Ratio, Proportion, and Dimensional Analysis

Unit: Basic Skills

Problem Area: Basic Mathematics Skills

Lesson: Ratio, Proportion, and Dimensional Analysis

Student Learning Objectives.

Instruction in this lesson should result in students achieving the following objectives:

1. **Solve ratio and proportion problems.**
2. **Solve dimensional analysis problems.**

Resources.

The following resources may be useful in teaching this lesson:

Ansel, Howard and Stoklosa, Mitchell. *Pharmaceutical Calculations*, 12th ed. Lippincott Williams & Wilkins, 2006.

Brown, Michael C. "Introduction to Pharmaceutical Calculations," *American Journal of Pharmaceutical Education*. Accessed July 1, 2010. <http://www.ajpe.org/view.asp?art=aj670267&pdf=yes>.

Fred, Linda Y., ed. *Manual for Pharmacy Technicians*, 3rd ed. American Society for Health-System Pharmacists, 2005.

"Pharmacy Technician Math," *Pharmacy Tech Study*. Accessed July 1, 2010. <http://www.pharmacy-tech-study.com/math.html>.



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Equipment, Tools, Supplies, and Facilities

- ✓ Overhead or PowerPoint projector
- ✓ Visual(s) from accompanying master(s)
- ✓ Copies of sample test, lab sheet(s), and/or other items designed for duplication
- ✓ Materials listed on duplicated items
- ✓ Computers with printers and Internet access
- ✓ Classroom resource and reference materials

Key Terms.

The following terms are presented in this lesson (shown in bold italics):

- concentration
- conversion unit
- dimensional analysis
- drip rate
- parenteral nutrition (PN)
- proportion
- ratio

Interest Approach.

Use an interest approach that will prepare the students for the lesson. Teachers often develop approaches for their unique class and student situations. A possible approach is included here.

> *Ask your students the following questions: Have you ever been in the hospital as a patient or to visit a friend or family member? Have you seen patients roaming the halls steering a pole on wheels that holds an intravenous (IV) bag with attached tubing that connects to their arms? Explain that they are receiving a continuous IV infusion and that pharmacy technicians have great responsibility in making this all happen safely. Give them five minutes to write down in what ways they think a pharmacy technician would be involved in the process?*

CONTENT SUMMARY AND TEACHING STRATEGIES

Objective 1: Solve ratio and proportion problems.

Anticipated Problem: What steps and calculations are needed to solve ratio and proportion problems as they relate to pharmacy?

I. Solving ratio and proportion problems

A. A ***ratio*** is the mathematical relationship between one quantity and another. It compares the size of one number to the size of another. There are several ways in

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which to express a ratio. For example, the ratio of 5 and 10 may me written as: 5:10, $^{5}/_{10}$, or 5 to 10.

1. Ratios are just another way of expressing fractions. All of the same rules of fractions apply.
2. The most frequent rule is: If the two terms of the ratio are multiplied or divided by the same number, the value of the terms do not change. For instance, 4:2 or $^{4}/_{2}$ has a value of 2. If both terms are multiplied by 5, the ratio becomes 20:10 or $^{20}/_{10}$, and the value is still 2.

B. ***Proportion*** is a comparative relation between things, such as the equality of two ratios. When two ratios have the same value, they are equivalent. Example: $^{1}/_{3} = {}^{3}/_{9}$

$$\frac{\text{Numerator 1 (1)}}{\text{Denominator 1 (3)}} = \frac{\text{Numerator 2 (3)}}{\text{Denominator 2 (9)}}$$

1. Therefore, when cross multiplication occurs, the products are the same.
   Numerator 1 × Denominator 2 = Denominator 1 × Numerator 2
   $1 \times 9 = 3 \times 3$
2. By using basic algebra skills and if three of the four values are known, a person can solve for the fourth value.

