Medical Math

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- Mathematics is a vital skill in everyday life. It is important for everyone to learn basic mathematic functions. Using mathematics makes daily activities easier and more efficient.

Whiners gonna Whine

- But, I thought we don't get a math credit!
  - You don't. Or else we would be doing math every day. You DO get Allied Health college credits in Medical Dialogue. Part of Medical dialogue is medical math… so…..
- But I'm **BAD** at math!
  - No you aren't. You've been ***TOLD*** you are bad at math, either by someone else, or by yourself! Maybe if there is a point to the problem, you will do well.
- Do we really have to do math to work in Health Care?
  - Yes, we do. <u>**Every. Single. Day**</u>.

Math Anxiety

- Many students become nervous when they hear the word "math." This worried feeling is called **math anxiety**.
- Because mathematics is important to all areas of life, it is important for students to overcome math anxiety.

Overcoming Math Anxiety

- Before learning new material, mentally assess what you already know about the topic. The best learning takes place when you participate and engage your mind.
- Take notes during class so that you will remember important concepts.

Medical Mathematics

- Health care workers must have mathematical skills to perform their daily duties. Examples of mathematics in health care include:
- Calculating medical dosages
- Reading prescriptions
- Analyzing test results
- Weighing and measuring patients
- Taking temperatures
- Determining concentration levels
- Billing and record-keeping

- A **numerical system** is an organized method of counting. Numerical systems have existed since the beginning of civilization. The most common numerical system is the Hindu-Arabic system. This system uses a set of 10 digits, 0 through 9, to create specific values.

- The **Roman numeral** system is a numerical system that was developed over 3,000 years ago. This system uses seven letters to express certain values.
- I = 1
- V = 5
- X = 10
- L = 50
- C = 100
- D = 500
- M = 1000
- When arranged in specific orders, these seven letters can express any numerical value. Roman numerals are often used in health care for medications, solutions, and even filing.

Rules for Roman Numerals

- **If a smaller numeral is placed in front of a larger numeral, the smaller numeral is *subtracted* from the larger numeral.**
- IV = 5 - 1 = 4
- IX = 10 - 1 = 9
- XC = 100 - 10 = 90

- **If a smaller numeral is placed behind a larger numeral, the smaller numeral is *added* to the larger numeral.**
- VI = 5 + 1 = 6
- XI = 10 + 1 = 11
- CXV = 100 + 10 + 5 = 115

- **If the same numeral is placed next to itself, the numerals are *added* together.**
- II = 1 + 1 = 2
- XXI = 10 + 10 + 1 = 21
- MMV = 1000 + 1000 + 5 = 2005
- **The same numeral should not be placed next to itself more than three times.**
- IIII does not equal 4. Instead, IV = 4.
- XXXX does not equal 40. Instead, XL = 40.

Rules for subtracting Roman Numerals

- Use the following rules when subtracting to create values in the Roman numeral system:
- **Subtract only powers of 10, such as I (1), X (10), or C (100). Never subtract V (5), L (50), or D (500).**
- VL does not equal 45. Instead, XLV = 40 + 5 = 45.
- LD does not equal 450. Instead, CDL = 400 + 50 = 450.
- **Subtract only one number from another.**
- IIX does not equal 8. Instead, VIII = 8.
- LIIV does not equal 53. Instead, LIII = 53.
- **Do not subtract a number from another that is more than 10 times greater.**
- IC does not equal 99. Instead, XCIX = 90 + 9 = 99.
- XD does not equal 490. Instead, CDXC = 400 + 90 = 490

Number Parts

- umbers are the language of mathematics. **Whole numbers** are the numbers used to count, beginning with 0, 1, 2, 3, and so on. Numbers also exist in parts. **Number parts** may be expressed in one of the following forms:
- Fractions
- Decimals
- Percentages

Fractions

- A **fraction** represents a part of a whole. For example, suppose a pizza is cut into eight slices, and you eat one slice. You have eaten one out of eight slices, or 1/8, of the pizza.
- A fraction is made of two parts:
- The **numerator** is the top number in the fraction. It shows the actual number of parts.
- The **denominator** is the bottom number in the fraction. It tells how many parts it takes to make a whole.
- The following points are reminders when working with fractions:
- When adding or subtracting, fractions must have the same denominator.
- To multiply, first multiply the numerators and then multiply the denominators.
- To divide, first flip the divisor fraction. Then multiply the numerators and multiply the denominators.
- After finishing a mathematic function, fractions should always be reduced to lowest terms.

Decimals

- A **decimal** represents a fraction of a whole number whose denominator is a multiple of 10. For example, suppose that a pizza is cut into 10 slices. If you eat 3 slices, you have eaten three tenths of the pizza. This figure could be expressed as a fraction by writing 3/10. However, as a decimal, this figure is expressed as 0.3.
- Decimals have place values. The place values of decimals are located to the right of the decimal point on a number line. The first place value is tenths, then hundredths, thousandths, and so on.
- When adding and subtracting, the decimal points must be aligned.
- When multiplying, multiply the factors without aligning decimal points. Then, count the total number of digits to the right of the decimal points in the factors. Finally, place the decimal point so that the answer includes the number of decimal places that you counted in the factors.
- When dividing, first move the decimal point of the divisor to the right so that it becomes a whole number. Then, move the decimal point of the dividend the same number of spaces to the right. Divide as usual.

Percentages

- **Percentages** can express a whole or part of a whole. With percentages, the whole is always in terms of 100. For example, if a pizza is cut into 10 slices, then all 10 slices make up 100 percent, or 100%, of the pizza. Each individual slice makes up 10% of the pizza, because 100 ÷ 10 = 10. Now, suppose that you eat 2 slices. You have eaten 20% of the pizza, because 10% × 2 slices = 20%.
- When performing mathematic calculations with percentages, it is often easier to convert the percent to either a decimal or a fraction. The following points demonstrate how 20% may be converted.
- To convert 20% to a decimal, drop the percent symbol and move the decimal point two places to the left. 20% is equal to 0.20. Because the zero in the hundredths place holds no value, this decimal can be written as 0.2.
- To convert 20% to a fraction, first determine the value of the whole. The whole in a percentage is always 100. Therefore, 100 is the denominator of the fraction. 20 is the numerator of the fraction because it tells how much of the pizza was eaten. So 20% is equal to 20/100. When reduced to lowest terms, 20/100 is written as 1/5.
- As shown in the example above, one value may be expressed in several different forms. In this case, 20% equals 0.2 which equals 1/5. Number parts are interchangeable and may be converted from one form into another.

Numbers in Health Care

- Health care workers use whole numbers and number parts every day. It is important to perform correct calculations with each number form. It is also important to understand the relationship between fractions, decimals, and percentages. Learning to convert number parts from one form into another is a valuable skill.

Ratios

- A **ratio** shows a relationship between like values. Ratios ask the question, "How much of *X* is present when compared to *Y*?" For example, suppose that a doctor's office has three male doctors and five female doctors. The ratio of male doctors to female doctors is 3 to 5.
- Ratios can be expressed in several forms. The ratio that compares male doctors and female doctors can be written in the following ways.
- 3 to 5
- 3 : 5
- 3/5

Reducing Ratios

- A ratio can be expressed in the form of a fraction. Fractions must be reduced to lowest terms. For example, 9/15 is not a correct fraction because both the numerator and the denominator are divisible by 3. When reduced, 9/15 is written as 3/5.
- Likewise, ratios must also be reduced. Suppose an emergency room has four unoccupied beds and eight occupied beds. The ratio of unoccupied beds to occupied beds is 4/8 (or 4 : 8). However, the ratio 4/8 is not written correctly because both the numerator and the denominator are divisible by 4. Therefore, the ratio of unoccupied beds to occupied beds should be written as 1/2 (or 1 : 2). In other words, for every one unoccupied bed, there are two occupied beds.

Solution Strength

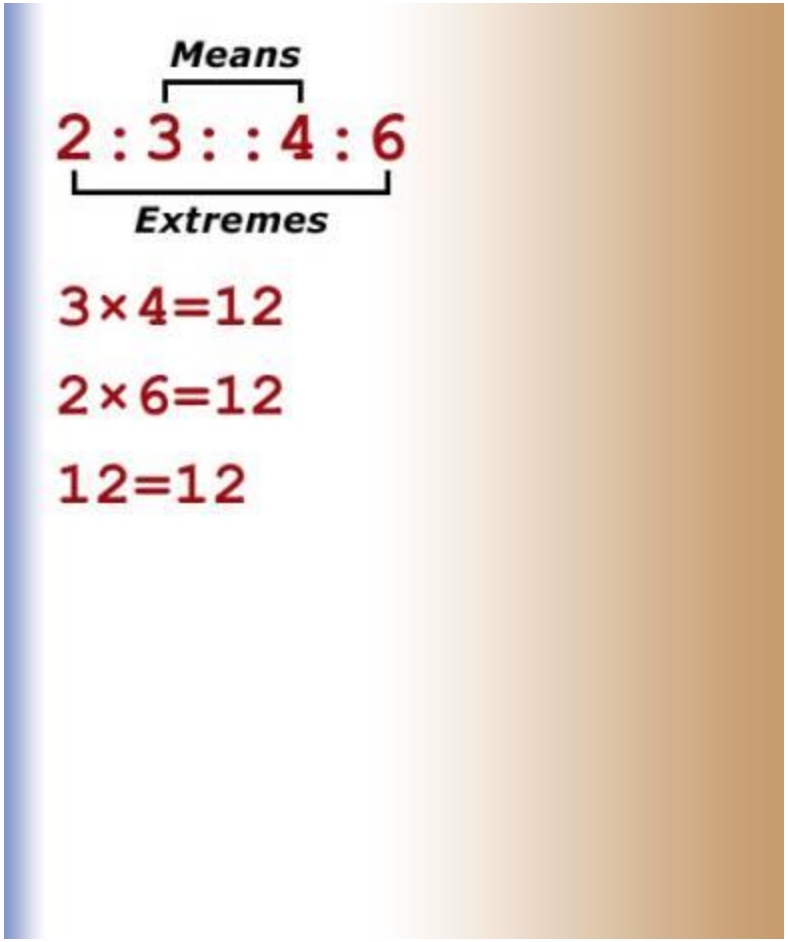
- Ratios are often used by health care workers to determine the strength, or concentration, of a solution. A common cleaning solution is a mixture of bleach and water in a 1 : 2 ratio. This means that for every one part of bleach, there are two parts of water. This relationship applies to any unit of measurement.

Solution Strength

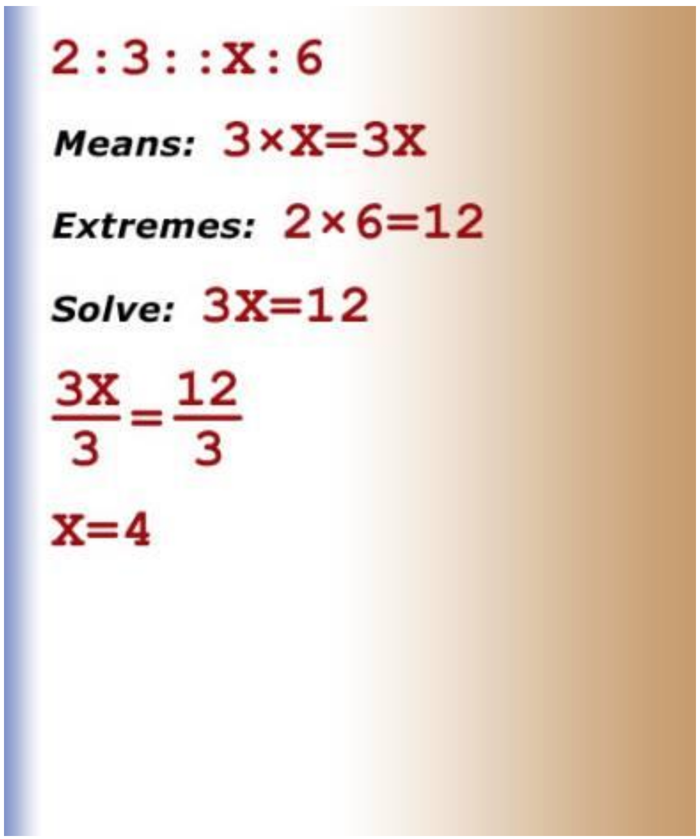
- 1 cup of bleach and 2 cups of water
- 1 gallon of bleach and 2 gallons of water
- 2 liters of bleach and 4 liters of water
- 1/2 quart of bleach and 1 quart of water

Proportions

- A **proportion** is an equation that shows equality between two ratios. The proportion 2 : 3 :: 4 : 6 literally means that 2 is related to 3 in the same way that 4 is related to 6.
- In a proportion, the two middle terms are called the **means**. The two outer terms are called the **extremes**. To determine if a proportion is equal, follow this rule: *The product of the means is equal to the product of the extremes.* In the proportion 2 : 3 :: 4 : 6, the means are 3 and 4. The extremes are 2 and 6. Because 3 × 4 = 12 and 2 × 6 = 12, the proportion is equal.



