3. **Carpentry** How many boards $4\frac{5}{8}$ in. wide will it take to cover a floor 222 in. wide?

4. **Building Construction** How many supporting columns $88\frac{1}{2}$ in. long can be cut from six pieces each 22 ft long? (*Hint:* Be careful of units.)

5. **Building Construction** How many pieces of $\frac{1}{2}$-in. plywood are there in a stack 42 in. high?

6. **Drafting** If $\frac{1}{4}$ in. represents 1 ft 0 in. on a drawing, how many feet will be represented by a line $10\frac{1}{8}$ in. long?

7. **Masonry** If we allow $2\frac{5}{8}$ in. for the thickness of a course of brick, including mortar joints, how many courses of brick will there be in a wall $47\frac{1}{4}$ in. high?

8. **Plumbing** How many lengths of pipe $2\frac{5}{8}$ ft long can be cut from a pipe 21 ft long?

9. **Machine Technology** How many pieces $6\frac{1}{4}$ in. long can be cut from 35 metal rods each 40 in. long? Disregard waste.

10. **Machine Technology** The architectural drawing for a room measures $3\frac{5}{8}$ in. by $4\frac{1}{4}$ in. If $\frac{1}{8}$ in. is equal to 1 ft on the drawing, what are the actual dimensions of the room?

11. **Printing** How many full $3\frac{1}{2}$-in. sheets can be cut from $24\frac{3}{4}$-in. stock?

12. **Machine Technology** The feed on a boring mill is set for $\frac{1}{32}$ in. How many revolutions are needed to advance the tool $3\frac{3}{8}$ in.?

13. **Machine Technology** If the pitch of a thread is $\frac{1}{18}$ in., how many threads are needed for the threaded section of a pipe to be $2\frac{1}{2}$ in. long?

14. **Building Construction** The floor area of a room on a house plan measures $3\frac{1}{2}$ in. by $4\frac{5}{8}$ in. If the drawing scale is $\frac{1}{4}$ in. represents 1 ft, what is the actual size of the room?

15. **Building Construction** The family room ceiling of a new Happy Home is to be taped and mudded. A $106\frac{1}{2}$ sq ft area has already been done, and this represents $\frac{3}{8}$ of the job. How large is the area of the finished ceiling?

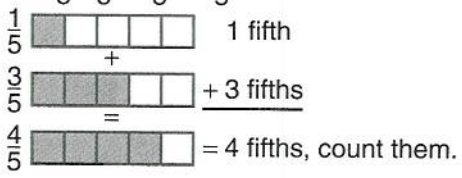
16. **Plumbing** A pipe fitter needs to divide a pipe $32\frac{5}{8}$ inches long into three pieces of equal length. Calculate the length of each piece.

Check your answers in the Appendix, then continue in Section 2-4.

2-4 ADDITION AND SUBTRACTION OF FRACTIONS

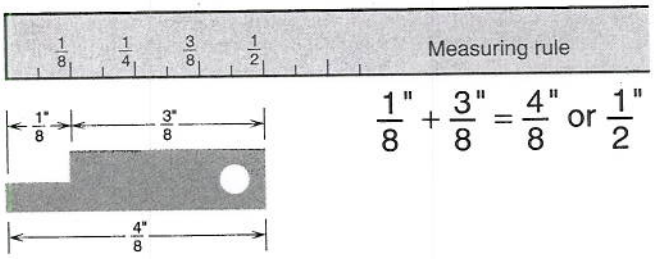
Addition At heart, adding fractions is a matter of counting:

$$\frac{1}{5}+\frac{3}{5}=\frac{1+3}{5}=\frac{4}{5}$$



Add $\frac{1}{8}+\frac{3}{8}=$ _____

This is easy to see with measurements:

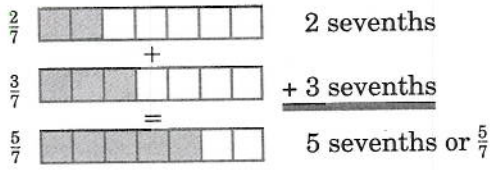


$$\frac{1"}{8} + \frac{3"}{8} = \frac{4"}{8} \text{ or } \frac{1"}{2}$$

EXAMPLE

Add $\frac{2}{7} + \frac{3}{7} =$ _____

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



Like Fractions Fractions having the same denominator are called *like* fractions. In the preceding problem, $\frac{2}{7}$ and $\frac{3}{7}$ both have denominator 7 and are like fractions. Adding like fractions is easy: *first,* add the numerators to find the numerator of the sum and *second,* use the denominator the fractions have in common as the denominator of the sum.

$$\frac{2}{9} + \frac{5}{9} = \frac{2+5}{9} = \frac{7}{9}$$

Add numerators

Same denominator

EXAMPLE

Adding three or more like fractions is easy: $\frac{3}{12} + \frac{1}{12} + \frac{5}{12} = ?$

$$\frac{3}{12} + \frac{1}{12} + \frac{5}{12} = \frac{3+1+5}{12} = \frac{9}{12} = \frac{3}{4}$$

Notice that we write the sum in lowest terms.

YOUR TURN

Try these problems for exercise.

(a) $\frac{1}{8} + \frac{3}{8}$

(b) $\frac{7}{9} + \frac{5}{9}$

(c) $2\frac{1}{5} + 3\frac{3}{5}$

(d) $\frac{1}{7} + \frac{4}{7} + \frac{5}{7} + 1\frac{2}{7} + \frac{8}{7}$

(e) $2 + 3\frac{1}{2}$

(f) $3\frac{1}{8} + 2\frac{3}{8}$

SOLUTIONS

a) $\frac{1}{8} + \frac{3}{8} = \frac{1+3}{8} = \frac{4}{8} = \frac{1}{2}$ (b) $\frac{7}{9} + \frac{5}{9} = \frac{7+5}{9} = \frac{12}{9} = \frac{4}{3} = 1\frac{1}{3}$

(c) $2\frac{1}{5} + 3\frac{3}{5} = 2 + 3 + \frac{1}{5} + \frac{3}{5} = 5 + \frac{4}{5} = 5\frac{4}{5}$

(d) $\frac{1}{7} + \frac{4}{7} + \frac{5}{7} + 1\frac{2}{7} + \frac{8}{7} = \frac{1}{7} + \frac{4}{7} + \frac{5}{7} + \frac{9}{7} + \frac{8}{7} = \frac{1+4+5+9+8}{7} = \frac{27}{7} = 3\frac{6}{7}$

(e) $2 + 3\frac{1}{2} = 2 + 3 + \frac{1}{2} = 5\frac{1}{2}$. Remember: $3\frac{1}{2}$ means $3 + \frac{1}{2}$.

(f) $3\frac{1}{8} + 2\frac{3}{8} = (3 + 2) + \left(\frac{1}{8} + \frac{3}{8}\right) = 5 + \frac{4}{8} = 5 + \frac{1}{2} = 5\frac{1}{2}$

This last problem can also be done by rewriting each of the mixed numbers as an improper fraction before adding.

$3\frac{1}{8} + 2\frac{3}{8} = \frac{25}{8} + \frac{19}{8} = \frac{44}{8} = \frac{11}{2}$ Write in lowest terms.

$= 5\frac{1}{2}$ Rewrite as a mixed number.

Note ▶ If the addition is done using improper fractions, large and unwieldy numerators may result. Be careful. ◀

Unlike Fractions How do we add fractions whose denominators are not the same? For example, how do we add $\frac{2}{3} + \frac{3}{4}$?

The problem is to find a name for this new number. One way to find it is to change these fractions to equivalent fractions with the same denominator.

$\frac{2}{3} = \frac{2 \times 4}{3 \times 4} = \frac{8}{12}$ We chose $\frac{4}{4}$ as a multiplier because it changes $\frac{2}{3}$ to an equivalent fraction with a denominator of 12.

$\frac{3}{4} = \frac{3 \times 3}{4 \times 3} = \frac{9}{12}$ We chose $\frac{3}{3}$ as a multiplier because it changes $\frac{3}{4}$ to an equivalent fraction with a denominator of 12.

The two fractions now have the same denominator.

