Addition and Subtraction with Fractions

2.5

Adding and subtracting fractions is actually just another application of the distributive property. The distributive property looks like this:

$$a(b + c) = a(b) + a(c)$$

where a, b, and c may be whole numbers or fractions. We will want to apply this property to expressions like

$$\frac{2}{7} + \frac{3}{7}$$

But before we do, we must make one additional observation about fractions.

The fraction $\frac{2}{7}$ can be written as $2 \cdot \frac{1}{7}$, because

$$2 \cdot \frac{1}{7} = \frac{2}{1} \cdot \frac{1}{7} = \frac{2}{7}$$

Likewise, the fraction $\frac{3}{7}$ can be written as $3 \cdot \frac{1}{7}$, because

$$3 \cdot \frac{1}{7} = \frac{3}{1} \cdot \frac{1}{7} = \frac{3}{7}$$

In general, we can say that the fraction $\frac{a}{b}$ can always be written as $a \cdot \frac{1}{b}$, because

$$a \cdot \frac{1}{b} = \frac{a}{1} \cdot \frac{1}{b} = \frac{a}{b}$$

Note Most people who have done any work with adding fractions know that you add fractions that have the same denominator by adding their numerators, but not their denominators. However, most people don't know why this works. The reason why we add numerators but not denominators is because of the distributive property. And that is what the discussion on the right is all about. If you really want to understand addition of fractions, pay close attention to this discussion.

To add the fractions $\frac{2}{7}$ and $\frac{3}{7}$, we simply rewrite each of them as we have done above and apply the distributive property. Here is how it works:

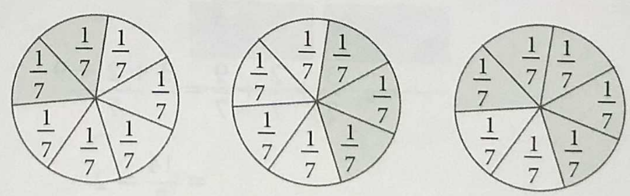
$$\frac{2}{7} + \frac{3}{7} = 2 \cdot \frac{1}{7} + 3 \cdot \frac{1}{7} \qquad \text{Rewrite each fraction}$$

$$= (2 + 3) \cdot \frac{1}{7} \qquad \text{Apply the distributive property}$$

$$= 5 \cdot \frac{1}{7} \qquad \text{Add 2 and 3 to get 5}$$

$$= \frac{5}{7} \qquad \text{Rewrite } 5 \cdot \tfrac{1}{7} \text{ as } \tfrac{5}{7}$$

We can visualize the process shown above by using circles that are divided into 7 equal parts:



$$\frac{2}{7} \qquad + \qquad \frac{3}{7} \qquad = \qquad \frac{5}{7}$$

The fraction $\frac{5}{7}$ is the sum of $\frac{2}{7}$ and $\frac{3}{7}$. The steps and diagrams on the previous page show why we add numerators, *but do not add denominators.* Using this example as justification, we can write a rule for adding two fractions that have the same denominator.

Rule

To add two fractions that have the same denominator, we add their numerators to get the numerator of the answer. The denominator in the answer is the same denominator as in the original fractions.

What we have here is the sum of the numerators placed over the *common denominator*. In symbols we have the following:

Addition and Subtraction of Fractions

If a, b, and c are numbers, and c is not equal to 0, then

$$\frac{a}{c} + \frac{b}{c} = \frac{a+b}{c}$$

This rule holds for subtraction as well. That is,

$$\frac{a}{c} - \frac{b}{c} = \frac{a-b}{c}$$

VIDEO EXAMPLES

SECTION 2.5

Example 1 Add or subtract.

a. $\frac{3}{8} + \frac{1}{8}$ **b.** $\frac{9}{5} - \frac{3}{5}$ **c.** $\frac{3}{7} + \frac{2}{7} + \frac{9}{7}$