Proportions



- Proportions are often used to solve for an unknown term. Suppose the proportion was written 2 : 3 :: X : 6. X is the unknown term. Follow these steps to solve for X:
- Multiply the means: **3 × X = 3X**
- Multiply the extremes: **2 × 6 = 12**
- Set up the equation according to the rule: *The product of the means is equal to the product of the extremes*: **3X = 12**
- Solve for X by dividing both sides of the equation by the number in front of the X: **3X ÷ 3 = 12 ÷ 3**
- Identify the solution: **X = 4**

Parallel Proportions

- To set up a proportion correctly, the equation must be arranged in the proper order. Consider the following model:
- **A : B :: A : B**
- This model shows that the equation is parallel. The first and third terms are alike, and the second and fourth terms are alike. For example, suppose that in the first part of the proportion, the A term is *milligrams* and the B term is *tablets*. In order to set up the proportion correctly, the A term in the second part of the equation must also be a value of *milligrams*. Likewise, the B term in the second part of the proportion must be a value of *tablets*.
- All proportions must be parallel.

Set Up Parallel Proportions

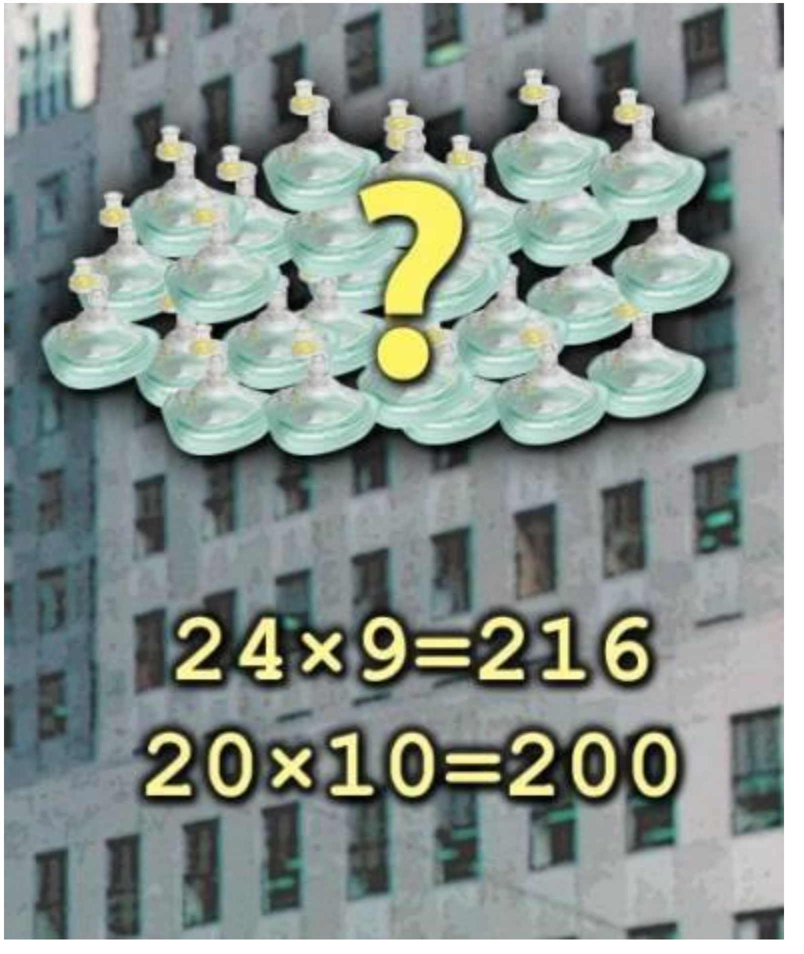
- Suppose a lab tech is able to complete 9 tests in 4 hours. How many hours will it take the technician to complete 36 tests? Follow these steps to set up a parallel proportion:
- Identify what is known: The tech can complete **9 tests in 4 hours**. The first part of the proportion is **9 tests : 4 hours**.
- Identify the unknown term: You do not know how many hours it takes to complete 36 tests. So the unknown term is the **number of hours**. This term is called **X hours**.
- Set up the proportion by following the A : B :: A : B model: You know that the first part is **9 tests : 4 hours**. Now, add the second part, so that the equation reads **9 tests : 4 hours :: 36 tests : X hours**. Notice that *tests* and *hours* are parallel on both sides of the proportion.
- Solve the proportion:
  - Multiply the means: **4 × 36 = 144**
  - Multiply the extremes: **9 × X = 9X**
  - Set up the equation so that the product of the means equals the product of the extremes: **9X = 144**
  - Divide each side of the equation by the number in front of the X: **9X ÷ 9 = 144 ÷ 9**
  - Identify the solution: **X = 16**. The proportion now reads **9 tests : 4 hours :: 36 tests : 16 hours**. It will take the lab tech **16 hours** to complete 36 tests.

Estimating

- Health care workers must be careful when making mathematical calculations. It is possible for errors to have harmful effects. For example, miscalculating a medication dosage for a patient can lead to further sickness or even death. Even simple errors, such as copying a wrong number or placing a decimal point incorrectly, may create serious problems.
- One way to reduce the number of mathematical errors is to estimate what the result of a calculation will be. **Estimating** is figuring out an approximate answer, and then judging if the result of the actual calculation seems reasonable. Many estimates involve mental mathematics that allow health care workers to determine when an answer looks out of place.
- Health care workers can use several strategies when estimating. Two of these strategies are **rounding** and **averaging**.

Rounding

- Mental calculations are easier when numbers are rounded to a multiple of 10. For example, suppose a supply clerk needs to order 24 CPR masks for each of the 9 floors of the hospital. The supply clerk can round 24 down to 20 and round 9 up to 10. It is much easier to mentally multiply 20 × 10 than it is to mentally multiply 24 × 9. At a glance, the supply clerk can see that about 200 CPR masks must be ordered. Although this figure is not an exact calculation, it provides a starting point. Later, the supply clerk may determine that the exact number of CPR masks needed is 216. By comparing the estimated figure of 200 to the actual figure of 216, the clerk may judge that the calculation was done correctly. The actual answer is reasonably close to the estimated answer.



Average

- An **average** is a number that represents a set of numbers. For example, suppose that it takes a volunteer 5 minutes to change the sheets on one bed, 8 minutes to change the sheets on a second bed, and 8 minutes to change the sheets on a third bed. The volunteer can estimate the number of minutes it will take to change the sheets on a fourth bed by finding the average in this set of numbers.
- Follow these steps to find the average:
- Add the numbers in the set to find the sum: **5 + 8 + 8 = 21**
- Divide the sum by the number of items in the set: In this scenario, the set contains 3 items - 5 minutes, 8 minutes, and 8 minutes. **21 ÷ 3 = 7**
- Identify the answer: **7 minutes.** It takes the volunteer an average of 7 minutes to change the sheets on a bed. Therefore, the volunteer can estimate that it will take about 7 minutes to change the sheets on the fourth bed.

Averaging

- Now, suppose the supervisor asks the volunteer how many beds he can change in 1 hour. The volunteer can estimate again by using the average. He knows that it takes an average of 7 minutes to change the sheets on 1 bed. By dividing 60 minutes (1 hour) by 7 minutes, he can determine about how many beds can be changed in 1 hour. **60 ÷ 7 = 8.57**, which rounds up to **9**. The volunteer can change the sheets on about 9 beds in 1 hour.

Stop here for worksheet!

Measurement Systems

- Various systems of measurement are used in health care. These systems include the English system, the metric system, and the apothecary system. Each system has its own units of measurement to designate length, volume, and weight. Health care workers must learn how to use each system, as well as how to convert measurements from one system to another.

The English System

- The **English system** is the most common measurement system in the United States. It is sometimes called the household system. The English system is not the most accurate measurement system. However, health care workers must learn to express measurements using this system so that patients, especially those in the United States, will understand information about their health care.

English Measurements Length

- In health care, units of length are used to measure a patient's height. For adults and children, height is usually taken by using the measuring bar on a balance beam scale. For infants, height is determined by the measurement markings made on a flat surface. Length units are also used to measure the circumference of an infant's head.
- In the English system, length is measured in the following units:
- inch (in)
- foot (ft)
- yard (yd)
- mile (mi)

English Measurements
Weight

- In health care, a patient's weight is usually measured on a balance beam scale. In the English system, weight is measured in the following units:
- ounce (oz)
- pound (lb)
- ton (tn)

English Measurement Volume

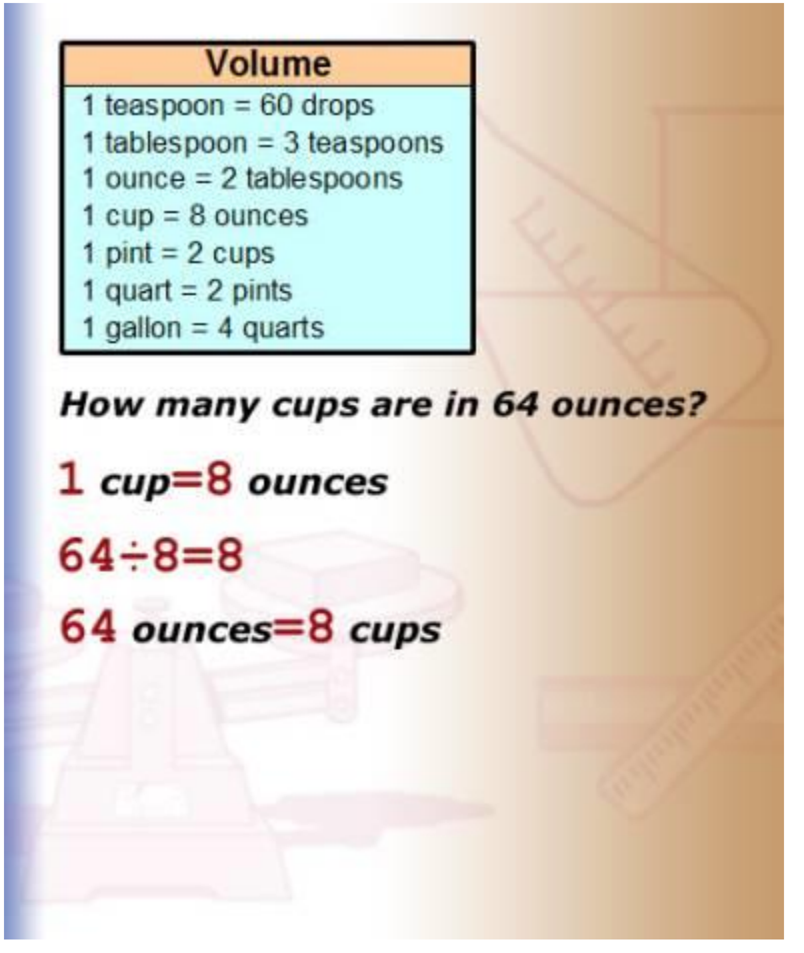
- In health care, units of volume, or capacity, are used when prescribing medication to be taken at home. Cleaning solutions and beverages may also be measured using English units. In the English system, volume is measured in the following units:
- drop (gtt or gt)
- teaspoon (t or tsp)
- tablespoon (T or tbsp)
- ounce (oz)
- cup (c)
- pint (pt)
- quart (qt)
- gallon (gal)

Converting English Units

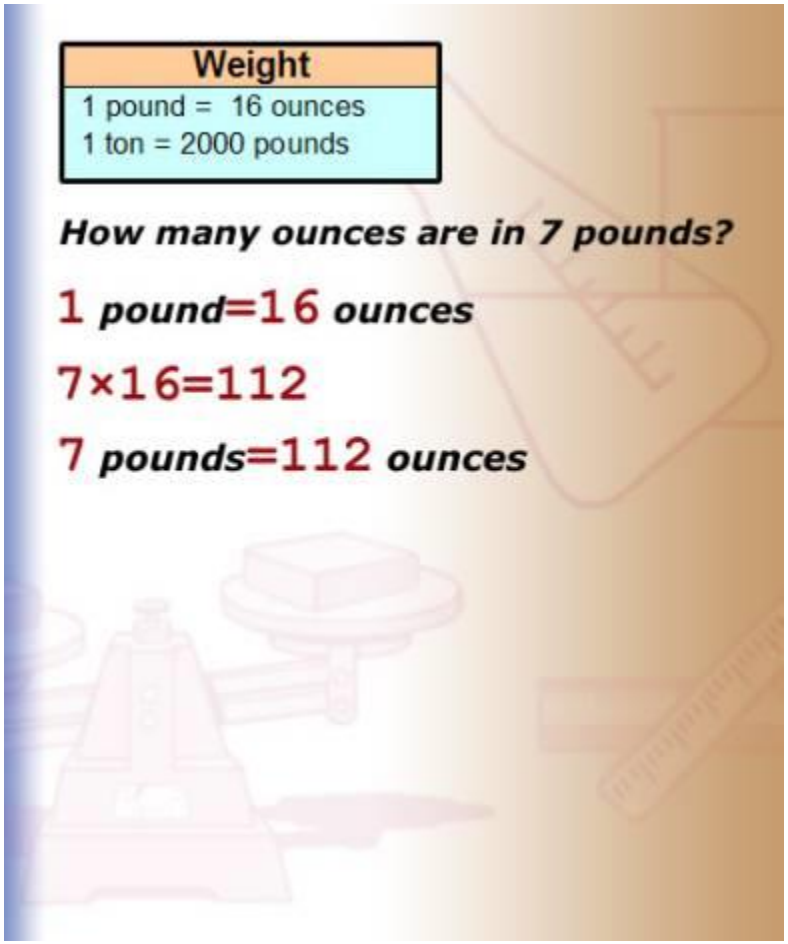
- The units in the English measuring system are related to each other. This chart shows the relationships between units. Simple calculations may be used to convert from one unit to another. Health care workers must memorize these relationships.