Note ▶ You should remember that we discussed equivalent fractions on page 64. Return for a quick review if you need it. ◀

EXAMPLE

Add $\frac{2}{3} + \frac{3}{4}$ using the equivalent fractions.

$\frac{2}{3} + \frac{3}{4} = \frac{8}{12} + \frac{9}{12} = \frac{17}{12} = 1\frac{5}{12}$

We change the original fractions to equivalent fractions with the same denominator and then add as before.

Least Common Denominator How do you know what number to use as the new denominator? In general, you cannot simply guess at the best new denominator. We need a method for finding it from the denominators of the fractions to be added. The new denominator is called the *least common denominator,* abbreviated LCD.

EXAMPLE

Suppose that we want to add the fractions $\frac{1}{8} + \frac{5}{12}$.

The first step is to find the LCD of the denominators 8 and 12. To find the LCD follow this procedure.

Step 1 Write each denominator as a product of its prime factors. If you need to review this concept, see page 40.

$8 = 2 \cdot 2 \cdot 2$ $\qquad$ $12 = 2 \cdot 2 \cdot 3$

Step 2 To form the LCD, write each factor that appears in either denominator, then repeat it for the most number of times it appears in any one denominator.

$$\text{LCD} = \underbrace{2 \cdot 2}_{\text{There are 3 factors of 2 in 8.}} \cdot \underbrace{2}_{} \cdot \underbrace{3}_{\text{There is 1 factor of 3 in 12.}} = 24$$

The LCD of 8 and 12 is 24. This means that 24 is the smallest number that is exactly divisible by both 8 and 12.

EXAMPLE

Find the LCD of 12 and 45.

Step 1 Find the prime factors of each number.

$12 = 2 \cdot 2 \cdot 3$ $\qquad$ $45 = 3 \cdot 3 \cdot 5$

Step 2 The LCD must contain the factors 2, 3, and 5. The factor 2 occurs twice in 12, the factor 3 occurs twice in 45, and the factor 5 occurs just once in 45.

$\text{LCD} = 2 \cdot 2 \cdot 3 \cdot 3 \cdot 5 = 180$

The number 180 is the smallest number that is exactly divisible by both 12 and 45.

YOUR TURN

Use the method described to find the LCD of the numbers 28 and 42.

SOLUTION

Step 1 Find the prime factors of each number.

$28 = 2 \cdot 2 \cdot 7$ $\qquad$ $42 = 2 \cdot 3 \cdot 7$

Step 2 The factors 2, 3, and 7 all appear. The factor 2 appears at most twice (in 28) and both 3 and 7 appear at most just once in any single number. Therefore the LCD is

$2 \cdot 2 \cdot 3 \cdot 7 = 84$

A CALCULATOR METHOD FOR FINDING THE LCD

Here is an alternative method for finding the LCD that you might find easier than the method just described. Follow these two steps.

Step 1 Choose the larger denominator and write down a few multiples of it.

Example: To find the LCD of 12 and 15, first write down a few of the multiples of the larger number, 15. The multiples are 15, 30, 45, 60, 75, and so on.

Step 2 Test each multiple until you find one that is exactly divisible by the smaller denominator.

Example: 15 is not exactly divisible by 12. 30 is not exactly divisible by 12. 45 is not exactly divisible by 12. 60 *is* exactly divisible by 12. The LCD is 60.

This method of finding the LCD has the advantage that you can use it with an electronic calculator. For this example the calculator steps would look like this:

15 ÷ 12 =	→ 1.25	*Not* a whole number; therefore, *not* exactly divisible by 12.
15 × 2 ÷ 12 =	→ 2.5	Second multiple: answer is *not* a whole number.
15 × 3 ÷ 12 =	→ 3.75	Third multiple: answer is *not* a whole number.
15 × 4 ÷ 12 =	→ 5.	Fourth multiple: answer *is* a whole number; therefore, the LCD is 4 × 15 or 60.

With smaller numbers, this process may be done mentally.

Ready for more practice in finding LCDs?

YOUR TURN

Find the LCD of 4, 10, and 15.

SOLUTION

Step 1 Write the prime factors of all three numbers.

$4 = 2 \cdot 2 \qquad 10 = 2 \cdot 5 \qquad 15 = 3 \cdot 5$

Step 2 The factors 2, 3, and 5 all appear and therefore must be included in the LCD. The factor 2 appears at most twice (in 4), and the factors 3 and 5 both appear at most just once in any single number. Therefore the LCD is

$2 \cdot 2 \cdot 3 \cdot 5 = 60$

This means that 60 is the smallest number that is exactly divisible by 4, 10, and 15.

PROBLEMS

Practice by finding the LCD for each of the following sets of numbers.

(a) 2 and 4 (b) 8 and 4 (c) 6 and 3

(d) 5 and 4 (e) 9 and 15 (f) 15 and 24

(g) 4, 5, and 6 (h) 4, 8, and 12 (i) 12, 15, and 21

ANSWERS

(a) 4 (b) 8 (c) 6 (d) 20 (e) 45

(f) 120 (g) 60 (h) 24 (i) 420

In order to use the LCD to add fractions, rewrite the fractions with the LCD as the new denominator, then add the new equivalent fractions.

EXAMPLE

Add $\frac{1}{6} + \frac{5}{8}$.

First, find the LCD. The LCD of 6 and 8 is 24.

Next, rewrite the two fractions with denominator 24.

$$\frac{1}{6} = \frac{1 \times \boxed{4}}{6 \times \boxed{4}} = \frac{4}{24}$$

$$\frac{5}{8} = \frac{5 \times \boxed{3}}{8 \times \boxed{3}} = \frac{15}{24}$$

Finally, add the new equivalent fractions.

$$\frac{1}{6} + \frac{5}{8} = \frac{4}{24} + \frac{15}{24} = \frac{19}{24}$$

YOUR TURN

Add $\frac{3}{8} + \frac{1}{10}$.

SOLUTION

The LCD of 8 and 10 is 40.

$$\frac{3}{8} = \frac{3 \times \boxed{5}}{8 \times \boxed{5}} = \frac{15}{40}$$

$$\frac{1}{10} = \frac{1 \times \boxed{4}}{10 \times \boxed{4}} = \frac{4}{40}$$

$$\frac{3}{8} + \frac{1}{10} = \frac{15}{40} + \frac{4}{40} = \frac{19}{40}$$

PROBLEMS

Ready for some practice at this?

Find the LCD, rewrite the fractions, and add.

(a) $\frac{1}{2}+\frac{1}{4}$ (b) $\frac{3}{8}+\frac{1}{4}$ (c) $\frac{1}{6}+\frac{2}{3}+\frac{5}{9}$

(d) $\frac{3}{4}+\frac{1}{6}$ (e) $\frac{2}{5}+\frac{1}{4}$

(f) **Manufacturing** The Monterey Canning Co. packs $8\frac{1}{2}$ ounces of tuna into each can. If the can itself weighs $1\frac{7}{8}$ ounces, what is the total weight of a can of Monterey tuna?

SOLUTIONS

(a) The LCD of 2 and 4 is 4.

