Fundamentals of Math

CHAPTER 1

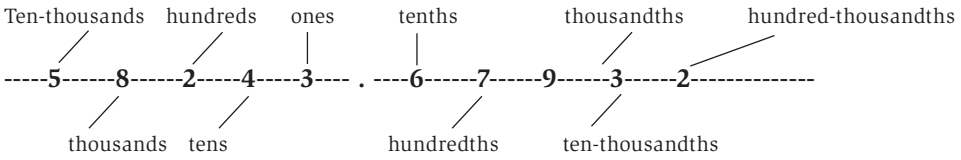
OBJECTIVES

- Understand the difference between the Arabic and Roman numeral systems
- Translate Arabic numerals to Roman numerals
- Translate Roman numerals to Arabic numerals
- Understand the metric system
- Understand the apothecary system
- Be able to convert metric to apothecary
- Be able to convert apothecary to metric

ARABIC NUMERALS

The Arabic number system uses the numerals 1, 2, 3, 4, 5, 6, 7, 8, 9, and zero (0). It is also known as the decimal system. Depending on how these numbers are arranged determines the value of the number. For example, digits 4, 7, and 2 placed together (472) represent the number four hundred seventy-two.

A decimal point (.) separates whole numbers, or units, from fractional numbers, or fractional units. All numbers on the left side of the decimal point are considered whole numbers. All numbers placed on the right of the decimal point are considered fractional units, or less than one whole unit. The following number line shows the relationship of Arabic numerals based on their position in a number.



The number 43.6 contains the numerals 4, 3, and 6. This represents forty-three units of one and six-tenths of one unit. Decimals will be covered in more detail in Chapter 2.

ROMAN NUMERALS

Remember: Dates are always capital letters **MCMXC** (1990).

The Roman numeral system does not utilize numerals. Instead, the putting together of alpha characters that follow specific rules represent each number. The alpha characters used are **c**, **d**, **i**, **l**, **m**, **s**, **v**, and **x**. These letters can be small case or capitalized—it does not matter. One exception is that dates (2009) always use capital letters. Each letter represents a specific number.

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

I or i = 1

V or v = 5

X or x = 10

L or l = 50

C or c = 100

D or d = 500

M or m = 1000

The Roman numeral system is not used to do calculations. It is used to document values or quantities only. In order to perform calculations, Roman numerals have to be converted to Arabic numerals. Once you know the rules, this becomes easy to do. When a number is represented by two letters, and the second letter corresponds to a number with the same value or a smaller value than the first one, you add them together.

VI = 5 + 1 = 6

II = 1 + 1 = 2

XV = 10 + 5 = 15

When there are two letters and the second one represents a number with a greater value than the first letter, you subtract the first from the second.

IX = I → 1, X → 10, 10 – 1 = 9

XL = X → 10, L → 50, 50 – 10 = 40

When there are more than two letters used to represent a number, you apply the subtraction rule first. Remember, you subtract any smaller value letter from a larger value letter that follows it. Once that is done, you add all the values together to determine the number.

XLIV = X → 10, L → 50, 50 – 10 = 40; I → 1, V → 5, 5 – 1 = 4; 40 + 4 = 44

CXXIV = C → 100, X → 10, I → 1, V → 5; 100 + 10 + 10 + (5 – 1) = 124

CCXLIX = 100 + 100 + (50 – 10) + (10 – 1) = 249

Practice Problems 1.1

Convert the Arabic to the Roman.

1. 2010 _____
2. 1949 _____
3. 24 _____
4. 520 _____
5. 13 _____
6. 93 _____
7. 42 _____
8. 375 _____
9. 6 _____
10. 787 _____
11. 400 _____
12. 231 _____
13. 86 _____
14. 66 _____
15. 39 _____

16. 161 _____
17. 684 _____
18. 57 _____
19. 1496 _____
20. 999 _____
21. 315 _____
22. 18 _____
23. 540 _____
24. 77 _____
25. 104 _____

Convert the Roman to the Arabic.

26. MMVII _____
27. dxxiv _____
28. cix _____
29. LIII _____
30. XLIX _____
31. iv _____
32. viii _____
33. CCCXXIV _____
34. LXI _____
35. dc _____
36. MCDLVI _____
37. vi _____
38. xxxvi _____
39. iii _____
40. LXXV _____
41. ccxxiv _____
42. mmmcccxxix _____
43. dxliv _____
44. CCL _____
45. mv _____
46. XXI _____
47. xliii _____
48. MCMLXXXII _____
49. xxviii _____
50. MDCCXCVI _____

METRIC SYSTEM

The measurement systems in place for pharmacy are:

- Metric
- Avoirdupois
- Apothecary

The avoirdupois system is based on British standards and states that 1 pound is equivalent to 16 ounces. Apothecary systems used the base of grains and minims. They are still seen in pharmacy calculations today. Other units you will see in the apothecary system are drams, ounces, and pounds.