Solution

a. $\frac{3}{8} + \frac{1}{8} = \frac{3+1}{8}$ Add numerators; keep the same denominator

$= \frac{4}{8}$ The sum of 3 and 1 is 4

$= \frac{1}{2}$ Reduce to lowest terms

b. $\frac{9}{5} - \frac{3}{5} = \frac{9-3}{5}$ Subtract numerators; keep the same denominator

$= \frac{6}{5}$ The difference of 9 and 3 is 6

c. $\frac{3}{7} + \frac{2}{7} + \frac{9}{7} = \frac{3+2+9}{7}$

$= \frac{14}{7} = 2$

As Example 1 indicates, addition and subtraction are simple, straightforward processes when all the fractions have the same denominator. We will now turn our attention to the process of adding fractions that have different denominators. In order to get started, we need the following definition:

> **Least Common Denominator**
>
> The **least common denominator** (LCD) for a set of denominators is the smallest number that is exactly divisible by each denominator. (Note that, in some books, the least common denominator is also called the **least common multiple**.)

In other words, all the denominators of the fractions involved in a problem must divide into the least common denominator exactly. That is, they divide it without leaving a remainder.

Example 2 Find the LCD for the fractions $\frac{5}{12}$ and $\frac{7}{18}$.

Solution The least common denominator for the denominators 12 and 18 must be the smallest number divisible by both 12 and 18. We can factor 12 and 18 completely and then build the LCD from these factors. Factoring 12 and 18 completely gives us

$$12 = 2 \cdot 2 \cdot 3 \qquad 18 = 2 \cdot 3 \cdot 3$$

Now, if 12 is going to divide the LCD exactly, then the LCD must have factors of $2 \cdot 2 \cdot 3$. If 18 is to divide it exactly, it must have factors of $2 \cdot 3 \cdot 3$. We don't need to repeat the factors that 12 and 18 have in common:

12 divides the LCD

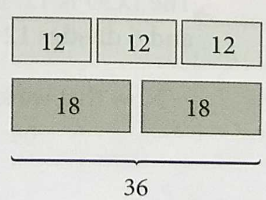
$$\left.\begin{aligned} 12 &= 2 \cdot 2 \cdot 3 \\ 18 &= 2 \cdot 3 \cdot 3 \end{aligned}\right\} \text{LCD} = 2 \cdot 2 \cdot 3 \cdot 3 = 36$$

18 divides the LCD

The LCD for 12 and 18 is 36. It is the smallest number that is divisible by both 12 and 18; 12 divides it exactly three times, and 18 divides it exactly two times. ■

> *Note* The ability to find least common denominators is very important in mathematics. The discussion here is a detailed explanation of how to find an LCD.

We can visualize the results in Example 2 with the diagram below. It shows that 36 is the smallest number that both 12 and 18 divide evenly. As you can see, 12 divides 36 exactly 3 times, and 18 divides 36 exactly 2 times.



Example 3 Add $\frac{5}{12} + \frac{7}{18}$.

Solution We can add fractions only when they have the same denominators. In Example 2, we found the LCD for $\frac{5}{12}$ and $\frac{7}{18}$ to be 36. We change $\frac{5}{12}$ and $\frac{7}{18}$ to equivalent fractions that have 36 for a denominator by applying Property 1 for fractions:

$$\frac{5}{12} = \frac{5 \cdot 3}{12 \cdot 3} = \frac{15}{36}$$

$$\frac{7}{18} = \frac{7 \cdot 2}{18 \cdot 2} = \frac{14}{36}$$

The fraction $\frac{15}{36}$ is equivalent to $\frac{5}{12}$, because it was obtained by multiplying both the numerator and the denominator by 3. Likewise, $\frac{14}{36}$ is equivalent to $\frac{7}{18}$, because it was obtained by multiplying the numerator and the denominator by 2. All we have left to do is to add numerators.

$$\frac{15}{36} + \frac{14}{36} = \frac{29}{36}$$

The sum of $\frac{5}{12}$ and $\frac{7}{18}$ is the fraction $\frac{29}{36}$. Let's write the complete problem again step by step.

$$\frac{5}{12} + \frac{7}{18} = \frac{5 \cdot 3}{12 \cdot 3} + \frac{7 \cdot 2}{18 \cdot 2}$$ *Rewrite each fraction as an equivalent fraction with denominator 36*

$$= \frac{15}{36} + \frac{14}{36}$$

$$= \frac{29}{36}$$ *Add numerators; keep the common denominator*

Example 4 Find the LCD for $\frac{3}{4}$ and $\frac{1}{6}$.

