

# Yavapai College Nursing Program



## Dosage Calculations Practice Packet

## Basic Mathematics Review

Fractions, decimals, percentage, ratio, and proportion.

### FRACTIONS

**Definition:** A fraction is a part of a whole number. A fraction has 2 parts, the top number is called the numerator and the bottom number is called the denominator.

Example:  $\frac{1}{2} = 1$  is the numerator and 2 is the denominator.

There are 4 types of fractions:

1. **Proper fractions** – the numerator is less than the denominator and the fraction has a value of less than 1.

Example:  $\frac{1}{2}$ .

2. **Improper fractions** – the numerator is larger than or equal to the denominator and has a value of 1 or greater than 1. \*Example:  $\frac{6}{5}$

**\*An improper fraction must be reduced to the lowest terms by dividing the numerator by the denominator. (Therefore,  $\frac{6}{5}$  should be “reduced” to  $1\frac{1}{5}$  or one and one-fifth.)**

3. **Complex fractions** – the numerator or denominator may be either a fraction or a whole number. The value may be less than, greater than, or equal to 1.

Example:  $\frac{\frac{1}{2}}{2}$  or  $\frac{\frac{1}{2}}{\frac{3}{4}}$

4. **Mixed number** – there is a whole number and a fraction combined with a value greater than 1.

\*\*Example:  $3\frac{1}{2}$ .

\*\*A mixed number must be reduced to the lowest terms also. To change a mixed number to an improper fraction, multiply the whole number by the denominator and add the numerator.

\*\*\* Example:  $3\frac{1}{2} = \frac{(2 \times 3) + 1}{2} = \frac{7}{2}$

\*\*\* **Remember: Unless asked to give an answer as an improper fraction, never leave it as such. Therefore,  $\frac{7}{2}$  should be reduced to  $3\frac{1}{2}$  or three and one half.**

### Practice Problems # 1

Reduce the following fractions to the lowest terms.

1.  $\frac{2}{4} = \underline{\hspace{2cm}}$
2.  $\frac{2}{8} = \underline{\hspace{2cm}}$
3.  $\frac{15}{20} = \underline{\hspace{2cm}}$
4.  $\frac{3}{9} = \underline{\hspace{2cm}}$
5.  $\frac{10}{15} = \underline{\hspace{2cm}}$
6.  $\frac{7}{49} = \underline{\hspace{2cm}}$
7.  $\frac{64}{128} = \underline{\hspace{2cm}}$
8.  $\frac{20}{28} = \underline{\hspace{2cm}}$
9.  $\frac{14}{98} = \underline{\hspace{2cm}}$
10.  $\frac{24}{36} = \underline{\hspace{2cm}}$

Change the following improper fractions to mixed numbers and reduce to lowest terms.

1.  $6/4 =$  \_\_\_\_\_ 2.  $7/5 =$  \_\_\_\_\_ 3.  $15/8 =$  \_\_\_\_\_ 4.  $3/2 =$  \_\_\_\_\_ 5.  $18/5 =$  \_\_\_\_\_  
 6.  $60/14 =$  \_\_\_\_\_ 7.  $13/8 =$  \_\_\_\_\_ 8.  $35/12 =$  \_\_\_\_\_ 9.  $112/100 =$  \_\_\_\_\_ 10.  $30/4 =$  \_\_\_\_\_

Change the following mixed numbers to improper fractions and reduce to lowest terms.

1.  $3 \frac{1}{2} =$  \_\_\_\_\_ 2.  $6 \frac{1}{2} =$  \_\_\_\_\_ 3.  $10 \frac{1}{2} =$  \_\_\_\_\_ 4.  $33 \frac{1}{3} =$  \_\_\_\_\_ 5.  $1 \frac{4}{25} =$  \_\_\_\_\_  
 6.  $4 \frac{2}{8} =$  \_\_\_\_\_ 7.  $4 \frac{1}{2} =$  \_\_\_\_\_ 8.  $3 \frac{3}{8} =$  \_\_\_\_\_ 9.  $15 \frac{4}{5} =$  \_\_\_\_\_ 10.  $9 \frac{1}{4} =$  \_\_\_\_\_

**Adding Fractions:** To add fractions with the same denominator, add the numerators, place the sum over the denominator, and reduce to lowest terms. Example:  $\frac{1}{6} + \frac{4}{6} = \frac{5}{6}$

To add fractions with different denominators, change fractions to their equivalent fraction with the lowest common denominator, add the numerators, write the sum over the common denominator, and reduce to lowest terms. Example:  $\frac{1}{4} + \frac{1}{3} = \frac{3}{12} + \frac{4}{12} = \frac{7}{12}$

**Subtracting Fractions:** To subtract fractions with the same denominator, subtract the numerators, and place this amount over the denominator. Reduce to lowest terms. Example:  $\frac{5}{4} - \frac{3}{4} = \frac{2}{4} = \frac{1}{2}$

To subtract fractions with different denominators, find the lowest common denominator, change to equivalent fractions, subtract the numerators, and place the sum over the common denominator. Reduce to lowest terms. Example:  $\frac{15}{6} - \frac{3}{5} = \frac{75}{30} - \frac{18}{30} = \frac{57}{30} = 1 \frac{27}{30} = 1 \frac{9}{10}$

**Multiplying Fractions:** Multiple the numerators and multiple the denominators and reduce to lowest terms. Example:  $\frac{3}{4} \times \frac{2}{3} = \frac{6}{12} = \frac{1}{2}$

**Dividing Fractions:** Invert the second fraction and multiply and reduce to lowest terms. Example:  $\frac{1}{3}$  divided by  $\frac{1}{2} = \frac{1}{3} \times \frac{2}{1} = \frac{2}{3}$

### **Practice Problems # 2**

Add, subtract, multiply or divide the fractions and reduce to lowest terms. The answers are on page 34 of the dosage calculations packet.

Add the following fractions and reduce to lowest terms.

1.  $2/3 + 5/6 =$  \_\_\_\_\_ 2.  $2 \frac{1}{8} + 2/3 =$  \_\_\_\_\_ 3.  $2 \frac{3}{10} + 4 \frac{1}{5} + 2/3 =$  \_\_\_\_\_ 4.  $7 \frac{2}{5} + 2/3 =$  \_\_\_\_\_  
 5.  $12 \frac{1}{2} + 10 \frac{1}{3} =$  \_\_\_\_\_ 6.  $1/2 + 1/5 =$  \_\_\_\_\_ 7.  $1/4 + 1/6 + 1/8 =$  \_\_\_\_\_ 8.  $2/5 + 1/3 + 7/10 =$  \_\_\_\_\_

Subtract the following fractions and reduce to lowest terms.

1.  $4/3 - 3/7 =$  \_\_\_\_\_ 2.  $3^{3/8} - 1^{3/5} =$  \_\_\_\_\_ 3.  $15/16 - 1/4 =$  \_\_\_\_\_ 4.  $2^{5/6} - 2^{3/4} =$  \_\_\_\_\_  
 5.  $1/8 - 1/12 =$  \_\_\_\_\_ 6.  $4/9 - 3/9 =$  \_\_\_\_\_ 7.  $4/5 - 1/6 =$  \_\_\_\_\_ 8.  $4/7 - 1/3 =$  \_\_\_\_\_

Multiply the following fractions and reduce to lowest terms.

1.  $2/3 \times 1/8 =$  \_\_\_\_\_ 2.  $9/25 \times 4/32 =$  \_\_\_\_\_ 3.  $1/3 \times 4/12 =$  \_\_\_\_\_ 4.  $5/4 \times 2/4 =$  \_\_\_\_\_  
 5.  $2/5 \times 1/6 =$  \_\_\_\_\_ 6.  $3/10 \times 4/12 =$  \_\_\_\_\_ 7.  $1/9 \times 7/3 =$  \_\_\_\_\_ 8.  $10/25 \times 5/3 =$  \_\_\_\_\_

Divide the following fractions and reduce to lowest terms.

1.  $1/3 \div 1/2 =$  \_\_\_\_\_ 2.  $25 \div 12 \frac{1}{2} =$  \_\_\_\_\_ 3.  $7/8 \div 2 \frac{1}{4} =$  \_\_\_\_\_ 4.  $6/2 \div 3/4 =$  \_\_\_\_\_  
 5.  $4/6 \div 1/2 =$  \_\_\_\_\_ 6.  $7/8 \div 7/8 =$  \_\_\_\_\_ 7.  $6 \div 2/5 =$  \_\_\_\_\_ 8.  $1/60 \div 1/2 =$  \_\_\_\_\_

### **DECIMALS:**

A decimal is a fraction that has a denominator that is a multiple of 10. The decimal point indicates place value. Numbers written to the right of the decimal represent a value of less than one. Numbers written to the left of the decimal represent a value greater than one.

### **IMPORTANT NOTE:**

- 1) When there is no whole number before a decimal point, it is important to place a zero to the left of the decimal point to emphasize that the number has a value of less than one. **The Joint Commission's official "Do Not Use" List prohibits writing a decimal with a value of less than one without a leading zero preceding the decimal point. Example: 0.75, not .75**
- 2) When writing decimals, unnecessary zeros should not be placed at the end of the number to avoid misinterpretation of a value and overlooking a decimal point. **The Joint Commission's official "Do Not Use" List forbids the use of trailing zeros for medication orders or other medication related documentation. Example: 1, not 1.0**

### **Dividing Decimals:**

1. Change the dividing number to a whole number by moving the decimal point to the right.
2. Change the number being divided by moving its decimal point the same number of places to the right.
3. Divide as usual.
4. Place the decimal point in the answer directly above the decimal point in the dividend.
5. To express the answer to the nearest tenth, carry the division to the hundredth place and round. To express the answer to the nearest hundredth, carry the division to the thousandth place and round.

