\frac{7}{10} - \frac{3}{10} = \frac{4}{5}$.
   a) What was Swee Lin's error?
   b) Show the correct answer.
   c) What can you tell Swee Lin so that she will not make the same error again?

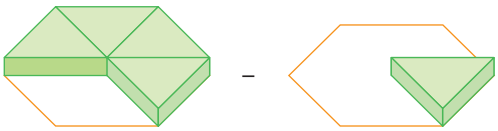
Practise

For help with #4 and #5, refer to Example 1 on page 218.

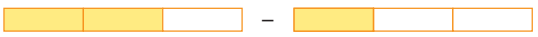
4. Write a subtraction statement for each set of pattern blocks. Estimate the answer, and then subtract.

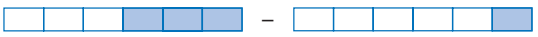
a) 

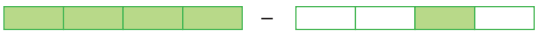
b) 

c) 

5. Write a subtraction statement for each set of fraction strips. Estimate the answer, and then subtract.

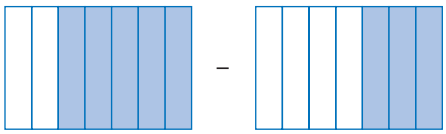
a) 

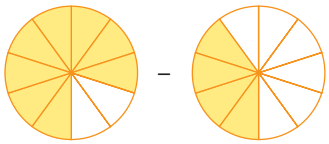
b) 

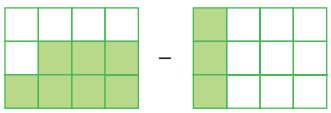
c) 

For help with #6 and #7, refer to Example 2 on pages 218–219.

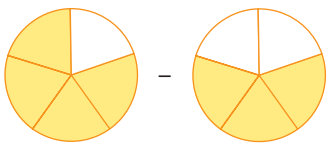
6. Write a subtraction statement for each diagram. Then subtract. Write your answer in lowest terms.

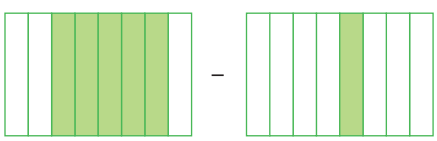
a) 

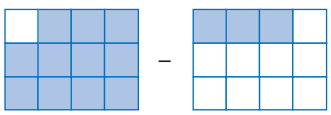
b) 

c) 

7. Write a subtraction statement for each diagram. Then subtract. Write your answer in lowest terms.

a) 

b) 

c) 

For help with #8 and #9, refer to Example 3 on page 219.

8. Subtract. Write your answer in lowest terms.

a) $\frac{2}{7} - \frac{1}{7}$ **b)** $\frac{5}{12} - \frac{1}{12}$ **c)** $\frac{2}{3} - \frac{1}{3}$

d) $\frac{4}{9} - \frac{2}{9}$ **e)** $\frac{7}{10} - \frac{3}{10}$ **f)** $1 - \frac{2}{5}$

9. Determine the difference. Write your answer in lowest terms.

a) $\frac{5}{6} - \frac{1}{6}$ **b)** $\frac{8}{9} - \frac{1}{9}$ **c)** $\frac{7}{12} - \frac{7}{12}$

d) $\frac{7}{12} - \frac{1}{12}$ **e)** $1 - \frac{3}{10}$ **f)** $\frac{7}{8} - \frac{3}{8}$

Apply

10. You order a six-slice pizza. You eat $\frac{5}{6}$ of the pizza. What fraction is left?

11. Matt is running a race. He still has $\frac{3}{4}$ of the race to go. If he runs $\frac{1}{4}$ more of the race, will he be halfway through? Explain.

Extend

12. Mrs. Bondarev needs $\frac{5}{9}$ of a bag of raisins to make a Ukrainian bread called babka. The bag is $\frac{8}{9}$ full. Her son eats $\frac{2}{9}$ of the bag. Her daughter eats another $\frac{2}{9}$ of the bag.

a) How much of the bag is left? Does she have enough to make the bread?

b) If not, how much more does she need?

13. The sum of two fractions is 1. If the difference between the two fractions is $\frac{2}{8}$, what are the two fractions?

14. Tom is in charge of the high kick game for Arctic Games day at his school. He was given two boxes of prizes. He has given out $\frac{7}{5}$ boxes. He estimates he will give out another $\frac{4}{5}$ box.

a) Does he have enough?

b) If he does not have enough, how much more does he need?

MATH LINK

With a partner, compare the table of daily activities you each made on page 216. For a), b), and c), show your answers in fractions, and then describe them in words.

a) Which of the same activities do you spend the same fraction of time on?

b) Which of the same activities do you spend more time on than your partner? How much more?

c) Which of the same activities do you spend less time on than your partner? How much less?