The most common system is metric. The three basic units of measure are meter, gram, and liter. The two most common units in pharmacy are grams (weight) and liters (volume). The liter is based on the volume of 1000 cubic centimeters (cc) of water. One cubic centimeter is equivalent to 1 milliliter (ml), so 1000 mL equals 1 liter. The gram is based on the weight of 1 cubic centimeter of distilled water at 4°C.

Remember: It takes lots of small parts to equal one large part!

The metric system was developed in the late 18th century in France. The United States adopted this system in the late 1800s and made it our standard of measure in 1893. It is the accepted system of measure for scientists all around the world because of its simplicity.

The liter is the base unit for measuring liquid volumes in the metric system. It represents the volume of a cube that is one-tenth of a meter on each side. The most common units used for volume in pharmacy are the liter, milliliter, and microliter. **Table 1.1** displays the measures of metric volume.

Remember: It only takes a portion of a large part to equal a smaller part.

Use the liter as your homebase. Kilo- and milli- represent 1000. Multiplying by 1000 will get you to kilo- (small to large) and dividing by 1000 will get you to milli- (large to small). Hecto- and centi- represent 100. Deka- and deci- represent 10.

When doing calculations with metric measures, you must be sure all your values are in the same measure. If your final answer needs to be in milligrams (mg)

TABLE 1.1 Metric Volumes

Volume Label	Abbreviation	Liters	Comparison to a Liter
Kiloliter	kL	1000	0.001 kL
Hectoliter	hL	100	0.01 hL
Dekaliter	dkL	10	0.1 dkL
Liter	L	1	1.0 L
Deciliter	dL	0.1	10 dL
Centiliter	cL	0.01	100 cL
Milliliter	mL	0.001	1000 mL
Microliter	mcL (μL)	0.000001	1,000,000 mcL

and you are dealing with grams (g), you need to convert your values into the desired measure. You can do this before you begin, or once the calculations are completed. If you are dealing with multiple measures, you need to convert them all into one common measure. To convert from a large measure to a smaller one, you need to multiply. To convert from small measures to large measures, division is the tool to use.

EXAMPLE 1

You have a 3 L bottle of cough syrup. How many milliliters are in this container?

3 L
(1 L = 1000 mL)
3 L × 1000 = 3000 mL

EXAMPLE 2

You have an IV bag that contains 600 mL. How many liters is this?

1. 1 L
   (1 L = 1000 mL)
   1 × 1000 mL = 1000 mL
2. 600 mL ÷ 1000 mL = 0.6 L
   (1000 mL = 1 L)

EXAMPLE 3

A 5 L bag of fluid contains how many microliters?

1. 5 L
   (1 L = 1000 mL)
   5 × 1000 mL = 5000 mL (milliliters)
2. 5000 mL
   (1 mL = 1000 mcL)
   5000 × 1000 = 5,000,000 mcL (microliters)

Practice Problems 1.2

Convert the following.

1. 2 L = _____ mL
2. 3000 mL = _____ L
3. 1 L = _____ mcL
4. 3 mL = _____ mcL
5. 100 mcL = _____ L
6. 500 mL = _____ L
7. 500 mcL = _____ mL
8. 1000 L = _____ kL
9. 540 L = _____ kL
10. 30 mL = _____ mcL
11. 350,000 mcL = _____ L
12. 1500 mL = _____ mcL

The gram is the base unit of measure for weight in the metric system. It represents the weight of 1 cubic meter (cm^3) of water at 4°C. The amount, or concentration, of a drug is measured in metric weight. The most common measures used are grams, milligrams, and micrograms. A person's weight is also converted to kilograms, from pounds, in order to calculate the dose of medication necessary for treatment. **Table 1.2** displays the measures of metric weight.

The most common conversions are micrograms → milligrams, milligrams → grams, and grams → kilograms.

1000 mcg = 1 mg
1000 mg = 1 g
1000 g = 1 kg

EXAMPLE 4

How many mg are in 5.4 g?

(1 g = 1000 mg)
5.4 × 1000 = 5400 mg

Remember that you want to know how many small parts are in the big part.

EXAMPLE 5

Convert 15,000 mg to grams.