Example:

$$\begin{array}{r}
 \phantom{0.03.} \overline{)2.19} \\
 \underline{21} \\
 09 \\
 \underline{9} \\
 0
 \end{array}$$

The answer is 73

**Practice Problems # 3**

Divide the decimals below. **Record your answer using two decimal places unless instructed otherwise.**

1.  $0.75 \div 0.5 =$  \_\_\_\_\_ (**Record using one decimal place**).
2.  $0.2 \div 0.02 =$  \_\_\_\_\_ (**Record using a whole number**).      3.  $140 \div 6 =$  \_\_\_\_\_
4.  $140 \div 7.8 =$  \_\_\_\_\_      5.  $2 \div 0.5 =$  \_\_\_\_\_ (**Record using a whole number**).
6.  $1.4 \div 1.2 =$  \_\_\_\_\_      7.  $63.8 \div 0.9 =$  \_\_\_\_\_      8.  $39.6 \div 1.3 =$  \_\_\_\_\_
9.  $5.7 \div 0.9 =$  \_\_\_\_\_      10.  $3.75 \div 2.5 =$  \_\_\_\_\_ (**Record using one decimal place**).

**Rounding Decimals:**

To express an answer to the nearest tenth (**or one decimal place**), carry the division to the hundredth place (**or two decimal places**). If the number in the hundredth place (**or two decimal places**) is 5 or greater, add one to the tenth place (**or one decimal place**). If less than 5, drop the number.

Example:  $4.15$  to the nearest tenth (**or one decimal place**) = 4.2  
 $1.24$  to the nearest tenth (**or one decimal place**) = 1.2

To express an answer to the nearest hundredth (**or two decimal places**), carry the division to the thousandths place (**or three decimal places**). If the number in the thousandth place (**or three decimal places**) is 5 or greater, add one to the hundredth place (**or two decimal places**). If less than 5, drop the number.

Example:  $0.176$  to the nearest hundredth (**or two decimal places**) = 0.18  
 $0.554$  to the nearest hundredth (**or two decimal places**) = 0.55

**Practice Problems # 4**

**Record your answer using one decimal place unless instructed otherwise.**

1.  $0.75 =$  \_\_\_\_\_      2.  $0.23 =$  \_\_\_\_\_      3.  $0.98 =$  \_\_\_\_\_ (**Record using a whole number**).
4.  $0.36 =$  \_\_\_\_\_      5.  $3.57 =$  \_\_\_\_\_      6.  $0.95 =$  \_\_\_\_\_ (**Record using a whole number**).
7.  $1.98 =$  \_\_\_\_\_ (**Record using a whole number**).      8.  $1.75 =$  \_\_\_\_\_
9.  $0.13 =$  \_\_\_\_\_      10.  $0.25 =$  \_\_\_\_\_

**Record using two decimal places:**

1.  $1.086 =$  \_\_\_\_\_      2.  $0.456 =$  \_\_\_\_\_      3.  $12.234 =$  \_\_\_\_\_      4.  $19.014 =$  \_\_\_\_\_      5.  $1.427 =$  \_\_\_\_\_
6.  $0.147 =$  \_\_\_\_\_      7.  $3.550 =$  \_\_\_\_\_      8.  $0.607 =$  \_\_\_\_\_      9.  $0.738 =$  \_\_\_\_\_      10.  $1.268 =$  \_\_\_\_\_

**PERCENTAGE:**

A percentage is a part of 100.

**Changing Percent to Fractions:**

To change a percent to a fraction, drop the percent sign, place the number over 100, and reduce to lowest terms.

Example:  $25\% = \frac{25}{100} = (25 \div 100) = \frac{1}{4}$

**Practice Problems # 5**

Change each percentage to a fraction. Reduce to lowest terms.

1.  $10\% =$  \_\_\_\_\_ 2.  $45\% =$  \_\_\_\_\_ 3.  $75\% =$  \_\_\_\_\_ 4.  $25\% =$  \_\_\_\_\_ 5.  $1\% =$  \_\_\_\_\_  
 6.  $80\% =$  \_\_\_\_\_ 7.  $2\% =$  \_\_\_\_\_ 8.  $3\% =$  \_\_\_\_\_ 9.  $50\% =$  \_\_\_\_\_ 10.  $60\% =$  \_\_\_\_\_

**Changing Fractions to Percent:**

Change the fraction to a percent, multiply by 100, and add the percent sign.

Example:  $\frac{1}{4} = 1 \div 4 = 0.25 \times 100 = 25\%$

**Practice Problems # 6**

Change each fraction to a percent. The answers are on page 34 of the dosage calculations packet.

1.  $\frac{1}{2} =$  \_\_\_\_\_ 2.  $\frac{2}{5} =$  \_\_\_\_\_ 3.  $\frac{1}{4} =$  \_\_\_\_\_ 4.  $\frac{4}{5} =$  \_\_\_\_\_ 5.  $1\frac{1}{4} =$  \_\_\_\_\_  
 6.  $\frac{7}{10} =$  \_\_\_\_\_ 7.  $\frac{7}{100} =$  \_\_\_\_\_ 8.  $\frac{3}{8} =$  \_\_\_\_\_ 9.  $\frac{2}{4} =$  \_\_\_\_\_ 10.  $\frac{3}{4} =$  \_\_\_\_\_

**Changing Percent to a decimal:**

To change a percent to a decimal, drop the percent sign, and move the decimal point two places to the left.

**Remember to lead with a zero if needed, but do not trail (follow) with a zero.**

Example:  $25\% = \frac{25}{100} = 0.25$  not .25 or .250

**Practice Problems # 7**

Change each percent to a decimal. **Record your answer using two decimal places unless instructed otherwise.**

1.  $10\% =$  \_\_\_\_\_ (**Record using one decimal place**). 2.  $45\% =$  \_\_\_\_\_ 3.  $75\% =$  \_\_\_\_\_  
 4.  $25\% =$  \_\_\_\_\_ 5.  $14\% =$  \_\_\_\_\_ 6.  $35\% =$  \_\_\_\_\_  
 7.  $20\% =$  \_\_\_\_\_ (**Record using one decimal place**). 8.  $50\% =$  \_\_\_\_\_ (**Record using one decimal place**).  
 9.  $13\% =$  \_\_\_\_\_ 10.  $40\% =$  \_\_\_\_\_ (**Record using one decimal place**).

## **RATIO and PROPORTION:**

### **Ratio:**

A ratio expresses the relationship of one quantity to another. When solving dosage calculations, a ratio is composed of two numbers that are separated by a colon.

Examples: 2:4 or 4:16 or 1:50

### **Proportion:**

A proportion shows the relationship between two ratios that are equal. Examples: 1 : 2 :: 2 : 4 or 2 : 8 :: 5 : 20

The first example is read like this: 1 is to 2 as 2 is to 4. You can see that these two ratios are equal. The way to demonstrate this mathematically is to multiply the two outer numbers (extremes) together and the two inner numbers together (means). The answers will be equal.

Example: 2 : 8 :: 5 : 20  
 $2 \times 20 = \mathbf{40}$  (outer numbers multiplied together)  
 $8 \times 5 = \mathbf{40}$  (inner numbers multiplied together)

Ratio and proportions are used to solve dosage calculation problems when you do not know one of the four numbers. This is called solving for "X" or solving for the unknown.

### **Solving for "X":**

Multiply the means by the extremes and solve for X.

Example: 3 : 5 :: 15 : X  
 $3X = 75$  (divide the equation by 3)  
 $\frac{3X}{3} = \frac{75}{3}$  X = 25

**OR:**  $3X = 75$  (then invert the number in front of the X and divide the whole number by the inverted number).

Example:  $X = 75/3 = 25.$ )

To check your work, put the answer into the equation and multiply the outer numbers and the inner numbers and they should be equal.

Example: 3 : 5 :: 15 : 25  
 $3 \times 25 = \mathbf{75}$  (outer numbers multiplied together)  
 $5 \times 15 = \mathbf{75}$  (inner numbers multiplied together)

**Practice Problems # 8**

Find the value of X. **Record your answer using one decimal place unless instructed otherwise.**

1.  $2 : 3 :: 8 : X$  **(Record using a whole number).**
2.  $X : 5000 :: 10 : 500$  **(Record using a whole number).**
3.  $\frac{2}{3} : \frac{3}{4} :: X : \frac{21}{24}$  **(Record using a fraction).**
4.  $5 : X :: 20 : 30$
5.  $12.5 : 5 :: 24 : X$
6.  $\frac{1}{300} : 3 :: \frac{1}{120} : X$
7.  $1.5 : 1 :: 4.5 : X$  **(Record using a whole number).**
8.  $X : 12 :: 9 : 6$  **(Record using a whole number).**
9.  $20 : 40 :: X : 10$  **(Record using a whole number).**
10.  $X : 9 :: 5 : 10$

## Systems of Measurement and Conversion

Nurses have the legal responsibility for administering the appropriate amount of medications. They must be able to interpret dosage instructions from manufacturers and doctors to administer doses accurately. They must also be able to provide patient/family education regarding home administration.

