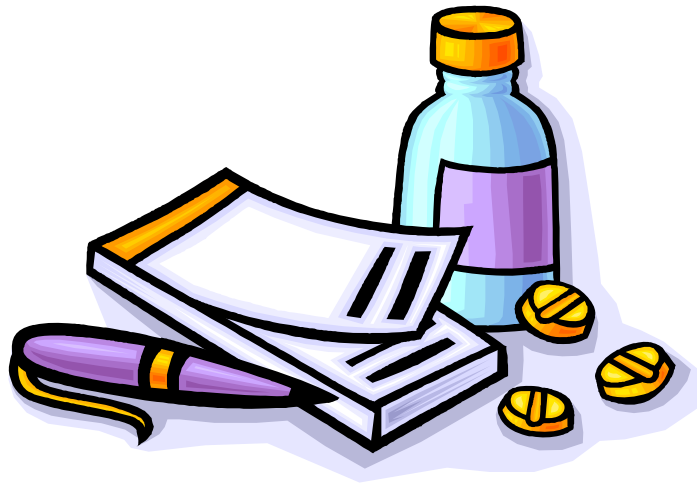


LINCOLN MEMORIAL UNIVERSITY

Caylor School of Nursing



Dosage Calculation Packet 2009-2010

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Unit I – Basic Mathematics Review

This unit will review fractions, decimals, percentage, and 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. Example: $\frac{1}{2}$.
2. Improper fractions – the numerator is greater than the denominator. Example: $\frac{6}{5}$.
3. Complex fractions – the numerator or denominator may be either a fraction or a whole number.

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

To change a mixed number to an improper fraction, you must multiply the whole number by the denominator and add the numerator. Example: $3\frac{1}{2} = \frac{7}{2}$.

Practice Problems # 1

Reduce the following fractions to the lowest terms. The answers are on pages 29-31 of the dosage calculation packet.

1. $\frac{2}{4} = \underline{\hspace{1cm}}$ 2. $\frac{2}{8} = \underline{\hspace{1cm}}$ 3. $\frac{15}{20} = \underline{\hspace{1cm}}$ 4. $\frac{3}{9} = \underline{\hspace{1cm}}$

Change the following improper fractions to mixed numbers

1. $\frac{6}{4} = \underline{\hspace{1cm}}$ 2. $\frac{7}{5} = \underline{\hspace{1cm}}$ 3. $\frac{15}{8} = \underline{\hspace{1cm}}$ 4. $\frac{3}{2} = \underline{\hspace{1cm}}$

Change the following mixed numbers to improper fractions

1. $3\frac{1}{2} = \underline{\hspace{1cm}}$ 2. $6\frac{1}{2} = \underline{\hspace{1cm}}$ 3. $10\frac{1}{2} = \underline{\hspace{1cm}}$ 4. $33\frac{1}{3} = \underline{\hspace{1cm}}$

Multiplying Fractions:

1. Multiply the numerators.
2. Multiply the denominators.
3. Reduce to the lowest terms.

Example: $\frac{3}{4} \times \frac{2}{3} = \frac{6}{12}$ Reduced = $\frac{1}{2}$

Dividing Fractions:

1. Invert the divisor ($2/3$ would become $3/2$).
2. Change the division sign to multiplication.
3. Multiply the numerators.
4. Multiply the denominators.
5. Reduce to the lowest terms.

Example: $\frac{1}{3}$ divided by $\frac{1}{2} = \frac{1}{3} \times \frac{2}{1} = \frac{2}{3}$

This answer is reduced to the lowest terms.

Practice Problems # 2

Multiply or divide the fractions. The answers are on pages 29-31 of the dosage calculation packet.

1. $2/3 \times 1/8 =$ _____ 2. $9/25 \times 4/32 =$ _____ 3. $1/9 \div 3/9 =$ _____ 4. $1/5 \div 1/2 =$ _____

DECIMALS:**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. Carry out the answer to 3 decimal places before rounding off to 2 places.

Example:

$$\begin{array}{r} 73. \\ 0.03 \overline{) 2.19} \\ \underline{21} \\ 09 \\ \underline{9} \\ 0 \end{array}$$

The answer is 73.

Practice Problems # 3

Divide the decimals. The answers are on pages 29-31 of the dosage calculation packet

1. $0.75 \div 0.5 = \underline{\hspace{2cm}}$ 2. $0.2 \div 0.02 = \underline{\hspace{2cm}}$ 3. $140 \div 6 = \underline{\hspace{2cm}}$ 4. $140 \div 7.8 = \underline{\hspace{2cm}}$

Rounding Decimals:

1. Determine at what place you are going to round.
2. If the number to the right of the place you are going to round is greater than or equal to 5, round up to the next number.
3. If that number is less than 5, delete the remaining number or numbers.