15,000 ÷ 1000 = 15 g

TABLE 1.2 Metric Weights

Weight Label	Abbreviation	Grams	Comparison to a Gram
Kilogram	kg	1000	0.001 kg
Hectogram	hg	100	0.01 hg
Dekagram	dkg	10	0.1 dkg
Gram	g	1	1 g
Decigram	dg	0.1	10 dg
Centigram	cg	0.01	100 cg
Milligram	mg	0.001	1000 mg
Microgram	mcg (μg)	0.000001	1,000,000 mcg

EXAMPLE 6

150,000 mcg is equivalent to how many grams?

(1 g = 1000 mg)
(1 mg = 1000 mcg)
150,000 ÷ 1000 = 150 mg ÷ 1000 = 0.15 g

Practice Problems 1.3

Convert the following.

1. 2 g = _____ mcg
2. 1 mg = _____ mcg
3. 100 mg = _____ g
4. 2 kg = _____ g
5. 5 kg = _____ mg
6. 4000 mcg = _____ mg
7. 3 g = _____ mg
8. 500 mg = _____ g
9. 630 mg = _____ kg
10. 5.4 kg = _____ g
11. 0.2 mg = _____ mcg
12. 4 g = _____ kg
13. 250 mcg = _____ mg
14. 0.5 mg = _____ mcg
15. 22 g = _____ mg
16. 320 mcg = _____ g

Metric Conversions

Converting different measurements to a common one makes it easier to perform calculations. There are many different types of measurements. The most common used by people outside the medical and scientific community are the household measurements (e.g., tsp, tbsp, ounce, quart, gallon). While these are the least accurate, they are the easiest ones to direct patients on dosing at home. The common tablespoon can vary from 15 mL up to 22 mL in measurement. The accurate dose of a tablespoon is 15 mL when comparing to the metric system. Knowing common conversions can help ensure that proper doses are being calculated and dispensed. Most retail pharmacies will send a dispensing spoon home with liquid medications because it has "mL" markings along with teaspoon/tablespoon markings to ensure accurate dosing.

EXAMPLE 7

A medication has 5 mg/mL and the patient needs to take 1 tablespoon four times a day.

If the patient takes 15 mL per dose, he or she would receive 60 mL daily. If he or she took 22 mL per dose, that would be 88 mL daily. At 60 mL daily, the patient receives 300 mg (prescribed). At 88 mL daily, the patient receives 440 mg (overdose).

Conversions are done in relation to the metric system. The metric system is always used to perform calculations. **Table 1.3** lists some common conversions that should be committed to memory. These are used almost daily in the pharmacy. Many products list both measures on their labels. The United States may be the only country in the world that does not use the metric system as their standard.

Practice this exercise to become familiar with common conversions:

1 tsp = 5 mL
1 tbsp = 3 tsp = 15 mL
2 tbsp = 6 tsp = 30 mL = 1 ounce

TABLE 1.3 Household to Metric Conversions

Household Measure	Metric Measure
1 teaspoon	5 mL
1 tablespoon	15 mL
1 ounce	30 mL
8 ounces ($\frac{1}{2}$ pint)	240 mL
1 pint (16 ounces)	473 mL (480 mL)
1 quart (32 ounces)	946 mL
1 gallon (128 ounces)	3785 mL
1 pound (lb)	454 g
2.2 pounds (lbs)	1 kg

Practice Problems 1.4

Convert the following.

1.	$\frac{1}{2}$ tsp = _____ mL	a. 1.55	b. 2.5	c. 1.75
2.	3 tsp = _____ mL	a. 10	b. 12	c. 15
3.	2 pints = _____ mL	a. 946	b. 900	c. 500
4.	$\frac{1}{2}$ lb = _____ g	a. 225	b. 227	c. 300
5.	3 qts = _____ mL	a. 2838	b. 2800	c. 3000
6.	3 tbsp = _____ mL	a. 40	b. 48	c. 45
7.	2 oz = _____ mL	a. 60	b. 65	c. 75
8.	3 oz = _____ mL	a. 80	b. 90	c. 95
9.	45 mL = _____ oz	a. 1.5	b. 2	c. 3
10.	15 mL = _____ tsp	a. 2	b. 3	c. 4
11.	$\frac{1}{4}$ tsp = _____ mL	a. $\frac{1}{2}$	b. $\frac{1}{4}$	c. 1.25
12.	20 mL = _____ tsp	a. 4	b. 5	c. 6
13.	100 kg = _____ lbs	a. 120	b. 100	c. 220
14.	66 lbs = _____ kg	a. 33	b. 30	c. 20
15.	1892 mL = _____ gal	a. $\frac{1}{2}$	b. $\frac{3}{4}$	c. 1
16.	2 qts = _____ pts	a. 2	b. 4	c. 3
17.	8 oz = _____ tsp	a. 48	b. 24	c. 12
18.	7.5 mL = _____ tsp	a. 3	b. $1\frac{1}{2}$	c. $\frac{1}{2}$
19.	45 mL = _____ tbsp	a. 3	b. 2	c. 1
20.	8 oz = _____ tbsp	a. 8	b. 6	c. 16

