Pharmaceutical Calculations

version 0.6

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PREFACE

The purpose of creating Pharmaceutical Calculations is to provide instructors, students, pharmacy technicians, or anyone else even interested with a math book that offers better flexibility and affordability than any other text book you might find. By making it available in a modifiable electronic format with a license that guarantees your rights, you have the freedom to use this textbook for any purpose, the ability to adapt the book to your needs, the freedom to improve the book and release those improvements to the public, and the freedom to use this book to help your neighbor.

I do request a $15 donation for each person you provide this book to, but honestly that is up to you and your school to collect that donation. I will not show up at your front door demanding payment, I will not accuse you of cheating me, and I will not create a website where I bash your name. That request for a donation is simply to help me supplement all the time and effort that I have placed into writing and updating this book.

I honestly hope that this textbook becomes the best math book you ever teach/learn pharmacy math from, and with your help this book can achieve such a lofty goal.

INTRODUCTION

I have broken this book up into four sections, *Basic Arithmetic*, *Basic Pharmacy Math*, *Community Pharmacy Math*, and Institutional *Pharmacy Math*.

- *Basic Arithmetic* is intended to reintroduce the students to some basic math concepts and get everyone on the same page. It includes things such as Roman numerals, decimals, fractions, percentages, 24-hour time, exponents, scientific notation, and basic problem solving methods.
- *Basic Pharmacy Math* provides an introduction to converting between different temperature scales, the household system, the metric system, the apothecary system, some basic terminology, some fairly simple work with providing 24 hour supplies of medication, drip rates, and even some percentage strength problems, and dilutions.
- *Community Pharmacy Math* will teach some compounding math and how to bill for those compounds, days' supply, par levels, percent mark-up, and third party insurance billing and other concepts related to pharmacy business math.
- *Institutional Pharmacy Math* will teach basic parenteral dosage calculations, insulin dosing, how to calculate milliMoles, milliEquivalents, and how international units are derived. It will also teach drug reconstitution, percentage strength, milligram percents, ratio strength, parts, reducing and enlarging formulas, dosage calculations based on body weight, dosage calculations based on body surface area, carboplatin dosing, infusion rates and drip rates, dilutions and alligations, parenteral nutrition, aliquots and double aliquots, pediatric and geriatric dosing.

Upon completion of this book, a student should be well prepared for the calculations expected of a pharmacy technician.

ACKNOWLEDGEMENTS

With any book, an author has to make a large sacrifice of time, and the people that suffer most dearly are his loved ones. In this particular case I want to let everyone know how much I love and adore my wife Shannon and my daughter Sammantha, without either of which this book would have been impossible. I also want to thank my supervisor Connie Geiger, whom never seemed bothered by how much effort I placed into this book. I should also thank Bidwell Training Center for offering me a job to teach pharmacy math (if I had never been offered this job, I am pretty sure I wouldn't have written a math book).

My students also deserve a lot of *'props'* for all their initial encouragement that made me consider even writing a book, and their willingness to function as guinea pigs as I tested my hair brained ideas on how to teach pharmacy math. In that same vein I also want to thank Barb Snyder and my other coworkers for their continued encouragement throughout this whole process.

Last, but certainly not least, I want to thank everyone whom has ever sent me or ever will send me an edit to improve this book. I feel that this book, created along with the collaborative efforts of others is an example of the direction that the text book industry will need to move to keep up with the rapid advancements of science and technology.

Sincerely
Sean E. Parsons

CONTENTS

UNIT 1

BASIC ARITHMETIC

What is arithmetic?

Arithmetic or arithmetics (from the Greek word arithmētikē which literally means the art of counting) is the oldest and most elementary branch of mathematics, used by almost everyone, for tasks ranging from simple daily counting to advanced science and business calculations. In common usage, the word refers to a branch of (or the forerunner of) mathematics which records elementary properties of certain operations on numbers. Professional mathematicians sometimes use the term higher arithmetic as a synonym for number theory, but this should not be confused with elementary arithmetic.

What will be learned/reviewed in this unit?

- roman numerals
- decimal places
- rounding
- significant figures
- addition, subtraction, multiplication and division of decimals
- parts of a fraction
- addition, subtraction, multiplication and division of fractions
- percentages
- 24 hour clocks
- exponents
- scientific notation
- ratios
- proportions
- dimensional analysis
- 5 step problem solving method

Math is usually taught as all scales and no music.

-- *Persis Herold*

CHAPTER 1

NUMERAL SYSTEMS USED IN PHARMACY

There are two major number systems used in pharmacy :

- Arabic Numbers – these are the symbols we use every day for enumeration, such as 1, 16, and 1337.
- Roman Numerals – this is a numeral system originating in ancient Rome. Roman numerals are expressed by letters of the alphabet.

The following is a chart showing how to convert back and forth between Arabic numbers and Roman numerals:

i	1	xxi	21	xli	41	lxi	61	lxxxi	81
ii	2	xxii	22	xlii	42	lxii	62	lxxxii	82
iii	3	xxiii	23	xliii	43	lxiii	63	lxxxiii	83
iv	4	xxiv	24	xliv	44	lxiv	64	lxxxiv	84
v	5	xxv	25	xlv	45	lxv	65	lxxxv	85
vi	6	xxvi	26	xlvi	46	lxvi	66	lxxxvi	86
vii	7	xxvii	27	xlvii	47	lxvii	67	lxxxvii	87
viii	8	xxviii	28	xlviii	48	lxviii	68	lxxxviii	88
ix	9	xxix	29	xlix	49	lxix	69	lxxxix	89
x	10	xxx	30	l	50	lxx	70	xc	90
xi	11	xxxi	31	li	51	lxxi	71	xci	91
xii	12	xxxii	32	lii	52	lxxii	72	xcii	92
xiii	13	xxxiii	33	liii	53	lxxiii	73	xciii	93
xiv	14	xxxiv	34	liv	54	lxxiv	74	xciv	94
xv	15	xxxv	35	lv	55	lxxv	75	xcv	95
xvi	16	xxxvi	36	lvi	56	lxxvi	76	xcvi	96
xvii	17	xxxvii	37	lvii	57	lxxvii	77	xcvii	97
xviii	18	xxxviii	38	lviii	58	lxxviii	78	xcviii	98
xix	19	xxxix	39	lix	59	lxxix	79	xcix	99
xx	20	xl	40	lx	60	lxxx	80	c	100
								d	500
								m	1000

Most people that have previously learned Roman numerals learned them using all capital letters; but in health care you will usually see them written in lower case letters (although either way is acceptable). Roman numerals consist of a basic set of seven symbols:

I *or* i	1	C *or* c	100
V *or* v	5	D *or* d	500
X *or* x	10	M *or* m	1000
L *or* l	50		

Here is how to count from 1 to 10 using Roman numerals:

I *or* i for one
II *or* ii for two
III *or* iii for three
IV *or* iv for four*
V *or* v for five
VI *or* vi for six
VII *or* vii for seven
VIII *or* viii for eight
IX *or* ix for nine
X *or* x for ten

* four strokes seemed like too many to the Romans, so they limited letter repetition to three

The principles for reading Roman numerals are:

- A letter repeated once or twice repeats its value that many times (XXX = 30, CC = 200, etc.).
- One or more letters that are placed after another letter of greater value increases the greater value by the amount of the smaller(VI = 6, LXX = 70, MCC = 1200, etc).
- A letter placed before another letter of greater value decreases the greater value by the amount of the smaller (IV = 4, XC = 90, CM = 900, etc.).*

* Rules regarding Roman numerals often state that a symbol representing 10^x may not precede any symbol larger than 10^{x+1}. For example, C cannot be preceded by I or V, only by X (or, of course, by a symbol representing a value equal to or larger than C). Thus, one should represent the number "ninety-nine" as XCIX, not as the "shortcut" IC

Convert the following Roman numerals to Arabic numbers:

1) VII
2) xxii
3) XXVII
4) iv
5) XIX
6) xiv
7) XII
8) ii
9) XXIV
10) vi
11) IV
12) iii

Convert the following Arabic numbers to Roman numerals:

13) 28
14) 13
15) 17
16) 15
17) 9
18) 12
19) 50
20) 41
21) 89
22) 2007
23) 1776
24) 1337

1) 7 2) 22 3) 27 4) 4 5) 19 6) 14 7) 12 8) 2 9) 24 10) 6 11) 4 12) 3
13) xxviii 14) xiii 15) xvii 16) xv 17) ix 18) xii 19) l 20) xli 21) lxxxix
22) mmvii 23) mdcclxxvi 24) mcccxxxvii

Worksheet 1-1

Name:

Date:

Convert the following Arabic numerals to Roman numerals:

1) 1	=	____________	11) 20	=	____________
2) 2	=	____________	12) 40	=	____________
3) 3	=	____________	13) 45	=	____________
4) 4	=	____________	14) 100	=	____________
5) 5	=	____________	15) 400	=	____________
6) 6	=	____________	16) 1,000	=	____________
7) 7	=	____________	17) 900	=	____________
8) 8	=	____________	18) 69	=	____________
9) 9	=	____________	19) 24	=	____________
10) 10	=	____________	20) 1,999	=	____________

Convert the following Roman numerals to Arabic numerals:

21) ix	=	____________	29) mcxi	=	____________
22) xviii	=	____________	30) cmxcix	=	____________
23) xxiv	=	____________	31) iv	=	____________
24) xxxvi	=	____________	32) vii	=	____________
25) iii	=	____________	33) xii	=	____________
26) ccxl	=	____________	34) xvi	=	____________
27) lv	=	____________	35) xxii	=	____________
28) dlv	=	____________	36) xlii	=	____________

37)	xxxi	=	____________	39)	mmviii	=	____________
38)	mcccxxxvii	=	____________	40)	mdcclxxxiii	=	____________

Worksheet 1-2

Name:

Date:

Perform the indicated operations and record the results in Arabic numbers.

1) VII + XXII = ____________
2) xxvii – iv = ____________
3) XIX – XIV = ____________
4) XII × II = ____________
5) xxiv ÷ vi = ____________
6) IV × III = ____________

Perform the indicated operations and record the results in Roman numerals.

7) 5 × 4 = ____________
8) 18 + 12 = ____________
9) 16 ÷ 4 = ____________
10) 4 × 3 = ____________
11) 625 ÷ 125 = ____________
12) 17 + 14 – 11 + 4 = ____________
13) 6 + 3 = ____________
14) 20 – 16 + 3 = ____________

Fill in the following multiplication table using Roman numerals.

	I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**
I										
II										
III										
IV										
V										
VI										
VII										
VIII										
IX										
X										

XXIV

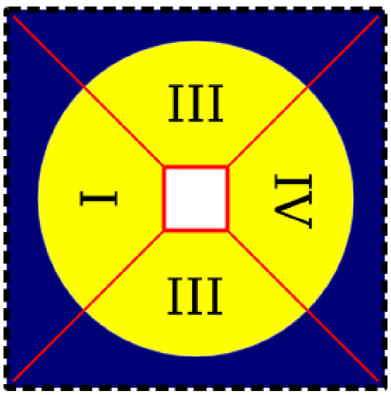
The following pages include a card game that can help students become more comfortable working rapidly with Roman numerals. If you've ever played *24 Game®*, the rules are very similar.

How to play:

1) First someone will need to use a pair of scissors to cut out their XXIV cards.
2) Then, students will need to pair up in groups of three to six.
3) Then all the students in a group will look at the card on the top of the pile and try to solve it. In order to solve it you must use all four numbers on the card once and only once. You can use any combination of multiplying, dividing, adding, and subtracting to make the card total '24'.
4) After the card is solved, flip the card and work on the other side as a group. Once both sides of the card have been solved, discard it and work on the next card in the deck.

This game is not about who scores the most points, instead it is about working collaboratively to better everyones' understanding of Roman numerals.

example card:



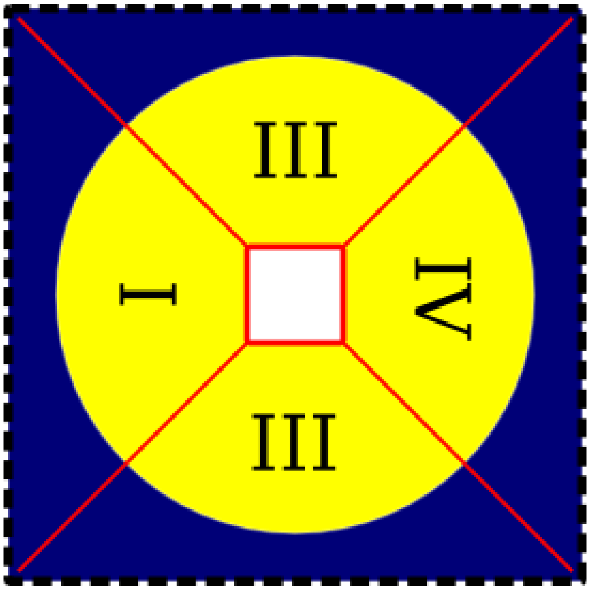
The Roman numerals on this card are III, IV, III, and I which translate into the Arabic numbers 3, 4, 3, and 1. I can solve this card any of the following ways:

$(3 \times 4) \times (3 - 1) = 24$

$[(3 - 1) \times 4] \times 3 = 24$

$(3 + 3) \times 4 \times 1 = 24$

Despite the fact that each card can usually be solved numerous ways, it only needs to be solved once.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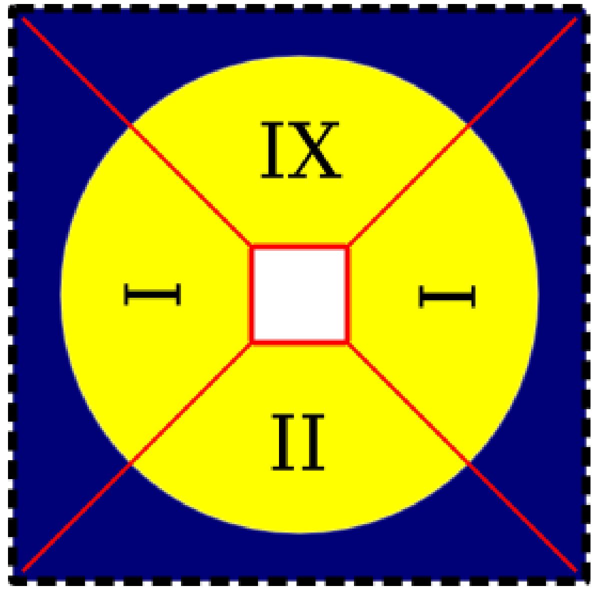
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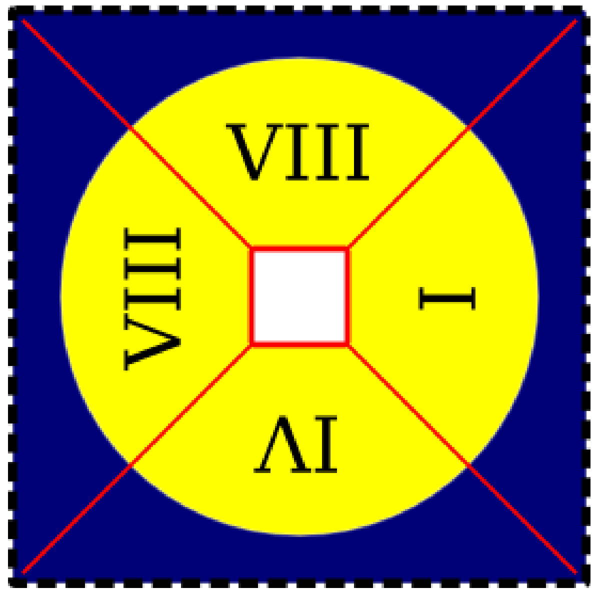
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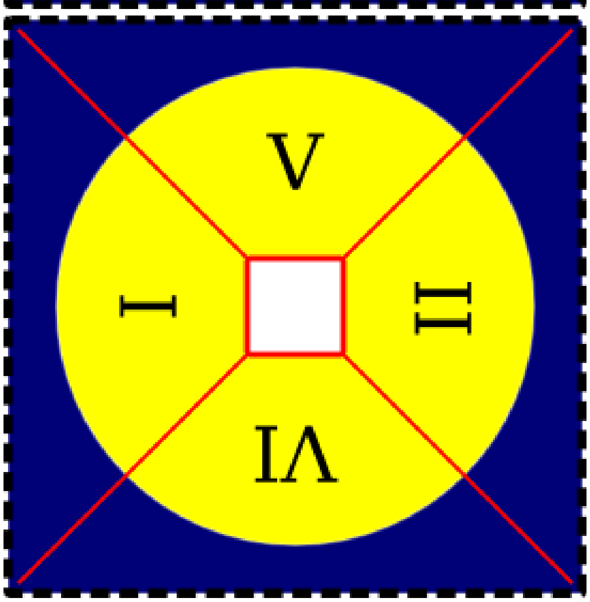
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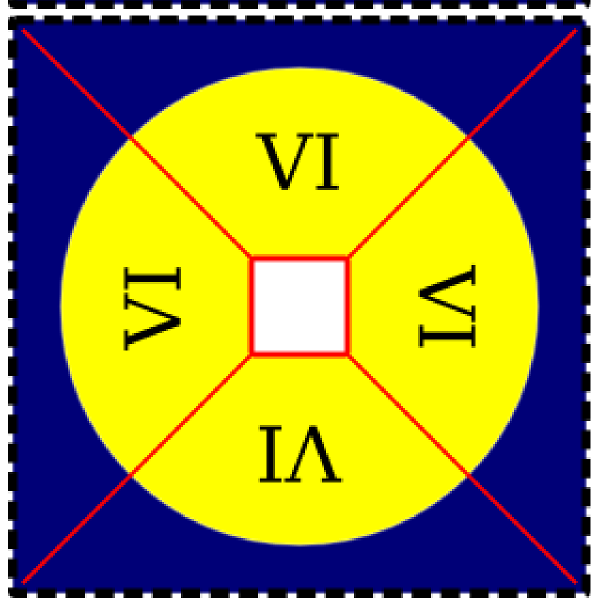
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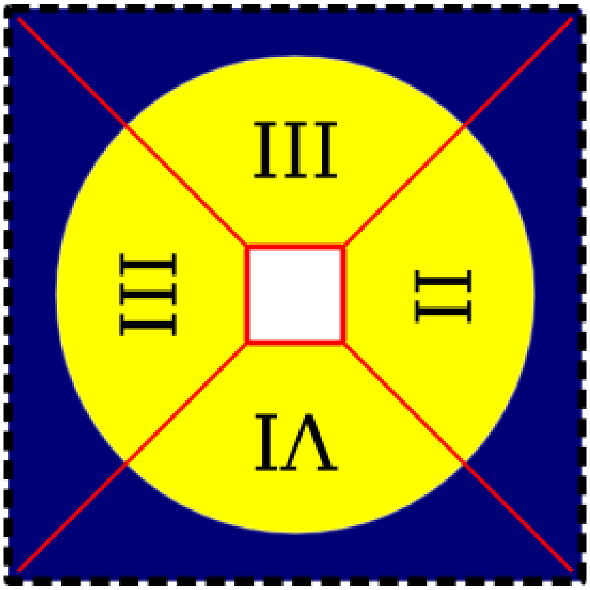
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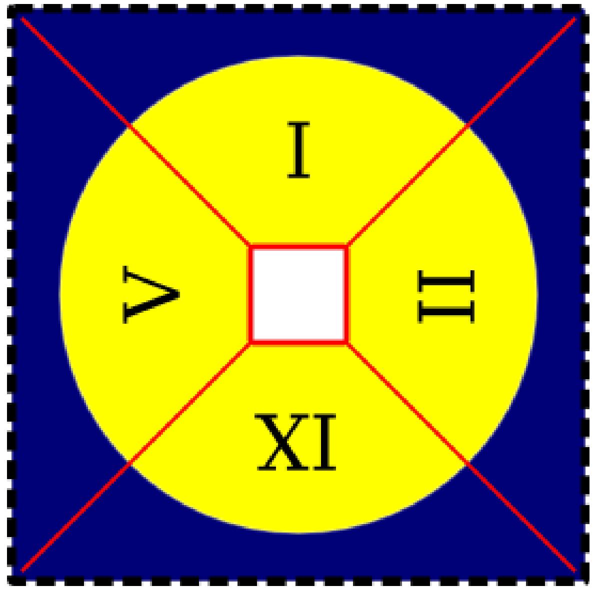
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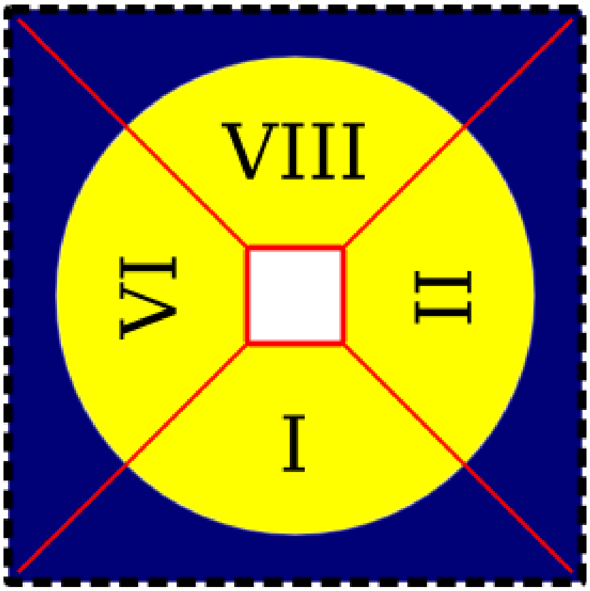
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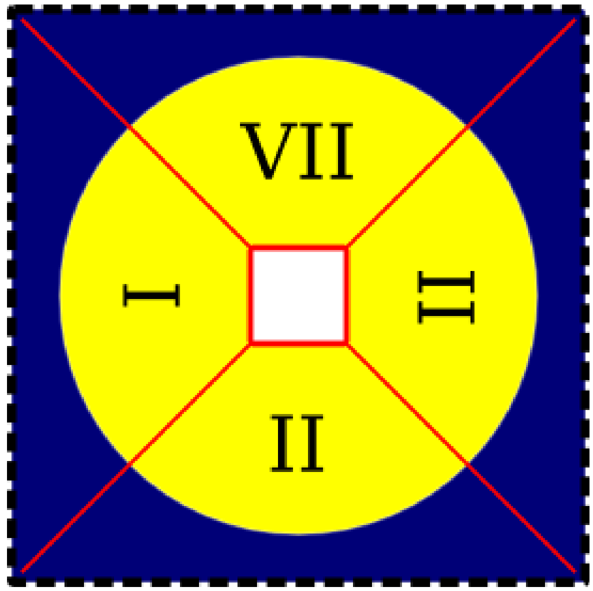
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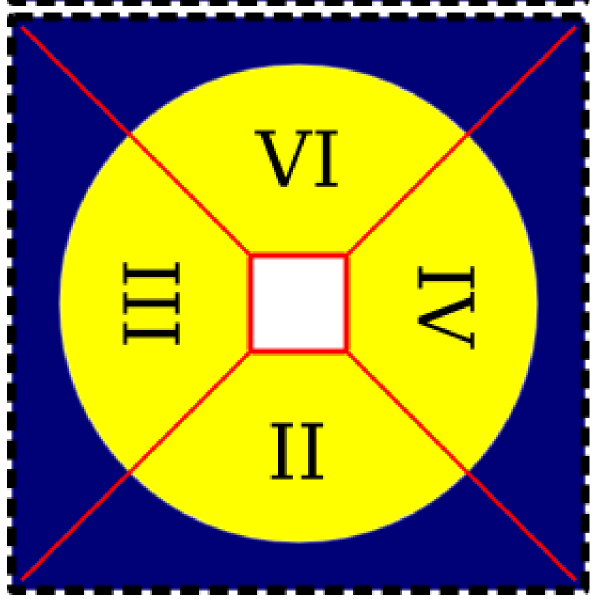
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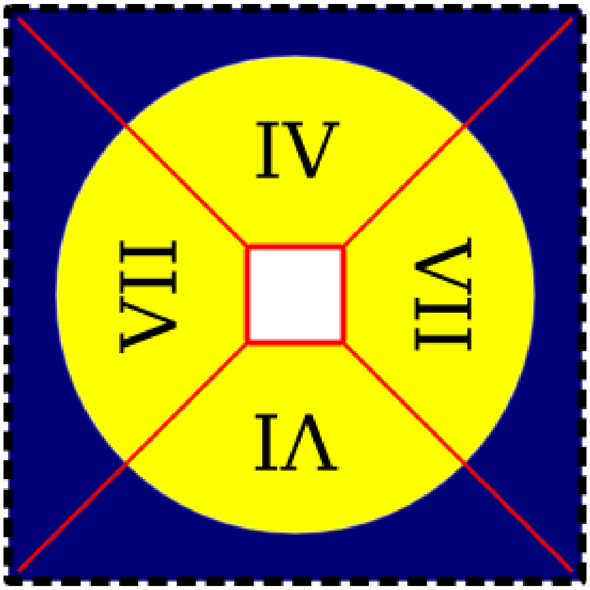
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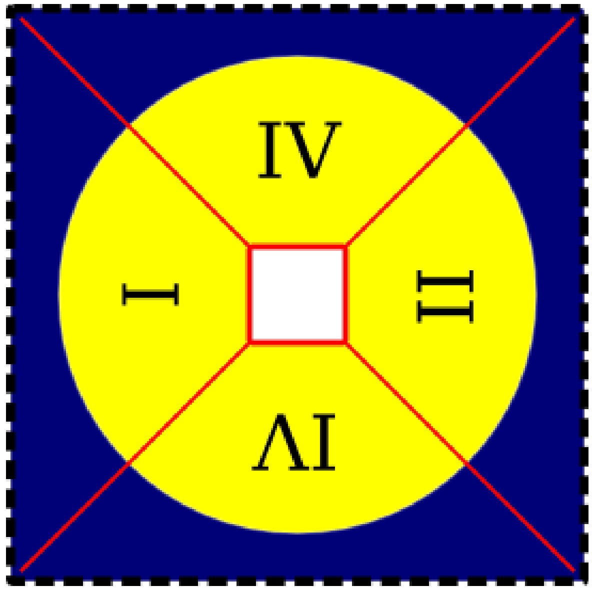
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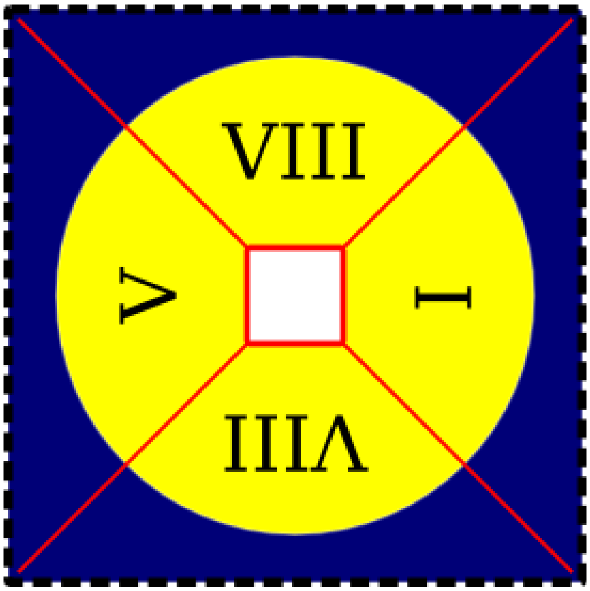
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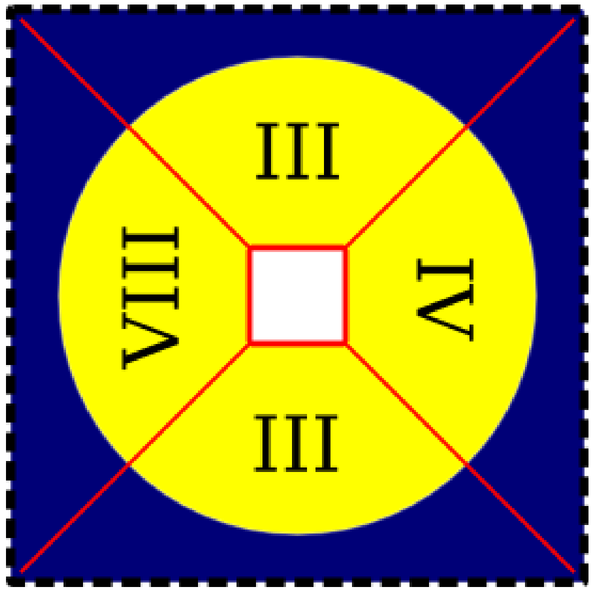
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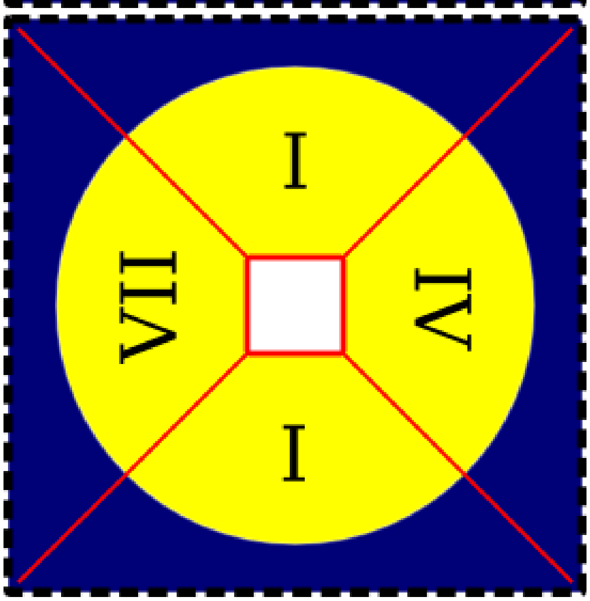
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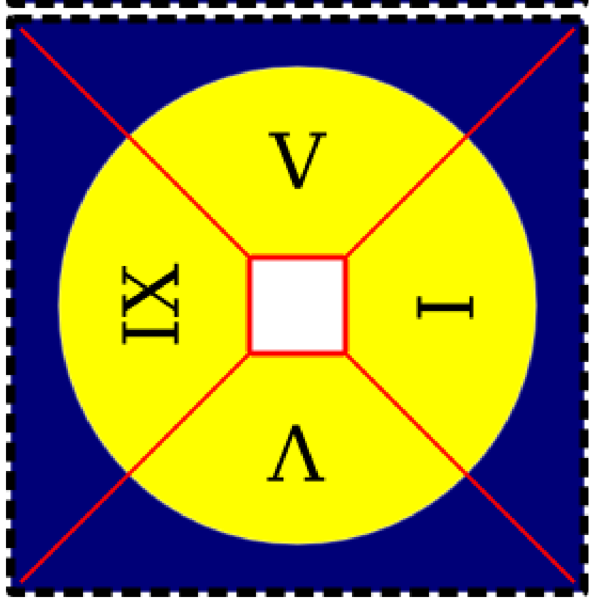
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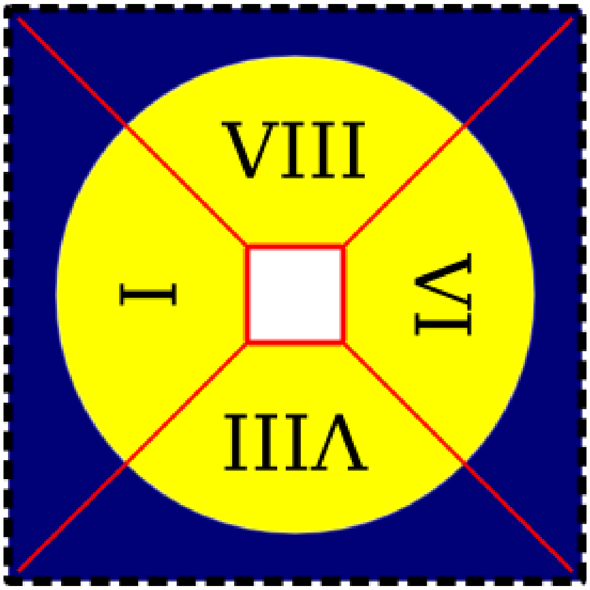
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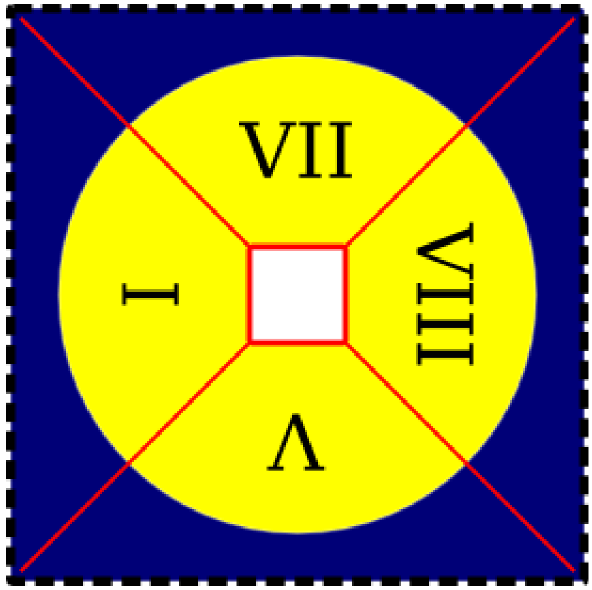
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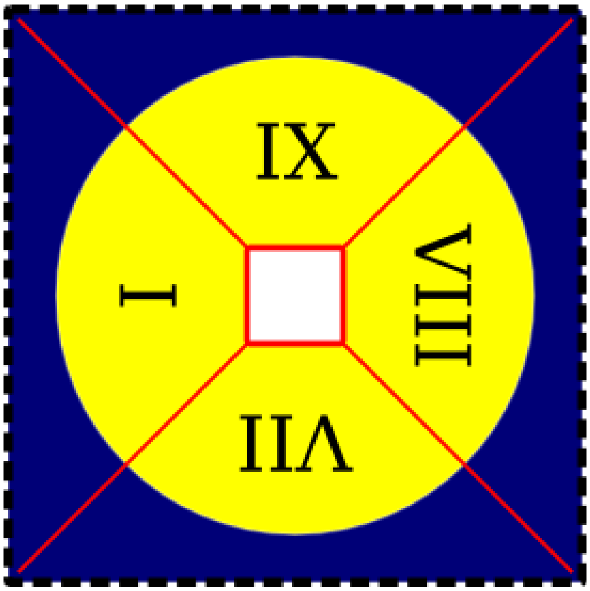
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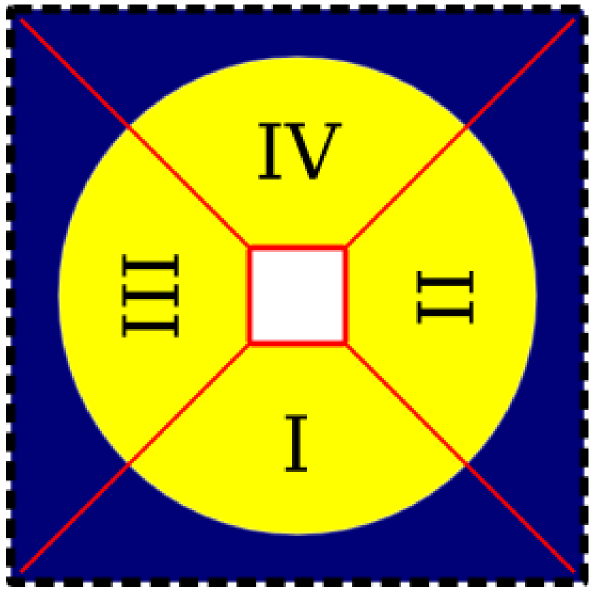
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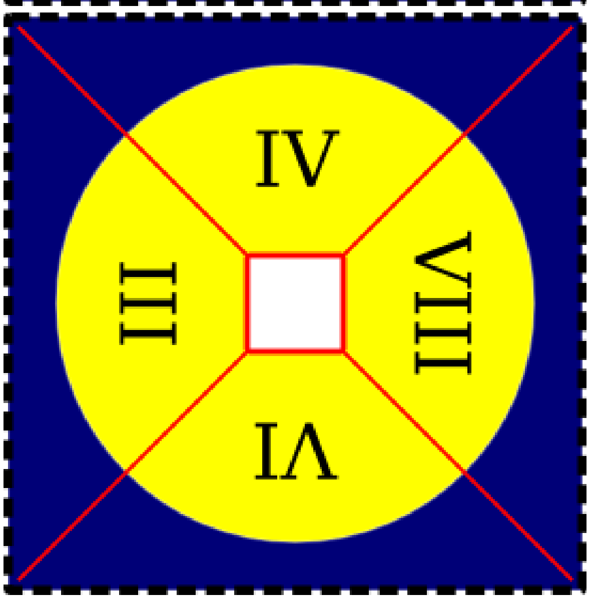
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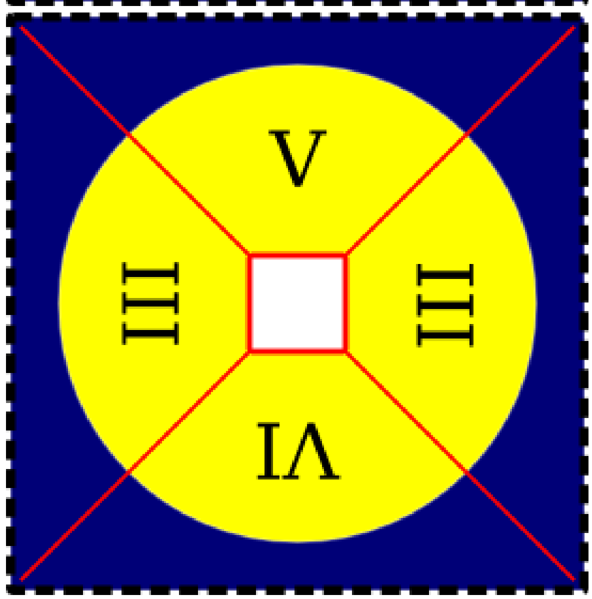
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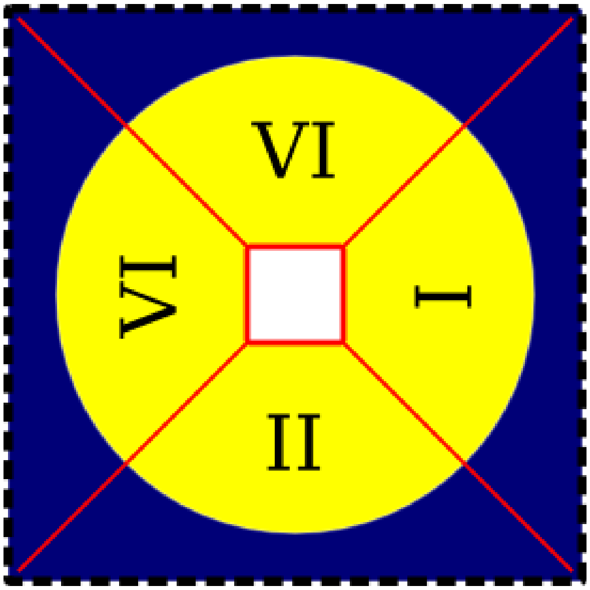
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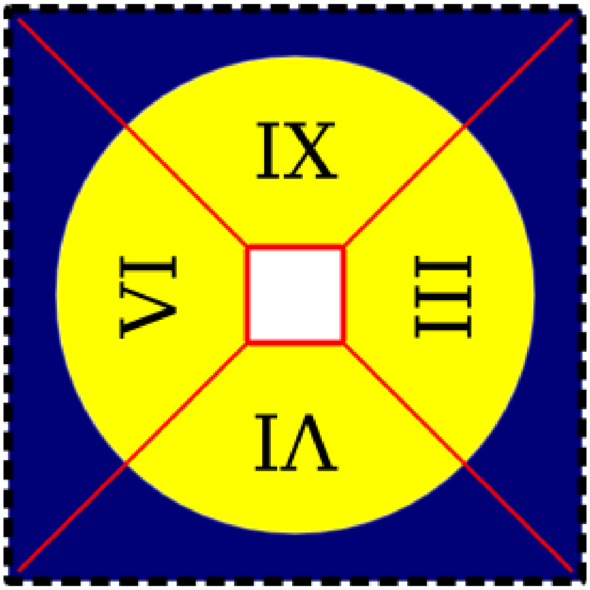
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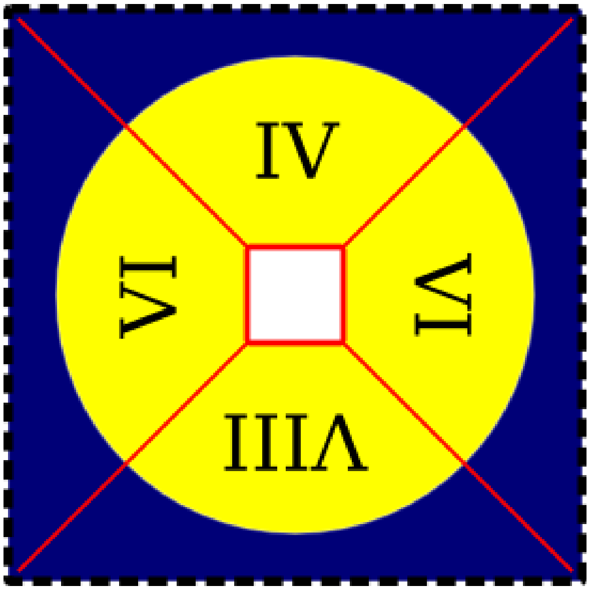
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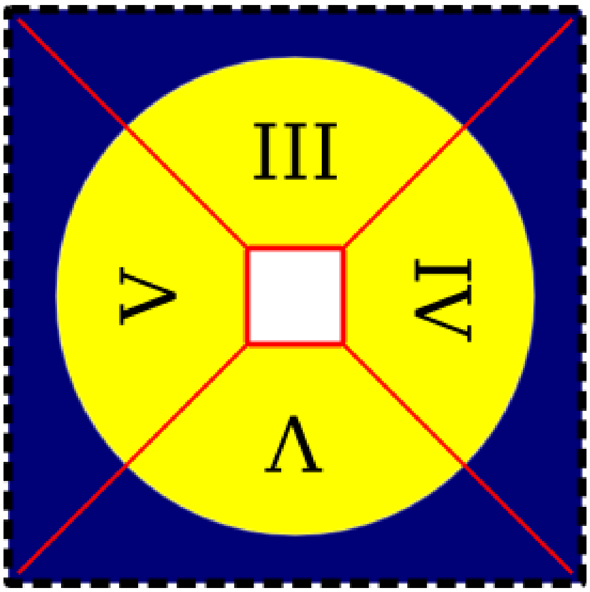
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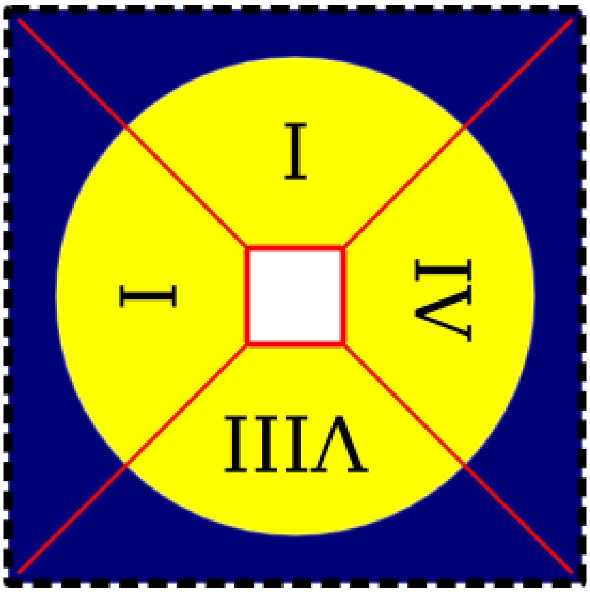
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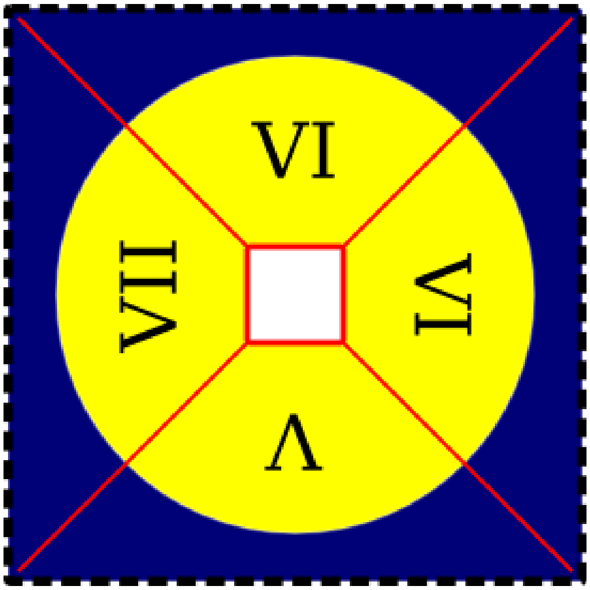
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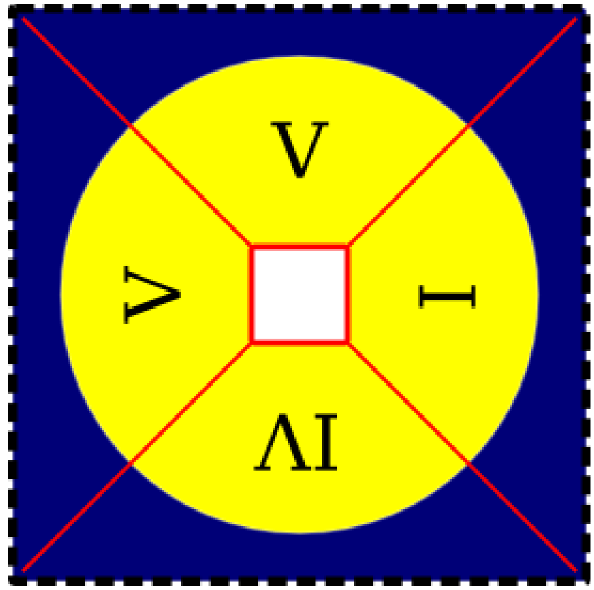
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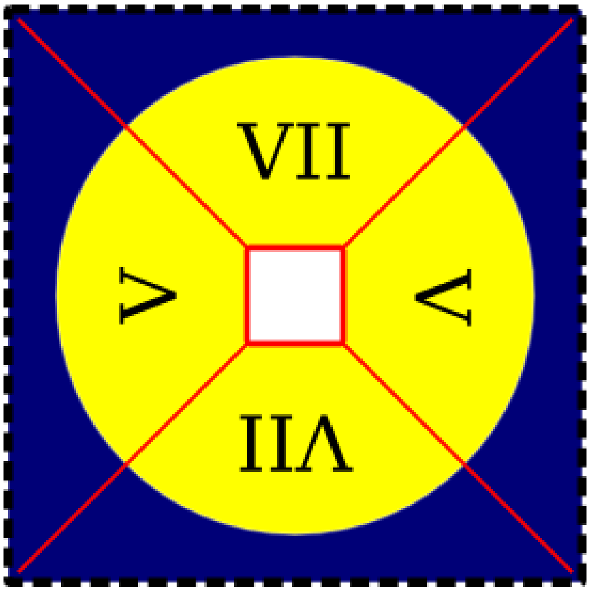
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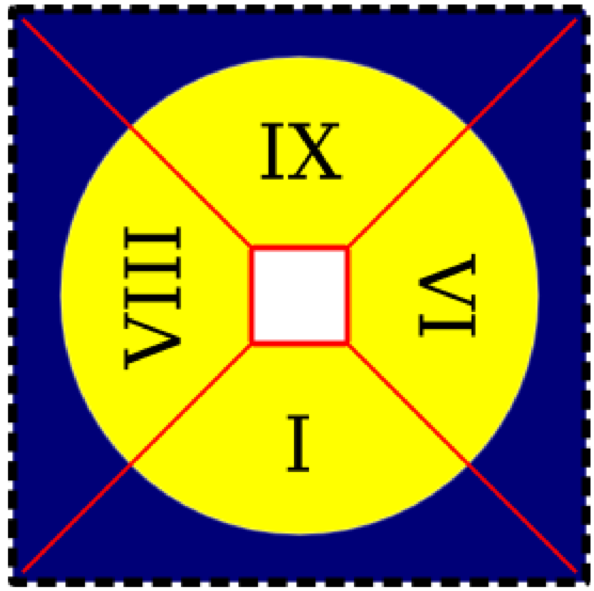
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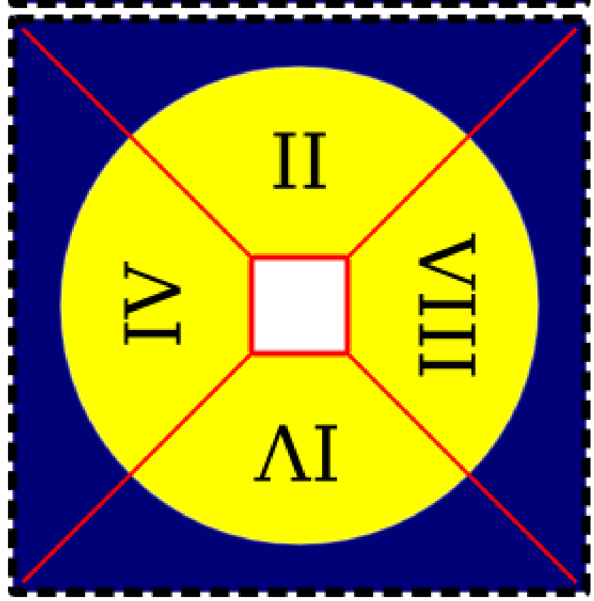
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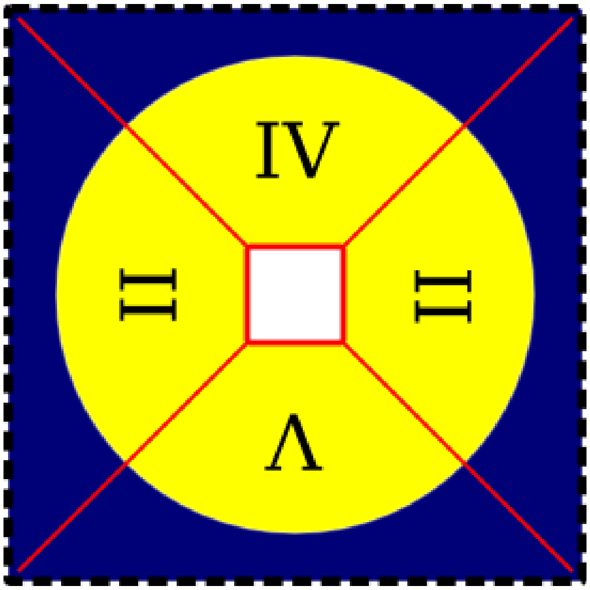
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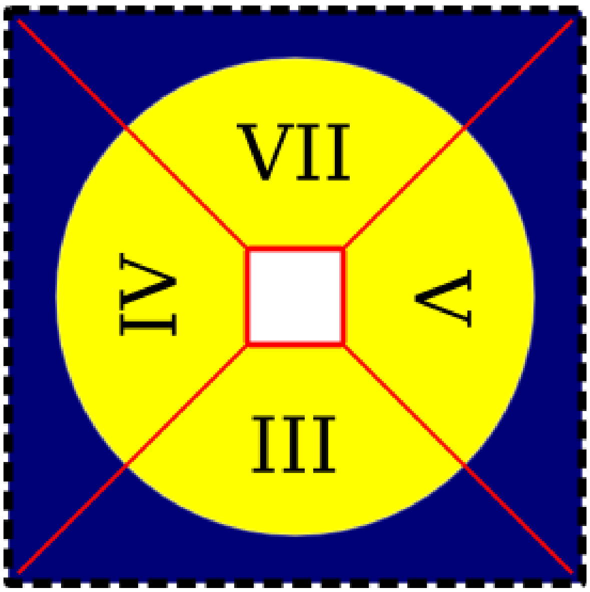
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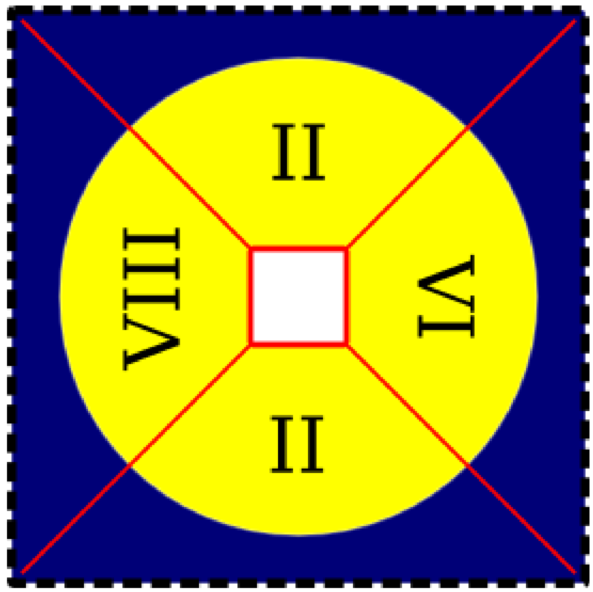
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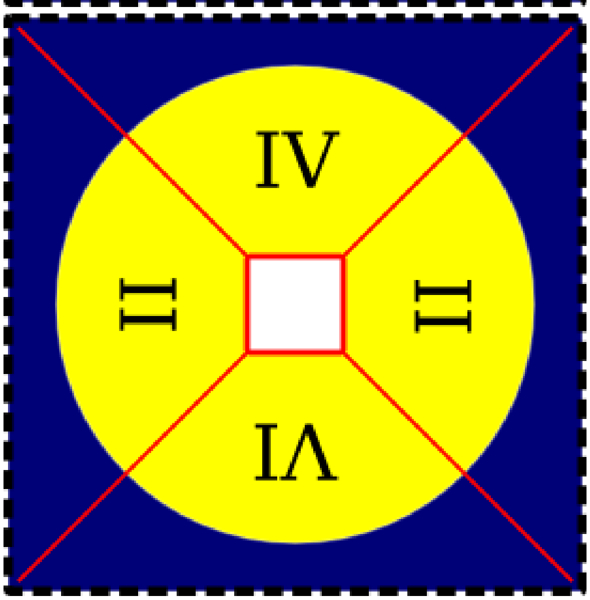
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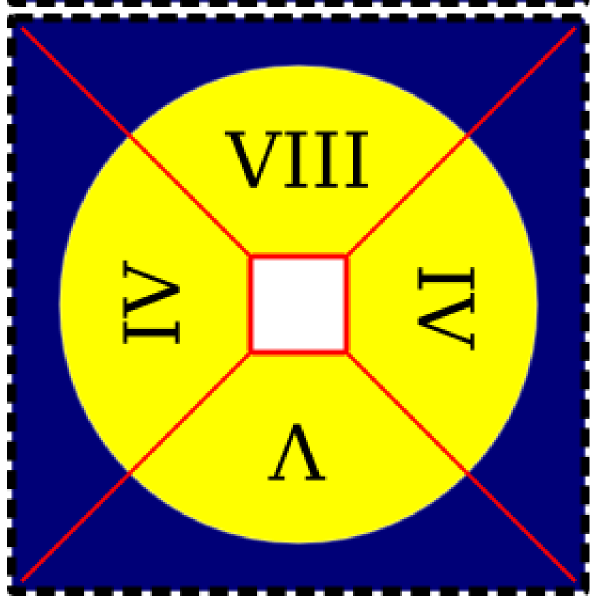
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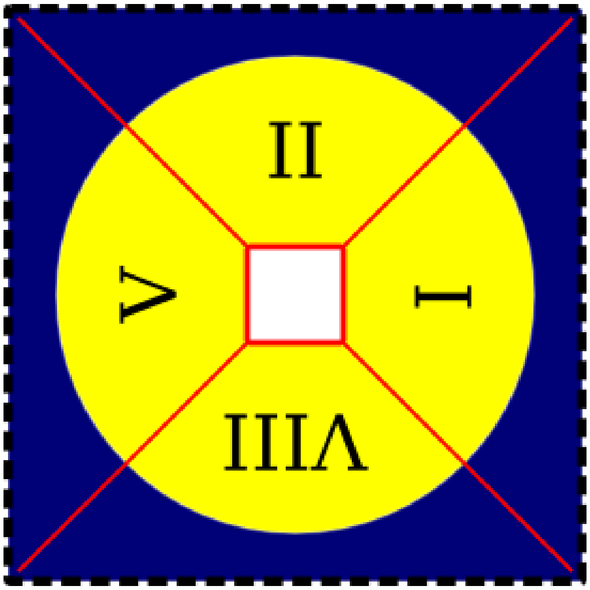
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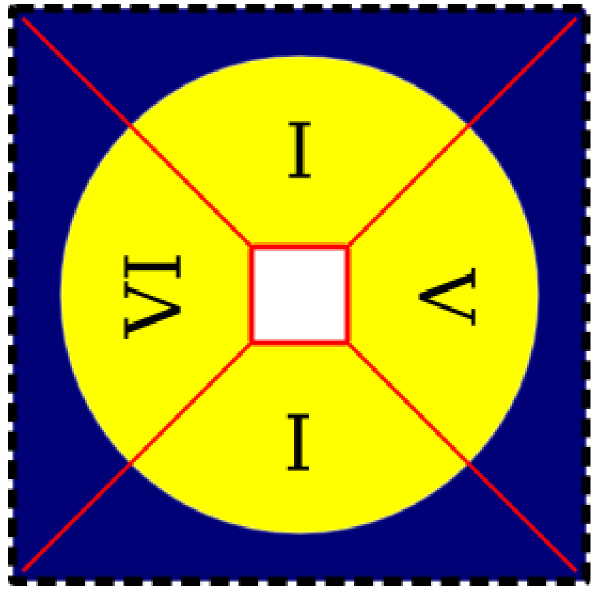
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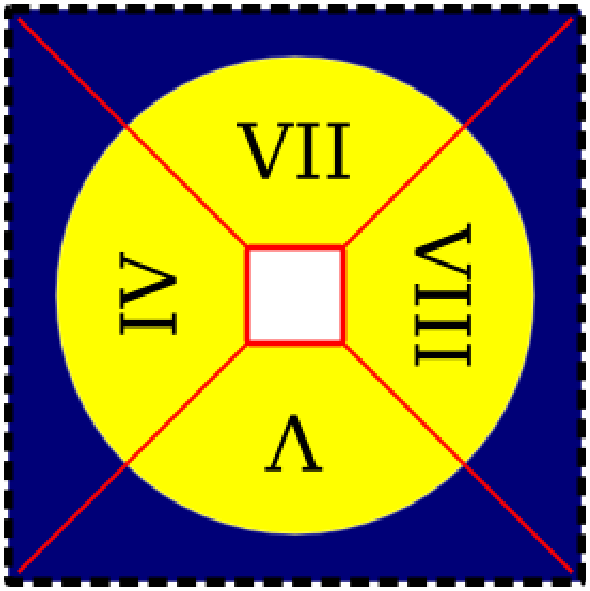
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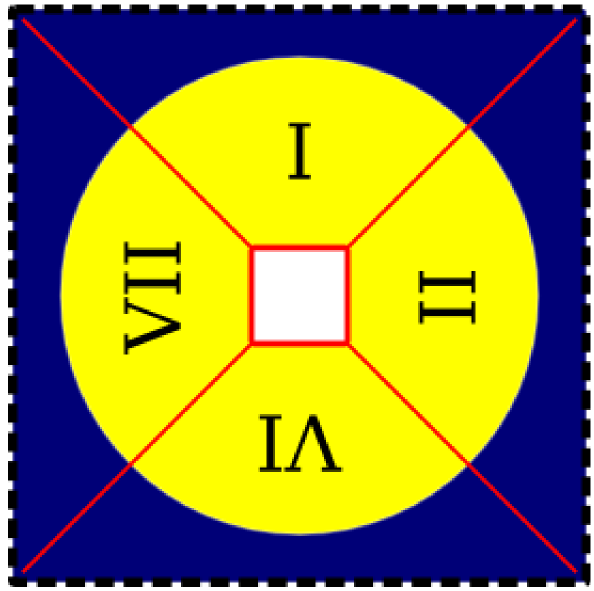
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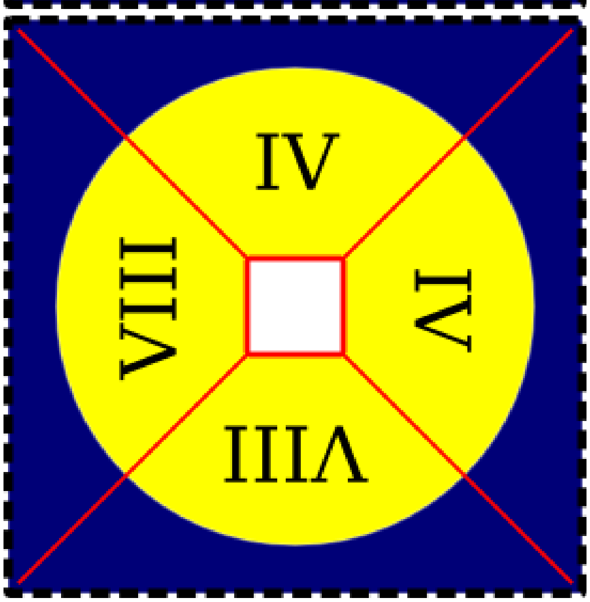
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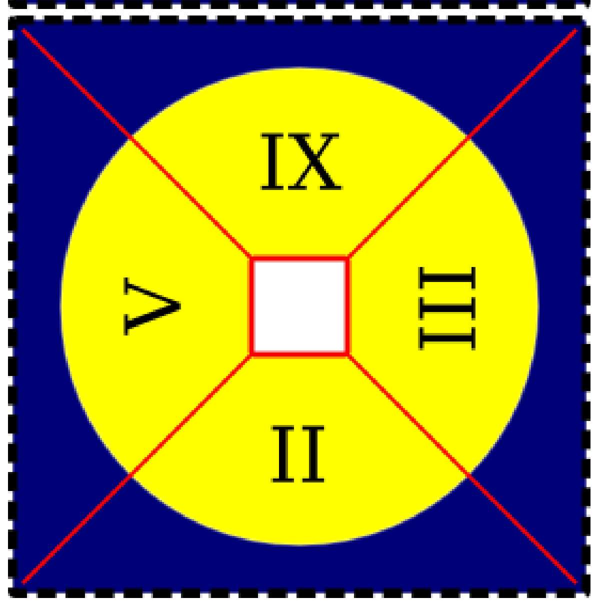
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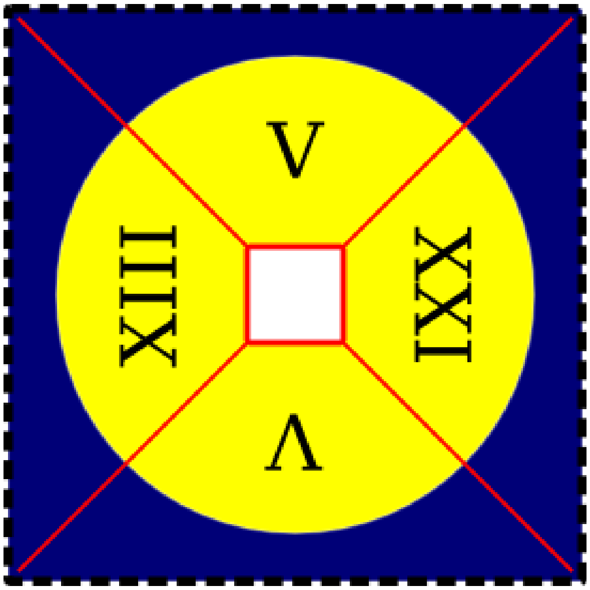
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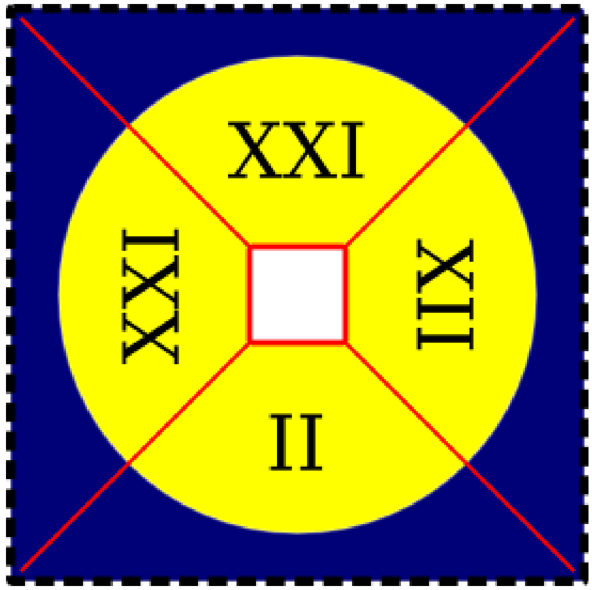
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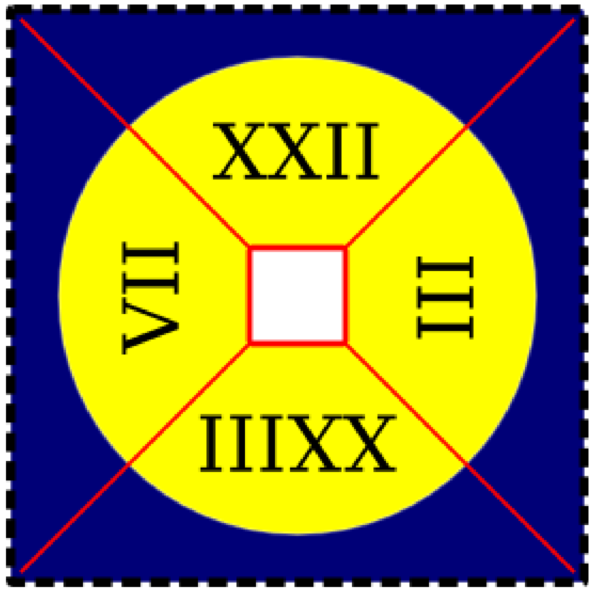
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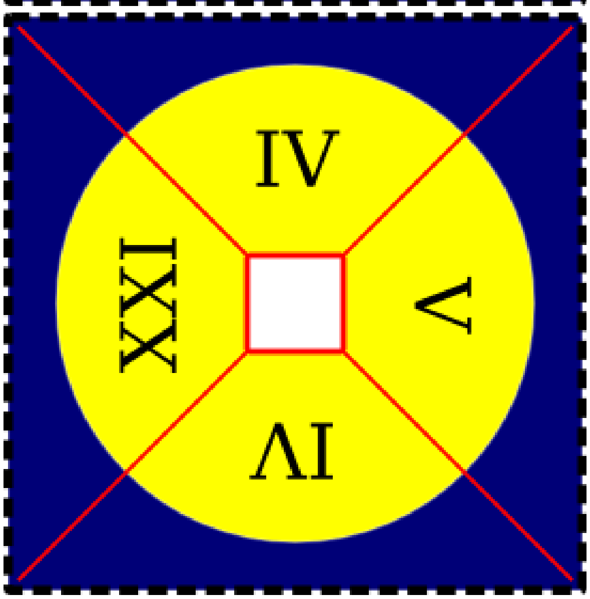
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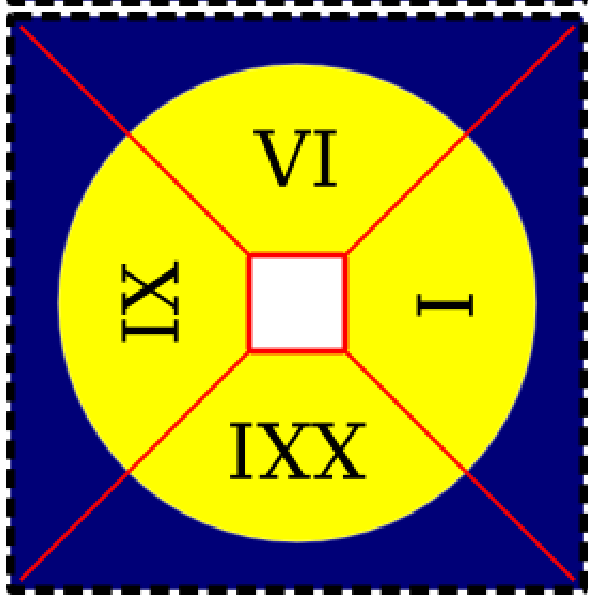
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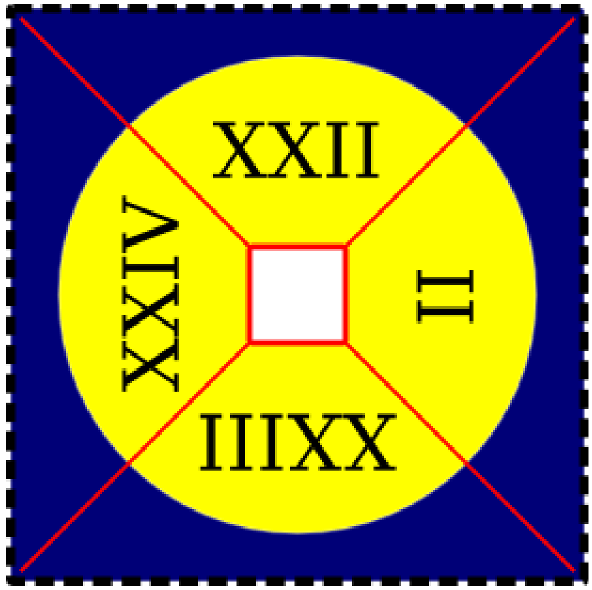
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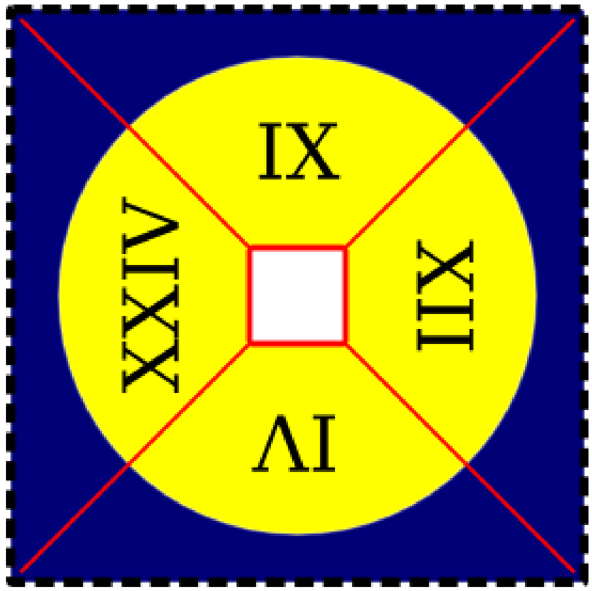
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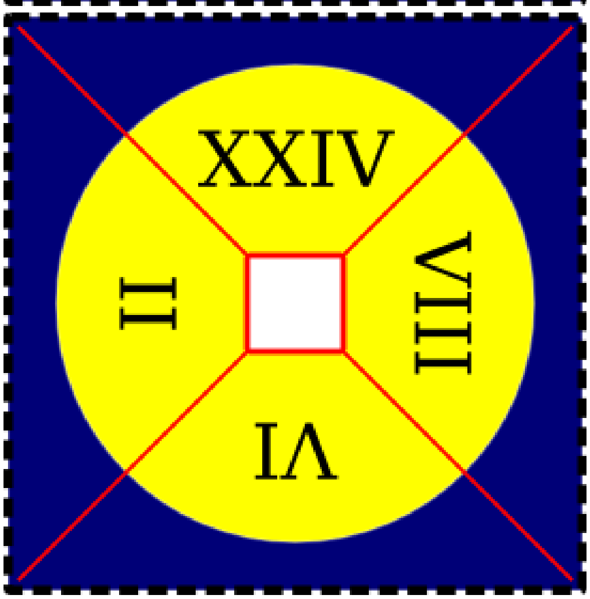
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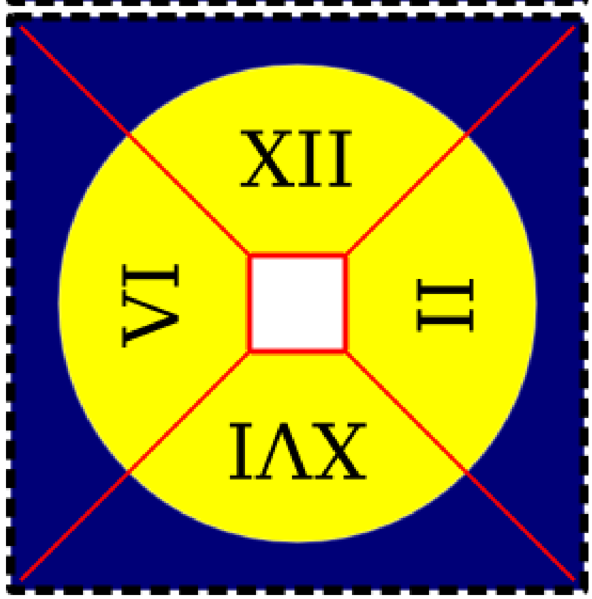
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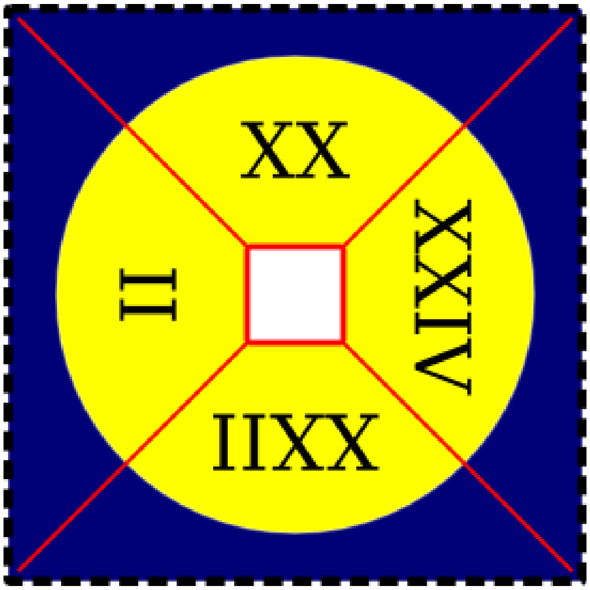
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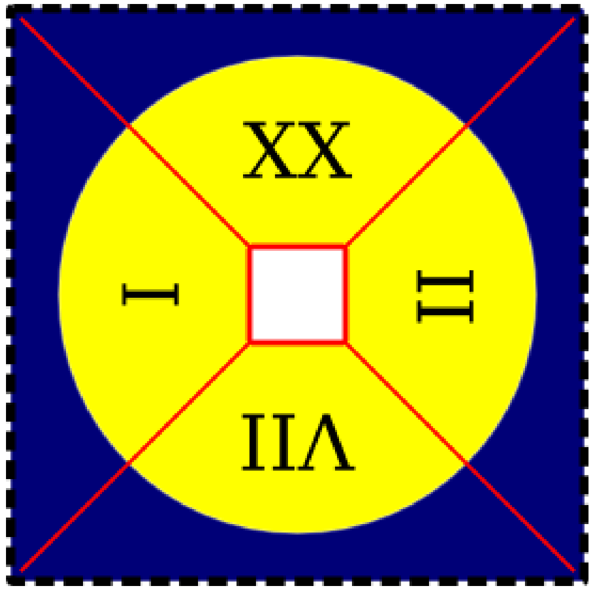
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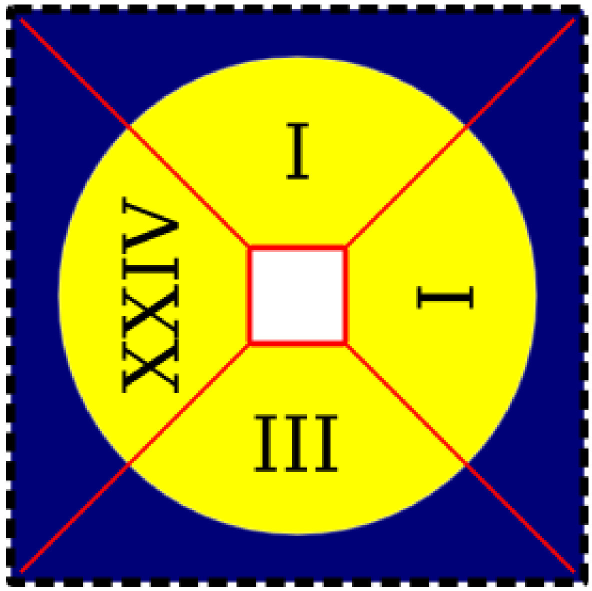
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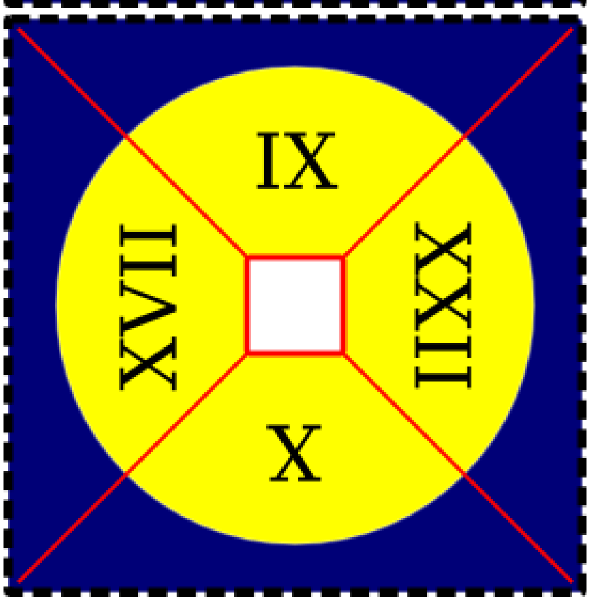
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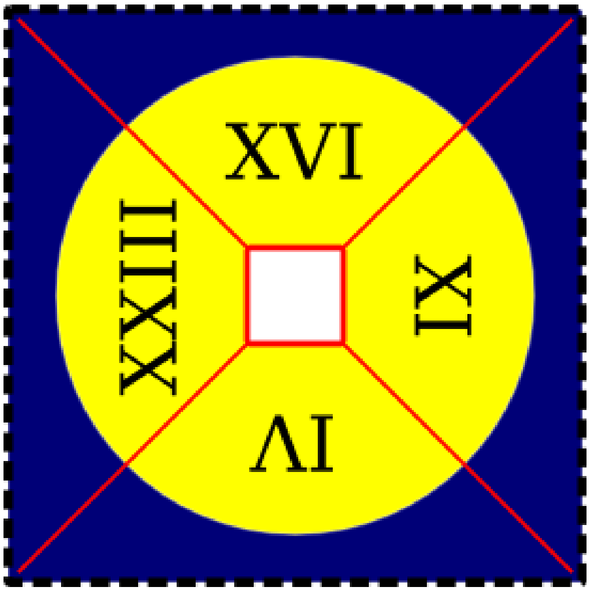
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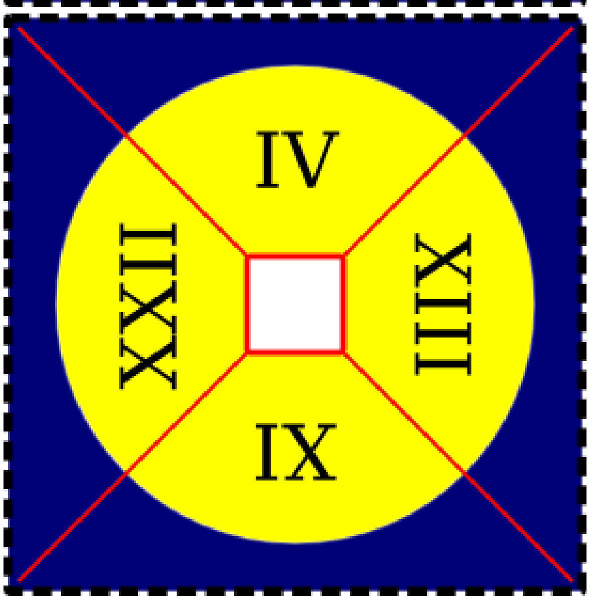
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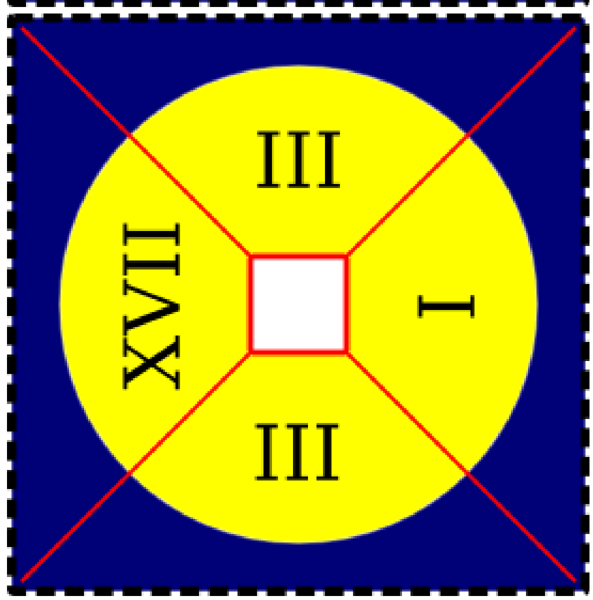
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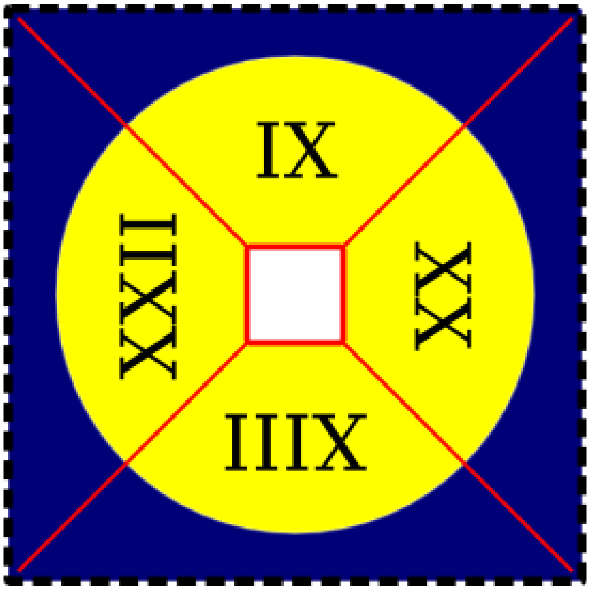
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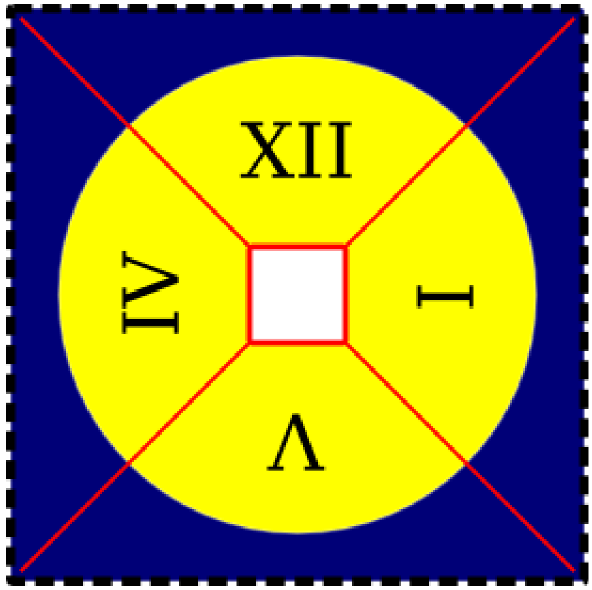
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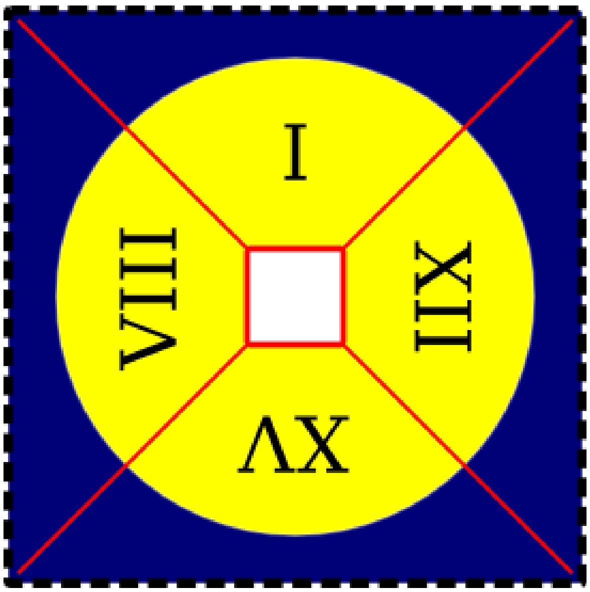
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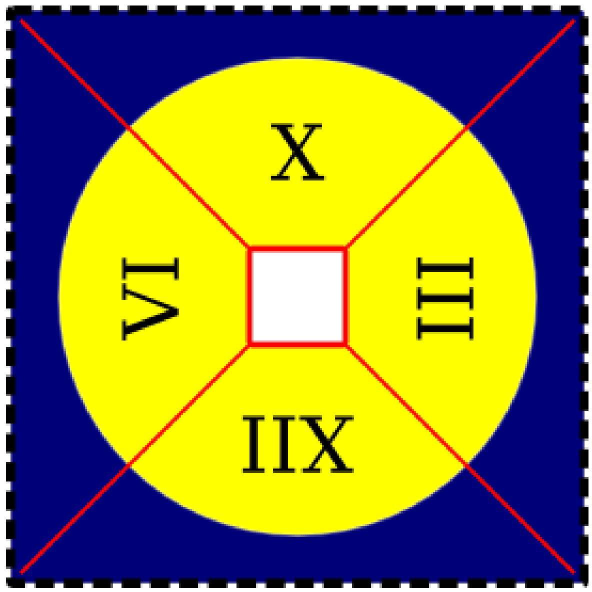
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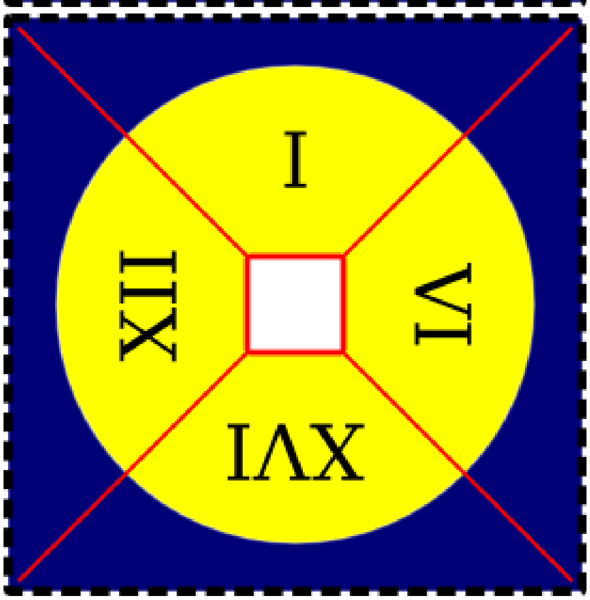
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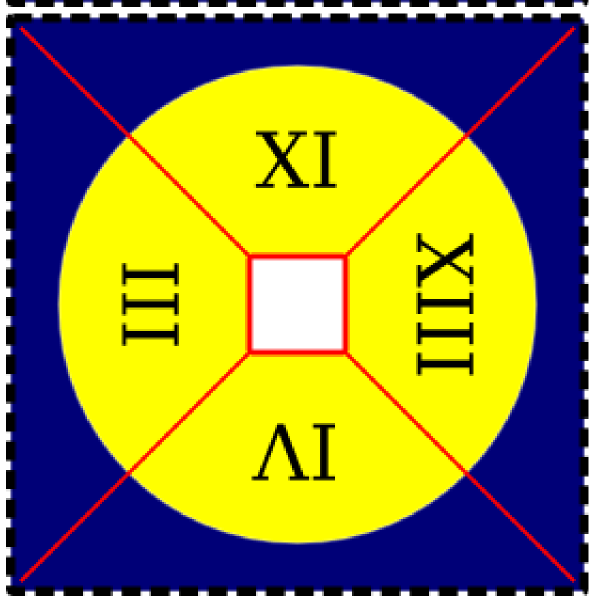
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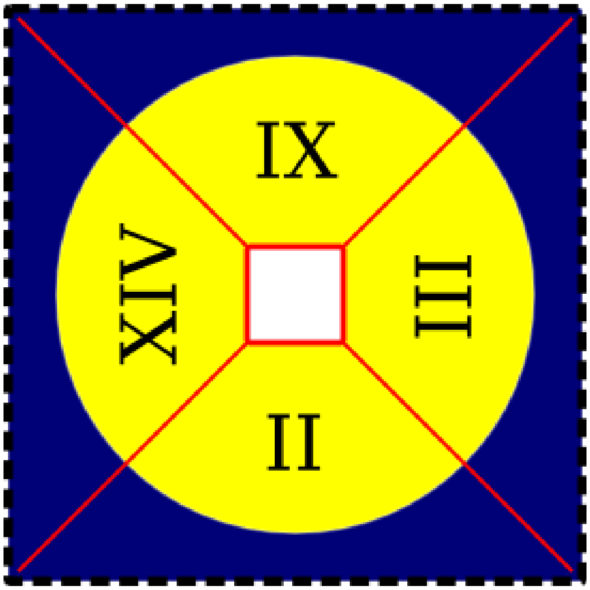
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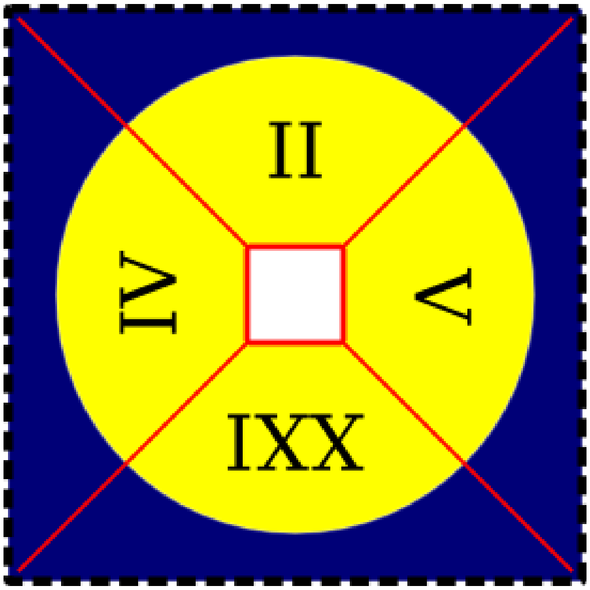
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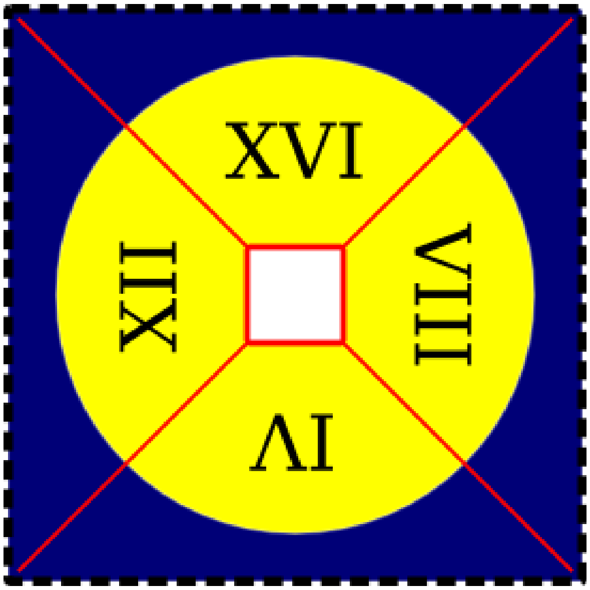
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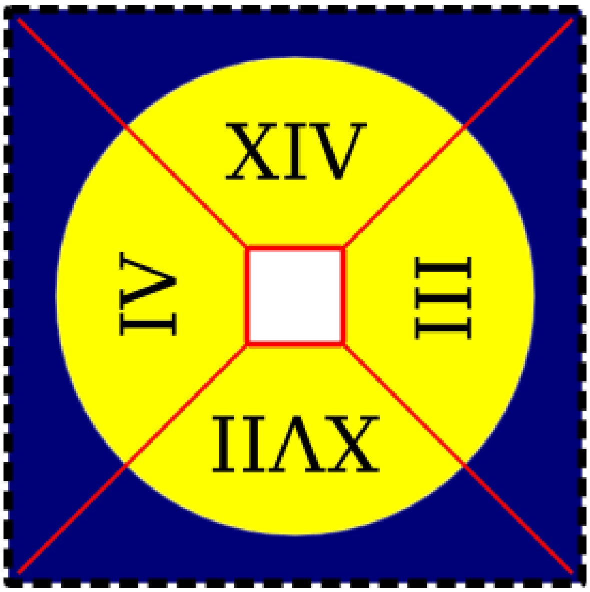
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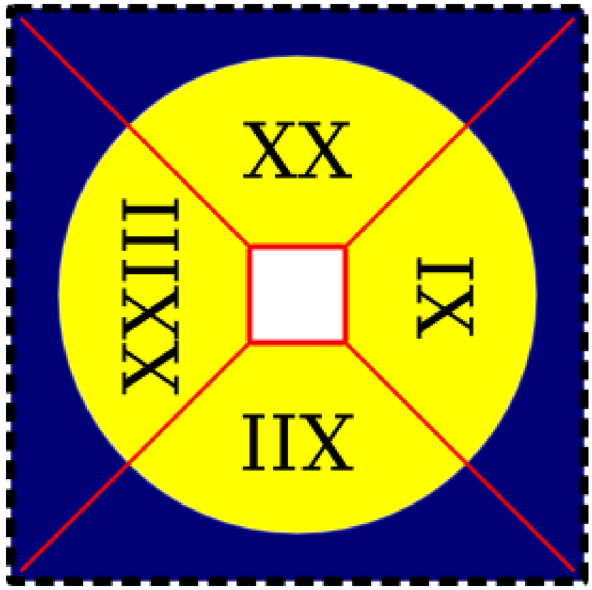
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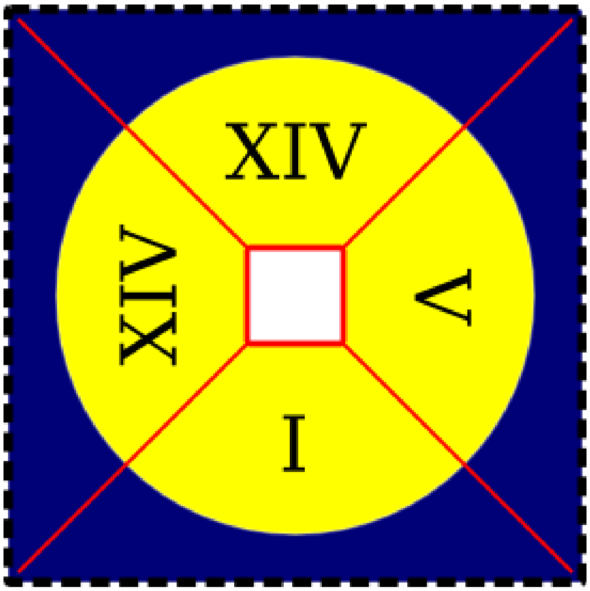
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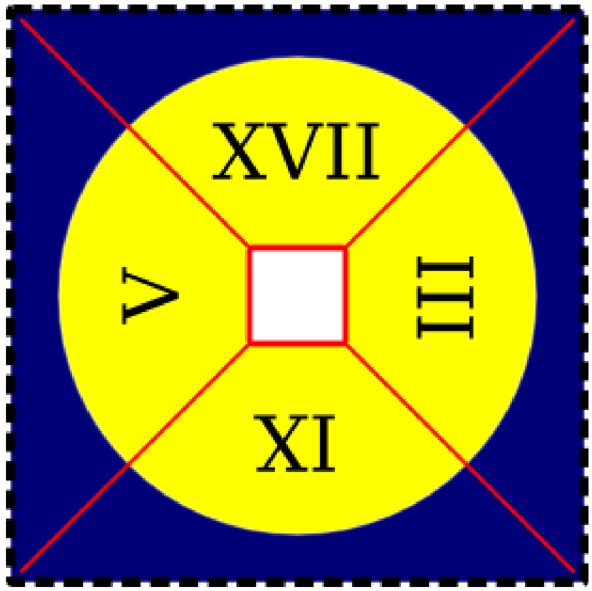
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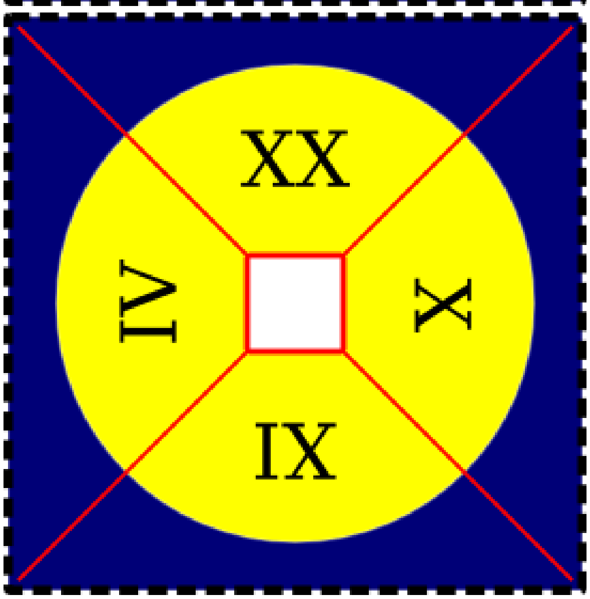
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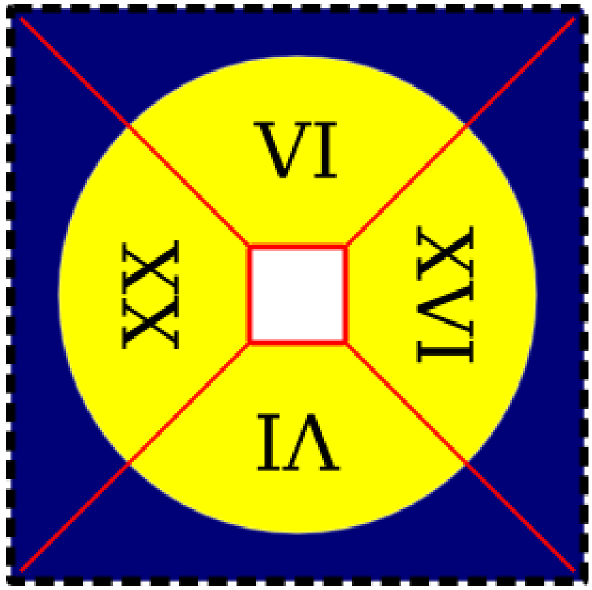
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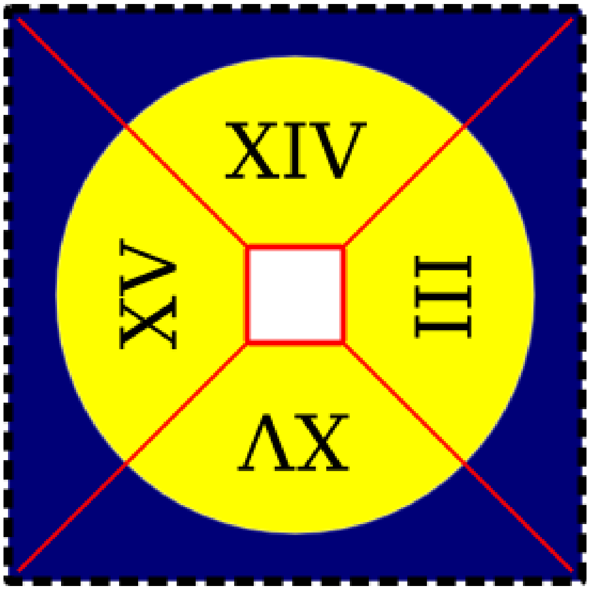
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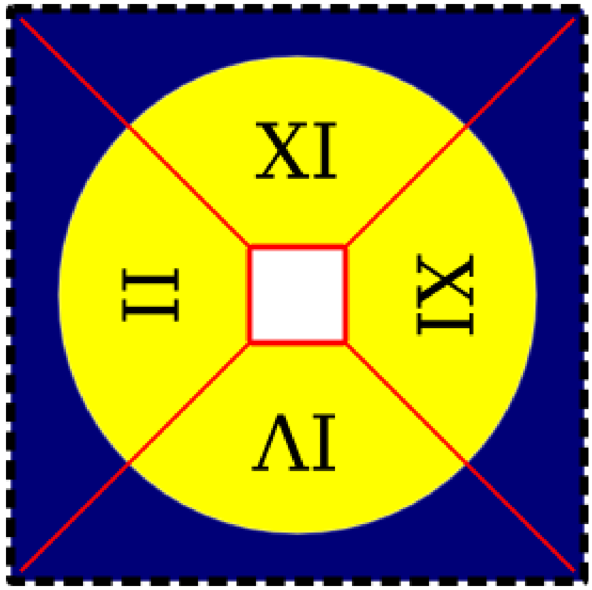
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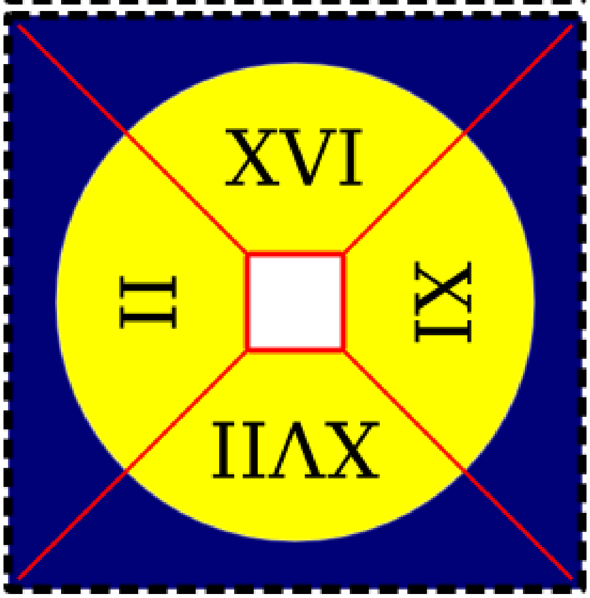
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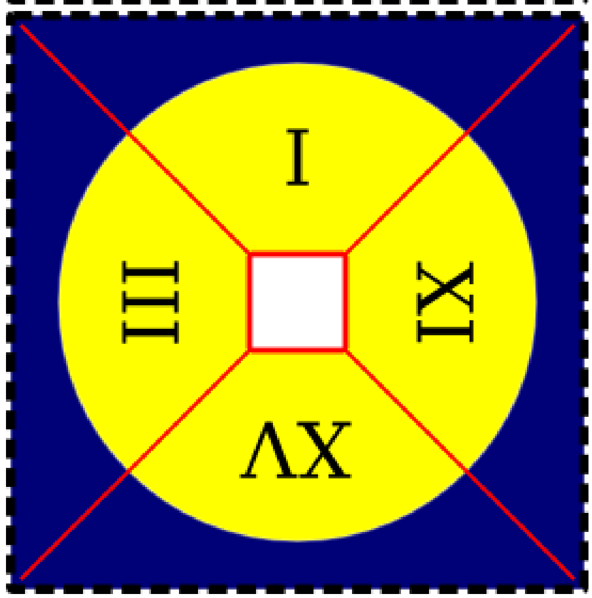
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Decimal Places