### THE METRIC SYSTEM

The metric system is widely used in dosage calculations. It uses powers of 10 and the basic units of measure are the gram, liter, and meter. A **gram** measures weight, a **liter** measures fluid, and a **meter** measures length.

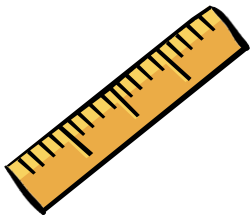


Gram: measures weight. **Gram** may be written **g** or **gm**.

(**Kilogram** may be written **kg**; **milligram** as **mg**; and **microgram** as **mcg**.)



Liter: measures liquid. **Liter** may be written **L**. (**Milliliter** may be written **mL**.)



Meter: measures length. **Meter** may be written **m**.

The metric system also uses prefixes to describe how much of the basic unit:

**Kilo** = 1000 times the basic unit.

**Centi** = 1/100 of the basic unit or 0.01.

**Milli** = 1/1000 of the basic unit or 0.001.

**Micro** = 1/1,000,000 of the basic unit or 0.000001.

### Metric System Rules:

1. Express parts of a unit or fractions of a unit as decimals. Example: 0.5 L not  $\frac{1}{2}$  L
2. Always write the quantity, whether in whole numbers or in decimals, before the abbreviation or symbol for a unit of measure. Example: 1,000 mg not mg 1,000
3. Use a full space between the numeral and abbreviation. Example: 2 mL not 2mL
4. Always lead with a zero but do not trail with a zero. Example 0.75 mg not .75 mg, 2 mg not 2.0 mg
5. Do not use the abbreviation  $\mu\text{g}$  for microgram. It may be mistaken for mg. Write out the word microgram.
6. Do not use the abbreviation cc for mL. This abbreviation may be misinterpreted as zeros.
7. Avoid periods after the abbreviation for a unit of measure to avoid it being misread for the number 1 in a poorly handwritten order. Example: mg not mg.

8. Place commas in values at 1,000 or above to improve readability. Example 25, 000 units not 250000 units
9. Do not add “s” on a unit of measure to make it plural as this could lead to misinterpretation. Example mg not mgs.
10. Fractions are written as decimals (Example: 0.25, not 1/4).

<b>METRIC BASIC EQUIVALENT</b>		
<b>You must learn all conversions to be successful with dosage calculation!!!</b>		
<b>Weight</b>	<b>Volume</b>	<b>Length</b>
1 kg = 1,000 g	1 L = 1,000 mL	1 m = 100 cm
1 g = 1,000 mg	1 mL = 0.001 L	1 mm = 0.001 m
1 mg = 1,000 mcg		

### Using Ratio and Proportion within the Metric System

As stated earlier, nurses use ratios (1:2) to make comparisons, and proportions to show that two ratios are equal (1 : 2 :: 2 : 4). This principle is used to exchange weights within the metric system.

<b>RULES OF PROPORTION</b>
<ol style="list-style-type: none"> <li>1. Units of ratios must correspond within the same proportion.</li> <li>2. Correct = g : kg :: g : kg</li> <li>3. No more than 2 different units of measure can be used within the proportion.</li> <li>4. Label all numbers with the appropriate unit of measure.</li> </ol>

Example: 0.5 kg = \_\_\_\_\_g

First, find the basic equivalent in the previous chart.

This would be 1 kg = 1,000 g. Now you know 3 of the 4 numbers in the equation. Solve for “X” and utilize the above rules of proportion.

Set the problem up: 1 kg : 1,000 g :: 0.5 kg : X g  
X = 500

Remember, you multiply the outside numbers and then the inside numbers and then divide. In this example, it was not necessary to divide.

What label comes after 500? Look up at your problem, it would be 500 g. The label will always be what follows the unknown “X”. **You must correctly label the answer.**

**Practice Problems # 9**

Solve for "X". **Record your answer using two decimal places unless instructed otherwise.**

1. 250 g = X \_\_\_\_\_ kg
2. 15 mg = X \_\_\_\_\_ mcg (**Record using a whole number**).
3. 3.5 L = X \_\_\_\_\_ mL (**Record using a whole number**).
4. 5 g = \_\_\_\_\_ mg (**Record using a whole number**).
5. 360 mg = \_\_\_\_\_ g
6. 4 mcg = \_\_\_\_\_ mg (**Record using three decimal places**).
7. 0.2 g = \_\_\_\_\_ mg (**Record using a whole number**).
8. 500 mL = \_\_\_\_\_ L (**Record using one decimal place**).

**HOUSEHOLD MEASURE**

The Household Unit of Measure is the most recognized by laypeople in America. It includes drops, teaspoons, tablespoons, and cups. **Drop** is written as gtt; **Teaspoon** is written **tsp** or **t.**; **Tablespoon** is written **T**, **Tbsp** or **tblsp**; and **cup** is written **C** or **c** (or written as **cup**). This system is not standardized ; it utilizes approximate measures.

**HOUSEHOLD EQUIVALENTS**

**You must learn all conversions to be successful in dosage calculation!!!**

$$1 \text{ t or tsp} = 5 \text{ mL}$$

$$1 \text{ T, Tbsp or tblsp} = 15 \text{ mL}$$

$$2 \text{ T, Tbsp or tblsp} = 1 \text{ oz}$$

$$1 \text{ c} = 8 \text{ oz or } 240 \text{ mL}$$

$$2.2 \text{ lb} = 1 \text{ kg}$$

**Practice Problems # 11**

Solve for "X" using ratio and proportion.

**Record your answer using a whole number.**

1. 5 T = X \_\_\_\_\_ t    2. 2 oz = X \_\_\_\_\_ t    3. 2 tsp = X \_\_\_\_\_ mL    4. 45 mL = X \_\_\_\_\_ tbsp

5. 1 oz = X \_\_\_\_\_ mL    6. 1 c = X \_\_\_\_\_ oz    7. 1 t = X \_\_\_\_\_ mL    8. 3 t = X \_\_\_\_\_ Tbsp

**Nurses must learn all units of measure (metric and household) because medicines are ordered or labeled using the metric system, and we tell patients how much medicine to take using the household system.****Conversion between Systems**

Now that you know the equivalences, it is time to learn how to convert values between systems or changing a measurement of one system to another system. Keep your charts of equivalences handy and refer to them often.

Many times, the healthcare provider (HCP) will order a medication in one strength, but the pharmacy stocks the medication in a different strength. By using ratio and proportion, you can determine how much of the medication that the pharmacy stocks will be needed to equal the amount ordered by the provider.

Always set up your problem in the following manner:

KNOWN UNIT : OF MEASURE	KNOWN EQUIVALENT	::	UNKNOWN (DESIRED) UNIT : OF MEASURE	UNKNOWN EQUIVALENT (X)
----------------------------	---------------------	----	--	------------------------------

**Example:** How many grams are there in 500 mg? **Record your answer using one decimal place.**

(The known ratio is 1000 mg = 1 gm)

KNOWN UNIT : OF MEASURE	KNOWN EQUIVALENT UNIT OF MEASURE	::	UNKNOWN (DESIRED) : UNIT OF MEASURE	X
----------------------------	---	----	---	---

1000 mg : 1 gm :: 500 mg : X gm

1000 X = 500

$$X = \frac{500}{1000}$$

X = 0.5 gm (Remember to check your answer).

**Practice Problems # 12**

Solve for "X" using ratio and proportion.

**Record your answer using a whole number unless instructed otherwise.**

1. gr  $\frac{1}{4}$  = X \_\_\_\_\_mg
2. 55 lb = X \_\_\_\_\_kg
3. 4 t = X \_\_\_\_\_mL
4. 600 mL = \_\_\_\_\_L (**Record using one decimal place**).
5. 0.16 kg = \_\_\_\_\_g
6. 1,700 mL = \_\_\_\_\_L (**Record using one decimal place**).
7. 180 mg = \_\_\_\_\_gm (**Record using two decimal places**).
8. 4 kg = \_\_\_\_\_g

**INTAKE AND OUTPUT (I & O)**

The measurement and documentation of fluid intake for a patient over a 24-hour period is often required as part of the patient's assessment. Careful calculation of both the liquid intake as well as the liquid output is essential. This relies upon the use of the previously mentioned systems of measurement and conversion.

**Intake and output are always measured (or converted) to milliliters (mL) for measurement and documentation purposes.**

Intake includes all liquids administered either through the oral, enteral, and/or parenteral routes. In addition to liquids such as water or juice, intake will also include any food item which can become liquid at room temperature (example: popsicles or ice cream.) It is important to include all liquid medications, **ice chips**, and water used for enteral flushing when calculating the shift or daily fluid intake.

**NOTICE: When calculating I & O, the amount of ice chips should be reduced by one half. Example: 1 ounce (30 mL) of ice chips equals one half ounce (15 mL) of liquid.**

Liquid output includes urine, diarrhea, and emesis, drainage from a wound drain (ex. Jackson Pratt drain or Hemovac), gastric contents (NG attached to suction) or other tube (i.e., chest drain). It may be necessary in cases of strict I & O to estimate the amount of fluid lost through extensive burns, diaphoresis, or external blood loss.

Example: Calculate the following **intake** for the 8-hour shift.