Practice Problems # 4

The answers are the last pages of the dosage calculation packet

Round the decimal to the tenth place:

1. $0.75 = \underline{\hspace{2cm}}$ 2. $0.23 = \underline{\hspace{2cm}}$ 3. $0.98 = \underline{\hspace{2cm}}$ 4. $0.36 = \underline{\hspace{2cm}}$

Round the decimal to the hundredth place:

1. $1.086 = \underline{\hspace{2cm}}$ 2. $0.456 = \underline{\hspace{2cm}}$ 3. $12.234 = \underline{\hspace{2cm}}$ 4. $19.014 = \underline{\hspace{2cm}}$

PERCENTAGE:

A percentage is a part of 100.

Changing Percent to Fractions:

1. The numerator will be the number in front of the % sign.
2. The denominator will always be 100.
3. Divide as usual.
4. Reduce to the lowest terms.

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

Practice Problems # 5

Change each percent to a fraction. Reduce to lowest terms. The answers are on pages 29 -31 of the dosage calculation packet.

1. $10\% = \underline{\hspace{2cm}}$ 2. $45\% = \underline{\hspace{2cm}}$ 3. $75\% = \underline{\hspace{2cm}}$ 4. $25\% = \underline{\hspace{2cm}}$

Changing Fractions to Percent:

1. Divide the numerator by the denominator.
2. Multiply the answer by 100.

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 pages 29-31 of the dosage calculation packet.

1. $\frac{1}{2} =$ _____ 2. $\frac{1}{3} =$ _____ 3. $\frac{1}{4} =$ _____ 4. $\frac{4}{5} =$ _____

Changing Percent to a decimal:

1. Remove the % sign.
2. Divide by 100 (or move the decimal 2 places to the left).
3. If the answer is not a whole number, place a zero before the decimal. This is a leading zero. If the answer is a whole number, do not place a zero before the decimal. This is a trailing zero and is incorrect.

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

Practice Problems # 7

Change each percent to a decimal. The answers are on pages 29-31 of the dosage calculation packet.

1. $10\% =$ _____ 2. $45\% =$ _____ 3. $75\% =$ _____ 4. $25\% =$ _____

RATIO and PROPORTION:

Ratio:

Definition: 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:

Definition: 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 together and the two inner numbers together. The answers will be equal to one another.

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”:

1. Multiply the outer numbers.
2. Multiply the inner numbers.
3. Place the answer that contains the “X” to the left of the equals sign and solve the equation by dividing the entire equation by the number before the “X”.

Example: $3 : 5 :: 15 : X$

$$3X = 75 \text{ (divide the equation by 3)}$$

$$\frac{3X}{3} = \frac{75}{3} \quad X = 25$$

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: $3 : 5 :: 15 : 25$

$$3 \times 25 = 75 \text{ (outer numbers multiplied together)}$$

$$5 \times 15 = 75 \text{ (inner numbers multiplied together)}$$

Practice Problems # 8

Find the value of x. The answers are on pages 29-31 of the dosage calculation packet.

1. $2 : 3 :: 8 : x$
2. $x : 5000 :: 10 : 500$
3. $2/3 : 3/4 :: x : 21/24$
4. $5 : x :: 20 : 30$

Unit II – 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. There are three primary systems of measure that are currently used in medication administration: the metric system, the apothecary system, and the household system.

THE METRIC SYSTEM

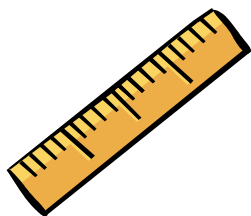
The metric system is widely used in dosage calculations. It uses powers of 10 and the basic units of measure are the gram, liter, and meter. A **gram** measures weight, a **liter** measures fluid, and a **meter** measures length.



Gram: measures weight. Gram may be written G, g, Gm or gm.



Liter: measures liquid. Liter may be written L or l.



Meter: measures length. Meter may be written M or 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.

Commonly seen units are the Kg or kg (kilogram), mL or ml (milliliter), and mcg (microgram).

The metric system contains the following rules:

1. Arabic numbers are used (i.e. 150)
2. The symbol of measure is placed after the number (i.e. 150 **ml**)

METRIC BASIC EQUIVALENTS

1 Kg or kg = 1000 Gm, gm, G, or g
 1 Gm, gm, G, or g = 1000 mg
 1 mg = 1000 mcg
 1 mL or ml = 1 cc **DO NOT USE cc in documentation.**
 1 L or l = 1000 mL or ml

Practice Problems # 9

Abbreviate the following metric notations. The answers are on pages 29-31 of the dosage calculation packet.

1. Five grams _____
2. Seven hundred fifty milliliters _____
3. One and one-half kilograms _____
4. Two hundred micrograms _____

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.

