Drug Calculations

WHEN THE PRESCRIBED DOSAGE of a drug does not match the amount of manufactured drug in a tablet, capsule, liquid, or injection medication, the pharmacy technician must calculate the proper amount of medicine to be administered. Precise calculations are needed to be certain the patient receives the proper dosage. When you learn the elements of equations and the order of operations, the math calculations will be easy.



Objectives:

1. Practice basic math skills, including the use of Roman numerals, decimals, fractions, addition, subtraction, multiplication, and division.
2. Demonstrate proficiency in the order of operations.
3. Solve ratio, proportion, concentration, and drip-rate problems.

Key Terms:

Arabic numerals
concentration
decimal
drip rate
fraction
order of operations
percent
proportion
ratio
Roman numerals

Basic Math Skills of a Pharmacy Technician

The pharmacy technician must be able to understand the information on the prescription. The label on the medication will tell you how much medicine is in a capsule, tablet, liquid, and injection medication. You will learn to set up and calculate equations to determine the dosage that equals the prescribed amount.

For liquid or injection medications, you will multiply the prescribed dose by the amount of liquid in which a standard dose is suspended. Then divide the result by the standard dose. The result is the medication that has been prescribed. For tablets and capsules, divide the prescribed

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dose by the amount of drug contained in one tablet or capsule. Your result will be the number of tablets or capsules prescribed.

BASIC MATH SKILLS EMPLOYED BY PHARMACY TECHNICIANS

A pharmacy technician uses math skills, such as Roman numerals, decimals, fractions, addition, subtraction, multiplication, and division. A numeral is a written expression of a number and can take many forms, such as a word, letter, symbol, or figure. The two main types of numerals used in pharmacy are Arabic and Roman.



FIGURE 1. Medicine labels will tell you the quantity and strength of medicine in the bottle.

Arabic Numerals

Arabic numerals are the 10 digits 0 through 9: 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9.

Roman Numerals

Roman numerals are letters: s, I, V, X, L, C, and M. These numerals represent numbers in a system created in ancient Rome. Roman numerals are often used to show quantity on medications. Below are the equivalents:

Roman	Arabic
ss	½
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

Conversion Rules

Because pharmacists regularly convert Arabic and Roman numerals, you are required to know both systems. There are two basic rules to interpret Roman numerals. To write "4," you place the smaller number I before V. To write "9," you place I before X. The smaller number

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is subtracted from the larger number, as VL= 45; CD = 400. But when a smaller number is written after a larger number, the two numbers are added together (e.g., XXII = 22, XVI = 16, and DCL = 650).

Examples of quantities expressed on prescriptions:

iii drops	(3 drops)
i tsp	(1 teaspoon)
IV oz	(4 ounces)
XX tabs	(20 tablets)
LX lozenges	(60 lozenges)
XIV patches	(14 patches)

Arabic numbers are written as whole numbers, fractions, or mixed numbers. A whole number is a counting or natural number: 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9. Meanwhile, a **fraction** is a part of a whole number: 1/2, 2/3, 3/4. Yet a mixed number is a combination of a whole number and a fraction: $2\frac{1}{2}$, $3\frac{3}{4}$, $5\frac{4}{5}$, $10\frac{7}{8}$. A **decimal** is a fraction written in a linear format (e.g., ¼ = 0.25 and $1\frac{3}{4}$ = 1.75) and is based on the power of 10: $\frac{1}{10}$ = 0.1 and $\frac{5}{10}$ (or $\frac{1}{2}$) = 0.5; $2\frac{3}{4}$ = 2.75.

Decimals Contain Decimal Points

The Joint Commission, the main accrediting agency for hospitals and other health institutions, has mandated the format of decimals on prescriptions. As a safety goal, there are to be no trailing zeros after a decimal point. For example, you should never write 5.0 (5 or 5. is correct), but always include a zero before the decimal point for a quantity less than one (e.g., 0.5). Serious and deadly errors can occur by misreading a number when the decimal point is not legible. If the decimal point in 5.0 is not noticed, the number will be read as 50, resulting in a tenfold overdose. To prevent this error, the number should be written as 5, with no trailing zero. If a zero is placed before the decimal point, but it is not legible, the zero indicates that a decimal point should be there.

Correct	Incorrect
2. and 2	2.0
0.2	.2

Mathematical Functions and Fractions

Fractions, addition, subtraction, multiplication, and division are common mathematical functions used in everyday pharmacy calculations.

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Fractions

Fractions must have a common denominator to be added or subtracted, but they do not need a common denominator to be multiplied or divided.

Addition

How many teaspoonfuls of amoxicillin suspension would be needed per day if the dosage is $^3/_4$ teaspoonful in the morning and $^1/_2$ teaspoonful in the evening?