Patient drank  $\frac{1}{2}$  glass of milk, 1 cup of coffee, and 6 ounces of soup. Patients also have a continuous IV pump rate of 50 mL/hour.

What is the patient's intake?

$$\frac{1}{2} \text{ glass of milk} = 4 \text{ ounces} \times 30 \text{ mL/ounce} = 120 \text{ mL}$$

$$1 \text{ cup of coffee} = 8 \text{ ounces/cup} \times 30 \text{ mL/ounce} = 240 \text{ mL}$$

$$6 \text{ ounces of soup} = 6 \text{ ounces/cup} \times 30 \text{ mL/ounce} = 180 \text{ mL}$$

$$\text{Total oral intake} = 120 \text{ mL} + 240 \text{ mL} + 180 \text{ mL} = 540 \text{ mL}$$

$$\text{Total IV intake} = 50 \text{ mL} \times 8 = 400 \text{ mL}$$

$$\text{Total intake (oral + IV)} = 540 \text{ mL} + 400 \text{ mL} = 940 \text{ mL}$$

Example: Calculate the following **output** for the 8-hour shift.

360 mL urine

200 mL diarrhea

$$2 \text{ tsp blood drainage} = 5 \text{ mL/tsp} \times 2 = 10 \text{ mL}$$

NG suction = 180 mL

**Total output (urinary, stool, drainage, and NG suction) =**  
 360 mL + 200 mL + 10 mL + 180 mL = 750 mL

### **Practice Problem # 13**

Calculate the following intake and output for an 8-hour shift. **(Record your answers using whole numbers).**

Patient intakes the following: ½ cup water, a 2-ounce Popsicle, and 3 T broth. He has a continuous IV of NS (0.9% Normal Saline) infusing at 75 mL/hour.

During the 8-hour shift, he experiences diarrhea in the amount of 125 mL. There is 410 mL of urine emptied from the indwelling urinary catheter and 1 tsp of drainage from the wound drain.

What is the 8-hour total I & O for this patient? Intake = \_\_\_\_\_ Output= \_\_\_\_\_

## **Simple Dosage Calculations**

The focus of this unit is learning to interpret Healthcare Provider orders and read medication labels correctly. In addition, the administration of safe dosages of oral and parenteral medication will be discussed.

### **INTERPRETING PHYSICIAN or HEALTHCARE PROVIDER (HCP) ORDERS**

To administer medications safely and correctly the nurse must first be able to interpret the physician's or Healthcare Provider's order. Components of an order are to have the patient's full name, date and time the order was written, name of the medication, dosage of the medication, route of administration, frequency of administration, and signature of the person writing the order. Special instructions or parameters must be clearly written. **If any component of the medication order is missing the order is not complete and not a legal medication order.**

### **Abbreviations, Acronyms, & Symbols Not to be Used When Writing Medication Orders**

<b>Do not use</b>	<b>Potential problems</b>	<b>Use instead</b>
> <	Misinterpreted as 7 or L Confused for one another	Write greater than Write less than
Abbreviations for drug names	Misinterpreted because of similar abbreviations for similar drugs	Write drug names in full
Apothecary units	Confused with metric units	Use metric units
@	Mistaken for the 2	Write at
Cc	Mistaken for units	Write mL or milliliters
Mg	Mistaken for mg	Write mcg or micrograms
U	Mistaken for 0, 4, or cc	Write units

**Name**

The name of the medication may be ordered in a generic or trade name. The **trade (or brand name)** is the name under which the manufacturer markets the medication. The trade is followed by the registration symbol. The name will start with a capital letter or is all in capital letters. The generic name is usually in lowercase letters. It is the proper name, chemical name, or nonproprietary name.

**Students will be required to learn the generic names of medications since only the generic names will be included on exams and appear on the NCLEX-RN licensure exam.**

**Nurses must also be familiar with look-alike sound alike medications to prevent errors. Example: glyburide and glipizide.**

**Trade names remain helpful in improving communication with patients regarding their medications.**

**Dosage**

Dosage must be written clearly with the correct abbreviation. **Never assume what an order state. Clarify an order when in doubt. If an order is not clear, or if essential components are omitted, it is not a legal order and should not be implemented. The nurse is accountable.**

**Route**

GT (gastrostomy tube), NGT (Nasogastric tube)

SVN (small volume nebulizer), MDI (Meter dose inhaler)

p.o. (oral, by mouth), pr (rectum)

ID (Intradermal), IM (Intramuscular), IV (Intravenous), IVPB (Intravenous piggyback), IVP (Intravenous push)

SL (Sublingual), Sub Q (Subcutaneous), S & S (Swish & Swallow)

**Time**

<b>Time Abbreviation</b>	<b>Meaning</b>	<b>Do Not Use</b>
Ac	Before meals: 7:30 am (0730), 11:30 am (1130), 4:30 pm (1630)	
Pc	After meals: 10 am (1000), 2 pm (1400), and 6 pm (1800)	
Daily	Every day: 9 am (0900)	<b>q.d. or qd</b>
Bid	Twice a day: 9 am (0900) and 9 pm (2100)	
Tid	Three times a day: 6 am (0600), 2 pm (1400), and 10 pm (2200)	
Qid	Four times a day: 6 am (0600), 12 pm (1200), 6 pm (1800), and 12 am (2400)	
Qh	Every hour	
at bedtime	At bedtime	<b>hs or h.s.</b>
Qn	Every night	
Stat	Immediately	
q2h or q2 <sup>o</sup>	Every 2 hours (12 times in 24 hours)	
q4h or q4 <sup>o</sup>	Every 4 hours (6 times in 24 hours)	
q6h or q6 <sup>o</sup>	Every 6 hours (4 times in 24 hours)	
q8h or q8 <sup>o</sup>	Every 8 hours (3 times in 24 hours)	
q12h or q12 <sup>o</sup>	Every 12 hours (2 times in 24 hours)	
Every other day	Every other day	<b>qod or q.o.d.</b>
Prn	As needed	
3 times weekly	3 times per week	<b>tiw or t.i.w.</b>
Biw	Twice per week	

Example: zolpidem tartrate (Ambien) 10 mg p.o. at bedtime prn for sleep

What is the name of the medication? Ambien (**trade/brand name**); zolpidem tartrate (**generic name**)

What is the prescribed dosage? 10 mg

What is the route of administration? p.o. (by mouth)

When is the drug to be administered? At bedtime

Why is the drug to be administered? To help the patient sleep

### **Practice Problems # 14**

For each of the Healthcare Provider orders interpret the following. If an error is noted with an order, list the error and what action the nurse would take.

- a. Medication name?
  - b. Prescribed dosage?
  - c. Route of administration?
  - d. Time of administration?
  - e. What other directions, if any, are given?
1. Potassium chloride (K-Dur) 20 mEq (**milliequivalent**) p.o. in 120 mL orange juice bid
  2. zidovudine (Retrovir) 200 mg p.o. every 4 hours
  3. gentamicin sulfate (Garamycin) 45 mg IVPB every 12 hours
  4. Humulin Regular Insulin IM at 7:30 am (or 0730 hours military time) \*
  5. levothyroxine (Synthroid) 200 p.o. daily
  6. digoxin (Lanoxin) 0.125 p.o.
  7. furosemide (Lasix) 40 mg IM stat
  8. chlorthalidone (Librium) 50 mg p.o. every 4 hours prn agitation
  9. acetaminophen (Tylenol) 650 mg p.o. every 4 hours prn
  10. Folic acid 1 mg p.o. every day

### **INTERPRETING MEDICATION LABELS**

Medication label information varies from one medication to another. However, most labels contain the following information: brand name, generic name, dosage, route of administration and manufacturer. If a medication must be reconstituted, the label will contain information regarding suitable diluents, amount of diluent to be added, concentration of medication after it is reconstituted and its stability. The label of a medication to be administered IV should tell what IV fluids are compatible with the medication. If the medication is in a multi-dose package it will give the total amount of the medication contained.

### **Practice Problems # 15**

Identify the following for each of the medication labels.

- a. Trade/Brand name
- b. Generic name
- c. Route of administration or form
- d. Dosage

1. 200 mg  
NDC 0108-5012-20
- Tagamet
- cimetidine tablets
- 100 tablets
- Store at controlled room temperature  
Dispense in a tight, light resistant  
container.
- Dosage: See accompanying prescribing  
information.
- Important: Use safety closures when  
dispensing this product unless  
otherwise directed by healthcare provider or  
requested by purchaser.
- Caution: Federal law prohibits  
Dispensing without prescription.
- SmithKline Beecham Pharmaceuticals

2. 5 mg/mL  
NDC 0007-3343-01
- Compazine
- prochlorperazine
- Store below 86 F. Do not freeze.  
Protect from light. Discard if discolored.
- Dosage: For deep IM or IV injection.  
See accompanying prescribing information.
- Caution: Federal law prohibits  
Dispensing without prescription.
- SmithKline Beecham Pharmaceuticals

### CALCULATION OF ORAL DOSAGES

Oral dosage forms of medications include tablets, capsules, suspensions, lozenges, powders, emulsions, solutions, tinctures, syrups, and elixirs. The liquid forms of oral medications are generally calculated to be administered in millimeters, cubic centimeters teaspoons, tablespoons and sometimes minims.

Example: ORDERED: amoxicillin (Moxatag) 500 mg p.o.  
 AVAILABLE: amoxicillin (Moxatag) 250 mg tablets  
 How many tablets will the nurse administer?