RULES OF PROPORTION

1. Units of ratios must correspond within the same proportion.
2. Correct = Gm : Kg :: Gm : Kg
3. No more than 2 different units of measure can be used within the proportion.
4. Label all numbers with the appropriate unit of measure.

Example: 0.5 Kg. = ___?___gm

First, find the basic equivalent in the previous chart.

This would be, 1 Kg = 1000 Gm. Now you know 3 of the 4 numbers in the equation. Solve for "X" as you were taught in Unit I and utilize the above rules of proportion.

Set the problem up: 1 Kg: 1000 gm:: 0.5 Kg: X gm
 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 (unit of measure) comes after 500? Look up at your problem, it would be 500 gm. The label will always be what follows the unknown "X". **To obtain credit for dosage calculation questions, you must correctly label the answer.**

Practice Problems # 10

Solve for “X”. The answers are on pages 29-31 of the dosage calculation packet.

1. 250 Gm = X Kg _____ 2. 15 mg = X mcg _____ 3. 3.5 L = X mL _____


THE APOTHECARY SYSTEM

The Apothecary System is another method of expressing units of measure. It is an old system and is not used exclusively because it is not standardized. That means that each measure is an approximate amount, not an exact amount. But, some doctors still order medicines using this system, and some labels contain this system as well. It is different from the metric system in the following ways:


1. It uses Roman numerals (ss = 1/2, i = 1, iv = 4, v = 5, ix = 9, x = 10)
2. The unit is written before the amount (gr i, gr ss, gr iv)
3. Fractions are written as common fractions (gr. 1/150). The only exception is 1/2, which is written as is.

The basic units of measure that are commonly used are the grain and ounce.



Grain:  measures weight and is written gr. 1 gr = 60 mg
(* 1 gr = 65 mg is often used in dosage calculations involving aspirin or acetaminophen.)



Ounce:  measures liquid amounts and is written like a cursive **Z** but with an extra hump on top.

Apothecary measures for dry weight are infrequently used. Therefore, the word “fluid” is generally dropped when referring to the ounce. The table below reflects apothecary measures for volume.

APOTHECARY BASIC EQUIVALENCES	
16 fluid ounces	= 1 pint
2 pints	= 1 quart
4 quarts	= 1 gallon

Practice Problems # 11

Solve for "X" using ratio and proportion. The answers are on pages 29-31 of the dosage calculation packet.

1. 32 oz = X qt _____ 2. 2 qt = X pt _____ 3. 8 oz = X pt _____

HOUSEHOLD MEASURE

The Household Unit of Measure is the most commonly recognized by laypeople in America. It includes drops, teaspoons, tablespoons, and cups. **Drop** is written gtt, **teaspoon** is written tsp or t., **tablespoon** is written Tbsp, tbs or T and **cup** is written C. This system is not standardized either, it utilizes approximate measures.

HOUSEHOLD EQUIVALENTS

60 drops (gtts) = 1 teaspoon (t)
 3 teaspoons = 1 Tablespoon (T)
 2 Tablespoons = 1 ounce
 8 ounces = 1 cup (C)

Practice Problems # 12

Solve for "X" using ratio and proportion. The answers are on pages 29-31 of the dosage calculation packet.

1. 5 T = X t _____ 2. 2 oz = X t _____ 3. 150 gtt = X t _____

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

LEARNING the BASIC EQUIVALENCES

In order to calculate dosage amounts you must first **memorize** these basic equivalences:

BASIC EQUIVALENCES COMMONLY USED

gr 15 = 1 g (gram)	60 mg = gr 1 (grain)
1 g (gram) = 1000 mg (milligrams)	1 kg = 2.2 lb (pounds)
1 kg (kilogram) = 1000 g	30 ml = 1 oz (ounce)
1 L (liter) = 1000 ml (milliliters)	1 T = 3 tsp (teaspoon)
1 ml = 1 cc (cubic centimeter)	1 C (cup) = 8 oz
1 mg = 1000 mcg. (micrograms)	1 T = 15 ml
2 T (tablespoon) = 1 oz	1 tsp = 5 ml
15 – 16 gtt (drop) = 1 ml	

Now that you know the equivalences, it is time to learn how to convert values between systems. Keep your charts of equivalences handy and refer back to them often.

Many times the physician will order a medication in one strength but the pharmacy stocks the medication in a different strength. By using ratio and proportion that you were taught in Unit I, you can determine how much of the medication that the pharmacy stocks will be needed to equal the amount ordered by the physician.