Converting English Units

- It is generally recommended that adults drink 64 ounces of water each day. How many cups is this? Follow these steps to convert ounces to cups:
- Determine the number of ounces in 1 cup: **1 cup = 8 ounces**
- Divide the total number of ounces by the number of ounces in 1 cup: **64 ÷ 8 = 8**
- Identify the answer: Adults should drink **8 cups** of water per day.



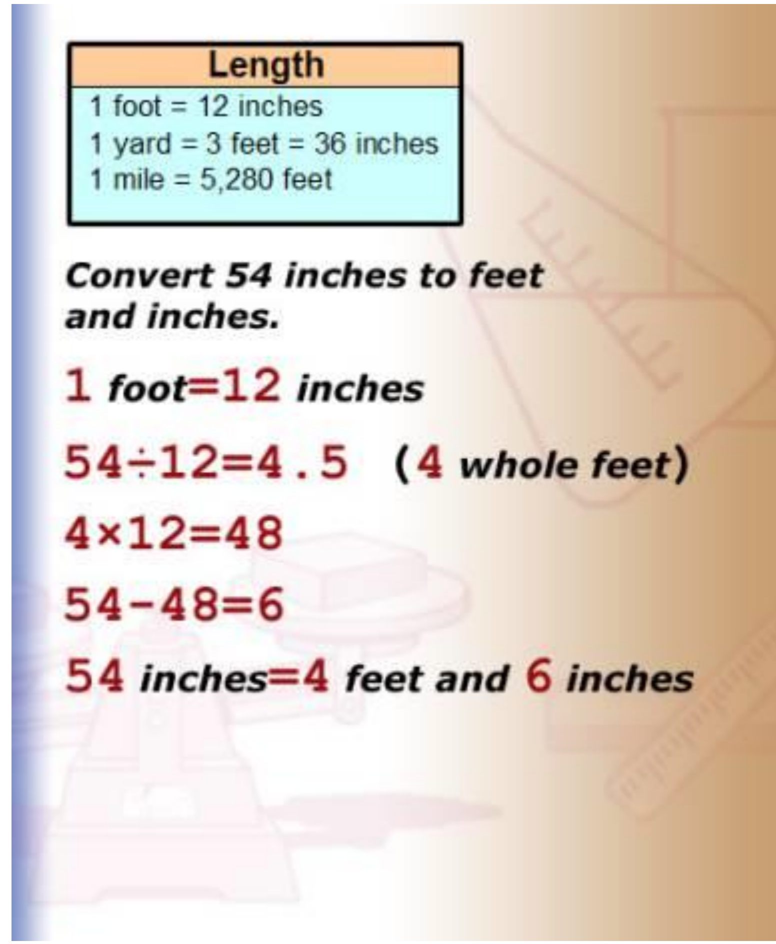
Converting English Units



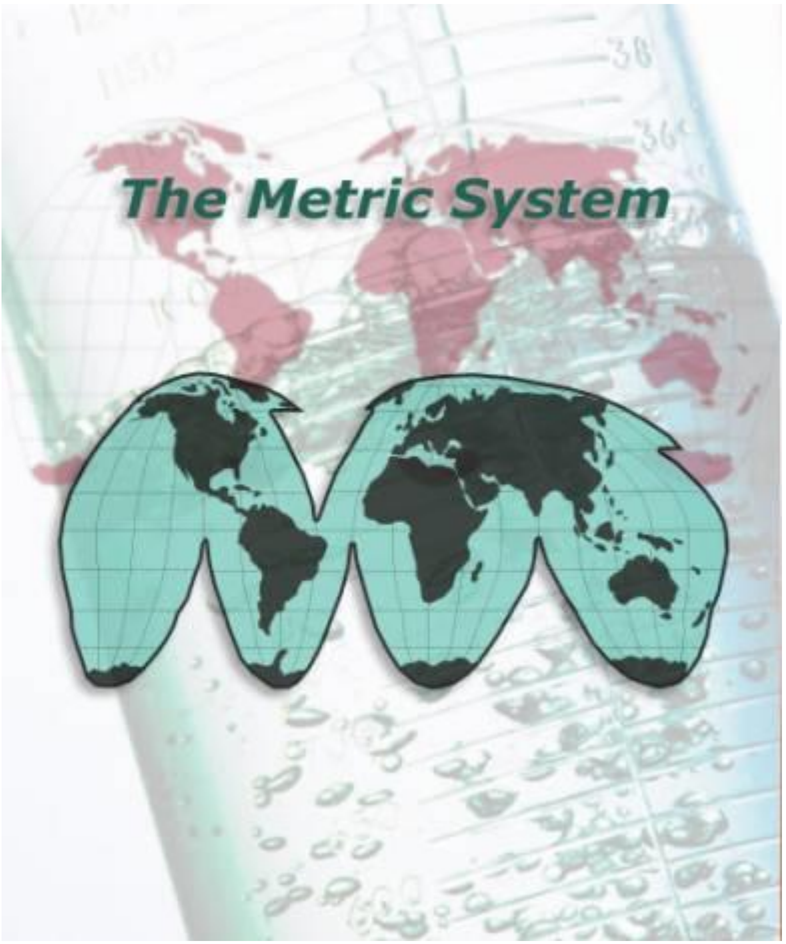
- An infant weighs 7 pounds. How many ounces in this? Follow these steps to convert pounds (a larger unit) to ounces (a smaller unit):
- Determine the number of ounces in 1 pound: **1 pound = 16 ounces**
- Multiply the total number of pounds by the number of ounces in 1 pound: **7 × 16 = 112**
- Identify the answer: The infant weighs **112 ounces**.

Converting English Units

- A medical assistant measures the height of a patient as 54 inches. How many feet and inches is this? Follow these steps to convert inches to *feet and inches*:
- Determine the number of inches in 1 foot: **1 foot = 12 inches**
- Divide the total number of inches by the number of inches in 1 foot: **54 ÷ 12 = 4.5**. Notice that 4.5 does *not* equal 4 feet and 5 inches. The figure 4.5 means 4 and 5 tenths, or 4 and 1/2 feet.
- Multiply the number of *whole feet* by the number of inches in 1 foot: **4 × 12 = 48**
- Subtract the product of #3 from the total number of inches: **54 - 48 = 6**. Notice that 6 is the number of inches that remain after the whole feet are subtracted from the patient's height.
- Identify the answer: The patient is **4 feet and 6 inches** tall.



The Metric System



- The **metric system** is more accurate than the English system. In addition, many people find the metric system easier to use than the English system. Most countries outside of the United States use the metric system as the standard for measuring. Health care workers often find themselves in situations where they need to translate English measurements into metric measurements.

Metric Units

- The metric system has three base units of measurement:
- Length is measured in **meters** (m).
- Weight is measured in **grams** (g).
- Volume is measured in **liters** (L).

Metric prefixes

- Larger and smaller units are created by adding a prefix. Each prefix represents a value that relates to the base unit. The values are based on multiples of 10.
- *Kilo* has a value of 1,000.
- *Hecto* has a value of 100.
- *Deca* has a value of 10.
- The base unit has a value of 1.
- *Deci* has a value of 0.1.
- *Centi* has a value of 0.01.
- *Milli* has a value of 0.001

Prefix	Value
Kilo	1,000
Hecto	100
Deca	10
Base Unit	1
Deci	0.1
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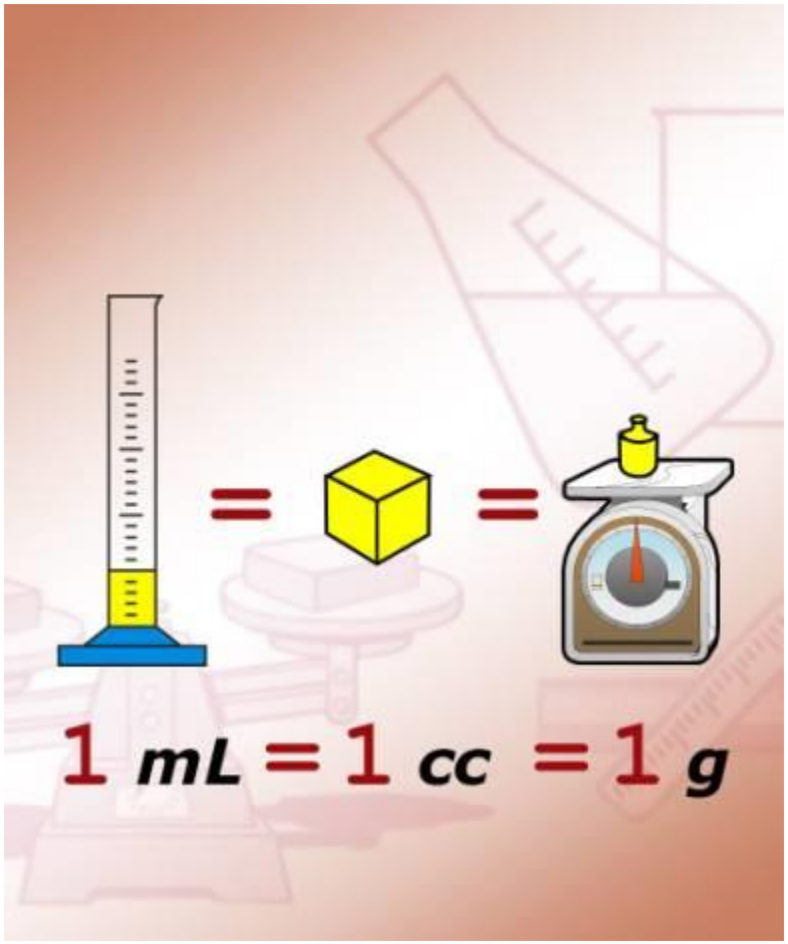
Milli	0.001

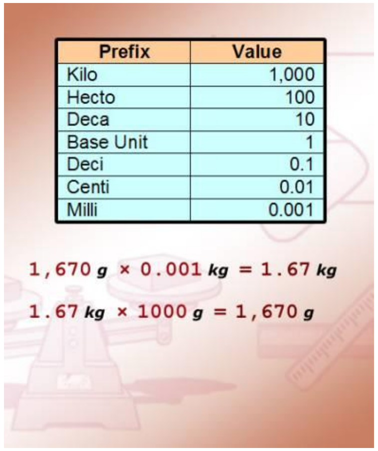
Metric Relationships



- There is an important relationship in the metric system:
- **1 milliliter = 1 cubic centimeter = 1 gram**
- In other words, the amount of liquid in 1 milliliter (mL) is equal to the amount of liquid that can be held in 1 cubic centimeter (cc). In addition, the amount of liquid in 1 milliliter or 1 cubic centimeter weighs 1 gram. This relationship is important to health care workers. Medication is often measured in milliliters or cubic centimeters. Health care workers must be able to recognize this connection and measure medication correctly.