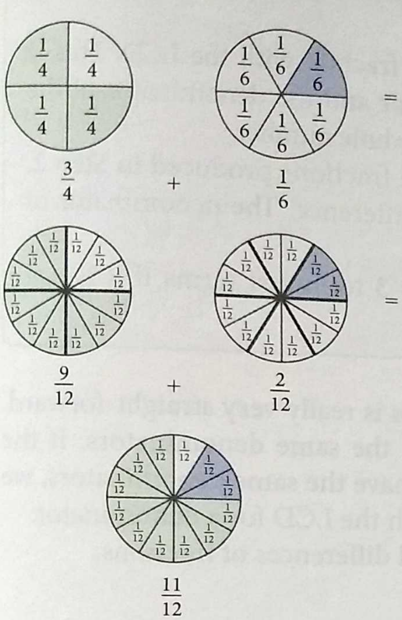
Solution We factor 4 and 6 into products of prime factors and build the LCD from these factors.

$$\left.\begin{aligned} 4 &= 2 \cdot 2 \\ 6 &= 2 \cdot 3 \end{aligned}\right\} \text{LCD} = 2 \cdot 2 \cdot 3 = 12$$

The LCD is 12. Both denominators divide it exactly; 4 divides 12 exactly 3 times, and 6 divides 12 exactly 2 times.

Now that we know the LCD is 12, we can add the two fractions.

Note We can visualize the work in Example 5 using circles and shading:



Example 5 Add $\frac{3}{4} + \frac{1}{6}$.

Solution In Example 4, we found that the LCD for these two fractions is 12. We begin by changing $\frac{3}{4}$ and $\frac{1}{6}$ to equivalent fractions with denominator 12:

$$\frac{3}{4} = \frac{3 \cdot 3}{4 \cdot 3} = \frac{9}{12}$$

$$\frac{1}{6} = \frac{1 \cdot 2}{6 \cdot 2} = \frac{2}{12}$$

The fraction $\frac{9}{12}$ is equal to the fraction $\frac{3}{4}$, because it was obtained by multiplying the numerator and the denominator of $\frac{3}{4}$ by 3. Likewise, $\frac{2}{12}$ is equivalent to $\frac{1}{6}$, because it was obtained by multiplying the numerator and the denominator of $\frac{1}{6}$ by 2. To complete the problem we add numerators:

$$\frac{9}{12} + \frac{2}{12} = \frac{11}{12}$$

The sum of $\frac{3}{4}$ and $\frac{1}{6}$ is $\frac{11}{12}$. Here is how the complete problem looks:

$$\frac{3}{4} + \frac{1}{6} = \frac{3 \cdot 3}{4 \cdot 3} + \frac{1 \cdot 2}{6 \cdot 2}$$ Rewrite each fraction as an equivalent fraction with denominator 12

$$= \frac{9}{12} + \frac{2}{12}$$

$$= \frac{11}{12}$$ Add numerators; keep the same denominator

Example 6 Subtract $\frac{7}{15} - \frac{3}{10}$.