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

$$\frac{1}{2}+\frac{1}{4}=\frac{2}{4}+\frac{1}{4}=\frac{3}{4}$$

(b) The LCD of 8 and 4 is 8.

$$\frac{1}{4}+\frac{?}{8}=\frac{1\times 2}{4\times 2}=\frac{2}{8}$$

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

(c) The LCD of 6, 3, and 9 is 18.

$$\frac{1}{6}=\frac{?}{18}=\frac{1\times 3}{6\times 3}=\frac{3}{18} \qquad \frac{2}{3}=\frac{?}{18}=\frac{2\times 6}{3\times 6}=\frac{12}{18}$$

$$\frac{5}{9}=\frac{?}{18}=\frac{5\times 2}{9\times 2}=\frac{10}{18}$$

$$\frac{1}{6}+\frac{2}{3}+\frac{5}{9}=\frac{3}{18}+\frac{12}{18}+\frac{10}{18}=\frac{25}{18}=1\frac{7}{18}$$

(d) The LCD of 4 and 6 is 12.

$$\frac{3}{4}=\frac{?}{12}=\frac{3\times 3}{4\times 3}=\frac{9}{12} \qquad \frac{1}{6}=\frac{?}{12}=\frac{1\times 2}{6\times 2}=\frac{2}{12}$$

$$\frac{3}{4}+\frac{1}{6}=\frac{9}{12}+\frac{2}{12}=\frac{11}{12}$$

(e) The LCD of 5 and 4 is 20.

$$\frac{2}{5}=\frac{?}{20}=\frac{2\times 4}{5\times 4}=\frac{8}{20} \qquad \frac{1}{4}=\frac{?}{20}=\frac{1\times 5}{4\times 5}=\frac{5}{20}$$

$$\frac{2}{5}+\frac{1}{4}=\frac{8}{20}+\frac{5}{20}=\frac{13}{20}$$

(f) $8\frac{1}{2} + 1\frac{7}{8} = (8 + 1) + \left(\frac{1}{2} + \frac{7}{8}\right)$

$= 9 + \left(\frac{4}{8} + \frac{7}{8}\right)$ since $\frac{1}{2} = \frac{4}{8}$

$= 9 + \frac{11}{8} = 9 + 1 + \frac{3}{8}$

$= 10\frac{3}{8}$ oz

Note ▶ It is not necessary to find the LCD when you *multiply* fractions. ◀

Subtraction Once you have mastered the process of adding fractions, subtraction is very simple indeed. To find $\frac{3}{8} - \frac{1}{8}$, notice that the denominators are the same. We can subtract the numerators and write this difference over the common denominator.

$$\frac{3}{8} - \frac{1}{8} = \frac{3 - 1}{8} = \frac{2}{8} \text{ or } \frac{1}{4}$$

Subtract numerators

Same denominator

To find $\frac{3}{4} - \frac{1}{5}$, first find the LCD of 4 and 5.

The LCD of 4 and 5 is 20.

Find equivalent fractions with a denominator of 20:

$$\frac{3}{4} = \frac{?}{20} = \frac{3 \times 5}{4 \times 5} = \frac{15}{20}$$

$$\frac{1}{5} = \frac{?}{20} = \frac{1 \times 4}{5 \times 4} = \frac{4}{20}$$

Subtract the equivalent fractions:

$$\frac{3}{4} - \frac{1}{5} = \frac{15}{20} - \frac{4}{20} = \frac{15 - 4}{20} = \frac{11}{20}$$

The procedure is exactly the same as for addition.

If the fractions to be subtracted are given as mixed numbers, it is usually simplest to work with them as improper fractions.

EXAMPLE

$3\frac{1}{2} - 1\frac{1}{3} = \frac{7}{2} - \frac{4}{3}$. The LCD of 2 and 3 is 6.

$$\frac{7}{2} = \frac{7 \times 3}{2 \times 3} = \frac{21}{6} \qquad \frac{4}{3} = \frac{4 \times 2}{3 \times 2} = \frac{8}{6}$$

Then, $3\frac{1}{2} - 1\frac{1}{3} = \frac{21}{6} - \frac{8}{6} = \frac{13}{6} = 2\frac{1}{6}$

Because $\frac{1}{2}$ is greater than $\frac{1}{3}$, we could have worked with the whole-number parts separately.

$$3\frac{1}{2} - 1\frac{1}{3} = (3 - 1) + \left(\frac{1}{2} - \frac{1}{3}\right)$$
$$= 2 + \left(\frac{3}{6} - \frac{2}{6}\right)$$
$$= 2 + \frac{1}{6} = 2\frac{1}{6}$$

Arranged vertically:

$$3\frac{1}{2} \rightarrow \qquad 3 + \frac{1}{2} \rightarrow \quad 3 + \frac{3}{6}$$
$$-1\frac{1}{3} \rightarrow -\left(1 + \frac{1}{3}\right) \rightarrow \quad -1 - \frac{2}{6} \quad \text{or} \quad 2\frac{1}{6}$$
$$2 \quad \frac{1}{6}$$

EXAMPLE

$$5\frac{1}{4} - 2\frac{3}{8} = \frac{21}{4} - \frac{19}{8}$$
$$= \frac{42}{8} - \frac{19}{8} = \frac{23}{8} = 2\frac{7}{8}$$

If one of the fractions is a whole number, write it as a fraction first, then add or subtract as with any other fraction.

EXAMPLE

$$3 - \frac{2}{5} = \frac{3}{1} - \frac{2}{5}$$
$$= \frac{15}{5} - \frac{2}{5}$$
$$= \frac{13}{5} \quad \text{or} \quad 2\frac{3}{5}$$

YOUR TURN

Try these problems for practice in subtracting fractions.

(a) $\frac{7}{8} - \frac{5}{8}$ (b) $9\frac{13}{16} - 3\frac{1}{4}$ (c) $\frac{4}{5} - \frac{1}{6}$

(d) $6 - 2\frac{3}{4}$ (e) $7\frac{1}{6} - 2\frac{5}{8}$

(f) **Machine Technology** A bar $6\frac{3}{16}$ in. long is cut from a piece $24\frac{3}{8}$ in. long. If $\frac{5}{32}$ in. is wasted in cutting, what length remains?

SOLUTIONS

(a) $\frac{7}{8} - \frac{5}{8} = \frac{7 - 5}{8} = \frac{2}{8} = \frac{1}{4}$ (b) $9\frac{13}{16} - 3\frac{1}{4} = (9 - 3) + \left(\frac{13}{16} - \frac{1}{4}\right)$
$$= 6 + \left(\frac{13}{16} - \frac{4}{16}\right) = 6\frac{9}{16}$$

(c) The LCD of 5 and 6 is 30.

$$\frac{4}{5} = \frac{?}{30} = \frac{4 \times 6}{5 \times 6} = \frac{24}{30}$$

$$\frac{1}{6} = \frac{?}{30} = \frac{1 \times 5}{6 \times 5} = \frac{5}{30}$$

$$\text{so } \frac{4}{5} - \frac{1}{6} = \frac{24}{30} - \frac{5}{30}$$

$$= \frac{19}{30}$$

(d) $$6 - 2\frac{3}{4} = \frac{24}{4} - \frac{11}{4} = \frac{24 - 11}{4} = \frac{13}{4} = 3\frac{1}{4}$$

$$6 = \frac{6}{1} = \frac{6 \times 4}{1 \times 4}$$

$(2 \times 4) + 3$

(e) The LCD of 6 and 8 is 24. $\frac{1}{6} = \frac{4}{24}$ $\frac{5}{8} = \frac{15}{24}$

$$\text{so } 7\frac{1}{6} = 7\frac{4}{24} = \frac{172}{24} \quad \text{and} \quad 2\frac{5}{8} = 2\frac{15}{24} = \frac{63}{24}$$

$$7\frac{1}{6} - 2\frac{5}{8} = \frac{172}{24} - \frac{63}{24} = \frac{109}{24} = 4\frac{13}{24}$$

(f) $$24\frac{3}{8} - \frac{5}{32} - 6\frac{3}{16} = 24\frac{12}{32} - \frac{5}{32} - 6\frac{6}{32}$$

$$= (24 - 6) + \left(\frac{12}{32} - \frac{5}{32} - \frac{6}{32}\right)$$

$$= 18 + \frac{1}{32} = 18\frac{1}{32} \text{ in.}$$

Now turn to Exercises 2-4 for a set of problems on adding and subtracting fractions.