Always set up your problem in the following manner:

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

Example: How many grams are there in 500 mg?
(The known ratio is 1000 mg = 1 gm)

KNOWN UNIT :	KNOWN	::	DESIRED :	X
OF MEASURE	EQUIVALENT		UNIT OF	
	UNIT OF		MEASURE	
	MEASURE			

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

$$1000 X = 500$$

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

$$X = 0.5 \text{ gm (Remember to check your answer)}$$

Practice Problems # 13

Solve for "X" using ratio and proportion. The answers are on pages 29-31 of the dosage calculation packet.

1. $\frac{1}{4}$ gr = X mg _____ 2. 55 lb = X kg _____ 3. 4 tsp = X mL _____

UNIT III – Simple Dosage Calculations

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

INTERPRETING PHYSICIAN ORDERS

In order to administer medications safely and correctly the nurse must first be able to interpret the physicians order.

Example: Zolpidem tartrate 10 mg p.o. at bedtime prn for sleep

What is the name of the medication? Zolpidem tartrate

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 MD orders interpret the following. The answers are on pages 29-31 of the dosage calculation packet.

- 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 20 mEq p.o. in 120 mLs orange juice bid

INTERPRETING MEDICATION LABELS

Medication label information varies from one medication to another. However, most all labels contain the following information; brand name, generic name, dosage, route of administration and manufacturer. If a medication has to be reconstituted, the label will contain information regarding suitable diluents, amount of diluents 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. The answers are on pages 29-31 of the dosage calculation packet.

- a. 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 physician 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.

To calculate oral dosages you will use the previously discussed method of ratio and proportion. Set the problems up just as you did in Unit II. **To obtain credit for dosage calculation questions, you must correctly label the answer.**

Example: ORDERED: Amoxicillin 500 mg p.o.
 AVAILABLE: Amoxicillin 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

$$250 \times 2 = \mathbf{500}$$

$$1 \times 500 = \mathbf{500}$$

Example: ORDERED: Pentobarbital sodium 30 mg p.o.
 AVAILABLE: Pentobarbital sodium scored
 tablets gr. I
 How many tablets will the nurse administer?

Since the ordered form of the medication and the available form of the medication are values from different systems of measurement, you must first change the ordered form of the medication to the available form of the medication. **This type of a problem is always going to require 2 steps.**

Step 1:

(The known ratio is 60 mg = 1 grain)

60 mg: 1 grain :: 30 mg : X grain

$$60 X = 30$$

$$X = \frac{30}{60} \quad X = \frac{1 \text{ grain}}{2} \text{ or } 0.5 \text{ grain}$$

Step 2:

Now put this answer into an equation and determine how many tablets you should administer.

1 grain: 1 tablet:: 0.5 grain : X tablet

X = 0.5 ½ of a tablet.

NOTE: When calculating oral doses, it is important to differentiate between the dosage calculation (math calculation) and the amount of oral medication to be administered.

Example: If the dosage calculation equals 1.44 tablets or 1.4 tablets, the nurse must recognize that this amount can not be given safely to a patient. She will administer 1 ½ tablets since scored tablets may only be divided in two.

The same is true regarding oral solutions. If the dosage calculation equals 4.94 mLs, the nurse will pour 5 mLs of oral solution into a calibrated medication cup.

CALCULATION OF PARENTERAL DOSAGES

Parenteral means injection of drugs into the tissue or fluids of the body. The various routes for this include; Intradermal, 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. The answers are on pages 29-31 of the dosage calculation packet. **To obtain credit for dosage calculation questions, you must correctly label the answer. Round the answer to the appropriate amount that can be administered in the clinical area. For example: If the answer is less than 1 mL, round to the correct hundredths place. If the answer is greater than 1 mL, round to the correct tenths place.**

- Order: doxepin HCl (Sinequan) 30 mg po at bedtime
Available: doxepin HCl 10 mg per capsule
How many capsules will the nurse administer?
- Order: nitrostat 1/150 gr sublingual stat
Available: nitrostat 0.4 mg per tablet
How many tablets will the nurse administer?

3. Order: digoxin 0.25 mg IM daily
Available: digoxin 0.5 mg/2 mL
How many mL(s) will the nurse administer?

4. Order: atropine 0.3 mg IM stat
Available: atropine 0.4 mg per mL
How many mL(s) will the nurse administer?

NOTE: When calculating parenteral doses, it is important to differentiate between the dosage calculation (math calculation) and the amount of the parenteral medication to be administered.

Example: If the dosage calculation equals 1.43 mLs of a parenteral solution, the nurse must recognize that when she selects a 3 mL syringe, she will administer 1.4 mLs of the solution since this syringe is divided into tenths.

UNIT IV – 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 nurse's. 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 multi-use vial it is the nurse's responsibility to date and time the container.

Example: Ordered: Imipenem 750 mg IM.
Available: Imipenem 750 mg vial. Dissolve in 3ml of 1% lidocaine HCl solution.