Solution Let's factor 15 and 10 completely and use these factors to build the LCD:

$$\left.\begin{array}{l} 15 = 3 \cdot 5 \\ 10 = 2 \cdot 5 \end{array}\right\} \text{LCD} = 2 \cdot 3 \cdot 5 = 30$$

15 divides the LCD (3 · 5); 10 divides the LCD (2 · 5)

Changing to equivalent fractions and subtracting, we have

$$\frac{7}{15} - \frac{3}{10} = \frac{7 \cdot 2}{15 \cdot 2} - \frac{3 \cdot 3}{10 \cdot 3}$$ Rewrite as equivalent fractions with the LCD for the denominator

$$= \frac{14}{30} - \frac{9}{30}$$

$$= \frac{5}{30}$$ Subtract numerators; keep the LCD

$$= \frac{1}{6}$$ Reduce to lowest terms

As a summary of what we have done so far, and as a guide to working other problems, we now list the steps involved in adding and subtracting fractions with different denominators.

> **To Add or Subtract Any Two Fractions**
>
> **Step 1** Factor each denominator completely, and use the factors to build the LCD. (Remember, the LCD is the smallest number divisible by each of the denominators in the problem.)
>
> **Step 2** Rewrite each fraction as an equivalent fraction with the LCD. This is done by multiplying both the numerator and the denominator of the fraction in question by the appropriate whole number.
>
> **Step 3** Add or subtract the numerators of the fractions produced in Step 2. This is the numerator of the sum or difference. The denominator of the sum or difference is the LCD.
>
> **Step 4** Reduce the fraction produced in Step 3 to lowest terms if it is not already in lowest terms.

The idea behind adding or subtracting fractions is really very straight-forward. We can only add or subtract fractions that have the same denominators. If the fractions we are trying to add or subtract do not have the same denominators, we rewrite each of them as an equivalent fraction with the LCD for a denominator.

Here are some additional examples of sums and differences of fractions.

Example 7 Subtract $\frac{3}{5} - \frac{1}{6}$.

Solution The LCD for 5 and 6 is their product, 30. We begin by rewriting each fraction with this common denominator:

$$\frac{3}{5} - \frac{1}{6} = \frac{3 \cdot 6}{5 \cdot 6} - \frac{1 \cdot 5}{6 \cdot 5}$$

$$= \frac{18}{30} - \frac{5}{30}$$

$$= \frac{13}{30}$$

Example 8 Add $\frac{1}{6} + \frac{1}{8} + \frac{1}{4}$.

Solution We begin by factoring the denominators completely and building the LCD from the factors that result:

$$\left.\begin{aligned} 6 &= 2 \cdot 3 \\ 8 &= 2 \cdot 2 \cdot 2 \\ 4 &= 2 \cdot 2 \end{aligned}\right\} \text{LCD} = 2 \cdot 2 \cdot 2 \cdot 3 = 24$$

8 divides the LCD

4 divides the LCD

6 divides the LCD

We then change to equivalent fractions and add as usual:

$$\frac{1}{6} + \frac{1}{8} + \frac{1}{4} = \frac{1 \cdot 4}{6 \cdot 4} + \frac{1 \cdot 3}{8 \cdot 3} + \frac{1 \cdot 6}{4 \cdot 6} = \frac{4}{24} + \frac{3}{24} + \frac{6}{24} = \frac{13}{24}$$

Example 9 Subtract $3 - \frac{5}{6}$.

Solution The denominators are 1 $\left(\text{because } 3 = \frac{3}{1}\right)$ and 6. The smallest number divisible by both 1 and 6 is 6.

$$3 - \frac{5}{6} = \frac{3}{1} - \frac{5}{6} = \frac{3 \cdot 6}{1 \cdot 6} - \frac{5}{6} = \frac{18}{6} - \frac{5}{6} = \frac{13}{6}$$

Here are some examples that involve addition or subtraction with negative numbers.