250 mg : 1 tablet :: 500 mg : X tablets

$$250 X = 500$$

$$X = \frac{500}{250} \quad X = 2 \text{ tablets}$$

Check your answer: 250 mg : 1 tab :: 500 mg : 2 tab

$$250 \times 2 = 500$$

$$1 \times 500 = 500$$

### CALCULATION OF PARENTERAL DOSAGES

Parenteral means injection of drugs into the tissue or fluids of the body. The various routes for this include Intradermal (ID), Subcutaneous (Sub-Q or Sub Q), Intramuscular (IM) and Intravenous (IV). The calculation of these dosages is no different from oral dosage calculations. You will use ratio and proportion to solve the problems. Keep your conversion charts handy!

#### Practice Problems # 16

Calculate the correct amount of oral or parenteral medications to be administered. **Record your answer using a whole number unless instructed otherwise.**

- Order: doxepin HCl (Sinequan) 30 mg p.o. at bedtime  
 Available: doxepin HCl (Sinequan) 10 mg per capsule  
 How many capsules will the nurse administer?
- Order: nitroglycerin (Nitrostat) gr 1/150 sublingual stat  
 Available: nitroglycerin (Nitrostat) 0.4 mg per tablet  
 How many tablets will the nurse administer?
- Order: digoxin (Lanoxin) 0.25 mg IM daily  
 Available: digoxin (Lanoxin) 0.5 mg/2 mL  
 How many mL will the nurse administer?
- Order: atropine (Atreza) 0.3 mg IM stat  
 Available: atropine (Atreza) 0.4 mg per mL  
 How many mL will the nurse administer? **(Record using two decimal places).**
- Order: gr 1/300 of a prescribed medication

Available: gr 1/150 per tablet

How many tablets will the nurse administer? (**Record using one decimal place**).

6. Order: glyburide (Diabeta) 5 mg p.o. daily  
Available: glyburide (Diabeta) 2.5 mg tablets  
How many tablets will the nurse administer?
7. Order: temazepam (Restoril) 30 mg p.o. at bedtime prn  
Available: temazepam (Restoril) 15 mg tablets  
How many tablets will the nurse administer?
8. Order: cephalexin (Keflex) 0.5 g p.o. qid  
Available: cephalexin (Keflex) 250 mg capsules  
How many capsules will the nurse administer?

## **ADVANCED DOSAGE CALCULATIONS**

This unit will cover the following topics: reconstitution of powdered drugs, insulin administration and calculating safe pediatric dosages of medications.

### **RECONSTITUTION OF POWDERED DRUGS**

Reconstitution of powdered drugs involves the addition of a sterile diluent, usually distilled water or normal saline, to a drug that is in the form of a powder. The pharmacist usually carries out this task, but in many areas of the hospital the task becomes that of the nurses. The package insert or the container will contain the directions for reconstituting a particular drug. The diluent, as well as instructions for storage, will be included. If the vial is a multiple-use vial, then it is the nurse's responsibility to label the container with date/time and initials.

Example: Ordered: imipenem (Primaxin) 750 mg IM X 1.

Available: imipenem (Primaxin) 750 mg vial. Dissolve in 3mL of 1% lidocaine HCl solution.

How many mL of diluent should you add? 3mL

What amount of medication will you administer? All that is in the vial. (The whole vial = 750 mg.)

Example: Ordered: cefazolin (Ancef) 250 mg IM.

Available: cefazolin (Ancef) 1 gm vial. Add 3 mL of NS (0.9% Normal Saline) to obtain a concentration of 1gm per 4 mL.

How many mL of diluent should you add? 3 mL

What amount of medication will you administer?

1000 mg : 4 mL :: 250 mg : X mL

1000 X = 1000

**X = 1 mL**

### **Practice Problems # 17**

Solve the following reconstitution problems. **Record your answer using one decimal place.**

- Order: cefazolin (Ancef) 0.3 g IM.  
Available: cefazolin (Ancef) 500 mg powder. Add 2 mL of sterile water to obtain a concentration of 225 mg/mL.  
How many mL will the nurse administer?
- Order: hydrocortisone (Solu-Cortef) 200 mg IV q6h for 1 week.  
Available: hydrocortisone (Solu-Cortef) 250 mg powder. Add 2 mL of sterile water to obtain a concentration of 250 mg/2 mL.  
How many mL will the nurse administer?

## INSULIN ADMINISTRATION

In addition to various sources of insulin, there are different categories of insulin. The categories are short, intermediate, and long-acting insulin and the bottles will be labeled accordingly. This means that the effect the insulin has on the body varies in terms of time. The nurse needs to use caution that he/she is giving the correct type of insulin because a patient may be receiving more than one type of insulin at various times throughout the day.

Insulin is measured by a standard that is called USP units. The most common concentrations is **100 units per milliliter or U-100**. (Learn this!) This is true for all sources and all categories of insulin.

**An insulin syringe can only be used for measuring insulin. Units are not interchangeable. A unit of insulin is not the same as a unit of penicillin. Do not use a Tuberculin syringe to measure insulin. Insulin syringes are designed with less dead space in the hub of the syringe.**  
\*Note: Insulin injection pens are now available for many of the various categories/types of insulin.

### **POINTS TO REMEMBER WHEN ADMINISTERING INSULIN**

- When mixing categories of insulin in the same syringe, always draw up the short-acting first.
- Gently roll the bottle of insulin to mix it before drawing up the dose. Do not shake the bottle vigorously.
- Always have another nurse verify that you have drawn up the correct amount and type of insulin.**
- Only Regular (short acting) insulin can be given intravenously.
- Insulin is considered a High Alert medication and can be lethal if not given correctly.**

Because insulin is supplied as units/mL and the insulin syringe is measured in units/mL, there is no calculation required for insulin administration. If the order states 5 units Humulin Insulin R, you would administer 5 units of regular insulin via a 1 mL insulin syringe.

Many times, the patient will receive long-acting insulin once or twice daily, as well as short acting insulin every 4 hours depending upon his blood sugar. To determine the amount of the short-acting insulin to administer, the nurse will have to refer to the Healthcare Provider's sliding scale order.

Example: Order: Humulin Regular insulin Sub-Q q every 4 hours according to sliding scale below. The

patient's blood glucose (sugar) is 235. How much insulin will the nurse administer?

Blood Glucose (mg/dL)	Regular Insulin
0 – 150	No insulin
151 – 200	2 units
201 – 240	4 units
241- 280	6 units
281 – 330	8 units
Over 330	Call Healthcare Provider (MD, NP, PA)

Based on the above sliding scale, you administer 4 units.

### **Practice Problems # 18**

Use the sliding scale above to determine how much Regular insulin should be administered based on the following blood glucose results. The answers are on page 36 of the dosage calculations packet.

1. 265 mg/dL = \_\_\_\_\_
2. 75 mg/dL = \_\_\_\_\_
3. 364 mg/dL = \_\_\_\_\_
4. 204 mg/dL = \_\_\_\_\_
5. 165 mg/dL = \_\_\_\_\_

### **CALCULATING SAFE PEDIATRIC DOSAGES**

Infants and children require smaller quantities of drugs than adults. Their medications are commonly ordered in milligrams or micrograms per kilogram of body weight. Below are the steps to determine a safe pediatric medication dosage:

1. Weigh the child.
2. Convert pounds to kilograms. **Round to two decimal places.**
3. Calculate the ordered dose using ratio and proportion.
4. Determine if the dose is safe according to the manufacturers' safe dosage range.

Example: Order: morphine 0.5 mg/kg IM. The child weighs 20 pounds.

**Step 1:** Convert pounds to kilograms

$$2.2 \text{ lb} : 1 \text{ kg} :: 20 \text{ lb} : X \text{ kg}$$

$$2.2 X = 20$$

$$X = 9.0909 \text{ (Always round kilogram weight to two decimal places for both children and adults).}$$

$$X = 9.09 \text{ kg}$$

**Step 2:** Calculate the ordered dose of morphine.

$$1 \text{ kg} : 0.5 \text{ mg} :: 9.09 \text{ kg} : X \text{ mg}$$

$$X = 4.545$$

$$X = 4.55 \text{ mg morphine}$$

Now that you know how to determine the amount of medication to administer based on weight, you need to learn how to determine if that dose is within the safe range.

Drug manufacturers will include safe pediatric ranges for medications. You must insert the dosage for your pediatric patient into the equation and use ratio and proportion, to determine if it is a safe dose. If it is, you administer the drug. If it is not, call the ordering Healthcare Provider. Many times, a range will be given rather than one specific safe dosage amount.

Example: Order: carbamazepine (Tegretol) 400 mg p.o. BID. The recommended dose is 15 mg/kg – 20 mg/kg. The child weighs 55 lbs. Is the ordered dose a safe dose?

**Step 1:** Convert pounds to kilograms

$$2.2 \text{ lb} : 1 \text{ kg} :: 55 \text{ lbs} : X \text{ kg}$$

$$X = 25 \text{ kg}$$

**Step 2:** Calculate to determine if the dose is safe.

$$1 \text{ kg} : 15 \text{ mg} :: 25 \text{ kg} : X \text{ mg}$$

$$X = 375 \text{ mg/dose} \quad \textbf{and}$$

$$1 \text{ kg} : 20 \text{ mg} :: 25 \text{ kg} : X \text{ mg}$$

$$X = 500 \text{ mg/dose}$$

This tells you the safe range per dose is 375 mg/dose – 500 mg/dose.