- Find the common denominator between $^3/_4$ and $^1/_2$: ($^1/_2 = {}^2/_4$).
- Add the fractions: $^3/_4 + {}^2/_4 = {}^5/_4$.
- Change the fraction to a mixed number: $^5/_4 = 1^1/_4$ teaspoonfuls.

Subtraction

The pharmacy has $^1/_2$ bottle of Tylenol® and needs $^1/_3$ of the bottle to fill a prescription. How much will remain in the bottle after the prescription has been filled?

$$^1/_2 \text{ bottle} = {}^3/_6;\ ^1/_3 = {}^2/_6$$

$$^3/_6 - {}^2/_6 = {}^1/_6 \text{ of the bottle left}$$

Multiplication

How many ounces of suspension liquid would be required to fill a prescription with the following directions to the patient: "Take $^1/_2$ ounce orally six times daily for 1 day"? (Set up fraction: $^1/_2$ teaspoon + $^6/_1$ times)

1. Multiply the numerators: $1 \times 6 = 6$.
2. Multiply the denominators: $2 \times 1 = 2$.
3. Write as a fraction: $^6/_2$.
4. Reduce, if possible, to a whole number: 3 ounces is the amount needed for one day's dosage.

Division

How many days of antibiotics can be gotten from a 6-ounce bottle if the patient needs $^3/_4$ ounce per day? (Set up fraction: $^6/_1 \div {}^3/_4$.)

1. Multiply the first fraction times the inverse, or reciprocal, of the second fraction: $^6/_1 \times {}^3/_4 =$



FIGURE 2. Pharmacists must convert quantities and the strength of medication to match dosages.

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2. Multiply numerators: $6 \times 4 = 24$.
3. Multiply denominators: $1 \times 3 = 3$.
4. Write as a fraction: $^{24}/_{3}$.
5. Reduce to a whole number: $^{24}/_{3} = 8$ days of medication.

Converting Numbers

The ability to convert numbers back and forth is important.

- Convert fractions to decimals. Divide the numerator by the denominator: $^{1}/_{2}$ $(1 \div 2) = 0.5$; $^{3}/_{4}$ $(4 \div 3) = 0.75$; $^{7}/_{8}$ $(8 \div 7) = 0.875$.
- Convert a mixed number to a decimal: $2^{1}/_{3}$.
  - Think of the mixed number as two separate numbers.
  - Convert $^{1}/_{3}$ to a decimal $(1 \div 3) = 0.33$.
  - Add the decimal to the whole number: $2 + 0.33 = 2.33$.
- Convert the decimal to a mixed number or fraction: 0.75.
  - The decimal point shows the place value, which is the denominator (100); the number indicates the numerator (75): $0.75 = {}^{75}/_{100}$.
  - Reduce, if possible: $^{75}/_{100} = {}^{3}/_{4}$.
- Convert the percentage to a fraction. **Percent** is "per 100," so the denominator of a percentage is always 100.
  - $36\% = {}^{36}/_{100}$; reduced $= {}^{9}/_{25}$.
  - $2.5\% = {}^{2.5}/_{100} = {}^{25}/_{1,000} = {}^{1}/_{40}$.
- Convert a fraction to a percentage. To get a decimal, divide the numerator by the denominator. Then multiply by 100.
  - $^{4}/_{5} = 4 \div 5 = 0.8$
  - $0.8 \times 100 = 80\%$

Converting Volume, Weight, and Temperature

Pharmacists convert measures of volume, weight, and temperature between the English system of measurement and the International System of Units (SI). The International System of Units is a modern standardized form of the metric system. The metric system, first adopted in 1791, is a decimal system of measurement in which all units are based on multiples of 10. Because the system is based on the power of 10, its units can be easily converted between measurements. Common measurements in the English system include cups, teaspoons, tablespoons, quarts, ounces, pounds, and degrees Fahrenheit. Common measurements in the metric system include milliliters, liters, grams, kilograms, and degrees Celsius.

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Order of Operations

The **order of operations** is a set of guidelines used to solve math problems that require functions to be performed in the following order:

1. Parentheses
2. Exponents
3. Multiplication
4. Division
5. Addition
6. Subtraction

A mnemonic device to help you remember this order is **P**lease **E**xcuse **M**y **D**ear **A**unt **S**ally (PEMDAS).

The order of operations will be required to solve the following prescriptions:

Example of quantity: How many tablets are required to fill the prescription with the directions "Take 1 tablet by mouth on Monday, Wednesday, and Friday, and two tablets by mouth on Tuesday, Thursday, Saturday, and Sunday"? Give a 1-month supply.

$$[(1 \times 3) + (2 \times 4)] \times 4 \text{ weeks} = 11 \times 4 = 44 \text{ tablets.}$$

Example of duration: A prescription reads: "Give 15 ml by mouth two times daily." If this prescription were filled with a 300 ml bottle of cough medicine, how many days of cough medicine would the patient have?

