Chapter

10 Math

Terms to Know

12-hour clock
24-hour clock
addition
algebra
base ten system
Celsius temperature scale (°C)
common denominator
database
decimal numbers
division
English system of measurement
equations
Fahrenheit temperature scale (°F)
fractions
mean
median
metric system of measurement
mixed numbers
mode
multiplication
nominal numbers
ordinal numbers
percentage
prime number
proportion
ratio
spreadsheet
subtraction
whole numbers

Chapter Objectives

- Explain the different forms of numbers, including whole, mixed, decimals, and fractions.
- Perform basic mathematical computations such as addition, subtraction, multiplication, and division.
- Understand the uses of fractions, decimal fractions, percentages, and ratios in the healthcare environment.
- Perform computations using fractions, decimal fractions, percentages, and ratios.
- Explain how algebra can be applied to problem solving in healthcare.
- Demonstrate how to use a calculator to perform functions of addition, subtraction, multiplication, and division.
- Explain the possible functions of graphs and charts when displaying healthcare information.
- Identify the importance of the metric system in healthcare, and recognize key terms and prefixes used in the metric system.
- Demonstrate how to convert Fahrenheit temperatures to Celsius temperatures.
- Explain how the 24-hour clock works and why it is used in healthcare facilities.

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No matter which healthcare field you choose for your career, you will be required to perform some math calculations when doing your job. Of course, there are professions in the medical field such as pharmacists, physicians, or registered nurses that will require more math skills than others. But at the minimum, you will be required to know how to add, subtract, multiply, divide, and use the metric system. You will also be expected to understand and use decimals, fractions, and ratios. It is important that you are comfortable performing these basic math calculations.

This chapter begins with a review of important math skills. If you find this review too easy, answer the *Basic Math Review* questions in the *Additional Practice* section at the end of the chapter. If you are able to correctly answer these questions, and you feel confident using a calculator, skip to the section of the chapter entitled *Data Analysis*. The student workbook and a companion website associated with this textbook program contain additional math problems to help you review various math skills important in most health professions.

Numbers and the Base Ten System

The number system used for counting based on groups of ten is called the **base ten system**. Numbers that have more than one digit are defined by their place value. For example, the number 9,234,567 is read as: nine million, two hundred thirty-four thousand, five hundred, sixty-seven. If you understand the base ten system, you know that you can break that number down to 9 millions, 2 hundred thousands, 3 ten thousands, 4 thousands, 5 hundreds, 6 tens, and 7 ones. You could illustrate the number 9,234,567 as:

base ten system *numbering system used for counting that is based on multiples of ten*

9,000,000 + 200,000 + 30,000 + 4,000 + 500 + 60 + 7

- the ones digit shows the number of ones (1)
- the tens digit shows the number of tens (10)
- the hundreds digit shows the number of hundreds (100)
- the thousands digit shows the number of thousands (1,000)
- the ten thousands digit shows the number of tens of thousands (10,000)
- the hundred thousands digit shows the number of hundreds of thousands (100,000)
- the millions digit shows the number of millions (1,000,000)

Check Your Understanding

Read the following numbers out loud and identify the place value of each number. For example, how many ones, tens, hundreds, and thousands are in each number?

1. 540
2. 4,321
3. 98
4. 200,000
5. 4,444,444
6. 106
7. 2,435
8. 111,222
9. 12,432,000
10. 4

Types of Numbers

There are different types of numbers and each type is used for its own special purpose. The following descriptions of numbers will help you to understand the differences between types.

Whole Numbers

whole numbers *numbers used for counting; do not contain decimal points or fractions; integers*

Whole numbers (also called *integers*) are the numbers you use to count, including zero. Whole numbers do not have decimal points and are not fractions or negative numbers. Examples of whole numbers include 1, 5, 10, 13, 20, and 0. Another name for whole numbers is *cardinal numbers*. A cardinal number (1, 2, 3, for example), is different from an ordinal number.

Ordinal Numbers

ordinal numbers *numbers that place objects in a series in order*

When objects are placed in order, you use **ordinal numbers** to tell their position. If ten students were ranked according to their grade on their health occupations final, you would say that the student who got the top grade was in first place, the next student was in second place, and so on.

The first ten ordinal numbers are first, second, third, fourth, fifth, sixth, seventh, eighth, ninth, and tenth. They can also be written as 1st, 2nd, 3rd, 4th, 5th, 6th, 7th, 8th, 9th, and 10th.

Decimal Numbers

decimal numbers *numbers expressed with a decimal point; values left of the decimal are whole numbers and values to the right are fractions*

Decimal numbers are expressed with a decimal point separating whole numbers and decimal fractions. Whole numbers appear to the left of the decimal point. Decimal fractions, or numbers with a value that is less than 1, appear to the right of the decimal point.

Examples: 10.5, 5.54, 3.1416, 152.71

Fractions

fractions *numbers composed of a numerator on top and a denominator on the bottom; indicates part of a whole*

Fractions are numbers defined as one or more parts of a whole number. Using fractions is an easy way to show portions less than one. Fractions are used to express parts of a whole, like the numbers that appear to the right of the decimal point in decimal numbers. Fractions are used in cooking, building, sewing, the stock market, and many other places.

Examples: 1/2, 3/4, 5/8

Mixed Numbers

mixed numbers *whole numbers followed by a remaining fraction*

Mixed numbers are whole numbers with a fraction included.

Examples: 32¾, 1½, 416½

Negative Numbers

Negative numbers are less than zero, but are not a fraction or a decimal. Negative numbers are also called *negative integers*.

Examples: –5, –100, –235

Percentages

percentage *a number divided into 100 parts; expressed with the percent sign (%)*

The term *percent* means *per hundred*. When you use a **percentage**, you are working with a number by dividing it into 100 parts. For example, a dollar can be divided into 100 pennies. One penny is 1/100th of a dollar. Sometimes, it is easier to express a percentage using the percent sign (%). For example, seven pennies can be expressed as 7% of a dollar.

Prime Numbers

prime number *a number that is only divisible by itself and 1*

A **prime number** is a number that is only divisible by itself and 1. If you try to divide a prime number by any other number, you will have a number and a fraction left over. A prime number must be a whole number greater than 1 (Figure 10.1).

Nominal Numbers

nominal numbers *numbers that name or identify something*

Nominal numbers name something—a telephone number, a house number, or a zip code. Nominal numbers do not show quantity or rank. They are used only to identify something.

Examples: 417 Fern Avenue
The zip code for my hometown is 01796.
My office phone number is 708-967-5732.

2	3	5	7	11	13	17	19	23	29	31	37	41	43	47	53	59	61	67
71	73	79	83	89	97	101	103	107	109	113	127	131	137	139	149	151	157	163
167	173	179	181	191	193	197	199	211	223	227	229	233	239	241	251	257	263	269
271	277	281	283	293	307	311	313	317	331	337	347	349	353	359	367	373	379	383
389	397	401	409	419	421	431	433	439	443	449	457	461	463	467	479	487	491	499

Figure 10.1 Prime numbers

Adding Whole Numbers

addition
the process of combining two or more numbers to obtain their total value

Addition is the process of combining two or more numbers. The numbers being added together are called *addends*. The addends of a written addition problem are separated by an addition sign (+). The answer to an addition problem is called the *sum* and comes after an equal sign (=) in addition problems.

Examples: 5 + 4 = 9
4 + 6 = 10

When adding numbers that contain two or more digits, it is best to write numbers in a column, aligning the place value of the digits such as the ones, tens, or hundreds. Make sure the numbers in each column line up beneath one another. This alignment helps you add the correct numbers together. Always add the numbers in the right column first, before moving to the columns to the left.

Example:

$$\begin{array}{r} 21 \\ +\ 37 \\ \hline 58 \end{array}$$

This problem can be rewritten as:

$$\begin{array}{rl} & 2 \text{ tens and } 1 \text{ ones} \\ + & 3 \text{ tens and } 7 \text{ ones} \\ \hline & 5 \text{ tens and } 8 \text{ ones} \quad = 58 \end{array}$$

Sometimes, addition problems require you to carry over digits to the left.

Example:

$$\begin{array}{r} 36 \\ +\ 45 \\ \hline \end{array}$$

First add the ones column (6 + 5 = 11) and carry the remaining 1 to the tens column. Then, add the tens column.

$$\begin{array}{r} {\scriptstyle 1} \\ 36 \\ +\ 45 \\ \hline 81 \end{array}$$

Example:

$$\begin{array}{r} 788 \\ +\ 57 \\ \hline 845 \end{array}$$

Add the ones column and carry over the *1* to the tens column. Then, add the tens column, and carry the *1* to the hundreds column.

$$\begin{array}{r} {\scriptstyle 11} \\ 788 \\ +\ 57 \\ \hline 845 \end{array}$$

Real Life Scenario

Supply Inventory

1. Carlos works in a doctor's office. One day, he is asked to take inventory of disposable office surgery trays in the office. He finds 10 trays in exam room A's closet, 8 in exam room B's closet, and 24 in the supply cupboard. How many trays are in the doctor's office?
2. Carlos is then asked to take inventory of boxes of alcohol swabs in the office. He counts 20 boxes in exam room A's closet, 18 in exam room B's closet, 12 in the reception room drawers, and 9 in the supply cupboard. How many boxes of alcohol swabs are in the office?
3. Finally, Carlos must total the number of patients that were seen by the doctor over the course of the week (5 days). There were 20 patients seen on day 1, 35 on day 2, 40 on day 3, 34 on day 4, and 21 on day 5. How many patients did the doctor see over the course of five days?