Metric System Conversions

- Because the metric system is based on units of 10, converting between units requires simple multiplication. Suppose that a health care worker wants to convert 1,670 grams into kilograms. This chart shows that 1 kilogram is 1000 times the value of 1 gram. Therefore, 1 gram = 0.001 kilogram. To convert grams into kilograms, multiply the number of grams by 0.001:
- **1,670 grams × 0.001 kilogram = 1.67 kilograms**
- Now, suppose the health care worker knows the weight of an item is 1.67 kilograms. To express this term in grams, the opposite function must be performed. This chart shows that 1 kilogram = 1000 grams. To convert kilograms into grams, multiply the number of kilograms by 1000:
- **1.67 kilograms × 1000 grams = 1,670 grams**



Prefix	Value
Kilo	1,000
Hecto	100
Deca	10
Base Unit	1
Deci	0.1
Centi	0.01
Milli	0.001

Conversion Shortcut

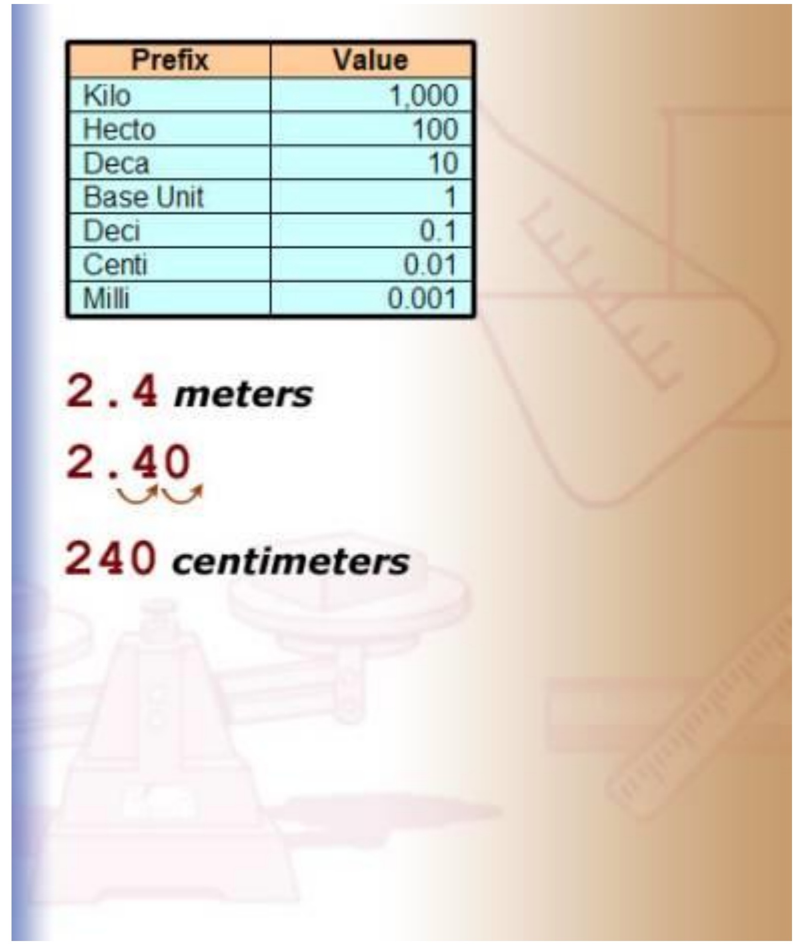
- An easy way to convert between units in the metric system is to move the decimal point to either the right or the left. For example, suppose a medical assistant must express 2.4 meters in terms of centimeters. This chart shows that 1 meter is 100 times the value of 1 centimeter. In other words, 1 meter = 100 centimeters. To convert meters into centimeters, the health care worker could multiply the number of meters by 100:
- **2.4 meters × 100 centimeters = 240 centimeters**

Prefix	Value
Kilo	1,000
Hecto	100
Deca	10
Base Unit	1
Deci	0.1
Centi	0.01
Milli	0.001

$2.4\ m \times 100\ cm = 240\ cm$

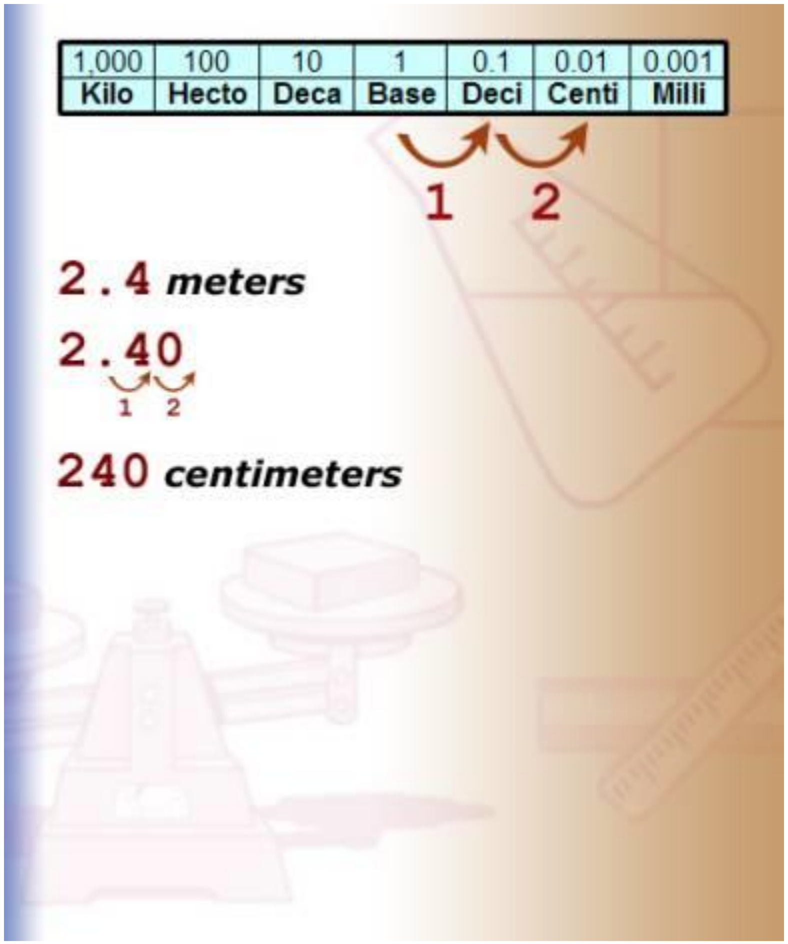
Conversion shortcut

- An easier way to perform this conversion is to simply move the decimal point two places to the right. Notice how the zero is added as a placeholder:



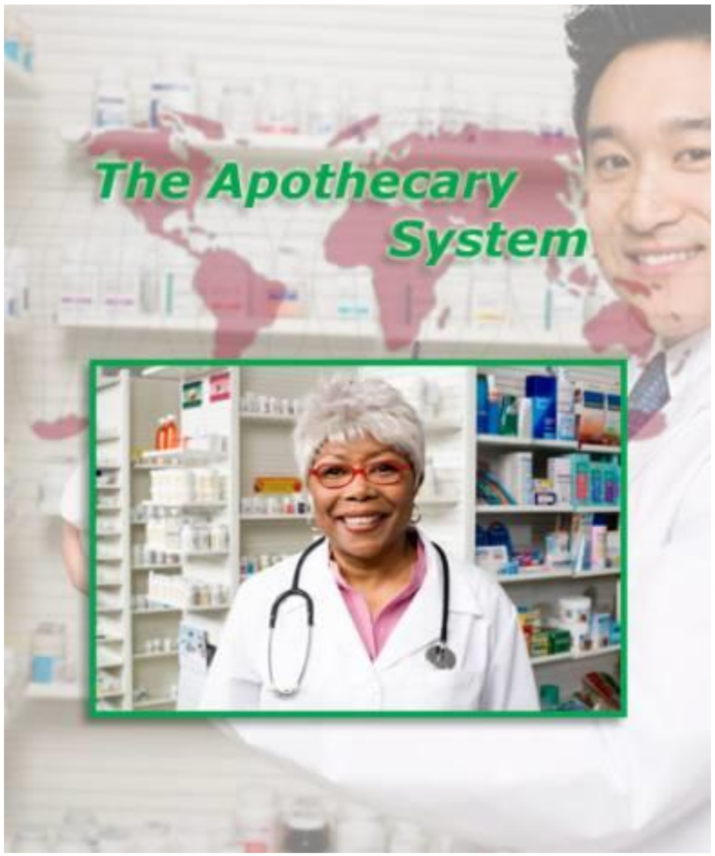
Prefix	Value
Kilo	1,000
Hecto	100
Deca	10
Base Unit	1
Deci	0.1
Centi	0.01
Milli	0.001

Conversion shortcuts, cont'd



- To convert from a larger unit to a smaller unit, move the decimal point the correct number of places to the *right*. To convert from a smaller unit to a larger unit, move the decimal point the correct number of places to the *left*. It may be necessary to add zeros as placeholders. A chart, like the one shown here, can be used to help determine the correct number of places to move the decimal point. This conversion process works for any metric unit: meters, grams, or liters.

The Apothecary System



- The apothecary system is not as common as the English or metric systems. The **apothecary system** is a system that was created in old England to measure weight and volume. It is primarily used by physicians and pharmacists to write medication dosages.

Apothecary System Weights

- In the apothecary system, weight is measured in the following units:
- grain (gr)
- dram (dr)
- ounce (oz)
- pound (lb)
- It is important to note that the ounce in the apothecary system is different from the ounce in the English system. In the English system, 16 ounces equals 1 pound. However, in the apothecary system, 12 ounces equals 1 pound.

Apothecary System
Volume

- Volume is measured in the following units:
- minim (m)
- fluidram (fldr)
- fluidounce (floz)
- pint (pt)
- quart (qt)
- gallon (gal)
- It is important to note that the fluidounce, pint, quart, and gallon in the apothecary system are equal to the ounce, pint, quart, and gallon in the English system.

Apothecary System conversions

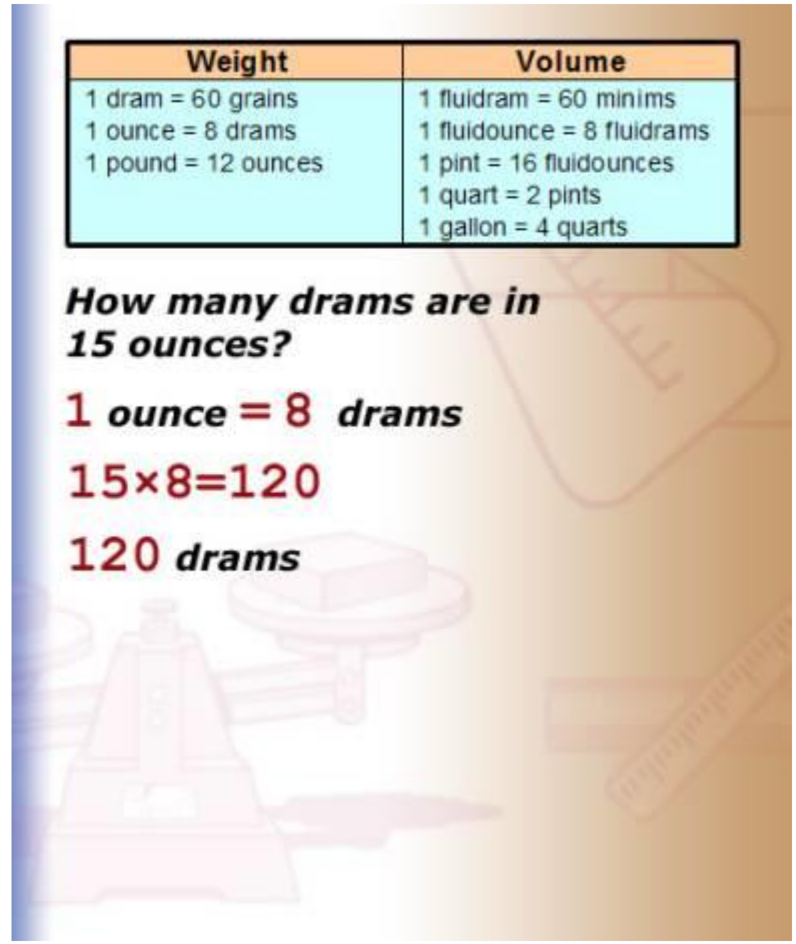
- Like the English system, the units of measurement in the apothecary system are related to each other. One unit may be converted to another unit by using simple calculations. This chart shows the relationships between units in the apothecary system. Health care workers must memorize these relationships and learn to make conversions

Weight	Volume
1 dram = 60 grains	1 fluidram = 60 minims
1 ounce = 8 drams	1 fluidounce = 8 fluidrams
1 pound = 12 ounces	1 pint = 16 fluidounces
	1 quart = 2 pints
	1 gallon = 4 quarts

How many drams are in 15 ounces?