Now that we've spent some time reviewing Roman numerals, we are going to spend some time reviewing Arabic numbers. With respect to this, I would like to start with working on writing fractions in decimal form. The following two lists represent whole number places and decimal places.

Whole Numbers

1 = one
10 = ten
100 = one hundred
1,000 = one thousand
10,000 = ten-thousand
100,000 = one hundred-thousand
1,000,000 = one million

Decimal Numbers

1/10 = 0.1 = one ten*th*
1/100 = 0.01 = one hundred*th*
1/1,000 = 0.001 = one thousand*th*
1/10,000 = 0.0001 = one ten-thousand*th*
1/100,000 = 0.00001 = one hundred-thousand*th*
1/1,000,000 = 0.000001 = one million*th*

So, based on the information above **9876.5432**

The **9** is in the thousands position
The **8** is in the hundreds position
The **7** is in the tens position
The **6** is in the ones position
The **5** is in the ten*th*s position
The **4** is in the hundred*th*s position
The **3** is in the thousand*th*s position
The **2** is in the ten-thousand*th*s position

If you were to write it as a fraction, it would be:

$$\mathbf{9876\,\frac{5432}{10000}}$$

You could read it as **nine thousand eight hundred seventy six and five thousand four hundred thirty two ten-thousand*th*s**

Let's look at a decimal number and decide which position each number is in.

167.2543

a) 1 is in the ______________________ place.

b) 2 is in the ______________________ place.

c) 3 is in the ______________________ place.

d) 4 is in the ______________________ place.

e) 5 is in the ______________________ place.

f) 6 is in the ______________________ place.

g) 7 is in the ______________________ place.

a) hundreds b) tenths c) ten-thousandths d) thousandths e) hundredths f) tens g) ones

On the following page is a worksheet to practice writing fractions in decimal form.

Worksheet 1-3

Name:

Date:

What is the place name of the 7 in each of these numbers?

1) 743 ____________
2) 5,763,482 ____________
3) 2,178,000,013 ____________
4) 26.74 ____________
5) 0.0007 ____________
6) 17.054 ____________

Write the following numbers in decimal format.

7) twelve million four thousand twenty-five ______________________________
8) thirty-one thousand three hundred thirty-seven ______________________________
9) five million three hundred eighteen thousand eight ______________________________
10) seven tenths ______________________________
11) thirty-nine hundredths ______________________________
12) fifteen and seven tenths ______________________________
13) six and seven hundredths ______________________________
14) seven hundred five and one hundred seven ten-thousandths______________________________

Write the following fractions in decimal format.

15) $\frac{7}{10}$ ____________
16) 95 $\frac{7}{100}$ ____________
17) $\frac{57}{100}$ ____________
18) $\frac{19}{10,000}$ ____________
19) 406 $\frac{214}{10,000}$ ____________
20) 507 $\frac{112}{10,000}$ ____________

Change the following decimals into fractions (but do not reduce your fractions).

21) 0.6 __________________
22) 0.85 __________________

23) 0.006 ____________________

24) 0.0574 ____________________

25) 13.000013 ____________________

26) 80.08135 ____________________

The following are the answers to the odd problems.

1) hundreds place
3) ten-millions place
5) ten-thousandths place
7) 12,004,025
9) 5,318,008
11) 0.39
13) 6.07
15) 0.7
17) 0.57
19) 406.0214
21) $\frac{6}{10}$
23) $\frac{6}{1,000}$
25) 13 $\frac{13}{1,000,000}$

Rounding Decimals & Significant Figures

Sometimes when you are working with numbers, you will find them to large to be manageable. In these scenarios, you should round.

- Rounding makes numbers that are easier to work with in your head.
- Rounded numbers are only approximate.
- An exact answer generally can not be obtained using rounded numbers.
- Use rounding to get a answer that is close but that does not have to be exact.

How to round numbers

For whole numbers:

- Make the numbers that end in 1 through 4 into the next lower number that ends in 0. For example 74 rounded to the nearest ten would be 70.
- Numbers that end in a digit of 5 or more should be rounded up to the next even ten. The number 88 rounded to the nearest ten would be 90.

For decimal numbers:

- When looking to round a significant figure that is proceeded by a 1 through 4, you may stop your decimal there. For example 0.74 rounded to the nearest tenth would be 0.7
- When looking to round a significant figure that is proceeded by a 5 or more should be rounded up. The number 0.88 rounded to the nearest tenth would be 0.9

Significant Figures

A significant figure is one that is actually measured.

Rules for assigning significant figures:

- Digits other than zero are always significant. For example, 34.12 has four significant figures.
- Zeros used only to space the decimal are never significant. For example, 0.007 has one significant figure and 16,000 only has two significant figures.
- Final zeros after a decimal point are always significant. For example, 0.0070 has two significant figures.
- Zeros between two other significant digits are always significant. For example, 50.04 has four significant figures.

Determine the number of significant figures in 0.20 ml of Lantus insulin.

0.20 ml of Lantus insulin has two significant figures

On the following page is a worksheet to attain some practice with determining significant figures and rounding numbers.

Worksheet 1-4

Name:

Date:

Round the following numbers to the nearest whole number.

1) 102.5 ____________
2) 1.0 ____________
3) 88.1 ____________
4) 99.7 ____________
5) 187.4999 ____________
6) 29,001.501 ____________

Round the following numbers to the nearest tenth.

7) 1.0 ____________
8) 99.7 ____________
9) 2.54 ____________
10) 29,001.501 ____________
11) 187.4999 ____________
12) 12.99 ____________

Round the following numbers to the nearest hundredth.

13) 187.4999 ____________
14) 12.99 ____________
15) 29,001.501 ____________
16) 1234567.8901 ____________
17) 66.666667 ____________
18) 5,454.5454 ____________

Determine the number of significant figures in each measurement.

19) 64.8 mg ______ significant figures
20) 1.609 km ______ significant figures
21) 0.25 mL ______ significant figures
22) 4.06 mEq ______ significant figures
23) 0.454 kg ______ significant figures
24) 0.06 mL ______ significant figures

25) 0.20 mcm

______ significant figures

26) 220 lb

______ significant figures

27) 0.001 kg

______ significant figures

Adding & Subtracting Decimal Numbers

Adding and subtracting decimals is the same as adding and subtracting whole numbers.

To add decimal numbers:

- Put the numbers in a vertical column, aligning the decimal points.
- Add each column of digits, starting on the right and working left.
- Place the decimal point in the answer directly below the decimal points in the terms.

$$\begin{array}{r} 9817.543 \\ \underline{+\quad 0.123} \\ 9817.666 \end{array}$$

Do the following practice problems:

1) $\begin{array}{r} 324.5678 \\ \underline{+\quad 2.3456} \end{array}$

3) $\begin{array}{r} 32.255 \\ \underline{+\quad 1.0123} \end{array}$

5) $\begin{array}{r} 6.6663 \\ \underline{+ 12.0007} \end{array}$

2) $\begin{array}{r} 0.6 \\ +\ 0.4 \\ \underline{+\ 1.5} \end{array}$

4) $\begin{array}{r} 4.0068 \\ +\quad 0.06 \\ \underline{+ 43.667} \end{array}$

6) $\begin{array}{r} 5.004 \\ +\ 17 \\ \underline{+ 12.02} \end{array}$

1) 326.9134 2) 2.5 3) 33.2673 4) 47.7338 5) 18.6670 6) 34.024

To subtract decimal numbers:

- Put the numbers in a vertical column, aligning the decimal points.
- Subtract each column, starting on the right and working left. If the digit being subtracted in a column is larger than the digit above it, “borrow” a digit from the next column to the left.
- Place the decimal point in the answer directly below the decimal points in the terms.

$$\begin{array}{r} 9817.544 \\ \underline{-\quad 5.123} \\ 9812.421 \end{array}$$

Do the following practice problems:

1) $\begin{array}{r} 324.5678 \\ \underline{-\quad 2.3456} \end{array}$	3) $\begin{array}{r} 32.255 \\ \underline{-\quad 1.0123} \end{array}$	5) $\begin{array}{r} 6.6663 \\ \underline{-\ 2.0007} \end{array}$
2) $\begin{array}{r} 0.6 \\ \underline{-\ 0.5} \end{array}$	4) $\begin{array}{r} 4.0068 \\ \underline{-\quad 0.06\ \ } \end{array}$	6) $\begin{array}{r} 5.004 \\ \underline{-\ 2.02\ \ } \end{array}$

1) 322.2222 2) 0.1 3) 31.2427 4) 3.9468 5) 4.6656 6) 2.984

Worksheet 1-5

Name:

Date:

Perform the following addition problems.

1)	28,291 + 27,595	2)	5.08 + 0.17	3)	25.09 + 18.7	4)	97.07 + 0.09	5)	31.05 + 4.7	6)	85.2 + 1.764

7) 31 + 24 + 18 = ____________

9) 35.07 + 19.1 = ____________

11) 1.28 + 31.05 + 4.7 = ____________

8) 4951 + 3287 = ____________

10) 88.08 + 0.02 = ____________

12) 18 + 0.042 + 16.3 = ____________

Perform the following subtraction problems.

13)	28,291 - 27,595	14)	5.08 - 0.17	15)	25.09 - 18.7	16)	97.07 - 0.09	17)	31.05 - 4.7	18)	85.2 - 1.764

19) 4951 – 3287 = ____________

21) 88.08 – 0.02 = ____________

23) 4.5 – 4.05 = ____________

20) 35.07 – 19.1 = ____________

22) 0.97 – 0.012 = ____________

24) 0.951 – 0.112 = ____________

Perform the following applied problems.

25) A neonate initially weighed 4.03 kg at birth. Three days later, he weighed 3.944 kg. How many kg did the neonate lose?

26) Normal body temperature is 37.0° C. What temperature is 0.4° above normal?

Multiplying Decimal Numbers

To multiply decimal numbers:

- Multiply the numbers just as if they were whole numbers.
- Line up the numbers on the right.
- Starting on the right, multiply each digit in the top number by each digit in the bottom number.
- Add the products.
- Place the decimal point in the answer by starting at the right and moving the point the number of places equal to the sum of the decimal places in both number that were multiplied.

36.3	←	one decimal place
× 0.21	←	+ two decimal places
363		
+ 7260		
7.623	←	three decimal places

Let's try a few practice problems.

1)	2)	3)	4)	5)	6)
2020	5.08	25.09	97.07	31.05	1.764
× 1.1	× 0.17	× 18.7	× 0.09	× 4.7	× 85.2

1) 2222 2) 0.8636 3) 469.183 4) 8.7363 5) 145.935 6) 150.2928

Worksheet 1-6

Name:

Date:

Solve the following multiplication problems.

1) $\begin{array}{r} 28{,}291 \\ \underline{\times\ 27{,}595} \end{array}$ 2) $\begin{array}{r} 4.06 \\ \underline{\times\ 0.25} \end{array}$ 3) $\begin{array}{r} 22.33 \\ \underline{\times\ \ 16.4} \end{array}$ 4) $\begin{array}{r} 69.09 \\ \underline{\times\ \ 0.06} \end{array}$ 5) $\begin{array}{r} 50.13 \\ \underline{\times\ \ \ 7.4} \end{array}$ 6) $\begin{array}{r} 1.337 \\ \underline{\times\ \ 31.3} \end{array}$

7) 4951 × 3287 = ____________

8) 35.07 × 19.1 = ____________

9) 88.08 × 0.02 = ____________

10) 0.012 × 0.97 = ____________

11) 4.05 × 4.5 = ____________

12) 0.951 × 0.112 = ____________

Perform the following applied problems.

13) Sal is to take 1.25 grains of aspirin every day. Each grain weighs 64.8 mg, so how many mg of aspirin is Sal to take every day?

14) Nauseous Nancy bought 12 vials of ondansetron at a cost of $17.56 per vial. How much did she spend on ondansetron?

15) Theophylus Monk is to receive 81.6 mg of theophylline three times per day for the next three days. How many mg of theophylline should he receive in total?

Dividing Decimal Numbers

The statement “4 divided by 2” can be written several ways:

$2\overline{)\,4}$ $\qquad 4 \div 2 \qquad$ $\frac{4}{2}$

Write the statement “48 divided by 6” three different ways (use the above example as a template if necessary):

The names of the numbers in a division problem are shown below:

$$\begin{array}{r} \mathbf{8} \\ \mathbf{6}\overline{)\,\mathbf{48}} \end{array}$$

- The **6** is called the **divisor**
- The **48** is called the **dividend**
- The **8** is called the **quotient**

The most common method of per forming long division is called the long-division algorithm.

Example

Solve the following problem:

$$6\overline{)3108}$$

The pattern in the long division algorithm is:

- Divide
- Multiply back
- Subtract
- Bring down the next number

You can check how to solve the above example on the next two pages.

Solution to example on previous page:

$$\begin{array}{r} 5 \\ 6\overline{)3108} \end{array}$$

Divide

6 can not go into 3, but it can go into 31 a total of 5 times.

$$\begin{array}{r} 5 \\ 6\overline{)3108} \\ 30 \end{array}$$

Multiply back

5 times 6 is 30.

$$\begin{array}{r} 5 \\ 6\overline{)3108} \\ \underline{-30} \\ 1 \end{array}$$

Subtract

31 minus 30 equals 1

$$\begin{array}{r} 5 \\ 6\overline{)3108} \\ \underline{-30} \\ 10 \end{array}$$

Bring down the next number

$$\begin{array}{r} 51 \\ 6\overline{)3108} \\ \underline{-30} \\ 10 \end{array}$$

Divide

6 can go into 10 a total of 1 time.

$$\begin{array}{r} 51 \\ 6\overline{)3108} \\ \underline{-30} \\ 10 \\ 6 \end{array}$$

Multiply back

1 times 6 is 6.

$$\begin{array}{r} 51 \\ 6\overline{)3108} \\ \underline{-30} \\ 10 \\ \underline{-\ \ 6} \\ 4 \end{array}$$

Subtract

10 minus 6 equals 4

$$\begin{array}{r} 51 \\ 6\overline{)3108} \\ \underline{-30} \\ 10 \\ \underline{-\ \ 6} \\ 48 \end{array}$$

Bring down the next number

$$
\begin{array}{r}
518 \\
6\overline{)3108} \\
\underline{-30} \\
10 \\
\underline{-6} \\
48
\end{array}
$$

Divide

6 can go into 48 a total of 8 times.

$$
\begin{array}{r}
518 \\
6\overline{)3108} \\
\underline{-30} \\
10 \\
\underline{-6} \\
48 \\
48
\end{array}
$$

Multiply back

8 times 6 is 48.

$$
\begin{array}{r}
518 \\
6\overline{)3108} \\
\underline{-30} \\
10 \\
\underline{-6} \\
48 \\
\underline{-48} \\
0
\end{array}
$$

Subtract

48 minus 48 equals 0.

There is nothing else to bring down; therefore, the final answer to “3,108 divided by 6” is 518.

Division of decimal numbers also use long division.

- If the problem does not have a whole-number divisor, it is necessary to change the problem to an equivalent division with a whole number divisor.
- This is done by shifting the decimal point to the right in both the divisor and the dividend.
- The decimal point is shifted as many places as needed to make the divisor a whole number.
- The new place that the decimal is at in the dividend is directly below where the decimal point in the quotient should be.
- Now you may use the long division algorithm like you normally would.

Example

$8.2\overline{)\,73.8}$

Our initial problem is "73.8 divided by 8.2".

The **divisor** is **8.2**

The **dividend** is **73.8**

$8.2\overline{)\,73.8}$

The divisor must be a whole-number. To achieve this, shift the decimal one spot to the right.

Since you shifted the decimal in the divisor one spot, you should shift the decimal the same number of spots in the dividend.

Now move the decimal straight up from the dividend to where it will be in the quotient.

$$\begin{array}{r} 9. \\ 82\overline{)\,738} \\ \underline{-\,738} \\ 0 \end{array}$$

Now, use the long division algorithm like you would normally to solve the problem.

Try the following practice problems.

1) $9\overline{)\,7.2}$ 2) $0.18\overline{)\,36}$ 3) $0.06\overline{)\,5.85}$

1) 0.8 2) 200 3) 97.5

Worksheet 1-7

Name:

Date:

Solve the following problems and round answers to the thousandths position when necessary.

1) $27\overline{)2{,}835}$ 2) $0.25\overline{)4.06}$ 3) $16.4\overline{)22.33}$ 4) $0.06\overline{)69.09}$ 5) $7.4\overline{)50.13}$ 6) $31.3\overline{)1.337}$

7) 49.51 ÷ 3287 = ____________

8) 35.07 ÷ 19.1 = ____________

9) 88.08 ÷ 0.2 = ____________

10) 0.97 ÷ 0.012 = ____________

11) 4.05 ÷ 4.5 = ____________

12) 0.951 ÷ 0.112 = ____________

Perform the following applied problems.

13) A dispensary has 256 ounces of rubbing alcohol on hand; how many 8 oz bottles can be filled with alcohol?

14) The average dose of a drug is 7.5 mg daily. If a vial contains 1,500 mg, how many days' supply are in the vial?

15) You receive a prescription for 6.25 mg capsules of metoprolol tartrate that you will have to compound. If you have 750 mg of metoprolol tartrate on hand, how many capsules will you be able to compound?

16) Four capsules of ampicillin are to be administered daily. How many days' supply would 32 capsules be?

Worksheet 1-8

Name:

Date:

Write the following Arabic numerals as Roman numerals.

1) 38 ____________
2) 551 ____________
3) 24 ____________

Write the following Roman numerals as Arabic numerals.

4) xxi ____________
5) cd ____________
6) xlviii ____________

What is the place name of the 3 in each of these numbers.

7) 2,432,484 ____________
8) 24.032 ____________
9) 107.3 ____________

Write the following numbers.

10) Two million fifteen thousand six hundred

____

11) Four thousand four ten-thousandths

____

12) Nine thousand eight hundred seventy six and five thousand four hundred thirty two ten-thousandths

____

Perform the following additions.

13) $\begin{array}{r} 19{,}867 \\ \underline{+\ 12{,}482} \end{array}$

14) $\begin{array}{r} 82.07 \\ \underline{+\ \ 0.18} \end{array}$

15) $\begin{array}{r} 23 \\ \underline{+\ \ 0.7} \end{array}$

16) $\begin{array}{r} 38 \\ 0.042 \\ \underline{+\ \ 2.8} \end{array}$

17) $\begin{array}{r} 107.3 \\ \underline{+\ \ 4.65} \end{array}$

18) $\begin{array}{r} 81.9 \\ \underline{+\ 52.89} \end{array}$

Perform the following subtractions.