Subtracting Whole Numbers

subtraction
the process of removing one number from another number; the opposite of addition

Subtraction is the opposite of addition. When numbers are subtracted, one number is taken away from another. Simple subtraction is written as 6 – 2 = 4, with the minus sign (–) indicating subtraction. The answer obtained in a subtraction problem is called the *difference*. Subtraction problems can be written in two ways:

$$\begin{array}{r} 54 \\ -\ 23 \\ \hline 31 \end{array} \quad \text{or } 54 - 23 = 31$$

You can check your answer by adding the difference to the number subtracted. If your answer is correct, your total will equal the first number in the equation. To check the above problem, 54 – 23 = 31, you would add 31 + 23 = 54.

Subtracting by Borrowing Numbers

Some subtraction problems require that you "borrow" a number. When beginning a subtraction problem, align the numbers one on top of the other, as you do during an addition problem. Look at the rightmost column. If the

number on top is smaller than the number on the bottom, you will have to "borrow" from the column on the left.

Consider the following subtraction problem:

$$\begin{array}{r} 34 \\ -\ 16 \\ \hline \end{array}$$

To subtract a larger number (6) from a smaller number (4), you must borrow 10 from the column to the left to complete the subtraction.

Example:

$$\begin{array}{r} {\scriptstyle 1} \\ 34 \\ -\ 16 \\ \hline 18 \end{array}$$

By borrowing the one 10 from the three 10s in the left column, 4 becomes 14. The 3 in the left column becomes a 2. When you subtract 6 from 14, you get 8, and 2 minus 1 equals 1, leaving you with an answer of 18.

Real Life Scenario

Subtraction in Everyday Life

1. Paul is an emergency medical technician who has earned 14 vacation days this year. He has already taken 8. How many days does Paul have left?
2. As part of his job, Paul is required to complete 50 hours of continuing education every year. So far this year, he has completed 13 hours. How many hours does he have left to complete his education requirement for the year?
3. Last month, Paul recorded 675 miles traveled in his ambulance. This month, he has traveled 1,220 miles. How many more miles has he traveled this month than last month?

Check Your Understanding

1. 2,222 + 99 =
2. 123,456 + 777 =
3. 9,689 + 245 =
4. 68,834 + 8,834 =
5. 64 + 7 =
6. 9,888 – 999 =
7. 90,145 – 326 =
8. 11,103 – 871 =
9. 48 – 19 =
10. 576 – 68 =

multiplication
mathematical operation that indicates how many times a number is added to itself; a shortcut for addition

Multiplication

Multiplication is a shortcut for addition. The standard symbol for multiplication is (×). Other ways of expressing multiplication include an asterisk (10 * 10 = 100) or parentheses (10)(10) = 100. The numbers to be multiplied are called the *multiplicand* (the first number) and the *multiplier* (the second number). The answer to a multiplication problem is called the *product*.

$$\begin{array}{rl} 87 & \leftarrow \text{multiplicand} \\ \times\ \ 15 & \leftarrow \text{multiplier} \\ \hline 1305 & \leftarrow \text{product} \end{array}$$

You will encounter many situations that require the use of multiplication throughout your healthcare career. The following is an example of one such situation.

> Joy is working out the budget for the healthcare facility where she is employed. As part of her budgeting, Joy needs to know how much 12 boxes of latex gloves cost. Joy researches the price for one package and finds it costs $10.35. Joy could determine the cost of 12 boxes of gloves by adding $10.35 together twelve times, but that is time-consuming. Instead, Joy can find the answer using multiplication. The equation Joy must solve is: $10.35 × 12 = ?

To solve such a problem, you might want to memorize some basic multiplication problems. Using a multiplication table is the best way to practice this skill (Figure 10.2). Knowing your multiplication tables allows you to calculate numbers quickly and without error.

To answer the problem above using a multiplication table, you would multiply each digit separately to create partial answers. Then add the partial answers to find the final answer. Note that alignment of the numbers is very important!

$$\begin{array}{r} \$10.35 \\ \times\ \ \ \ \ 12 \\ \hline \end{array}$$

First, multiply the ones digit of the multiplier (2) with each digit in the multiplicand. Because 2 × 5 = 10, you should place a 0 beneath the 5 and 2, and carry the 1 to the tens column, so it appears above the 3. Now, when you multiply 2 × 3, add 1 to the answer (2 × 3 = 6; 6 + 1 = 7). Place a 7 beneath the 3 and 1, and move on to the next digits. The first partial answer is 2,070.

$$\begin{array}{r} {\scriptstyle 1} \\ \$10.35 \\ \times\ \ \ \ \ 12 \\ \hline 2070 \end{array}$$

Next, multiply the tens digits. Since you have already multiplied the ones column, place a 0 or X beneath the 0 in the ones column. Multiply 1 with

each digit of the multiplicand (1 × 5 = 5, 1 × 3 = 3, 1 × 0 = 0, and 1 × 1 = 1). The second partial answer is 10,350.

$$\begin{array}{r} \$10.35 \\ \times \quad 12 \\ \hline 2070 \\ 10350 \end{array}$$

Now, add the two partial answers together to find the product. Because there is a decimal point in the number $10.35, the product also needs a decimal point. To determine the location of the decimal point, count the number of digits to the right of the decimal point in the multiplicand (two). Now, place the decimal point in the product so that there are two places to the right.

$$\begin{array}{r} \$10.35 \\ \times \quad 12 \\ \hline 2070 \\ + \quad 10350 \\ \hline \$124.20 \end{array}$$

	1	2	3	4	5	6	7	8	9	10	11	12
1	1	2	3	4	5	6	7	8	9	10	11	12
2	2	4	6	8	10	12	14	16	18	20	22	24
3	3	6	9	12	15	18	21	24	27	30	33	36
4	4	8	12	16	20	24	28	32	36	40	44	48
5	5	10	15	20	25	30	35	40	45	50	55	60
6	6	12	18	24	30	36	42	48	54	60	66	72
7	7	14	21	28	35	42	49	56	63	70	77	84
8	8	16	24	32	40	48	56	64	72	80	88	96
9	9	18	27	36	45	54	63	72	81	90	99	108
10	10	20	30	40	50	60	70	80	90	100	110	120
11	11	22	33	44	55	66	77	88	99	110	121	132
12	12	24	36	48	60	72	84	96	108	120	132	144

Figure 10.2 To use a multiplication table, choose one number from the top row and one number from the row on the left-hand side. Identify the cell where these two rows meet—this is the product of your multiplication problem.

Real Life Scenario

Multiplying on the Job

1. Elise is a respiratory therapist. Her supervisor has asked her to work 8 hour shifts for the next 3 weeks (Elise works 5 days a week). How many total hours will Elise work during the next 3 weeks?
2. During each 8 hour shift, Elise sees 13 patients. How many patients will she see in the next 3 weeks? Remember, Elise works 5 days a week.

Division

Division is a process that enables you to find how many times one number is present in another number. Division is the opposite of multiplication. Therefore, memorizing the multiplication table will help you to solve division problems.

division
process of determining how many times one number is present in another number

The most common symbol for division is (÷). The number that gets divided is called the *dividend*. The number that does the dividing is called the *divisor*. The answer to a division problem is called the *quotient*.

$$\begin{array}{rl} & 5 \leftarrow \text{quotient} \\ \text{divisor} \rightarrow & 3\overline{)15} \leftarrow \text{dividend} \end{array}$$

Division problems can be written several ways:

$$6 \div 3 \text{ or } \frac{6}{3} \text{ or } 3\overline{)6}$$

Many situations will arise during your career requiring the use of division. The following is an example of how you might use division in a healthcare setting:

> Hazel is the front office medical assistant in charge of buying new chairs for the medical office's reception room. She is given a budget of $745 to purchase five new chairs. What is the most that Hazel can pay for each chair while staying in budget? The equation Hazel must solve is 745 ÷ 5 = ?

To begin, divide 5 into the first digit of the dividend (7). Because 5 goes into 7 only one time, write a 1 above the 7. Next, multiply the 5 and 1, and write the product (5) below the 7. Then, subtract the 5 from the 7, which gives you the remainder of 2.

$$\begin{array}{l} 1 \\ 5\overline{)745} \\ \underline{5} \\ 2 \end{array}$$

Now, bring the 4 from the 745 down next to the 2. Divide 5 into 24. Because 5 goes into 24 four times, write a 4 next to the 1 in the quotient. Multiply the 4 and the 5 and put the result (20) below the 24. Subtract the 20 from the 24 and write the difference (4) beneath the 20.

```
   14
5 )745
   5
   24
   20
    4
```

Next, bring the third digit (5) down so that it is next to the 4. Divide 5 into 45. Write the answer (9) next to the 4 in the quotient. Because 9 × 5 = 45, the difference is 0 and there is no remainder. Hazel has $149 to spend on each chair for the reception room.

```
   149
5 )745
   5
   24
   20
    45
    45
     0
```

Remainders

Some numbers do not divide perfectly into others. In such division problems, there is a *remainder*, or number left over after dividing all of the numbers in the dividend by the divisor. A remainder can be expressed by using a lowercase r or as a fraction. For example, a problem with a quotient of 7 and a remainder of 2 would be written as: 7 r.2 or 7⅔.

Example:

```
   5
5 )26
   25
    1
```

Because 2 is less than 5, you should determine instead, how many times 5 goes into 26. Because 5 × 5 = 25, and 26 – 25 = 1, this quotient is 5 with a remainder of 1. This quotient can be expressed as

- 5 r.1;
- 5⅕; or
- 5.2.