Example 10 Add: $\frac{3}{8} + \left(-\frac{1}{8}\right)$

Solution We subtract absolute values. The answer will be positive, because $\frac{3}{8}$ is positive.

$$\frac{3}{8} + \left(-\frac{1}{8}\right) = \frac{2}{8}$$

$$= \frac{1}{4} \quad \text{Reduce to lowest terms}$$

Example 11 Add: $\frac{1}{10} + \left(-\frac{4}{5}\right) + \left(-\frac{3}{20}\right)$

Solution To begin, change each fraction to an equivalent fraction with an LCD of 20.

$$\frac{1}{10} + \left(-\frac{4}{5}\right) + \left(-\frac{3}{20}\right) = \frac{1 \cdot 2}{10 \cdot 2} + \left(-\frac{4 \cdot 4}{5 \cdot 4}\right) + \left(-\frac{3}{20}\right)$$

$$= \frac{2}{20} + \left(-\frac{16}{20}\right) + \left(-\frac{3}{20}\right)$$

$$= -\frac{14}{20} + \left(-\frac{3}{20}\right) = -\frac{17}{20}$$

Example 12 Find the difference of $-\frac{3}{5}$ and $\frac{2}{5}$.

Solution

$$-\frac{3}{5} - \frac{2}{5} = -\frac{3}{5} + \left(-\frac{2}{5}\right)$$

$$= -\frac{5}{5}$$

$$= -1$$

Comparing Fractions

As we have shown previously, we can compare fractions to see which is larger or smaller when they have the same denominator. Now that we know how to find the LCD for a set of fractions, we can use the LCD to write equivalent fractions with the intention of comparing them.

Example 13 Find the LCD for the fractions below, then write each fraction as an equivalent fraction with the LCD for a denominator. Then write them in order from smallest to largest.

$$\frac{5}{8} \quad \frac{5}{16} \quad \frac{3}{4} \quad \frac{1}{2}$$

Solution The LCD for the four fractions is 16. We begin by writing each fraction as an equivalent fraction with denominator 16.

$$\frac{5}{8} = \frac{10}{16} \qquad \frac{5}{16} = \frac{5}{16} \qquad \frac{3}{4} = \frac{12}{16} \qquad \frac{1}{2} = \frac{8}{16}$$

Now that they all have the same denominator, the smallest fraction is the one with the smallest numerator, and the largest fraction is the one with the largest numerator. Writing them in order from smallest to largest we have:

$$\frac{5}{16} < \frac{8}{16} < \frac{10}{16} < \frac{12}{16}$$

$$\frac{5}{16} < \frac{1}{2} < \frac{5}{8} < \frac{3}{4}$$

Getting Ready for Class

After reading through the preceding section, respond in your own words and in complete sentences.

A. When adding two fractions with the same denominators, we always add their __________, but we never add their __________.

B. What does the abbreviation LCD stand for?

C. What is the first step when finding the LCD for the fractions $\frac{5}{12}$ and $\frac{7}{18}$?

D. When adding fractions, what is the last step?

Problem Set 2.5

Find the following sums and differences, and reduce to lowest terms. (Add or subtract as indicated.)

1. $\frac{3}{6} + \frac{1}{6}$

2. $\frac{2}{5} + \frac{3}{5}$

3. $-\frac{3}{8} + \frac{5}{8}$

4. $-\frac{1}{7} + \frac{6}{7}$

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

6. $\frac{7}{9} - \frac{4}{9}$

7. $\frac{2}{3} + \left(-\frac{1}{3}\right)$

8. $\frac{9}{8} + \left(-\frac{1}{8}\right)$

9. $\frac{1}{4} + \frac{2}{4} + \frac{3}{4}$

10. $\frac{2}{5} + \frac{3}{5} + \frac{4}{5}$

11. $-\frac{1}{2} - \frac{1}{2}$

12. $-\frac{3}{4} - \frac{3}{4}$

13. $\frac{1}{10} + \frac{3}{10} + \frac{4}{10}$

14. $\frac{3}{20} + \frac{1}{20} + \frac{4}{20}$

15. $\frac{1}{3} + \frac{4}{3} + \frac{5}{3}$

16. $\frac{5}{4} + \frac{4}{4} + \frac{3}{4}$

Complete the following tables. In each case you will need to find the LCD before adding.