19)	19,867 - 12,482	20)	82.07 - 0.18	21)	23 - 0.7	22)	93.8 - 0.9	23)	107.3 - 4.65	24)	81.9 - 52.89

Perform the following multiplications.

25)	48 × 5	26)	9.3 × 8	27)	0.41 × 0.27	28)	3.94 × 2.64	29)	2.8 × 0.042	30)	31.337 × 0.67

Perform the following division and round your answers to the hundredths place.

31) $369 \div 6$ 32) $1.5\overline{)156.5}$ 33) $16.4\overline{)22.33}$ 34) $2.04\overline{)84}$ 35) $33\overline{)6.6}$ 36) $12.3 \div 100$

Solve the following word problems.

37) Find the total weight of two objects if one weighs 255.4 grams and the other weighs 198.6 grams.

38) If a patient weighs 75 kg one month and 72.7 kg the next month, how much weight did the patient lose?

39) What is the total cost of a dozen items at $2.49 each?

40) A patient is given 210 mL of medication to take. They are to take 15 mL of the medication daily till all of it is used. How many days should the medication last?

CHAPTER 2

FRACTIONS

I believe five out of four people have trouble with fractions.
--Steven Wright

Numerators, Denominators, and Reciprocals of Fractions

A fraction indicates a portion of a whole number. There are two types of fractions:

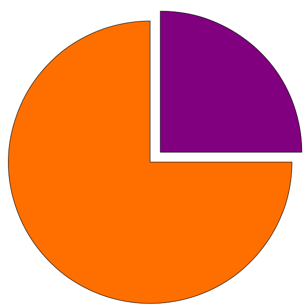
- common fractions such as ½ or ¾ ;
- decimal fractions such as 0.5 or 0.75 (we already covered these in Chapter 1).

A fraction is an expression of division, with one number placed over another number. The bottom number, or denominator, indicates the total number of parts into which the whole is divided. The top number, or numerator, indicates how many of those parts are considered. The fraction may be read as the "numerator divided by the denominator."

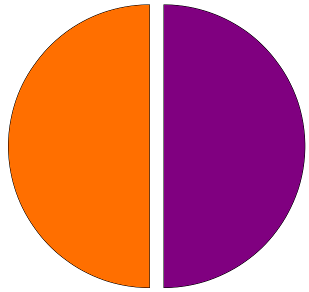
$$\frac{\textbf{Numerator}}{\textbf{Denominator}}$$

Examples

¼ = 1 part of 4 parts, or ¼ of the whole = 0.25



½ = 1 part of 2 parts, or ½ of the whole = 0.5



Reciprocals of fractions

To find the reciprocal of a fraction simply switch the numerator and denominator (flip it over)

- The reciprocal of $\frac{2}{3}$ is $\frac{3}{2}$
- The reciprocal of $\frac{4}{5}$ is $\frac{5}{4}$

A whole number could be considered to have a denominator of one, so the reciprocal of a whole number would be 1 over the original whole number.

- The reciprocal of 5 is $\frac{1}{5}$
- The reciprocal of 9 is $\frac{1}{9}$

The following page is a worksheet to help reinforce this information.

Worksheet 2-1

Name:

Date:

Convert the following fractions to decimals.

1) $\frac{1}{5}$ = ______

2) $\frac{1}{2}$ = ______

3) $\frac{2}{4}$ = ______

4) $\frac{1}{10}$ = ______

5) $\frac{1}{12}$ = ______

6) $\frac{1}{100}$ = ______

7) $\frac{1}{1000}$ = ______

8) $\frac{2}{3}$ = ______

9) $\frac{3}{4}$ = ______

10) $\frac{4}{5}$ = ______

11) $\frac{3}{8}$ = ______

12) $\frac{5}{12}$ = ______

13) $\frac{7}{18}$ = ______

14) $\frac{4}{11}$ = ______

15) $\frac{2}{22}$ = ______

16) $\frac{5}{35}$ = ______

17) $\frac{9}{55}$ = ______

18) $\frac{13}{63}$ = ______

19) $\frac{15}{71}$ = ______

20) $\frac{23}{83}$ = ______

Determine the reciprocal of the following fractions.

21) $\frac{1}{5}$ = ______

22) $\frac{1}{2}$ = ______

23) $\frac{2}{4}$ = ______

24) $\frac{1}{10}$ = ______

25) $\frac{1}{12}$ = ______

26) $\frac{1}{100}$ = ______

27) $\frac{1}{1000}$ = ______

28) $\frac{2}{3}$ = ______

29) $\frac{3}{4}$ = ______

30) $\frac{4}{5}$ = ______

31) $\frac{3}{8}$ = ______

32) $\frac{5}{12}$ = ______

33) $\frac{7}{18}$ = ______

34) $\frac{4}{11}$ = ______

35) $\frac{2}{22}$ = ______

36) $\frac{5}{35}$ = ______

37) $\frac{9}{55}$ = ______

38) $\frac{13}{63}$ = ______

39) $\frac{15}{71}$ = ______

40) $\frac{23}{83}$ = ______

Reducing fractions to lowest terms

Reducing a fraction to lowest terms (also called simplifying), you need to divide the numerator and denominator by their greatest common factor.

- The greatest common factor is the largest whole number that can divide into the numerator and the denominator.
- Some fractions are already in lowest terms if there is no factor common to the numerator and the denominator.

The steps to simplify a fraction:

- List the whole number factors of the numerator and the denominator.
- Find the factors common to both the numerator and denominator.
- Divide the numerator and denominator by the largest common factor.

Example: $\frac{30}{70}$

List the factors of the numerator and the denominator:

- Numerator: 1,2,3,5,6,10,15,30
- Denominator: 1,2,5,7,10,14,35,70

The greatest common factor is 10

Divide the numerator and the denominator by 10

- Numerator: 30 ÷ 10 = 3
- Denominator: 70 ÷ 10 = 7

$\frac{3}{7}$ is the fraction when reduced to lowest terms.

Reduce the fractions in the following practice problems:

1) $\frac{4}{8}$

2) $\frac{55}{99}$

3) $\frac{36}{144}$

1) 1/2 2) 5/9 3) 1/4

Worksheet 2-2

Name:

Date:

Reduce the following fractions to lowest terms.

1) $\frac{2}{4}$ = ______

2) $\frac{3}{9}$ = ______

3) $\frac{2}{16}$ = ______

4) $\frac{18}{54}$ = ______

5) $\frac{20}{240}$ = ______

6) $\frac{25}{125}$ = ______

7) $\frac{55}{75}$ = ______

8) $\frac{28}{35}$ = ______

9) $\frac{63}{90}$ = ______

10) $\frac{15}{75}$ = ______

11) $\frac{14}{36}$ = ______

12) $\frac{7}{11}$ = ______

13) $\frac{0}{18}$ = ______

14) $\frac{34}{51}$ = ______

15) $\frac{14}{63}$ = ______

16) $\frac{12}{35}$ = ______

17) $\frac{125}{500}$ = ______

18) $\frac{270}{2700}$ = ______

19) $\frac{65}{585}$ = ______

20) $\frac{82}{164}$ = ______

21) $\frac{79}{237}$ = ______

22) $\frac{17}{102}$ = ______

23) $\frac{19}{285}$ = ______

24) $\frac{18}{81}$ = ______

25) $\frac{121}{605}$ = ______

26) $\frac{63}{135}$ = ______

27) $\frac{42}{72}$ = ______

28) $\frac{33}{77}$ = ______

29) $\frac{108}{180}$ = ______

30) $\frac{110}{363}$ = ______

Adding and subtracting fractions

In order to add and subtract fractions, they must have a common denominator. Once they have a common denominator, you may add and subtract the numerators like you would in an ordinary addition or subtraction problem and then write the sum or the difference over top of the common denominator.

How to create equivalent fractions with a common denominator:

- Find a multiple for the denominator of both numbers.
- Rewrite the fractions as equivalent fractions with the common denominator.

Example: $\frac{4}{5} - \frac{1}{3}$

You can multiply the denominators to find a common denominator:

$5 \times 3 = 15$

Now create equivalent fractions:

$\frac{4}{5} \times \frac{3}{3} = \frac{12}{15}$ $\qquad$ $\frac{1}{3} \times \frac{5}{5} = \frac{5}{15}$

Now let's solve the problem with the equivalent fractions:

$$\frac{12}{15} - \frac{5}{15} = \mathbf{\frac{7}{15}}$$

Try the following practice problems:

1) $\frac{1}{3} - \frac{1}{5}$

2) $\frac{3}{8} + \frac{3}{5}$

3) $\frac{1}{19} + \frac{3}{38} + \frac{5}{76} + \frac{7}{152}$

1) 2/15 2) 39/40 3) 37/152

Worksheet 2-3

Name:

Date:

Solve the following problems.

1) $\frac{1}{3}+\frac{1}{3}$ = ____

2) $\frac{5}{8}-\frac{3}{8}$ = ____

3) $\frac{7}{8}-\frac{3}{8}$ = ____

4) $\frac{4}{25}+\frac{1}{5}$ = ____

5) $\frac{1}{8}+\frac{3}{16}$ = ____

6) $\frac{7}{8}-\frac{1}{4}$ = ____

7) $\frac{2}{7}+\frac{3}{7}+\frac{1}{7}$ = ____

8) $\frac{1}{8}+\frac{2}{8}+\frac{7}{8}$ = ____

9) $\frac{14}{38}-\frac{1}{19}$ = ____

10) $\frac{11}{12}-\frac{2}{3}$ = ____

11) $\frac{9}{24}-\frac{1}{6}$ = ____

12) $\frac{4}{5}-\frac{67}{100}$ = ____

13) $5+\frac{7}{10}+\frac{3}{1000}$ = ____

14) $\frac{5}{8}+\frac{4}{27}+\frac{1}{48}$ = ____

15) $1+\frac{7}{100}+\frac{3}{10}$ = ____

16) $\frac{1}{2}+\frac{1}{9}+\frac{1}{36}$ = ____

17) $\frac{1}{3}+\frac{1}{6}+\frac{1}{9}$ = ____

18) $\frac{11}{99}+\frac{4}{9}+\frac{11}{33}$ = ____

19) $\frac{1}{8}+\frac{1}{4}+\frac{1}{2}+\frac{3}{8}$ = ____

20) $\frac{12}{19}+\frac{14}{38}+\frac{1}{19}+\frac{1}{38}$ = ____

21) $\frac{1}{8}+\frac{2}{8}+\frac{7}{8}$ = ____

22) $\frac{10}{30}+\frac{13}{15}+\frac{1}{5}+\frac{17}{60}$ = ____

23) $\frac{1}{8}+\frac{2}{8}+\frac{7}{8}$ = ____

24) $\frac{1}{81}+\frac{2}{27}+\frac{1}{3}$ = ____

Multiplying fractions

- Reduce if possible
- Multiply the numerators of the fraction to get the new numerator.
- Multiply the denominators of the fractions to get the new denominator.
- Simplify the resulting fraction if possible.

Example: $\frac{2}{3}\times\frac{4}{7} = ?$

Reduce if possible

$\frac{2}{3}\times\frac{4}{7}$ no reduction is possible.

Multiply the numerators

$2\times 4 = 8$

Multiply the denominators

$3\times 7 = 21$

Simplify the resulting fraction if possible

$\frac{8}{21}$ is already in simplest terms.

$$\frac{2}{3}\times\frac{4}{7} = \mathbf{\frac{8}{21}}$$

Try the following practice problems:

1) $\frac{2}{5}\times\frac{1}{8} =$

2) $\frac{2}{3}\times\frac{2}{3} =$

3) $\frac{7}{8}\times\frac{9}{21} =$

1) 1/20 2) 4/9 3) 3/8

Multiplying mixed numbers

- Write mixed numbers as improper fractions.
- Reduce if possible.
- Multiply the numerators of the fraction to get the new numerator.
- Multiply the denominators of the fractions to get the new denominator.
- Simplify the resulting fraction if possible.

Example: $4\frac{1}{8} \times 1\frac{5}{11} = ?$

Write mixed numbers as improper fractions.

$$\frac{33}{8} \times \frac{16}{11}$$

Reduce if possible

$$\frac{{}^{3}\cancel{33}}{{}_{1}\cancel{8}} \times \frac{{}^{2}\cancel{16}}{{}_{1}\cancel{11}}$$

Multiply the numerators

$$3 \times 2 = 6$$

Multiply the denominators

$$1 \times 1 = 1$$

Simplify the resulting fraction if possible

$$\frac{6}{1} = 6$$

$$4\frac{1}{8} \times 1\frac{5}{11} = \frac{{}^{3}\cancel{33}}{{}_{1}\cancel{8}} \times \frac{{}^{2}\cancel{16}}{{}_{1}\cancel{11}} = \frac{6}{1} = \mathbf{6}$$

Try the following practice problems:

1) $13\frac{1}{3} \times 1\frac{4}{5} =$

2) $7\frac{1}{5} \times 3\frac{3}{4} =$

3) $20\frac{2}{3} \times 1\frac{4}{31} =$

1) 24 2) 27 3) 23 1/3

Worksheet 2-4

Name:

Date:

Solve the following problems.

1) $\frac{1}{3}$ of $\frac{1}{3}$ = ______

2) $\frac{1}{8}$ of $\frac{3}{8}$ = ______

3) $\frac{2}{3}$ of $\frac{1}{3}$ = ______

4) $\frac{5}{8}$ of $\frac{3}{8}$ = ______

5) $\frac{1}{5}$ of $\frac{3}{5}$ = ______

6) $\frac{7}{8}$ of $\frac{3}{8}$ = ______

7) $\frac{0}{4}$ of $\frac{5}{6}$ = ______

8) $\frac{1}{2}$ of $\frac{3}{5}$ = ______

9) $\frac{1}{9}$ of $\frac{1}{2}$ = ______

10) $\frac{2}{7}$ of $\frac{1}{5}$ = ______

11) $\frac{9}{10}$ of $\frac{3}{4}$ = ______

12) $\frac{3}{11}$ of $\frac{3}{4}$ = ______

Multiply the following fractions.

13) $\frac{3}{10} \times \frac{1}{4}$ = ______

14) $\frac{13}{15} \times \frac{7}{8}$ = ______

15) $\frac{21}{25} \times \frac{2}{5}$ = ______

16) $\frac{49}{50} \times \frac{1}{4}$ = ______

17) $\frac{6}{7} \times 21$ = ______

18) $25 \times \frac{3}{10}$ = ______

19) $\frac{8}{15} \times \frac{5}{6}$ = ______

20) $\frac{11}{14} \times \frac{2}{33}$ = ______

Multiply the following mixed numbers.

21) $4\frac{4}{5} \times 1\frac{1}{6}$ =

22) $7\frac{1}{2} \times 2\frac{2}{3}$ =

23) $1\frac{17}{18} \times 1\frac{1}{5}$ =

24) $1\frac{5}{7} \times 10\frac{1}{2}$ =

Dividing Fractions

Dividing by fractions is just like multiplying fractions with one exception, you need to "flip" (find the reciprocal of) the fraction you are dividing by.

The following are the steps to dividing fractions:

- Find the reciprocal of the fraction you are dividing by.
- Reduce if possible.
- Multiply the numerators of the fraction to get the new numerator.
- Multiply the denominators of the fractions to get the new denominator.
- Simplify the resulting fraction if possible.

A simpler way of remembering this is to simply think "Flip and Multiply"

Example: $\frac{2}{3} \div \frac{4}{7}$

"Flip and Multiply"

$$\frac{{}^{1}\cancel{2}}{3} \times \frac{7}{{}_{2}\cancel{4}} = \frac{7}{6} = \mathbf{1\frac{1}{6}}$$

Try the following practice problems:

1) $\frac{2}{5} \div \frac{1}{8} =$

2) $\frac{2}{3} \div \frac{2}{3} =$

3) $\frac{7}{8} \div \frac{9}{21} =$

1) 16/5 = 3 1/5 2) 1 3) 147/72 = 2 3/72 = 2 1/24

Worksheet 2-5

Name:

Date:

Divide the following fractions:

1) $\frac{1}{3} \div \frac{1}{3}$ = ______

2) $\frac{1}{8} \div \frac{3}{8}$ = ______

3) $\frac{1}{8} \div \frac{3}{16}$ = ______

4) $\frac{4}{25} \div \frac{1}{5}$ = ______

5) $\frac{2}{3} \div \frac{1}{2}$ = ______

6) $\frac{16}{27} \div \frac{8}{9}$ = ______

7) $\frac{5}{15} \div 5$ = ______

8) $\frac{9}{10} \div \frac{9}{10}$ = ______

9) $\frac{7}{5} \div \frac{5}{7}$ = ______

10) $12 \div \frac{3}{8}$ = ______

11) $3\frac{2}{3} \div 1\frac{1}{4}$ =______

12) $1\frac{5}{6} \div 7\frac{1}{3}$ =______

13) $15\frac{3}{4} \div 5\frac{1}{7}$ =______

14) $15 \div 1\frac{1}{5}$ = ______

Solve the following word problems:

15) How many 6 ¼ milligram capsules of metoprolol tartrate can be made from 500 mg of metoprolol tartrate?

16) The OR likes to use phenylephrine syringes, each containing 4/5 of a milligram. How many phenylephrine syringes can I make if I have a 20 mg vial on hand?

Worksheet 2-6

Name:

Date:

Convert these fractions into equivalent decimals (you only need to solve them out to the thousandths position).

1) $\frac{7}{15}$ = ___________

4) $\frac{13}{15}$ = ___________

7) $\frac{9}{27}$ = ___________

2) $\frac{13}{40}$ = ___________

5) $\frac{17}{30}$ = ___________

8) $\frac{17}{25}$ = ___________

3) $\frac{5}{8}$ = ___________

6) $\frac{7}{8}$ = ___________

9) $\frac{13}{37}$ = ___________

Determine the reciprocals of the following fractions.

10) $\frac{3}{4}$ = ___________

12) $\frac{15}{24}$ = ___________

14) $\frac{65}{585}$ = ___________

11) $\frac{1}{5}$ = ___________

13) $\frac{2}{8}$ = ___________

15) 1 = ___________

Reduce the following fractions.

16) $\frac{6}{8}$ = ___________

19) $\frac{2}{8}$ = ___________

22) $\frac{27}{45}$ = ___________

17) $\frac{12}{48}$ = ___________

20) $\frac{12}{36}$ = ___________

23) $\frac{17}{31}$ = ___________

18) $\frac{15}{24}$ = ___________

21) $\frac{18}{24}$ = ___________

24) $\frac{52}{148}$ = ___________

Perform the following additions and subtractions.

25) $\frac{1}{6}+\frac{3}{6}$ = ___________

28) $\frac{5}{6}-\frac{2}{3}$ = ___________

26) $\frac{7}{6}+\frac{5}{24}$ = ___________

29) $\frac{1}{8}+\frac{2}{3}$ = ___________

27) $\frac{7}{8}-\frac{7}{12}$ = ___________

30) $\frac{11}{16}-\frac{1}{2}$ = ___________

31) $\frac{1}{6} + \frac{4}{7}$ = ___________

32) $\frac{9}{11} - \frac{2}{5}$ = ___________

Perform the following multiplications and divisions.

33) $\frac{1}{6} \times \frac{4}{7}$ = ___________

34) $4 \times \frac{7}{8}$ = ___________

35) $\frac{3}{4} \div \frac{1}{6}$ = ___________

36) $\frac{7}{16} \div 7$ = ___________

37) $10 \div \frac{1}{2}$ = ___________

38) $\frac{7}{16} \times 7$ = ___________

39) $\frac{3}{4} \times \frac{1}{3}$ = ___________

40) $\frac{3}{4} \div \frac{1}{3}$ = ___________

Solve the following word problems.

41) What is the total volume of a mixture of 1/8 milliliter of solution X mixed with 2 and 1/4 milliliters of solution Y?

42) A patient is to receive 3 liters of an intravenous solution. If 2 1/8 liters have already been administered, how much solution remains?

43) How many milligrams of drug are needed to make 20 tablets of 1/4 milligrams each?

44) A bottle of Children's Tylenol contains 20 teaspoons of liquid. If each dose for a 2 year-old child is 1/2 teaspoon, how many doses are available in this bottle?

45) A patient is on strict recording of fluid intake and output, including measurements of liquid medications. A nursing student gave the patient 1/4 ounce of medication at 8 AM and 1/3 ounce of medication at 12 noon. What is the total amount of medication to be recorded on the Intake and Output sheet?

Chapter 3

Percentages

Baseball is 90% mental and the other half is physical.
--Yogi Berra

What is a percentage?

The word **percent** means “per 100” or “out of 100”

The percent symbol (%) is an easy way to write a fraction with a common denominator of 100.

Example

27 out of 100 equals 27%

Example

19% = 19/100 = 0.19

Nineteen percent (19%) is the same as the fraction 19/100 and the decimal 0.19

Writing Decimals as Percents

2.61 = 261%
3 = 3.00 = 300%
0.5 = 0.50 = 50%
0.004 = 0.4%

Move the decimal points over two places to the right and add a percent sign. At times, you may need to insert zeros.

Try the following practice problems

1) 0.27
2) 0.13
3) 0.06
4) 0.2
5) 0.018
6) 1.5

1) 27% 2) 13% 3) 6% 4) 20% 5) 1.8% 6) 150%

Writing Percents as Decimals

49% = 0.49
180% = 1.8
3% = 0.03
0.7% = 0.007

Move the decimal point over two places to the left and omit the percent sign. You may need to add zeros.

Try the following practice problems

1) 100%
2) 77%
3) 1.8%
4) 50%
5) 9.3%
6) 0.2%

1) 1 2) 0.77 3) 0.018 4) 0.5 5) 0.093 6) 0.002

Writing Fractions as Percents

The following is an example of two different ways that you can turn a fraction into a percent.

- You can turn a fraction into an equivalent fraction so that the denominator becomes equal to 100.

$$\frac{1}{5} = \frac{1}{5} \times \frac{20}{20} = \frac{20}{100} = \mathbf{20\ \%}$$

- Or, you can turn it into a decimal and the shift the decimal two-points to the right.

$$\frac{1}{5} = 1 \div 5 = 0.2 = \mathbf{20\ \%}$$

Try the following practice problems, convert these fractions into percents.

1) $\frac{3}{10}$
2) $\frac{12}{25}$
3) $\frac{3}{8}$
4) $\frac{13}{40}$
5) $\frac{13}{20}$
6) $\frac{2}{3}$

1) 30% 2) 48% 3) 37.5% 4) 32.5% 5) 65% 6) 66.7%

Worksheet 3-1

Name:

Date:

Express the following decimals as percents.

1) 0.2444 = ___________
2) 0.3 = ___________
3) 0.5 = ___________
4) 0.125 = ___________
5) 0.75 = ___________
6) 0.02 = ___________
7) 0.09 = ___________
8) 0.1 = ___________
9) 0.8 = ___________
10) 0.36 = ___________
11) 0.52 = ___________
12) 0.4 = ___________
13) 0.65 = ___________
14) 0.025 = ___________
15) 0.035 = ___________
16) 0.055 = ___________
17) 0.004 = ___________
18) 1.10 = ___________
19) 1.75 = ___________
20) 2 = ___________

Express the following percents as decimals.

21) 33% = ___________
22) 24% = ___________
23) 33.3% = ___________
24) 50.5% = ___________
25) 20% = ___________
26) 47% = ___________
27) 93% = ___________
28) 32.5% = ___________
29) 75% = ___________
30) 83.32% = ___________
31) 66.66667% = ___________
32) 18.5% = ___________
33) 1.3% = ___________
34) 0.25% = ___________
35) 0.125% = ___________

Write the following fractions as percents.

36) $\frac{4}{5}$ = ___________
37) $\frac{2}{10}$ = ___________
38) $\frac{7}{8}$ = ___________
39) $\frac{15}{20}$ = ___________
40) $\frac{30}{35}$ = ___________
41) $\frac{85}{100}$ = ___________
42) $\frac{5}{8}$ = ___________
43) $\frac{3}{7}$ = ___________

44) $\frac{6}{20}$ = ____________

45) $\frac{12}{20}$ = ____________

46) $\frac{35}{40}$ = ____________

47) $\frac{40}{50}$ = ____________

48) $\frac{55}{100}$ = ____________

49) $\frac{80}{90}$ = ____________

50) $\frac{32}{64}$ = ____________

Writing Percents as Fractions

You can turn percents back into fractions, just remember that percent means out of 100.

Examples

$$68\% = \frac{68}{100} = \mathbf{\frac{17}{25}}$$

$$3\% = \mathbf{\frac{3}{100}}$$

Try converting the following practice problems from percentages to fractions.

1) 55%
2) 60%
3) 0.4%
4) 5%
5) 29%
6) 260%

1) 11/20 2) 3/5 3) 1/250 4) 1/20 5) 29/100 6) 2 3/5

Finding a Percentage of a Number

There are two common ways of finding a percentage of a number:

- you can turn your percent into a decimal and multiply it by the total value the percent is out of,
- or you can use the *'is over of'* method

Example

How much is 90% out of 20? *(this can be solved 2 ways)*

$$n = 0.9 \times 20$$
$$n = \mathbf{18}$$

or

$$\frac{is}{of} = \frac{\%}{100}$$

$$\frac{n}{20} = \frac{90}{100}$$

$$(n)(100) = (20)(90)$$

$$n = \mathbf{18}$$

Complete the following practice problems.

1) How much is 75% of 200?
2) How much is 30% of 50?
3) How much is 25% of 16?
4) How much is 12% of 250?

1) 150 2) 15 3) 4 4) 30

Worksheet 3-2

Name:

Date:

Write the following percentages as fractions (reduce if possible).

1) 50% = ________	6) 100% = ________	11) 12.5% = ________
2) 75% = ________	7) 68% = ________	12) 67% = ________
3) 60% = ________	8) 41% = ________	13) 66.6% = ________
4) 35% = ________	9) 93% = ________	14) 36% = ________
5) 30% = ________	10) 1.2% = ________	15) 110% = ________

Calculate the following problems.

16) 25% of 600 = ________	24) 110% of 5 = ________
17) 20% of 30 = ________	25) 33% of 90 = ________
18) 15% of 20 = ________	26) 5% of 50 = ________
19) 75% of 50 = ________	27) 30% of 120 = ________
20) 12.5% of 24 = ________	28) 40% of 50 = ________
21) 80% of 40 = ________	29) 60% of 150 = ________
22) 90% of 100 = ________	30) 70% of 400 = ________
23) 17% of 10 = ________	

Find the value of n:

31) If n is 20% of 50 n = ________	34) If n is 75% of 10 n = ________
32) If n is 35% of 24 n = ________	35) If n is 80% of 15 n = ________
33) If n is 60% of 8 n = ________	36) If n is 40% of 30 n = ________

37) If n is 50% of 100 n = ________

38) If n is 25% of 50 n = ________

39) If n is 30% of 90 n = ________

40) If n is 100% of 50 n = ________

Finding What Percent One Number is of Another

There are two common ways of finding what percentage one number is of another:

- you can divide your parts by the total it is out of to get a decimal and then turn your decimal into a percentage,
- or you can use the *'is over of'* method

Example

What percent of 40 is 15? *(this can be solved 2 ways)*

$n = 15 \div 40 = 0.375 = \mathbf{37.5\,\%}$

or

$$\frac{is}{of} = \frac{\%}{100}$$

$$\frac{15}{40} = \frac{n}{100}$$

$$(n)(40) = (15)(100)$$

$$n = \mathbf{37.5\,\%}$$

Attempt the following practice problems.

1) What percent of 50 is 2?
2) 0.6 is what percent of 20?
3) What percent of 40 is 8?
4) 20 is what percent of 80?
5) What percent of 60 is 2.4?
6) 10 is what percent of 50?

1) 4% 2) 3% 3) 20% 4) 25% 5) 4% 6) 20%

Finding a Number When a Percent of it is Known

There are two common ways of finding a number when a percent of it is known:

- you can divide your parts by your percentage (as a decimal) and this will provide you with your total,
- or you can use the *'is over of'* method

Example

8 is 32% of what number? *(this can be solved 2 ways)*

$n = 8 \div 0.32 = \mathbf{25}$

or

$$\frac{is}{of} = \frac{\%}{100}$$

$$\frac{8}{n} = \frac{32}{100}$$

$$(n)(32) = (8)(100)$$

$$n = \mathbf{25}$$

Attempt the following practice problems.

1) 12 is 60% of what number?
2) 95% of what number is 114?
3) 14 is 35% of what number?
4) 75% of what number is 60?
5) 35.7 is 42% of what number?
6) 3% of what number is 27?

1) 20 2) 120 3) 40 4) 80 5) 85 6) 900

Worksheet 3-3

Name:

Date:

Fill in the blank boxes with all boxes in the same row being equal.

Percent	***Decimal***	***Reduced Fraction***
20%		
	0.06	
		7/8
15%		
	0.11	
		4/5
96%		
	0.55	
		3/25
53%		
	1	
		3/40

Solve the following problems.

1) How much is 4% of 50?
2) What percent of 90 is 14.4?
3) 7 is 4% of what number?
4) 99% of 200 is how much?
5) 42 is what percent of 150?
6) 55% of what number is 1375?
7) How much is 65% of 500?
8) What percent of 48 is 12?
9) 20% of what number is 3?
10) 90% of 112 is how much?
11) 15 is what percent of 75?
12) 70% of what number is 14?
13) How much is 45% of 40?
14) What percent of 80 is 72?
15) 20 is 62.5% of what number?
16) 77.5% of 80 is how much?

17) 23 is what percent of 25?

18) 88% of what number is 440?

19) How much is 140% of 30?

20) What percent of 64 is 52?

Solve the following word problems.

21.) Smart Sally got 2 out of 25 wrong on her math quiz. What percent did she get correct?

22.) 34.8% of the pharm tech class wanted the holiday party to be semi-formal. How many students are in the class if 8 wanted a semi-formal party?

23.) Of the 3,620 people polled, 85% enjoyed mixing IVs. How many people liked mixing IVs?

24.) Frugal Fred saved $78.25 by purchasing generic medications. He decided to splurge and buy a nice engraved mortar and pestle for himself. The mortar and pestle was $50.08. What percent of his savings was that?

25.) Alopecia Allen was having a problem with his hair falling out. He lost 112 hairs yesterday which was 4% of his total hair. How many hairs did he have at the beginning of the day?

26.) When asked, 270 out of the 400 patients at the Funny Farm said that they felt a sense of humor was the most important trait in a physician. What percent is this rounded to the nearest whole number?

Worksheet 3-4

Name:

Date:

Convert the following percents to fractions.

1) 16%

2) 45%

3) 6%

Convert the following percents to decimals

4) 33%

5) 4.5%

6) 2.94%

Convert the following fractions to percentages.

7) 12/48

8) 2/5

9) 7/10

Convert the following decimals to percentages.

10) 0.7

11) 0.467

12) 0.006

Solve the following problems involving percents.

13) What is 40% of 120?

14) What is 20% of 30?

15) What percent of 150 is 15?

16) What percent of 45 is 30?

17) 35 is 14% of what number?

18) 30 is 110% of what number?

19) What number is 75% of 280?

20) What percent of 140 is 7?

Solve the following applied problems.

21) At Bidwell Training Center Inc. 28.6% of the instructors in the medical department are male. If there are two male instructors in the medical department, then how many instructors are there in the medical department?

22) The recommended daily allowance (RDA) of a particular vitamin is 60 milligrams. If a multivitamin tablet claims to provide 45% of the RDA, how many milligrams of the particular vitamin would a patient receive from the multivitamin tablet.

23) A person weighed 130 pounds at his last doctor's visit. At this visit the patient lost 5% of his weight. How many pounds has the patient lost?

24) In a drug study, it was determined that 4% of the participants developed the *headache* side effect. If there were 600 participants in the study, how many developed headaches?

25) You are employed in a health clinic where each employee must work 25% of 8 major holidays. How many holidays will you be required to work?

Chapter 4

24 Hour Time, Exponents, & Scientific Notation

Even a broken clock is correct twice a day.
--Polish Proverb

The 24 Hour-Clock

The 24-hour clock is increasingly used in medical facilities. This time system avoids confusion between *A.M.* and *P.M.* time. Four digits are used to express time in this system. The first two digits indicate the hour, and the last two the minutes.

Here are some examples of A.M. time on the 24-hour clock:

24-Hour Time	Reading	*A.M.* Time
0400	zero four hundred hours	4:00 A.M.
1130	eleven thirty hours	11:30 A.M.
0910	zero nine ten hours	9:10 A.M.

Notice several things:

1) A.M. times and 24 hour times *(excluding midnight to 12:59 A.M.)* possess the same digits except A.M. times drop the leading zero,
2) notice that when reading 24 hour time, you always say *'hours'* at the end,
3) military times that end in a double zero are read as *'hundred hours'*,
4) hours and minutes are read as groups,
5) if the number of hours and/or minutes are less than 9 then each digit is read separately *(example 0908 would be read as 'zero nine zero eight hours')*,
6) and if the number of hours and/or minutes are greater than 9 then each set is read as one number *(example 1132 would be read as 'eleven thirty two hours')*.

Based on the information you've been given so far complete the following table:

24-Hour Time	**Reading**	***A.M.* Time**
0230		
1045		
0100		
1150		
0600		
1030		
0235		
1120		

The following are the answers to the above table: 0230 - zero two thirty hours - 2:30 A.M.; 1045 -ten forty five hours - 10:45 A.M.; 0100 - zero one hundred hours - 1:00 A.M.; 1150 - eleven fifty hours - 11:50 A.M.; 0600 - zero six hundred hours - 6:00 A.M.; 1030 - ten thirty hours - 10:30 A.M.; 0235 - zero two thirty five hours - 2:35 A.M. - 1120 - eleven twenty hours - 11:20 A.M.

The following illustrates how P.M. time is indicated on the 24-hour clock:

24-Hour Time	**Reading**	***P.M.* Time**
1300	thirteen hundred hours	1:00 P.M.
1830	eighteen thirty hours	6:30 P.M.
2150	twenty one fifty hours	9:50 P.M.

To obtain P.M. time from 24-hour time, subtract the number 1200 from the 24-hour time.

1300 – 1200 = 1:00 P.M.
1830 – 1200 = 6:30 P.M.
2150 – 1200 = 9:50 P.M.

Complete the following table:

24-Hour Time	Reading	*P.M.* Time
1800		
1945		
1415		
2320		
1500		
1730		
2145		
2350		

The following are the answers to the above table: 1800 – eighteen hundred hours – 6:00 P.M.; 1945 – nineteen forty five hours – 7:45 P.M.; 1415 – fourteen fifteen hours – 2:15 P.M.; 2320 – twenty three twenty hours – 11:20 P.M.; 1500 – fifteen hundred hours – 3:00 P.M.; 1730 – seventeen thirty hours – 5:30 P.M.; 2145 – twenty one forty five hours – 9:45 P.M.; 2350 – twenty three fifty hours – 11:50 P.M.

The time between 12:00 midnight and 1:00 A.M. is written and read as follows:

24-Hour Time	Reading	*A.M.* Time
0010	zero zero ten hours	12:10 A.M.
0045	zero zero forty five hours	12:45 A.M.

Complete the following table:

24-Hour Time	Reading	*A.M.* Time
0020		
0008		
0030		
0015		

The following are the answers to the above table: 0020 – zero zero twenty hours – 12:20 A.M.; 0008 – zero zero zero eight hours – 12:08 A.M.; 0030 – zero zero thirty hours – 12:30 A.M.; 0015 – zero zero fifteen hours – 12:15 A.M.

Technically midnight is supposed to be *'zero zero zero zero hours'* but is often referred to as *'twenty four hundred hours'*. Expect to see both done at some point when working in a hospital.

Worksheet 4-1

Name:

Date:

Complete the following table:

24-Hour Time	Reading	*A.M./P.M. Time*
0315	zero three fifteen hours	3:15 A.M.
1140		
1400		
2230		
0030		
1050		
		6:15 A.M.
		10:50 A.M.
		9:45 P.M.
		1:15 P.M.
		12:15 A.M.
		12:05 A.M.
	zero nine thirty hours	
	twenty-two thirty hours	
	zero zero twenty hours	
	fourteen twenty-five hours	
	zero zero zero seven hours	
	zero one hundred hours	

Exponents

Exponents show how many times a number is multiplied by itself. A number with an exponent is said to be "raised to the power" of that exponent.

Example:

Three raised to the power of four would be written:

3^4

and it would equal:

$3^4 = 3 \times 3 \times 3 \times 3 = 81$

A couple of "powers" have their own names. If something is raised to the power of two, it may also be called "squared".

Example:

Three squared = $3^2 = 3 \times 3 = 9$

If something is raised to the power of three, it may also be called "cubed".

Example:

Three cubed = $3^3 = 3 \times 3 \times 3 = 27$

There are two additional rules to remember:

any number raised to the zero power (except 0) equals 1;

Example:

$3^0 = 1$

any number raised to the power of one equals itself.

Example:

$3^1 = 3$

Solve the following practice problems:

1) 2^3
2) 4^5
3) 6^2
4) 1^3
5) 3^5
6) 5^3
7) 7^4
8) 8^1
9) 9^0

1) 8 2) 1,024 3) 36 4) 1 5) 243 6) 125 7) 2,401 8) 8 9) 1

Scientific Notation

Scientific notation provides an easier way of writing very small and very large numbers and is sometimes referred to as “power-of-ten”. A number written in scientific notation is written as a product of a number between 1 and 10 and multiplied by a power of 10 .

Here are some examples of large numbers:

$$100=1\times10\times10=1\times10^2$$

$$100{,}000=1\times10\times10\times10\times10\times10=1\times10^5$$

$$427{,}000=4.27\times10\times10\times10\times10\times10=4.27\times10^5$$

There is an easy shortcut to scientific notation, move the decimal point so that there is only one digit to the left of it. Count the number of spaces the decimal has been moved, and this becomes the exponent on the base 10.

- If you move the decimal to the left, the exponent will be positive.
- If you move the decimal to the right, the exponent will be negative.

The mass of the Earth would be a very large number:

$5{,}973{,}600{,}000{,}000{,}000{,}000{,}000{,}000$ kg = 5.9736×10^{24} kg

Here are some examples of small numbers:

$0.008 = 8 \times 10^{-3}$

$0.000234 = 2.34 \times 10^{-4}$

The mass of an electron would be a very small number:

$0.00000000000000000000000000000091093826$ kg = $9.1093826 \times 10^{-31}$ kg

Write the following numbers in scientific notation:

1) 1,000,000
2) 1
3) 807,000
4) 0.1
5) 6,100,000
6) 0.0303
7) 0.0018
8) 0.00014

1) 1×10^6 2) 1×10^0 3) 8.07×10^5 4) 1×10^{-1} 5) 6.1×10^6 6) 3.03×10^{-2} 7) 1.8×10^{-3} 8) 1.4×10^{-4}

Worksheet 4-2

Name:

Date:

Solve for the values of the following exponential numbers.

1) 1^1	=	____________	11) 5^0	=	____________
2) 2^1	=	____________	12) 5^2	=	____________
3) 1^2	=	____________	13) 4^0	=	____________
4) 2^2	=	____________	14) 9^2	=	____________
5) 2^3	=	____________	15) 9^0	=	____________
6) 3^2	=	____________	16) 12^4	=	____________
7) 3^3	=	____________	17) 12^3	=	____________
8) 3^4	=	____________	18) 10^4	=	____________
9) 10^2	=	____________	19) 7^0	=	____________
10) 6^3	=	____________	20) 7^3	=	____________

Convert the following numbers to scientific notation.

21) 1,000	=	____________	26) 1,000,000	=	____________
22) 1	=	____________	27) 909,000	=	____________
23) 67,000,000	=	____________	28) 0.001	=	____________
24) 0.1	=	____________	29) 0.00028	=	____________
25) 0.00306	=	____________	30) 0.000000614	=	____________

Convert the following scientific notation to regular numbers.

31) 6.14×10^{-7}	=	____________	33) 2.8×10^{-4}	=	____________
32) 3.06×10^{-3}	=	____________	34) 1×10^{-1}	=	____________

35) 1×10^{-3} = ______________

36) 6.7×10^{7} = ______________

37) 9.09×10^{5} = ______________

38) 1×10^{0} = ______________

39) 1×10^{6} = ______________

40) 1×10^{3} = ______________

Worksheet 4-3

Name:

Date:

Complete the following table.

24-Hour Time	**Reading**	***A.M./P.M. Time***
0315	zero three fifteen hours	3:15 A.M.
1040		
2100		
1230		
		7:15 A.M.
		10:45 P.M.
	zero eight thirty hours	
	twenty-two fifteen hours	
1020		
2200		
1130		
		7:15 P.M.
		10:45 A.M.
	twelve thirty hours	
	twenty-two ten hours	

Solve for the values of the following exponential numbers.