6 Chapter Review

Key Words

Unscramble the letters for each puzzle. Use the clues to help you solve the puzzles.

1. T E W L S O E M R T S
when the numerator and denominator of a fraction have no common factors other than 1 (two words)

2. L I B I I S V E D
when a number divides into another number, with no remainder

3. M O O M N C T R A C O F
a number that two or more numbers are divisible by (two words)

6.1 Divisibility, pages 198–209

4. Copy and complete the table. If the number in the left column is divisible by the number in the top row, put a ✓. If it is not divisible, put an ✗.

	2	3	4	5	6	8	9	10
630								
5184								
2035								
810								

5. a) How do you know that 210 is divisible by 2, 5, and 10?

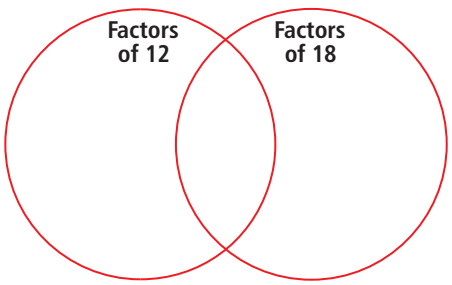
b) How do you know that 1232 is divisible by 4 and 8?

c) How do you know that 333 is divisible by 3 and 9 but not by 6?

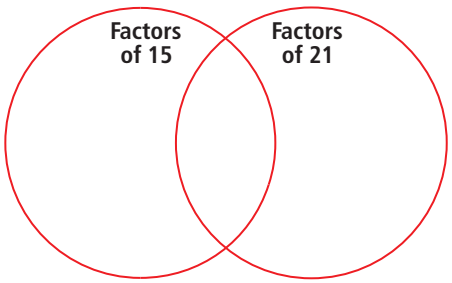
6. Use a pattern to show why numbers cannot be divided by 0.

7. Copy and complete the following Venn diagrams to determine the greatest common factor of each pair of numbers.

a)



b)



8. Write each fraction in lowest terms.

a) $\frac{4}{8}$ **b)** $\frac{6}{10}$

c) $\frac{20}{30}$ **d)** $\frac{15}{24}$

e) $\frac{12}{16}$ **f)** $\frac{10}{24}$

9. A drama teacher is putting his students into groups. There must be the same number of females in each group and the same number of males in each group. There are 12 males and 18 females. Each student must be in a group. What is the greatest number of groups there can be?

6.2 Add Fractions With Like Denominators, pages 210–216

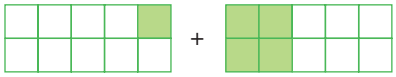
10. Write each addition statement shown by the fraction strips. Then add. Write each answer in lowest terms.

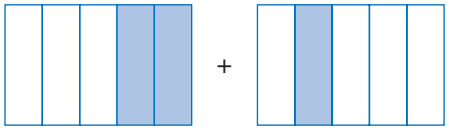
a) 

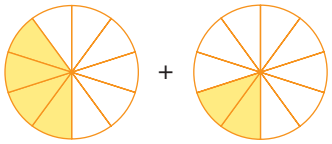
b) 

c) 

11. Write each addition statement shown. Add. Write each answer in lowest terms.

a) 

b) 

c) 

12. Add. Write each answer in lowest terms.

a) $\frac{2}{3} + \frac{1}{3}$

b) $\frac{3}{8} + \frac{1}{8}$

c) $\frac{1}{12} + \frac{5}{12}$

d) $\frac{3}{5} + \frac{1}{5}$

e) $\frac{1}{14} + \frac{1}{14}$

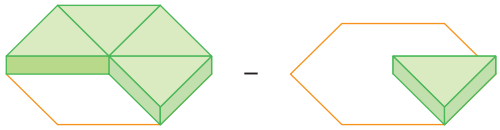
f) $\frac{2}{7} + \frac{4}{7}$

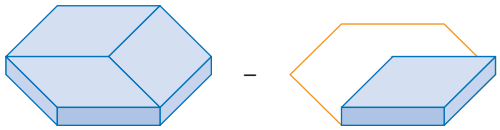
13. Two students volunteered to clean the desks in one of the classrooms.

Did the students get the job done? Explain.