Exercises 2-4

Addition and Subtraction of Fractions

A. Add or subtract as shown.

1. $\frac{1}{16} + \frac{3}{16}$
2. $\frac{5}{12} + \frac{11}{12}$
3. $\frac{5}{16} + \frac{7}{16}$
4. $\frac{2}{6} + \frac{3}{6}$
5. $\frac{3}{4} - \frac{1}{4}$
6. $\frac{13}{16} - \frac{3}{16}$
7. $\frac{3}{5} - \frac{1}{5}$
8. $\frac{5}{12} - \frac{2}{12}$
9. $\frac{5}{16} + \frac{3}{16} + \frac{7}{16}$
10. $\frac{1}{8} + \frac{3}{8} + \frac{7}{8}$
11. $1\frac{7}{8} - \frac{3}{8}$
12. $3\frac{9}{16} - 1\frac{5}{16}$
13. $\frac{1}{4} + \frac{1}{2}$
14. $\frac{7}{16} + \frac{3}{8}$
15. $\frac{5}{8} + \frac{1}{12}$
16. $\frac{5}{12} + \frac{3}{16}$
17. $\frac{1}{2} - \frac{3}{8}$
18. $\frac{5}{16} - \frac{3}{32}$
19. $\frac{15}{16} - \frac{1}{2}$
20. $\frac{7}{16} - \frac{1}{32}$
21. $\frac{3}{5} + \frac{1}{8}$

22. $\frac{2}{3} + \frac{4}{5}$ 23. $\frac{7}{8} - \frac{2}{5}$ 24. $\frac{4}{9} - \frac{1}{4}$

25. $\frac{1}{2} + \frac{1}{4} - \frac{1}{8}$ 26. $\frac{11}{16} - \frac{1}{8} - \frac{1}{3}$ 27. $1\frac{1}{2} + \frac{1}{4}$

28. $2\frac{7}{16} + \frac{3}{4}$ 29. $2\frac{1}{2} + 1\frac{5}{8}$ 30. $2\frac{8}{32} + 1\frac{1}{10}$

31. $2\frac{1}{3} + 1\frac{1}{5}$ 32. $1\frac{7}{8} + \frac{1}{4}$ 33. $4\frac{1}{8} - 1\frac{3}{4}$

34. $5\frac{3}{4} - 2\frac{1}{12}$ 35. $3\frac{1}{5} - 2\frac{1}{12}$ 36. $5\frac{1}{3} - 2\frac{2}{5}$

B. Add or subtract as shown.

1. $8 - 2\frac{7}{8}$ 2. $3 - 1\frac{3}{16}$ 3. $3\frac{5}{8} - \frac{13}{16}$

4. $\frac{1}{2} + \frac{1}{3} + \frac{1}{4} + \frac{1}{5}$ 5. $\frac{1}{2} + \frac{1}{4} + \frac{1}{8}$ 6. $6\frac{1}{2} + 5\frac{3}{4} + 8\frac{1}{8}$

7. $\frac{7}{8} - 1\frac{1}{4} + 2\frac{1}{2}$ 8. $1\frac{3}{8}$ subtracted from $4\frac{3}{4}$

9. $2\frac{3}{16}$ less than $4\frac{7}{8}$ 10. $6\frac{2}{3}$ reduced by $1\frac{1}{4}$

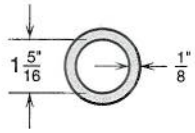
11. $2\frac{3}{5}$ less than $6\frac{1}{2}$ 12. By how much is $1\frac{8}{7}$ larger than $1\frac{7}{8}$?

C. Practical Problems

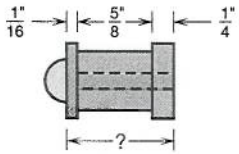
1. **Building Construction** The exterior wall of a small office building under construction is constructed of $\frac{1}{4}$-in. paneling, $\frac{5}{8}$-in. firecode sheetrock, $5\frac{3}{4}$-in. studs, $\frac{1}{2}$-in. CDX plywood sheathing, $1\frac{1}{4}$-in. insulation board, and $\frac{5}{8}$-in. exterior surfacing. Calculate the total thickness of the wall.

2. **Carpentry** A countertop is made of $\frac{5}{8}$-in. particleboard and is covered with $\frac{3}{16}$-in. laminated plastic. What width of metal edging is needed to finish off the edge?

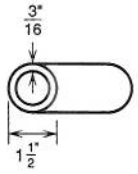
3. **Welding** A welder needs a piece of half-inch pipe $34\frac{3}{4}$ in. long. She has a piece that is $46\frac{3}{8}$ in. long. How much must she cut off from the longer piece?



Problem 5



Problem 6



Problem 9

4. **Plumbing** If a piece of $\frac{3}{8}$-in.-I.D. (inside diameter) copper tubing measures $\frac{9}{16}$ in. O.D. (outside diameter), what is the wall thickness?

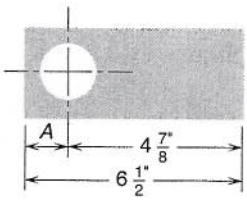
5. **Manufacturing** What is the outside diameter of tubing whose inside diameter is $1\frac{5}{16}$ in. and whose wall thickness is $\frac{1}{8}$ in.?

6. **Machine Technology** How long a bolt is needed to go through a piece of tubing $\frac{5}{8}$ in. long, a washer $\frac{1}{16}$ in. thick, and a nut $\frac{1}{4}$ in. thick?

7. **Office Services** Newspaper ads are sold by the column inch (c.i.). What is the total number of column inches for a month in which a plumbing contractor has had ads of $6\frac{1}{2}$, $5\frac{3}{4}$, $3\frac{1}{4}$, $4\frac{3}{4}$, and 5 c.i.?

8. **Plumbing** While installing water pipes, a plumber used pieces of pipe measuring $2\frac{3}{4}$, $4\frac{1}{8}$, $3\frac{1}{2}$, and $1\frac{1}{4}$ ft. How much pipe would remain if these pieces were cut from a 14-ft length of pipe? (Ignore waste in cutting.)

9. **Electrical Technology** A piece of electrical pipe conduit has a diameter of $1\frac{1}{2}$ in. and a wall thickness of $\frac{3}{16}$ in. What is its inside diameter?



Problem 12

10. **Metalworking** What is the total length of a certain machine part that is made by joining four pieces that measure $3\frac{1}{8}$, $1\frac{5}{32}$, $2\frac{7}{16}$, and $1\frac{1}{4}$ in.?

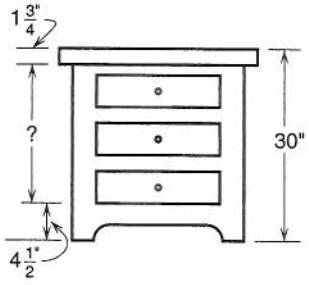
11. **Carpentry** A blueprint requires four separate pieces of wood measuring $5\frac{3}{8}$, $8\frac{1}{4}$, $6\frac{9}{16}$, and $2\frac{5}{8}$ in. How long a piece of wood is needed to cut these pieces if we allow $\frac{1}{2}$ in. for waste?

12. **Drafting** Find the missing dimension A in the drawing shown.

13. **Machine Technology** Two splice plates are cut from a piece of sheet steel that has an overall length of $18\frac{5}{8}$ in. The plates are $9\frac{1}{4}$ in. and $6\frac{7}{16}$ in. long. How much material remains from the original piece if each saw cut removes $\frac{1}{16}$ in.?

14. **Printing** A printer has $2\frac{3}{4}$ rolls of a certain kind of paper in stock. He must do three jobs that require $\frac{5}{8}$, $1\frac{1}{2}$, and $\frac{3}{4}$ roll, respectively. Does he have enough?

15. **Auto Mechanics** The wheel stagger of an automobile is the difference between the axle-to-axle lengths on the right and left sides. If this length is $101\frac{1}{4}$ in. on the right side of a particular car and is $100\frac{7}{8}$ in. on the left side, find the wheel stagger of this automobile.

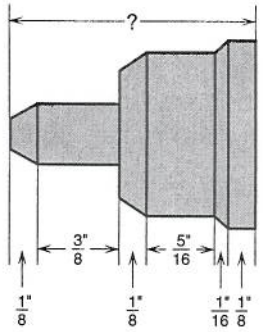


Problem 16

16. **Woodworking** A cabinet 30 in. high must have a $4\frac{1}{2}$-in. base and a $1\frac{3}{4}$-in. top. How much space is left for drawers?

17. **Printing** Before it was trimmed, a booklet measured $8\frac{1}{4}$ in. high by $6\frac{3}{4}$ in. wide. If each edge of the height and one edge of the width were trimmed $\frac{1}{4}$ in. what is the finished size?