1) 6^3 = ____________

2) 5^2 = ____________

3) 4^7 = ____________

4) 3^4 = ____________

5) 10^2 = ____________

6) 6^2 = ____________

7) 5^3 = ____________

8) 4^5 = ____________

9) 3^3 = ____________ 10) 10^4 = ____________

Express the following numbers in scientific notation.

11) 10,000,000 = ____________

12) 351 = ____________

13) 7,100 = ____________

14) 0.037 = ____________

15) 0.3750 = ____________

16) 0.0064 = ____________

17) 1,000,000 = ____________

18) 35 = ____________

19) 6,100 = ____________

20) 0.37 = ____________

21) 0.375 = ____________

22) 0.0056 = ____________

Worksheet 4-4 (tougher problems)

Name:

Date:

Solve the following problems to further your knowledge on 24 hour time, exponents, and scientific notation.

1) While working in the pharmacy, you receive an order to give a medication every four hours around the clock. If the patient's nurse tells you that she wants to give the first dose at 1 p.m., what times will you schedule the medication? *(give your answers in 24-hour time)*

2) Avogadro's Number is very useful in pharmaceutical chemistry as it provides a means for accurately determining the number of atom's that exist in a mass of a specific substance. If you have $6.02 \text{ x } 10^{23}$ atoms of a pure substance it will have the same mass (in grams) as its SI number found on the periodic table. Write out Avogadro's Number ($6.02 \text{ x } 10^{23}$) without using scientific notation.

3) $27^2 \div 3^2 =$

4) Whenever two problems written in scientific notation are multiplied you may multiply the initial numbers normally and add the exponents to get your answer. An example would be:

   $(2 \times 10^2)(3 \times 10^4) = 6 \times 10^6$

   With that in mind solve the following problem:

   $(1.2 \times 10^5)(5 \times 10^7) =$

5) Whenever two problems written in scientific notation are divided you may divide the initial numbers normally and subtract the exponents to get your answer. An example would be:

   $(6 \times 10^6) \div (3 \times 10^4) = 2 \times 10^2$

   With that in mind solve the following problem:

   $(6 \times 10^{12}) \div (1.2 \times 10^5) =$

Chapter 5

Problems Solving Methods

The essence of mathematics is not to make simple things complicated, but to make complicated things simple.
--Stanley Gudder

Most calculations in pharmacy can be solved using either ratios and proportions or dimensional analysis (*a.k.a.,* factor labels).

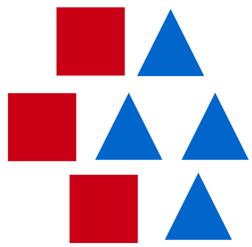
Ratios

We use ratios to make comparisons between two things. When we express ratios in words, we use the word "to" -- we say "the ratio of something to something else"

Example :

The ratio of squares to triangles in the illustration below. Ratios can be written in several different ways:

as a fraction	$\frac{3}{4}$
using the word “to”	3 to 4
using a colon	3:4



Using the above images, make a comparison of triangles to all shapes written the following ways:

1) as a fraction

2) using the word “to”

3) using a colon

1) 4/7 2) 4 to 7 3) 4:7

Multiplying or dividing each term by the same nonzero number will give an equal ratio.

Example :

The ratio 2:4 is equal to the ratio 1:2. To tell if two ratios are equal, use a calculator and divide. If the division gives the same answer for both ratios, then they are equal.

$$1:2 = 2:4 = 4:8 = 6:12 \qquad \textit{or} \qquad \frac{1}{2}=\frac{2}{4}=\frac{4}{8}=\frac{6}{12}$$

Are 3:9, 1:3, and 9:27 all equal?

Yes, 3:9 = 1:3 = 9:27

Example :

Janine has a bag with 3 videocassettes, 4 marbles, 7 books, and 1 orange.

1) What is the ratio of books to marbles?
   - Expressed as a fraction, with the numerator equal to the first quantity and the denominator equal to the second, the answer would be 7/4.
   - Two other ways of writing the ratio are 7 to 4, and 7:4.

2) What is the ratio of videocassettes to the total number of items in the bag?
   - There are 3 videocassettes, and 3 + 4 + 7 + 1 = 15 items total.
   - The answer can be expressed as 3/15, 3 to 15, or 3:15.

Complete the following practice problems.

1) 
What is the ratio of squares to total?

2) 
What is the ratio of circles to triangles?

3) 
What is the ratio of triangles to squares?
What is the ratio of circles to all?
What is the ratio of triangles to squares to circles?

1) 7:8 2) 7:2 3) 3:2 ; 4:9 ; 3:2:4

Attempt the following practice word problems.

1) Write a ratio comparing the oxygen tension of arterial blood (100 milliliters) to that of venous blood (40 milliliters).

2) If 2 oz of boric-acid are added to 598 oz of water, how many ounces are in the total solution? What is the ratio of ounces of boric acid to ounces of solution?

3) If 35 oz of a chemical are combined with 65 oz of water, how many oz are in the solution? What is the ratio of oz of chemical to oz of solution?

1) 100:40 would be an acceptable answer, I would also accept it if someone reduced it down too 5:2   2) There are 600 ounces in the total solution and the ratio of boric acid to solution is 2:600 which could be reduced to 1:300   3) There are 100 ounces in the solution and the ratio of chemical to solution is 35:100 which could be reduced to 7:20

Worksheet 5-1

Name:

Date:

Express the following as ratios reduced to lowest terms.

1) 1 to 5
2) 2 to 11
3) 2 grams to 9 grams
4) 15 cm to 23 cm
5) 3 feet to 27 feet
6) 25 liters to 5 liters
7) 36 cm to 6 cm
8) 24 inches to 9 inches
9) 3 meters to 9 meters
10) 100 g to 1,000 g

Solve the following problems.

11) If 3 oz of boric-acid solution are added to 897 oz of water, how many ounces are in the total solution? What is the ratio of ounces of boric acid to ounces of solution?

12) If 30 oz of a chemical are combined with 60 oz of water, what is the ratio of chemical to ounces of solution?

13) If 20 oz of alcohol are added to 40 oz of water, how many ounces are in the total solution? What is the ratio of ounces of alcohol to ounces of total solution?

14) If 10 grams of salt are added to 40 grams of water, what is the total weight of the water-and-salt solution? What is the ratio of grams of salt to grams of solution? (*Ordinarily, you would not measure water by mass, but it is possible to do and therefore the problem could be reproduced.*)

15) If 3 mL of glycerin are added to 87 mL of water, what is the ratio of the mL of glycerin to the mL of solution?

16) If 2 grams of a drug are added to 38 grams of petrolatum, what is the ratio of the grams of drug to the grams of the mixture?

17) If 5 oz of a drug are added to 95 oz of water, how many ounces are in the total solution? What is the ratio of ounces of drug to ounces of solution?

Worksheet 5-2

Name:

Date:

Express the following as ratios reduced to lowest terms.

1) 1 to 4
2) 3 to 17
3) 3 grams to 15 grams
4) 2 cm to 7 cm
5) 5 feet to 19 feet
6) 23 liters to 25 liters
7) 3 cm to 18 cm
8) 35 inches to 7 inches
9) 1,000 m to 10 m
10) 12 grams to 48 grams

Solve the following problems.

11) To perform a test, a lab technician adds 5 oz of a test liquid to 395 oz of water. How many ounces are in the solution? What is the ratio of ounces of test liquid to ounces of solution?

12) If 2 oz of chemical are combined with 8 oz of water, how many ounces are in the total solution? What is the ratio of ounces of chemical to ounces of solution?

13) A marathon runner has a normal heart rate of 68 beats/min. After completing a marathon, her heart rate is 110 beats/min. Express the ratio of her normal heart rate to her heart rate after a marathon.

14) If 3 oz of boric-acid[1] solution are added to 741 oz of water, how many ounces are in the total solution? What is the ratio of boric acid to ounces of solution?

15) In 1964, the U.S. Public Health Service reported that the risk of developing lung cancer is 10 times greater for moderate smokers and 20 times greater for heavy smokers than for nonsmokers. Express ratio of risk of cancer for nonsmokers to moderate smokers to heavy smokers. *(Hint, even if you don't smoke you still have a chance of developing lung cancer.)*

1 Since it has been mentioned repeatedly for various problems, you may be asking, “What's boric-acid?”. Boric-acid, also called boracic acid or orthoboric acid, is a mild acid often used as an antiseptic, insecticide, flame retardant, in nuclear power plants to control the fission rate of uranium, and as a precursor of other chemical compounds. It exists in the form of colorless crystals or a white powder and dissolves in water. It has the chemical formula $B(OH)_3$. When occurring as a mineral, it is called sassolite.

Proportions

A proportion is a statement of equality between two ratios.

Example:

$$\frac{1}{2}=\frac{2}{4}$$

This proportion can also be expressed as “1:2 = 2:4” or “1 is to 2 as 2 is to 4”.

Question:

What would be two other ways to express the following:

$$\frac{a}{b}=\frac{c}{d}$$

This proportion can also be expressed as “a:b = c:d” or “a is to b as c is to d”.

Solving for a Variable in a Proportion

You have three options:

1) basic algebra
2) cross multiplying
3) “means” and “extremes”

Let's solve the following equation for *a* using all three methods

$$\frac{a}{b}=\frac{c}{d}$$

algebra

Solving for *a* using basic algebra. First, we need to isolate *a*, we can do this by multiplying both sides of the equation by *b*. Then you can cancel out the *b*s on the left hand side of the equation, and this will leave you with your final answer.

$\frac{a}{b}=\frac{c}{d}$ → Multiply both sides by *b*. → $\frac{b\times a}{b}=\frac{b\times c}{d}$ → Now cancel out the *b*s on the left. → $\frac{\cancel{b}\times a}{\cancel{b}}=\frac{b\times c}{d}$ → Your final answer → $\boldsymbol{a=\frac{b\times c}{d}}$

cross multiplying

Solving for *a* using cross multiplication. You can multiply diagonally and set both multiplication problems as equal. Then we will want to isolate the *a* by dividing both sides by *d*. Cancel out the *d*s on the appropriate side and you will be left with the final answer.

$\frac{a}{b}=\frac{c}{d}$ → Cross multiply → $\frac{a}{b} \times \frac{c}{d}$ → $a \times d = b \times c$ → Divide by *d*. → $\frac{a \times d}{d}=\frac{b \times c}{d}$ → Cancel →

$\frac{a \times \cancel{d}}{\cancel{d}}=\frac{b \times c}{d}$ → Your final answer → $\boldsymbol{a=\frac{b \times c}{d}}$

"means" and "extremes"

Solving for *a* using "means" and "extremes". To do this, you need to rewrite your proportion using colons. Next, you multiply your means (your inside numbers) and set them equal to the value of your extremes (outside numbers) when they are multiplied. Then we will want to isolate the *a* by dividing both sides by *d*. Cancel out the *d*s on the appropriate side and you will be left with the final answer.

$\frac{a}{b}=\frac{c}{d}$ → Rewrite it using colons → $a:b=c:d$ → Multiply your "means" and "extremes" → $a:b=c:d$ → $a \times d = b \times c$ → Divide by *d*.

→ $\frac{a \times d}{d}=\frac{b \times c}{d}$ → Cancel → $\frac{a \times \cancel{d}}{\cancel{d}}=\frac{b \times c}{d}$ → Your final answer → $\boldsymbol{a=\frac{b \times c}{d}}$

Now that you've been shown three different ways to solve for a variable in a ratio proportion, let's try a practice problem. Solve for each of the variables in the statement "W is to X as Y is to Z".

1) The value of *W* is:

2) The value of *X* is:

3) The value of *Y* is:

4) The value of *Z* is:

1) $W=\frac{X \times Y}{Z}$ 2) $X=\frac{W \times Z}{Y}$ 3) $Y=\frac{W \times Z}{X}$ 4) $Z=\frac{X \times Y}{W}$

Solve for the variable in each of the following practice problems.

1) $\frac{3.8\,L}{14\,L} = \frac{N}{25\,L}$

2) $\frac{x}{7.2\,g} = \frac{3.0\,g}{2.0\,g}$

3) $5 : N = 7 : 9$

4) $3 : 4 = x : 15$

1) 6.8 L 2) 10.8 g 3) 6.4 4) 11.25

Worksheet 5-3

Name:

Date:

Solve the following ratio proportion problems.

1) In the proportion 5:8 = 25:40,
   a) The extremes are ______ and ______.
   b) The means are ______ and ______.

Solve for N in each of these problems.

2) $\frac{2}{3}=\frac{4}{N}$ $N =$ ______

3) $\frac{5}{7}=\frac{15}{N}$ $N =$ ______

4) $\frac{3}{6}=\frac{1}{N}$ $N =$ ______

5) $\frac{5}{10}=\frac{7}{N}$ $N =$ ______

6) $\frac{2}{8}=\frac{3}{N}$ $N =$ ______

7) $\frac{N}{3}=\frac{4}{6}$ $N =$ ______

8) $\frac{N}{8}=\frac{3}{24}$ $N =$ ______

9) $\frac{N}{12}=\frac{5}{6}$ $N =$ ______

10) $\frac{N}{4}=\frac{6}{8}$ $N =$ ______

11) $\frac{N}{5}=\frac{10}{25}$ $N =$ ______

12) $\frac{N}{6}=\frac{10}{12}$ $N =$ ______

13) $\frac{N}{7}=\frac{6}{42}$ $N =$ ______

14) $\frac{N}{15}=\frac{2}{5}$ $N =$ ______

15) $\frac{N}{5}=\frac{4}{10}$ $N =$ ______

16) $\frac{3}{5}=\frac{N}{100}$ $N =$ ______

17) $\frac{125}{1{,}000}=\frac{N}{8}$ $N =$ ______

18) $\frac{3}{8}=\frac{375}{N}$ $N =$ ______

19) $\frac{2}{3}=\frac{N}{12}$ $N =$ ______

Worksheet 5-4

Name:

Date:

Write the following problems in fractional-equation form.

1) $3:x = 6:7$

2) $5:8 = N:10$

3) $K:8 = 4:16$

4) $7:9 = 14:N$

5) $2:3 = x:9$

6) $7:N = 14:28$

Solve the following proportions for N.

7) $N:7 = 6:14$

8) $8:10 = 4:N$

9) $3:N = 6:18$

10) $5:8 = N:24$

11) $N:9 = 6:18$

12) $8:N = 16:32$

13) $\frac{2.5}{16} = \frac{N}{8}$

14) $\frac{4.2}{N} = \frac{2.1}{100}$

15) $\frac{6.8}{50} = \frac{13.6}{N}$

16) $\frac{12.0\,g}{4.6\,g} = \frac{8.4\,g}{N}$

Solve the following word problems.

17) Given a boric-acid solution of 1:400, how many ounces are in 70 oz of the solution?

18) How much magnesium sulfate is needed for a preparation of 24 oz of a 1:4 mixture?

19) The ratio of salt to water in a very concentrated saline solution is 3:8. How much salt should be added to 360 g of water to prepare a solution with this ratio?

20) Given a boric-acid solution of 1:500, how many ounces of boric acid are in 80 oz of solution?

Worksheet 5-5

Name:

Date:

Write the following proportions in fractional-equation form.

1) $4:X = 7:9$

2) $3:5 = N:8$

3) $N:72 = 4.8:12.0$

4) $15.0:N = 31.0:1$

5) $5:17.1 = N:2$

6) $315:32 = N:35$

Solve the following proportions for N.

7) $N:2 = 15:3$

8) $4:5 = 8:N$

9) $5:N = 10:17$

10) $5:9 = N:10$

11) $\frac{3.5}{N} = \frac{70}{100}$

12) $\frac{N}{1.4} = \frac{12}{28}$

13) $\frac{N}{2.2} = \frac{1.7}{1}$

14) $\frac{14.0\,g}{70\,mL} = \frac{12.0\,g}{N}$

15) $\frac{2.1\,L}{8\,L} = \frac{N}{12.0\,L}$

16) $\frac{14.1\,oz}{5.8\,oz} = \frac{4\,oz}{N}$

17) $\frac{N}{\$712} = \frac{\$0.07}{\$1.00}$

Solve the following word problem.

18) Given a colloidal suspension of 3.5:100, how many mL of colloids are present in 946 mL of this colloidal suspension?

Dimensional Analysis *(a.k.a., Factor Label Method)*

Dimensional analysis is a conceptual tool often utilized in health care to understand physical situations involving a mix of different kinds of physical quantities. It is routinely used by pharmacists and pharmacy technicians to calculate things such as weight, volume, dose, dosage form, and time. To solve a problem using dimensional analysis, you need to first identify what information is provided by the problem as well as any conversion factors that you will need to solve the problem. Terms that are equal to each other may be written in the form of a fraction.

If 1 capsule is 250 mg you could say that 1 capsule = 250 mg. To write that as a fraction you could write:

$$\frac{1\,capsule}{250\,mg} \quad \text{or} \quad \frac{250\,mg}{1\,capsule}$$

Example:

How many tablets will be taken in seven days if a prescription order reads zafirlukast 20mg/tablet, one tablet twice a day?

QUESTION:

How many tablets?

DATA:

7 days — 20mg/tablet

1 tablet/dose — 2 doses/day

MATHEMATICAL METHOD / FORMULA:

Dimensional Analysis

DO THE MATH

$$\frac{7\,days}{1} \times \frac{2\,doses}{day} \times \frac{1\,tablet}{dose}$$

cancel out dimensions where applicable

$$\frac{7\,\cancel{days}}{1} \times \frac{2\,\cancel{doses}}{\cancel{day}} \times \frac{1\,tablet}{\cancel{dose}} = \mathbf{14\,\textit{tablets}}$$

DOES THE ANSWER MAKE SENSE ?

Yes

Notice in the above example how dimensions are used to cancel everything out until you are left with just what you need, in this case tablets.

5 Step Method

You may also notice the way the example was broken down with five questions. This is known as the “5 Step Method”. The “5 Step Method” is simply a way to help you interpret the data in a problem and get the answer. While certainly the problems in this book can be solved without using the “5 Step Method”, you will find that many example problems throughout the book are broken down this way.

The five steps are: 1) QUESTION (identify what the question is asking); 2) DATA (identify the data in the problem and any necessary conversion factors); 3) MATHEMATICAL METHOD/FORMULA (identify the method or formula needed to solve the problem), 4) DO THE MATH (exactly what the statement says), and 5) DOES THE ANSWER MAKE SENSE? (sometimes an answer will not make sense, and that may mean that there is an error).

Now we should try a practice problem using dimensional analysis and the “5 Step Method”.

How many tablets will you need to provide a 24 hour supply of metoprolol succinate 50 mg/dose 1 dose/day if you have 25 mg tablets available.

QUESTION

DATA

MATHEMATICAL METHOD / FORMULA

DO THE MATH

DOES THE ANSWER MAKE SENSE

2 tablets

Worksheet 5-6

Name:

Date:

Solve the following problems using dimensional analysis.

1) How many tablets will be taken in three days if a prescription reads zafirlukast 20 mg/tablet, one tablet twice a day?

2) How many capsules will be taken in seven days if a prescription order reads tetracycline 250 mg/capsule, one capsule four times a day?

3) How many tablets will be taken in four days if a prescription order reads sucralfate 1 g/tablet, one tablet four times a day?

4) How many tablets will be taken in 10 days if a prescription order reads warfarin 5 mg/tablet, one tablet daily at bedtime?

5) How many tablets will be taken in 30 days if a prescription order reads metoprolol tartrate 50 mg/tablet, one tablet two times a day?

6) How many tablets will be taken in two days if a prescription reads famotidine 20 mg/tablet, one tablet three times a day before meals?

7) How many tablets are needed to fill a prescription for 34 days for albuterol 2 mg/tablet four times a day?

8) How many capsules are needed to fill a 4 week supply of fluoxetine HCl controlled release 60 mg/capsule, one capsule every week?

9) How many tablets are needed to fill a prescription for 21 days for repaglinide 0.5 mg/tablet, one tablet three times a day?

10) How many tablets are needed to fill a 72 hour supply for dipyridamole 50 mg/tablet, one tablet four times a day?

Worksheet 5-7

Name:

Date:

Solve the following problems using dimensional analysis.

1) How many tablets will be taken in seven days if a prescription order reads furosemide 20 mg/tablet, one tablet twice a day?

2) How many tablets are needed to fill a prescription for seven days for alprazolam 0.5 mg/tablet, one tablet three times a day?

3) How many tablets are needed to fill a prescription for 90 days for dipyridamole 50 mg/tablet, one tablet four times a day?

4) How many capsules are needed to fill a prescription for 28 days for potassium chloride 10 mEq/capsule, one capsule four times a day?

5) How many tablets are needed to fill a four day prescription of azithromycin 500 mg/tablet, one tablet daily?

6) How many tablets will be taken in 30 days if a prescription order reads methylphenidate 10 mg/tablet, one tablet three times a day?

7) How many capsules are needed to fill a 90 day supply of zidovudine 100 mg/capsule, three capsules twice daily?

8) You receive the following order for 10 mg terazosin HCl capsules:

   Rx terazosin HCl 10 mg/capsules
   Dispense: 30 day supply
   Sig: Take 1 capsule by mouth at bedtime for 3 days,
   then take 2 capsules by mouth at bedtime for 5 days,
   then take 4 capsules by mouth at bedtime thereafter.

   How many capsules should you dispense? *(Hint ~ This problem will require several dimensional analysis equations to get your final answer.)*

Worksheet 5-8

Name:

Date:

Solve the following problems using dimensional analysis.

1) How many tablets will be needed to fill a prescription for three days for upsadasium 25 mg/tablet if it is ordered 50 mg of upsadasium three times a day?

2) How many capsules are needed to fill a 30 day prescription for 25 mg/capsule of downagain if it is ordered one capsule every day.

3) How many tablets will be taken in three days if a prescription order reads sucralfate 1 g/tablet, one tablet four time a day?

4) How many tablets will be taken in seven days if a prescription order reads Ambien 5 mg/tablet, one tablet daily at bedtime?

5) How many capsules are needed to fill a prescription for 90 days if a prescription order reads zidovudine 100 mg/capsules, three capsules twice daily?

6) How many capsules are needed to fill a prescription for 14 days for potassium chloride 10 mEq/capsule, one capsule four times a day?

7) How many capsules are needed to fill a prescription for 30 days for prazosin 1 mg/capsule, two capsules three times a day?

8) You dispense a prescription for furosemide 40 mg. The instructions read take one tablet by mouth twice a day for 10 days. What is the total number of tablets you should dispense?

9) An order is received for dexamethasone 10 mg twice a day for 5 days, 5 mg twice a day for 4 days, and 2.5 mg twice a day for 2 days. Your stock is 10 mg tablets scored in fourths. What would be the total amount of tablets for you to dispense? *(Hint ~ This problem will require several dimensional analysis equations to get your final answer.)*

Worksheet 5-9

Name:

Date:

Express the following as ratios reduced to lowest terms.

1) 1 to 9
2) 2 g to 12 g
3) 6 cm to 36 cm

Solve the following word problems.

4) What is the ratio of chemical to ounces of solution if 20 oz of chemical are combined with 80 oz of water?

5) How many ml of a drug are needed to prepare 2,500 ml of a 1:20 solution?

6) How much hydrocortisone is needed to prepare a 120 grams of a 1:50 ointment?

Write the following proportions in fractional-equation form.

7) 5:*x* = 10:15
8) 6:11 = *Y*:12
9) 1:3 = *N*:18

Solve the following ratio proportions for *N*.

10) *N*:10 = 3:5

11) *N*:10 = 4:5

12) *N*:9 = 2:3

13) $\frac{3.1\,g}{15.5\,g} = \frac{8.1\,g}{N}$

14) $\frac{4.2\,g}{16.8\,g} = \frac{7.1\,g}{N}$

15) $\frac{4.1\,g}{12.3\,g} = \frac{6.1\,g}{N}$

16) $\frac{4.4\,mL}{17.6\,mL} = \frac{N}{4\,mL}$

17) $\frac{5\,in.}{12\,in.} = \frac{N}{8\,in.}$

18) $\frac{50\,g}{100\,mL} = \frac{N}{4\,mL}$

Solve the following problems using dimensional analysis.

19) How many tablets will be taken in seven days if a prescription order reads zafirlukast 20 mg/tablet, one tablet twice a day?

20) How many tablets are needed to fill a prescription for seven days for cyproheptadine 4 mg/tablet, one tablet three times a day?

21) How many tablets are needed to fill a prescription for 30 days for dipyridamole 50 mg/tablet, one tablet four times a day?

22) How many capsules are needed to fill a prescription for 14 days for potassium chloride 10 mEq/capsule, one capsule four times a day?

23) How many capsules are needed to fill a 14 day prescription of ampicillin 500 mg/capsule, one capsule four times a day?

24) How many tablets will be taken in 90 days if a prescription order reads atomoxetine 10 mg/capsules, one capsule three times a day?

25) How many capsules are needed to fill a three day supply of zidovudine 100 mg/capsule, three capsules twice daily?

26) How many tablets will be taken in two days if a prescription order reads promethazine 12.5 mg/tablet, one tablet three times a day?

27) Each tablet of TYLENOL WITH CODEINE contains 30 mg of codeine phosphate and 300 mg of acetaminophen. By taking two tablets daily for a week, how many milligrams of each drug would the patient take?

28) The biotechnology drug filgrastim (NEUPOGEN) is available in vials containing 480 micrograms (mcg) of filgrastim per 0.8 mL. How many micrograms of the drug would be administered by each 0.5 mL injection?

UNIT 2

BASIC PHARMACY MATH

What does basic pharmacy math consist of?

Before you start calculating dosages of antineoplastic infusions based on a patient's body surface area, you need to learn some basics. We need to be able to convert between various measurement systems, learn a little bit of terminology and how to manipulate data to find some simple dosages for oral medications, days' supply, and IV drip rates. That is what most would consider basic pharmacy math, and this unit is designed to provide a guide to learning this information.

What are the specific learning objectives in this unit?

- temperature conversions
- household measurements
- metric system
- apothecary system
- medication abbreviations
- calculating dosages when giving medications in tablet or capsule form
- calculating dosages when giving medications in liquid form
- preparing solutions
- diluting stock solutions
- determining the rate of intravenous medications
- dosages based on body weight
- dosages based on body surface area
- pediatric dosing

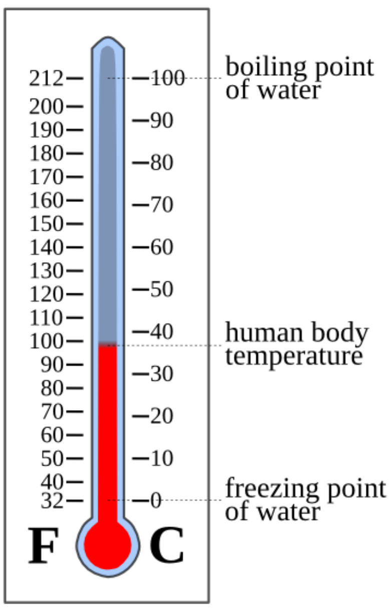
CHAPTER 6

TEMPERATURE SCALE CONVERSIONS

It doesn't make a difference what temperature a room is, it's always room temperature.
--Steven Wright

The temperature for storing medication is extremely important for the stability—and therefore the effectiveness—of the medication. The two common temperature scales used in pharmacy are Celsius and Fahrenheit. Usually, storage requirements (including storage temperature) are listed in small print on the package label. The necessary temperature is usually given in both Celsius and Fahrenheit degrees, although not always. Furthermore, the Pharmacy Technician Certification Exam (a certification required by some of the higher paying technician jobs) always ask several questions involving temperatures. Hence, you need to be able to convert between Celsius and Fahrenheit.

Fahrenheit and Celsius are both linear scales, so let's gather some basic information on them and create a formula to compare them.



What is the temperature when water freezes in degrees Fahrenheit?

32° F

What is the temperature when water boils in degrees Fahrenheit?

212° F

What is the temperature when water freezes in degrees Celsius?

0° C

What is the temperature when water boils in degrees Celsius?

100° C

How many degrees does it take to get from the freezing point of water to the boiling point of water on the Fahrenheit scale?

180° F

How many degrees does it take to get from the freezing point of water to the boiling point of water on the Celsius scale?

100° C

Now lets create a ratio comparing the two ranges.

180° F : 100° C

That ratio can be reduced to....

9° F : 5° C

Now that we've established all that information, there is one other thing we need to look at before we can come up with a formula.

What is the difference between the freezing point of water in Fahrenheit and the freezing point of water in Celsius?

32º F

So, based on this information I can create the following formula to convert from a Celsius temperature to a Fahrenheit temperature:

$$T^{o}C \times \frac{9^{o}F}{5^{o}C} + 32^{o}F = \textit{your equivalent degrees } F$$

Often, you'll see this formula simplified to:

$$C \times \frac{9}{5} + 32 = F$$

From this point we can use some basic algebra to create a formula to convert from Fahrenheit temperature to Celsius temperature:

$$(F - 32) \times \frac{5}{9} = C$$

Practice Problem

Let's test our new formulas. You may already know that the ideal body temperature for a homo sapien is 98.6º F or 37º C.

Change 98.6º F to Celsius using the following equation:

$$(F - 32) \times \frac{5}{9} = C$$

Change 37º C to Fahrenheit using the following equation:

$$C \times \frac{9}{5} + 32 = F$$

Worksheet 6-1

Name:

Date:

Convert the following temperatures. Round all your answers to the tenths position.

1) 50º C = _____º F
2) 47º C = _____º F
3) 45º C = _____º F
4) 40º C = _____º F
5) 37º C = _____º F
6) 32º C = _____º F
7) 30º C = _____º F
8) 25º C = _____º F
9) 22º C = _____º F
10) 20º C = _____º F
11) 18º C = _____º F
12) 15º C = _____º F
13) 12º C = _____º F
14) 10º C = _____º F
15) 7º C = _____º F
16) 5º C = _____º F
17) 2º C = _____º F
18) 0º C = _____º F
19) -5º C = _____º F
20) -10º C = _____º F
21) -40º C = _____º F
22) 100º F = _____º C
23) 90º F = _____º C
24) 89º F = _____º C
25) 82º F = _____º C
26) 80º F = _____º C
27) 79º F = _____º C
28) 75º F = _____º C
29) 70º F = _____º C
30) 63º F = _____º C
31) 60º F = _____º C
32) 58º F = _____º C
33) 55º F = _____º C
34) 45º F = _____º C
35) 37º F = _____º C
36) 32º F = _____º C
37) 25º F = _____º C
38) 22º F = _____º C
39) 15º F = _____º C
40) 12º F = _____º C
41) 5º F = _____º C
42) 0º F = _____º C
43) -5º F = _____º C
44) -14º F = _____º C
45) -20º F = _____º C

Worksheet 6-2 (part I)

Name:

Date:

Specific storage conditions are required to be printed in product literature and on drug packaging and drug labels to ensure proper storage and product integrity. The conditions are defined by the following terms[1]:

Cold: any temperature not exceeding 8° C

Freezer: -25° to -10° C

Refrigerator: 2° to 8° C

Cool: 8° to 15° C

Room temperature: the temperature prevailing in a working area

Controlled room temperature: 15° to 30° C

Warm: 30° to 40° C

Excessive heat: any temperature above 40° C

Calculate all the above temperatures in Fahrenheit, round to the nearest whole number degree.

Cold: any temperature not exceeding ____ F

Freezer: ____ to ____ F

Refrigerator: ____ to ____ F

Cool: ____ to ____ F

Room temperature: the temperature prevailing in a working area

Controlled room temperature: ____ to ____ F

Warm: ____ to ____ F

Excessive heat: any temperature above ____ F

1 These important standards are contained in a combined publication that is recognized as the official compendium, the United States Pharmacopeia (USP) and the National Formulary (NF)

Worksheet 6-2 (part II)

Name:

Date:

Specific storage conditions are required to be printed in product literature and on drug packaging and drug labels to ensure proper storage and product integrity. The conditions are defined by the following terms[2]:

Cold: any temperature not exceeding 46° F

Freezer: -13° to 14° F

Refrigerator: 36° to 46° F

Cool: 46° to 59° F

Room temperature: the temperature prevailing in a working area

Controlled room temperature: 59° to 86° F

Warm: 86° to 104° F

Excessive heat: any temperature above 104° F

Calculate all the above temperatures in Celsius, round to the nearest whole number degree.

Cold: any temperature not exceeding ____ C

Freezer: ____ to ____ C

Refrigerator: ____ to ____ C

Cool: ____ to ____ C

Room temperature: the temperature prevailing in a working area

Controlled room temperature: ____ to ____ C

Warm: ____ to ____ C

Excessive heat: any temperature above ____ C

2 These important standards are contained in a combined publication that is recognized as the official compendium, the United States Pharmacopeia (USP) and the National Formulary (NF)

Worksheet 6-3

Name:

Date:

Solve the following temperature conversion problems.

1) When making a mixture, you are instructed to heat the mixture to 130° C. You have only a Fahrenheit thermometer. What is the equivalent temperature on the Fahrenheit scale?

2) Most of the drugs in a pharmacy need to be stored at controlled room temperature, which is defined by the USP/NF as 15° C to 30° C. The air conditioning at Bidwell Community Pharmacy breaks down on a warm day in August. The weather forecast says that it is supposed to get up to 90° F. Is that within the acceptable range?

3) The following sterile compounding request is sent to the hospital pharmacy:

Alteplase in a Syringe

Rx	alteplase, 2mg/ml	50 mg
	sterile water for injection	25 mL

1. Reconstitute the alteplase with SWFI.
2. Draw up 5 mL in 10 mL syringes.
3. Label syringes with contents, concentration, and date of preparation.
4. Place syringes in freezer. They should be frozen with premix piggybacks.

The syringes are stable for 45 days, at -25° C to -10° C

a) What is the Fahrenheit at which you should store this product?

b) What expiration should you put on this product if you made it today?

4) A prescription is sent to the pharmacy requesting a substance to be heated in a 300° F oven for 12-18 hours. At what Celsius temperature does the oven need to be set?

5) An autoclave is usually set to 250° F to sterilize medical instruments. What is the equivalent temperature in degrees Celsius?

6) Convert the following refrigerator temperatures and record them in the appropriate spaces on the log below. Note any temperatures out of the safe range (2° to 8° C).

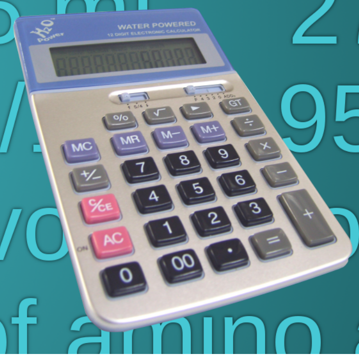
Date	**Degrees F**	**Degrees C**
1/25	36.1	a.
1/26	37.7	b.
1/27	39.0	c.
1/28	34.5	d.
1/29	36.9	e.
1/30	36.7	f.
1/31	38.8	g.
2/1	43.8	h.
2/2	48.8	i.

Which days, if any, fell outside the safe range?

7) Convert the following freezer temperatures and record them in the appropriate spaces on the log below. Note any temperatures out of the safe range (-13° F to 14° F).

Date	Degrees C	Degrees F
1/25	-15.1	a.
1/26	-12.9	b.
1/27	-13.2	c.
1/28	-9.4	d.
1/29	-10.5	e.
1/30	-13.5	f.
1/31	-15.7	g.
2/1	-18.9	h.
2/2	-21.0	i.

Which days, if any, fell outside the safe range?



Chapter 7

Units Of Measurement

You can't control what you can't measure.
--Tom DeMarco

We will need to know three major systems of measurement thoroughly.

- The English/Household System
- The Metric System
- The Apothecary System

Health care has been combining science into its repertoire long before the majority of the world standardized on the metric system; therefore, many directions and recipes will still call for knowledge of all three systems, and how to convert between them.

The English/Household System

The household system (sometimes referred to as the English system) is the measurement system most commonly used in the United States today and is nearly the same as that brought by the colonists from England. These measures had their origins in a variety of cultures –Babylonian, Egyptian, Roman, Anglo-Saxon, and Norman French. The ancient "digit," "palm," "span" and "cubic" units of length slowly lost preference to the length units "inch," "foot," and "yard."

Because this is the system of measurement we are most familiar with, we tend to be capable of making conversions within this system very rapidly for length, volume, and weight (the term weight is more commonly used in health care than mass).

Some common conversions within this system include:

Length

12 inches = 1 foot
3 feet = 1 yard
5,280 feet = 1 mile

Weight

16 ounces = 1 pound

Volume

3 teaspoon = 1 tablespoon
2 tablespoon = 1 fluid ounce
8 fluid ounces = 1 cup
2 cup = 1 pint
2 pints = 1 quart
4 quarts = 1 gallon

Along with knowing their relationship to each other, you should also be aware of accepted abbreviations and symbols.:

inch ~ in., "
foot ~ ft., '
yard ~ yd.
ounce ~ oz.,
pound ~ lb., lbs, #
teaspoon ~ tsp , t
tablespoon ~ Tbsp , T
fluid ounce ~ fl. oz., ƒ℥
pint ~ pt.
quart ~ qt.
gallon ~ gal.

Example:

Using the aforementioned conversions we can use dimensional analysis to figure out how many inches are in one mile.

$$\frac{1\,mile}{1} \times \frac{5{,}280\,ft}{1\,mile} \times \frac{12\,in.}{1\,ft.} = \mathbf{63{,}360}\,\boldsymbol{inches}$$

Practice Problem

How many teaspoons are in one gallon?

768 teaspoons

Review

1) The system of measurement most commonly used in the United States is the ___________ or ___________ system.

2) Quart and fluid ounce are household units that measure ___________.

3) Pound and ounce are household units that measure ___________.

4) Yard and inch are household units that measure ___________.

Interpret these abbreviations

5) ƒ℥ = ___________

6) tsp = ___________

7) pt. = ___________

8) lbs. = ___________

9) ' = ___________

10) oz. = ___________

1) household *or* English 2) volume 3) weight 4) length 5) fluid ounce 6) teaspoon 7) pint 8) pound 9) foot 10) ounce

The Metric System

In 1790, in the midst of the French Revolution, the National Assembly of France requested the French Academy of Sciences to "deduce an invariable standard for all the measures and all the weights."

The Commission appointed by the Academy created a system that was, at once, simple and scientific. The unit of length was to be a portion of the Earth's circumference. Measures for capacity (volume) and mass were to be derived from the unit of length, thus relating the basic units of the system to each other and to nature. Furthermore, larger and smaller multiples of each unit were to be created by multiplying or dividing the basic units by 10 and its powers. This feature provided a great convenience to users of the system, by eliminating the need for such calculations as dividing by 16 (to convert ounces to pounds) or by 12 (to convert inches to feet). Similar calculations in the metric system could be performed simply by shifting the decimal point Thus, the metric system is a "base-10" or "decimal" system.

The metric system is based on three basic units, meter(m) for length, gram(g) for weight, and liter(L) for volume. You can use the following prefixes to describe larger and smaller units of meters, grams, and liters:

Factor	***Name***	***Symbol***
10^9	giga	G
10^6	mega	M
10^3	kilo	k
10^2	hecto	h
10^1	deka	da
1	base unit	(m, g, L)
10^{-1}	deci	d
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	mc, µ
10^{-9}	nano	n
10^{-12}	pico	p

Based on the table above, 1.1 gigaliters would equal 1.1×10^9 liters or 1,100,000,000 liters.

$$\frac{1.1GL}{1} \times \frac{10^9 L}{1GL} = \mathbf{1{,}100{,}000{,}000}\,\boldsymbol{liters}$$

Some common conversions within the metric system include:

Length	*Weight*	*Volume*
10 mm = 1 cm	1,000 mcg = 1 mg	1 mL = 1 cc
1,000 mm = 1 m	1,000 mg = 1 g	1,000 mL = 1 L
100 cm = 1 m	1,000 g = 1 kg	1,000 cc = 1 L
1,000 m = 1 km		

Example:

Using the aforementioned conversions we can use dimensional analysis to figure out how many centimeters are in one kilometer.

$$\frac{1\,km}{1} \times \frac{1{,}000\,m}{1\,km} \times \frac{100\,cm}{1\,m} = \mathbf{100{,}000}\,\boldsymbol{centimeters}$$

Practice Problem

How many micrograms are in one kilogram?

1,000,000,000 micrograms

Review

1) The measurement system most commonly used in prescribing and administering medication is the ___________ system.

2) Liter and milliliter are metric units that measure ___________.

3) Gram and milligram are metric units that measure ___________.

4) Meter and millimeter are metric units that measure ___________.