6.3 Subtract Fractions With Like Denominators, pages 217–221

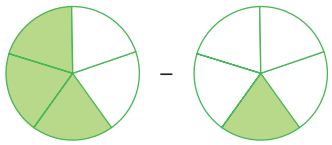
14. Write each subtraction statement shown by the pattern blocks. Then subtract. Write each answer in lowest terms.

a) 

b) 

15. Write a subtraction statement for each diagram. Then subtract. Write each answer in lowest terms.

a) 

b) 

16. Subtract. Write each answer in lowest terms.

a) $\frac{2}{3} - \frac{1}{3}$

b) $\frac{7}{8} - \frac{1}{8}$

c) $\frac{5}{6} - \frac{5}{6}$

d) $\frac{11}{15} - \frac{2}{15}$

e) $\frac{7}{8} - \frac{3}{8}$

f) $\frac{9}{10} - \frac{3}{10}$

17. Jack is making vegetable dip for a party. He needs $\frac{2}{5}$ of a jar of mayonnaise to make it. The jar is $\frac{4}{5}$ full. He drops it and only $\frac{1}{5}$ of a jar is left.

a) Does he have enough left in the jar to make the dip? If not, how much more does he need?

b) How much of the jar spilled out?

6 Practice Test

For #1 to #5, select the best answer.

1. When is a number divisible by 6?

A when it is divisible by 2

B when it is divisible by 3

C both A and B

D none of the above

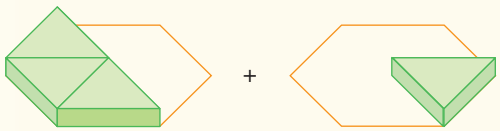
2. What is the greatest common factor of 15 and 18?

A 1 **B** 3 **C** 5 **D** 6

3. What is $\frac{8}{12}$ in lowest terms?

A $\frac{4}{6}$ **B** $\frac{3}{4}$ **C** $\frac{2}{3}$ **D** $\frac{1}{2}$

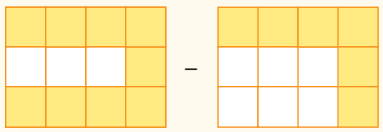
4. Which addition statement do the pattern blocks show?



A $\frac{3}{8} + \frac{1}{8}$ **B** $\frac{6}{3} + \frac{6}{1}$

C $\frac{3}{5} + \frac{1}{5}$ **D** $\frac{3}{6} + \frac{1}{6}$

5. Which subtraction statement does the diagram show?



A $\frac{10}{12} - \frac{6}{12}$ **B** $\frac{9}{12} - \frac{7}{12}$

C $\frac{9}{12} - \frac{6}{12}$ **D** $\frac{8}{12} - \frac{6}{12}$

Short Answer

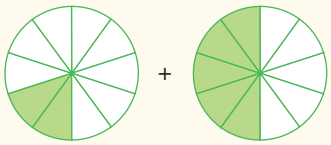
6. What are the common factors of 54 and 36? Use a diagram or table.

7. What is each fraction in lowest terms?

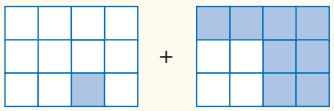
a) $\frac{8}{10}$ **b)** $\frac{15}{16}$ **c)** $\frac{12}{30}$

8. Write the addition expression that each diagram shows. Then add. Write each answer in lowest terms.

a)

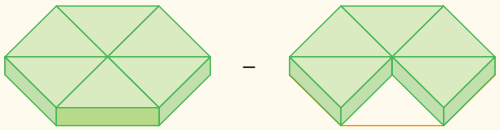


b)

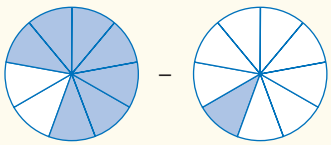


9. Write each subtraction statement shown. Then subtract. Write each answer in lowest terms.

a)



b)



10. Add. Write each answer in lowest terms.

a) $\frac{8}{15} + \frac{2}{15}$ **b)** $\frac{5}{6} + \frac{1}{6}$ **c)** $\frac{19}{24} + \frac{1}{24}$

11. Subtract. Write each answer in lowest terms.

a) $\frac{8}{9} - \frac{2}{9}$ **b)** $\frac{9}{14} - \frac{1}{14}$

c) $\frac{14}{15} - \frac{2}{15}$ **d)** $\frac{23}{24} - \frac{11}{24}$

12. The Li family is donating clothes to charity. Amy is giving away $\frac{3}{8}$ of a bag of clothes. Kevin is giving away $\frac{1}{8}$ of a bag.

a) How much are Amy and Kevin donating in total?

b) Mr. Li fills $\frac{3}{8}$ of a bag with clothes. What is the total now?

13. Jason needs $\frac{7}{9}$ of a can of paint to finish the doghouse he built. His father gives him a used can of red paint. $\frac{4}{9}$ has been used.

a) Is there enough paint left in the can? If not, how much more does Jason need?

b) Jason decides to use a new can of blue paint instead. How much will be left after he is finished painting?

Extended Response

14. How do you know that 1248 is divisible by 4 and 8?

15. Jonathon and Mia were given this question to answer:

Subtract. Write your answer in lowest terms.