$$\frac{5}{20} = \frac{x}{100}$$

$$\frac{5 \times 100}{\cancel{20}} = \frac{\cancel{20} \times (x)}{100}$$

$$x = 25$$

3. The units in the numerator of the proportion must be the same, and the units in the denominator must match as well.

C. Concentration ties into ratios. ***Concentration*** is the amount of drug per volume or weight of the product and may be written as a percentage or as a ratio strength. In pharmacy, concentration may be expressed in the following ways:

1. Percent weight-in-weight (w/w) is grams of drug in 100 g of product.
   For example: Hydrocortisone 0.5 percent cream = 0.5 g hydrocortisone / 100 g cream
2. Percent weight-in-volume (w/v) is the grams of a drug in 100 ml of the product. For instance: 0.9 percent sodium chloride in water (also called normal saline) = 0.9 g sodium chloride in 100 ml water
3. Percent volume-in-volume (v/v) is ml of drug in 100 ml of the product. This is not a common way to express concentration in pharmacy.
4. The most common way to express concentration in pharmacy is in mg/ml or as a percentage.

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D. Concentrations of very weak or dilute solutions are sometimes written as ratios.
For instance: Epinephrine is commercially available in different strengths.

1:100 (1 to 100)	= 1 g of epinephrine in 100 ml of solution
1:1000 (1 to 1000)	= 1 g of epinephrine in 1000 ml of solution
1:10,000 (1 to 10,000)	= 1 g of epinephrine in 10,000 ml of solution

1. The above information can be used to solve problems.
For example: How many g of lidocaine would be contained in 30 ml of a lidocaine solution that is 1:1000?

$$\frac{1\text{ g}}{1000\text{ ml}} = \times \frac{x\text{ g}}{30\text{ ml}}$$

$$\frac{1\text{g} \times 30\ \cancel{\text{ml}}}{1000\ \cancel{\text{ml}}} = x\text{ g} \times \frac{\cancel{1000\text{ ml}}}{\cancel{1000\text{ ml}}}$$

$x = 0.03$ g

2. Another concentration example is as follows:
How many g of hydrocortisone powder would you need to weigh out to compound a 30 g jar of 2.5 percent hydrocortisone cream?

$$\frac{2.5\text{ g hydrocortisone}}{100\text{ g compounded cream}} = \frac{x\text{ g hydrocortisone}}{30\text{ g compounded cream}}$$

$$\frac{2.5\ \cancel{\text{g}} \times 30\text{ g}}{100\ \cancel{\text{g}}} = \frac{\cancel{100\ \text{g}} \times (x)}{\cancel{100\ \text{g}}}$$

$x = 0.75$ g

Teaching Strategy: *The key to mastering the objectives comes with practice and exposure to commonly encountered problems. Use VM–A and the following Web site for practice in calculating doses: http://www.pharmacy-tech-study.com/math.html. Invite a pharmacist to class to discuss the applications of ratios and proportions.*

Objective 2: Solve dimensional analysis problems.

Anticipated Problem: What steps and calculations are needed to solve dimensional analysis problems as they relate to pharmacy?

II. Solving dimensional analysis problems

A. Although ratios and proportions can solve the simple one-step problems, more complicated problems require multiple steps and may involve the use of several ratios and or proportions.

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1. ***Dimensional analysis*** is the problem-solving technique that uses ratios in multiple steps to cancel units until the remaining units are those desired for the calculated answer.
2. It is the most common and useful mathematical formula to solve many pharmacy calculations.
3. Other names for this include factor analysis, factor—label method, and unit-factor method.

B. To set up the dimensional analysis problem, several steps may be followed.

1. It is necessary to determine what unit is given and what unit is needed for the answer.
2. The unit being sought should be placed as an X in the numerator of the first fraction.
3. That same unit should be placed in the next fraction's denominator where it will be ready to cancel later.
4. It is important to search for a conversion unit or factor. A ***conversion unit*** is a fraction with units needed for cancellation and is always equivalent to one. The following conversion chart will be useful in solving dimensional analysis problems.