As stated above, the Healthcare Provider ordered 400 mg. Since 400 falls within the safe range, you would determine that 400 mg is a safe dose. If, for example, the Healthcare Provider had ordered 600 mg carbamazepine (Tegretol) then you would determine that not to be a safe dose and you would notify the ordering Healthcare Provider.

Another variation of this principle is that the nurse may have to determine if a dose is safe in terms of a 24-hour period. Some medications will list a 24-hour safe dose range and the nurse must determine if the number of doses of a medication to be given in 24 hours falls within that range.

Example: Order: erythromycin (E-mycin) 62.5 mg, p.o. every 6 hr for an infant that weighs 11 lbs.  
Safe dose range is 30 mg/kg/24 hours– 50 mg/kg/24 hours.

**Step 1:** Convert lbs to kg

$$2.2 \text{ lb} : 1 \text{ kg} :: 11 \text{ lbs} : X \text{ kg}$$

$$X = 5 \text{ kg}$$

**Step 2:** Determine safe dose range for 24-hour period.

$$1 \text{ kg} : 30 \text{ mg} :: 5 \text{ kg} : X \text{ mg}$$

$$X = 150 \text{ mg}/24 \text{ hr}$$

$$1 \text{ kg} : 50 \text{ mg} :: 5 \text{ kg} : X \text{ mg}$$

$$X = 250 \text{ mg}/24 \text{ hour}$$

**Safe dosage range for 24-hour period = 150 mg/24 hour – 250 mg/24 hour.**

**Step 3:** Determine if the ordered dosage for the 24-hour period is safe.

The ordered medication is ordered every 6 hours. The nurse determines that the child will receive 4 doses in a 24-hour period.

62.5 mg X 4 doses = 250 mg of erythromycin (E-mycin) in a 24-hour period. The nurse determines this to be a safe 24-hour period dose by comparing this number to the safe range in step 2.

### **Practice Problems # 19**

Solve the following. **Record your answer using two decimal places unless instructed otherwise.**

1. Order: acetaminophen (Tylenol) elixir 10 mg/kg p.o. Child weight is 10 pounds.  
Available: acetaminophen (Tylenol) elixir 160 mg/ 5mL. How many mL of acetaminophen (Tylenol) will the nurse administer?
2. Order: amoxicillin (Amoxil) 100 mg p.o. every 6 hours. Child weighs 15 lbs. Safe range is 25 mg/kg/24 hours to 30 mg/kg/24 hours.
  - a. What is the safe 24-hour range? **(Record using one decimal place).**
  - b. Is the ordered dose safe for a 24-hour period?
3. Order: digoxin (Lanoxin) 18 mcg p.o. bid. Child weighs 7 lbs. The safe range is 10mcg/kg/24 hours - 12 mcg/kg/24 hours.
  - a. What is the safe 24-hour range? **(Record using one decimal place).**
  - b. Is the ordered dose safe for a 24-hour period?
  - c. If the medication is supplied 50 mcg/mL, how many mL will the nurse administer per dose?
4. Order: phenytoin (Dilantin) 40 mg p.o. every 8 hours. Child weighs 27 lbs. The safe range is 8 mg/kg/24 hours –10 mg/kg/24 hours.
  - a. What is the safe dose range? **(Record using one decimal place).**
  - b. Is the prescribed dose safe?
  - c. If the medication is supplied 125 mg/5 mL, how many mL will the nurse administer per dose? **(Record using one decimal place).**

## **Intravenous Preparation with Clinical Calculations**

Intravenous fluids are used in health care settings to rehydrate patients or to give medicines. Calculation of IV flow rates ensures that fluids do not infuse too fast, which could overload the patient or too slowly, delaying treatment. This unit will explain how to calculate and administer IV fluids and medications. The topics to be discussed include calculating flow rates for electronic and manual IV flow regulators, calculating hourly IV heparin dosages and calculating IV flow rates to administer a specific concentration of a medication per minute or hour.

### **ELECTRONIC IV FLOW REGULATORS**

Electronic pumps are used in all health care settings. In some instances, it is mandatory policy to use these devices. Such is the case when administering narcotics, heparin or various heart medications via continuous IV drip. In addition, very small amounts of fluid can be infused over an extended period by using these electronic pumps.

The key concept to **understand** about these electronic pumps is that they are designed to infuse the IV fluid/medication in **milliliters per hour (mL/hr)**. The Healthcare Provider will order the flow rate in milliliters (mL) per hour or specify the amount of time necessary to infuse the IV fluid/medication.

When the Healthcare Provider orders the specific mL per hour, the nurse simply hangs the correct IV fluid/medication and sets the pump to the ordered flow rate. There are NO calculations!!!

However, if the Healthcare Provider only specifies the duration of time to take to infuse an amount of IV fluid/medication and does not order mL per hour, the nurse must calculate the flow rate.

Example: Order: 1000 mL NS (0.9% Normal Saline) IV to infuse over 8 hours.

8 hr : 1000 mL :: 1 hr : X mL

$$8X = 1000$$

X = 125 mL/hr This is the flow rate!

**Shortcut:** Actually, all you have to do is divide the total amount of fluid by the number of hours.

Example (as noted above): 1000 (mL) divided by 8 (hours) = 125 mL/hr.

**OR:** If the infusion time is not in whole hours, you must calculate using 60 minutes rather than 1 hour.

Example: Order: ondansetron (Zofran) 10 mg in 100 mL NS (0.9% Normal Saline) IVPB (IV piggyback) every 8 hours. Infuse over 30 minutes.

30 mins : 100 mL :: 60 mins : X mL

$$30 X = 6000$$

X = 200 mL/hr

The nurse sets the electronic pump to deliver 200 mL/hr and after 30 minutes the 100 mL of medication would have been infused.

**Note:** The mg of medication has nothing to do with calculating the flow rate. Don't be confused and try to use this number in your calculation!

### **Practice Problems # 20**

Calculate the flow rate when using an electronic pump. **Record your answer using a whole number unless instructed otherwise.**

1. Infuse 1,000 mL D5W (Dextrose 5% in Water) over 15 hours. **(Record using one decimal place).**
2. Infuse 600 mL LR (Lactated Ringers) over 3 hours.
3. Infuse 1,800 mL D5W (Dextrose 5% in Water) over 24 hours.
4. Infuse 3,000 mL LR (Lactated Ringers) over 24 hours.
5. Infuse 500 mL D5W (Dextrose 5% in Water) over 4 hours.
6. Infuse cimetidine (Tagamet) 300 mg IVPB mixed in 100 mL NS (0.9% Normal Saline) over 45 minutes. **(Record using one decimal place).**
7. Infuse ampicillin (Omnipen) 500 mg IVPB mixed in 50 mL NS (0.9% Normal Saline) over 10 minutes.
8. Infuse cefazolin (Kefzol) 0.5 g IVPB mixed in 50 mL D5W (Dextrose 5% in Water) over 30 minutes.
9. Infuse 50 mL of an antibiotic over 25 minutes.
10. Infuse 80 mL of an antibiotic over 40 minutes.

### **MANUAL IV FLOW REGULATORS**

Nurses are using fewer and fewer manual IV flow regulators to administer IV fluids/medications in the health care setting. Another term used to describe these regulators is gravity drip IV infusions. This describes how manual flow regulators work. The rate of infusion is dependent upon the gravity of the bag of IV fluid/medication. The rate of these infusions will always be calculated in **drops per minute (gtt/min)**. (There will not be a pump!)

To calculate the accurate rate of infusion, the nurse must know the type of tubing or administration set to be used. Each type of administration set has a drop chamber with either a **macro** drop set that delivers 10, 15 or 20 drops per milliliter while the **micro** drop set always delivers 60 drops per milliliter. This is referred to as the drip (or drop) factor. To prevent errors in calculating the infusion rate, always check the manufacturer's label to verify the drip factor of the administration set.

The nurse will have to manually regulate the flow of IV fluid/medication when using the above administration sets. There are two steps to this process. The first step is that the nurse must calculate the drop rate, which will always be gtt/min. The second step is that the nurse adjusts the roller clamp on the IV tubing and count the drops to insure accurate infusion. This type of infusion will have to be monitored frequently because kinked tubing or a change in arm position can slow or increase the rate of flow.

There are various formulas to use to calculate the flow rates for manual IV regulators. The following formula must be learned:

$$\frac{\text{Amount of fluid X Drop factor}}{\text{Time (always in minutes)}}$$

Example: Infuse 3,000 mL IV fluid over the next 24 hours. Drop factor of tubing = 15 gtt/mL.

$$\frac{3,000 \text{ mL} \times 15 \text{ gtt/mL}}{24 \text{ hr} \times 60 \text{ min}} = \frac{45,000}{1,440} = 31.25 = 31 \text{ gtt/min}$$

**This number will have to be rounded to a whole number because a manual IV flow regulator cannot deliver a portion of a drop!**

If the infusion time is less than one hour, you simply put this amount of time as the denominator.