APOTHECARY SYSTEM

The apothecary system uses the measure units of minims, drams, and grains for smaller measures, and then progresses to ounces, pints, quarts, gallons, and pounds as seen in the household measure system. This system is seldom used

TABLE 1.4 Apothecary Conversions

Apothecary	Abbreviation/Symbol	Household Conversion	Metric Conversion
1 minim	♏		0.06 mL
16.23 minims	♏		1 mL
1 dram	ʒ	1 teaspoon (5 mL)	3.69 mL (4 mL)
8 drams (volume)	℥	1 ounce (6 drams)	29.57 mL (30 mL)
8 drams (weight)	℥	1 ounce	30 g
1 grain	gr		65 mg
15.4 grains	gr		1 g
1 pound	lb	1 pound	454 g

For calculating purposes, 6 drams = 1 oz based on the dram being 5 mL, even though the true measure would be 8 drams (4 mL).

anymore but does make an appearance in pharmacy occasionally. For calculation purposes, these units are also converted to metric. (See **Table 1.4**.)

The liquid measures are minims, drams, ounces, pints, quarts, and gallons. You will occasionally see prescriptions written with drams as a unit of measure and, very rarely, the unit of minims is used. A dram is a little less than a teaspoon. Typically, it is converted to a teaspoon measure (5 mL) when calculating or dispensing liquid medications.

The weight measure of grains is still used today for many medications (e.g., aspirin, 5 grains). Many older medications are still measured in grains also (e.g., thyroid, phenobarbital). You will often see both grains and milligrams on the packaging of medications that are dispensed with grains as their unit of measure. Some examples would be aspirin 5 grains (325 mg) tablets or phenobarbital 1 grain (65 mg) tablets.

Grains
Sometimes
1 gr = 60 mg.
It depends
on the
manufacturer:
Codeine
1 gr = 60 mg
Phenobarb
1 gr = 65 mg

Practice Problems 1.5

Convert the following.

1. 3 gr = _____ mg	a. 185	b. 190	c. 195
2. $\frac{1}{2}$ gr = _____ mg	a. 32	b. 32.5	c. 33
3. 4 drams = _____ oz	a. $\frac{1}{2}$	b. 1	c. 3
4. 130 mg = _____ gr	a. 2	b. 3	c. 4
5. 2 oz = _____ g	a. 30	b. 45	c. 60
6. 30 mL = _____ drams	a. 8	b. 6	c. 3
7. 4 oz = _____ g	a. 100	b. 120	c. 140
8. $\frac{1}{2}$ dram = _____ tsp	a. 2	b. $\frac{1}{2}$	c. 3

CHAPTER 1 QUIZ

Convert the following Arabic numerals to Roman numerals.

1. 84
2. 310
3. 490
4. 19
5. 28

Convert the following Roman numerals to Arabic numerals.

1. MCMXCVI
2. CCXXXIV
3. XCV
4. MMIX
5. DCCC

Perform the following conversions.

1. 3 L = _____ mL
2. 2 g = _____ mcg
3. 500 mL = _____ L
4. 3 kg = _____ mg
5. 5000 mcL = _____ L
6. 700 mg = _____ mcg
7. 1.5 L = _____ mL
8. 650 mcg = _____ mg
9. 100 mL = _____ mcL
10. 3500 g = _____ kg
11. 2 L = _____ mcL
12. 4.5 g = _____ mg
13. 300 mL _____ mcL
14. 5 kg = _____ g
15. 8,000 mcL = _____ mL
16. 450 mg = _____ g
17. 1300 mL = _____ L
18. 6 g = _____ mcg
19. 4.2 L = _____ mL
20. 8200 mg = _____ g

Convert the following household measures.

1. 2 tsp = _____ mL
2. 2 pts = _____ mL
3. 2 lbs = _____ g
4. 2 qts = _____ mL

5. 3 tbsp = _____ mL
6. 176 lbs = _____ kg
7. 6 oz = _____ tsp
8. 5 gr = _____ mg
9. 5 oz = _____ g
10. 650 mg = _____ gr
11. 8 oz = _____ mL
12. 25 kg = _____ lbs
13. 15 mL = _____ tsp
14. 60 mL = _____ tbsp
15. 120 mL = _____ oz
16. 180 g = _____ oz
17. 7.5 mL = _____ tsp
18. $\frac{1}{4}$ tsp = _____ mL
19. 45 mL = _____ tbsp
20. 275 lbs = _____ kg