How many ml of diluent should you add? 3mL
What amount of the medication will you administer? All that is in the vial. (The whole vial = 750 mg).

Example: Ordered: Cefazolin 250 mg IM.
Available: Cefazolin 1 gm vial. Add 3 mL of normal saline to obtain a concentration of 1gm per 4 mL(s).

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. The answers are on pages 29-31 of the dosage calculation packet. **To obtain credit for dosage calculation questions, you must correctly label the answer. Round the answer to the appropriate amount that can be administered in the clinical area. For example: If the answer is less than 1 mL, round to the correct hundredths place. If the answer is greater than 1 mL, round to the correct tenths place.**

- Order: Cefazolin sodium 0.3 g IM.
Available: Cefazolin 500 mg powder. Add 2 ml of sterile water to obtain a concentration of 225 mg/mL.
How many mL(s) will the nurse administer?

INSULIN ADMINISTRATION

Insulin is a natural hormone produced by the pancreas to maintain the body's blood sugar within the normal range of 60-110 mg/dL. You will learn much more about this during lecture. The purpose of this unit is to teach you how to safely calculate and administer insulin to patients.

The insulin that is used for replacement therapy is obtained from animal and human sources. **However, within the United States beef and pork insulin is no longer available.** This is important for the nurse to know because the patient needs to remain on the same source of insulin between home care and hospitalization. The label on the insulin bottle will tell whether the insulin is from an animal source or human source.

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. Once again, this will be taught in detail at a later time in the curriculum. 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. It is routinely supplied in concentrations of **100 units per milliliter**. This is the standard concentration used when administering insulin. (There is an insulin concentration of 500 units per 1 mL used for patients requiring large doses and in certain emergencies. It is rarely used. **HOWEVER, DO NOT CONFUSE THE TWO CONCENTRATIONS!** For obvious safety reasons, the 500 units per 1 mL insulin should be stored separately from the standard or universal 100 units per 1 mL insulin solution.)

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.

POINTS TO REMEMBER WHEN ADMINISTERING INSULIN

1. When mixing categories of insulin in the same syringe, always draw up the short-acting (unmodified) insulin first.
2. Gently roll the bottle of (modified) insulin to mix it before drawing up the dose. Do not shake the bottle vigorously.
3. **Always have another nurse verify that you have drawn up the correct amount and type of insulin.**
4. Only Regular (short acting) insulin can be given intravenously.
5. **If not given correctly, insulin can be a lethal drug.**

Because insulin is routinely supplied as 100 units/ml and the insulin syringe is measured in units/mL, there is no calculation required for this 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 a long-acting insulin once or twice daily, as well as a 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 physician's sliding scale order.

Example: Order: Regular insulin Sub-Q q 4 hr according to sliding scale below. The patient's blood sugar was 235. How much insulin will the nurse administer?

Blood Sugar (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 MD

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 sugar results. The answers are on pages 29-31 of the dosage calculation packet. **To obtain credit for dosage calculation questions, you must correctly label the answer.**

1. 265 mg/dL = _____
2. 75 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 as you did in Unit II. **Round to the hundredths place.**
3. Calculate the ordered dose using ratio and proportion.
4. Determine if the dose is safe according to the manufacturer's safe dosage

Example: Order: Meperidine 1.5 mg/kg IM. The child weighs 20 pounds.

Step 1: Convert pounds to kilogram

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

$$2.2 X = 20$$

$$X = 9.0909 \text{ (Always round to the hundredth place for children)}$$

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

Step 2: Calculate the ordered dose of Meperidine.

$$1 \text{ kg} : 1.5 \text{ mg} :: 9.09 \text{ kg} : X \text{ mg}$$

$$X = 13.635 \text{ (Always round to the hundredth place for children)}$$

$$X = 13.64 \text{ mg Meperidine}$$

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 the safe pediatric ranges for medications. You have to 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, you call the ordering physician. Many times a range will be given rather than one specific safe dosage amount.

Example: Order: Carbamazepine 400 mg po BID. The recommended dose is 15 – 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.

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

$$X = 375 \text{ mg} \quad \text{and}$$

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

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

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

As stated above, the MD ordered 400 mg. Since 400 falls within the safe range, you would determine that 400 mg is a safe dose. If, for example, the MD had ordered 600 mg Carbamazepine then you would determine that not to be a safe dose and you would notify the ordering physician.

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 has to determine if the number of doses of a medication to be given in 24 hours falls within that range.

Example: Order: Erythromycin 62.5 mg, po q6 hr for an infant that weighs 11 lbs. Safe dose range is 30 – 50 mg/kg/24 hrs.