Example: Order: ampicillin (Omnipen) 500 mg IVPB in 100 mL NS (0.9% Normal Saline) to infuse over 30 minutes. Tubing drop factor = 10 gtt/mL.

$$\frac{100 \text{ mL} \times 10 \text{ gtt/mL}}{30 \text{ min}} = \frac{1000}{30} = 33.33 = 33 \text{ gtt/min}$$

### **Practice Problems # 21**

Determine the infusion rate for the following. **Remember to always record your answer (manual or gravity IV flow rates) using a whole number since there cannot be a partial drop!**

1. Order: 1000 mL NS (0.9% Normal Saline) to infuse in 8 hours. Drop factor = 15 gtt/mL.
2. Order: 1000 mL NS (0.9% Normal Saline) to infuse in 6 hours. Drop factor = 20 gtt/mL.
3. Order: 500 mL NS (0.9% Normal Saline) to infuse in 4 hours. Drop factor = 15 gtt/mL.
4. Order: 40 mg famotidine (Pepcid) IVPB mixed in 100 mL NS (0.9% Normal Saline) to infuse over 30 minutes. Drop factor = 20 gtt/mL.
5. Order: 1,000 mL Dextrose 5 1/2 Normal Saline (Dextrose 5% in 0.45% Normal Saline) to infuse in 3 hours. Drop factor = 20 gtt/mL.
6. Order: 1,500 mL NS (0.9% Normal Saline) to infuse in 12 hours. Drop factor = 10 gtt/mL.
7. Order: 2,000 mL D5W (Dextrose 5% in Water) to infuse in 16 hours. Drop factor = 20 gtt/mL.
8. Order: 250 mL D5W (Dextrose 5% in Water) to infuse in 10 hours. Drop factor = 60 gtt/mL.
9. Order: 500 mL D5W (Dextrose 5% in Water) to infuse in 8 hours. Drop factor = 15 gtt/mL.
10. Order: 1,500 mL D5W (Dextrose 5% in Water) in 24 hours. Drop factor = 15 gtt/mL.

### CALCULATING HOURLY IV HEPARIN DOSAGES

The administration of continuous IV heparin is a common practice in the hospital setting. It is vital that the nurse know how to calculate an accurate infusion rate since the margin is very small and can easily result in death. IV heparin will always be administered via an electronic pump; thus, it will be calculated in milliliters per hour. **Record your answer using one decimal place.** The dosage of heparin is measured in units. Ratio and proportion are used to calculate the dosage. (This same information regarding the rate calculation is also true of an IV insulin infusion also.)

Order: heparin 800 units/hr via continuous IV infusion.

Medication comes mixed from Pharmacy (Supply): heparin 25,000 units in 250 mL NS (0.9% Normal Saline).

$$25,000 \text{ units} : 250 \text{ mL} :: 800 \text{ units} : X \text{ mL}$$

$$25,000 X = 200,000$$

$$X = \frac{200,000}{25,000} = 8 \text{ mL/hr}$$

### Practice Problems # 22

Determine the flow rate (mL/hr) for the following. **(Record your answer using a whole number unless instructed otherwise).**

1. Order: heparin 1,500 units per hr via IV infusion.  
Medication comes mixed from pharmacy (Supply): heparin 25,000 units in 250 mL NS.
2. Order: heparin 1,800 units per hr via IV infusion.  
Medication comes mixed from pharmacy (Supply): heparin 20,000 units in 250 mL NS.  
**(Record using one decimal place).**
3. Order: heparin 1,200 units per hr via IV infusion.  
Medication comes mixed from pharmacy (Supply): heparin 25,000 units in 200 mL NS.  
**(Record using one decimal place).**
4. Order: heparin 800 units per hr via IV infusion.  
Medication comes mixed from pharmacy (Supply): heparin 20,000 units in 100 mL NS.
5. Order: heparin 2,000 units per hr via IV infusion.  
Medication comes mixed from pharmacy (Supply): heparin 25,000 units in 1,000 mL NS.
6. Order: heparin 1,400 units per hr via IV infusion.  
Medication comes mixed from pharmacy (Supply): heparin 40,000 units in 1,000 mL D5W.
7. Order: heparin 850 units per hr via IV infusion.  
Medication comes mixed from pharmacy (Supply): heparin 25,000 units in 500 mL D5W.
8. Order: heparin 1,200 units per hr via IV infusion.  
Medication comes mixed from pharmacy (Supply): heparin 20,000 units in 250 mL NS.

#### **IV ADMINISTRATION BY CONCENTRATION**

Usually IV fluids/medications are ordered to be infused at a certain rate or time as has already been taught. However, some IV's, especially in the critical care areas, are ordered to be administered with a specific concentration of the medication per hour, per minute or per milliliter. These medications will be administered via an electronic infusion device. This is a difficult calculation to master, but if you learn the basic steps of the calculation, and think about what the problem is asking, you will have no problems!

Below are the basic steps to these types of problems. Remember, you may not have to use all the steps for each problem.

**Step 1:** Convert pounds to kilograms. **Round using two decimal places.**

**Step 2:** Determine the correct dosage based on the patients weight (in kilograms.)

**Step 3:** Convert the unit of measurement (equivalent) ordered to the unit of measurement on hand.

**Step 4:** Calculate the number of mL/min to administer.

**Step 5:** Calculate the number of mL/hr to administer. **Record using one decimal place.**

**WOCAT:** A mnemonic which may help you to remember the order in which the calculations are done is the word **WOCAT**.

W = Weight

O = Order

C = Conversion

A = Available

T = Time

Example: Order: bretylium (Bretylol) 5mcg/kg/min. Medication comes mixed 50 mg in 50 mL NS (0.9% Normal Saline). The patient's weight is 187 lbs.

**Step 1:** Convert lbs to kg. **(Round using two decimal places).**  
**(This is the W in WOCAT).** *(This is the calculation of Weight in kilograms).*

$$2.2 \text{ lb} : 1 \text{ kg} :: 187 \text{ lb} : X \text{ kg}$$

$$X = 85 \text{ kg}$$

**Step 2:** Determine the correct dosage based on patient's weight.  
**(This is the O in WOCAT).** *(This uses the information in the original Order. Example=5mcg/kg/min).*

$$1 \text{ kg} : 5 \text{ mcg} :: 85 \text{ kg} : X \text{ mcg}$$

$$X = 425 \text{ mcg}$$

**Step 3:** Convert the unit of measurement (equivalent) ordered to the unit of measurement on hand.  
**(This is the C in WOCAT).** *(This is the Conversion step. Example=mcg to mg as in the supply).*

$$1000 \text{ mcg} : 1 \text{ mg} :: 425 \text{ mcg} : X \text{ mg}$$

$$X = 0.425 \text{ mg}$$

**Step 4:** Calculate the number of mL/min to administer.

**(This is the A in WOCAT).** *(This uses the information from the Available or Supply section).*

$$50 \text{ mg} : 50 \text{ mL} :: 0.425 \text{ mg} : X \text{ mL}$$

$$X = 0.425 \text{ mL/min}$$

**Step 5:** Calculate the number of mL/hr to administer. **(Record using one decimal place).**

**(This is the T in WOCAT).** *(This is when you multiply your mL/min X 60 to get the Time as mL/hr).*

$$1 \text{ min} : 0.425 \text{ mL} :: 60 \text{ min} : X \text{ mL}$$

$$X = 25.5 \text{ mL/hr}$$

**Remember, you may not always have to go through all five (5) steps. Think through the problem and determine the steps needed!!!**

Example: Order: IV nitroglycerin 50 mg in 500 mL D5W (Dextrose 5% in Water) at 50 mcg/min. Set the pump at \_\_\_\_\_ mL/hr?

**Step 1:** Convert to kilograms. **(W)-- NOT NEEDED!!!**

**Step 2:** Determine the correct dosage based on the patient's weight. **(O) -- NOT NEEDED!!!**

**Step 3:** Convert the unit of measurement (equivalent) ordered to the unit of measurement on hand. **(C)--**

$$1000 \text{ mcg} : 1 \text{ mg} :: 50 \text{ mcg} : X \text{ mg}$$

$$X = 0.05 \text{ mg}$$

**Step 4:** Calculate the number of mL/min to administer. **(A)--**

$$50 \text{ mg} : 500 \text{ mL} :: 0.05 \text{ mg} : X \text{ mL}$$

$$X = 0.5 \text{ mL/min}$$

**Step 5:** Calculate the number of mL/hr to administer. **(T)-- (Record using a whole number).**

$$1 \text{ min} : 0.5 \text{ mL} :: 60 \text{ min} : X \text{ mL}$$

$$X = 30 \text{ mL/hr}$$

### **Practice Problems # 23**

Determine the rate (**mL/hr**) for the following. **(Record your answer using one decimal place unless instructed otherwise).**

- Order: Administer clindamycin (Cleocin) IV at a rate of 10 mg/min. Available: clindamycin (Cleocin) 900 mg in 100 mL NS.
- Order: Administer chlorothiazide (Diuril) at a rate of 15 mg/min. Available: chlorothiazide (Diuril) 350 mg in 50 mL NS.
- Order: nitroprusside (Nipride) IV 0.5 mcg/kg/min. Wt. = 125 pounds. Available: nitroprusside (Nipride) 10 mg in 100 mL D5W. **(Record using a whole number).**