Real Life Scenario

Calculating Volunteer Hours and Student Loans

1. Madison is a high school senior who wants to be an LPN (licensed practical nurse). Madison's school counselor recommends volunteering at a hospital to observe the daily responsibilities of an LPN. The volunteer program at the local hospital requires a commitment of 100 volunteer hours to complete the program. If Madison volunteers for 5 hours a week, how many weeks will it take her to complete her volunteer commitment?
2. Steven decides he wants to become an EMT. He will need a student loan to pay for the required classes. The cost of an EMT program is $1,195 with additional fees for textbook rentals of $240. After training, he will have to pay back the loan at $100 a month. How many months will it take Steven to pay back the loan?

Check Your Understanding

1. 100 × 10 =
2. 325 × 35 =
3. 220 ÷ 20 =
4. 1,425 ÷ 5 =
5. $15.20 × 9 =
6. 457 ÷ 3 =
7. $547.89 × 40 =
8. $546.20 ÷ 4 =
9. $10,439 × 426 =
10. 40,200 ÷ 9 =

Fractions

Fractions, decimals, and percentages are mathematical concepts that express numbers that are part of a whole (Figure 10.3). These three concepts will be especially important for anyone entering the healthcare field to understand. As you will recall, fractions are one or more parts of a whole number. Fractions are written in the following way:

1/2 or $\frac{1}{2}$ 13/15 or $\frac{13}{15}$ 5/7 or $\frac{5}{7}$

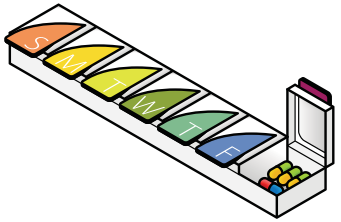

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Figure 10.3 A seven-day pill box represents a fraction. In this image, 1/7 of the pill box is open and 6/7 are closed.

The number written above or before the line is called the *numerator*. The number below or after the line in a fraction is called the *denominator*. The denominator is the number of parts into which the fraction is divided. When reading fractions, you always read the top number first, followed by the bottom number.

$$\frac{\text{Numerator}}{\text{Denominator}}$$

Fractions with the Same Denominator

common denominator *the number that can be divided evenly by all of the denominators in a group of fractions*

When adding or subtracting fractions with a **common denominator** only the numerator is added or subtracted.

Example: $\frac{9}{8} + \frac{6}{8} + \frac{4}{8} = \frac{9+6+4}{8} = \frac{19}{8}$

If adding the fraction leaves you with a numerator that is divisible by the denominator, the fraction must be reduced. This can be done by dividing the numerator by the denominator.

The answer $\frac{19}{8}$ must be reduced by dividing $19 \div 8 = 2\frac{3}{8}$

Because 8 goes into 19 twice, the answer includes a 2 next to the remaining fraction, which is 3/8. This creates the mixed number of 2⅜.

Subtraction of fractions with common denominators is similar to addition.

Example: $\frac{10}{9} - \frac{5}{9} - \frac{4}{9} = \frac{10-5-4}{9} = \frac{1}{9}$

Fractions with Different Denominators

To add or subtract two or more fractions that have different denominators, a lowest common denominator must be found.

Example: $\frac{1}{2} + \frac{2}{5} + \frac{4}{10} = ?$

To find the lowest common denominator for 2, 5, and 10, consider the multiples of each number.

Multiples of 2: 2, 4, 6, 8, **10**…
Multiples of 5: 5, **10**, 15, 20…
Multiples of 10: **10**, 20…
10 is the lowest common denominator.

For the first two fractions that do not already have a denominator of 10 (1/2 and 2/5), you need to multiply both the numerator and denominator by the number that will produce a denominator of 10. So the fraction 1/2 will have its numerator and denominator multiplied by 5 to equal 5/10. The fraction 2/5 will have its numerator and denominator multiplied by 2 to become 4/10. The fraction 4/10 already has a common denominator of 10. So the problem becomes:

$$\frac{5}{10} + \frac{4}{10} + \frac{4}{10} = \frac{13}{10} = 1\frac{3}{10}$$

Subtracting fractions is done through the same process used to add fractions. First, find a common denominator, then subtract the numerators, and write the answer using the common denominator.

Multiplying Fractions

When multiplying fractions, it is not necessary to find a common denominator. Instead, simply multiply across the fraction (numerator × numerator, and denominator × denominator).

Example: $\frac{3}{4} \times \frac{2}{3} = \frac{6}{12}$
(3 × 2 = 6 and 4 × 3 = 12) = 6/12

The fraction 6/12 needs to be reduced (or *simplified*). You are trying to get the smallest possible number for both the numerator and denominator. To reduce this fraction, you would divide 6 into the top number, and 6 into the bottom number (6 goes into 6 once, 6 goes into 12 twice).

The fraction 6/12 becomes 1/2.

Dividing Fractions

The process of dividing fractions is very unique and requires the use of the reciprocal fraction. To identify a fraction's reciprocal, turn the second fraction in the problem upside down to switch the numerator and denominator. For example, the fraction 5/8 would become 8/5. Then, multiply the first fraction and the inverted second fraction. There is no need for a common denominator.

Example: $\frac{3}{4} \div \frac{5}{8} = \frac{3}{4} \times \frac{8}{5} = \frac{24}{20} = \frac{6}{5} = 1\frac{1}{5}$

Note that the answer was reduced from 24/20 to 6/5 by dividing the numerator and denominator each by 4. The fraction 6/5 was then converted to a mixed number. When dividing mixed numbers, you will need to convert them to fractions first.

Converting Mixed Numbers to Fractions. A mixed number is composed of a whole number and a fraction (5½). If you want to convert 5½ into a fraction, you must first multiply the whole number (5) by the denominator of the fraction (2). Now you have solved how many 1/2s there are in 5 (10). Next, add the numerator (1) to give you 11/2. 11/2 is another way of expressing 5½.

Real Life Scenario

Using Fractions in Healthcare

1. Dennis has been told that his blood pressure is bordering on high. Dennis' physician has given him a prescription to reduce his blood pressure. The prescription calls for Dennis to take 1/2 a pill daily for 45 days, and then have his blood pressure checked to see if there is improvement. How many pills will Dennis need so he can take half of a pill every day, for 45 days?
2. Leeann is a nurse's aide on the surgical floor of a busy hospital. 1/4 of the patients will have surgery on Monday and will go home on Wednesday. Another 1/4 of the remaining patients will go home on Thursday. If no new patients arrive, what fraction of the patients will be left on the floor on Friday?

Check Your Understanding

Convert the following mixed numbers to fractions.

1. 6½
2. 7¼
3. 1⅛

Reduce the following fractions to their simplest form.

4. 6/18
5. 10/80
6. 14/17

Complete the following calculations.

7. 1/8 + 4/8 + 3/8 =
8. 1/2 + 1/4 + 3/8 =
9. 1/2 + 3/5 + 2/10 =
10. 7/8 – 5/8 =
11. 7/16 – 1/8 =
12. 1/2 – 1/4 =
13. 1/4 × 2/3 =
14. 1/8 × 5/8 =
15. 5/8 × 3/4 =
16. 4/8 ÷ 1/8 =
17. 3/4 ÷ 1/8 =
18. 9/10 ÷ 1/4 =

Decimal Fractions

In healthcare, you will be working primarily with decimal fractions (often referred to as *decimals*). Decimals are special types of fractions that most people find easier to use than traditional fractions. Decimal fractions are much easier to write and compute than traditional fractions. Decimals represent parts of the whole. For example, 0.5 is 1/2 of 1 and 0.75 is 3/4 of 1.

Decimal fractions are always expressed in multiples of ten, making them easier to work with. A decimal fraction has a denominator that is a multiple of 10, such as 100, 1,000, or 10,000. When writing a decimal fraction, eliminate the denominator and place a dot, or *decimal point* next to the ones digit. For example, 1/10 becomes 0.1. Both stand for one-tenth.

When there is one number to the right of the decimal point that is read as a tenth. Two numbers to the right of the decimal point are hundredths. Figure 10.4 shows the decimal, fraction, and written-out expression of various parts of a whole using multiples of 10.

Example: 28.74 is a decimal fraction. 28 is the whole number, the (.) is a decimal point, and the numbers to the right of the decimal point represent the decimal itself.

Expressing Parts of a Whole

Decimal	Fraction	Written-Out
.1	1/10	One-tenth
.01	1/100	One-hundredth
.001	1/1,000	One-thousandth
.0001	1/10,000	One ten-thousandth

Figure 10.4 Expressing parts of a whole

In the healthcare field, it is standard to always place a zero to the left of the decimal point when there is not a digit in that value (for example, 0.95). Putting a zero before the decimal point prevents misinterpretation, such as reading .95 as the number 95. Also, a zero after the last digit to the right of the decimal point is not necessary (1.2, not 1.20).

When writing an equation that features a decimal fraction, you must remember to properly align all of the numbers. Make sure when you add or subtract decimal fractions, you line up the decimal points from each number.

Example:

```
  23.45
   1.40
+ 451.23
  476.08
```

Converting a Fraction to a Decimal

You will sometimes need to convert fractions to decimals. Converting a fraction to a decimal is done through a division problem. The first step is to divide the numerator of the fraction by the denominator. If your fraction is 2/3, you should divide 3 into 2.

Example: Change the fraction 7/8 to a decimal number.

```
     0.875
8 )7.000
   64
    60
    56
     40
     40
      0
```

Create a long division problem in which the denominator (8) is dividing into the numerator (7). Add a decimal and zeros to the numerator to complete the division problem. You can add as many zeroes as you need.

Think It Through

Notice that a gas station posts the cost of a gallon of gas on its sign. What kind of numbers do gas stations use to post the cost of a gallon of gas?