$\frac{29}{30} - \frac{11}{30}$

Jonathon wrote this:

$\frac{29}{30} - \frac{11}{30} = \frac{16}{30}$

$= \frac{8}{15}$

Mia wrote this:

$\frac{29}{30} - \frac{11}{30} = \frac{18}{30}$

$= \frac{9}{15}$

a) Whose answer is correct? Show your work.

b) Is the answer in lowest terms? Explain.

16. Ann wrote $\frac{3}{6} + \frac{2}{6} = \frac{5}{12}$.

a) Was Ann correct? If not, what error did she make?

b) What can you tell Ann about adding fractions so that she will not make this error again?

c) What is the correct answer? Show your work.

WRAP IT UP!

a) Make a diagram using the data in your table of daily activities. Use Joseph's diagram on page 196 as an example.

b) Add to determine what fraction of the day you spend

- on school-related activities, such as going to school and doing homework
- on social activities, such as seeing friends and talking on the phone
- on recreational activities, such as after-school activities and video games
- on self-care activities such as sleeping, eating, and washing up

c) Compare the sets of activities in b). Make four comparisons. Each should involve subtraction. For example, do you spend a greater fraction of the day on recreational activities or on social activities? How much greater?

Math Games

It's Divisible

1. Play the It's Divisible game with a partner or in a small group.

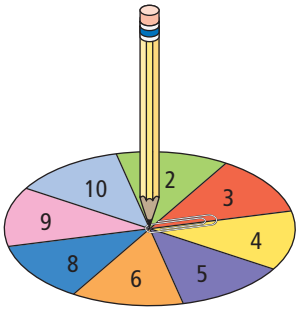
These are the rules:

- Each player rolls one die to decide who will play first. If there is a tie, roll again.
- For each turn, roll the three dice and spin the spinner.
- Make 3-digit numbers from the three numbers rolled. Check if any of the 3-digit numbers are divisible by the number spun.
- If you find at least one divisible number, you score the sum of the numbers showing on the three dice.
- If you do not find a divisible number, you score 0 points for this turn.
- Take turns until the winner reaches a total of at least 50 points.

I rolled 6, 5, and 1, and spun 4. I can make 651, 615, 516, 561, 165, and 156 from the numbers I rolled. The odd numbers cannot be divisible by 4. Both 516 and 156 are divisible by 4, because I can divide the number formed by the last two digits evenly by 4.

I rolled 6, 5, and 1. My score is 6 + 5 + 1 points, which is 12 points.

2. Is there a number spun that always gives a score of 0 points from one turn? Explain.



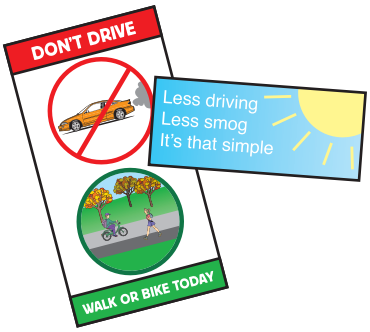
Materials

- 3 six-sided dice per pair or group of students
- 1 spinner per pair or group of students

- 1 paper clip per pair or group of students (to be used with the spinner)

Challenge in Real Life

1. Green Mathematics



Your community wants to reduce carbon dioxide (CO_2) emissions by $\frac{1}{20}$.

You be the Green Team! Work as a team to create an advertising campaign designed to convince drivers to drive less often.

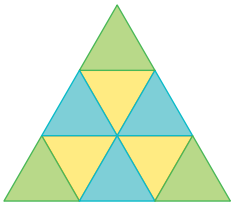
Use the following information in your campaign.

a) Out of 40 work days, how many days would people have to choose not to drive to reduce CO_2 emissions by $\frac{1}{20}$?

b) If five people drive back and forth to work 20 days a month each, how many round trips is that? How many fewer trips would have to be made to reach the $\frac{1}{20}$ goal? Explain how these five people could reach this goal.

c) Develop a presentation to show how drivers can do their part. Include the information you gathered, along with other facts. Use fractions with like denominators in your presentation.

2. Math Mosaics



Many stained-glass windows, tile mosaics, and jewellery are created using geometric shapes. The design shown can be used to teach about fractions:

- There are 9 equal triangles. Each triangle is $\frac{1}{9}$ of the design.
- $\frac{3}{9} + \frac{3}{9} = \frac{6}{9}$ of the design is yellow or blue. You be the artist!

a) Design a stained-glass window, mosaic, or piece of jewellery that could help teach students about fractions with like denominators. Make your design using different colours of one shape. Each shape should be equal in size.

b) Describe how your design could help teach about the meaning of fractions, equivalent fractions, and addition and subtraction of fractions with like denominators.

c) Use your design to teach a classmate about fractions.