Step 1: Convert lbs to kg

2.2 lb: 1 kg:: 11 lbs: X kg

X = 5 kg

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

1 kg: 30 mg:: 5 kg: X mg

X = 150 mg

1 kg: 50 mg:: 5 kg: X mg

X = 250 mg

Safe dosage range for 24-hr period = 150 mg – 250 mg

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

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

62.5 mg X 4 doses = 250 mg of Erythromycin in a 24-hr period. The nurse determines this to be a safe 24-hr period dose by comparing this number to the safe range in step 2.

Practice Problems # 19

Solve the following. The answers are on pages 29-31 of the dosage calculation packet.

To obtain credit for dosage calculation questions, you must correctly label the answer. Round the answer to the hundredths place.

1. Order: Acetaminophen elixir 10 mg/kg po.
Child weight is 10 pounds.
Available: Acetaminophen elixir 160 mg/ 5ml.
How much Acetaminophen will the nurse administer?

2. Order: Amoxicillin 100 mg po q6 hr.
Child weighs 15 lbs.
Safe range is 25 – 30 mg/kg/24 hr.
 - a. What is the safe 24-hr range?
 - b. Is the ordered dose safe for a 24-hr period?

3. Order: Digoxin 18 mcg po bid.
Child weighs 7 lbs. The safe range is 10 – 12 mcg/kg/24 hrs.
 - a. What is the safe 24-hr range?
 - b. Is the ordered dose safe for a 24-hr period?
 - c. If the medication is supplied 50 mcg/mL, how many mL(s) will the nurse administer per dose?

4. Order: Phenytoin 40 mg po q 8 hr.
Child weighs 27 lb. The safe range is 8–10 mg/kg/24 hr
 - a. What is the safe 24-hr range?
 - b. Is the dose safe for a 24-hr period?
 - c. If the medication is supplied 125 mg/5 mL, how many mL(s) will the nurse administer per dose?

UNIT V – 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 in order 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 of time by using these electronic pumps.

The key concept to **memorize** about these electronic pumps is that they are designed to infuse the IV fluid/medication in **milliliters per hour** (some of the newer pumps can be set to administer tenths of a milliliter per hour). The physician 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 physician 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 physician 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. You will use ratio and proportion to calculate the flow rate.

Example: Order: 1000 mL NS IV to infuse over 8 hrs.

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

$8X = 1000$

$X = 125 \text{ mL/hr}$ This is the flow rate!

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

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

Example: Order: Ondansetron 10 mg in 100 mL NS IVPB q 8 hr.
 Infuse over 30 minutes.

30 min : 100 mL :: 60 min : 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. The answers are on pages 29-31 of the dosage calculation packet. **To obtain credit for dosage calculation questions, you must correctly label the answer. Round the answer to the tenths place.**

1. Infuse 1000 mL D5W over 15 hours.
2. Infuse 600 mL LR over 3 hours.
3. Infuse Cimetidine 300 mg IVPB mixed in 100 mL NS over 45 minutes.
4. Infuse Ampicillin 500 mg IVPB mixed in 50 mL NS over 10 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 dependant upon the gravity of the bag of IV fluid/medication. The rate of these infusions will always be calculated in **drops (gtts) per minute**. (There will not be a pump!)

In order 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 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 gtts/min. The second step is that the nurse will adjust 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 needs to be **memorized**:

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

Example: Order: 3000 mL NS IV over 24 hrs.
Drip factor of tubing: 15 gtts/mL.

$$\frac{3000 \text{ mL} \times 15 \text{ gtts/mL}}{24 \text{ hr} \times 60 \text{ min}} = \frac{45000}{1440} = 31.25 = 31 \text{ gtts/min}$$

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 500 mg IVPB in 100 mL NS to infuse over 30 min. Drip factor: 10 gtts/mL.

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

Practice Problems # 21

Determine the infusion rate for the following. The answers are on pages 29-31 of the dosage calculation packet. **To obtain credit for dosage calculation questions, you must correctly label the answer. Round the answer to the nearest whole number.**

1. Order: 1000 mL NS to infuse in 8 hours.
Drip factor of administration set: 15 gtts/mL.
2. Order: 1000 mL NS to infuse in 6 hours.
Drip factor of administration set: 20 gtts/mL.
3. Order: 500 mL NS to infuse in 4 hours.
Drip factor of administration set: 15 gtts/mL.
4. Order: Famotidine 40 mg IVPB mixed in 100 mL NS to infuse over 30 minutes. Drip factor: 20 gtts/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. **Round the answer to the tenths place.** The dosage of heparin is measured in units. Ratio and proportion are used to calculate the dosage.

Example: Order: Heparin 800 units/hr via continuous IV infusion. Medication comes mixed from pharmacy: Heparin 25,000 units in 250 mL NS.