Rounding Decimal Fractions

Decimal fractions can be rounded up or down for the specific degree of accuracy required. The rounding off rule states that if the digit to the right of the number you are rounding is 5 or greater, round it up to the next number. If the digit is less than 5, round the number down by deleting any digits that follow the chosen place value. Leave the original digit unchanged.

Let's suppose that a decimal must be accurate to two place values. To round a number such as 17.363 up or down two places, you would first locate the digit two places to the right of the decimal point. In this case, that number is 6. Next, look at the number that comes after the 6, which is 3. Since that number is less than 5, you would round the number off to 17.36. In the case of the number 17.367, the number 7 is greater than 5, so you would have rounded the 6 up to a 7, making the number 17.37.

Real Life Scenario

Working with Decimal Fractions

1. Suzanne is a part-time occupational therapist. Her schedule for next week has her working some partial shifts as well as a full shift. Suzanne's schedule looks like this:
   Monday: 5½ hours
   Tuesday: 5¼ hours
   Wednesday: 6½ hours
   Thursday: 3¼ hours
   Friday: 8 hours
   A. Convert the mixed numbers into decimal fractions.
   B. Add the decimal fractions together to find out how many total hours Suzanne will be working next week.
2. Suzanne wakes up on Thursday with a sore throat. She calls her supervisor to tell him she will not be working Thursday, but will be in on Friday. Now how many hours will Suzanne work for the week?

Percentages

The term used to describe part of a whole number is *percentage*. Percent means *per one hundred*. Thirty percent, written as 30%, means 30 parts out of 100 parts. Written as a fraction, it would be expressed as 30/100. A number can be written as a fraction, a decimal, or a percentage (Figure 10.5). To solve mathematical problems, sometimes it may be necessary to convert a percentage to a fraction or decimal fraction.

Calculating Percentages

To calculate a percentage, you must divide the part by the whole. Then convert the decimal answer to a percentage by moving the decimal point two places to the right and adding a percentage sign (%). This will tell you what percentage represents the part of the whole.

Fractions, Decimals, and Percentages

Fraction	Decimal	Percentages
3/20	0.15	15%
1/5	0.20	20%
5¼	5.25	525%

Figure 10.5 Moving from fractions to decimals and percentages provides a variety of ways to express numbers less than 1.

Example: Grace is in a health occupations class. There are 35 students in the class. A high percentage of the students are interested in a nursing career. The total number of students interested in a nursing career is 28, representing 80% of the students. The calculation to establish this percentage is: 28 ÷ 35 = .80, or 80%.

Think It Through

If you have a credit card, and you do not pay off your balance, or *total*, every month, what percentage does the credit card company charge you as interest on the unpaid amount?

Converting a Percentage to a Decimal Fraction

To convert a percentage into a decimal fraction, you must divide by 100 or move the decimal point two places to the left and drop the percent sign.

Examples: 14% = 14.0 = 0.14
29.9% = 0.299

In the same manner, a decimal fraction can be converted to a percentage by multiplying by 100, or by moving the decimal point two places to the right and adding a percent sign.

Percentages are often used in your daily life. For example, you are charged a sales tax on every purchase you make. The sales tax is always a percentage of the total bill. You will also see percentages used during department store sales. The sale price represents a percentage of the original price (Figure 10.6).

Bikeworldtravel/Shutterstock.com

Figure 10.6 Percentages are often used in department store sales.

Examples: 0.41 = 41%
0.042 = 4.2%

Real Life Scenario

Using Percentages

1. A box of table salt (sodium chloride) is comprised of 40% sodium. If a box of salt weighs 26 ounces, how many ounces of sodium are in the box of salt?
2. 30 people at Eastridge Hospital had surgery on May 21st—4 were children, 12 were men, and 14 were women. What percentage of the people who received surgery on May 21st were children?
3. Dr. Levin, an orthopedist, has 36 patients who suffer from osteoporosis. This condition causes the bones to become brittle and break more easily than healthy bones. This year, 15 patients had broken hips, 11 had collapsing vertebrae, and 10 had broken wrists. What percentage of Dr. Levin's osteoporosis patients had broken hips this year?

Ratios

ratio
comparison of one quantity with another, similar quantity

A **ratio** expresses the relationship between two numbers. Ratios can be used to show how many times one number can be found within another number.

The quantities that are compared in a ratio are called the terms, or *components*, of the ratio. The components are written with a colon (:) or the word "to" between them. A ratio can also be expressed as a fraction.

Example: In Eastridge High School's medical terminology class, there are 15 girls and 10 boys. What is the ratio of girls to boys?
15:10 or 15 to 10 or 15/10

As was discussed with fractions, ratios can be reduced. Because both 15 and 10 can be divided by 5, you can use that number to reduce the ratio.

15 ÷ 5 = 3
10 ÷ 5 = 2
The ratio expressed in its lowest terms would be: 3:2 or 3 to 2 or 3/2

A ratio is written in the same order as the words describing it are written. For instance, the newborn nursery in Eastridge Hospital has one nurse for every four newborns, so the ratio of nurses to newborns would be expressed as 1:4. But, if you wish to express how many newborns there are in the nursery for every nurse, you would write the ratio 4:1.

If a ratio is known, you can determine what percentage one of the components is of the whole. To do so, first add the components together to get the total. Then, divide the component for which you want to find the percentage by the total. Your answer will be a decimal fraction and you can determine the percentage by multiplying the decimal by 100.

Example: In Eastridge Extended Care Hospital, the ratio of male patients to female patients is 1:4. What is the percentage of male patients at the hospital?
The ratio is 1:4, males to females.
The total number is 1 male + 4 females = 5.
The percentage of males in the hospital is 1/5 or 0.2
Multiply 0.2 by 100 to get the percentage. 0.2 × 100 = 20%

Real Life Scenario

Ratios in Real Life

1. Last month at Eastridge Hospital, 32 infants were born. Of these 32 deliveries, doctors performed 8 caesarean sections (surgical removal of a baby). What is the ratio of caesarean sections to normal deliveries expressed in lowest terms?
2. On his flight last week, Jamal sat next to a woman who was coughing and sneezing throughout the entire trip. There were 8 people seated in direct contact with the sick woman. Jamal and two other people became sick a few days later. Of the people exposed to the germs, what was the ratio of those who became sick to those who did not? What percentage of people exposed became sick?

Proportions

proportion
a statement of the equality of two ratios

A **proportion** is an equation with a ratio on each side. To use a proportion, the ratios must be equal to each other.

Example: 8:4 = 2:1.

Another way of expressing this is 8/4 = 2/1 or: $\frac{8}{4} = \frac{2}{1}$

One way proportions are used by healthcare professionals is in determining dosages of medicine.

Example: John is a 150-pound man. The dosage directions for one of John's medications is to give a 150-pound man 10 milliliters (ml) of the liquid medicine. What if John weighed 300 pounds (lb)? What dosage would he be given then? A proportion can be used to find the answer.

$$\frac{150}{10} = \frac{300}{x \text{ (or unknown)}}$$

Cross multiply to begin solving for x. Multiply the numerator of the first fraction by the denominator of the second. Repeat this step with the numerator of the second fraction and the denominator of the first. In this case, you end up with:

$150x = 3000$

To find the value of x, divide 3000 by 150.

$3000/150 = x$
$x = 20$
A 300-pound man would need 20 ml of the medication to receive the proper dose.

Real Life Scenario

Ratios and Proportions

1. The Eastridge Hospital Emergency Department reported that 1 out of 6 patients arriving on the second Saturday in December had the flu. If 78 people were admitted, how many of these patients had the flu?
2. If 1:16 patients on a hospital floor need special meals, and there are 64 patients on the floor, how many special meals should the kitchen prepare?

Using a Calculator

Healthcare workers are required to perform math calculations when doing various tasks such as determining medication dosages, working in a healthcare facility's accounting department, or determining the salt content of a low-sodium diet. Even though calculators are on hand in most cases, it is important to understand the fundamentals of mathematics. You

may have to solve a problem by knowing how to manipulate the numbers involved if a calculator is not available to you.

You are likely familiar with the calculator's functions, but a brief review of how to add, subtract, multiply, and divide using a calculator follows. Many calculators perform much more complex functions such as graphing, calculus, trigonometric operations.

However, when used correctly, a calculator saves valuable time and ensures accuracy, especially in the case of complex problems. Double-check your answers by performing the calculation at least twice—wrong entries will result in wrong answers.

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Figure 10.7 Using a calculator will make it easier to complete math problems while on the job.

Entries are made by pressing certain numbers and symbols on the keyboard of the calculator (Figure 10.7). The information entered appears in the display area above the keyboard. It is always helpful to check the display area after entering a number to make sure you've entered the number correctly. Figure 10.8 explains some of the common buttons on a calculator and their uses.

- **Addition.** Enter the first addend of your problem and then press the (+) key. Enter the second addend. Press the (=) key and the sum will appear on the display.
- **Subtraction.** Enter a number and press the (–) key. Next, enter the number to be subtracted from the first number. Then press the (=) key to find the difference.
- **Multiplication.** Enter the multiplicand and press the (×) key. Next, enter the multiplier and press the (=) key. The product will appear on the display.

Common Symbols on a Calculator

Key	*Function*
C	clears all entries
CE	clears last entry
.	enters a decimal point
+	adds
–	subtracts
×	multiplies
÷	divides
%	calculates percentage
=	calculates the final answer

Figure 10.8 Common symbols on a calculator

- **Division.** Let's say you want to divide 100 by 20. Enter the dividend (100), press the (÷) key, and enter the divisor (20). After pressing the (=) key, the quotient (5) will appear on the display.
- **Calculating a percentage.** Say you need to identify 20% of 50. Enter 50, press the (×) key, then enter 20, and then press the (%) key. The answer, 10, will appear on the display. If your calculator does not have a (%) key, you can calculate this percentage by multiplying 50 by 0.2.