17.

First Number a	Second Number b	The Sum of a and b $a + b$
$\frac{1}{2}$	$\frac{1}{3}$	
$\frac{1}{3}$	$\frac{1}{4}$	
$\frac{1}{4}$	$\frac{1}{5}$	
$\frac{1}{5}$	$\frac{1}{6}$	

18.

First Number a	Second Number b	The Sum of a and b $a + b$
1	$\frac{1}{2}$	
1	$\frac{1}{3}$	
1	$\frac{1}{4}$	
1	$\frac{1}{5}$	

19.

First Number a	Second Number b	The Sum of a and b $a + b$
$\frac{1}{12}$	$\frac{1}{2}$	
$\frac{1}{12}$	$\frac{1}{3}$	
$\frac{1}{12}$	$\frac{1}{4}$	
$\frac{1}{12}$	$\frac{1}{6}$	

20.

First Number a	Second Number b	The Sum of a and b $a + b$
$\frac{1}{8}$	$\frac{1}{2}$	
$\frac{1}{8}$	$\frac{1}{4}$	
$\frac{1}{8}$	$\frac{1}{16}$	
$\frac{1}{8}$	$\frac{1}{24}$	

Find the LCD for each of the following; then use the methods developed in this sections to add or subtract as indicated.

21. $\frac{4}{9}+\frac{1}{3}$

22. $\frac{1}{2}+\frac{1}{4}$

23. $2+\frac{1}{3}$

24. $3+\frac{1}{2}$

25. $\frac{3}{4}+1$

26. $\frac{3}{4}+2$

27. $\frac{1}{2}+\frac{2}{3}$

28. $\frac{1}{8}+\frac{3}{4}$

29. $\frac{1}{4}-\frac{1}{5}$

30. $\frac{1}{3}-\frac{1}{5}$

31. $-\frac{1}{2}-\frac{1}{5}$

32. $\frac{1}{2}+\left(-\frac{1}{5}\right)$

33. $\frac{5}{12}+\frac{3}{8}$

34. $\frac{9}{16}+\frac{7}{12}$

35. $\frac{8}{30}+\frac{1}{20}$

36. $\frac{9}{40}-\frac{1}{30}$

37. $\frac{3}{10}-\left(-\frac{1}{100}\right)$

38. $\frac{9}{100}-\left(-\frac{7}{10}\right)$

39. $\frac{10}{36}+\frac{9}{48}$

40. $\frac{12}{28}+\frac{9}{20}$

41. $\frac{17}{30}+\frac{11}{42}$

42. $\frac{19}{42}+\frac{13}{70}$

43. $-\frac{25}{84}-\frac{41}{90}$

44. $-\frac{23}{70}-\frac{29}{84}$

45. $\frac{13}{126}-\frac{13}{180}$

46. $\frac{17}{84}-\frac{17}{90}$

47. $\frac{3}{4}+\frac{1}{8}+\frac{5}{6}$

48. $\frac{3}{8}+\frac{2}{5}+\frac{1}{4}$

49. $\frac{3}{10}+\frac{5}{12}+\frac{1}{6}$

50. $\frac{5}{21}+\frac{1}{7}+\frac{3}{14}$

51. $\frac{1}{2}+\frac{1}{3}+\frac{1}{4}+\frac{1}{6}$

52. $\frac{1}{8}+\frac{1}{4}+\frac{1}{5}+\frac{1}{10}$

53. $-10+\frac{2}{9}$

54. $-9+\frac{3}{5}$

55. $\frac{1}{10}+\frac{4}{5}-\frac{3}{20}$

56. $\frac{1}{2}+\frac{3}{4}-\frac{5}{8}$

57. $\frac{1}{4}-\frac{1}{8}+\frac{1}{2}-\frac{3}{8}$

58. $\frac{7}{8}-\frac{3}{4}+\frac{5}{8}-\frac{1}{2}$

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

60. $-\frac{4}{7}-\frac{3}{7}$

61. $\frac{5}{12}-\frac{5}{6}$

62. $\frac{7}{15}-\frac{4}{5}$

63. $-\frac{13}{70}-\frac{23}{42}$

64. $-\frac{17}{60}-\frac{17}{90}$

65. $\frac{1}{2}-\frac{1}{3}-\frac{1}{4}$

66. $\frac{1}{5}-\frac{1}{6}-\frac{1}{7}$