Pharmacy Conversions (AP = apothecary; AV = Avoirdupois)

Measurement	Equivalent
Volume	
1 L	1000 ml
1 lb	16 oz
1 cup	8 oz
1 fl oz	30 ml
1 tsp	5 ml
1 TBS	15 ml
1 TBS	0.5 fl oz
1 pt	480 ml
1 pt	16 oz
2 pt	1 qt
4 qt	1 gal
1 cup	8 fl oz = 240 ml
1 gal	3840 ml
Weight	
1 kg	1000 g
1 mg	1000 mcg
1 g	1000 mg
1 oz	30 g
16 oz	1 lb (AV)
12 oz	1 lb (AP)

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Measurement	Equivalent
1 lb (AV)	454 g
1 kg	2.2 lb
1 gr (AP)	64.8 mg
1 oz (AP)	480 gr
Length	
1 inch	2.54 cm
1 mile	~ 1.6 km
1 m	39.37 in
1 km	1000 m
1 m	1000 cm
1 cm	1000 mm

Reciprocals are often needed to help cancel out unwanted terms. Examples of conversion units (also called unit factors) are listed below.

$$\frac{1 \text{ tsp}}{5 \text{ ml}} \text{ or } \frac{5 \text{ ml}}{1 \text{ tsp}}; \quad \frac{1000 \text{ mcg}}{1 \text{ mg}} \text{ or } \frac{1 \text{ mg}}{1000 \text{ mcg}}; \quad \frac{1 \text{ oz}}{30 \text{ ml}} \text{ or } \frac{30 \text{ ml}}{1 \text{ oz}}; \quad \frac{1 \text{ lb}}{2.2 \text{ kg}} \text{ or } \frac{2.2 \text{ kg}}{1 \text{ lb}}$$

5. It is necessary to continue this process unit the last unit left is the unit required for the answer.
6. Like units should be cancelled out.
7. The remaining numbers should be multiplied and divided, leaving a new number with its corresponding units.

C. These types of problems are much easier to visualize and understand through example. An example here will show a dimensional analysis problem. A patient weighs 40 lb and is prescribed amoxicillin 40 mg/kg/day. The daily dose is to be divided into two doses and to be given 12 hours apart. If the concentration of amoxicillin suspension dispensed is 400 mg/ 5 ml, how much will the patient need in ml every 12 hours?

1. Unit needed: dose in mg first then ml
2. $\frac{40 \text{ mg}}{\cancel{\text{kg}}} \times \frac{1 \cancel{\text{kg}}}{2.2 \cancel{\text{lb}}} \times 40 \cancel{\text{lb}} = 727 \text{ mg/day}$

   divided by 2 times/day = 363 mg (rounded)
3. $363 \cancel{\text{mg}} \times \frac{5 \text{ ml}}{400 \cancel{\text{mg}}} = 4.5 \text{ ml}$ (rounded) given every 12 hours

D. Concentration problems are commonly encountered in pharmacy. A good illustration of this is with parenteral nutrition. Patients in the hospital or at home may be unable to receive their nutrition orally for a variety of reasons. They may have had a stomach or intestinal surgery; they may be on a breathing machine (ventilator); or they may just be too sick to eat. In these cases, patients must obtain their nutrition intravenously. ***Parenteral nutrition (PN)*** is nutrition received

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through the patient's veins. A pharmacist and pharmacy technician may need to calculate desired concentrations from a stock concentration of the three main components to mix the parenteral nutrition.

1. Protein is manufactured as amino acids in a 10 or 15 percent concentration.
2. Carbohydrates are manufactured most commonly in a 50 and 70 percent dextrose concentration.
3. Fats are called Intralipids and are manufactured in a 10 and 20 percent concentration.