Apothecary System conversions

- **Example:** How many drams are in 15 ounces of medication? Follow these steps to convert ounces to drams:
- Determine the number of drams in 1 ounce: **1 ounce = 8 drams**
- Multiply the number of ounces by the number of drams in 1 ounce: **15 × 8 = 120**
- Identify the answer: **120 drams**

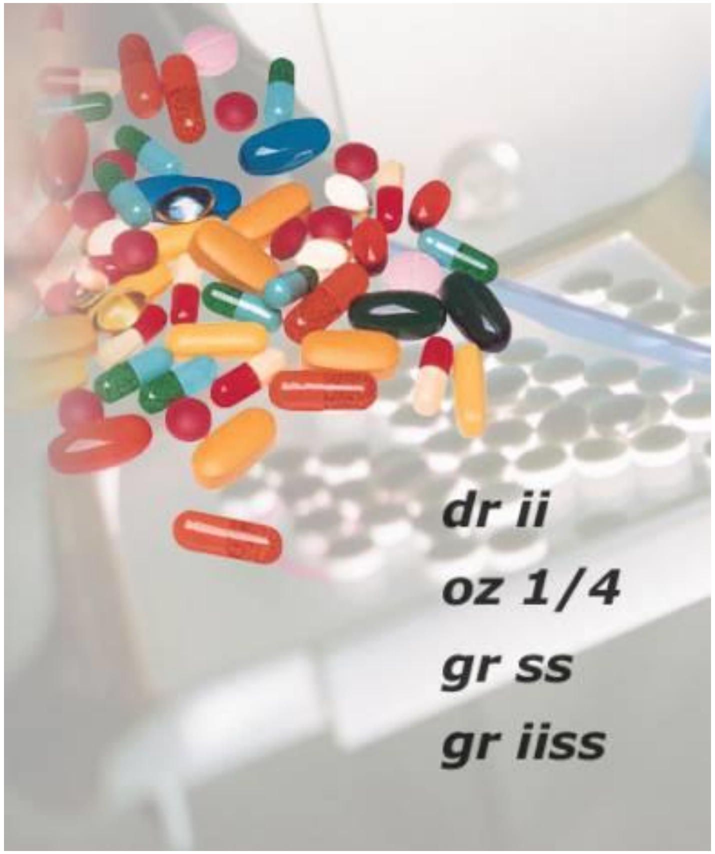


Weight	Volume
1 dram = 60 grains	1 fluidram = 60 minims
1 ounce = 8 drams	1 fluidounce = 8 fluidrams
1 pound = 12 ounces	1 pint = 16 fluidounces
	1 quart = 2 pints
	1 gallon = 4 quarts

Apothecary Abbreviations

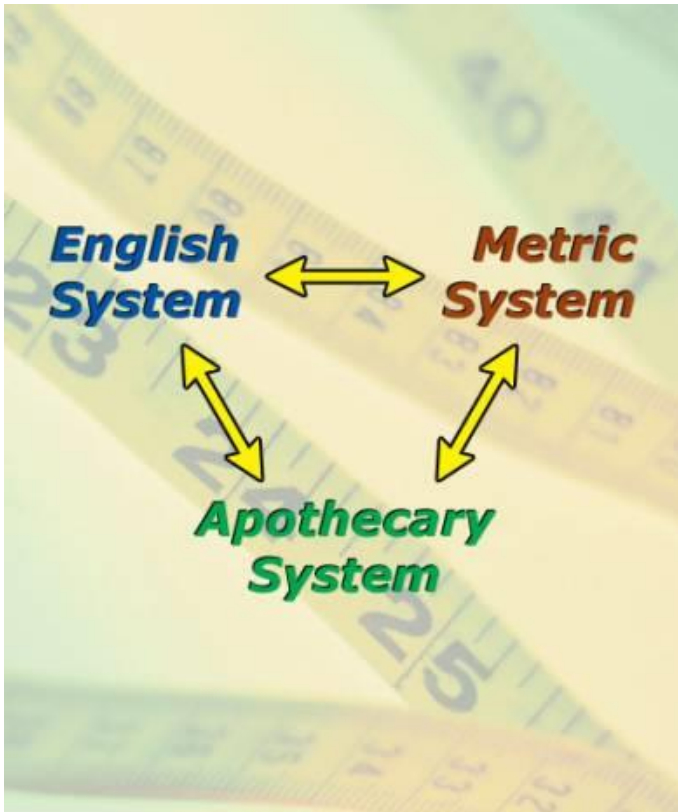
- When writing medication dosages, physicians and pharmacists often use abbreviations. A combination of letters, numbers, and symbols are used to make abbreviations in the apothecary system. Roman numerals are used to represent whole numbers. However, unlike standard Roman numerals, which are written with capital letters, the apothecary system uses lower case letters. Another common symbol is *ss*, which stands for 1/2.

To write abbreviations in the apothecary system, first write the unit of measurement. Then write the amount. Follow these general guidelines for writing amounts in the apothecary system.



- If the amount is 1 or greater, use lower case Roman numerals. For example, 2 drams is written **dr ii**.
- If the amount is less than 1, use a fraction. For example, 1/4 of an ounce is written **oz 1/4**.
- If the amount contains the value 1/2, use *ss*. For example, 1/2 grain is written **gr ss**, and 2 and 1/2 grains is written **gr iiss**.

Convert Between Systems



Health care workers are often asked to convert from one system of measurement to another. For example, hospitals frequently give medication in metric units, such as milliliters or cubic centimeters. However, in the home, patients are likely to measure medication using the English system, such as tablespoons or ounces. Health care workers must learn methods for converting between systems.

Nomenclature

- Each system has its own method of naming measurement units. This is called **nomenclature**. An important part of the conversion process is to use the correct nomenclature. Health care workers must be able to distinguish between systems and recognize the correct unit names for each system.

Procedure to convert between systems

Weight Equivalents	English	Metric	Apothecary
		1 milligram	0.02 grain
		65 milligrams	1 grain
	0.03 ounce	1 gram	15 grains
	0.15 ounce	4 grams	1 dram
	1 ounce	28.4 grams	7.2 drams
	1 pound	454 grams	1.2 pound
	2.2 pounds	1 kilogram	2.6 pounds
	1 ton	900 kilograms	

Volume Equivalents	English	Metric	Apothecary
	1 drop	0.06 milliliter	1 minim
	15 drops	1 milliliter	15 minims
	1 teaspoon	5 milliliters	1 fluidram
	1 tablespoon	15 milliliters	4 fluidrams
	1 ounce	30 milliliters	1 fluidounce
	1 pint	500 milliliters	1 pint
	1 quart	1 liter	1 quart
	1 gallon	4 liters	1 gallon

Length Equivalents	English	Metric
	0.04 inch	1 millimeter
	0.4 inch	1 centimeter
	1 inch	2.5 centimeters
	1 foot	30 centimeters
	1 yard	0.9 meter
	3.3 feet	1 meter
	0.62 mile	1 kilometer
	1 mile	1.6 kilometers

- To convert between systems, health care workers must learn the relationships between measuring units. It is important to note that exact equivalents between systems often do not exist. Charts, like those shown here, show close approximations. They may be used to determine fairly accurate values.

Weight Equivalents

English	Metric	Apothecary
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1 quart	1 liter	1 quart
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English	Metric
0.04 inch	1 millimeter
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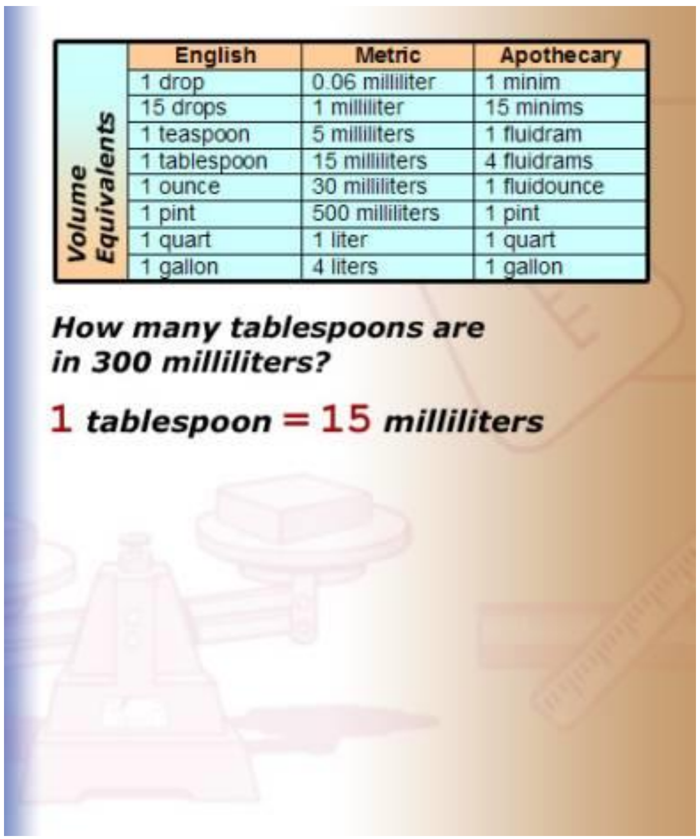
1 inch	2.5 centimeters
1 foot	30 centimeters
1 yard	0.9 meter
3.3 feet	1 meter
0.62 mile	1 kilometer
1 mile	1.6 kilometers

- Use the following steps to convert between systems:

1. Determine an equivalent between the two systems.
2. Set up a parallel proportion, and use X for the unknown term.
3. Solve for X.
4. Verify that the answer is reasonable:
   - If converting from a smaller unit to a larger unit, the answer will be smaller.
   - If converting from a larger unit to a smaller unit, the answer will be larger.

While in the hospital, a patient received 300 milliliters of medication per day. How many tablespoons is this?

Determine an equivalent between two systems: 1 tbsp = 15 mL



Volume Equivalents	English	Metric	Apothecary
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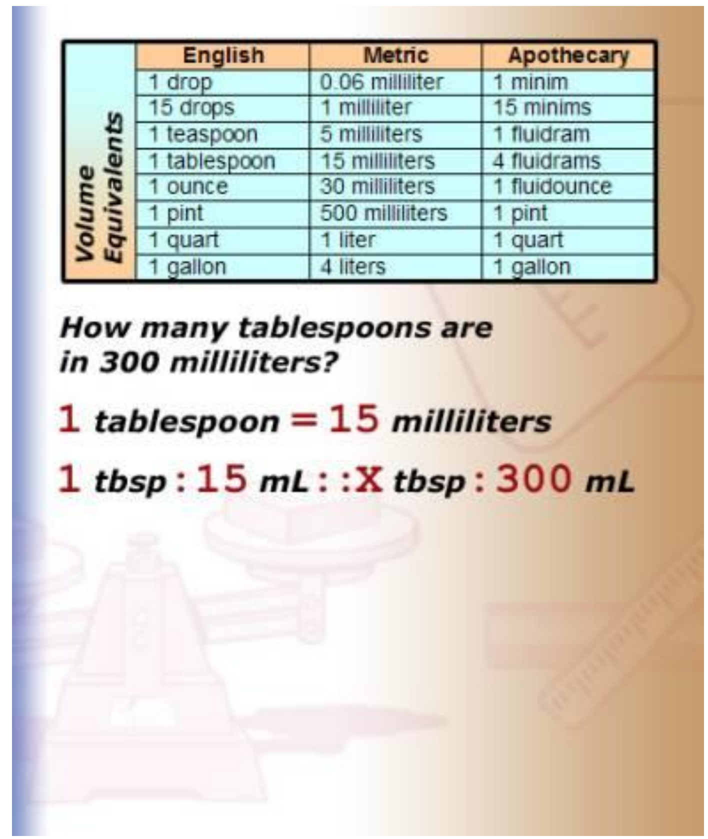
	1 teaspoon	5 milliliters	1 fluidram
	1 tablespoon	15 milliliters	4 fluidrams
	1 ounce	30 milliliters	1 fluidounce
	1 pint	500 milliliters	1 pint
	1 quart	1 liter	1 quart
	1 gallon	4 liters	1 gallon

How many tablespoons are in 300 milliliters?

1 *tablespoon* = 15 *milliliters*

Set up a parallel proportion, while using X for the unknown term: 1 tbsp : 15 mL :: X tbsp : 300 mL



Volume Equivalents	English	Metric	Apothecary
	1 drop	0.06 milliliter	1 minim
	15 drops	1 milliliter	15 minims
	1 teaspoon	5 milliliters	1 fluidram
	1 tablespoon	15 milliliters	4 fluidrams
	1 ounce	30 milliliters	1 fluidounce
	1 pint	500 milliliters	1 pint
	1 quart	1 liter	1 quart
	1 gallon	4 liters	1 gallon

How many tablespoons are in 300 milliliters?

1 *tablespoon* = 15 *milliliters*

1 *tbsp* : 15 *mL* : : X *tbsp* : 300 *mL*

Solve for X

Multiply the means: 15 × X = 15X
Multiply the extremes: 1 × 300 = 300

Volume Equivalents	English	Metric	Apothecary
	1 drop	0.06 milliliter	1 minim
	15 drops	1 milliliter	15 minims
	1 teaspoon	5 milliliters	1 fluidram
	1 tablespoon	15 milliliters	4 fluidrams
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	1 quart	1 liter	1 quart
	1 gallon	4 liters	1 gallon

How many tablespoons are in 300 milliliters?