18. **Carpentry** A wall has $\frac{1}{2}$-in. paneling covering $\frac{3}{4}$-in. drywall attached to a $3\frac{3}{4}$-in. stud. What is the total thickness of the three components?



Problem 20

19. **Machine Technology** The large end of a tapered pin is $2\frac{15}{16}$ in. in diameter, while the small end is $2\frac{3}{8}$ in. in diameter. Calculate the difference to get the amount of taper.

20. **Machine Technology** Find the total length of the metal casting shown.

21. **Carpentry** A joiner is set to remove $\frac{7}{64}$ in. from the width of an oak board. If the board was $4\frac{5}{8}$ in. wide, find its width after joining once.

22. **Carpentry** A rule of thumb used in constructing stairways is that the rise and the run should always add up to 17 inches. Applying this rule, what should be the run of a stairway if the rise is $7\frac{3}{4}$ in.?

Check your answers in the Appendix.

Using a Calculator, II: Fractions

Fractions can be entered directly on most calculators, and the results of arithmetic calculations with fractions can be displayed as fractions or decimals. If your calculator has a $\boxed{a\frac{b}{c}}$ key, you may enter fractions or mixed numbers directly into your machine without using the division key.

The calculator display will indicate fractions and mixed numbers with a ⌋ symbol. For example, the fraction $\frac{3}{4}$ is shown as 3⌋4,

3 $\boxed{a\frac{b}{c}}$ **4** $\boxed{=}$ → 3⌋4

and the mixed number $1\frac{7}{8}$ is shown as 1⌋7⌋8,

1 $\boxed{a\frac{b}{c}}$ **7** $\boxed{a\frac{b}{c}}$ **8** $\boxed{=}$ → 1⌋7⌋8

Improper fractions or fractions not in lowest terms can be simplified or written in decimal form. The improper fraction $\frac{12}{7}$ can be simplified as follows:

12 $a\frac{b}{c}$ **7** $=$ → 1⌟5⌟7 or $1\frac{5}{7}$

To write it as a decimal number press the fraction key again.

12 $a\frac{b}{c}$ **7** $=$ → 1⌟5⌟7 $a\frac{b}{c}$ → 1.714285714

To simplify the fraction $\frac{6}{16}$

6 $a\frac{b}{c}$ **16** $=$ → 3⌟8 or $\frac{3}{8}$ in lowest terms.

Perform arithmetic operations in the usual way. For example, $\frac{26}{8} - 1\frac{2}{3}$ is

26 $a\frac{b}{c}$ **8** $-$ **1** $a\frac{b}{c}$ **2** $a\frac{b}{c}$ **3** $=$ → 1⌟7⌟12 $a\frac{b}{c}$ → 1.583333333

$1\frac{7}{12}$

Notice that pressing the $a\frac{b}{c}$ key again will display the fraction as a decimal number.

YOUR TURN

For practice in calculating with fractions and decimals, work the following problems. Write your answer both as a fraction or mixed number and as a decimal rounded to two decimal places.

(a) $\frac{2}{3} + \frac{7}{8}$ (b) $1\frac{3}{4} - \frac{2}{5}$ (c) $\frac{25}{32} + 1.87$ (d) $8\frac{1}{5} \div 2\frac{1}{6}$

(e) $\frac{17}{20} \times \frac{1}{3}$

ANSWERS

(a) **2** $a\frac{b}{c}$ **3** $+$ **7** $a\frac{b}{c}$ **8** $=$ → 1⌟13⌟24 $a\frac{b}{c}$ → 1.541666667 or 1.54 rounded

$1\frac{13}{24}$

(b) **1** $a\frac{b}{c}$ **3** $a\frac{b}{c}$ **4** $-$ **2** $a\frac{b}{c}$ **5** $=$ → 1⌟7⌟20 $a\frac{b}{c}$ → 1.35

$1\frac{7}{20}$

(c) **25** $a\frac{b}{c}$ **32** $+$ **1.87** $=$ → 2.65125 or 2.65 rounded

(d) **8** $a\frac{b}{c}$ **1** $a\frac{b}{c}$ **5** $\div$ **2** $a\frac{b}{c}$ **1** $a\frac{b}{c}$ **6** $=$ → 3⌟51⌟65 $a\frac{b}{c}$ → 3.784615385 or 3.78 rounded

$3\frac{51}{65}$

(e) **17** $a\frac{b}{c}$ **20** $\times$ **1** $a\frac{b}{c}$ **3** $=$ → 17⌟60 $a\frac{b}{c}$ → 0.283333333 or 0.28 rounded

$\frac{17}{60}$

PROBLEM SET

2

Fractions

Answers are given in the Appendix.

A. Write as an improper fraction.

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

5. $3\frac{3}{32}$ 6. $2\frac{1}{16}$ 7. $1\frac{5}{8}$ 8. $3\frac{7}{16}$

Write as a mixed number.

9. $\frac{10}{4}$ 10. $\frac{19}{2}$ 11. $\frac{25}{3}$ 12. $\frac{9}{8}$

13. $\frac{25}{16}$ 14. $\frac{21}{16}$ 15. $\frac{35}{4}$ 16. $\frac{7}{3}$

Write in lowest terms.

17. $\frac{6}{32}$ 18. $\frac{8}{32}$ 19. $\frac{12}{32}$ 20. $\frac{18}{24}$

21. $\frac{5}{30}$ 22. $1\frac{12}{21}$ 23. $1\frac{16}{20}$ 24. $3\frac{10}{25}$

Complete these.

25. $\frac{3}{4} = \frac{?}{12}$ 26. $\frac{7}{16} = \frac{?}{64}$ 27. $2\frac{3}{4} = \frac{?}{16}$ 28. $1\frac{3}{8} = \frac{?}{32}$

29. $5\frac{2}{3} = \frac{?}{12}$ 30. $1\frac{4}{5} = \frac{?}{10}$ 31. $1\frac{1}{4} = \frac{?}{12}$ 32. $2\frac{3}{5} = \frac{?}{10}$

Circle the larger number.

33. $\frac{7}{16}$ or $\frac{2}{15}$ 34. $\frac{2}{3}$ or $\frac{4}{7}$ 35. $\frac{13}{16}$ or $\frac{7}{8}$ 36. $1\frac{1}{4}$ or $\frac{7}{6}$

37. $\frac{13}{32}$ or $\frac{3}{5}$ 38. $\frac{2}{10}$ or $\frac{3}{16}$ 39. $1\frac{7}{16}$ or $\frac{7}{4}$ 40. $\frac{3}{32}$ or $\frac{1}{9}$

Name

Date

Course/Section

B. Multiply or divide as shown.

1. $\frac{1}{2} \times \frac{3}{16}$ 2. $\frac{3}{4} \times \frac{2}{3}$ 3. $\frac{7}{16} \times \frac{4}{3}$ 4. $\frac{15}{64} \times \frac{1}{12}$

5. $1\frac{1}{2} \times \frac{5}{6}$ 6. $3\frac{1}{16} \times \frac{1}{5}$ 7. $\frac{3}{16} \times \frac{5}{12}$ 8. $14 \times \frac{3}{8}$

9. $\frac{3}{4} \times 10$ 10. $\frac{1}{2} \times 1\frac{1}{3}$ 11. $18 \times 1\frac{1}{2}$ 12. $16 \times 2\frac{1}{8}$

13. $2\frac{2}{3} \times 4\frac{3}{8}$ 14. $3\frac{1}{8} \times 2\frac{2}{5}$ 15. $\frac{1}{2} \div \frac{1}{4}$ 16. $\frac{2}{5} \div \frac{1}{2}$

17. $4 \div \frac{1}{8}$ 18. $8 \div \frac{3}{4}$ 19. $\frac{2}{3} \div 4$ 20. $1\frac{1}{2} \div 2$

21. $3\frac{1}{2} \div 5$ 22. $1\frac{1}{4} \div 1\frac{1}{2}$ 23. $2\frac{3}{4} \div 1\frac{1}{8}$ 24. $3\frac{1}{5} \div 1\frac{5}{7}$

C. Add or subtract as shown.

1. $\frac{3}{8} + \frac{7}{8}$ 2. $\frac{1}{2} + \frac{3}{4}$ 3. $\frac{3}{32} + \frac{1}{8}$ 4. $\frac{3}{8} + 1\frac{1}{4}$