Paying Attention to Instructions The following two problems are intended to give you practice reading, and paying attention to, instructions. (Leave answers that are improper fractions as improper fractions.)

67. **a.** Find the sum of $\frac{1}{2}$ and $\frac{4}{5}$.

b. Find the difference of $\frac{1}{2}$ and $\frac{4}{5}$.

c. Find the product of $\frac{1}{2}$ and $\frac{4}{5}$.

d. Find the quotient of $\frac{1}{2}$ and $\frac{4}{5}$.

68. **a.** Find the sum of $-\frac{1}{2}$ and $\frac{3}{4}$.

b. Find the difference of $-\frac{1}{2}$ and $\frac{3}{4}$.

c. Find the product of $-\frac{1}{2}$ and $\frac{3}{4}$.

d. Find the quotient of $-\frac{1}{2}$ and $\frac{3}{4}$.

There are two ways to work the problems below. You can combine the fractions inside the parentheses first and then multiply, or you can apply the distributive property first, then add.

69. $15\left(\frac{2}{3}+\frac{3}{5}\right)$ **70.** $15\left(\frac{4}{5}-\frac{1}{3}\right)$ **71.** $4\left(\frac{1}{2}+\frac{1}{4}\right)$ **72.** $6\left(\frac{1}{3}+\frac{1}{2}\right)$

73. Write the fractions in order from smallest to largest.

$$\frac{3}{4} \quad \frac{3}{8} \quad \frac{1}{2} \quad \frac{1}{4}$$

74. Write the fractions in order from smallest to largest.

$$\frac{1}{2} \quad \frac{1}{6} \quad \frac{1}{4} \quad \frac{1}{3}$$

75. Find the sum of $\frac{3}{7}$, 2, and $\frac{1}{9}$.

76. Find the sum of 6, $\frac{6}{11}$, and 11.

77. Give the difference of $\frac{7}{8}$ and $\frac{1}{4}$.

78. Give the difference of $\frac{9}{10}$ and $\frac{1}{100}$.

Applying the Concepts

Some of the application problems below involve multiplication or division, while others involve addition or subtraction.

79. **Capacity** One carton of milk contains $\frac{1}{2}$ pint while another contains 4 pints. How much milk is contained in both cartons?

80. **Baking** A recipe calls for $\frac{2}{3}$ cup of flour and $\frac{3}{4}$ cup of sugar. What is the total amount of flour and sugar called for in the recipe?

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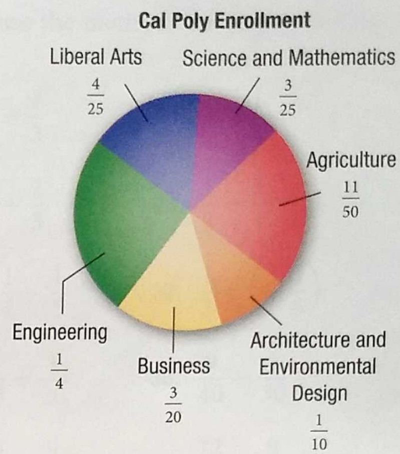
81. **Budget** A family decides that they can spend $\frac{5}{8}$ of their monthly income on house payments. If their monthly income is \$2,120, how much can they spend for house payments?

82. **Savings** A family saves $\frac{3}{16}$ of their income each month. If their monthly income is \$1,264, how much do they save each month?

Reading a Pie Chart The pie chart shows how the students at one of the universities in California are distributed among the different schools at the university. Use the information in the pie chart to answer questions 83 and 84.