1 ***tablespoon*** = 15 ***milliliters***

1 ***tbsp*** : 15 ***mL*** : : X ***tbsp*** : 300 ***mL***

Means: $15 \times X = 15X$

Extremes: $1 \times 300 = 300$

Set up an equation so that the product of the means equals the product of the extremes: 15X = 300

Volume Equivalents	English	Metric	Apothecary
	1 drop	0.06 milliliter	1 minim
	15 drops	1 milliliter	15 minims
	1 teaspoon	5 milliliters	1 fluidram
	1 tablespoon	15 milliliters	4 fluidrams
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How many tablespoons are in 300 milliliters?

1 ***tablespoon*** = 15 ***milliliters***

1 ***tbsp*** : 15 ***mL*** : : X ***tbsp*** : 300 ***mL***

Means: $15 \times X = 15X$

Extremes: $1 \times 300 = 300$

Solve: $15X = 300$

Identify the answer

Divide both sides of the equation by the number in front of the X: 15X ÷ 15 = 300 ÷ 15

Volume Equivalents	English	Metric	Apothecary
	1 drop	0.06 milliliter	1 minim
	15 drops	1 milliliter	15 minims
	1 teaspoon	5 milliliters	1 fluidram
	1 tablespoon	15 milliliters	4 fluidrams
	1 ounce	30 milliliters	1 fluidounce
	1 pint	500 milliliters	1 pint
	1 quart	1 liter	1 quart
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How many tablespoons are in 300 milliliters?

1 ***tablespoon*** = 15 ***milliliters***

1 ***tbsp*** : 15 ***mL*** : : X ***tbsp*** : 300 ***mL***

Means: $15 \times X = 15X$

Extremes: $1 \times 300 = 300$

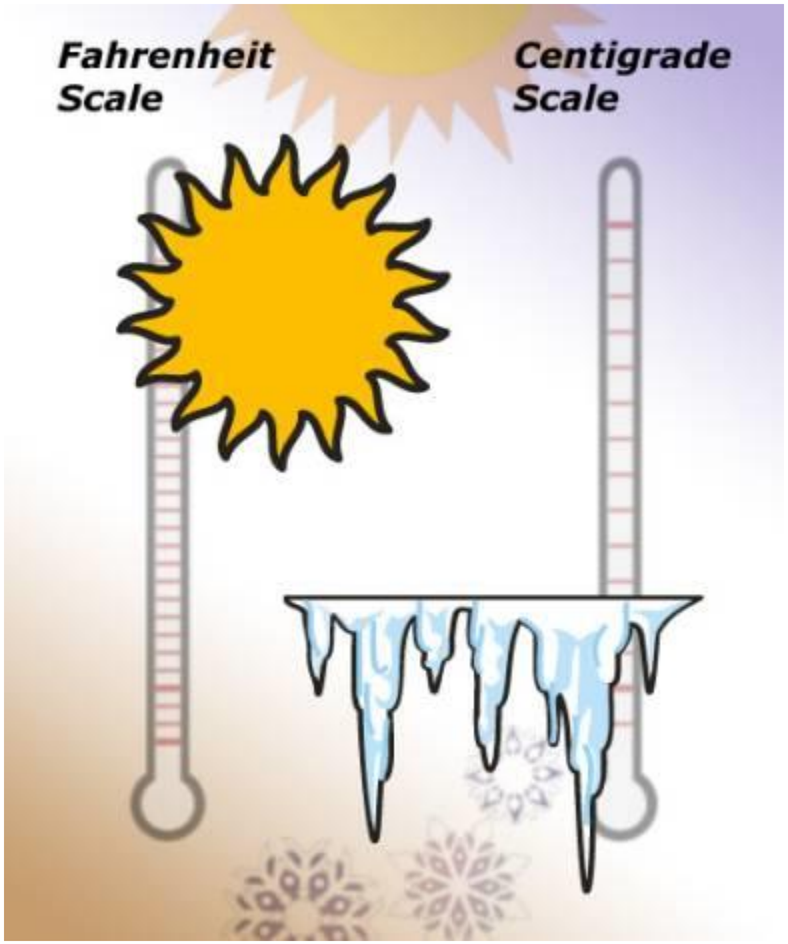
Solve: $15X = 300$

$$\frac{15X}{15} = \frac{300}{15}$$

Identify the answer: X = 20 tbsp

- Verify that the answer is reasonable: Milliliters are smaller than tablespoons. When converting milliliters to tablespoons, the answer will be a smaller number. The number 20 is smaller than 300. Therefore, the answer is reasonable

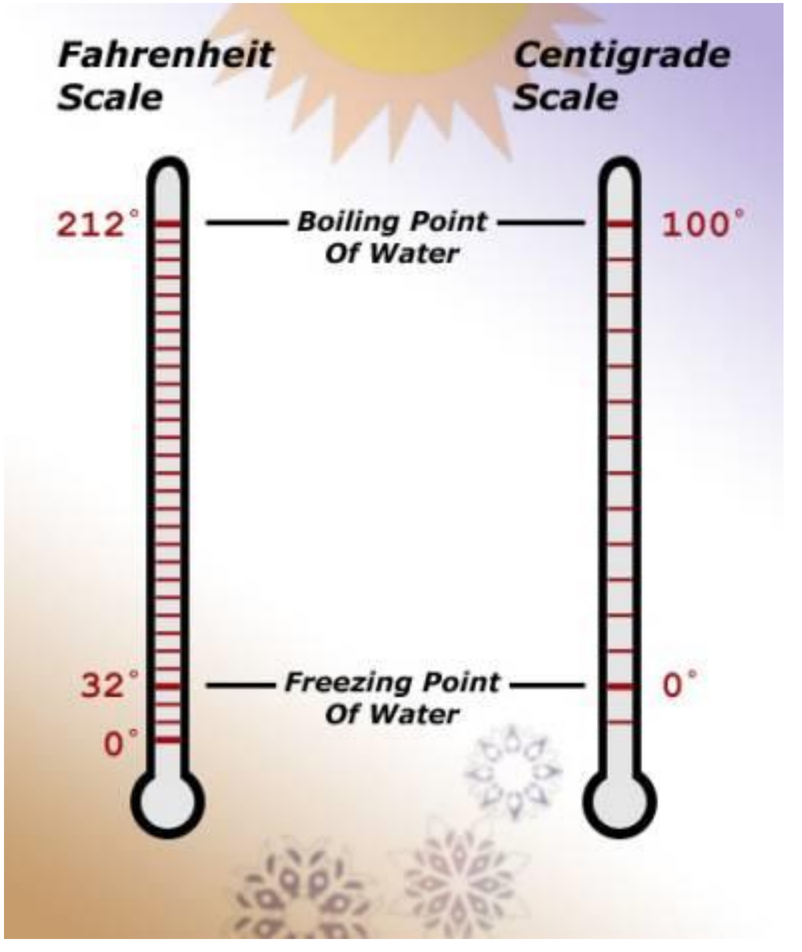
Temperature



- In the United States, temperature is usually measured on the **Fahrenheit** scale. However, in many parts of the world, the Centigrade system is used. The **Centigrade**, or Celsius, scale is used frequently in medical facilities. Health care workers must learn to convert between the two systems.

Comparing Temperatures

- One way to understand the difference between the Fahrenheit system and the Centigrade system is to compare the values for freezing point and boiling point. On the Fahrenheit scale, the freezing point is 32° and the boiling point is 212°. On the Centigrade scale, the freezing point is 0° and the boiling point is 100°.



Converting from Fahrenheit to Centigrade

- Some medical facilities have conversion charts to show the relationship between Fahrenheit and Centigrade. However, when a conversion chart is not available, health care workers can use a mathematic formula to convert between systems.
- To convert from Fahrenheit to Centigrade, use the equation **°C = (°F - 32) ÷ 1.8**. For example, normal temperature for an adult is 98.6°F. What is this temperature in degrees Centigrade?
- Follow these steps to convert Fahrenheit into Centigrade:
- Set up the equation: **°C = (98.6°F - 32) ÷ 1.8**
- Subtract the numbers in the parentheses: **98.6 - 32 = 66.6**
- Divide the answer from #2 by 1.8: **66.6 ÷ 1.8 = 37**
- Identify the answer: **°C = 37**. Normal adult temperature is 98.6°F, or 37°C

°F	°C	°F	°C	°F	°C
32	0	98	36.7	105	41.1
70	21.1	98.6	37	106	41.7
75	23.9	99	37.2	107	42.2
80	26.7	100	37.8	108	42.8
85	29.4	101	38.3	109	43.3
90	32.2	102	38.9	110	43.9
95	35	102	39.4	111	44.4
96	35.6	103	40	212	100
97	36.1	104	40.6		

$$°C=(°F-32)\div 1.8$$

$$°C=(98.6°F-32)\div 1.8$$

$$98.6-32=66.6$$

$$°C=66.6\div 1.8$$

$$°C=37$$

$$98.6°F=37°C$$

Converting from Centigrade to Fahrenheit

$$°F = (°C \times 1.8) + 32$$

$$°F = (40°C \times 1.8) + 32$$

$$40 \times 1.8 = 72$$

$$°F = 72 + 32$$

$$°F = 104$$

$$40°C = 104°F$$

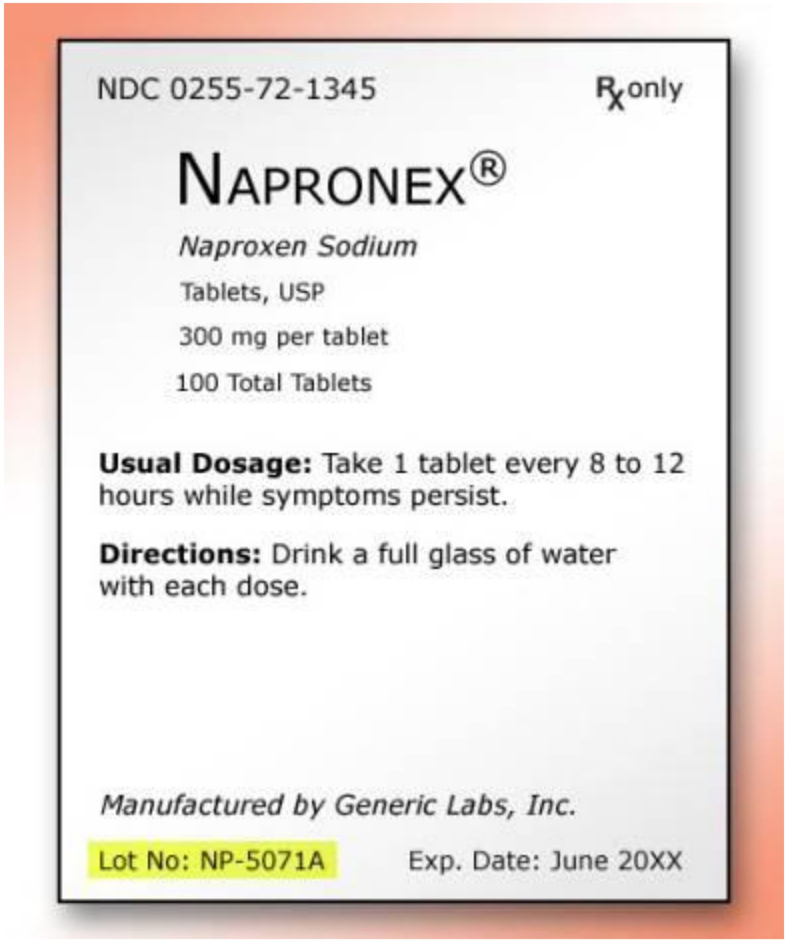
- To convert from Centigrade to Fahrenheit, use the equation **°F = (°C × 1.8) + 32**. For example, a patient has a temperature of 40°C. What is this temperature in degrees Fahrenheit?
- Follow these steps to convert from Centigrade to Fahrenheit:
- Set up the equation: **°F = (40°C × 1.8) + 32**
- Multiply the numbers in the parentheses: **40 × 1.8 = 72**
- Add the product from #2 to 32: **72 + 32 = 104**
- Identify the answer: **°F = 104**. The patient's temperature is 40°C, or 104°F

Baby Otters

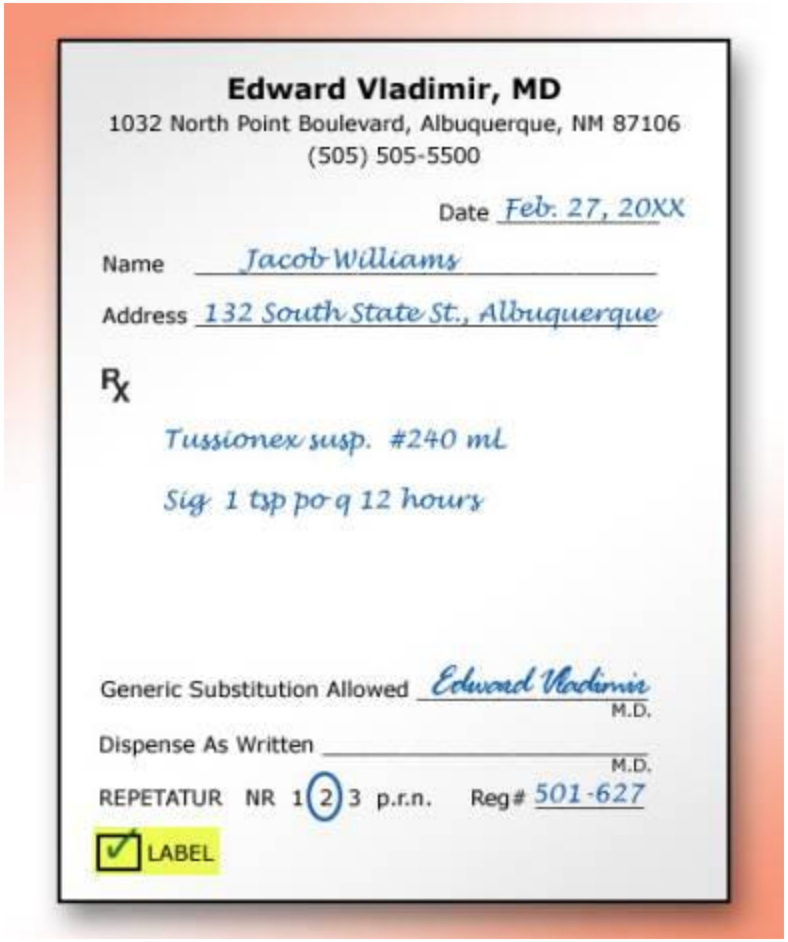
Why? Because **LOOK** at how cute they are!!!!