Real Life Scenario

Calculator Uses in Healthcare

1. Karen works in the accounting department of Eastridge Hospital. Her boss has asked her to calculate how many employees make over $50,000 each year. Karen finds that the hospital employs 450 people. 75 employees make over $50,000. What is the percentage of employees who make over $50,000?
2. Gail is studying to become a cardiac care nurse. She learns that the heart pumps about 65 milliliters of blood every time it beats. Gail measures her own pulse and finds that her heart beats 75 times per minute. How many milliliters of blood does Gail's heart pump per minute? per hour?

Introduction to Algebra

Algebra is the branch of mathematics that substitutes letters for numbers to solve for unknown quantities. The term *algebra* comes from the Arabic *al-jebr* meaning "reunion of broken parts." Algebra problems are designed to solve a problem with the answer represented by a letter—typically *x* or *y*. When you learned how to solve for x in the Proportions section of this chapter, you were using algebra. This section will briefly explain how algebra can be used while treating patients.

algebra *branch of mathematics that substitutes letters for numbers; involves solving for the unknown*

The mathematics involved in an algebraic equation are like a balancing scale (recall the scale used to illustrate the scale of justice). What is done on one side must be done to the other side to balance the scale. In the case of an algebra problem, what is done to one side of the problem must be done to the other. Moving from arithmetic (simple math including, addition, subtraction, multiplication, and division) to algebra will look something like this:

Arithmetic: $3 + 4 = 4 + 3$
Algebra: $x + y = y + x$

The examples above are **equations**. An equation consists of expressions (collections of numbers and letters) separated by an equal sign. The two sides of the equation must be equal, like a scale that has equal weights on both sides.

equations *mathematical statements containing expressions composed of both numbers and letters; two sides of an equation are separated by an equal sign and must be equal to one another*

When solving an algebra problem, you must first write out the equation and identify the unknown quantity you plan to solve for. Then, use your basic arithmetic skills—addition, subtraction, multiplication, and

division—to isolate the unknown on one side of the equation. This will help you determine the value of the unknown.

Example: $3x - 5 = 10$
$3x - 5 = 10$
$+5 \quad +5$

Add 5 to both sides of the equation to isolate the $3x$ on the left.

$3x = 15$
$3 \quad 3$

Divide each side by 3, so that only the x remains on the left-hand side of the equation.

$x = 5$

To check your answer, plug 5 into the equation where x appears.

$3(5) - 5 = 10$
$15 - 5 = 10$
$10 = 10$

Because both sides of the equation are equal, you know that 5 is the correct answer.

One way algebra is commonly used in healthcare is to calculate medicine dosage. Nurses, in particular, are responsible for performing these calculations and administering the proper amount of medicine to a patient. The following example shows one way of using algebra to calculate the ml (milliliters) amount for a liquid medication administered by injection (Figure 10.9).

Kidsana Maimeetook/Shutterstock.com

Figure 10.9 Calibrated syringes are used for medication injections.

To calculate the amount of medicine to administer, use the following algebraic equation:

$$\frac{\text{D (desired dose)}}{\text{H (have on hand)}} \times \text{V (vehicle)} = x \text{ (amount to be administered)}$$

Example: A vial of medication states that there are 300 mg of the medicine per 0.5 ml. The doctor orders 600 mg of medication to be administered to the patient. How many ml of the medication should the nurse inject?

$$\frac{600 \text{ mg}}{300 \text{ mg}} \times 0.5 = x$$

$600/300 = 2$

$2 \times 0.5 = x$

$x = 1$ ml

The nurse should administer one ml of the medicine to achieve the desired dose of 600 mg.

Real Life Scenario

Using Algebra to Calculate Vacation Days

Judy works in the Human Resources Department of Eastridge Hospital. She is told to calculate how many vacation days will be given to new, full-time employees in one year if the employee earns one-and-a-half vacation days every two months. How would you set up an algebraic equation for this calculation? How many vacation days would the employee earn per year?

Check Your Understanding

Solve for x.

1. $5x - 5 = 20$
2. $x + 30 = 50$
3. $5x = 100$
4. $400 \times 5 = 2x$
5. $20x - 20 = 400$

Data Analysis

The healthcare world produces a wealth of information each day. Hospitals need to keep track of inventory to maintain all vital supplies, pharmacies need to be aware of the drugs they have on hand, and health departments need to analyze rates of contagious disease outbreaks such as influenza and venereal disease.

Information like this is commonly stored in databases and spreadsheets and presented in charts and graphs. Charts and graphs allow for analysis of large amounts of information. This analysis is necessary to fully understand the subjects and themes of the information. A common way of analyzing information is the use of basic statistical methods, which are mean, median, and mode.

Mean, Median, and Mode

The statistical tools of mean, median, and mode are three ways of analyzing data. Each of these statistical tools will help you find a different type of average. To find the **mean**, total all numbers in your information and divide the result by the quantity of numbers you have been given.

mean
mathematical average of data

Example: Lori decides to calculate how much she spent taking her beagle to the veterinarian in the past year. Her charges are listed in Figure 10.10.

After adding up the total of each bill, Lori determines she spent $795.00 on vet bills last year. Now she wants to know what the mean amount was for each visit. To calculate the mean, take the total Lori has paid ($795) and then divide by the number of visits (5).

$$\frac{\$795}{5} = \$159$$

Calculating Mean, Median, and Mode		
Month	**Services**	**Charges**
January	Checkup, shots	$140
March	Office visit, ear examination, ear medicine, nail trim	$165
May	Office visit, allergy testing, hypoallergenic food	$270
July	Office visit, allergy shots	$110
October	Office visit, allergy shots	$110

Figure 10.10 Calculating, mean, median, and mode

On average, Lori spent $159 per vet visit.

The **median** is the number that falls exactly in the middle of a list of numbers organized in either ascending (*increasing*) or descending (*decreasing*) order.

Example: As Figure 10.10 shows, Lori spent $110, $110, $140, $165, $270 (in ascending order). The median number is $140 because it is in the exact middle of the values.

In the example above, it was easy to identify the median because there were an odd number of bills. However, if you have an even numbered list (let's say that Lori went to the vet six times), look for the *two* numbers that fall in the middle of the group. Add these two numbers together, and then divide the total by 2 because that's how many numbers were entered into the equation.

Example: Imagine the numbers in your list are 1, 2, 3, 4, 5, and 6; the median numbers are 3 and 4.

median
the number exactly in the middle of a group of numbers listed in ascending or descending order

Add 3 + 4 together and you get 7. Now you divide by 2 because there were two median numbers.

7 ÷ 2 = 3.5, the median is 3.5

The **mode** is the number(s) that occur most frequently in a set of numbers. Some lists of numbers do not have a mode, while others may have one or more. In the case of Lori's vet bills, the mode is $110.

mode
the number(s) that occur most frequently in a set of numbers

Real Life Scenario

Using Mean, Median, and Mode in Healthcare

1. Five people who visited the Eastridge Hospital emergency room on Sunday were admitted with the following temperatures:
   98.6°F, 101°F, 105°F, 98.6°F, 98.6°F
   Calculate the mean, median, and mode of these temperatures.
2. Over the course of the past week, the following number of meals was served each day in the Eastridge Hospital cafeteria:
   Monday—145 meals, Tuesday—152 meals, Wednesday—192 meals, Thursday—230 meals, Friday— 230 meals
   Calculate the mean, median, and mode for the number of meals served over the course of those five days.

Spreadsheets and Databases

A **spreadsheet** is a document that holds information in rows and columns, and is usually created by a computer program. Each row and column contains cells that hold information in the form of words or numbers (Figure 10.11). Spreadsheet programs make it easy to perform mathematical operations on groups of numbers. You can easily add a column; calculate the mean, median, or mode of a column; or perform other mathematical operations on information organized in a column or a row. Inserting formulas into the spreadsheet will enable the user to perform automatic calculations.

spreadsheet
a document containing rows and columns of data; useful for organizing numeric values and executing computer calculations

A **database** is a detailed collection of related information organized for convenient access, generally on a computer. An example of a database in a physician's office is a specialized database with patient information such as name, address, telephone number, emergency contact number, social security number, health insurance information, and dates of office visits.

database
collection of records such as addresses, phone numbers, and other patient information

Charts and Graphs

Charts and graphs are used to display information clearly and quickly. Healthcare environments use charts and graphs extensively. Temperature is often graphed on a patient's chart so the physician can quickly view the fluctuations in a clear, easy-to-read manner.

Many graphs and charts are used throughout the healthcare world, but the examples below depict sample annual cases of influenza in one clinic. The same data is represented in four formats—a simple table, line graph, bar graph, and circle graph (or *pie chart*).

A simple table arranges dates and numbers of influenza cases in a clinic in rows and columns (Figure 10.12). A line graph shows the relationship of two or more numbers. This graph can also show trends across periods of time (Figure 10.13). The bar graph shows comparisons among categories (Figure 10.14). For our purposes, the pie chart in Figure 10.15 presents the number of influenza cases by season.

Peter Sobolev/Shutterstock.com

Figure 10.11 Spreadsheets are particularly useful for compiling and calculating numerical data.