   For instance, a physician orders the following parenteral nutrition:

   Amino acids 85 g
   Dextrose 200 g
   Fats 40 g

   a. Ask your students the following: If the pharmacy has amino acids (10 percent) in stock, how many ml would be needed to measure for this PN?

   $$\frac{\text{amino acids 10 g}}{\text{100 ml solution}} = \frac{\text{amino acids 85 g needed}}{\text{x ml solution needed}}$$

   $$\frac{\cancel{10\ g} \times (x)}{\cancel{10\ g}} = \frac{85\ \cancel{g} \times 100\ \text{ml}}{10\ \cancel{g}}$$

   $$x = 850\ \text{ml}$$

   b. Ask the students the following: If the pharmacy stocks dextrose 70 percent, how many ml would be needed for this PN?

   $$\frac{\text{dextrose 70 g}}{\text{100 ml solution}} = \frac{\text{200 g dextrose needed}}{\text{x ml solution needed}}$$

   $$\frac{\cancel{70\ g} \times (x)}{\cancel{70\ g}} = \frac{200\ \cancel{g} \times 100\ \text{ml}}{70\ \cancel{g}}$$

   $$x = 285.7\ \text{ml—round to } 286\ \text{ml}$$

   c. Ask the students the following: If the pharmacy stocks Intralipids 20 percent for fats, how many ml would be needed to complete this PN?

   $$\frac{\text{20 g fats}}{\text{100 ml solution}} = \frac{\text{40 g fats needed}}{\text{x ml solution needed}}$$

   $$\frac{\cancel{20\ g} \times (x)}{\cancel{20\ g}} = \frac{40\ \cancel{g} \times 100\ \text{ml}}{20\ \cancel{g}}$$

   $$x = 200\ \text{ml}$$

   d. Ask the students the following: What would the total volume be when mixed together?

   850 ml amino acids + 286 ml dextrose + 400 ml fats = 1336 ml

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e. Ask the students the following: If this needs to run over 24 hours, what would the drip rate be in ml/hr?

$$\frac{1336 \text{ ml}}{24 \text{ h}} = \sim \underline{56 \text{ ml/hr}}$$

E. Additional examples of concentration problems are listed below.

1. Ask the students the following: If the infant concentration of Tylenol is 80 mg in 0.8 ml—which is marked on the dropper—and the pediatrician instructed the parent to give 110 mg to her baby, what would be the number of ml to measure on the dropper?

Ratio and Proportion Method

$$\frac{110 \text{ mg}}{\text{x ml needed}} \times \frac{80 \text{ mg}}{0.8 \text{ ml}}$$

$$\frac{110 \cancel{\text{ mg}} \times 0.8 \text{ ml}}{80 \cancel{\text{ mg}}} = \frac{\cancel{80 \text{ mg}} \times \text{(x) ml needed}}{\cancel{80 \text{ mg}}}$$

$$\underline{\text{x} = 1.1 \text{ ml}}$$

Dimensional Analysis Method

$$110 \cancel{\text{ mg}} \times \frac{0.8 \text{ ml}}{80 \cancel{\text{ mg}}} = 1.1 \text{ ml}$$

2. Ask the students the following: If you mix a 200 mcg Synthroid vial of medication with 4 ml of sterile water for injection per the manufacturer's instructions, how many mg would be contained in each ml?

$$\frac{\text{x mg}}{1 \text{ ml}} = \frac{200 \text{ mcg}}{4 \text{ ml}}$$

$$\frac{\text{(x) mg} \times \cancel{4 \text{ ml}}}{\cancel{4 \text{ ml}}} = \frac{200 \text{ mcg} \times 1 \cancel{\text{ ml}}}{4 \cancel{\text{ ml}}}$$

x = 50 mcg

or

$$\frac{200 \text{ mcg}}{4 \cancel{\text{ ml}}} \times 1 \cancel{\text{ ml}} = 50 \text{ mcg}$$

F. The calculated rate that an intravenous medication infuses into the patient from an IV pump is the ***drip rate*** and is usually expressed in ml/hr (milliliters per hour). The nurse has the responsibility of programming the pump, but the pharmacy is their second check. For safety reasons, this second check is extremely important. If programmed incorrectly, the medication could infuse too fast or too slow, both of which could be detrimental to the patient. To solve drip rate problems, it is

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critical to know two things: the concentration of the IV medication and the units for the desired drip rate, usually ml/hr. Examples of drip rates are as follows:

1. The nurse needs to run a diltiazem drip (heart medication) at 15 mg/hr, and the concentration of the prepared drip is 5 mg/ml. What would the pump be set at in ml/hr?