Medication Labels

- Health care workers must learn the basic components of a medication label. Though the styles may vary, most labels contain the following items:
- **Trade name**: the brand name
- **Generic name**: the common name
- **Manufacturer**: the name of the company that manufactures the medication
- **NDC**: the National Drug Code, which is used to identify the medication, the manufacturer, and the container size
- **Dosage strength**: the amount of medication in one dose
- **Drug form**: the form of the medication, such as liquid, tablet, capsule, or drop
- **Usual dose**: the typical adult dose for normal use of the medication
- **Total Amount Enclosed**: the amount of tablets, capsules, milliliters, or drops contained in the package
- **Caution**: the federal warning that prohibits the medication to be dispensed without a prescription
- **Expiration Date**: the last date in which the prescription should be used
- **Lot** or **Control Number**: the shipping number, which is used by the manufacturer for tracking and quality control



Prescriptions

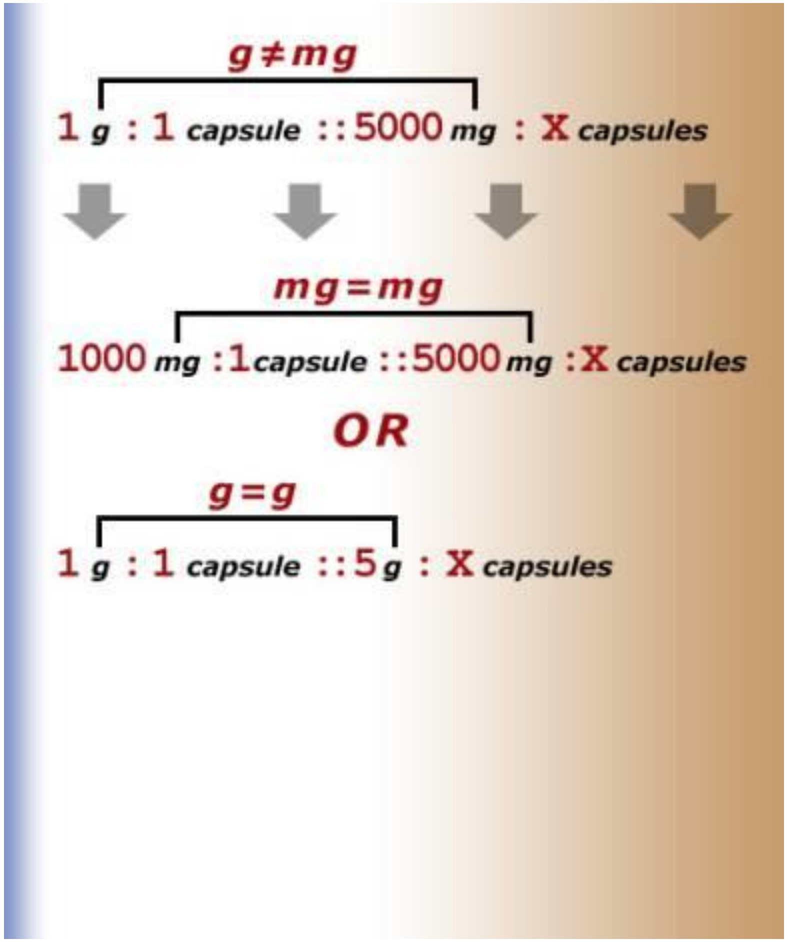


- A **prescription** is a written order for medication. Doctors write prescriptions so that patients may purchase medication for home use. A prescription contains all of the information a pharmacist will need to fill an order. Most prescriptions contain the following items:
- The doctor's name, address, and telephone number.
- The patient's name and address.
- The date the prescription was written.
- The medication instructions, which is usually preceded by the symbol Rx. The medication instructions include:
  - the name of the medication.
  - directions for filling the prescription.
  - the signature, or Sig, which provides directions to the patient for taking the medication.
- Two signature lines for the doctor. By signing the first line, the doctor indicates that a generic substitution is allowed. By signing the second line, the doctor indicates that the prescription must be filled as written. Only one line should be signed.
- Refill instructions, where the doctor indicates the number of times the prescription may be filled. NR means *no refills*, and p.r.n. means *refill as needed*.
- The doctor's registration number.
- A label checkbox, which indicates to the pharmacist that the medication should be labeled properly

Two ways to administer medication are oral and parenteral:

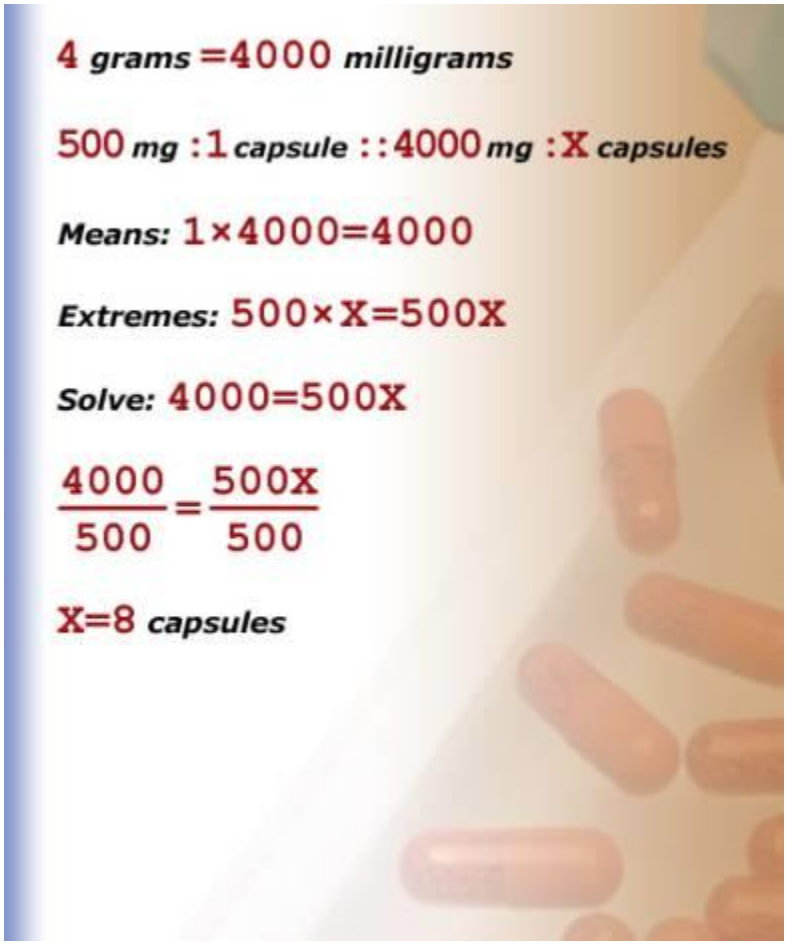
- **Oral** medication is taken by mouth. It is available in solid forms, such as capsules, tablets, and powders. It is also available in liquid form, such as syrups, solutions, and elixirs.
- **Parenteral** medication is injected into the body. Syringes are used to inject medication into the skin or muscle tissue. Intravenous lines, or IVs, are used to inject medication into a vein.

Calculating Dosages



- Most dosages are calculated by using proportions. An important rule for using proportions is that all units of measurement must be the same. In other words, the proportion must be parallel.
- For example, the proportion **1 g : 1 capsule :: 5000 mg : X capsules** is invalid. Grams and milligrams are not equal terms. Before this proportion can be solved, all units of measurement must be converted to the same unit. Because 1 g = 1000 milligrams, this proportion could be changed to **1000 mg : 1 capsule :: 5000 mg : X capsules**.
- Another way to convert this proportion is to covert all units to grams by writing **1 g : 1 capsule :: 5 g : X capsules**. Both proportions are now parallel and may be solved for X.

Calculating Oral Dosage



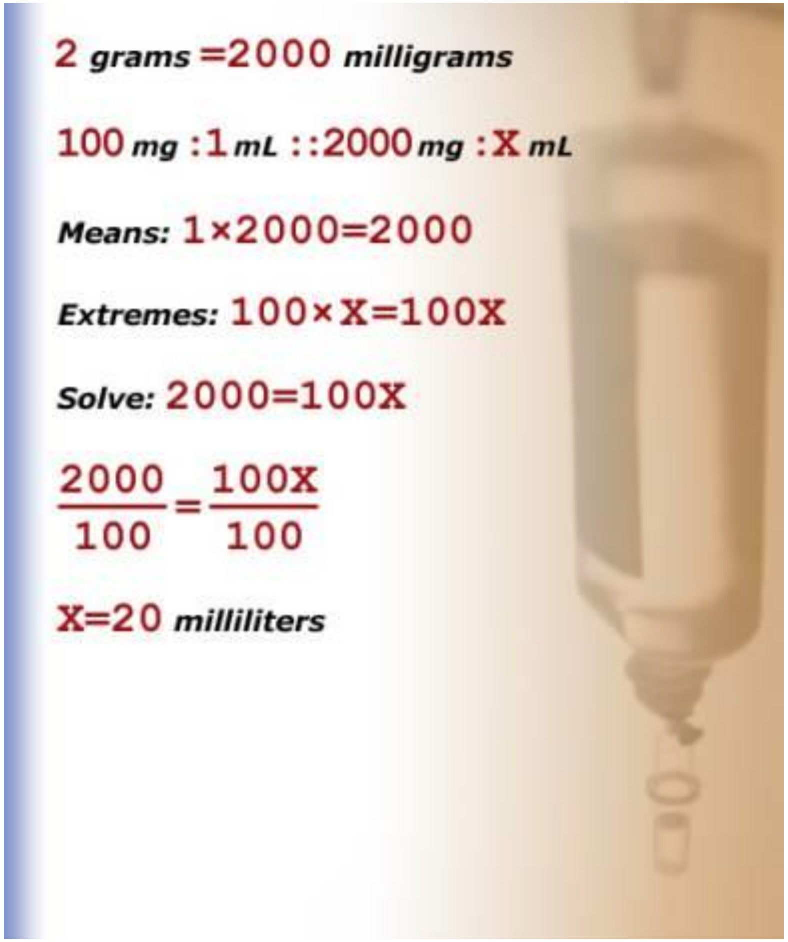
- A doctor orders 4 grams of medication for a patient. The medication is available in capsules of 500 milligrams. How many capsules should be given?
- Follow these steps to solve for oral dosage:
- Convert all units of measurement to the same unit: 4 grams is converted into milligrams by moving the decimal point three spaces to the right. **4 grams = 4000 milligrams**
- Set up a parallel proportion: **500 mg : 1 capsule :: 4000 mg : X capsules**
- Solve for X:
  - Multiply the means: **1 × 4000 = 4000**
  - Multiply the extremes: **500 × X = 500X**
  - Set up the equation so that the product of the means equals the product of the extremes: **4000 = 500X**
  - Divide both sides of the equation by the number in front of the X: **4000 ÷ 500 = 500X ÷ 500**
  - Identify the answer: **X = 8 capsules**