Interpret these abbreviations

5) mcg = ___________

6) mL = ___________

7) cc = ___________

8) g = ___________

9) mm = ___________

10) kg = ___________

1) metric 2) volume 3) weight 4) length 5) microgram 6) milliliter 7) cubic centimeter 8) gram 9) millimeter 10) kilogram

Converting between household units and metric units

One of the common challenges of health care is that we are often given units in the English (or household) system, but we will need to convert them to metric to do our jobs. The following are some of the more common conversions:

Length	*Weight*	*Volume*
1 in. = 2.54 cm	1 lb. = 454 g	1 tsp = 5 mL
1 m = 1.09 yds.	1 kg = 2.2 lbs	1 Tbsp = 15 mL
	1 oz. = 28.4 g	1 fl. oz. = 29.6 mL (usually approximated to 30 mL)
		1 pt. = 473 mL (usually approximated to 480 mL)

Practice Problem

Your instructor is 6' 1” and weighs 165 lbs. What is his height in meters, and his weight in kilograms?

Height: 1.85 m Weight: 75 kg

Worksheet 7-1

Name:

Date:

Make the following conversions.

1) 1 L = ________ ml
2) 10 cc = ________ ml
3) 697 ml = ________ L
4) 2.6 L = ________ ml
5) 0.25 L = ________ cc
6) 2.5 kg = ________ g
7) 415 g = ________ kg
8) 2,160 mg = ________ g
9) 8.9 mg = ________ mcg
10) 200 g = ________ lb
11) 4 liters = ________ qt
12) 50 miles = ________ km
13) 5 m = ________ in
14) 3 in = ________ cm
15) 4 lb = ________ kg
16) 50 g = ________ oz
17) 5 fl oz = ________ cc
18) 2 qt = ________ ml
19) 2 kg = ________ oz
20) 2.5 L = ________ fl oz
21) 20 oz = ________ kg
22) 5' 3” = ________ m

Solve the following word problems.

23) A neonatal patient needs to receive a medication based on their weight in grams. The patient weighs 4 lbs 6 oz. How many grams does the baby weigh?

24) If Richard Stallman weighs 220 lbs, how much does he weigh in kg?

25) A physician writes for 137 mcg of levothyroxine by mouth once a day. All the levothyroxine tablets on your shelves are measured in mg. How many mg will each tablet need to be?

Worksheet 7-2

Name:

Date:

Make the following conversions. Feel free to use the estimated numbers for milliliters to fluid ounces and pints.

1) 205 lb = ______ kg

2) 9,080 g = ______ lb.

3) 5' 10” = ______ inches = ______ cm = ______ m

4) 4 lb 8 oz. = ______ oz. = ______ g = ______ kg

5) 960 mL = ______ fl. oz. = ______ pt.

6) 1,920 mL = ______ qt.

7) 3 tsp = ______ mL = ______ Tbl = ______ ƒ℥

8) 2 pt. = ______ cups = ______ oz. = ______ mL

9) 0.75 gal = ______ qt. = ______ pt. = ______ mL = ______ L

10) 7 lb 6 oz. = ______ kg

11) 6' 2” = ______ m

12) 1.5 cups = ______ cc

13) 5 L = ______ gal

14) 172 lb. = ______ kg

15) 1/3 tsp = ______ mL

Solve the following word problems.

16) If you purchased one-half ounce of papaverine hydrochloride and fill two prescriptions, one for 1.50 g and one for 0.125 oz., how many grams of papaverine hydrochloride do you have left in stock?

17) You're working in a pharmacy and receive the following prescription:

Rx	Cefaclor 250 mg/5mL
Disp:	150 mL
Sig.:	Take 375 mg by mouth two times a day for 10 days.

a) How many tsp should the patient take for each dose.

b) Did the physician write for you to dispense enough to cover a 10 day supply?

18) You're working in a pharmacy and receive the following prescription:

Rx	Erythromycin 200 mg/5mL
Sig.:	Take 200 mg by mouth three times a day for 5 days.

a) How many tsp should the patient take for each dose.

b) How many mL should you dispense to cover a 5 day supply?

The Apothecary System

Although fast becoming obsolete, the apothecary system for weighing and calculating pharmaceutical preparations is still used and must be taken into consideration. It has two divisions of measurement: weight and volume. In this system, the basic unit of weight is the grain, and the basic unit of volume is the minim. Some common conversions within the apothecary system are:

Weight	*Volume*
ounce (℥) = 8 drams = 480 grains	fluid ounce (*f* ℥) = 8 fluid drams = 480 minims
dram (ʒ) = 3 scruples = 60 grains	fluid dram (*f* ʒ) = 3 fluid scruples = 60 minims
scruple (℈) = 20 grains	fluid scruple (*f* ℈) = 20 minims
grain (gr) = 1 grain	minim (♍) = 1 minim
	drop (gtt) = 1 minim

How apothecary units are written

In metric you write units of measurement in this order:

number of units + unit wanted

Examples:

350 mg = three hundred fifty milligrams
1.8 m = one point eight meters

But in the apothecary system you write units of measurements in this order:

unit wanted + number of units (often written in Roman numerals)

Examples:

gr ii = two grains
gtt xii = twelve drops

While this is the order in which these systems of measurement are usually written, you will see them in other orders.

Another item worth noting is that apothecary units frequently add in a Latin abbreviation with the Roman numerals to gain a subdivision between units. This Latin abbreviation is ss, which equals 0.5 and is often read as the fraction one-half.

Example:

gr iiss = two and one-half grains

Practice Problems

Let's write the meaning or symbols of the given dosages:

1) *f* ℥ iiiss
2) ♏ ix
3) five drams
4) three drops
5) three and one-half grain
6) two hundred fifty cubic centimeters

1) three and one-half fluid ounces 2) nine minims 3) v 4) gtt iii 5) gr iiiss 6) 250 cc

Now, let's look at using dimensional analysis to make some conversions within the apothecary system.

Example:

Convert ʒ iiiss to gr.

$$\frac{3.5\,drams}{1} \times \frac{60\,grains}{1\,dram} = \mathbf{210}\,\boldsymbol{grains} \quad or \quad \boldsymbol{gr\,ccx}$$

Practice Problems:

1) Convert *f* ʒ xvi to *f* ℥ .
2) Convert 90 gr to ʒ.

1) *f* ii 2) iss

Review

Provide the appropriate symbol for each unit.

1) The measurement system dating back to the 11th century and still occasionally used in prescribing and administering medication is the ___________ system.
2) Fluid dram and minim are apothecary units that measure ___________.
3) Dram and grain are apothecary units that measure ___________.
4) ounce = ___________
5) scruple = ___________
6) grain = ___________
7) fluid dram = ___________
8) minim = ___________
9) drop = ___________

1) apothecary 2) volume 3) weight 4) 5) ℈ 6) gr 7) *f* 8) 9) gtt

Conversions

Now for some tables with all the pertinent conversions needed for this chapter.

Apothecary	**Household**	**Metric**
Volume	Length	Length
1 ♏ = 1 gtt	12 in = 1 ft	100 cm = 1 m
60 ♏ = 1 *f* ʒ	Volume	Volume
8 *f* ʒ = 1 *f* ℥	3 tsp = 1 Tbs	1 cc = 1 ml
Weight	8 fl oz = 1 cup	1000 ml = 1 L
60 gr = 1 ʒ	16 fl oz = 1 pt	Weight
8 ʒ = 1 ℥	Weight	1000 ng = 1 mcg (µg)
	16 oz = 1 lb	1000 mcg (µg) = 1 mg
		1000 mg = 1g
		1000 g = 1 kg

	Apothecary	**Household**	**Metric**
Length		1 in.	2.54 cm
Volume	1 ♏ or 1 gtt		0.06 ml
	1 *f* ʒ		3.6 ml (occasionally rounded all the way up to 5 mL)
		1 tsp	5 ml
		1 Tbs	15 ml
	1 *f* ℥		28.4 ml (usually rounded to 30 ml)
		1 *f* ℥	29.6 ml (usually rounded to 30 ml)
		1 pt	473 ml (usually rounded to 480 ml)
Weight	1 gr		64.8 mg (60 or 65 mg is frequently used)
		1 ℥	28.4 g (sometimes rounded to 30 g)
	1 ℥		31.1 g (sometimes rounded to 30 g)
		1 lb	454 g
		2.2 lb	1 kg

Something to pay careful attention to is how far many of the apothecary units are rounded. This can be difficult when trying to figure out how many milligrams of thyroid medication to dispense when a physician orders it in grains or how many milliliters to dispense of an antibiotic suspension when a physician doses it in fluid drams.

On the back of this page, we will look at some examples and practice problems.

Example:

Convert ʒ iiiss to g.

$$\frac{3.5\,drams}{1} \times \frac{60\,grains}{1\,dram} \times \frac{64.8\,milligrams}{1\,grain} \times \frac{1\,gram}{1{,}000\,milligrams} = \mathbf{13.6}\,\boldsymbol{grams}$$

or

$$\frac{3.5\,drams}{1} \times \frac{1\,apothecary\,ounce}{8\,drams} \times \frac{31.1\,grams}{1\,apothecary\,ounce} = \mathbf{13.6}\,\boldsymbol{grams}$$

If you used rounded numbers you could have been as low as *12.6 grams* or as high as *13.7 grams*, which is something that can be difficult to keep track of when looking at the answers that others may achieve.

Practice Problems:

1) If someone orders gr v of ferrous sulfate, may I give them a 300 mg tablet of ferrous sulfate?

2) If someone orders gr i of thyroid medication, may I give them a 65 mg tablet?

3) If I make 120 ml of GI Cocktail, will I be able to fit it in an amber vial marked 'iv *f* ℥'?

1) Yes, but it requires you to do the calculation using 60 milligrams per grain. 2) Yes, but this time you need to do the calculation using 65 milligrams per grain. 3) Yes, remember that 1 fluid ounce is usually rounded to 30 milliliters.

Worksheet 7-3

Name:

Date:

Perform the appropriate conversions to solve the following problems and also write the appropriate symbol or abbreviation above each problem.

1) 1 ounce = ______ drams
2) 1 dram = ______ grains
3) 1 fluid ounce = ______ fluid drams
4) 1 fluid dram = ______ drops
5) 1 drop = ______ minim
6) 1 meter = ______ centimeters
7) 1 meter = ______ millimeters
8) 1 kilogram = ______ grams
9) 1 gram = ______ milligrams
10) 1 milligram = ______ micrograms
11) 1 microgram = ______ nanograms
12) 1 liter = ______ milliliters
13) 1 liter = ______ cubic centimeters
14) 1 cubic centimeter = ______ milliliter
15) 1 foot = ______ inches
16) 1 pound = ______ ounces
17) 1 gallon = ______ quarts
18) 1 quart = ______ pints

19) 1 pint = ______ cups

20) 1 pint = ______ fluid ounces

21) 1 cup = ______ ounces

22) 1 ounce = ______ tablespoons

23) 1 tablespoon = ______ teaspoons

24) 1 grain = ______ milligrams

25) 1 fluid ounce = ______ milliliters

26) 1 drop = ______ milliliters

27) 1 inch = ______ centimeters

28) 1 kilogram = ______ pounds

29) 1 pound = ______ grams

30) 1 ounce (household) = ______ grams

31) 1 pint = ______ milliliters

32) 1 tablespoon = ______ teaspoons

33) 1 teaspoon = ______ millilters

34) 3 teaspoons = ______ fluid ounces

35) 960 milliliters = ______ pints

36) 20 drops = ______ milliliters

37) 6 foot 1 inch = ______ centimeter

38) 165 pounds = ______ kilograms

39) 8 pounds 13 ounces = ______ kilograms

40) 7.5 milliliters = ______ teaspoons

41) 4 fluid drams = ______ milliliters

Worksheet 7-4

Name:

Date:

Solve the following problems, and know that when reviewing answers in class or with other students, some problems may have a small range of acceptable answers.

1) gr xvi = ʒ _____

2) 150 gr = ℥ _____

3) gr iii = _____ mg

4) ƒʒ viii = ƒ℥ _____

5) ƒ℥ ss = ƒʒ _____

6) 90 mL = ƒ℥ _____

7) ƒ℥ viii = _____ pt

8) ƒʒ ss = _____ gtt

9) ƒʒ iii = _____ mL

10) 120 mg = gr _____

11) ℥ ii = _____ g

12) 30 mL = ƒ℥ _____

13) ƒ℥ iv = _____ mL

14) 6 oz. = _____ g

15) 97.2 mg = gr _____

16) 60 mL = ƒʒ _____

17) 75 mL = ƒ℥ _____

18) 15.5 g = ℥ _____

19) 195 mg = gr _____

20) 120 mL = ƒ℥ _____

21) ƒʒ iv = _____tsp

22) 125 mL = _____tsp

23) 120 mL = _____tsp

24) 240 mL = ƒ ℥ _____

25) 15 mg = gr_____

26) gr xv = _____mg

27) 10 mg = gr_____

28) 2.5 g = gr_____

29) 42 kg = _____lb

30) 44 lb = _____kg

31) ƒ ℥ vi = _____mL

Solve the following word problems.

32) During the total course of his treatment, a patient will receive 720 mL of medication. How many pints will he receive?

33) If an order calls for the patient to receive 2 tsp of cough syrup, how many milliliters of syrup should the patient receive?

34) A patient weighs 65 kg. How many pounds does she weigh?

35) A patient weighs 187 lbs. How many kilograms does he weigh?

36) A physician orders eight fluid drams of liquid medication per dose. How many tablespoons should the patient take.

37) A patient drinks 2 pt of liquid during the morning. How many milliliters did the patient drink?

38) An order is for gr iii of medication. How many milligrams should the patient be given?

39) A physician orders that a patient be given gr ss three times a day. How many milligrams will the patient receive in a day?

40) An order calls for 1.5 Tbs of medicated mouthwash. How many milliliters should the patient receive?

Worksheet 7-5

Name:

Date:

Complete the following equivalences.

1) 1 m = _____cm
2) 1 cm = _____mm
3) 1 L = _____ml
4) 1 m = _____mm
5) 1 cc = _____ml
6) 1 kg = _____g
7) *f* ℥ i = *f* ʒ_____
8) gtt i = ♍_____
9) 1 Tbs = _____tsp
10) 1 ft = ______in

Change the following measurements to the desired unit (feel free to use approximations for fluid ounces, as this is what you will commonly do in practice and when taking the Pharmacy Technician Certification Exam).

11) 3.6 m = ________mm
12) 47 cm = ________m
13) 9.4 cm = ________mm
14) 482 ml = ________L
15) 3.9 L = ________ml
16) 3.6 g = ________mg
17) 2 oz = ________g
18) 0.5 lb = ________g
19) 2 fl oz = ________cc
20) 5.08 cm = ________in
21) gr xc = ʒ________
22) gr xvss = ________g
23) 90 ml = ________Tbs
24) 5 tsp = ________ml
25) 3 tsp = ________Tbs
26) 120 lb = ________kg
27) 93 lb = ________kg
28) 3 lb 4.5 oz = ________g
29) 1 lb 5.2 oz = ________g
30) 5'11” = ________m
31) 36” = ________cm
32) ♍ iii = gtt________
33) ♍ xvii = ________ml

Select the best possible answer for the next two multiple choice problems.

34) 1/200 gr nitroglycerin SL = ________mg

You get a prescription for the above. Which product will you dispense?

a) Nitrostat 0.3 mg (nitroglycerin)
b) Nitrostat 0.4 mg (nitroglycerin)
c) Nitrostat 0.6 mg (nitroglycerin)
d) Nitrobid 2.5 mg capsules (nitroglycerin)

35) gr v ferrous gluconate = _______mg

A patient tells you her doctor wanted her to take one of these every day. Which product will you recommend?

a) ferrous sulfate 324 mg tablets
b) ferrous fumarate 324 mg tablets
c) ferrous gluconate 240 mg tablets
d) ferrous gluconate 325 mg tablets

Solve the following word problems.

36) A physician tells a patient to drink 2400 mL of fluid per day. How many cups of liquid should this patient drink?

37) Several months ago, a patient weighed 95 kg. When he comes in for his next appointment, he tells you that he lost 11 lbs. If he is correct, how many kilograms should he weigh?

Worksheet 7-6 (tougher problems)

Name:

Date:

Convert the following recipes to metric

1) The following is a historic formula for a cough ball to be used in a horse:

Rx	Ipecacuanha (powdered ipecac)	ʒ i
	Codeine sulfate	gr x
	Powdered digitalis	ʒ i
	Honey	qs to form 1 ball (which will weigh ℥ ss)

Hint: honey has a specific gravity of 1.425 g/mL according to the U.S.P.

2) The following recipe is similar to Vick's VapoRub

Rx	Camphor	ʒ $^{2}/_{3}$
	Eualyptol	gr x
	Menthol	ʒ ss
	Petrolatum	qs ℥ ii

3) The following is the real recipe for BC Powder

Rx	ASA	gr x
	Caffeine	gr ss
	Salicylamide	gr iii

4) The following is similar to the original Milk of Magnesia (MOM)

Rx	Magnesium Hydroxide Powder	ʒ x
	Sodium Hypochlorite Powder	ʒ i
	Purified Water	qs pt i

How many mg of magnesium hydroxide are in 2 tbs of this?

5) “BROMPTON'S COCKTAIL”

Rx	Morphine Powder	gr i
	Cocaine HCl	gr i
	Simple Syrup	*f* ℥ ss
	90% Ethanol	qs *f* ℥ ii

How many mg of morphine and how many mg of cocaine are in 1 tsp?

Worksheet 7-7

Name:

Date:

Complete the following equivalences.

1) 1 g = ________mg
2) 1 m = ________cm
3) 1 L = ________mL

Change the following measurements to the desired unit.

4) 5.8 m = ________cm
5) 92 cm = ________m
6) 3.7 L = ________mL
7) 247 mL = ________L
8) 4.6 L = ________mL
9) 1400 mg = ________g
10) 4.2 kg = ________g
11) 1.4 m = ________in
12) 5 oz = ________g
13) 0.6 lb = ________g
14) 5 qt = ________L
15) 3 fl oz = ________cc
16) 7.62 cm = ________in
17) 5 L = ________qt
18) 6.6 lb = ________kg
19) 450 g = ________oz
20) 150 fl oz = ________mL
21) 18 mL of water is ________cc of water.

Write the name or the abbreviation of the following apothecary and household units.

22) grain
23) ounce
24) fluid ounce
25) pint
26) tablespoon
27) tsp
28) gtt
29) qt
30) ʒ
31) ℥
32) ♏
33) f℥

Give the following relationships.

34) f℥ i = _______mL
35) ♏ i = ________mL
36) ℥ i = ________g
37) gtt i = ________mL
38) gr i = ________mg
39) gtt i = ♏________
40) 1 tsp = ________mL
41) 1 Tbs = ________tsp

Make these conversions.

42) gr xc = ʒ________

43) gr ss = ________mg

44) ʒ xvi = ℥ ________

45) f℥ iii = ʒ________

46) 150 ♏ = fʒ________

47) 0.5 pt = f℥ ________

48) 2 tsp = ________mL

49) gr iii = ________mg

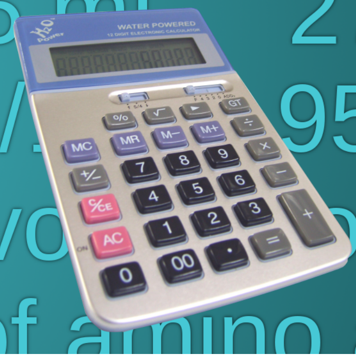
50) 40 ♏ = ________mL

51) 10 g = gr ________

52) ʒ i = ________mg

Chapter 8

Working With Prescriptions



A doctor is to give a speech at the local AMA dinner. He jots down notes for his speech. Unfortunately, when he stands in front of his colleagues later that night, he finds that he can't read his notes. So he asks, "Is there a pharmacist in the house?"

--Author Unknown

Have you ever seen a prescription and wondered, "What the heck does that mean?", and even thought, "That doesn't even look like English!". Now it is time to owe up to the truth...much of it is not English. Prescriptions have been obfuscated by a combination of Latin and English abbreviations (sometimes they even throw in Greek words). They are commonly used on prescriptions to communicate essential information on formulations, preparation, dosage regimens and administration of the medication. Our goal is to demystify this drug nomenclature. Our goals this chapter include:

- learning common medical abbreviations,
- learning the parts of a prescription and how to incorporate medical abbreviations,
- and the additional prescriptions requirements and limitations when dealing with controlled substances.

Common Medical Abbreviations

In total there are nearly 20,000 medical abbreviations; instead of providing an exhaustive and meaningless list, we will present you with the most common medical abbreviations that are necessary for interpreting prescriptions and performing calculations.

There are several key things to point out about the tables on the next several pages.

categories – for ease of memorization, the abbreviations have been broken up into five categories: route, form, time, measurement, and other.

abbreviations – the abbreviations can often be written with or without the 'periods' and in upper or lower case letters (e.g., p.o. and PO both mean 'by mouth').

meaning – sometimes you will need to place an abbreviation in context to know its meaning (e.g., IV could mean a dosage form as in an 'IV bag', it could mean a route of administration as in 'to give a medication IV', or it could even be the roman numeral meaning 'four').

Latin root – not all the words on this list are derived from Latin words, nor is it necessary to know the Latin root words to be able to understand the abbreviations, but it is simply provided to help you understand how some of these abbreviations were derived.

Route

Abbreviation	*Meaning*	*Latin Root*
a.d.[1]	right ear	auris dexter
a.s.	left ear	auris sinister
a.u.	each ear	auris utro
IM	intramuscular	
IV	intravenous	
IVP	intravenous push	
IVPB	intravenous piggyback	
KVO	keep vein open	
n.g.t.	naso-gastric tube	
n.p.o.	nothing by mouth	nasquam per os
nare	nostril	
o.d.	right eye	oculus dexter
o.s.	left eye	oculus sinister
o.u.	each eye	oculus utro
per neb	by nebulizer	
p.o.	by mouth	per os
p.r.	rectally	per rectum
p.v.	vaginally	
SC, SQ	subcutaneously	
S.L.	sublingually (under the tongue)	
top.	topically	

1 Always keep context in mind. In some prescription that require compounding '*ad*' without the periods could mean *to* or *up to*.

Form

Abbreviation	*Meaning*	*Latin Root*
amp.	Ampule	
aq, aqua	water	aqua
caps	capsule	capsula
cm.[2]	cream	
elix.	elixir	
liq.	liquid	liquor
sol.	solution	
supp.	suppository	suppositorum
SR, XR, XL	slow/extended release	
syr.	syrup	syrupus
tab.	tablet	tabella
ung., oint	ointment	ungentum

2 Always keep context in mind as '*cm*' can also mean centimeter.

Time

Abbreviation	*Meaning*	*Latin Root*
a.c.	before food, before meals	ante cibum
a.m.	morning	ante meridian
atc	around the clock	
b.i.d., bid	twice a day	bis in die
b.i.w., biw	twice a week	
h, °	hour	hora
h.s.	at bedtime	hora somni
p.c.	after meals	post cibum
p.m.	evening	post meridian
p.r.n., prn	as needed	pro re nata
q.i.d., qid	four times a day	quarter in die
q	each, every	quaque
q.d.	every day	quaque die
q_h, q_°	every__hour(s)	
qod	every other day	
stat	immediately	statim
t.i.d., tid	three times a day	ter in die
t.i.w., tiw	three times a week	

Measurement

Abbreviation	Meaning	Latin Root
i, ii, ...	one, two, etc.	
a.a., aa[3]	of each	ana
ad[4]	to, up to	ad
aq. ad	add water up to	
BSA	body surface area	
cc	cubic centimeter	
dil	dilute	dilutus
f, fl.	fluid	
fl. oz.	fluid ounce	
g, G, gm	gram	
gr.	grain	
gtt	drop(s)	guttae
l, L	liter	
mcg, µg	microgram	
mEq	milliequivalent	
mg	milligram	
ml, mL	milliliter	
q.s.	a sufficient quantity	quantum sufficiat
q.s. ad	add sufficient quantity to make	quantum sufficiat ad
ss[5]	one-half	
Tbs, T	tablespoon	
tsp, t	teaspoon	
U	unit	
>	greater than	
<	less than	

3 Always keep context in mind as '*aa*' can also mean affected area when applying topical medications.
4 Always keep context in mind as '*ad*' can also refer to the right ear.
5 Sometimes, it is easier to think of '*ss*' as meaning 0.5 instead of one-half.

Other

Abbreviation	*Meaning*	*Latin Root*
c	with	cum
disp.	dispense	
f, ft[6]	make, let it be made	fac, fiat, fiant
n/v	nausea and vomiting	
neb	nebulizer	
NR	no refill	
NS	normal saline	
s	without	sine
Sig	write, label	signatura
SOB	shortness of breath	
T.O.	telephone order	
ut dict, u.d.	as directed	ut dictum
V.O.	verbal order	

Practice Problems:
Translate the following abbreviation statements to provide proper household directions.

1) i gtt ou bid x7d
2) i tab po q6h prn pain
3) i tab po qid pc
4) iss tsp po tid prn cough
5) iii gtt ad q4h x5d
6) i supp pr q4h prn n/v
7) i cap po tid ac + hs
8) i tab sl q5 minutes prn chest pain, may repeat up to 3 times.
9) ii tabs stat, then i tab po qid x10d

6 Be careful with this abbreviation as '*f*' could also mean fluid and '*ft*' could also mean feet.

Worksheet 8-1

Name:

Date:

Your assignment for tonight is two fold. One, you must make a set of flash cards using the abbreviations presented to you on the preceding pages. Two, in the space provided below, you must make up ten abbreviation statements similar to the ones you just did, but this time **do not translate them**.

1)

2)

3)

4)

5)

6)

7)

8)

9)

10)

Learning the Parts of a Prescription and how to incorporate Medical Abbreviations

The word "prescription" stems from two Latin word parts, prae-, a prefix meaning before, and scribere, a word root meaning to write. Putting it all together, prescription means "to write before," which reflects the historical fact that a prescription traditionally had to be written before a drug could be mixed and administered to a patient.

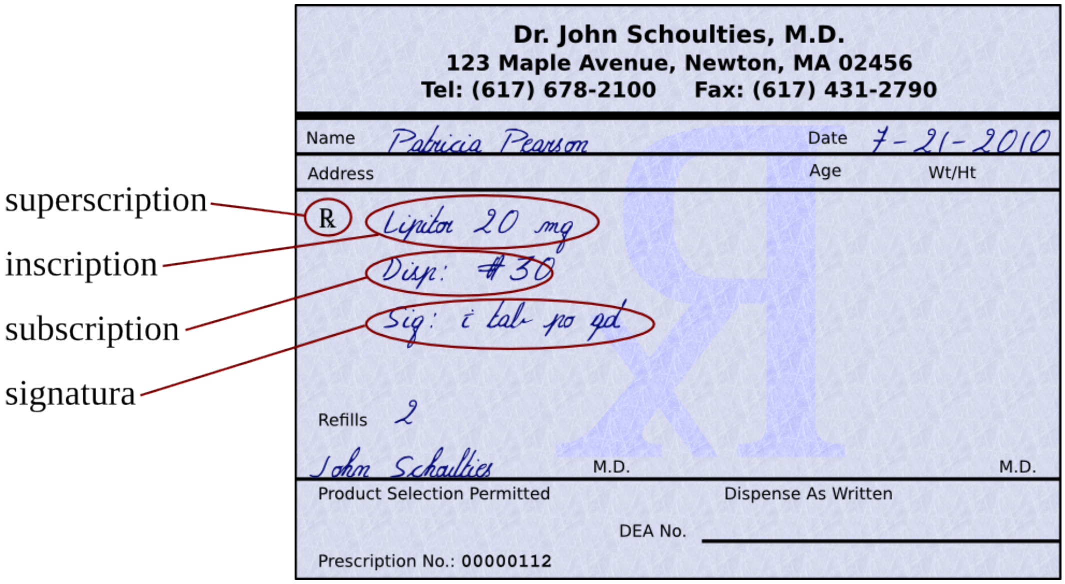
Many ancient prescriptions were noted for their multiple ingredients and complexity of preparation. The importance of the prescription and the need for complete understanding and accuracy made it imperative that a universal and standard language be used. Thus, Latin was adopted, and its use was continued until approximately a generation ago.

Present day prescription are written in English, with doses usually being given in the metric system, but often you still find contracted Latin words and Roman numerals intertwined. The ancient "Rx" and the Latin "Signatura," abbreviated as Sig., the occasional Roman numeral, and a hand full of apothecary symbols are all that remain of the ancient art of the prescription.

Traditionally a prescription is a written order for compounding, dispensing, and administering drugs to a specific client or patient and once it is signed by the physician it becomes a legal document! Prescriptions are required for all medications that require the supervision of a physician, that must be controlled because they are addictive and carry the potential of being abused, and that could cause health threats from side effects if taken incorrectly, for example cardiac medications, controlled substances, and antibiotics.

The following is a list of the parts of a prescription, and in bold are the most significant portions:

- Patient Information
- **Superscription**
- **Inscription**
- **Subscription**
- **Signatura**
- Date
- Signature lines, signature, degree, generic substitution
- Prescriber information
- DEA# if required
- Refills
- Warnings



The **superscription** which consists of the heading where the symbol Rx (an abbreviation for recipe, the Latin for take thou) is found. The Rx symbol comes before the inscription.

The **inscription** is also called the body of the prescription, and provides the names and quantities of the chief ingredients of the prescription. Also in the inscription you find the dose and dosage form, such as tablet, suspension, capsule, syrup.

The **subscription**, which gives specific directions for the pharmacist on how to compound the medication. These directions to the pharmacist are usually expressed in contracted Latin or may consist of a short sentence such as: "make a solution," "mix and place into 10 capsules," or "dispense 10 tablets." However, that was in the old days. Today... doctors just name the pill!

The **signatura** (also called sig, or transcription), gives instructions to the patient on how, how much, when, and how long the drug is to be taken. These instructions are preceded by the symbol “S” or “Sig.” from the Latin, meaning "write" or "label." Whenever translating the signatura into instructions for a patient, begin it with an action verb such as take, inhale, spray, inject, place, swish, or whatever other verb seems appropriate for the medication.

Below the Sig line is room for special instructions, such as the number of times the prescription may be refilled, if any. You will also find the purpose of the prescription, special instructions, warnings followed by the signature of the prescriber.

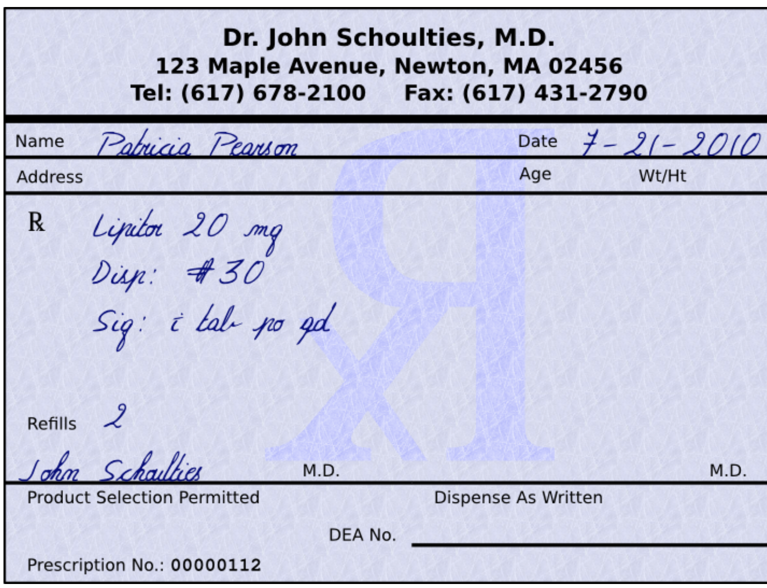
You should also know and understand:

- The ***date*** and ***patient information***, which consists of the name of the party for whom it is designed and the address, usually occupies the upper part of the prescription. Sometimes age or weight is also added, though rarely.
- The instruction, "***take as directed***" is not satisfactory and should be avoided. The directions to the patient should include a reminder of the intended purpose of the medication by including

such phrases as "for pain," "for relief of headache," or "to relieve itching"

- And if the patient is to receive a ***brand name medication***, rather then generic, the physician enters NO SUBSTITUTIONS at the end of the prescription.
- If there are ***no refills*** to be dispensed, it is advisable not to enter the number 0, because it can be altered by adding numbers before the zero, thus making it a 10 to receive ten refills (or more!). Always write out the word *None*, or *No Refills*!!!
- The Drug Enforcement Administration (DEA) registration number system was implemented as a way to successfully ***track controlled substances*** from the time they are manufactured until the time they are dispensed to the patient.
- The ***DEA opposes use of the DEA number*** for other than its intended purpose, which is tracking controlled substances, and strongly opposes insurance company practice of requiring that a DEA number be placed on prescriptions for non-controlled substances.
- ***Not all medications require prescriptions***. There are certain medications on the market that can be purchased over the counter, thus their name over-the-counter drugs (OTC.)

Now to put it all together, let's look at the previous example and translate the information on it:


Dr. John Schoulties, M.D.
123 Maple Avenue, Newton, MA 02456
Tel: (617) 678-2100 Fax: (617) 431-2790

Name Patricia Pearson Date 7-21-2010
Address Age Wt/Ht

℞ Lipitor 20 mg
Disp: #30
Sig: i tab po qd

Refills 2

John Schaulties M.D. M.D.

Product Selection Permitted Dispense As Written

DEA No.

Prescription No.: 00000112

So, if we look at this script for Patricia Pearson we can see that it is for Lipitor (atorvastatin Ca) 20 mg tablets and that the patient is to receive 30 of them with 2 refills. The instructions to the patient would be, "*Take 1 tablet by mouth daily*."

Other things of note include the date that the prescription is written for is July 21, 2010. Prescriptions for non-controlled substances are only good for one year, so Ms. Beaty will need a new script if she still needs this medication past July 21, 2011, irregardless of how many refills were written for. Another noteworthy item is that the physician signed permitting product selection (*i.e.*, generic substitution). The last significant item on this label is that the physician did not include their DEA number. A DEA number should only be used for controlled substances.

This brings us to one last major concept in this chapter:

The Additional Prescription Requirements and Limitations when dealing with Controlled Substances

Besides over the counter medications (OTC) such as aspirin and ibuprofen, behind the counter medications (BTC) such as Allegra-D (fexofenadine with pseudoephedrine), and prescription medications (Rx legend) such as amoxicillin and digoxin, there is another group of medications to be concerned with called controlled substances. Controlled substances are medications with further restrictions due to abuse potential. There are 5 schedules of controlled substances with various prescribing guidelines based on abuse potential as determined by the Drug Enforcement Administration and individual state legislative branches. Let's look at the table below.

Schedule	Characteristics	Examples
CI	Unaccepted medical use Highest potential for abuse Not available by a prescription	Heroin and LSD
CII	High potential for abuse or misuse	oxycodone, morphine, and amphetamines
CIII	Potential risk for abuse, misuse, and dependence	Tylenol with Codeine tablets and Vicodin
CIV	Low potential for abuse and limited risk of dependence	phenobarbital, benzodiazepines, and other sedatives and hypnotics
CV	Low potential for abuse or misuse	Cough medicines that contain a limited amount of codeine, and antidiarrheal medications that contain a limited amount of an opiate such as Lomotil

- CI medications are not available via a prescription.
- CII medications may only be written for a 90 day supply excluding hospice patients.
- CIII-IV medications may only be written for a 6 month supply.
- CV medications may be written for up to I year. Many states limit this to 6 months.

Many problems associated with drug abuse are the result of legitimately-manufactured controlled substances being diverted from their lawful purpose into the illicit drug traffic. Many of the narcotics, depressants and stimulants manufactured for legitimate medical use are subject to abuse, and have therefore been brought under legal control. The goal of controls is to ensure that these "controlled substances" are readily available for medical use, while preventing their distribution for illicit sale and abuse.

Under federal law, all businesses which manufacture or distribute controlled drugs, all health professionals entitled to dispense, administer or prescribe them, and all pharmacies entitled to fill prescriptions must register with the DEA. Authorized registrants receive a "DEA number". Registrants must comply with a series of regulatory requirements relating to drug security, records accountability, and adherence to standards. Any properly licensed medical professional that wishes to prescribe a controlled substance must include their DEA number on the prescription.

A physician's DEA number is a two letter seven digit number designed in such a way that a pharmacy can verify it via a mathematical algorithm. An example of a DEA number would be:

BP4567890

Let's go to the next several pages and practice thoroughly translating some prescriptions.

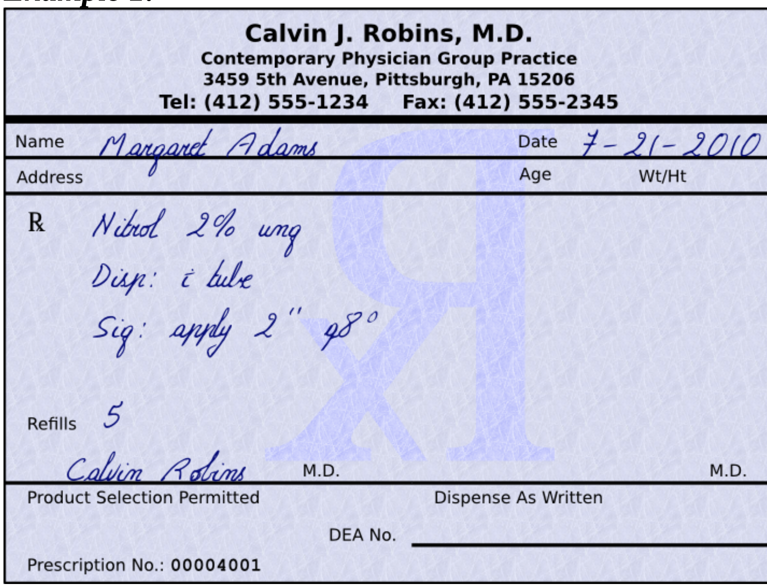
Worksheet 8-2

Name:

Date:

Translate the following prescriptions, and make note of anything that you find interesting. I will be breaking you into teams that are responsible for thorough translations on specific scripts. I've provided two examples of what I'm looking for.

Example 1:



Calvin J. Robins, M.D.
Contemporary Physician Group Practice
3459 5th Avenue, Pittsburgh, PA 15206
Tel: (412) 555-1234 Fax: (412) 555-2345

Name Margaret Adams Date 7-21-2010
Address Age Wt/Ht

℞ Nitrol 2% ung
Disp: i tube
Sig: apply 2" q8°

Refills 5

Calvin Robins M.D. M.D.

Product Selection Permitted Dispense As Written

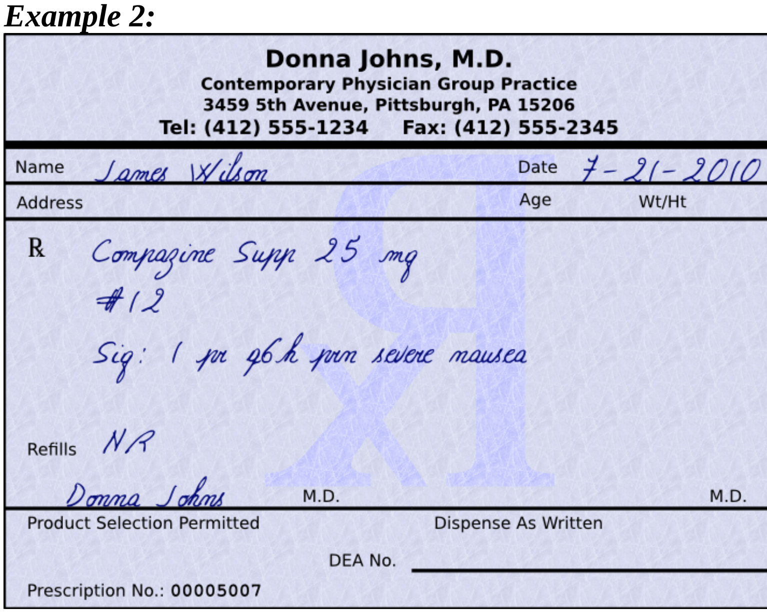
DEA No.

Prescription No.: **00004001**

This script for Margaret Adams is for one tube of Nitrol 2% ointment (nitroglycerin 2% ointment) and the patient is allowed 5 refills. The instructions to the patient would be, "*Apply 2 inches every 8 hours*."

Things to note: This is interesting because NTG ung is usually measured in inches. A patient should know to rotate sites and apply to well cleaned areas that have minimal hair. Also, you should probably check with the physician to see if they want the patient to receive a nitrate free interval or not.

Example 2:



Donna Johns, M.D.
Contemporary Physician Group Practice
3459 5th Avenue, Pittsburgh, PA 15206
Tel: (412) 555-1234 Fax: (412) 555-2345

Name James Wilson Date 7-21-2010
Address Age Wt/Ht

℞ Compazine Supp 25 mg
#12
Sig: 1 pr q6h prn severe nausea

Refills NR

Donna Johns M.D. M.D.