5. $\frac{3}{5} + \frac{5}{6}$ 6. $\frac{5}{8} + \frac{1}{10}$ 7. $\frac{9}{16} - \frac{3}{16}$ 8. $\frac{7}{8} - \frac{1}{2}$

9. $\frac{11}{16} - \frac{1}{4}$ 10. $\frac{5}{6} - \frac{1}{5}$ 11. $\frac{7}{8} - \frac{3}{10}$ 12. $1\frac{1}{2} - \frac{3}{32}$

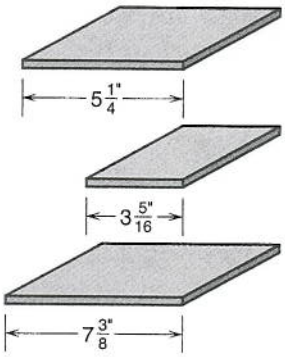
13. $2\frac{1}{8} + 1\frac{1}{4}$ 14. $1\frac{5}{8} + \frac{13}{16}$ 15. $6 - 1\frac{1}{2}$ 16. $3 - 1\frac{7}{8}$

17. $3\frac{2}{3} - 1\frac{7}{8}$ 18. $2\frac{1}{4} - \frac{5}{6}$ 19. $\frac{1}{2} + \frac{1}{3} + \frac{1}{5}$ 20. $1\frac{1}{2} + 1\frac{1}{4} + 1\frac{1}{5}$

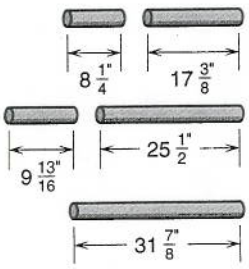
21. $3\frac{1}{2} - 2\frac{1}{3}$ 22. $2\frac{3}{5} - 1\frac{4}{15}$ 23. $2 - 1\frac{3}{5}$ 24. $4\frac{5}{6} - 1\frac{1}{2}$

D. Practical Problems

1. **Welding** In a welding job three pieces of 2-in. I-beam with lengths $5\frac{7}{8}$, $8\frac{1}{2}$, and $22\frac{3}{4}$ in. are needed. What is the total length of I-beam needed? (Do not worry about the waste in cutting.)
2. **Machine Technology** How many pieces of $10\frac{5}{16}$-in. bar can be cut from a stock 20-ft bar? The metal is torch cut and allowance of $\frac{3}{16}$ in. kerf (waste) should be made for each piece. (*Hint:* 20 ft = 240 in.)
3. **Welding** A piece of metal must be cut to a length of $22\frac{3}{8}$ in. $\pm \frac{1}{16}$ in. What are the longest and shortest acceptable lengths? (*Hint:* The symbol $\pm$ means to add $\frac{1}{16}$ in. to get the longest length and subtract $\frac{1}{16}$ in. to get the shortest length. Longest = $22\frac{3}{8}$ in. + $\frac{1}{16}$ in. = ? Shortest = $22\frac{3}{8}$ in. − $\frac{1}{16}$ in. = ?)
4. **Auto Mechanics** A damaged car is said to have "sway" when two corresponding diagonal measurements under the hood are different. If these diagonals are found to be $64\frac{1}{4}$ in. and $62\frac{7}{8}$ in., calculate the magnitude of the sway, the difference between these measurements.
5. **Machine Technology** A shaft $1\frac{7}{8}$ in. in diameter is turned down on a lathe to a diameter of $1\frac{3}{32}$ in. What is the difference in diameters?
6. **Machine Technology** A bar $14\frac{5}{16}$ in. long is cut from a piece $25\frac{1}{4}$ in. long. If $\frac{3}{32}$ in. is wasted in cutting, will there be enough left to make another bar $10\frac{3}{8}$ in. long?
7. **Manufacturing** A cubic foot contains roughly $7\frac{1}{2}$ gallons. How many cubic feet are there in a tank containing $34\frac{1}{2}$ gallons?
8. **Manufacturing** Find the total width of the three pieces of steel plate shown.
9. **Machine Technology** What would be the total length of the bar formed by welding together the five pieces of bar stock shown on the next page?

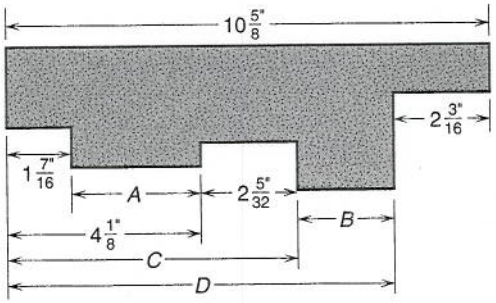


Problem 8

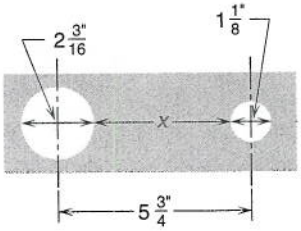


Problem 9

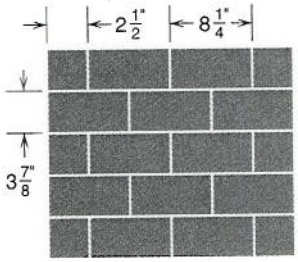
10. **Machine Technology** The Ace Machine Shop has the job of producing 32 zinger bars. Each zinger bar must be turned on a lathe from a piece of stock $4\frac{7}{8}$ in. long. How many feet of stock will they need?
11. **Carpentry** What is the thickness of a tabletop made of $\frac{3}{4}$-in. plywood and covered with a $\frac{3}{16}$-in. sheet of glass?
12. **Building Construction** For the wooden form shown, find the lengths *A*, *B*, *C*, and *D*.



Problem 12



Problem 13



Problem 14

13. **Carpentry** Find the spacing x between the holes.
14. **Masonry** Find the height of the five-course (five-bricks-high) brick wall shown if each brick is $2\frac{1}{2}$ in. by $3\frac{7}{8}$ in. by $8\frac{1}{4}$ in. and all mortar joints are $\frac{1}{2}$ in.
15. **Masonry** If the wall in problem 14 has 28 stretchers (bricks laid lengthwise), what is its length?
16. **Electrical Technology** An electrical wiring job requires the following lengths of 14/2 BX cable: seven pieces each $6\frac{1}{2}$ ft long, four pieces each $34\frac{3}{4}$ in. long, and nine pieces each $19\frac{3}{8}$ in. long. What is the total length of cable needed?
17. **Printing** An invitation must be printed on card stock measuring $4\frac{1}{4}$ in. wide by $5\frac{1}{2}$ in. long. The printed material covers a space measuring $2\frac{1}{8}$ in. wide by $4\frac{1}{8}$ in. long. If the printed material is centered in both directions, what are the margins?
18. **Printing** As a rule of thumb, the top margin of a page of a book should be $\frac{2}{5}$ of the total margin, and the bottom margin should be $\frac{3}{5}$ of the total margin. If the print takes up $9\frac{1}{2}$ in. of an 11-in.-long page, what should the top and bottom margins be? (*Hint:* The total margin = 11 in. $-$ $9\frac{1}{2}$ in. = $1\frac{1}{2}$ in.)
19. **Welding** A 46-in. bar must have 9 equally spaced holes drilled through the centerline. If the centers of the two end holes are each $2\frac{1}{4}$ in. in from their respective ends, what should the center-to-center distance of the holes be? (*Hint:* There are 8 spaces between holes.)
20. **Building Construction** If an I-beam is to be $24\frac{3}{8}$ in. long with a tolerance of $\pm\frac{1}{4}$ in., find the longest and shortest acceptable lengths.
21. **Machine Technology** If a positioner shaft turns at 18 revolutions per minute, and the tool feed is $\frac{1}{16}$ in. per revolution, how long will it take to advance $7\frac{1}{2}$ in.?
22. **Sheet Metal Technology** The total allowance for both edges of a grooved seam is three times the width of the seam. Half of this total is added to each edge of the seam. Find the allowance for each edge of a grooved seam if the width of the seam is $\frac{5}{16}$ in.