Month	Cases of influenza
Jan	55
Feb	50
Mar	45
Apr	35
May	26
Jun	14
Jul	7
Aug	6
Sep	7
Oct	25
Nov	31
Dec	40

Figure 10.12 A simple table

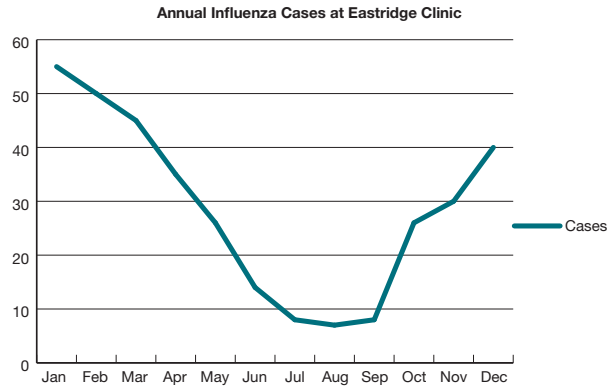

Figure 10.13 Line graph

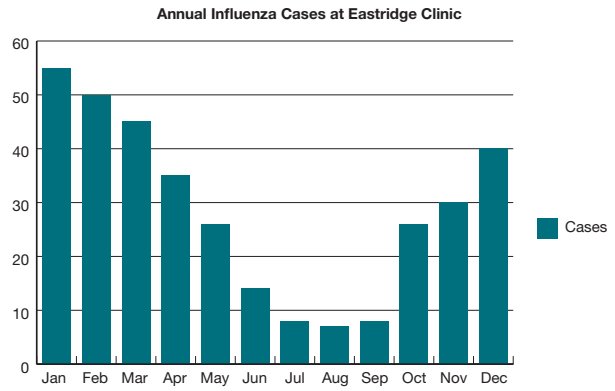

Figure 10.14 Bar graph

Reading Graphs

When you read bar and line graphs, you will see a vertical axis called the *x axis* and a horizontal axis called the *y axis*. In Figure 10.13, the graph's *y* axis represents a clinic's total flu cases. The *x* axis represents the period

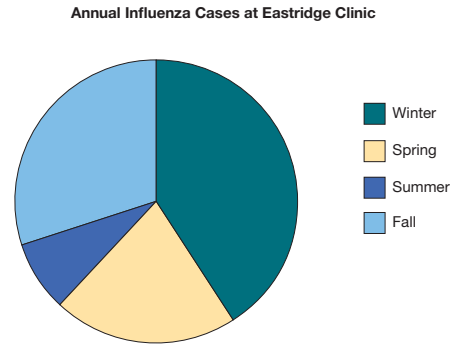

Figure 10.15 A circle graph is sometimes called a pie chart.

of time in which the cases were recorded (January–December). Data was entered for each month, and the line connecting the data points illustrates the trends in number of flu cases. You can see that in the winter months the flu cases were highest, and in the summer months the number of cases declined.

The bar graph in Figure 10.14 shows the same values represented on the *x* and *y* axes as Figure 10.13. In the case of a bar graph, the number of flu cases per month is easily read. Data trends are also easy to identify by comparing the height of each month's bar.

Real Life Scenario

Creating Charts and Graphs

1. John works in sports medicine. Broken arms account for 1/4 of his patients' injuries, knee injuries make up another 1/4 of the cases, broken fingers account for 1/8 of his cases, 1/8 are elbow injuries, and 1/4 are shoulder injuries. Create a pie chart representing this data.
2. Emile works in the human resources department of Eastridge Hospital. His boss has asked him to make a bar graph showing how many total sick days hospital employees used during each month of the last year. Put the following data into a bar graph:

January: 190	July: 110
February: 195	August: 100
March: 165	September: 110
April: 130	October: 125
May: 125	November: 140
June: 115	December: 180

Measurement in Healthcare

English system of measurement
a system of measurement commonly used in the United States; measurements are based on the inch, pound, gallon, and Fahrenheit degrees

metric system of measurement
a system of measurement using units related by factors of ten; measurements based on the gram, liter, meter, and temperature measured in Celsius

When asked to measure something in the United States, most people use the **English system of measurement**. Today, the United States is one of the very few countries that have not converted to the metric system. The rest of the world has adopted the **metric system of measurement**.

The main differences between the metric and English systems of measurement can be found in the measurement units. The metric system uses units organized by factors of ten. This allows the various types of units to be related. Units of measurement in the English system are not related or consistent. While the English system uses several different units, the metric system has only three basic units: the gram, liter, and meter. In the metric system, temperature is measured in degrees Celsius.

Calculations performed using the metric system are much easier than calculations using the English system. For example, 1,000 meters are found in 1 kilometer; however, there are 5,280 feet in a mile. In the English system, there is no common base, which makes it challenging to use. The relationship between the different units of measure can be confusing because English system units are not based in the powers of 10, as in the metric system. For example, in the English system, the length of a yard was based on the distance from King Henry I's nose to his thumb.

For these reasons, the metric system is universally used in science and medicine. Those who wish to have a career in the health sciences must become comfortable using the metric system by understanding its terminology, including its basic units and its prefixes.

Did You Know?

The History of Measurement

The English system of measurement was originally based on the human body, nature, and everyday activities. For example, an acre originally was a measure of land based on the amount of land that could be plowed in a day. An inch was the width of a thumb. Such natural measures were fine for a simple, agricultural society. However, as trade and commerce grew, there was a need for more exact measures.

The metric system was developed by the French to create a system that uses units related by factors of ten and only three basic measurements for weight, volume, and length. When moving from one unit to another when using the decimal system, simply move the decimal point to the appropriate power of 10.

Metric Units

There are three basic units of measurement in the metric system—grams, liters, and meters (Figure 10.16). The gram (g) is the basic metric unit of measurement for weight. Weight is the physical measurement of an object subjected to the force of gravity. Scientists consider mass and weight the same within the gravitational field of Earth. In the English system, weight is measured in ounces and pounds.

The liter is the basic metric measurement of liquid volume. In the English system, volume is measured in cups, pints, quarts, and gallons.

The meter is the metric unit for linear measurement (length). It is slightly longer than the English yard. Inches, feet, and miles are other English units of measurement for length.

Basic Metric Measurements

Metric System	Measures	English System
gram (g)	weight or mass	ounces and pounds
liter (l)	volume	cups, pints, quarts, and gallons
meter (m)	length	inches, feet, yards, miles

Figure 10.16 Basic measurements as represented in the metric and English measurement systems

Metric Prefixes

To properly use the metric system as a healthcare professional, you will need to recognize a variety of metric prefixes. These prefixes are added to the front of one of the basic units (meters, grams, liters) to indicate the size of a particular metric unit. Figure 10.17 lists the metric prefixes, the related multiple of 10, and an example.

Converting Measurements

In addition to scientific use, the metric system is being used in industry, governmental agencies, education, and many other important areas in the United States. Being able to convert a measurement from one type to another is a very useful skill to master. As a healthcare professional, you

Metric Prefixes

Prefix	Multiple	Example
nano-	1/1,000,000,000	1 nanometer=1/1,000,000,000 of a meter
micro-	1/1,000,000	1 microliter=1/1,000,000 of a liter
milli-	1/1,000	1 millimeter = 1/1,000 of a meter
centi-	1/100	1 centiliter = 1/100 of a liter
deci-	1/10	1 decimeter = 1/10 of a meter
deca-	10	1 decagram = 10 grams
hecto-	100	1 hectometer = 100 meters
kilo-	1000	1 kilogram = 1000 grams
mega-	1,000,000	1 megameter = 1,000,000 meters
giga-	1,000,000,000	1 gigameter = 1,000,000,000 meters

Figure 10.17 Metric prefixes

will likely find yourself converting English measurements to metric measurements more often than converting metric to English. Appendix A in the back of this textbook contains conversion information and calculations.

Consult the metric conversion chart in Appendix A for converting values in the English system to the metric system. Find the English measurement that you wish to convert in the left-hand column. Then, multiply by the number in the middle column to convert to the related metric system value.

Think It Through

Why do you think the United States has not converted from the English system of measurement to the metric system?

Example: 145 pounds = _____ kilograms
140 pounds × 0.45 = 65.25 kilograms

You can also convert from the metric system to the English system. To do so, divide the metric value by the number given in the middle column of the chart. The quotient is the related English system value.

Example: 100 grams = _____ ounces
100 grams ÷ 28.0 = 3.6 ounces

Extend Your Knowledge

Examining Food Labels

Look at the food labels of 10 products you have in your home. How many labels use only the metric system? How many use only the English system? How many represent measurements using both the English and metric systems? Select two labels from each system and convert them to the opposite system. Show your work.

Check Your Understanding

1. Calculate your weight, height, and body measurements (waist, hips, and chest) by converting the English measurements to metric units.
2. Convert the mileage on your car to kilometers.
3. On a recent trip to Canada, you filled your gas tank with 40 liters of gasoline. How many gallons of gasoline did you put in your tank?
4. Convert 100 kilometers per hour into miles per hour.

Celsius temperature scale (°C)
metric temperature scale; defines the freezing point of water as 0° and the boiling point of water as 100°

Fahrenheit temperature scale (°F)
the temperature scale commonly used in the United States; the freezing point of water is 32° and the boiling point is 212°

Metric Temperature Measurement

The **Celsius temperature scale (°C)** is a metric scale used to measure temperature throughout the healthcare world. The Celsius scale is in general use wherever metric units are accepted, and it is used in scientific work everywhere. Many countries have adopted the Celsius scale, but the United States has not. The **Fahrenheit temperature scale (°F)** is the non-metric

scale used in the United States to measure body temperature in healthcare settings.