$$\frac{15\ \cancel{mg}}{hr} \times \frac{1\ ml}{5\ \cancel{mg}} = 3\ ml/hr$$

2. A physician orders a norepinephrine drip for a patient with a very low blood pressure at a rate of 10 mcg/min. If someone prepared and sent a norepinephrine drip of 16 mcg/ml, what would the drip rate be in ml/hr?

$$\frac{10\ \cancel{mcg}}{1\ \cancel{min}} \times \frac{60\ \cancel{min}}{1\ hr} \times \frac{1\ ml}{16\ \cancel{mcg}} = 37.5\ ml/hr$$

Teaching Strategy: *The key to mastering the objectives comes with practice and exposure to commonly encountered problems. Assign LS–A.*

Review/Summary.

Use the student learning objectives to summarize the lesson. Have students explain the content associated with each objective. Student responses can be used in determining which objectives need to be reviewed or taught from a different angle. Questions at the ends of chapters in the textbook may also be used.

Application.

Use the included visual master(s) and lab sheet(s) to apply the information presented in the lesson.

Evaluation.

Evaluation should focus on student achievement of the objectives for the lesson. Various techniques can be used, such as student performance on the application activities. A sample written test is provided.

Answers to Sample Test:

Part One: Matching

1. c
2. f
3. a
4. e
5. d
6. g
7. b

Part Two: Completion

1. numerator, denominator
2. pharmacy

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3. factor analysis, factor—label method or unit-factor
4. mg/ml, percentage
5. very weak or dilute
6. the concentration of the IV medication and the units for the desired drip rate

Part Three: Multiple Choice

1. c
2. a
3. c
4. d
5. a
6. b

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Sample Test

Name _____

Ratio, Proportion, and Dimensional Analysis

Part One: Matching

Instructions: **Match the term with the correct definition.**

a. ratio
b. drip rate
c. concentration
d. proportion
e. conversion unit
f. dimensional analysis
g. parenteral nutrition (PN)

_____1. The amount of drug per volume or weight of the product

_____2. A problem-solving technique that uses ratios in multiple steps to cancel units until the remaining units are those desired for the calculated answer

_____3. The mathematical relationship between one quantity and another

_____4. A fraction with units needed for cancellation and is always equivalent to one

_____5. Showing the equality of two ratios

_____6. Nutrition received through the veins

_____7. The calculated rate that an intravenous medication infuses into the patient



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Part Two: Completion

Instructions: **Provide the word or words to complete the following statements.**

1. When setting up ratios it is important to remember that the units in the _____ of the proportion must be the same and the units in the _____ must match as well.
2. Although the nurse has the responsibility of programming the pump with the drip rate, _____ is their second check.
3. Other names for dimensional analysis include _____, _____, or _____.
4. The most common way to express concentration in pharmacy is in _____ or as a _____.
5. Concentrations of _____ or _____ solution are sometimes written as ratios.
6. To solve drip rate problems, you usually need to know two things: _____ and _____.

Part Three: Multiple Choice

Instructions: **Circle the letter of the correct answer.**

_____1. The three main components of parenteral nutrition are _____.

a. vitamins, minerals, and fats
b. fats, carbohydrates, and vitamins
c. protein, carbohydrates, and fats
d. protein, carbohydrates, and minerals

_____2. The nurse has a vial of Synthroid injection that has 200 mcg in 4 ml. She needs to give the patient 75 mcg, which is equivalent to _____.

a. 1.5 ml
b. 1 ml
c. 1.25 ml
d. 2 ml

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_____3. You need to compound a prescription for betamethsone ointment 5 percent, 30 g jar. The amount of betamethasone powder you will need to measure and mix with the base ointment is _____.

a. 15 g
b. 1.5 mg
c. 1.5 g
d. 5 g

_____4. The nurse needs to program her pump in ml/hr and she has the following information: dopamine drip to run at 20 mcg/kg/min; pt weighs 90 kg; drip concentration is 3200 mcg/ml. Her answer is _____.