- $300 \div [15 \times 2]$
- $300 \div 30 = 10$ days

Ratio, Proportion, Concentration, and Drip Rate

Knowledge of ratio, proportion, concentration, and drip rate are vital in all areas of pharmacy, especially in hospital and home care environments.

RATIO

Ratio is the mathematical relationship between one quantity and another (e.g., 0.9 g of sodium in 100 ml of water or "normal saline").

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DIGGING DEEPER...

UNCOVERING ADDITIONAL FACTS: Untangling Order of Operation Rules

Working with mathematical problems that have multiple operations can be confusing. Remembering these simple steps will make solving complex problems much easier. First perform all operations inside parentheses. This also applies to enclosure symbols: {} and []. If parentheses are enclosed within other parentheses, work from the inside out. There is no particular significance in the use of brackets instead of parentheses.

Simplify exponents, also working from left to right. The exponent is attached to the number in closest proximity to it. Then perform all multiplication and division operations, working from left to right. Next, perform all addition and subtraction operations from left to right.

It is most important to remember that the order of operations means to work from the inside out and to do each step separately and completely from left to right. Do not try to compute two steps at once or to do complex computations in your head. Follow these guidelines to avoid making mistakes.

PROPORTION

Proportion is the equality between two ratios. Example:

$$\frac{0.9 \text{ g sodium}}{100 \text{ ml water}} = \frac{9 \text{ g sodium}}{1000 \text{ ml}}$$

CONCENTRATION

Concentration is the amount of drug per volume or weight of the product and may be written as a percentage or as ratio strength.

- Percent weight-in-weight (w/w) is the grams of a drug in 100 g of a product, usually a cream or ointment (e.g., hydrocortisone 1% = 1 g hydrocortisone/100 g cream).
- Percent weight-in-volume (w/v) is the grams of a drug in 100 ml of a product (e.g., dextrose 5% in water = dextrose 5g/100 ml water).
- Percent volume-in-volume (v/v) is the ml of a drug in 100 ml of product. This is not a common way of expressing concentration in the practical world of pharmacy.
- The most common way concentration is expressed is in mg/ml or as a percentage.

In hospitals, many patients are unable to take medications orally. As a result, the drugs are given directly into a vein (intravenously) and are called intravenous (IV) medications. One form of this type of medication is called an IV drip because it must infuse (drip) slowly into the patient.

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DRIP RATE

The **drip rate** is the rate of how fast medication infuses into a patient. The concentration of the drug and the period of infusion are used to calculate the drip rate. Ways to express the drip rate include ml/hr, ml/min, and mg/kg/min.

Summary:



Pharmacy technicians must be able to read and correctly interpret prescriptions. When the prescribed dosage of a drug does not match the amount of manufactured drug in a tablet, capsule, liquid, or injection medication, the pharmacy technician must calculate the proper amount of medicine to be administered. The math skills used include Roman numerals, decimals, fractions, addition, subtraction, multiplication, and division.

It is often necessary to convert measurements between Arabic and Roman numerals and between measurements in the English system and the metric system. Mathematical functions must follow a specific order of operations, easily remembered with the mnemonic device: **P**lease **E**xcuse **M**y **D**ear **A**unt **S**ally.

Decimal point usage is also very specific, and there should be no trailing zeros after a decimal point. Basic math skills will enable you to convert dosages between fractions and whole numbers. Good math skills will help you calculate how much medication is needed to fill prescriptions.

Checking Your Knowledge:



1. What math will you perform to calculate the prescribed amount of liquid or injection medication?
2. What math will you perform to calculate the prescribed amount of capsules and tablets?
3. What are the Arabic numbers for s, I, V, X, L, C, and M?
4. In a dosage, what is the difference between 2 and 0.2?
5. Why is the mnemonic **P**lease **E**xcuse **M**y **D**ear **A**unt **S**ally important in calculating prescription dosages?

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Expanding Your Knowledge:

Practice the following pharmacy conversions:

4 tsp = _____ ml

9 tsp = _____ TBS

3 gal = _____ qt

480 ml = _____ oz

1.2 L = _____ ml

½ cup = _____ ml

0.13 g = _____ mg

12.5 mg = _____ g

1 tsp = _____ ml

45 ml = _____ TBS

0.35 = _____%

1¾ tsp = _____ ml

88 mcg = _____ mg

0.5 L = _____ fl oz

Web Links:

Calculations for Pharmacy Technicians

http://www.ehow.com/facts_7665169_simple-guide-calculations-pharmacy-technicians.html

Pharmacy Technician Math

http://www.pharmacy-tech-resources.com/Pharmacy-Technician-Math.html

Calculating Drug Dosages

http://www.docstoc.com/docs/46419673/Calculating-Drug-Dosages

Pediatric Dosage Calculations

http://www.drugguide.com/ddo/ub/view/Davis-Drug-Guide/109514/0/Pediatric_Dosage_Calculations

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