4. Order: nitroprusside (Nipride) 3 mcg/kg/min. Weight = 60 kg.  
Available: nitroprusside (Nipride) 50 mg in 250 mL D5W. **(Record using a whole number).**
5. Order: aminophylline (Theophylline) 0.7 mg/kg/hr. Weight = 73.5 kg.  
Available: aminophylline (Theophylline) 800 mg in 500 mL D5W.
6. Order: dobutamine (Dobutrex) 3 mcg/kg/min. Weight = 80 kg.  
Available: dobutamine (Dobutrex) 250 mg in 500 mL D5W.
7. Order: inamrinone (Inocor) 5 mcg/kg/min. Weight = 165 lb.  
Available: inamrinone (Inocor) 250 mg in 250 mL NS.
8. Order: esmolol (Brevibloc) 75 mcg/kg/min. Weight = 60 kg.  
Available: esmolol (Brevibloc) 5,000 mg in 500 mL D5W. **(Record using a whole number).**

## References

- Billings, D. M. (2013). *Lippincott Q & A review for NCLEX-RN* (11th ed.). Philadelphia, PA: Lippincott Williams & Wilkins.
- Buchholz, S. (2011). *Henke's med-math: Dosage calculation, preparation & administration* (7th ed.). Philadelphia: Lippincott Williams & Wilkins.
- Kee, J., Hayes, E., & McCuiston, L. (2012). *Pharmacology: A nursing approach* (7th ed.). St. Louis, MO: Mosby Elsevier.
- Morris, D. G. (2010). *Calculate with confidence* (5th ed.). St. Louis, MO: Mosby Elsevier.
- Perry, A.G., Potter, P. A., & Ostendorf, W. R. (2013). *Clinical nursing skills & techniques* (8th ed.). St. Louis, MO: Mosby Elsevier.
- Potter, P. A., Perry, A. G., Stockert, P., & Hall, A. (2017). *Fundamentals of Nursing* (9th ed.). St. Louis, MO: Mosby Elsevier.
- Skidmore-Roth, L. (2017). *Mosby's drug guide for nurses* (12th ed.). St. Louis, MO: Mosby Elsevier.
- Smeltzer, S., Bare, B., Hinkle, J., & Cheever, K. (2008). *Brunner & Suddarth's medical surgical nursing* (11th ed.). Philadelphia: Lippincott Williams & Wilkins.
- Wissman, J. (Ed.). (2016). *Fundamentals for nursing version 9.0: Content Mastery Series review module*. Stilwell, KS: Assessment Technologies Institute.

## Answers to Practice Problems

### Practice Problems # 1

#### Reduce the fractions

1.  $1/2$    2.  $1/4$    3.  $3/4$    4.  $1/3$    5.  $2/3$    6.  $1/7$    7.  $1/2$    8.  $5/7$    9.  $1/7$    10.  $2/3$

#### Improper fractions to mixed numbers

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

#### Mixed numbers to improper fractions

1.  $7/2$    2.  $13/2$    3.  $21/2$    4.  $100/3$    5.  $29/25$    6.  $17/4$    7.  $9/2$    8.  $27/8$    9.  $79/5$    10.  $37/4$

### Practice Problems # 2

#### Addition

1.  $1\frac{1}{2}$    2.  $2\frac{19}{24}$    3.  $7\frac{1}{6}$    4.  $8\frac{1}{15}$    5.  $22\frac{5}{6}$    6.  $7/10$    7.  $13/24$    8.  $1\frac{13}{30}$

#### Subtraction

1.  $19/21$    2.  $1\frac{31}{40}$    3.  $11/16$    4.  $1/12$    5.  $1/24$    6.  $1/9$    7.  $19/30$    8.  $5/21$

#### Multiplication

1.  $1/12$    2.  $9/200$    3.  $1/9$    4.  $5/8$    5.  $1/15$    6.  $1/10$    7.  $7/27$    8.  $2/3$

#### Division

1.  $2/3$    2. 2   3.  $7/18$    4. 4   5.  $1\frac{1}{3}$    6. 1   7. 15   8.  $1/30$

### Practice Problems # 3

1. 1.5   2. 10   3. 23.33   4. 17.95   5. 4   6. 1.17   7. 70.89   8. 30.46   9. 6.33   10. 1.5

### Practice Problems # 4

#### Record your answer using one decimal place:

1. 0.8   2. 0.2   3. 1   4. 0.4   5. 3.6   6. 1   7. 2   8. 1.8   9. 0.1   10. 0.3

#### Record your answer using two decimal places:

1. 1.09   2. 0.46   3. 12.23   4. 19.01   5. 1.43   6. 0.15   7. 3.55   8. 0.61   9. 0.74   10. 1.27

### Practice Problems # 5

1.  $1/10$    2.  $9/20$    3.  $3/4$    4.  $1/4$    5.  $1/100$    6.  $4/5$    7.  $1/50$    8.  $3/100$    9.  $1/2$    10.  $3/5$

### Practice Problems # 6

1. 50%   2. 40%   3. 25%   4. 80%   5. 275%   6. 70%   7. 7%   8. 37.5%   9. 50%   10. 75%

**Practice Problems # 7**

1. 0.1    2. 0.45    3. 0.75    4. 0.25    5. 0.14    6. 0.35    7. 0.2    8. 0.5    9. 0.13    10. 0.4

**Practice Problems # 8**

1. 12    2. 100    3. 7/9    4. 7.5    5. 9.6    6. 7.5    7. 3    8. 18    9. 5    10. 4.5

**Practice Problems # 9**

1. 0.25 kg    2. 15,000 mcg    3. 3,500 mL    4. 5,000 mg    5. 0.36 g    6. 0.004 mg    7. 200 mg  
8. 0.5 L

**Practice Problems # 10**

1. 1 qt    2. 4 pt    3. 0.5 pt    4. 8 oz    5. 3 oz    6. 15 mL    7. 32 oz    8. 300 mg

**Practice Problems # 11**

1. 15 t    2. 12 t    3. 10 mL    4. 3 tbsp    5. 30 mL    6. 8 oz    7. 5 mL    8. 1 tbsp

**Practice Problems # 12**

1. 15 mg    2. 25 kg    3. 20 mL    4. 0.6 L    5. 160 g    6. 1.7 L    7. 0.18 g    8. 4000 g

**Practice Problems # 13**

1. Intake = 825 mL  
Output = 540 mL

**Practice Problems # 14**

1. potassium chloride (Kdur) 20 mEq (**milliequivalent**) p.o. bid in 120 mL of orange juice
2. zidovudine (Retrovir) 200 mg p.o. every 4 hours
3. gentamicin sulfate (Garamycin) 45 mg IVPB, every 12 hours
4. Humulin Regular Insulin (U-100) (**No dosage, clarify**), (**Ordered IM, clarify**)
5. levothyroxine (Synthroid) 200 (**No unit of measure, clarify**) p.o. daily
6. digoxin (Lanoxin) 0.125 (**No unit of measure, clarify**) p.o. (**No frequency, clarify**)
7. furosemide (Lasix) 40 mg, IM, stat
8. chlordiazepoxide (Librium) 50 mg, p.o. every 4 hours prn for agitation
9. acetaminophen (Tylenol) 650 mg, p.o. every 4 hours prn (**No reason, clarify**)
10. Folic acid 1 mg, p.o. every day

**Practice Problems # 15**

1. a. Tagamet  
b. cimetidine  
c. Tablets  
d. 200 mg
2. a. Compazine  
b. prochlorperazine  
c. Injection  
d. 5 mg/mL

**Practice Problems # 16**

1. 3 capsules
2. 1 tablet
3. 1 mL
4. 0.75 mL
5. 0.5 tablet
6. 2 tablets
7. 2 tablets
8. 2 capsules

\* Refer to the text regarding military time.

**Practice Problems # 17**

1. 1.3 mL
2. 1.6 mL

**Practice Problems # 18**

1. 6 units
2. No insulin
3. Call Healthcare Provider (MD, NP, PA)
4. 4 units
5. 2 units

**Practice Problems # 19**

- |   |        |            |
|---|--------|------------|
| 1. 1.42 mL  |        |            |
| 2. a) 170.5 mg/24 hours (day) – 204.6 mg/24 hours (day) | b) No  |            |
| 3. a) 31.8 mcg/24 hours (day) - 38.2 mcg/24 hours (day) | b) Yes | c) 0.36 mL |
| 4. a) 32.7 mg/dose (8 hours) - 40.9 mg/dose (8 hours)   | b) Yes | c) 1.6 mL  |

**Practice Problems # 20**

1. 66.7 mL/hr
2. 200 mL/hr
3. 75 mL/hr
4. 125 mL/hr
5. 125 mL/hr
6. 133.3 mL/hr
7. 300 mL/hr
8. 100 mL/hr
9. 120 mL/hr
10. 120 mL/hr

**Practice Problems # 21**

1. 31 gtt/min
2. 56 gtt/min
3. 31 gtt/min
4. 67 gtt/min
5. 111 gtt/min
6. 21 gtt/min
7. 42 gtt/min

8. 25 gtt/min
9. 16 gtt/min
10. 16 gtt/min

**Practice Problems # 22**

1. 15 mL/hr
2. 22.5 mL/hr
3. 9.6 mL/hr
4. 4 mL/hr
5. 80 mL/hr
6. 35 mL/hr
7. 17 mL/hr
8. 15 mL/hr

**Practice Problems # 23**

1. 66.7 mL/hr
2. 128.6 mL/hr
3. 17 mL/hr
4. 54 mL/hr
5. 32.2 mL/hr
6. 28.8 mL/hr
7. 22.5 mL/hr
8. 27 mL/hr