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

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

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

Practice Problems # 22

Determine the flow rate (ml/hr) for the following. The answers are on pages 29-31 of the dosage calculation packet. **To obtain credit for dosage calculation questions, you must correctly label the answer. Round the answer to the tenths place.**

1. Order: Heparin 1500 units per hr via IV infusion .
Medication comes mixed from pharmacy:
Heparin 25,000 units in 250 mL NS.
2. Order: Heparin 1800 units per hr via IV infusion.
Medication comes mixed from pharmacy:
Heparin 20,000 units in 250 mL NS.
3. Order: Heparin 1200 units per hr via IV infusion.
Medication comes mixed from pharmacy:
Heparin 25,000 units in 200 mL NS.
4. Order: Heparin 800 units per hr via IV infusion.
Medication comes mixed from pharmacy:
Heparin 20,000 units in 100 mL NS.

IV ADMINISTRATION BY CONCENTRATION

Usually IV fluids/medications are ordered to be infused at a certain rate or time period 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. This is a difficult calculation to master, but if you will 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 of the steps for each problem.

Step 1: Convert pounds to kilograms.

Step 2: Determine the correct dosage based on the patients weight (in kilograms).
Round weight to the hundredths place.

Step 3: Convert the ordered unit to the unit you have on hand.

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

Step 5: Calculate the # of mL/hr to administer. **Round to the nearest tenths place.**

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

Example: Order: Bretylium 5mcg/kg/min. Medication comes mixed 0.05 g in 50 mL NS. Patient's weight is 187 lbs.

Step 1: Convert lbs to kg

$$\begin{aligned} 2.2 \text{ lb} & : 1 \text{ kg} :: 187 \text{ lb} : X \text{ kg} \\ X & = 85 \text{ kg} \end{aligned}$$

Step 2: Determine the correct dosage based on pts weight

$$\begin{aligned} 1 \text{ kg} : 5 \text{ mcg} :: 85 \text{ kg} : X \text{ mcg} \\ X & = 425 \text{ mcg} \end{aligned}$$

Step 3: Convert the ordered unit to the unit on hand.

$$\begin{aligned} 1 \text{ g} : 1,000,000 \text{ mcg} :: 0.05 \text{ g} : X \text{ mcg} \\ X & = 50,000 \text{ mcg (there are 50,000 mcg in 50 mL NS)} \end{aligned}$$

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

$$50,000 \text{ mcg} : 50 \text{ mL} :: 425 \text{ mcg} : X \text{ cc}$$

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

Step 5: Calculate the # of mL/hr to administer.

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

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

Example: Order: Nitroglycerin 50 mg in 500 mL D5W
at 50 mcg/min. Set the pump at ____mL/hr?

Step 1: Convert to kilograms. – NOT NEEDED!!!

Step 2: Determine the correct dosage based on the
patients weight. - NOT NEEDED!!!

Step 3: Convert the ordered unit to the unit on hand.

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

$$X = 50,000 \text{ mcg (50,000 mcg in 500 mL D5W)}$$

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

$$50,000 \text{ mcg} : 500 \text{ mL} :: 50 \text{ mcg} : X \text{ mL}$$

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

Step 5: Calculate the # of mL/hr to administer.

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

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

Practice Problems # 23

Determine the **rate (mL/hr)** for the following. The answers are on pages 29-31 of the dosage calculation packet. **To obtain credit for dosage calculation questions, you must correctly label the answer. Round the answer to the tenths place.**

- Order: Administer Clindamycin IV at a rate of 10 mg/min.
Available: Clindamycin 900 mg in 100 mL NS.
- Order: Administer Chlorothiazide at a rate of 15 mg/min.
Available: Chlorothiazide 350 mg in 50 mL NS.
- Order: Nitroprusside IV 0.5 mcg/kg/min. Pt. weight = 125 lb.
Available: Nitroprusside 10 mg in 100 mL D5W.

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Answers to Practice Problems**Practice Problems # 1****Reduce the fractions**

- 1.
- $\frac{1}{2}$
- 2.
- $\frac{1}{4}$
- 3.
- $\frac{3}{4}$
- 4.
- $\frac{1}{3}$

Improper fractions to mixed numbers

- 1.
- $1\frac{1}{2}$
- 2.
- $1\frac{2}{5}$
- 3.
- $1\frac{7}{8}$
- 4.
- $1\frac{1}{2}$

Mixed numbers to improper fractions

- 1.
- $\frac{7}{2}$
- 2.
- $\frac{13}{2}$
- 3.
- $\frac{21}{2}$
- 4.
- $\frac{100}{3}$

Practice Problems # 2

- 1.
- $\frac{1}{12}$
- 2.
- $\frac{9}{200}$
- 3.
- $\frac{1}{3}$
- 4.
- $\frac{2}{5}$