Problem Set 1, page 49

A.

1. 93	2. 83	3. 528	4. 860
5. 934	6. 2980	7. 15	8. 26
9. 649	10. 196	11. 195	12. 2615
13. 1504	14. 3423	15. 1407	16. 3690
17. 13,041	18. 290,764	19. 230,384	20. 1,575,056
21. 37	22. 213	23. 57	24. 62
25. 9	26. 43	27. 18	28. 69
29. 6	30. 9	31. 115	32. 40
33. 7	34. 627	35. 1245	36. 833

B.

1. (a) 1, 2, 4, 8 (b) $2 \times 2 \times 2$
2. (a) 1, 2, 4, 7, 14, 28 (b) $2 \times 2 \times 7$
3. (a) 1, 31 (b) 31
4. (a) 1, 5, 7, 35 (b) 5×7
5. (a) 1, 2, 3, 4, 6, 9, 12, 18, 36 (b) $2 \times 2 \times 3 \times 3$
6. (a) 1, 2, 3, 6, 7, 14, 21, 42 (b) $2 \times 3 \times 7$

C.

1. 43 ft	2. 64 rods	3. 1892 sq ft	4. 445 lb
5. 6	6. 24 hr	7. 207 lb	8. \$754
9. \$1742	10. 252 ft	11. 739,689 mi	12. \$165,359
13. 650 gpm	14. (a) 513 (b) 5068 ft		
15. 2839 lb	16. 263°	17. 24 hr	

18. $3 \times \$20 + 3 \times 6 \times \$9 + 3 \times 6 \times \$4$
or $3 \times \$20 + 3 \times 6 \times (\$9 + \$4) = \$294$

19. 87,780 cu in.	20. 646	21. 193 rpm	22. 101 lb
23. 6 ft	24. 1145 pF		

Chapter 2

Exercises 2-1, page 69

A. 1. $\frac{7}{3}$ 2. $\frac{15}{2}$ 3. $\frac{67}{8}$ 4. $\frac{17}{16}$ 5. $\frac{23}{8}$
6. $\frac{2}{1}$ 7. $\frac{8}{3}$ 8. $\frac{259}{64}$ 9. $\frac{29}{6}$ 10. $\frac{29}{16}$

B. 1. $8\frac{1}{2}$ 2. $1\frac{3}{5}$ 3. $1\frac{3}{8}$ 4. $2\frac{8}{16}$ or $2\frac{1}{2}$ 5. $1\frac{1}{2}$
6. $3\frac{2}{3}$ 7. $16\frac{4}{6}$ or $16\frac{2}{3}$ 8. $1\frac{1}{3}$ 9. $2\frac{16}{32}$ or $2\frac{1}{2}$ 10. $2\frac{1}{2}$

C. 1. $\frac{3}{4}$ 2. $\frac{2}{3}$ 3. $\frac{3}{8}$ 4. $\frac{9}{2}$ 5. $\frac{2}{5}$
6. $\frac{7}{6}$ 7. $\frac{4}{5}$ 8. $\frac{5}{2}$ 9. $4\frac{1}{4}$ 10. $\frac{17}{16}$
11. $\frac{21}{32}$ 12. $\frac{2}{7}$ 13. $\frac{5}{12}$ 14. $\frac{5}{2}$ 15. $\frac{19}{12}$

D. 1. 14 2. 12 3. 8 4. 24 5. 20 6. 92
7. 36 8. 34 9. 5 10. 24 11. 42 12. 34

E. 1. $\frac{3}{5}$ 2. $\frac{13}{8}$ 3. $1\frac{1}{2}$ 4. $\frac{13}{16}$ 5. $\frac{7}{8}$ 6. $2\frac{1}{2}$
7. $\frac{6}{4}$ 8. $\frac{25}{60}$ 9. $\frac{13}{5}$ 10. $2\frac{7}{4}$ 11. $\frac{5}{12}$ 12. $1\frac{1}{5}$

F. 1. $15\frac{3}{4}$ in. 2. $\frac{3}{4}$ 3. $\frac{19}{6}$, $\frac{25}{8}$ 4. $\frac{13}{64}$-in. fastener
5. No. 6. $2\frac{2}{3}$ in. 7. $\frac{3}{5}$ 8. $1\frac{1}{2}$ 9. $\frac{1}{5}$ 10. $\frac{3}{12}$

Exercises 2-2, page 73

A. 1. $\frac{1}{8}$ 2. $\frac{4}{15}$ 3. $\frac{2}{15}$ 4. 3 5. $2\frac{2}{3}$
6. $\frac{11}{45}$ 7. $1\frac{1}{9}$ 8. $\frac{13}{16}$ 9. $2\frac{1}{2}$ 10. 14
11. 3 12. 8 13. $3\frac{1}{4}$ 14. $1\frac{1}{21}$ 15. 69
16. $35\frac{3}{4}$ 17. 74 18. $9\frac{7}{8}$ 19. $10\frac{3}{8}$ 20. $21\frac{1}{3}$
21. $\frac{1}{8}$ 22. $\frac{3}{10}$ 23. $\frac{1}{15}$ 24. $1\frac{1}{3}$ 25. 2

B. 1. $\frac{1}{6}$ 2. $\frac{3}{32}$ 3. $\frac{1}{2}$ 4. $\frac{7}{16}$ 5. $\frac{3}{4}$
6. $\frac{15}{16}$ 7. $1\frac{5}{16}$ 8. $2\frac{7}{9}$ 9. 1 10. $\frac{7}{10}$
11. $1\frac{1}{20}$ 12. $2\frac{2}{5}$ 13. $2\frac{5}{8}$ 14. $\frac{5}{14}$ 15. 1 16. $1\frac{1}{2}$

C. 1. $137\frac{3}{4}$ in. 2. $99\frac{3}{4}$ in. 3. $11\frac{2}{3}$ ft
4. $4\frac{5}{16}$ in. 5. 14 ft $1\frac{1}{2}$ in. 6. $110\frac{1}{4}$ in.
7. $318\frac{1}{2}$ mi 8. $36\frac{3}{4}$ in. 9. $356\frac{1}{2}$ lb
10. 118 in. 11. $\frac{9}{10}$ in. 12. 210 in. or 17 ft 6 in.
13. $9\frac{3}{4}$ in. 14. $431\frac{41}{64}$ cu in. 15. $348\frac{3}{4}$ min
16. 1001 cu in. 17. $10\frac{2}{3}$ hr 18. 126 in.
19. $5\frac{2}{5}$ in. 20. 390 lb 21. $22\frac{1}{2}$ picas
22. 24 MGD 23. $31\frac{1}{8}$ 24. 45°, 72°, 60°
25. $3\frac{1}{4}$ in. 26. $2\frac{1}{2}$ in. 27. $\frac{15}{32}$ in.

Exercises 2-3, page 80

A. 1. $1\frac{2}{3}$ 2. 9 3. $\frac{5}{16}$ 4. 32 5. $\frac{1}{2}$ 6. 1
7. $\frac{1}{4}$ 8. $2\frac{2}{5}$ 9. 9 10. 4 11. $1\frac{1}{3}$ 12. $1\frac{3}{4}$
13. $1\frac{1}{5}$ 14. $8\frac{1}{3}$ 15. 16 16. $\frac{1}{9}$ 17. 18 18. $\frac{6}{7}$
19. $7\frac{1}{2}$ 20. $\frac{3}{5}$ 21. $\frac{5}{6}$ 22. $\frac{7}{8}$ 23. $\frac{1}{8}$ 24. $1\frac{1}{3}$

B. 1. 8 ft 2. 14 ft 3. 48 4. 12 5. 84
6. $40\frac{1}{2}$ ft 7. 18 8. 8 9. 210 10. 29 ft by 34 ft
11. 7 sheets 12. 108 rev 13. 45 threads 14. 14 ft by $18\frac{1}{2}$ ft
15. 284 sq ft 16. $10\frac{7}{8}$ in.