Calculating Oral Liquid Dosage

- To calculate oral dosage for a liquid medication, two units of measurement must be used: weight and volume. For example, a doctor orders 250 milligrams of liquid medication for a patient. One milliliter of liquid contains 50 milligrams of medication. How many milliliters must be given to the patient?
- Follow these steps to solve for oral liquid dosage:
- Set up a parallel proportion: **50 mg : 1 mL :: 250 mg : X mL**. Notice that two different units of measurement are used to indicate weight (mg) and volume (mL).
- Solve for X:
  - Multiply the means: **1 × 250 = 250**
  - Multiply the extremes: **50 × X = 50X**
  - Set up the equation so that the product of the means equals the product of the extremes: **250 = 50X**
  - Divide both sides of the equation by the number in front of the X: **250 ÷ 50 = 50X ÷ 50**
  - Identify the answer: **X = 5 milliliters**

Calculating Parenteral Dosage

- Parenteral medication is always liquid. Like oral liquid medication, parenteral medication is written in terms of weight and volume. For example, a doctor orders that a patient is injected with 2 grams of medication. One milliliter of liquid contains 100 milligrams of medication. How many milliliters should be injected into the patient?
- Follow these steps to solve for parenteral dosage:
- Convert weight measurements to the same unit: 2 grams is converted to milligrams by moving the decimal point three spaces to the right. **2 grams = 2000 milligrams**
- Set up a parallel proportion: **100 mg : 1 mL :: 2000 mg : X mL**
- Solve for X:
  - Multiply the means: **1 × 2000 = 2000**
  - Multiply the extremes: **100 × X = 100X**
  - Set up the equation so that the product of the means equals the product of the extremes: **2000 = 100X**
  - Divide each side of the equation by the number in front of the X: **2000 ÷ 100 = 100X ÷ 100**
  - Identify the answer: **X = 20 milliliters**

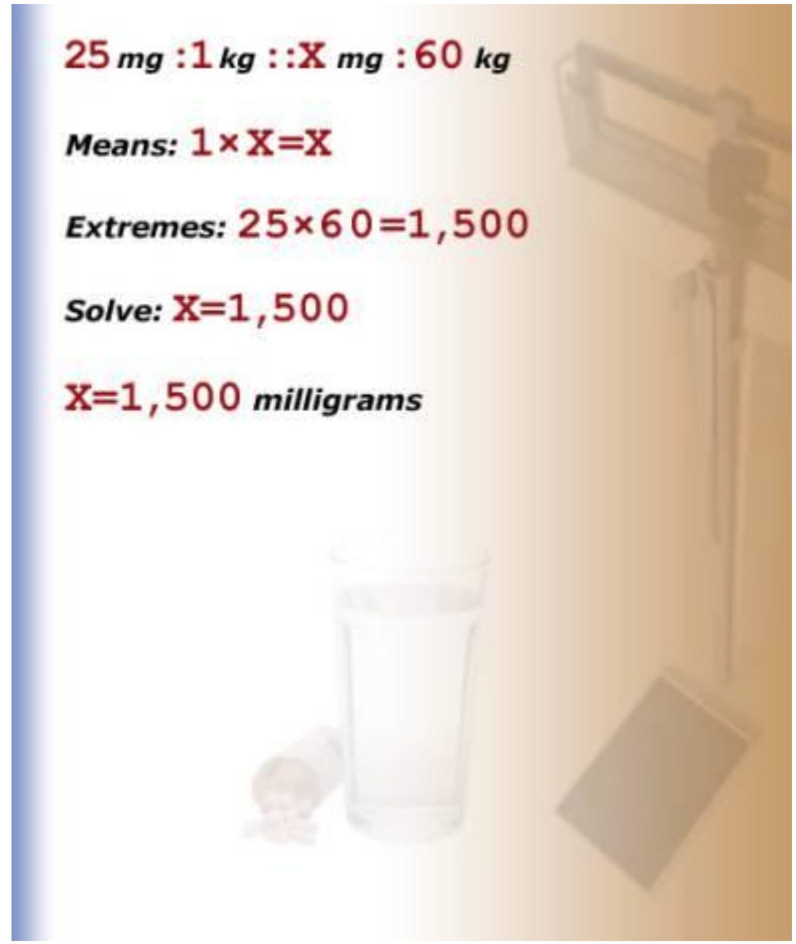


Dosage by Weight

- Many medication dosages are calculated according to the patient's body weight. This prevents giving too much medication to a smaller patient or too little medication to a larger patient. Dosage by weight is typically given in terms of milligrams per kilogram per day (mg/kg/day). For example, suppose a patient must receive medication in the amount of 25 mg/kg/day. This means that for every 1 kilogram of body weight, the patient must receive 25 milligrams of medication per day. If the patient weighs 60 kilograms, a proportion can be used to determine the number of milligrams the patient should take each day.

Dosage by weight, contd

- Set up a parallel proportion: **25 mg : 1 kg :: X mg : 60 kg**
- Solve for X:
  – Multiply the means: **1 × X = X**
  – Multiply the extremes: **25 × 60 = 1,500**
  – Set up the equation so that the product of the means equals the product of the extremes: **X = 1,500**
  – Identify the answer: A patient that weighs 60 kilograms should receive **1,500 milligrams of medication per day**

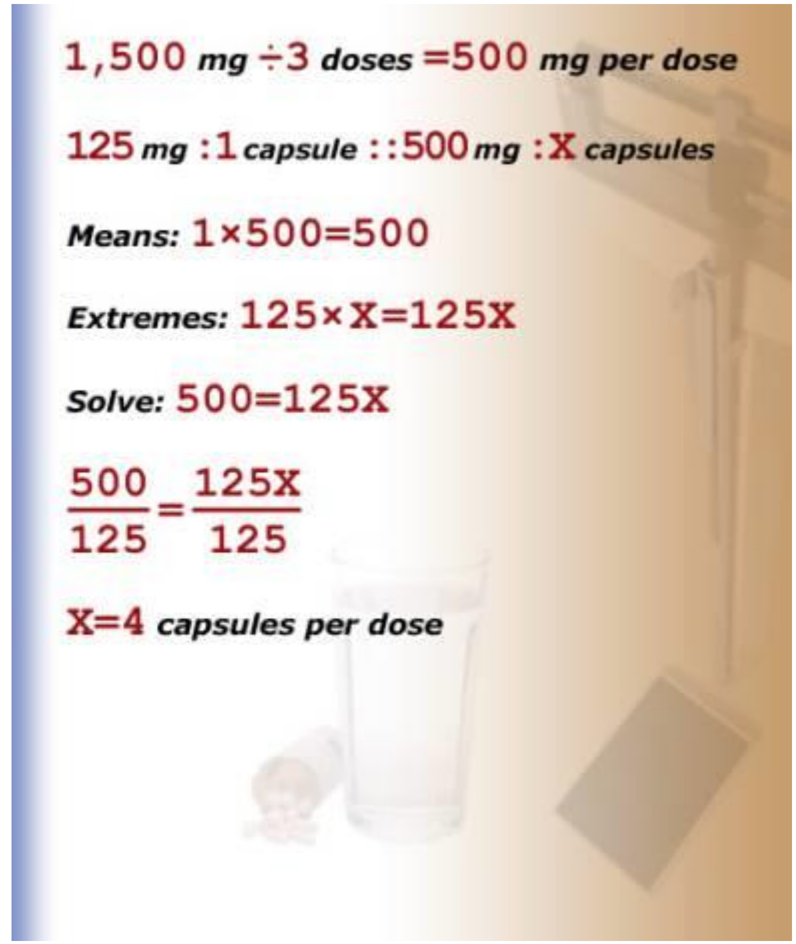


Dosage by weight, contd

- In the previous example, dosage by weight was calculated at a rate of 25 mg/kg/day. A patient that weighs 60 kilograms must receive 1,500 milligrams of medication per day. However, it is likely that the patient will not receive all 1,500 milligrams in one dose. Suppose the doctor orders the medication to be given in 3 doses during the day. In addition, the medication is available in capsules of 125 milligrams. How many capsules should be given in each dose?

Dosage by weight contd

- Divide the total dosage by the number of doses to be given each day: **1,500 milligrams ÷ 3 doses = 500 milligrams**. During each of the 3 doses per day, the patient will receive 500 milligrams of medication.
- Set up a parallel proportion to show the relationship between the number of milligrams in each capsule and the number of milligrams to be given during each dose: **125 mg : 1 capsule :: 500 mg : X capsules**
- Solve for X:
  - Multiply the means: **1 × 500 = 500**
  - Multiply the extremes: **125 × X = 125X**
  - Set up the equation so that the product of the means equals the product of the extremes: **500 = 125X**
  - Divide each side of the equation by the number in front of the X: **500 ÷ 125 = 125X ÷ 125**
  - Identify the answer: **X = 4 capsules**. The patient will receive 4 capsules of medication 3 times per day



Dosage Calculations

- Several formulas may be used when calculating drug doses. One formula uses RATIOS based on the desired dose and dose on hand.
- For Example: Keflex, an anti-infective, 500mg po q.i.d is ordered by the physician. The dose on hand in 250mg/5ml. The formula is as follows:
- 500mg(desired dose) X x(quantity desired)
- 250mg(dose on hand) 5ml(quantity on hand)
-
- Cross multiply and Milligrams cancel out.
- 250x=500X5
- 500X5/250 = 10ml
- X=10ml
- So we know that we need to administer 10ml of medication four times daily to arrive at desired dose

Dosage Calculation for Oral Medication

- Amoxicillan 500mg tid

- Available tablets are 250mg each.

- 2 tablets three times daily

Oral Dosage

- Most patients still use household measurements.
- Barbara needs to take 300mg of a suspension medication twice daily (300mg po bid)
- The strength of her medication is 50mg/5ml
- How many TABLESPOONS of medication should she take at each dosage?

- First, find the dosage in mls
- $\frac{\text{300mg(desired dose)}}{\text{50mg(dose on hand)}} \times \frac{\text{x(quantity desired)}}{\text{5 ml (quantityon hand)}}$

50x=1500

X= 30ml

- Next, do the conversion…

- 15ml=1tbsp
- So 30ml= 2tbsp

- So Barbara should take 2 tablespoons of medication

Parenteral Medication

- Medication that is injected into the body is called parenteral medication. **Syringes** are used to inject a precise amount of medication into the skin or muscle tissue. **Intravenous lines**, or IVs, inject medication directly into a vein. IVs can release small amounts of fluid at a time. In this way, the body receives constant medication over a long period of time. Health care workers must learn to correctly read the amount of fluid in a syringe or IV bag. In addition, health care workers must learn the equation to determine the appropriate IV drip rate.

Syringes

- Syringes contain markings to indicate volume. Though size may vary, most syringes are marked in units of milliliters. Syringes are read by identifying the number that is at the *end* of the rubber stopper. This syringe contains 3.5 milliliters of liquid.

IV bags

- The fluids for IVs are usually kept in plastic IV bags. IV bags are commonly found in sizes of 100, 250, 500, or 1000 milliliters.
- The milliliter markings on IV bags are arranged from top to bottom. In other words, on a 500 milliliter bag, *0* is at the top of the bag, and *500* is at the bottom of the bag. This arrangement allows health care workers to quickly determine how many milliliters of medicine have been infused into the patient. The level of the fluid in this IV bag shows that 300 milliliters have already been infused. To determine the amount of medication remaining in the bag, subtract the number of milliliters that have been infused from the total number of milliliters. In this case, 200 milliliters remain in the bag, because 500 mL - 300 mL = 200 mL.

Drip Rate

- **Drip rate** is the rate at which medication drips from the IV bag into the intravenous line. One of the factors needed to determine drip rate is the drip set. The **drip set** is the number of drops it takes to equal 1 milliliter. The two common types of drip sets are macrodrip sets and microdrip sets:
- **Macrodrip sets** release large drops. Typical macrodrip sets are available in 10-, 12-, or 15-drip sets. In a 10-drip set, it takes 10 drops to equal 1 milliliter. But in a 15-drip set, it takes 15 drops to equal 1 milliliter. The size of the drop decreases as the drip set increases.
- **Microdrip sets** release much smaller drops of fluid. In a microdrip set, it takes 60 drops to equal 1 milliliter. Microdrip sets are used to limit the volume of medication that is infused into the patient.
- Drip rate is given in terms of drops per minute. The following mathematic equation is used to determine drip rate:
- **Drip Rate = Milliliters of Fluid × Drip Set ÷ Minutes of Infusion**

Calculating Drip Rate

- A health care worker is asked to infuse 500 milliliters of medication into a patient over a period of 2 hours. The hospital uses 15-drip sets. What is the drip rate?
- Follow these steps to determine drip rate. Remember that the equation for drip rate is:
- **Drip Rate = Milliliters of Fluid × Drip Set ÷ Minutes of Infusion**
- Multiply the milliliters of fluid by the drip set: **500 × 15 = 7,500**
- Convert the length of time into minutes: **2 hours × 60 minutes = 120 minutes**
- Divide the product of #1 by the total number of minutes: **7,500 ÷ 120 = 62.5**
- Identify the answer: **62.5 drops per minute**. The health care worker must set the IV control so that it drips at 62.5 drops per minute