a. 1.5 ml/hr (rounded)
b. 3.4 ml/hr (rounded)
c. 15 ml/hr (rounded)
d. 34 ml/hr (rounded)

_____5. Percent weight-in-volume (w/v) is the _____.

a. g of drug in 100 g of the product
b. g of a drug in 100 ml of the product
c. ml of drug in 100 ml of the product
d. None of the above

_____6. When solving proportion problems with basic algebra skills and if three of the four values are known, you _____.

a. need more information
b. can solve for the fourth
c. cannot solve the problem
d. All of the above

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TITLE PHARMACY CONVERSIONS (AP = APOTHECARY; AV = AVOIRDUPOIS)

Measurement	Equivalent
Volume	
1 L	1000 ml
1 lb	16 oz
1 cup	8 oz
1 fl oz	30 ml
1 tsp	5 ml
1 TBS	15 ml
1 TBS	0.5 fl oz
1 pt	480 ml
1 pt	16 oz
2 pt	1 qt
4 qt	1 gal
1 cup	8 fl oz = 240 ml
1 gal	3840 ml



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Measurement	Equivalent
Weight	
1 kg	1000 g
1 mg	1000 mcg
1 g	1000 mg
1 oz	30 g
16 oz	1 lb (AV)
12 oz	1 lb (AP)
1 lb (AV)	454 g
1 kg	2.2 lb
1 gr (AP)	64.8 mg
1 oz (AP)	480 gr
Length	
1 inch	2.54 cm
1 mile	~ 1.6 km
1 m	39.37 in
1 km	1000 m
1 m	1000 cm
1 cm	1000 mm

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LS–A

Name _____

Ratio, Proportion, Dimensional Analysis, and Drip Rate Related Pharmacy Calculations

Purpose

The purpose of this activity is to gain experience in solving ratio, proportion, dimensional analysis, and drip rate related pharmacy calculations.

Objectives

1. Solve dimensional analysis problems as they relate to pharmacy.
2. Calculate drip rates.

Materials

- VM–A
- lab sheet
- writing utensil
- calculator (if permitted by instructor)

Procedure

1. Use ratios, proportions, dimensional analysis, and other calculations learned to solve the following problems.
2. Use VM–A as needed for conversion units to complete the problems.



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Problems:

1. A vial of cefazolin contains 100 mg/ml. How many ml should be given to a patient to obtain 750 mg?
2. When a vancomycin vial is reconstituted (powder mixed with water to make a solution), it yields a 50 mg/ml concentration. How many ml would you need to draw up for a 0.9 g dose?
3. If an injectable medication is labeled 100 mcg/2 ml and the dose is 0.125 mg, how many ml would you need?
4. You have the following formula prescribed for parenteral nutrition:

   Amino acids: 135 g (amino acids 15 percent concentration in stock)
   Dextrose: 200 g (dextrose 70 percent concentration in stock)
   Fats: 50 g (Intralipids 20 percent concentration in stock)

   a. Calculate the ml needed for each ingredient.
   b. Calculate the total volume of the parenteral nutrition.
   c. Calculate the drip rate in ml/hr if infused over 24 hr.
5. Calculate the drip rate in ml/hr for a dobutamine drip with the following information known: ordered dose is 2.5 mcg/kg/min; pt weighs 175 lb; dobutamine concentration is 2000 mcg/ml.
6. How many g of magnesium are in 6 ml of a 50 percent magnesium sulfate solution?
7. An order is written for 25,000 units of heparin in 250 ml of D5W to infuse at 17 ml/hr. How many units of heparin will the patient receive in 8 hours?
8. You have an epinephrine vial with a 1:100 concentration. How many g would be contained in 20 ml?
9. The nurse needs to program her IV pump in ml/hr with an IV drip medication in ml/hr and has the following information: Drug and dose ordered = amiodarone 0.5 mg/hr and drip concentration = 1.8 mg/ml
10. In 500 ml of D5W/0.45 percent NaCl (sodium chloride) solution:

    a. How many g of NaCl are there?
    b. How many g of dextrose are there?