83. If the students in the Schools of Engineering and Business are combined, what fraction results?

84. What fraction of the university's students are enrolled in the Schools of Agriculture, Engineering, and Business combined?

85. Final Exam Grades The table gives the fraction of students in a class of 40 that received grades of A, B, or C on the final exam. Fill in all the missing parts of the table.

Grade	Number of Students	Fraction of Students
A		$\frac{1}{8}$
B		$\frac{1}{5}$
C		$\frac{1}{2}$
below C		
Total	40	1

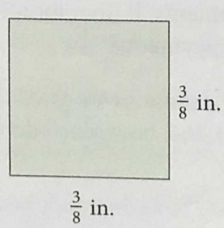
86. Flu During a flu epidemic a company with 200 employees has $\frac{1}{10}$ of their employees call in sick on Monday and another $\frac{3}{10}$ call in sick on Tuesday. What is the total number of employees calling in sick during this 2-day period?

87. Subdivision A 6-acre piece of land is subdivided into $\frac{3}{5}$-acre lots. How many lots are there?

88. Cutting Wood A 12-foot piece of wood is cut into shelves. If each is $\frac{3}{4}$ foot in length, how many shelves are there?

Find the perimeter of each figure.

89.



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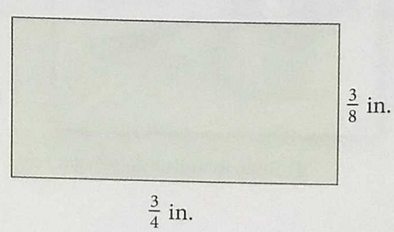

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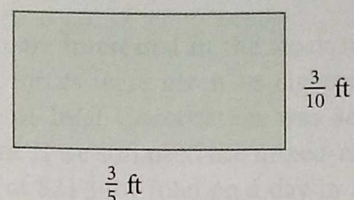
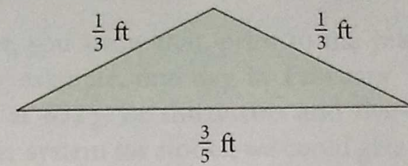


92.



Arithmetic Sequences An arithmetic sequence is a sequence in which each term comes from the previous term by adding the same number each time. For example, the sequence $1, \frac{3}{2}, 2, \frac{5}{2}, \ldots$ is an arithmetic sequence that starts with the number 1. Then each term after that is found by adding $\frac{1}{2}$ to the previous term. By observing this fact, we know that the next term in the sequence will be $\frac{5}{2} + \frac{1}{2} = \frac{6}{2} = 3$.

Find the next number in each arithmetic sequence below.

93. $1, \frac{4}{3}, \frac{5}{3}, 2, \ldots$

94. $1, \frac{5}{4}, \frac{3}{2}, \frac{7}{4}, \ldots$

95. $\frac{3}{2}, 2, \frac{5}{2}, \ldots$

96. $\frac{2}{3}, 1, \frac{4}{3}, \ldots$

Getting Ready for the Next Section

Simplify.

97. $9 \cdot 6 + 5$

98. $4 \cdot 5 + 3$

99. Write 2 as a fraction with denominator 8.

100. Write 2 as a fraction with denominator 4.

101. Write 5 as a fraction with denominator 4.

Add.

102. $\frac{8}{4} + \frac{3}{4}$

103. $\frac{16}{8} + \frac{1}{8}$

104. $2 + \frac{1}{8}$

105. $2 + \frac{3}{4}$

106. $5 + \frac{3}{4}$

Divide. Write your answer as a whole number with a remainder, R.

107. $11 \div 4$

108. $10 \div 3$

109. $208 \div 24$

110. Is $\frac{7}{8}$ greater than or less than $\frac{1}{2}$?

111. Is $\frac{1}{5}$ greater than or less than $\frac{1}{2}$?

112. Is $\frac{8}{11}$ greater than or less than $\frac{1}{2}$?