The freezing point of water on the Celsius scale is 0°, and the boiling point is 100°. The Fahrenheit scale is based on a system that is less logical and often more challenging to use. The freezing point of water in Fahrenheit is 32°, and the boiling point is 212°.

Most healthcare facilities have conversion charts that can be used to convert temperatures on one scale to the other and vice-versa. The conversions can also easily be made by using specific formulas.

Converting Temperatures from Fahrenheit to Celsius

The formula for converting Fahrenheit temperatures to Celsius is: °C = 5/9 × (°F – 32).

Example: F = 98.6°

$$C = \frac{5}{9} \times (98.6 - 32)$$

$$C = \frac{5}{9} \times 66.6$$

$$C = \frac{5 \times 66.6}{9}$$

$$C = \frac{333}{9}$$

C = 37°

Converting Temperatures from Celsius to Fahrenheit

The formula for converting Celsius temperatures to Fahrenheit is: °F = 9/5(C) + 32.

Example: C = 37°

$$F = \frac{9}{5} \times (37) + 32$$

$$F = \frac{9 \times 37}{5} + 32$$

$$F = \frac{333}{5} + 32$$

F = 66.6 + 32
F = 98.6°

Real Life Scenario

Converting Temperatures

1. While on vacation in Germany with your family, you become ill and need to visit a doctor. The doctor tells you that your temperature is 39°. Given your location, you assume, correctly, that he has given your temperature using the Celsius scale. Using the appropriate conversion formula, what is your Fahrenheit temperature?
2. You are a nurse at Eastridge Hospital and you have a patient from France. She asks you what her temperature is, and you tell her 103°F. She doesn't understand what this means. Convert her temperature into Celsius using the appropriate formula.

Check Your Understanding

Convert the following Fahrenheit temperatures to Celsius.

1. 98.6°F
2. 100°F
3. 10°F
4. 37°F
5. 40°F

Convert the following Celsius temperatures to Fahrenheit.

6. 0°C
7. 5°C
8. 37°C
9. 100°C
10. 50°C

The 24-Hour Clock

24-hour clock *method of measuring time based on 24-hour-long segments; also called military time*

12-hour clock *expression of time used internationally; based on a 12-hour system in which a.m. and p.m. designations must be assigned to identify the proper time*

In the healthcare world, time is often expressed using the **24-hour clock**, or what is commonly known as *military time*. A clear, concise way of accurately recording time is essential in a healthcare facility. Medical records are legal documents. Time is critical when treatment, medication, and duration of procedures depend on accurate timekeeping.

The 12-hour clock (which you typically use in your daily life) has the disadvantage of using just 12 numbers to designate 24 different hours. This means that each of those 12 numbers is used twice a day. Therefore, without the a.m. and p.m. designations, you cannot know for sure what time of day a particular number represents.

In contrast, the 24-hour clock designates every hour with a unique numerical time. When you say that it is 11:00 o'clock, do you mean 11:00 a.m. or 11:00 p.m.? If you are using military time, then those hours are written as 1100 and 2300, respectively. You don't need the a.m. or p.m. designation, and there is no chance for confusion.

Time on the 24-hour clock is always expressed in four digits. The first two digits represent the hours, and the second two digits represent the minutes. A 0 is placed in front of the hours 1 through 9 (01, 02, 03). Do not use colons to separate hours from minutes. Figure 10.18 shows how the 12-hour clock relates to the 24-hour clock.

Check Your Understanding

Convert the following 12-hour clock times to military time.

1. 1:35 a.m.
2. 3:34 p.m.
3. 7:15 p.m.
4. 10:45 p.m.
5. 9:09 a.m.

Convert the following military times to the 12-hour clock.

6. 2345
7. 1450
8. 0256
9. 1145
10. 0637

Conversion of the 12-Hour Clock to the 24-Hour Clock

12-hour clock	24-hour clock	12-hour clock	24-hour clock
1:00 a.m.	0100	1:00 p.m.	1300
2:00 a.m.	0200	2:00 p.m.	1400
3:00 a.m.	0300	3:00 p.m.	1500
4:00 a.m.	0400	4:00 p.m.	1600
5:00 a.m.	0500	5:00 p.m.	1700
6:00 a.m.	0600	6:00 p.m.	1800
7:00 a.m.	0700	7:00 p.m.	1900
8:00 a.m.	0800	8:00 p.m.	2000
9:00 a.m.	0900	9:00 p.m.	2100
10:00 a.m.	1000	10:00 p.m.	2200
11:00 a.m.	1100	11:00 p.m.	2300
12:00 p.m.	1200	12:00 a.m.	2400

Figure 10.18 Conversion of the 12-hour clock to the 24-hour clock

Chapter Review and Assessment

Summary

No matter what healthcare field you decide to enter, you will be required to perform some math calculations when doing your job. In this chapter you reviewed basic math skills such as recognizing types of numbers, and practicing addition, subtraction, multiplication, and division. Fractions, decimals, percentages, basic algebra, ratios, and proportions are also important skills to master, and will be used in your healthcare career.

Analyzing data is another skill for the healthcare worker to practice. You can use the mean, median, and mode, along with charts and graphs to illustrate the relationships among numbers. Data analysis is a critical part of healthcare. Healthcare employees continuously compile statistics about the facility. Compiling this data may include gathering and updating patient information, keeping track of nosocomial infection rates, and tracking on-hand medical supplies.

Although the metric system of measurement is used in healthcare and science disciplines, the majority of the United States continues to use the English system. As you begin your healthcare career you must understand the metric system and its basic units—the gram, liter, and meter. Converting measurements of temperature from the metric, Celsius scale to commonly used Fahrenheit values is another important math skill for all healthcare students to master.

Because of its accuracy, the 24-hour clock (military time) is used in most healthcare settings. Healthcare workers must learn how to read and easily use military time. Maintaining accurate and proper records is dependent on the use of this timekeeping system.

Improving your math skills will not only benefit your career, but it can make things easier in your daily life. People with strong math skills are, for example, better at maintaining a budget than those people who lack math skills.

Review Questions

Short Answer

1. What is the difference between the 12-hour clock and the 24-hour clock?
2. Explain how spreadsheets and databases might be used in a healthcare facility.
3. Which measuring system is used throughout most of the world? Why is this measuring system preferred?
4. Explain the concept of a common denominator.
5. What is the base ten system in math?
6. What are the differences between ordinal and nominal numbers?

True/False

7. *True or False?* The English system is more logical than the metric system.
8. *True or False?* Algebra contains equations.
9. *True or False?* The 24-hour clock is the same as military time.
10. *True or False?* The term percentage means *per 100*.
11. *True or False?* A yard is a metric measurement.
12. *True or False?* If you have a calculator, there is no need to improve your math skills.
13. *True or False?* Addition is the opposite of multiplication.
14. *True or False?* The statistical tool called the *mean* is a mathematical average of data.
15. *True or False?* A zero should be placed before a decimal point if there is no whole number.

Multiple Choice

16. _____ is the branch of mathematics that substitutes letters for numbers.
    A. Algebra
    B. Arithmetic
    C. Geometry
    D. Statistics

17. Each of the following is a metric prefix *except* _____.
    A. nano-
    B. maxi-
    C. mega-
    D. giga-
18. The three basic statistical terms used to analyze information are _____.
    A. averages, median, sum
    B. median, mean, mode
    C. mean, estimate, prediction
    D. total, mode, sum
19. The mode of a set of numbers is _____.
    A. the average
    B. the sum of the numbers
    C. an estimation
    D. the number that occurs most frequently in a number set
20. The top number of a fraction is called the _____.
    A. denominator
    B. numerator
    C. reciprocal
    D. remainder
21. Which of the following statements about decimal fractions is *true*?
    A. They are a special type of fractions that most people find easy to use.
    B. They are also called decimals.
    C. Decimal fractions represent parts of the whole.
    D. All of the above.
22. Which of the following statements about division is *true*?
    A. Division problems can be written several ways.
    B. The most common symbol for division is (÷).
    C. The number that gets divided is called the dividend.
    D. All of the above.
23. Which of the following is *not* a format of a graph or chart?
    A. Roman graph
    B. bar graph
    C. pie chart
    D. line graph
24. Which of the following statements about multiplication is *false*?
    A. Multiplication is a shortcut for subtraction.
    B. The standard symbol for multiplication is (×).
    C. Other symbols for multiplication are parentheses (1)(8) or an asterisk (*).
    D. The numbers to be multiplied are called the multiplicands.
25. Which of the following statements about the 12-hour clock is *true*?
    A. The 12-hour clock is used in all hospitals.
    B. The military uses the 12-hour clock exclusively.
    C. The 12-hour clock has unique numbers for each hour of the day.
    D. The 12-hour clock is commonly used in our everyday lives.

Critical Thinking Exercises

26. Some students argue that learning basic math skills such as the multiplication tables is not important because the calculator can do all math calculations for them. Why is it important to learn basic math skills? How will basic math skills be used during your healthcare career?
27. Why is it important for members of a healthcare team to use the 24-hour clock?
28. Do you have a preferred type of graph or table used to express data for analysis? pie chart? bar graph? line graph? simple table? Explain why you find one method better for expressing and analyzing data than the others.
29. Do you think that the United States should begin using the metric system and the 24-hour clock exclusively? Do you think a mathematic change to the metric system will happen in the future? Why or why not?
30. Which type of calculation do you find the most confusing? fractions? percentages? measurement conversions? algebra? basic arithmetic? Why? What can you do to feel more comfortable when performing the calculations that confuse you?

Additional Practice

Basic Math Review

If you are confident in your math abilities and are able to answer these questions correctly, skip ahead to the Data Analysis section. These questions can also be used as review upon completing the chapter.