Product Selection Permitted Dispense As Written

DEA No.

Prescription No.: **00005007**

Mr. James Wilson's script is for twelve 25 mg Compazine (prochlorperazine) suppositories with no refills. The instructions to the patient would be "*Insert 1 suppository rectally every 6 hours as needed for severe nausea*."

Things to note: Female patients may need to be informed to only use this suppository rectally as it will not have the correct systemic effects if given vaginally.

Prescription 1

David M. Ferguson, M.D.
Contemporary Physician Group Practice
3459 5th Avenue, Pittsburgh, PA 15206
Tel: (412) 555-1234 Fax: (412) 555-2345

Name Okla Beaty Date 7-21-2010

Address Age Wt/Ht

℞ Flonase Nasal Spray

Disp: 1

Sig: i spray each nare qam

Refills prn

M.D. David Ferguson M.D.

Product Selection Permitted Dispense As Written

DEA No.

Prescription No.: **00000107**

Prescription 2

David M. Ferguson, M.D.
Contemporary Physician Group Practice
3459 5th Avenue, Pittsburgh, PA 15206
Tel: (412) 555-1234 Fax: (412) 555-2345

Name Okla Beaty Date 7-21-2010

Address Age Wt/Ht

℞ Nitrostat 1/150 gr

Disp: 25

Sig: i SL q5 min prn chest pain

may repeat X3

Refills 3

David Ferguson M.D. M.D.

Product Selection Permitted Dispense As Written

DEA No.

Prescription No.: **00000108**

Prescription 3

David M. Ferguson, M.D.
Contemporary Physician Group Practice
3459 5th Avenue, Pittsburgh, PA 15206
Tel: (412) 555-1234 Fax: (412) 555-2345

Name *Okla Beaty* Date *7-21-2010*

Address Age Wt/Ht

℞ *NitroDur 0.4 mg*

Disp: #30

Sig: ī patch on 8 a.m.,

off 10 p.m. qd

Refills *3*

David Ferguson M.D. M.D.

Product Selection Permitted Dispense As Written

DEA No.

Prescription No.: **00000109**

Prescription 4

David M. Ferguson, M.D.
Contemporary Physician Group Practice
3459 5th Avenue, Pittsburgh, PA 15206
Tel: (412) 555-1234 Fax: (412) 555-2345

Name *Okla Beaty* Date *7-21-2010*

Address Age Wt/Ht

℞ *Coumadin 5 mg*

Disp: 1 month supply

Sig: ss tab on S-T-T-S,

ī tab on M-W-F

Refills *NR*

David Ferguson M.D. M.D.

Product Selection Permitted Dispense As Written

DEA No.

Prescription No.: **00000110**

Prescription 5

David M. Ferguson, M.D.
Contemporary Physician Group Practice
3459 5th Avenue, Pittsburgh, PA 15206
Tel: (412) 555-1234 Fax: (412) 555-2345

Name *Okla Bealy* Date *7-21-2010*

Address Age Wt/Ht

℞ *Spiriva*

Disp: #30

Sig: inhale i cap po qd

Refills *3*

David Ferguson M.D. M.D.

Product Selection Permitted Dispense As Written

DEA No.

Prescription No.: **00000111**

Prescription 6

Dr. John Schoulties, M.D.
123 Maple Avenue, Newton, MA 02456
Tel: (617) 678-2100 Fax: (617) 431-2790

Name *Patricia Pearson* Date *7-21-2010*

Address Age Wt/Ht

℞ *Lipitor 10 mg #90*

i po qd

Refills *NR*

John Schoulties M.D. M.D.

Product Selection Permitted Dispense As Written

DEA No.

Prescription No.: **00000212**

Prescription 7

Dr. John Schoulties, M.D.
123 Maple Avenue, Newton, MA 02456
Tel: (617) 678-2100 Fax: (617) 431-2790

Name *Patricia Pearson* Date *7-21-2010*

Address Age Wt/Ht

℞ *Humulin R 10 ml*
Disp: 1 vial
8 u SC ā bkfst, 8 u ā lunch,
& 11 u ā supper

Refills *2*

John Schoulties M.D. M.D.

Product Selection Permitted Dispense As Written

DEA No. ____________

Prescription No.: **00000213**

Prescription 8

Dr. John Schoulties, M.D.
123 Maple Avenue, Newton, MA 02456
Tel: (617) 678-2100 Fax: (617) 431-2790

Name *Patricia Pearson* Date *7-21-2010*

Address Age Wt/Ht

℞ *Novolin N 10 ml*
Disp: 1 vial
24 u SC qam
& 22 u SC qpm

Refills *5*

John Schoulties M.D. M.D.

Product Selection Permitted Dispense As Written

DEA No. ____________

Prescription No.: **00000214**

Prescription 9

Dr. John Schoulties, M.D.
123 Maple Avenue, Newton, MA 02456
Tel: (617) 678-2100 Fax: (617) 431-2790

Name Patricia Pearson Date 7-21-2010

Address Age Wt/Ht

℞ Cardizem CD 240 mg #90
ī po qd

Refills NR

John Schoulties M.D. M.D.

Product Selection Permitted Dispense As Written

DEA No.

Prescription No.: **00000215**

Prescription 10

Dr. John Schoulties, M.D.
123 Maple Avenue, Newton, MA 02456
Tel: (617) 678-2100 Fax: (617) 431-2790

Name Patrick Pearson Date 7-21-2010

Address Age Wt/Ht

℞ Hytrin 1 mg
Disp: 1 month supply
Sig: 1 po qhs X3d
then, 2 qhs X5d
then, 4 qhs thereafter

Refills 2

John Schoulties M.D. M.D.

Product Selection Permitted Dispense As Written

DEA No.

Prescription No.: **00000216**

Prescription 11

Dr. John Smith, M.D.
739 Stockton Street, Waltham, MA 02454
Tel: (781) 333-2121 Fax: (781) 734-6340

Name Richard Stallman Date 7-21-2010
Address Age Wt/Ht

℞ Ambien 5 mg #30
i po q hs prn sleep

Refills one

John Smith M.D. M.D.

Product Selection Permitted Dispense As Written

DEA No. AS3456325

Prescription No.: **00000317**

Prescription 12

Dr. John Smith, M.D.
739 Stockton Street, Waltham, MA 02454
Tel: (781) 333-2121 Fax: (781) 734-6340

Name Richard Stallman Date 7-21-2010
Address Age Wt/Ht

℞ Adderall XR 25 mg
Disp: #30
Sig: i po qd

Refills NR

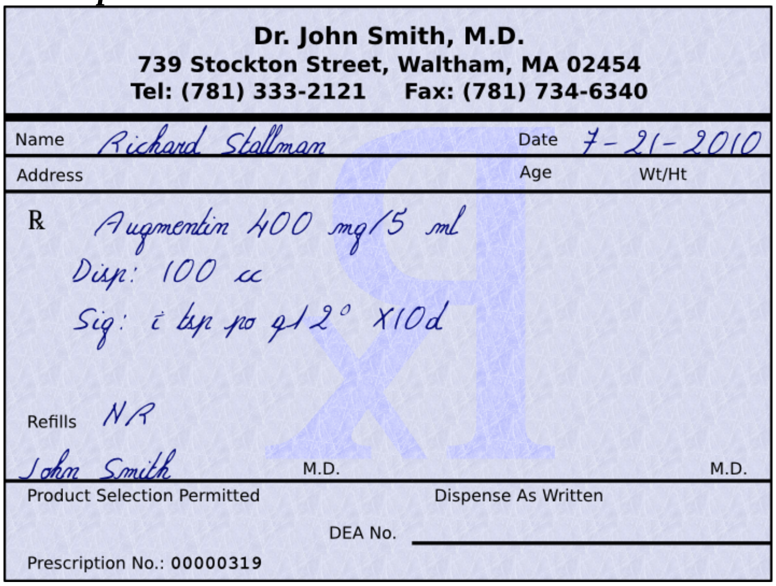
John Smith M.D. M.D.

Product Selection Permitted Dispense As Written

DEA No. AS3456325

Prescription No.: **00000318**

Prescription 13



Dr. John Smith, M.D.
739 Stockton Street, Waltham, MA 02454
Tel: (781) 333-2121 Fax: (781) 734-6340

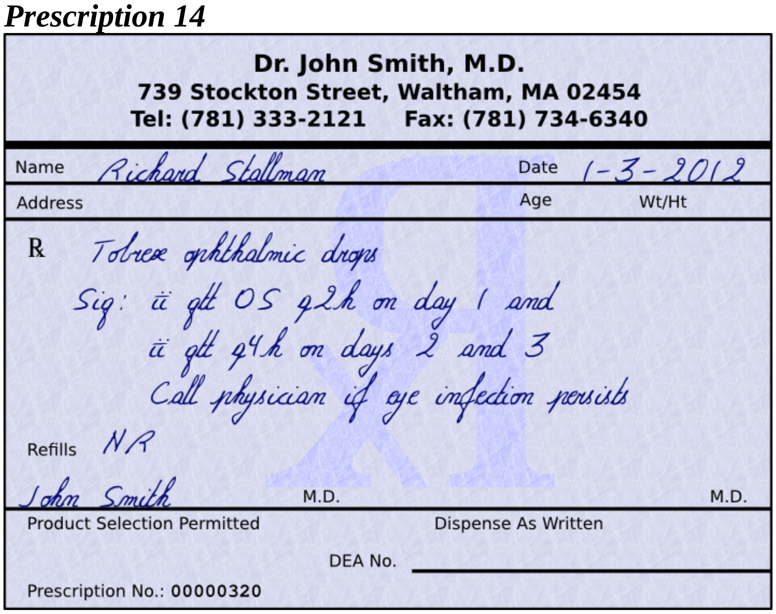
Name Richard Stallman Date 7-21-2010
Address Age Wt/Ht

℞ Augmentin 400 mg/5 ml
Disp: 100 cc
Sig: i tsp po q12° X10d

Refills NR

John Smith M.D. M.D.
Product Selection Permitted Dispense As Written
DEA No.
Prescription No.: **00000319**

Prescription 14



Dr. John Smith, M.D.
739 Stockton Street, Waltham, MA 02454
Tel: (781) 333-2121 Fax: (781) 734-6340

Name Richard Stallman Date 1-3-2012
Address Age Wt/Ht

℞ Tobrex ophthalmic drops
Sig: ii gtt OS q2h on day 1 and
ii gtt q4h on days 2 and 3
Call physician if eye infection persists

Refills NR

John Smith M.D. M.D.
Product Selection Permitted Dispense As Written
DEA No.
Prescription No.: **00000320**

Prescription 15

Dr. John Smith, M.D.
739 Stockton Street, Waltham, MA 02454
Tel: (781) 333-2121 Fax: (781) 734-6340

Name Richard Stallman Date 7-21-2010

Address Age Wt/Ht

℞ Sinemet 25/100

Disp: #180

Sig: ii PO TID

Refills 5

John Smith M.D. M.D.

Product Selection Permitted Dispense As Written

DEA No.

Prescription No.: **00000322**

Prescription 16

Dr. Andrew Yountz, M.D.
888 NW 27th Ave., Miami, FL 98885
Tel: (247) 555-6613 Fax: (247) 555-6340

Name Barbara Erickson Date 7-21-2010

Address Age Wt/Ht

℞ Imitrex 25 mg tab

Disp: #9

Sig: i q6h prn migraine

Refills 6

Andrew Yountz M.D. M.D.

Product Selection Permitted Dispense As Written

DEA No.

Prescription No.: **00006327**

Prescription 17

Dr. Andrew Yountz, M.D.
888 NW 27th Ave., Miami, FL 98885
Tel: (247) 555-6613 Fax: (247) 555-6340

Name Kurt Thomas Date 7-21-2010

Address Age Wt/Ht

℞ Oph Sol: Trusopt 2%

Sig: i gtt ou TID

Refills 6

Andrew Yountz M.D. M.D.

Product Selection Permitted Dispense As Written

DEA No.

Prescription No.: **00006328**

Prescription 18

Dr. Andrew Yountz, M.D.
888 NW 27th Ave., Miami, FL 98885
Tel: (247) 555-6613 Fax: (247) 555-6340

Name Tania Beltran Date 4-19-2010

Address Age Wt/Ht

℞ Fosamax 70 mg

Disp: #4

Sig: 1 tab weekly

Refills PRN

Andrew Yountz M.D. M.D.

Product Selection Permitted Dispense As Written

DEA No.

Prescription No.: **00006329**

ISMP's List of Error-Prone Abbreviations, Symbols, and Dose Designations

The abbreviations, symbols, and dose designations found on the following tables have been reported to the Institute for Safe Medication Practices (ISMP) through the ISMP Medication Error Reporting Program (MERP) as being frequently misinterpreted and involved in harmful medication errors. According to the ISMP they should NEVER be used when communicating medical information. This includes internal communications, telephone/verbal prescriptions, computer-generated labels, labels for drug storage bins, medication administration records, as well as pharmacy and prescriber computer order entry screens. The truth is that all the items we are about to discuss ARE ACTUALLY USED and with that in mind we should look over these to help us not make errors in interpreting these abbreviations.

Abbreviations	*Intended Meaning*	*Misinterpretation*	*Correction*
µg	Microgram	Mistaken as "mg"	Use "mcg"
AD, AS, AU	Right ear, left ear, each ear	Mistaken as OD, OS, OU (right eye, left eye, each eye)	Use "right ear", "left ear", or "each ear"
OD, OS, OU	Right eye, left eye, each eye	Mistaken as AD, AS, AU (right ear, left ear, each ear)	Use "right eye", "left eye", or "each eye"
BT	Bedtime	Mistaken as "BID" (twice daily)	Use "bedtime"
cc	Cubic centimeter	Mistaken as "u" (units)	Use "mL"
D/C	Discharge or discontinue	Premature discontinuation of medications if D/C (intended to mean "discharge") has been misinterpreted as "discontinued" when followed by a list of discharge medications	Use "discharge" and "discontinue"
IJ	Injection	Mistaken as "IV" or "intrajugular"	Use "injection"
IN	Intranasal	Mistaken as "IM" or "IV"	Use "intranasal" or "NAS"
HS **hs**	Half-strength At bedtime, hours of sleep	Mistaken as bedtime Mistaken as half-strength	Use "half-strength" or "bedtime"
IU	International unit	Mistaken as IV (intravenous) or 10 (ten)	Use "units"
o.d. Or OD	Once daily	Mistaken as "right eye" (OD – oculus dexter), leading to oral medications administered in the eye	Use "daily"

Abbreviations	*Intended Meaning*	*Misinterpretation*	*Correction*
OJ	Orange juice	Mistaken as OD or OS (right or left eye); drugs meant to be diluted in orange juice may be given in the eye	Use “orange juice”
Per os	By mouth, orally	The “os” can be mistaken as “left eye” (OS – oculus sinister)	Use “PO,” “by mouth,” or “orally”
q.d. Or QD	Every day	Mistaken as q.i.d., especially if the period after the “q” or the tail of the “q” is misunderstood as an “i”	Use “daily”
qhs	Nightly at bedtime	Mistaken as “qhr” or every hour	Use “nightly”
qn	Nightly or at bedtime	Mistaken as “qh” (every hour)	Use “nightly” or “at bedtime”
q.o.d. or QOD	Every other day	Mistaken as “q.d.” (daily) or “q.i.d.” (four times daily) if the “o” is poorly written	Use “every other day”
q1d	Daily	Mistaken as q.i.d. (four times daily)	Use “daily”
q6PM, etc.	Every evening at 6 PM	Mistaken as every 6 hours	Use “daily at 6 PM” or “6 PM daily”
SC, SQ, sub q	Subcutaneous	SC mistaken as SL (sublingual); SQ mistaken as “5 every;” the “q” in “sub q” has been mistaken as “every”	Use “subcut” or “subcutaneously”
ss	Sliding scale (insulin) or ½ (apothecary)	Mistaken as “55”	Spell out “sliding scale;” use “one-half” or “½”
SSRI **SSI**	Sliding scale regular insulin Sliding scale insulin	Mistaken as selective-seritonin reuptake inhibitor Mistaken as Strong Solution of Iodine (Lugol's)	Spell out “sliding scale (insulin)”
i/d	One daily	Mistaken as “tid”	Use “1 daily”
TIW or tiw	3 times a week	Mistaken as “3 times a day” or “twice in a week”	Use “3 times weekly”

Abbreviations	*Intended Meaning*	*Misinterpretation*	*Correction*
U or u	Unit	Mistaken as the number 0 or 4, causing a 10-fold overdose or greater (e.g., 4U seen as "40" or 4u seen as "44"); mistaken as "cc" so dose given in volume instead of units (e.g., 4u seen as 4cc)	Use "unit"
UD	As directed ("ut dictum")	Mistaken as unit dose (e.g., diltiazem 125 mg IV infusion "UD" misinterpreted as meaning to give entire infusion as unit [bolus] dose)	Use "as directed"
Dose Designations and Other Information	***Intended Meaning***	***Misinterpretation***	***Correction***
Trailing zero after decimal point (e.g., 1.0 mg)	1 mg	Mistaken as 10 mg if the decimal point is not seen	Do not use trailing zero for doses expressed in whole numbers
No leading zero before a decimal point (e.g., .5 mg)	0.5 mg	Mistaken as 5 mg if the decimal point is not seen	Use zero before a decimal point when the dose is less than a whole unit
Drug name and dose run together (especially problematic for drug names that end in "l" such as Inderal40 mg; Tegretol300 mg)	Inderal 40 mg Tegretol 300 mg	Mistaken as Inderal 140 mg Mistaken as Tegretol 1300 mg	Place adequate space between the drug name, dose, and unit of measure

Dose Designations and Other Information	*Intended Meaning*	*Misinterpretation*	*Correction*
Numerical dose and unit of measure run together (e.g., 10mg, 100mL)	10 mg 100 mL	The “m” is sometimes mistaken as a zero or two zeros, risking a 10- to 100-fold overdose	Place adequate space between the drug name, dose, and unit of measure
Abbreviation such as mg. or mL. With a period following the abbreviation	mg mL	The period is unnecessary and could be mistaken as the number 1 if written poorly	Use mg, mL, etc. without a terminal period
Large doses without properly placed commas (e.g., 100000 units; 1000000 units)	100,000 units 1,000,000 units	100000 has been mistaken as 10,000 or 1,000,000; 1000000 has been mistaken as 100,000	Use commas for dosing units at or above 1,000, or use words such as 100 “thousand” or 1 “million” to improve readability
Drug Name Abbreviations	*Intended Meaning*	*Misinterpretation*	*Correction*
ARA A	vidarabine	Mistaken as cytarabine (ARA C)	Use complete drug name
AZT	zidovudine (Retrovir)	Mistaken as azathioprine or aztreonam	Use complete drug name
CPZ	Compazine (prochlorperazine)	Mistaken as chlorpromazine	Use complete drug name
DPT	Demerol-Phenergan-Thorazine	Mistaken as diptheria-pertusis-tetanus (vaccine)	Use complete drug name
DTO	Diluted tincture of opium, or deodorized tincture of opium (Paregoric)	Mistaken as tincture of opium	Use complete drug name
HCl	Hydrochloric acid or hydrochloride	Mistaken as potassium chloride (the “H” is misinterpreted as “K”)	Use complete drug name unless expressed as salt of drug

Drug Name Abbreviations	***Intended Meaning***	***Misinterpretation***	***Correction***
HCT	hydrocortisone	Mistaken as hydrochlorothiazide	Use complete drug name
HCTZ	hydrochlorothiazide	Mistaken as hydrocortisone (seen as HCT250 mg)	Use complete drug name
$MgSO_4$	magnesium sulfate	Mistaken as morphine sulfate	Use complete drug name
MS, MSO_4	morphine sulfate	Mistaken as magnesium sulfate	Use complete drug name
MTX	methotrexate	Mistaken as mitoxantrone	Use complete drug name
PCA	procainamide	Mistaken as patient controlled analgesia	Use complete drug name
PTU	propylthiouracil	Mistaken as mercaptopurine	Use complete drug name
T3	Tylenol with codeine No. 3	Mistaken as liothyronine	Use complete drug name
TAC	triamcinolone	Mistaken as tetracaine, adrenalin, cocaine	Use complete drug name
TNK	TNKase	Mistaken as "TPA"	Use complete drug name
$ZnSO_4$	zinc sulfate	Mistaken as morphine sulfate	Use complete drug name
Stemmed Drug names	***Intended Meaning***	***Misinterpretation***	***Correction***
"Nitro" drip	Nitroglycerin infusion	Mistaken as sodium nitroprusside infusion	Use complete drug name
"Norflox"	norfloxacin	Mistaken as Norflex	Use complete drug name
"IV Vanc"	intravenous vancomycin	Mistaken as Invanz	Use complete drug name
Symbols	***Intended Meaning***	***Misinterpretation***	***Correction***
ʒ ♍	Dram Minim	Symbol for dram mistaken as "3" Symbol for minim mistaken as "mL"	Use metric system
x3d	For three days	Mistaken as "3 doses"	Use "for three days"

Symbols	*Intended Meaning*	*Misinterpretation*	*Correction*
> and <	Greater than and less than	Mistaken as opposite of intended of intended; mistakenly use incorrect symbol; “<10” mistaken as “40”	Use “greater than” or “less than”
/ (slash mark)	Separates two doses or indicates “per”	Mistaken as the number 1 (e.g., “25 units/10 units” misread as “25 units and 110 units”)	Use “per” rather than a slash mark to separate doses
@	At	Mistaken as “2”	Use “at”
&	And	Mistaken as “2, 3, 4, or 8”	Use “and”
+	Plus or and	Mistaken as “4”	Use “and”
°	Hour	Mistaken as a zero (e.g., q2° seen as q 20)	Use “hr,” “h,” or “hour”

Worksheet 8-3

Name:

Date:

Match the following abbreviations with their English translations.

Route

1)	_____	a.d.	a. by mouth
2)	_____	a.s.	b. by nebulizer
3)	_____	a.u.	c. each ear
4)	_____	IM	d. each eye
5)	_____	IV	e. intramuscular
6)	_____	IVP	f. intravenous
7)	_____	IVPB	g. intravenous push
8)	_____	KVO	h. intravenous piggyback
9)	_____	n.g.t.	i. keep vein open
10)	_____	n.p.o.	j. left ear
11)	_____	nare	k. left eye
12)	_____	o.d.	l. naso-gastric tube
13)	_____	o.s.	m. nostril
14)	_____	o.u.	n. nothing by mouth
15)	_____	per neb	o. rectally
16)	_____	p.o.	p. right ear
17)	_____	p.r.	q. right eye
18)	_____	p.v.	r. subcutaneously
19)	_____	SC, SQ	s. sublingually
20)	_____	S.L.	t. topically
21)	_____	top.	u. vaginally

Form

22) ______	amp	a. ampule
23) ______	aq, aqua	b. capsule
24) ______	caps	c. cream
25) ______	cm.	d. elixir
26) ______	elix.	e. liquid
27) ______	liq.	f. ointment
28) ______	sol.	g. slow/extended release
29) ______	supp.	h. solution
30) ______	SR, XR, XL	i. suppository
31) ______	syr.	j. syrup
32) ______	tab.	k. tablet
33) ______	ung., oint	l. water

Measurement

34) ______	i, ii	a. a sufficient quantity
35) ______	a.a. or aa	b. add sufficient quantity to make
36) ______	ad	c. add water up to
37) ______	aq. ad	d. body surface area
38) ______	BSA	e. cubic centimeter
39) ______	cc	f. dilute
40) ______	dil.	g. drops
41) ______	f, fl.	h. fluid
42) ______	fl. oz.	i. fluid ounce
43) ______	g, G, gm	j. grain
44) ______	gr.	k. gram
45) ______	gtt	l. greater than
46) ______	l, L	m. less than
47) ______	mcg, μg	n. liter
48) ______	mEq.	o. microgram
49) ______	mg	p. milliequivalent
50) ______	ml, mL	q. milligram
51) ______	q.s.	r. milliliter
52) ______	q.s. ad	s. of each
53) ______	ss	t. one, two, etc
54) ______	tbsp., T	u. one-half
55) ______	tsp., t	v. tablespoon
56) ______	U	w. teaspoon
57) ______	>	x. to, up to
58) ______	<	y. unit

Time

59) _____	a.c.	a. after meals
60) _____	a.m.	b. around the clock
61) _____	atc	c. as needed
62) _____	b.i.d., bid	d. at bedtime
63) _____	b.i.w., biw	e. before food, before meals
64) _____	h	f. each, every
65) _____	h.s.	g. evening
66) _____	p.c.	h. every __ hour(s)
67) _____	p.m.	i. every day
68) _____	p.r.n., prn	j. every other day
69) _____	q.i.d., qid	k. four times a day
70) _____	q	l. hour
71) _____	q.d.	m. immediately
72) _____	q_h	n. morning
73) _____	qod	o. three time a day
74) _____	stat	p. three times a week
75) _____	t.i.d., tid	q. twice a day
76) _____	t.i.w., tiw	r. twice a week

Other

77)	______	c	a. as directed
78)	______	disp.	b. dispense
79)	______	f, ft.	c. make, let it be made
80)	______	neb	d. nausea and vomiting
81)	______	n/v	e. nebulizer
82)	______	NR	f. no refill
83)	______	NS	g. normal saline
84)	______	s	h. shortness of breath
85)	______	Sig.	i. telephone order
86)	______	SOB	j. verbal order
87)	______	T.O.	k. with
88)	______	ut dict., u.d.	l. without
89)	______	V.O.	m. write, label

Choose the best answer for the following multiple choice questions.

90) The directions for use of a medication are “gtt ii os bid.” The route of administration is:

a) right eye
b) left eye
c) right ear
d) left ear

91) The directions for use of a medication are “Tylenol 80 mg pr q6h prn.” What dosage form should be dispensed?

a) chew tab
b) syrup
c) suppository
d) enema

92) The directions for use are “Nitrostat 1/200 gr S.L. prn.” How should this medication be administered?

a) In the left ear
b) Very slowly
c) Under the tongue
d) Under the skin

93) Which of the following ways would be the best way for a physician to write a prescription for levothyroxine?

a) levothyroxine .1 mg qam
b) levothyroxine 0.100 mg qam
c) levothyroxine .100 mg qam
d) levothyroxine 0.1 mg qam

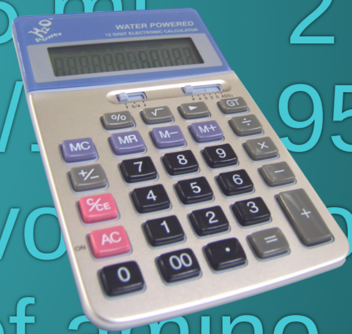
Answer the following questions.

94) Why is a physician supposed to avoid using the abbreviation “U” for units?

95) Why should physicians not use apothecary symbols when writing prescriptions?

96) Should you have a trailing zero after a decimal point? Why or why not?

97) Should you place a lead zero before a number that is less than one? Why or why not?



Chapter 9

Basic Medication Calculations

A student enters a pharmacy and asks, "Do you have a pill for math?" The pharmacist says "Wait just a moment", and goes back into the storeroom and brings back a whopper of a pill and plunks it on the counter. "I have to take that huge pill for math?" inquires the student. The pharmacist replies "Well, you know math always was a little hard to swallow."

--*Unknown Author*

This chapter is intended to provide an overview of some basic concepts involved in pharmacy math including:

- calculating dosages when giving medications in tablet or capsule form,
- calculating dosages when giving medications in liquid form, and
- percentage strength of solutions.

An important thing to keep in mind while doing this chapter is that many of the concepts taught in this section will still be applied in the coming weeks.

Calculating Dosages When Giving Medications in Tablet or Capsule Form

On a regular basis, you will need to figure out how many tablets or capsules to dispense. These problems are usually made easier with the “5 Step Method” and dimensional analysis. Key things to look for are the quantity of medication per dose, the strength of the tablet, how often the doses are being given and how long of a time frame we need to cover with these doses. You may need to include some conversion factors.

Without wanting to over explain the process, let's look at an example problem on the next page where we just want to find a number of tablets needed per dose.

Example

A 100 mg dose of medication is ordered, and the tablet size available is 25 mg. How many tablets will be needed per dose?

QUESTION

How many tablets will be needed per dose?

DATA

$$\frac{100\ mg}{dose} \qquad \frac{25\ mg}{tablet}$$

METHOD/FORMULA

dimensional analysis

DO THE MATH

$$\frac{100\ mg}{dose} \times \frac{tablet}{25\ mg} = \mathbf{4\ \mathit{tablets/dose}}$$

DOES THE ANSWER MAKE SENSE?

Yes

Some important items to point out are that you need to be able to interpret the data in the word problem to pick out the necessary information. An example would be that when the problem says “A 100 mg dose of medication is ordered.....” the ability to express it mathematically as 100 mg/dose. Another thing to point out is that when you are using dimensional analysis you need to line up your units the correct way. In the above problem, we need tablets on top and dose on the bottom, which was why we needed to 'flip' 25 mg/tablet so that tablet was on top.

Using what we've just discussed, let's attempt another practice problem.

Practice Problem

The ordered medication is gr xxx/dose. The available capsules are gr v. How many capsules are needed per dose?

QUESTION

DATA

MATHEMATICAL METHOD / FORMULA

DO THE MATH

DOES THE ANSWER MAKE SENSE?

6 capsules/dose

Provided that the practice problem on the previous page made sense, let's do a few more practice problems before we expand on this idea.

Practice Problems

Calculate the number of capsules or tablets needed per dose.

1) 300 mg ordered; 50 mg/capsule available

2) gr xvi ordered; gr iv/tab available

3) gr ii ordered; gr ss/tab available

4) 250 mg ordered; 125 mg/cap available

5) gr v ordered; 100 mg/cap available

1) 6 capsules/dose 2) 4 tablets/dose 3) 4 tablets/dose 4) 2 capsules/dose 5) 3 capsules/dose

Besides just figuring out how many tablets or capsules we will need for a particular dose, we will need to look at how many we need to cover a particular time frame in order for us to provide a sufficient quantity for the patient. Most institutional settings provide medications in 24 hour increments, although this may vary between various institutions.

Example

If gr v t.i.d. is ordered and 100 mg capsules are available, then what is the total number of capsules needed per day?

QUESTION

What is the total number of capsules needed per day?

DATA

$$\frac{5\ gr}{dose} \qquad \frac{3\ doses}{day} \qquad \frac{100\ mg}{cap}$$

And you will need a conversion factor for grains to milligrams, which is either:

$$\frac{60\ mg}{gr} \quad or \quad \frac{65\ mg}{gr}$$

MATHEMATICAL METHOD / FORMULA

dimensional analysis

DO THE MATH

$$\frac{5\ gr}{dose} \times \frac{3\ doses}{day} \times \frac{60\ mg}{gr} \times \frac{cap}{100\ mg} = \mathbf{9\ \textit{capsules/ day}}$$

DOES THE ANSWER MAKE SENSE

Yes

In the above scenario you needed to use 60 mg/gr, if you had used 65 mg/gr you would have ended up with 9.75 capsules. While tablets can be cut in half (and sometimes in quarters) capsules can only be given in whole numbers; therefore 60 mg/gr works out much better in this problem.

Now, using what we've just discussed let's attempt a practice problem on the next page using the “5 Step Method”.

Practice Problems

A physician orders 90 mg q.4h. of a medication; and you have gr ss/cap in stock on this medication. What is the total number of capsules needed per day?

QUESTION

DATA

MATHEMATICAL METHOD / FORMULA

DO THE MATH

DOES THE ANSWER MAKE SENSE?

18 capsules/day

Provided that the above practice problem made sense, let's do a few more practice problems

Practice Problems

Calculate the number of capsules or tablets needed per day.

1) 0.4 g q.2h ordered; 200 mg/tab available

2) 60 mg b.i.d. ordered; gr ss/cap available

3) 150 gr q.h. ordered; ʒ v/tab available

4) gr ss t.i.d. ordered; 65 mg/tab available

5) 600 mg q.8h. ordered; 50 mg/tab available

Worksheet 9-1

Name:

Date:

Calculate the number of capsules or tablets needed for the following doses.

1) If 200 mg/dose of a medication is ordered and it is available as 50 mg/cap, how many caps are needed per dose?

2) If gr iv/dose of a medication is ordered and it is available as gr ss/tab, how many tabs are needed per dose?

3) If 150 mg/dose of a medication is ordered and it is available as 25 mg/tab, how many tabs are needed per dose?

4) If gr viii/dose of a medication is ordered and it is available as gr ii/cap, how many caps are needed per dose?

5) If 75 mg/dose of a medication is ordered and it is available as 150 mg/tab, how many tabs are needed per dose?

6) If 500 mg/dose of a medication is ordered and it is available as 125 mg/cap, how many caps are needed per dose?

7) If 400 mg/dose of a medication is ordered and it is available as 0.1 g/tab, how many tabs are needed per dose?

8) If 300 gr/dose of a ʒ i/tab, how many tabs are needed per dose?

9) If 0.2 g/dose of a medication is ordered and it is available as 100 mg/tab, how many tabs are needed per dose?

10) If gr ii/dose of a medication is ordered and it is available as 60 mg/tab, how many tabs are needed per dose?

Calculate the number of capsules or tablets needed over 24 hours.

11) If 50 mg/dose of a medication is ordered t.i.d. and it is available as 25 mg/tab, how many tabs are needed per day?

12) If gr xx/dose of a medication is ordered q.4h. and it is available as gr v/tab, how many tabs are needed per day?

13) If 10 mg/dose of a medication is ordered q.4h. and it is available as 5 mg/tab, how many tabs are needed per day?

14) If 100 mg/dose of a medication is ordered b.i.d. and it is available as 25 mg/cap, how many caps are needed per day?

15) If gr xvi/dose of a medication is ordered q.3h. and it is available as gr viii/cap, how many caps are needed per day?

16) If 10 mg/dose of a medication is ordered q.h. and it is available as 5 mg/tab, how many tabs are needed per day?

17) If 0.2 g/dose of a medication is ordered q.4h. and it is available as 100 mg/tab, how many tabs are needed per day?

18) If gr ss/dose of a medication is ordered b.i.d. and it is available as 60 mg/tab, how many tabs are needed per day?

19) If 100 mg/dose of a medication is ordered b.i.d. and it is available as 0.1 g/tab, how many tabs are needed per day?

20) If gr ii/dose of a medication is ordered q.8h. and it is available as 60 mg/tab, how many tabs are needed per day?

Calculate the number of capsules or tablets needed to fill the following prescriptions.

21) Rx Ambien 5 mg/tab
Disp: 14 day supply
Sig: 1 tab po hs

22) Rx furosemide 20 mg/tab
Disp: 7 day supply
Sig: 1 tab po bid

23) Rx alprazolam 0.5 mg/tab
Disp: 7 day supply
Sig: 1 tab po tid

24) Rx Lopressor 25 mg/tab
Disp: 30 day supply
Sig: 12.5 mg po bid

25) Rx zafirlukast 20 mg/tab
Disp: 7 day supply
Sig: 1 tab bid

26) Rx tetracycline 250 mg/cap
Disp: 3 day supply
Sig: 1 cap qid

27) Rx repaglinide 0.5 mg/tab
Disp: 21 day supply
Sig: 1 tab po tid

28) Rx dipyridamole 50 mg
Disp: 21 day supply
Sig: 1 tab po qid

29) Rx zidovudine 100 mg/cap
Disp: 90 day supply
Sig: 300 mg po q12h

Calculating Dosages When Giving Medications in Liquid Form

Frequently you will need to transfer solutions from manufacturers' containers, to patient specific containers, which will contain just enough solution for the patient's needs. These problems are usually made easier with the "5 Step Method" and dimensional analysis or ratio proportions. Key things to look for are the quantity of medication per dose, the concentration of the liquid, how often the doses are being given and how long of a time-frame we need to cover with these doses. Just like in the previous section, you may need to include some conversion factors.

Without wanting to over explain the process, let's look at an example problem where we just want to find out how many mL need to be withdrawn from a vial.

Example

An order for 50 mg of a drug is received. A 10 mL vial with 100 mg/mL is available. How many mL should be withdrawn from the vial?

QUESTION

How many mL should be withdrawn from the vial?

DATA

$$\frac{50\ mg}{dose} \qquad \frac{10\ mL}{vial} \qquad \frac{100\ mg}{mL}$$

MATHEMATICAL METHOD / FORMULA

Dimensional Analysis or Ratio Proportion

DO THE MATH

dimensional analysis

$$\frac{50\ mg}{dose} \times \frac{mL}{100\ mg} = \mathbf{0.5\ mL/\ dose}$$

ratio proportion

$$\frac{50\ mg}{N} = \frac{100\ mg}{mL}$$

$$N = \mathbf{0.5\ mL}$$

DOES THE ANSWER MAKE SENSE?

Yes

Two things worth noting are the fact that you had more information than was needed to solve the problem (the 10 mL vial was not necessary information to do the math) and that you could have solved this with either dimensional analysis or ratio proportion. Using the above problem as a template, let's attempt the practice problem on the next page using the "5 Step Method".

Practice Problem

A physician orders azithromycin 500 mg IV. In the pharmacy you have 250 mg/5 mL in stock. Calculate the number of mL required to fill this order.

QUESTION

DATA

MATHEMATICAL METHOD / FORMULA

DO THE MATH

DOES THE ANSWER MAKE SENSE?

10 mL

Provided that the above practice problem made sense, let's do a few more practice problems before we expand on this idea.

Practice Problems

Assume that all of the solutions below are in 10 mL vials. Calculate the amount of solution to be withdrawn from the vial.

1) 20 mg is ordered; 50 mg/mL is available.

2) 60 mg is ordered; 40 mg/mL is available.

3) 80 mg is ordered; 50 mg/mL is available.

4) 40 mg is ordered; 50 mg/mL is available.

5) 75 mg of drug ordered; 100 mg/cc available

1) 0.4 mL 2) 1.5 mL 3) 1.6 mL 4) 0.8 mL 5) 0.75 cc

Sometimes drugs are ordered in units. A unit is a measurement for the amount of a substance, based on measured biological activity or effect. The unit is used for vitamins, hormones, some medications, vaccines, blood products, and similar biologically active substances. Calculating a dosage in units is no different than what we have already been doing with other labels (mg, gr, etc.). Let's take a moment and look at an example problem using units.

Example

8,000 units of a drug is ordered. A 10 cc vial containing 10,000 units/cc is available. How many cc should be withdrawn from the vial?

QUESTION

How many cc should be withdrawn from the vial?

DATA

$$\frac{8{,}000\ units}{dose} \quad \frac{10\ cc}{vial} \quad \frac{10{,}000\ units}{cc}$$

MATHEMATICAL METHOD / FORMULA

Dimensional Analysis or Ratio Proportion

DO THE MATH

dimensional analysis

$$\frac{8{,}000\ units}{dose} \times \frac{cc}{10{,}000\ units} = \mathbf{0.8\ cc/dose}$$

ratio proportion

$$\frac{8{,}000\ units}{N} = \frac{10{,}000\ units}{cc}$$

$$N = \mathbf{0.8\ cc}$$

DOES THE ANSWER MAKE SENSE?

Yes

Just like the previous problems, the above problem was able to be solved two different ways. Using the above problem as a template, let's attempt a few practice problems below.

Practice Problems

Assume that all of the solutions below are in 10 mL vials. Calculate the amount of solution to be withdrawn from the vial.

1) 6000 units ordered; 5000 units/cc is available.

2) 300,000 units ordered; 200,000 units/mL is available.

3) 500,000 units ordered; 1,000,000 units/mL is available.

1) 1.2 cc 2) 1.5 mL 3) 0.5 mL

Sometimes medications will come as a lyophylized powder to provide longer stability and/or easier shipping and they need to be reconstituted prior to patient use. Let's look at an example problem to demonstrate this concept.

Example

300,000 units is to be administered from a vial containing 1,000,000 units reconstituted with 5 cc of diluent. The reconstituted vial contains 200,000 units/cc. How many cc should be withdrawn from the reconstituted vial?

QUESTION

How many cc should be withdrawn from the reconstituted vial?

DATA

$$\frac{300{,}000\ units}{dose} \qquad \frac{200{,}000\ units}{cc} \qquad \frac{1{,}000{,}000\ units}{vial} \qquad reconstituted\ with\ 5\ cc$$

MATHEMATICAL METHOD / FORMULA

Dimensional Analysis or Ratio Proportion

DO THE MATH

$$\textit{dimensional analysis}$$
$$\frac{300{,}000\ units}{dose} \times \frac{cc}{200{,}000\ units} = \mathbf{1.5\ cc / dose}$$

$$\textit{ratio proportion}$$
$$\frac{300{,}000\ units}{N} = \frac{200{,}000\ units}{cc}$$
$$N = \mathbf{1.5\ cc}$$

DOES THE ANSWER MAKE SENSE?