Exercises 2-4, page 90

A. 1. $\frac{1}{4}$ 2. $1\frac{1}{3}$ 3. $\frac{3}{4}$ 4. $\frac{5}{6}$ 5. $\frac{1}{2}$ 6. $\frac{5}{8}$
7. $\frac{2}{5}$ 8. $\frac{1}{4}$ 9. $\frac{15}{16}$ 10. $1\frac{3}{8}$ 11. $1\frac{1}{2}$ 12. $2\frac{1}{4}$
13. $\frac{3}{4}$ 14. $\frac{13}{16}$ 15. $\frac{17}{24}$ 16. $\frac{29}{48}$ 17. $\frac{1}{8}$ 18. $\frac{7}{32}$
19. $\frac{7}{16}$ 20. $\frac{13}{32}$ 21. $\frac{29}{40}$ 22. $1\frac{7}{15}$ 23. $\frac{19}{40}$ 24. $\frac{7}{36}$
25. $\frac{5}{8}$ 26. $\frac{11}{48}$ 27. $1\frac{3}{4}$ 28. $3\frac{3}{16}$ 29. $4\frac{1}{8}$ 30. $3\frac{7}{20}$
31. $3\frac{8}{15}$ 32. $2\frac{1}{8}$ 33. $2\frac{3}{8}$ 34. $3\frac{2}{3}$ 35. $1\frac{7}{60}$ 36. $2\frac{14}{15}$

B. 1. $5\frac{1}{8}$ 2. $1\frac{13}{16}$ 3. $2\frac{13}{16}$ 4. $1\frac{17}{60}$ 5. $\frac{7}{8}$ 6. $20\frac{3}{8}$
7. $2\frac{1}{8}$ 8. $3\frac{3}{8}$ 9. $2\frac{11}{16}$ 10. $5\frac{5}{12}$ 11. $3\frac{9}{10}$ 12. $\frac{15}{56}$

C. 1. 9 in. 2. $\frac{13}{16}$ in. 3. $11\frac{5}{8}$ in. 4. $\frac{3}{32}$ in.
5. $1\frac{9}{16}$ in. 6. $\frac{15}{16}$ in. 7. $25\frac{1}{4}$ c.i. 8. $2\frac{3}{8}$ ft
9. $1\frac{1}{8}$ in. 10. $7\frac{31}{32}$ in. 11. $23\frac{5}{16}$ in. 12. $1\frac{5}{8}$ in.
13. $2\frac{13}{16}$ in. 14. No 15. $\frac{3}{8}$ in. 16. $23\frac{3}{4}$ in.
17. $7\frac{3}{4}$ in. by $6\frac{1}{2}$ in. 18. 5 in. 19. $\frac{9}{16}$ in. 20. $1\frac{1}{8}$ in.
21. $4\frac{33}{64}$ in. 22. $9\frac{1}{4}$ in.

Problem Set 2, page 95

A. 1. $\frac{9}{8}$ 2. $\frac{21}{5}$ 3. $\frac{5}{3}$ 4. $\frac{35}{16}$ 5. $\frac{99}{32}$ 6. $\frac{33}{16}$
7. $\frac{13}{8}$ 8. $\frac{55}{16}$ 9. $2\frac{1}{2}$ 10. $9\frac{1}{2}$ 11. $8\frac{1}{3}$ 12. $1\frac{1}{8}$
13. $1\frac{9}{16}$ 14. $1\frac{5}{16}$ 15. $8\frac{3}{4}$ 16. $2\frac{1}{3}$ 17. $\frac{3}{16}$ 18. $\frac{1}{4}$
19. $\frac{3}{8}$ 20. $\frac{3}{4}$ 21. $\frac{1}{6}$ 22. $1\frac{4}{7}$ 23. $1\frac{4}{5}$ 24. $3\frac{2}{5}$
25. 9 26. 28 27. 44 28. 44 29. 68 30. 18
31. 15 32. 26 33. $\frac{7}{16}$ 34. $\frac{2}{3}$ 35. $\frac{7}{8}$ 36. $1\frac{1}{4}$
37. $\frac{3}{5}$ 38. $\frac{2}{10}$ 39. $\frac{7}{4}$ 40. $\frac{1}{9}$

B. 1. $\frac{3}{32}$ 2. $\frac{1}{2}$ 3. $\frac{7}{12}$ 4. $\frac{5}{256}$ 5. $1\frac{1}{4}$ 6. $\frac{49}{80}$
7. $\frac{5}{64}$ 8. $5\frac{1}{4}$ 9. $7\frac{1}{2}$ 10. $\frac{2}{3}$ 11. 27 12. 34
13. $11\frac{2}{3}$ 14. $7\frac{1}{2}$ 15. 2 16. $\frac{4}{5}$ 17. 32 18. $10\frac{2}{3}$
19. $\frac{1}{6}$ 20. $\frac{3}{4}$ 21. $\frac{7}{10}$ 22. $\frac{5}{6}$ 23. $2\frac{4}{9}$ 24. $1\frac{13}{15}$

C. 1. $1\frac{1}{4}$ 2. $1\frac{1}{4}$ 3. $\frac{7}{32}$ 4. $1\frac{5}{8}$ 5. $1\frac{13}{30}$ 6. $\frac{29}{40}$
7. $\frac{3}{8}$ 8. $\frac{3}{8}$ 9. $\frac{7}{16}$ 10. $\frac{19}{30}$ 11. $\frac{23}{40}$ 12. $1\frac{13}{32}$
13. $3\frac{3}{8}$ 14. $2\frac{7}{16}$ 15. $4\frac{1}{2}$ 16. $1\frac{1}{8}$ 17. $1\frac{19}{24}$ 18. $1\frac{5}{12}$
19. $1\frac{1}{30}$ 20. $3\frac{19}{20}$ 21. $1\frac{1}{6}$ 22. $1\frac{1}{3}$ 23. $\frac{2}{5}$ 24. $3\frac{1}{3}$

D. 1. $37\frac{1}{8}$ in. 2. 22 3. $22\frac{5}{16}$ in.; $22\frac{7}{16}$ in. 4. $1\frac{3}{8}$ in.
5. $\frac{25}{32}$ in. 6. Yes 7. $4\frac{3}{5}$ cu ft 8. $15\frac{15}{16}$ in.
9. $92\frac{13}{16}$ in. 10. 13 ft 11. $\frac{15}{16}$ in.
12. *A*: $2\frac{11}{16}$ in. *B*: $2\frac{5}{32}$ in. *C*: $6\frac{9}{32}$ in. *D*: $8\frac{7}{16}$ in.
13. $4\frac{3}{32}$ in. 14. $21\frac{3}{8}$ in. 15. $244\frac{1}{2}$ in. 16. $859\frac{3}{8}$ in. or 71 ft $7\frac{3}{8}$ in.
17. $1\frac{1}{16}$ in. and $\frac{11}{16}$ in. 18. $\frac{3}{5}$ in. and $\frac{9}{10}$ in. 19. $5\frac{3}{16}$ in.
20. $24\frac{5}{8}$ in.; $24\frac{1}{8}$ in. 21. $6\frac{2}{3}$ min 22. $\frac{15}{32}$ in.

Chapter 3

Exercises 3-1, page 109

A. 1. Seventy-two hundredths
2. Eight and seven tenths
3. Twelve and thirty-six hundredths
4. Five hundredths
5. Three and seventy-two thousandths
6. Fourteen and ninety-one thousandths
7. Three and twenty-four ten-thousandths
8. Six and eighty-three ten-thousandths

9. 0.004 10. 3.4 11. 6.7
12. 0.005 13. 12.8 14. 3.021
15. 10.032 16. 40.7 17. 0.0116
18. 0.0047 19. 2.0374 20. 10.0222

B. 1. 21.01 2. 78.17 3. $15.02 4. $151.11
5. 1.617 6. 5.916 7. 828.6 8. 238.16
9. 63.7305 10. 462.04 11. 6.97 12. 1.04
13. $15.36 14. $6.52 15. 42.33 16. 36.18
17. $22.02 18. $24.39 19. 113.96 20. 13.22
21. 45.195 22. 245.11 23. $27.51 24. 151.402
25. 95.888 26. 39.707 27. 15.16 28. 86.07
29. 8.618 30. 18.6373 31. 31.23 32. 292.19