Values

Identify the value of each digit in the following numbers.

1. 210
2. 3
3. 203,987
4. 1,244,765
5. 66,789

Addition

Find the sum of the following addition problems without using a calculator.

6. 213 + 456 + 342 =
7. 4,500 + 97 + 456 =
8. 43 + 345 + 1,234,679 =
9. 45 + 678 + 1,908 =
10. A student studying to be a hospital dietician is told by her instructor that a diet should not contain large amounts of salt. The student is asked to track the salt intake in her lunch. She recorded: 1,200 mg in a tuna sandwich, 300 mg in French fries, 320 mg in a milkshake, and 325 mg in a cherry pie. How many mg of salt did the student consume during lunch?
11. 49 + 99 + 52,045 =
12. 669 + 4,000 + 924 =

Addition Using a Calculator

Use a calculator to find the sum of the following addition problems.

13. 998 + 2,346 + 21 + 367 + 1,489 =
14. 22 + 1,345,780 + 7,500 + 236 + 31 =
15. 2,331,498 + 226,560 + 67 + 7,611 + 85,423 =
16. 546 + 3,467 + 237,689 + 34 + 7 + 90,458 =
17. 34 + 345 + 1,234 + 12,608 + 214,896 =

Subtraction

Find the difference without using a calculator.

18. 23 – 12 =
19. 245 – 239 =
20. 1,200 – 36 =
21. 534 – 315 =
22. Dr. James told an obese patient that he needed to enroll in a weight loss program. The patient initially weighed 320 pounds; today the patient weighs 245 pounds. How much weight has he lost?
23. Javier's physician has told Javier that he needs to lose 15 pounds. Javier weighed in at 210 pounds. What does Javier's physician want him to weigh?
24. 10,000 – 9860 =
25. Lizzie's phlebotomy instructor announces that there will be a total of 100 internship hours required to pass the course. Lizzie has already finished 21 hours. How many hours does she have left?

Subtraction Using a Calculator

Use a calculator to find the difference in each of the following subtraction problems.

26. 2,345 – 300 =
27. 4,444 – 666 =
28. 2,890 – 345 =
29. 1,234,589 – 3,467 =
30. 3,590 – 768 =

Multiplication

Find the product without using a calculator.

31. 22 × 10 =
32. 56 × 8 =
33. 120 × 60 =
34. 28 × 28 =
35. A registered nurse is giving a patient 225 mg of penicillin 4 times a day. How many mg of penicillin does the patient receive each day?
36. On average, Juanita processes 35 insurance claims per day. How many claims does she process in a two-week period (assuming she works 5 days a week)?
37. 1,466 × 599 =

Multiplication Using a Calculator

Use a calculator to find the product in each of the following multiplication problems.

38. 23 × 234 × 543 =
39. 6,846 × 414 =
40. 14 × 6 × 678 =
41. 2,234 × 123 =
42. 12,375 × 346 =

Division

Find the quotient without using a calculator.

43. 120 ÷ 10 =
44. 300 ÷ 5 =
45. 450 ÷ 9 =
46. 240 ÷ 4 =
47. 320 ÷ 7 =
48. 410 ÷ 9 =
49. Ms. Mercer recently suffered a heart attack. She spent six days in the coronary care unit of the hospital. At the end of her hospital stay, her bill was $15,420. How much was Ms. Mercer charged per day?
50. Jesse is training to be a paramedic. He is expected to job shadow a paramedic in the field for a total of 96 hours. How many 12-hour shifts does Jesse have to shadow to reach the required 96 hours?

Division Using a Calculator

Use a calculator to find the quotient in each of the following division problems.

51. 125 ÷ 15 =
52. 400 ÷ 200 =
53. 1,456 ÷ 56 =
54. 54,320 ÷ 245 =
55. 23,000 ÷ 15 =

Fractions

Solve the following fraction equations without using a calculator.

56. $\frac{1}{10} + \frac{2}{10} + \frac{6}{10} =$
57. $\frac{4}{16} + \frac{3}{16} + \frac{10}{10} =$
58. $\frac{5}{9} \div \frac{2}{7} =$
59. $\frac{4}{5} \times \frac{1}{3} =$
60. Triplets were born yesterday at Eastridge Hospital. Each baby was weighed at birth. The three girls weighed: 3½ pounds (lbs), 4¼ lbs, and 3⅛ lbs. How much did they weigh all together?
61. $\frac{10}{12} \times \frac{1}{6} =$
62. $\frac{100}{125} \div \frac{25}{5} =$

Decimals

Answer the following questions without using a calculator.

63. 19.55 + 127 + 2,130.02 + 54.5 =
64. Round off each of the following numbers to the nearest tenth.
    A. 534.67
    B. 45.64
    C. 5.69

65. Round off each of the following numbers to the nearest one-hundredth.
    A. 3.456
    B. 43.333
    C. 57.892
66. A patient has a medical bill for $16,201.99. What is the balance remaining after her insurance company pays $12,961.59?
67. Convert the following fractions to decimal fractions.
    A. 5/16
    B. 43⅖
    C. 4⅐

Percentages

Answer the following questions without using a calculator. When necessary, round off to the nearest hundredth.

68. Convert 42% to a decimal fraction.
69. What is 20% of 150?
70. What is 6.5% of 645?
71. Convert 180% into a fraction.
72. Convert 0.657 into a percentage.
73. One study has found that 25% of people who get the flu shot will still get the flu. If 15,230 people got the vaccine, how many people would still get the flu even with the vaccination?
74. In a medical clerical class of 29 students, 12 students want to work in a hospital, 10 students want to work in a doctor's office, 3 students want to work in a clinic setting, and 4 are undecided. What percentage of students wants to work in a hospital?
75. Convert 85% into a fraction.
76. Convert 5¾ into a percentage.
77. Convert 3.1416 into a percentage.

Ratios

Answer the following questions without using a calculator.

78. Convert 1:5 into a fraction.
79. In a chemistry laboratory, a student is asked to create a solution that contains 10 milliliters of a weak acid to 400 milliliters of distilled water. What is the ratio of the weak acid to the distilled water?
80. A student planning to be a dietician is surprised to learn that a gallon of ice cream contains 15 grams of fat, 12 grams of which are saturated fat. What is the ratio of saturated fat to the total fat in the gallon of ice cream?
81. Express the ratio 6:4 two different ways.
82. An instructor grades a health occupations class final. 24 students passed. 4 students failed the class. What is the ratio between the students who passed and those who failed?

Algebra

Answer the following questions without using a calculator.

83. $x + 15 = 45$
84. $3x - 18 = 78$
85. $4x + 2 = 8x$
86. $\frac{1}{4}x + 12 = 220$
87. $\frac{1}{5}x - 10 = 365$
88. Dr. Edward has x number of patients. Dr. Ryan has twice as many patients as Dr. Edward. Dr. Ryan has 42 patients. How many patients does Dr. Edward have? Show your work.
89. A doctor has ordered 70 mg of medication to be given to a patient by mouth. The medicine label indicates that one capsule contains 20 mg of medicine. How many capsules should be given to the patient to reach the required dosage?
90. When working with a patient, a nurse is instructed to give an injection of 75 mg of liquid medication. The medication bottle reads 125 mg/ml. How many ml of the medicine should be injected to achieve the desired dosage of 75 mg?

91. A patient needs 600,000 units of a medication. The medicine bottle states that there are 400,000 units per ml. Identify the proper dosage in milliliters to be given to the patient.

Data Analysis

Answer the following data analysis questions using what you have learned in this chapter.

92. Grace, a patient at Eastridge Hospital, has been running a fever for the past eight hours. Construct a line graph showing Grace's temperature at each hour. Then, look at the resulting graph and explain why this representation of the data might be helpful to a healthcare professional.
    0600–102°F
    0700–102°F
    0800–101.6°F
    0900–101°F
    1000–100.6°F
    1100–100°F
    1200–99.2°F
    1300–99°F
93. Construct a bar graph using the following patient data from Eastridge Hospital.
    2 patients have a temperature of 103°F
    5 patients have a temperature of 99.8°F
    7 patients have a temperature of 101.6°F
    12 patients have a temperature of 98.6°F

Measurement in Healthcare

Answer the following questions about metric units, metric prefixes, and measurements using the metric system.

94. A gram measures _____.
95. A liter measures _____.
96. A meter measures _____.
97. One kilogram is equal to _____ grams.
98. One milliliter is equal to _____ liters.
99. One hectometer is equal to _____ meters.
100. One decagram is equal to _____ grams.
101. One microliter is equal to _____ liters.

Converting Measurements

Answer the following questions without using a calculator.

102. On Stan's hospital chart, the doctor notes that Stan must consume 2 liters of fluid per day. How many milliliters should Stan drink each day?
103. Convert the following measurements to liters.
    A. 769 kiloliters
    B. 77.2 deciliters
    C. 24 hectoliters
    D. 2,456 milliliters
104. The majority of adults have 5,000 to 6,000 ml of blood in their bodies. Convert this quantity to quarts.
105. Convert 68°F to Celsius.
106. Convert 100°C to Fahrenheit.
107. Convert 84°F to Celsius.
108. Convert 120 pounds to grams.
109. Convert 85 pounds to grams.

The 24-Hour Clock

Convert the following 12-hour clock times to military time.

110. 2:30 p.m.
111. 11:30 p.m.
112. 4:15 p.m.
113. 3:30 p.m.
114. 10:00 a.m.
115. 1:45 a.m.

Convert the following military times to 12-hour clock time.

116. 0155
117. 1137
118. 0320
119. 1305
120. 1700
121. 2212