Practice Problems # 3

1. 1.5 2. 10 3. 23.33 4. 17.95

Practice Problems # 4**Round to the tenths place**

1. 0.8 2. 0.2 3. 1.0 4. 0.4

Round to the hundredths place

1. 1.09 2. 0.46 3. 12.23 4. 19.01

Practice Problems # 5

- 1.
- $\frac{1}{10}$
- 2.
- $\frac{9}{20}$
- 3.
- $\frac{3}{4}$
- 4.
- $\frac{1}{4}$

Practice Problems # 6

1. 50% 2. 33% 3. 25% 4. 80%

Practice Problems # 7

1. 0.1 2. 0.45 3. 0.75 4. 0.25

Practice Problems # 8

1. 12 2. 100 3.
- $\frac{7}{9}$
- 4.
- $7\frac{1}{2}$

Practice Problems # 9

1. 5 gm 2. 750 mL 3.
- $1\frac{1}{2}$
- kg 4. 200 mcg

Practice Problems # 10

1. 0.25 kg 2. 15,000 mcg 3. 3500 mL

Practice Problems # 11

1. 1 qt 2. 4 pts 3.
- $\frac{1}{2}$
- pt

Practice Problems # 12

1. 15 t
2. 12 t
3. 2.5 t

Practice Problems # 13

1. 15 mg
2. 25 kg
3. 20 mL

Practice Problems # 14

- a. Potassium chloride
- b. 20 mEq
- c. po
- d. bid
- e. in 120 mL of orange juice

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

Practice Problems # 17

1. 1.3 mL

Practice Problems # 18

1. 6 units
2. No insulin

Practice Problems # 19

1. 1.42 mL
2. 170.5 mg – 204.6 mg/day, No
3. 31.8 mcg-38.16 mcg, Yes, 0.36 mL
4. 98.16 mg-122.7 mg, Yes, 1.6 mL

Practice Problems # 20

1. 66.7 mL/hr
2. 200 mL/hr
3. 133.3 mL/hr
4. 300 mL/hr

Practice Problems # 21

1. 31 gtt/min
2. 56 gtt/min
3. 31 gtt/min
4. 67 gtt/min

Practice Problems # 22

1. 15 mL/hr
2. 22.5 mL/hr
3. 9.6 mL/hr
4. 4 mL/hr

Practice Problems # 23

1. 66.6 mL/hr
2. 128.4 mL/hr
3. 17 mL/hr

Comprehensive Dosage Calculation Exam

To obtain credit for the following dosage calculation questions, the student must:

- **Correctly label the answer.**
- **Round the answer to the appropriate amount that can be administered in the clinical area. For example:**
 - **< 1mL round to the correct hundredths place.**
 - **> 1mL round to the correct tenth place.**
- **Round an IV pump answer to the correct tenth place.**
- **Round weight related answers to the hundredths.**
- **Pediatric questions should be rounded to the hundredths.**

1. gr 1/6 = _____ mg
2. Order: furosemide (Lasix) 15 mg
Available: furosemide (Lasix) 20 mg/2 mL
How many mL(s) will the nurse administer?
3. Order: phenytoin (Dilantin) 300 mg now and every morning
Available: phenytoin (Dilantin) 200 mg tablets
How many tablets will the nurse administer?
4. Order: ampicillin 100 mg/kg/day in four divided doses for a child weighing 31 lb.
Available: ampicillin 250 mg/2 mL.
How many mL(s) per dose will the nurse administer?
5. Order: D5W 600 mL to infuse over 8 hours. How many mL(s)/hr will the nurse set the IV pump to infuse?
6. Order: Vancomycin 500 mg in 250 mL of D5W to infuse over 2 hours. The drop factor is 10 gtts/mL. How many gtts/min will the nurse infuse?
7. Order: D5W 3000 mL to infuse over 24 hours. How many mL(s)/hr will the nurse set the IV pump to infuse?
8. Order: Doxycycline 200 mg IVPB in 100 mL NS to infuse over 30 min. The drop factor is 10 gtts/mL. How many gtts/min will the nurse infuse?
9. Order: Dopamine 5 mcg/kg/min. Patient weight 132 lb.
Available: Dopamine 200 mg in 250 mL NS.
How many mL(s)/hr will the nurse set the IV pump for?
10. Order: Aminophylline 0.5 mg/kg/hr. Patient weight 154 lb.
Available: Aminophylline 500 mg in 1000 mL of D5W.
How many mL(s)/hr will the nurse set the IV pump for?

Comprehensive Dosage Calculation Answers

1. 10 mg
2. 1.5 mL
3. 1.5 mL
4. 2.8 mL
5. 75 mL/hr
6. 21 gtt/min
7. 125 mL/hr
8. 33 gtt/min
9. 22.5 mL/hr
10. 70 mL/hr