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Ratio, Proportion, Dimensional Analysis, and Drip Rate Related Pharmacy Calculations

1. $\frac{100\text{ mg}}{1\text{ ml}} = \frac{750\text{ mg}}{x\text{ ml}}$

$\frac{\cancel{100\text{ mg}}}{\cancel{100\text{ mg}}} \times (x)\text{ ml} = \frac{750\,\cancel{\text{mg}} \times 1\text{ ml}}{100\,\cancel{\text{mg}}}$

$x = 7.5\text{ ml}$

2. $\frac{0.9\,\cancel{\text{g}}}{x\text{ ml}} \times \frac{1000\,\cancel{\text{mg}}}{1\,\cancel{\text{g}}} \times \frac{1\text{ ml}}{50\,\cancel{\text{mg}}}$

$x = 18\text{ ml}$

3. $\frac{0.125\,\cancel{\text{mg}}}{x\text{ ml}} \times \frac{1000\,\cancel{\text{mcg}}}{1\,\cancel{\text{mg}}} \times \frac{2\text{ ml}}{100\,\cancel{\text{mcg}}}$

$x = 2.5\text{ ml}$

4. a. amino acids 135 g

$\frac{135\text{ g}}{x\text{ ml}} = \frac{15\text{ g}}{100\text{ ml}}$

$\frac{135\,\cancel{\text{g}} \times 100\text{ ml}}{15\,\cancel{\text{g}}} = \frac{(x)\text{ ml} \times \cancel{15\text{ g}}}{\cancel{15\text{ g}}}$

$x = 900\text{ ml}$

dextrose 200 g

5. $\frac{2.5\text{ mcg}}{\cancel{\text{kg}}\text{ / min}} \times \frac{1\,\cancel{\text{kg}}}{2.2\,\cancel{\text{lb}}} \times 175\,\cancel{\text{lb}} = 199\text{ mcg/min};$

$\frac{199\text{ mcg}}{\text{min}} \times \frac{60\text{ min}}{1\text{ hr}} \quad \frac{1\text{ ml}}{2000\text{ mcg}} = 6\text{ ml/hr}$

(answer rounded)

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6. $\frac{50\text{ g}}{100\text{ ml}} = \frac{x\text{ g}}{6\text{ ml}}$

$\frac{50\text{ g} \times 6\text{ ml}}{100\text{ ml}} = \frac{\cancel{100\text{ ml}}}{100\text{ ml}} \times (x)\text{ g}$

$x = 3\text{ g}$

7. $\frac{25{,}000\text{ units}}{250\ \cancel{\text{ml}}} \times \frac{17\ \cancel{\text{ml}}}{\cancel{\text{hr}}} \times 8\ \cancel{\text{hr}} = 13{,}600\text{ units}$

8. $\frac{1\text{ g}}{1000\text{ ml}} = \frac{x\text{ g}}{20\text{ ml}}$

$\frac{1\text{ g} \times 20\text{ ml}}{100\text{ ml}} = \frac{\cancel{100\text{ ml}} \times (x)\text{ g}}{\cancel{100\text{ ml}}}$

$x = 0.2\text{ g}$ (200 mg)

9. $\frac{0.5\ \cancel{\text{mg}}}{\text{hr}} \times \frac{1\text{ ml}}{1.8\ \cancel{\text{mg}}} = 0.3\text{ ml/hr}$

10. a. $\frac{0.45\text{ g}}{100\text{ ml}} = \frac{x\text{ g}}{1000\text{ ml}}$

$\frac{0.45\text{ g} \times 1000\text{ ml}}{100\text{ ml}} = \frac{\cancel{100\text{ ml}}}{\cancel{100\text{ ml}}} \times (x)\text{ g}$

$x = 4.5\text{ g}$

b. $\frac{5\text{ g}}{100\text{ ml}} = \frac{x\text{ g}}{1000\text{ ml}}$

$5\text{ g} \times 1000\text{ ml} = 100\text{ ml} \times (x)\text{ g}$

$x = 50\text{ g}$ dextrose

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