Yes

Once again, you had unnecessary information and multiple ways to choose to solve these problems. Using the above problem as a template, let's attempt a couple of practice problems below.

Practice Problems

1) 200,000 units is to be administered from a vial containing 500,000 units reconstituted with 5 cc of diluent. The reconstituted vial now contains 100,000 units/cc. How many cc should be withdrawn from the reconstituted vial?

2) 750 mg of methylprednisolone injection is ordered. A vial containing 1000 mg is reconstituted with 7.4 mL of sterile water for injection and has 0.6 ml of powder volume. The final concentration in the vial is 125 mg/mL. How many mL should be withdrawn from the reconstituted vial?

1) 2 cc 2) 6 mL

Worksheet 9-2

Name:

Date:

Calculate the quantity of volume that needs to be withdrawn from the following vials to fill their orders.

1) 75 mg of drug ordered; a 10 cc vial with a concentration of 100 mg/cc is available.

2) 40 mg of drug ordered; a 10 cc vial with a concentration of 100 mg/cc is available.

3) 50 mg of drug ordered; a 10 cc vial with a concentration of 100 mg/cc is available.

4) 20 mg of drug ordered; a 10 cc vial with a concentration of 50 mg/cc is available.

5) 60 mg of drug ordered; a 10 cc vial with a concentration of 40 mg/cc is available.

6) 80 mg of drug ordered; a 10 cc vial with a concentration of 50 mg/cc is available.

7) 40 mg of drug ordered; a 10 cc vial with a concentration of 50 mg/cc is available.

8) A physician orders 37.5 mg of methotrexate, and the 2 mL stock vial in the pharmacy has a concentration of 25 mg/mL. How many mL will you need to dispense to provide the appropriate dose?

9) A physician orders 1050 mg of fluorouracil, and the stock vial in the pharmacy has a concentration of 50 mg/mL. How many mL will you need to dispense to provide the appropriate dose?

10) A physician orders 62.5 mg of methotrexate, and the 25 mL stock vials in the pharmacy have a concentration of 2 mg/mL. How many mL will you need to dispense to provide the appropriate dose?

11) 6,000 units of drug ordered; a 10 cc vial with a concentration of 5,000 units/cc is available.

12) 300,000 units of drug ordered; a 10 cc vial with a concentration of 200,000 units/cc is available.

13) 500,000 units of drug ordered; a 10 cc vial with a concentration of 1,000,000 units/cc is available.

14) A TPN requires the addition of 15 units of regular insulin. A 10 mL vial with a concentration of 100 units/mL is available. How many mL of insulin should be added to the TPN?

15) You receive an order for heparin 12,000 units to be added to an IV bag. If the concentration of the heparin available is 5,000 units/mL, how many mL of heparin should you use?

16) 200,000 units are ordered ; a vial containing 1,000,000 units is reconstituted with 10 cc of diluent. The reconstituted solution now contains 100,000 units/cc.

17) 300,000 units are ordered ; a vial containing 2,000,000 units is reconstituted with 10 cc of diluent. The reconstituted solution now contains 200,000 units/cc.

18) 50,000 units are ordered ; a vial containing 1,000,000 units is reconstituted with 10 cc of diluent. The reconstituted solution now contains 100,000 units/cc.

19) 150,000 units are ordered ; a vial containing 2,000,000 units is reconstituted with 10 cc of diluent. The reconstituted solution now contains 200,000 units/cc.

20) An order is written for 4,000,000 units of penicillin G potassium. You have a vial containing 20,000,000 units. The directions are to add 32 mL of sterile water for injection to reconstitute to a concentration of 500,000 units/mL (the vial contains 8 mL of powder volume). How many mL of the reconstituted solution will you need to dispense?

Percentage Strength Solutions

There are many ways to express the concentration of a drug, one of the most common is percentage strength (*hint: remember that "percent" means "per 100"*) .

There are three kinds of percentage strength that you will frequently use when doing dosage calculations:

> **weight/weight** (w/w) – examples include ointments, creams, etc.
> **volume/volume** (v/v) – a common example is an alcohol preparation
> **weight/volume** (w/v) – this is the most common group and includes items such as solutions, suspensions, etc.

Weight/Weight (w/w)

A weight/weight percentage strength expresses the number of parts in 100 parts of a preparation . Typically it is expressed as number of grams per 100 grams, but it could be expressed in any unit of weight (grams, grains, ounces, pounds, etc.) as long as the units on the top and bottom match. Let's look at an example to help this make more sense.

Example

What would be the weight, expressed in grams, of zinc oxide (zinc oxide is the active ingredient) in 120 grams of a 10% zinc oxide ointment (the ointment is the total mixture)?

QUESTION

How many grams of zinc oxide are in the ointment?

DATA

$120\ g\ of\ \ ointment \qquad 10\% = \frac{10\ g\ zinc\ oxide}{100\ g\ ointment}$

MATHEMATICAL METHOD / FORMULA

Ratio Proportion (This can be done other ways, but this is the easiest method to explain thoroughly.)

DO THE MATH

$$\frac{N}{120\ g\ ointment} = \frac{10\ g\ zinc\ oxide}{100\ g\ ointment}$$

$$N = \mathbf{12\ g\ zinc\ oxide}$$

DOES THE ANSWER MAKE SENSE?

Yes

Let's look at a couple of practice problems based on w/w percentage strength.

Practice Problem 1

What would be the percentage strength of a zinc oxide ointment if you prepared 90 grams of an ointment that contained 5 grams of zinc oxide? *(Hint: In this problem you have the weight of the active ingredient and the weight of the mixture, you need to find the percentage strength which would be out of 100 grams of mixture)*

QUESTION

DATA

MATHEMATICAL METHOD / FORMULA

DO THE MATH

DOES THE ANSWER MAKE SENSE?

5.6% zinc oxide ointment

Now, let's look at another w/w practice problem.

Practice Problem 2

If you were to prepare 150 g of a coal tar ointment containing 12 g of coal tar, what is the percent strength of coal tar in the ointment?

QUESTION

DATA

MATHEMATICAL METHOD / FORMULA

DO THE MATH

DOES THE ANSWER MAKE SENSE?

8% coal tar ointment

Volume/Volume (v/v)

Volume/volume percentage strength problems are worked out in a similar manner to w/w percentage strength problems, except now the ingredients are liquids. Typically it is expressed as number of milliliters per 100 milliliters, but it could be expressed in any unit of volume (liters, pints, fluid ounces, etc.) as long as the units on the top and bottom match. Look at the example problem below, and then complete the practice problem.

Example

How mL of isopropyl alcohol are in a 480 ml bottle of 70% isopropyl alcohol?

QUESTION

How many mL of isopropyl alcohol are in the bottle?

DATA

$480\ mL\ of\ mixture$ $\quad 70\%\, isopropyl\ alcohol = \frac{70\ mL\ isopropyl\ alcohol}{100\ mL\ mixture}$

MATHEMATICAL METHOD / FORMULA

Ratio Proportion (This can be done other ways, but this is the easiest method to explain thoroughly.)

DO THE MATH

$$\frac{N}{480\ mL\ mixture} = \frac{70\ mL\ isopropyl\ alcohol}{100\ mL\ mixture}$$

$$N = \mathbf{336\ mL\ isopropyl\ alcohol}$$

DOES THE ANSWER MAKE SENSE?

Yes

Practice Problem

How many mL of lysol would be required to make 4000 mL of a 2% lysol solution?

QUESTION

DATA

MATHEMATICAL METHOD / FORMULA

DO THE MATH

DOES THE ANSWER MAKE SENSE?

80 mL of lysol

Weight/Volume (w/v)

Weight/volume (w/v) percentage strengths are the most common percentages worked with in pharmacy. The units in this type of problem are **always** grams of drug dissolved in 100 milliliters of solution. Let's look at a practice problem.

Example

How many grams of sodium chloride are in a 500 mL bag of 0.9% sodium chloride?

QUESTION

How many g of sodium chloride are in the bag?

DATA

$500\ mL\ of\ mixture$ $\quad 0.9\%\ sodium\ chloride = \frac{0.9\ g\ sodium\ chloride}{100\ mL\ mixture}$

MATHEMATICAL METHOD / FORMULA

Ratio Proportion

DO THE MATH

$$\frac{N}{500\ mL\ mixture} = \frac{0.9\ g\ sodium\ chloride}{100\ mL\ mixture}$$

$$N = \mathbf{4.5\ g\ sodium\ chloride}$$

DOES THE ANSWER MAKE SENSE?

Yes

As w/v percentage strength problems are the ones we will be working with most frequently (and what we are going to concentrate on in this chapter) it is worth pointing out that our ratio proportions for w/v percentage strength problems always have grams on top and milliliters on the bottom. Let's look at a practice problem.

Practice Problem

How many grams of neomycin are needed to prepare 500 mL of a 1% neomycin solution?

QUESTION

DATA

MATHEMATICAL METHOD / FORMULA

DO THE MATH

DOES THE ANSWER MAKE SENSE?

5 g of neomycin

Let's look at some additional practice problems.

Practice Problems

1) You dissolve 10 g of mannitol in 50 mL of water. What is the percentage of mannitol?

2) How much solution can you make from 25 g of drug, if you want a 10% concentration?

3) How much drug is in 50 cc of a 1% solution?

4) How many cc of a 20% solution can be made with 5 g of drug?

1) 20%   2) 250 mL   3) 0.5 g   4) 25 cc

Worksheet 9-3

Name:

Date:

Make the calculations needed to prepare these solutions.

1) What weight of drug is in 10 cc of a 15% solution?

2) A 100 mL solution contains 10 g of a drug. What is the percent concentration of this solution?

3) How many cc of a 30% solution can be made with 15 g of drug?

4) What weight of drug is in 15 mL of a 10% solution?

5) A 200 cc solution contains 20 g of a drug. What is the percent concentration of this solution?

6) How many cc of a 10% solution can be made with 15 g of a drug?

7) What weight of drug is in 20 mL of an 8% solution?

8) What weight of drug is in 50 cc of a 1% solution?

9) A 200 cc solution contains 40 g of a drug. What is the percent concentration of this solution?

10) A 300 mL solution contains 3 g of a drug. What is the percent concentration of this solution?

11) How many cc of a 5% solution can be made with 10 g of a drug?

12) How many mL of a 2% solution can be made with 6 g of a drug?

13) How many cc of a 10% solution can be made with 5 g of drug?

14) What weight of drug is in 30 mL of a 15% solution?

15) A solution of 80 cc contains 50 g of a drug. What is the percent concentration of this solution?

Worksheet 9-4

Name:

Date:

Solve the following practical percentage strength problems. *Hint: All the problems on this worksheet are w/v percentage strength problems.*

1) You have a patient with severe renal impairment and the physician wants him to receive a TPN with 10 g of amino acid. How many mL of a 5.2% amino acid (Aminosyn-RF) solution will you need to add to the TPN?

2) You have an order for 1 g of calcium gluconate IV. It is available in a 10 mL vial with a 10% concentration. How many mL will you need to draw up?

3) You have a 10 mL vial of 50% magnesium sulfate, and you receive an order for 4 g of magnesium sulfate IV. How many mL will you need to draw up?

4) You receive an order for 2500 mg of magnesium sulfate IV. How many mL would you withdraw from a 10 mL vial of 50% magnesium sulfate.

5) A CRNA intern needs to administer 100 mg of procaine. The vial he has on his block cart in the OR has a concentration of 1%. How many mL should you tell him to administer?

6) You added 15.4 mL of a 14.6% sodium chloride solution to a 1000 mL bag of sterile water for injection. How many grams of sodium chloride are in the final bag?

7) A patient on an ICU unit was suffering from calcium channel blocker toxicity so a physician had a nurse give 10 cc of 10% calcium chloride injection stat. The nurse is asking you how many grams of calcium chloride she should chart as having given the patient.

8) A nurse hung a 500 mL IV bag with 20% mannitol, but only wants to infuse 50 g. How many mL should you tell her to infuse?

Worksheet 9-5

Name:

Date:

Calculate the number of capsules or tablets needed per dose.

1) 150 mg of drug ordered; 75 mg/tab available

2) 0.3 g/dose ordered; 100 mg/tab available

3) 240 gr/dose ordered; ʒ iv/tab available

4) 150 mg of drug ordered; 100 mg/tab available

5) 0.2 g/dose ordered; 200 mg/cap available

Calculate the total number of capsules or tablets needed over 24 hours.

6) If 0.4 g/dose of a medication is ordered q.i.d. and it is available as 200 mg/tab, how many tabs are needed per day?

7) If 120 mg/dose of a medication is ordered b.i.d. and it is available as gr iv/tab, how many tabs are needed per day?

8) If 0.1 g/dose of a medication is ordered q.6h. and it is available as 50 mg/cap, how many caps are needed per day?

9) If gr iiss/dose of a medication is ordered t.i.d. and it is available as gr ss/tab, how many tabs are needed per day?

10) If 240 mg/dose of a medication is ordered h.s. and it is available as gr ii/cap, how many caps are needed per day?

Calculate the amount of solution to be withdrawn from a 10 cc vial.

11) 60 mg of drug ordered; 100 mg/cc available

12) 40 mg of drug ordered; 100 mg/cc available

13) 60 mg of drug ordered; 40 mg/cc available

14) 80,000 units are ordered. A vial containing 1,000,000 is reconstituted with 10 cc of diluent. The reconstituted solution now contains 100,000 units/cc.

15) 50,000 units are ordered. A vial containing 200,000 is reconstituted with 10 cc of diluent. The reconstituted solution now contains 20,000 units/cc.

Solve the following (*w/v*) percent strength problems.

16) What weight of drug is in 10 mL of a 8% solution?

17) A 500 cc solution contains 15 g of a drug. What is the percent concentration of this solution?

18) How many mL of a 20% solution can be made with 18 g of drug?

19) What weight of drug is in 5 mL of a 10% solution?

20) A 150 mL solution contains 15 g of a drug. What is the percent concentration of this solution?

Chapter 10

Basic Infusion Calculations

Who wouldn't want to solve an alligation, after all it's more like playing Tic-Tac-Toe than math.
--Sean Parsons

Now the math starts to get really exciting as we look at calculations involving infusions. We will look at five major concepts in this section:

- diluting stock solutions,
- infusion rates,
- dosages based on body weight,
- body surface area, and
- pediatric dosing.

Diluting Stock Solutions

A stock solution is a concentrated solution from which less-concentrated solutions can be made. The stock solution is diluted with a solvent (sometimes also referred to as a diluent), which may be water or some other liquid substance. Two questions must be answered to solve a dilution problem.

1) What volume of the stock solution must be diluted to make the ordered solution?
2) What volume of solvent must be added to perform the dilution?

These questions can be answered using ratio-proportions, the dilution formula, or the alligation method . We will review all three possible methods.

Solving dilutions using the ratio-proportion method.

We have previously learned how to solve problems using the ratio-proportion method, but in order to solve dilution problems you will actually need to perform two ratio-proportions. Let's look at an example problem on the next page to demonstrate how this works.

Example:

If 500 mL of a 5% solution is ordered, how much of a 25% stock solution is needed to prepare the 5% solution?

QUESTION

How much stock solution is needed (we are looking for a volume)?

DATA

final volume is 500 mL final concentration is 5% and $5\% = \frac{5\ g}{100\ mL}$

stock volume is ??? stock concentration is 25% and $25\% = \frac{25\ g}{100\ mL}$

MATHEMATICAL METHOD / FORMULA

ratio-proportion

DO THE MATH

First, we need to figure out how much active ingredient is in our final solution:

$$\frac{5\ g}{100\ mL} = \frac{N}{500\ mL}$$

When you solve for *N* you will find:

$$N = 25\ g$$

Which means we will need to figure out how much volume of the stock solution is required to provide 25 g of drug.

$$\frac{25\ g}{100\ mL} = \frac{25\ g}{N}$$

When you solve for *N* you will find:

$N = \mathbf{100\ mL}$ ***of stock solution is required.***

DOES THE ANSWER MAKE SENSE?

Yes

Even though there is an extra problem involved, the ratio-proportion method is convenient because it is building on skills you have previously learned. Looking again at the problem we just solved, you will often also need to know how much solvent or diluent is required. In this scenario since we know what are final volume is, and what volume of stock solution is required we can logically ascertain that are final volume minus are stock volume will equal how much diluent is required:

500 mL – 100 mL = 400 mL of diluent

Try the practice problem on the next page to reinforce these concepts.

Practice Problem:

A 500 mL bag of 20% mannitol is ordered. 50% mannitol is the available stock solution. How much of the stock solution is needed to make this bag?

QUESTION

DATA

MATHEMATICAL METHOD / FORMULA

DO THE MATH

DOES THE ANSWER MAKE SENSE?

200 mL of stock solution

Now that you've solve that, also figure out how much diluent would be required to make the above IV bag?

300 mL of diluent

You will have more opportunities to practice this problem solving method shortly, but first I would like to introduce you to two new problem solving methods the dilution formula and the alligation method. We will look at the dilution formula first.

Solving dilutions using the dilution formula.

The dilution formula is exactly what it sounds like, a formula to make it quicker to solve dilutions. Without any further ado, let's concentrate our attention on the formula below:

The Dilution Formula

$$\mathbf{C_1Q_1 = C_2Q_2}$$

$\mathbf{C_1}$ = concentration of available stock solution
$\mathbf{Q_1}$ = quantity of available stock solution needed
$\mathbf{C_2}$ = concentration of ordered solution
$\mathbf{Q_2}$ = quantity of ordered solution needed

Let's look at our previous example and solve it using the dilution formula.

Example:

If 500 mL of a 5% solution is ordered, how much of a 25% stock solution is needed to prepare the 5% solution?

QUESTION
How much stock solution is needed (we are looking for a quantity)?

DATA
C_1 = stock concentration is 25%
Q_1 = stock quantity is ???
C_2 = final concentration is 5%
Q_2 = final quantity is 500 mL

MATHEMATICAL METHOD / FORMULA
dilution formula

DO THE MATH
$C_1Q_1 = C_2Q_2$
$(25\%)(Q_1)=(5\%)(500\ mL)$
To solve for Q_1 we will need to get is by itself (isolate it) by dividing both side by 25%.
$$\frac{(\cancel{25\%})(Q_1)}{\cancel{25\%}}=\frac{(5\%)(500\ mL)}{25\%}$$
$Q_1=\mathbf{100\ mL}$ ***of stock solution***

DOES THE ANSWER MAKE SENSE?
Yes, especially since it is the same answer we derived using the ratio-proportion method.

And if we needed to solve for the quantity of diluent required, we would use the same logic as last time, are final volume minus our stock volume will equal how much diluent is required:

500 mL – 100 mL = 400 mL of diluent

Try the practice problem on the following page to reinforce this concept.

Practice Problem:

You are instructed to make 1000 cc of a 0.8% solution. You have in stock a 95% solution. How much of the stock solution will you use?

QUESTION

DATA

MATHEMATICAL METHOD / FORMULA

DO THE MATH

DOES THE ANSWER MAKE SENSE?

8.4 cc of stock solution

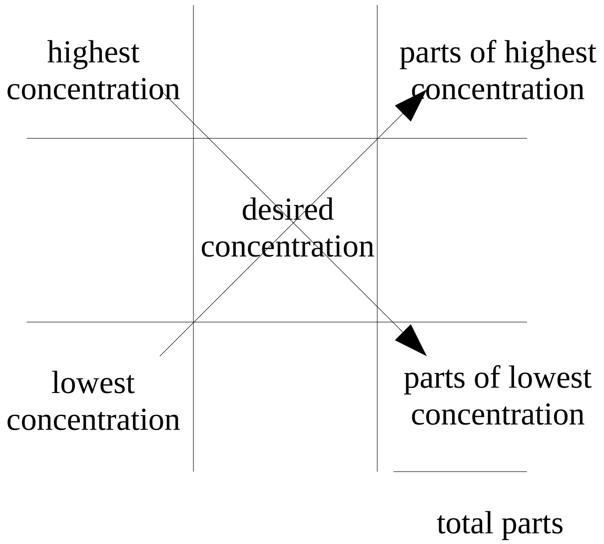
Now that you've solve that, also figure out how much diluent would be required to make the above solution?

991.6 cc of diluent

Solving dilutions using the alligation method.

The dilution formula is a very useful tool as it is quick and easy, but it will not work in certain circumstances, such as when no diluent is being used but instead multiple stock solutions of varying concentration are being mixed together. One tool that might be useful then is the alligation method. Also, depending on what information is present, the alligation method can also be useful for solving many dilution problems.

Below, we have a diagram explaining the alligation method. Based on the appearance of an alligation, you can see why it is sometimes referred to as the Tic-Tac-Toe method.



- Place the highest concentration in the upper left-hand corner
- Place the lower concentration in the lower left-hand corner
- Place the desired concentration in the center
- Find the difference between the highest concentration and the desired concentration to find the parts of lowest concentration
- Find the difference between the lowest concentration and the desired concentration to find the parts of highest concentration
- Add the parts of highest concentration and the parts of lowest concentration to find the total parts
- This provides you with a ratio that you can use to finish solving the problem.

The alligation method looks very abstract at first, but becomes much easier when we start using real numbers. Let's attempt the same example problem we've previously used with both the ratio-proportion method and the dilution formula on the next page

Example:

If 500 mL of a 5% solution is ordered, how much of a 25% stock solution is needed to prepare the 5% solution? How much diluent is needed?

QUESTION

How much stock solution is needed (we are looking for a quantity)?
How much diluent is needed (we are looking for a quantity)?

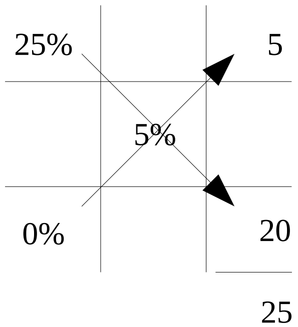
DATA

high concentration = 25%
desired concentration = 5%
low concentration = 0% (the diluent has no drug in it, therefore it has a 0% concentration)
final quantity = 500 mL

MATHEMATICAL METHOD / FORMULA

alligation method

DO THE MATH



$$\frac{5}{25} \times 500\ mL = \boldsymbol{100\ mL\ of\ 25\%\ solution.}$$

$$\frac{20}{25} \times 500\ mL = \boldsymbol{400\ mL\ of\ diluent.}$$

DOES THE ANSWER MAKE SENSE?

Yes, although we may need to look at some more practice problems to help this method make sense.

Let's look to the next page and attempt another problem using this same method.

Practice Problem:

200 cc of a 15% solution is ordered. A 30% solution is available. How much stock solution is needed, and how much solvent must be added to prepare the 15% solution?

QUESTION

DATA

MATHEMATICAL METHOD / FORMULA

DO THE MATH

DOES THE ANSWER MAKE SENSE?

100 cc of a 30% solution; 100 cc of solvent

Now, let's try a few more practice problems but use whichever method(s) you wish to perform the necessary calculations. The answers are on the next page.

1) 1000 cc of a 2% solution is needed. A 40% stock solution is available. How much stock solution is needed, and how much solvent must be added to prepare the 2% solution?

2) Respiratory needs you to make 3 mL of 3% sodium chloride. Your stock solution has a concentration of 14.6% sodium chloride. How many mL of stock solution will you need and how much sterile water will you need to add?

3) You are instructed to make 240 mL of a 0.45% solution. You have a 100% stock solution. How much of the stock solution will you use, and how much diluent will be needed?

4) Prepare 3 mL of a 1% phenobarbital solution from a 6.5% stock solution. How much stock solution and how much diluent are needed to make the 1% solution?

1) 50 cc of stock solution; 950 cc of solvent 2) 0.62 mL of stock solution; 2.38 mL of sterile water 3) 1.08 mL of stock solution; 238.92 mL of diluent 4) 0.46 mL of stock solution; 2.54 mL of diluent

There will be times when only one of the three methods may be appropriate for solving a particular dilution or alligation, but in this section most of the problems will be written in such a way that any of the three methods (ratio-proportion, dilution formula, or alligation method) will be viable options for solving the problems.

Worksheet 10-1

Name:

Date:

Solve the following dilution problems.

1) 40 cc of a 10% solution are ordered. A 50% stock solution is available. How much stock solution is needed, and how much solvent must be added to prepare the 10% solution?

2) 1000 cc of a 10% solution is ordered. How much of a 25% stock solution is needed to prepare the 10% solution? How much solvent must be added to prepare the 10% solution?

3) 500 mL of a 20% solution is ordered. How much of a 50% stock solution is needed to prepare the 20% solution? How much solvent must be added to prepare the 20% solution?

4) 500 cc of a 2% solution is needed. A 40% stock solution is available. How much stock solution is needed and how much solvent must be added to prepare the 2% solution?

5) 200 cc of an 8% solution is ordered. A 20% stock solution is available. How much stock solution is needed, and how much solvent must be added to prepare the 8% solution?

6) 20 cc of a 10% solution are ordered. A 40% stock solution is available. How much stock solution is needed, and how much solvent must be added to prepare the 10% solution?

7) A physician makes a special request for a 500 mL bag of 3% sodium chloride (hypertonic saline solution). How much 14.6% sodium chloride and how much sterile water for injection will you need to fulfill his request?

8) You receive an order for a 250 mL bag with 20% mannitol. You have 50% stock bottles of mannitol. How many mL of mannitol and how many mL of diluent will you need to make this order?

9) A physician orders 8 fl. oz. of a 1% povidone-iodine wash. You have a 10% povidone-iodine wash in stock. How many mL of stock solution and how many mL of diluent will you need to prepare the physician's order?

10) A physician orders a liter of 0.25% sodium hypochlorite solution (often referred to as half-strength Dakin's Solution). On hand in the pharmacy is a 5.95% stock solution of sodium hypochlorite. How many mL of stock solution and how many mL of diluent will you need to prepare the physician's order?

Problem 11 can only be solved by doing two ratio-proportions.

11) If you mix 100 mL of a 1% solution with 350 mL of a 0.5% solution, what is the percentage strength of the final solution?

Problem 12 can only be solved using the alligation method.

12) You have on hand 70% dextrose stock solution and 40% dextrose stock solution. You are to prepare 1000 mL of 45% dextrose solution. How many mL of each stock solution will you need?

Infusion Rates

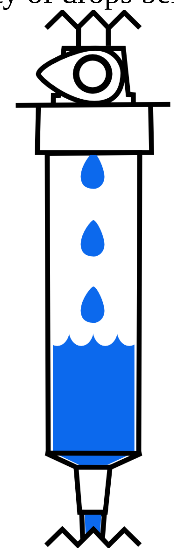
Infusion rates can be requested in many different ways:

- Infuse at 125 mL/hr
- Infuse 1000 mL over 8 hours
- Infuse 10 mg per minute
- Infuse at a drip rate of 32 gtt/min

So when discussing parenterals we can define an infusion rate a a quantity of drug per a quantity of time:

$$\frac{\textit{Quantity of Drug}}{\textit{Time}} = \textit{Infusion Rate}$$

When looking at infusion rates, let's start with drip rates. In many modern settings pumps will be used to infuse IV solutions, but sometimes when there are equipment failures, or times of excessively high census, IVs may need to be timed with an old fashioned drip chamber (also called a venoclysis set). You can use factor label to solve these kinds of problems to find your rate of flow. A drip rate is a specific kind of infusion rate, it is the quantity of drops being infused every minute.



drip chamber pictured above
(*a.k.a., venoclysis set)*

$$\textit{drip rate} = \frac{\textit{quantity of drops}}{\textit{minute}}$$

Something to keep in mind is that whenever measuring a drip rate you must use a whole number of drops as you can not cut a drop in half while it is falling. Therefore, you should use general rounding rules. If something calculated out to be 15.5 drops/minute you would set the drip rate to be 16 drops/minute and if another drip rate worked out to be 33.3 drops/minute you would set the drip rate at 33 drops/minute. Another point to make is that the drip rate should seem reasonable, such as you could have a drip rate of 20 drops/minute but not 2,000 drops per minute as you can't accurately count drops that fast.

In order to solve these problems we also need to introduce a new term, drop factor. A drop factor, simply put, is the number of drops that add up to 1 cc; and it is important to note that various administration sets will produce different sizes of drops. So if a particular administration set had a drop factor of 15, it would mean that you would have to count 15 drops in the drip chamber to equal 1 cc.

$$\boldsymbol{drop\ factor\ of\ 15 = \frac{15\ drops}{1\ cc}}$$

So, let's look at an example problem where we are solving for the drip rate. You will find that dimensional analysis tends to be a useful method for solving these problems.

Example:

A 1000 cc bag of NS is set to run for 5 hours. The infusion set has a drop factor of 20. What is the drip rate?

QUESTION
 What is the drip rate?
DATA
 1000 cc 5 hours drop factor of 20 = 20 gtt/cc
 a potentially useful conversion:
 1 hour/60 minute
MATHEMATICAL METHOD / FORMULA
 dimensional analysis
DO THE MATH

$$\frac{1000\,cc}{5\,hours} \times \frac{20\,gtt}{cc} \times \frac{1\,hour}{60\,minutes} = 66.67\,gtt/minute = \mathbf{67\ \boldsymbol{gtt/minute}}$$

DOES THE ANSWER MAKE SENSE?
 Yes

Notice how we can conveniently divide our amount of solution by the quantity of time it is being infused over and then just start canceling everything out until we arrive at the units we are looking for. Let's use the above example as a template to attempt a practice problem on the next page.

Practice Problem:

An I.V. bottle containing 500 cc is set to run for 3 hours with a drop factor of 25 gtt/cc. What is the drip rate?

QUESTION

DATA

MATHEMATICAL METHOD / FORMULA

DO THE MATH

DOES THE ANSWER MAKE SENSE?

Now, lets do a few more practice problems.

69 gtt/minute

Practice Problems:

1) An IV bottle containing 1000 cc of solution is set to run 15 hours with a drop factor of 30 gtt/cc. What is the drip rate?

2) Calculate the drip rate for an I.V. solution containing 2000 cc of solution with a drop factor of 20 set to run 15 hours.

3) An I.V. solution of 1200 cc is set to run 8 hours with a drop factor of 20. What is the drip rate?

4) An I.V. solution of 1500 cc is set to run 10 hours with a drop factor of 15. What is the drip rate?

1) 33 gtt/minute 2) 44 gtt/minute 3) 50 gtt/minute 4) 38 gtt/minute

Continuing with the concept of infusion rates let's look at some other infusion rate examples:

1) If a 1 liter bag of D5W is run through an IV over eight hours, what is the rate of infusion in mL/hr?

$$\frac{1\,L}{8\,hours}\times\frac{1000\,mL}{1\,L}=\mathbf{125\,mL/hr}$$

2) An order is for Heparin IV to infuse at 1000 units/hr. What will be the flow rate in mL/hr for a 500 mL bag of D5W with 25,000 units of heparin?

$$\frac{1000\,units}{1\,hour}\times\frac{500\,mL}{25{,}000\,units}=\mathbf{20\,mL/hr}$$

3) If a 1 liter bag of D5W is started on a patient at 1400 hours on Tuesday, when will the next bag be needed if it is running at a rate of 50 mL/hr?

$$\frac{1\,hour}{50\,mL}\times\frac{1000\,mL}{1}=20\,hours$$

This means the next bag won't be needed till **1000 on Wednesday**.

Now, lets do a few more practice problems.

Practice Problems:

1) If a 500 mL bag of 0.9% NaCl is run over 8 hours, what is the rate of infusion in mL/hr?

2) A patient is on a heparin drip, 12,500 units in 250 mL of half-normal saline. He is to receive 1500 units per hour. At what rate (mL/hr) should the drug be infused?

3) If a 1 liter bag of NSS is started on a patient at 1200 hours on Tuesday, when will the next bag be needed if it is running at a rate of 100 mL/hr?

1) 62.5 mL/hr 2) 30 mL/hr 3) 2200 on Tuesday

Worksheet 10-2

Name:

Date:

Solve the following problems.

1) An I.V. solution of 1000 cc is set to run over 8 hours with a drop factor of 15, what is the drip rate?

2) The physician orders 3000 mL to be infused over 24 hours and the IV set has a drop factor of 20 gtt/mL, what will the drip rate need to be?

3) A medication order calls for 1 L of D5W to be administered over an 8 hour period. Using an IV administration set that delivers 10 gtt/mL, how many drops/minute should be delivered to the patient?

4) Ten mL of 10% calcium gluconate injection and 10 mL of multivitamin infusion are mixed with 500 mL of D5W. The IV solution is to be infused over 5 hours. If the administration set has a drop factor of 15 what should the drip rate be? (*Hint: don't forget to calculate the total volume that is being infused.*)

5) A 50 mL IVPB bag of ampicillin 500 mg in Normal Saline is to be run in over 20 minutes. What is the infusion rate in mL/hr?

6) What is the flow rate in mL/hr for a TPN containing 500 mL of D10W, 500 mL of 7% amino acids, and 36 mL of micronutrients if it is run in over 16 hours?

7) A 50 mL IVPB contains 500,000 units of penicillin G potassium. The rate of infusion ordered by the physician is 120 mL/hr. How long will the IVPB take to infuse?

8) If a 1 liter bag of D5W is started on a patient at 2200 hours on Tuesday, when will the next bag be needed if it is running at a rate of 200 mL/hr?

9) A 100 mL bag containing 0.5 mg octreotide is to be infused at 50 mcg/hr. How many mL/hr will you need to set the pump to?

10) A patient received a 500 mL whole blood transfusion starting at 2113 at a rate of 180 mL/hr. At what time was the transfusion completed?

Dosages Based on Body Weight

Many drugs need to be calculated based on body weight. Some of the drugs where you will see this most often include:

- chemotherapy,
- steroids,
- antibiotics,
- heparinoids, and
- drugs for pediatric and geriatric patients

If a medication dose is to be based on a body weight it will usually be requested in mg/kg.

If a medication is ordered as 5mg/kg and the patient weighs 100kg you will need 500mg of drug.

$$\frac{100\,kg}{1} \times \frac{5\,mg}{kg} = \mathbf{500\,\mathit{mg}}$$

Example:

A physician orders cyclophosphamide to be given 5 mg/kg qid in 50mL D5W. The patient weighs 132 pounds. If the concentration of the drug available is 500 mg/10mL, how many mL should be added to each bag?

QUESTION

How many mL should be added to each bag?

DATA

5 mg/kg   qid   50 mL of D5W   132 lbs   500 mg/10 mL

a potentially useful conversion:

1 kg/2.2 lbs

MATHEMATICAL METHOD / FORMULA

dimensional analysis

DO THE MATH

$$\frac{132\,lbs}{1} \times \frac{1\,kg}{2.2\,lbs} \times \frac{5\,mg}{kg} \times \frac{10\,mL}{500\,mg} = \mathbf{6\,\mathit{mL}}$$

DOES THE ANSWER MAKE SENSE?

Yes

Notice that there was a lot of unnecessary information in the problem, and that you needed to use a conversion to solve the problem.

Sometimes you will need to incorporate additional units (such as time) into weight based dosage calculations. Let's look at an example of this.

Example:

You are asked to set the infusion rate for a patient's Remodulin, which is being infused via a CAD pump? The physician ordered 104 ng/kg/min. You pull up the patient's profile and verify the troprostenil cassette with 20 mg of troprostenil and 98 mL of NS has a total volume of 100 mL, and you confirm the patients weight of 58 kg that you have on file is correct. How many mL/day will you need to set this pump to?

QUESTION

How many mL/day will you need to set this pump to?

DATA

104 ng/kg/min 20 mg 98 mL NS 100 mL total volume 58 kg

a potentially useful conversion:

1 mcg/1000 ng 1 mg/1000 mcg 60 min/hr 24 hr/day

MATHEMATICAL METHOD / FORMULA

dimensional analysis

DO THE MATH

$$\frac{104\ ng}{kg\ min} \times \frac{58\ kg}{1} \times \frac{60\ min}{hr} \times \frac{24\ hr}{day} \times \frac{100\ mL}{20\ mg} \times \frac{1\ mg}{1000\ mcg} \times \frac{1\ mcg}{1000\ ng} = \mathbf{43.4\ mL/\ day}$$

DOES THE ANSWER MAKE SENSE?

Yes

Notice that minutes from *104 ng/kg/min* were kept with the kg for mathematical purposes. Often, when given a value with multiple '/' the unit after the *kg* will be kept with the *unit of time*. Besides *minutes*, you will also see *hours*, *days*, and *doses* kept with the *kg*.

Let's do a few practice problems.

Practice Problems:

To do these next four problems let's create a scenario where the 165 pound author of this textbook is in a terrible car accident and requires the spinal cord protocol for two methylprednisolone infusions.

1) First, you need to make a bolus dose of 30 mg/kg in 50 mL of NS. How many mg of methylprednisolone will you need to make the bolus dose? (The bolus dose will be infused over 1 hour)

2) If methylprednisolone comes in a double chamber vial with a concentration of 1 g/8 mL, how many mL will you need to add to the 50 mL bag of NS?

3) After the bolus dose is infused, your instructor will need a continuous infusion of methylprednisolone at a rate of 5.4 mg/kg/hr for 23 hours. How many mg of methylprednisolone will you need to make the continuous infusion?

4) The continuous infusion is to be administered with normal saline as the diluent. If the final bag has to have an exact volume of 1000 mL, how many mL methylprednisolone will be needed since it comes in a double chamber vial with a concentration of 1 g/8 mL and how many mL of NS will be needed?

1) 2,250 mg 2) 18 mL 3) 9,315 mg 4) 74.5 mL of methylprednisolone and 925.5 mL of normal saline

Worksheet 10-3

Name:

Date:

Solve the following problems.

1) Ceftazidime is ordered for a 55 pound pediatric patient at a dosage of 150 mg/kg/day to be infused over 24 hours. The drug when reconstituted has a concentration of 100 mg/mL. How many mL of the reconstituted solution will be required?

2) Succinylcholine is available in a concentration of 20 mg/ml in a 10 mL vial. The order reads 40 mcg/kg IV push ever 5 to 10 minutes as a maintenance dose for a patient that weighs 198 lbs. How many ml will the CRNA give IV push for each dose?

3) A patient, weighing 165 lbs, is ordered phenobarbital 5 mg/kg at bedtime. The phenobarbital is available in a 1 mL vial with a concentration of 65 mg/mL. How many mL will the patient need for this dose.

4) Gentamycin is ordered 5 mg/kg for a patient who weighs 220 pounds. Gentamycin is available in a 20 mL MDV with a concentration of 40 mg/mL. How many mL of Gentamycin should the patient receive?

5) The dose of vincristine, based on the patient's body weight, is 25 mcg/kg. The drug is available as 500 mcg/mL. The patient weighs 143 pounds. How many mL are used for a dose?

6) A 209 pound patient with an acute spinal cord injury is ordered a methylprednisolone bolus and drip.

   a) The bolus dose is 30 mg/kg of body weight in 50 ml of normal saline. How many milligrams of methylprednisolone will the patient receive in their bolus?

   b) The continuous infusion is 5.4 mg/kg/hour for 23 hours in normal saline with a total volume of 1000 ml. How many milligrams of methylprednisolone will the patient receive in their continuous infusion?

7) A physician writes for a 154 pound patient to receive a cyclophosphamide induction dose of 40 mg/kg equally divided into two doses. After that the patient is to receive maintenance dose of 10 mg/kg every seven days.

   a) How many mg of cyclophosphamide will the patient receive for each of their induction doses?

   b) How many mg of cyclophosphamide will the patient receive for each of their maintenance doses?

8) A two day old 5 pound 6 ounce neonate with a severe infection is ordered a continuous infusion of penicillin g potassium at a rate of 4,000 units/kg/hr. The nursing unit wants to hang a new bag every 12 hours, how many units of penicillin g potassium should be in each bag?

Dosage Calculations Based on Body Surface Area

The body surface area (BSA) is the measured or calculated surface of a human body, and it is measured in square meters (m^2). For many clinical purposes BSA is a better indicator of metabolic mass than body weight because it is less affected by abnormal adipose mass.

Examples of uses for BSA include:

- renal clearance is usually divided by the BSA to gain an appreciation of the true required glomelular filtration rate (GFR),
- chemotherapy is often dosed according to the patient's BSA, and
- glucocorticoid dosing can also be expressed in terms of BSA for calculating maintenance doses or to compare high dose use with maintenance requirement.

There are number of ways to calculate BSA:

such as various formulas:

- Dubois & Dubois; BSA (m^2) = 0.007184 x weight in $kg^{0.425}$ x height in $cm^{0.725}$
- Mosteller; BSA (m^2) = [(weight in kg x height in cm)/3600]$^{0.5}$
- Haycock; BSA (m^2) = 0.024265 x weight in $kg^{0.5378}$ x height in $cm^{0.3964}$

using a nomogram (a chart based method pictured on the next page),
or some more peculiar ways:

- geometry,
- thoroughly detailed 3D scans,
- even wrapping patients in aluminum foil.

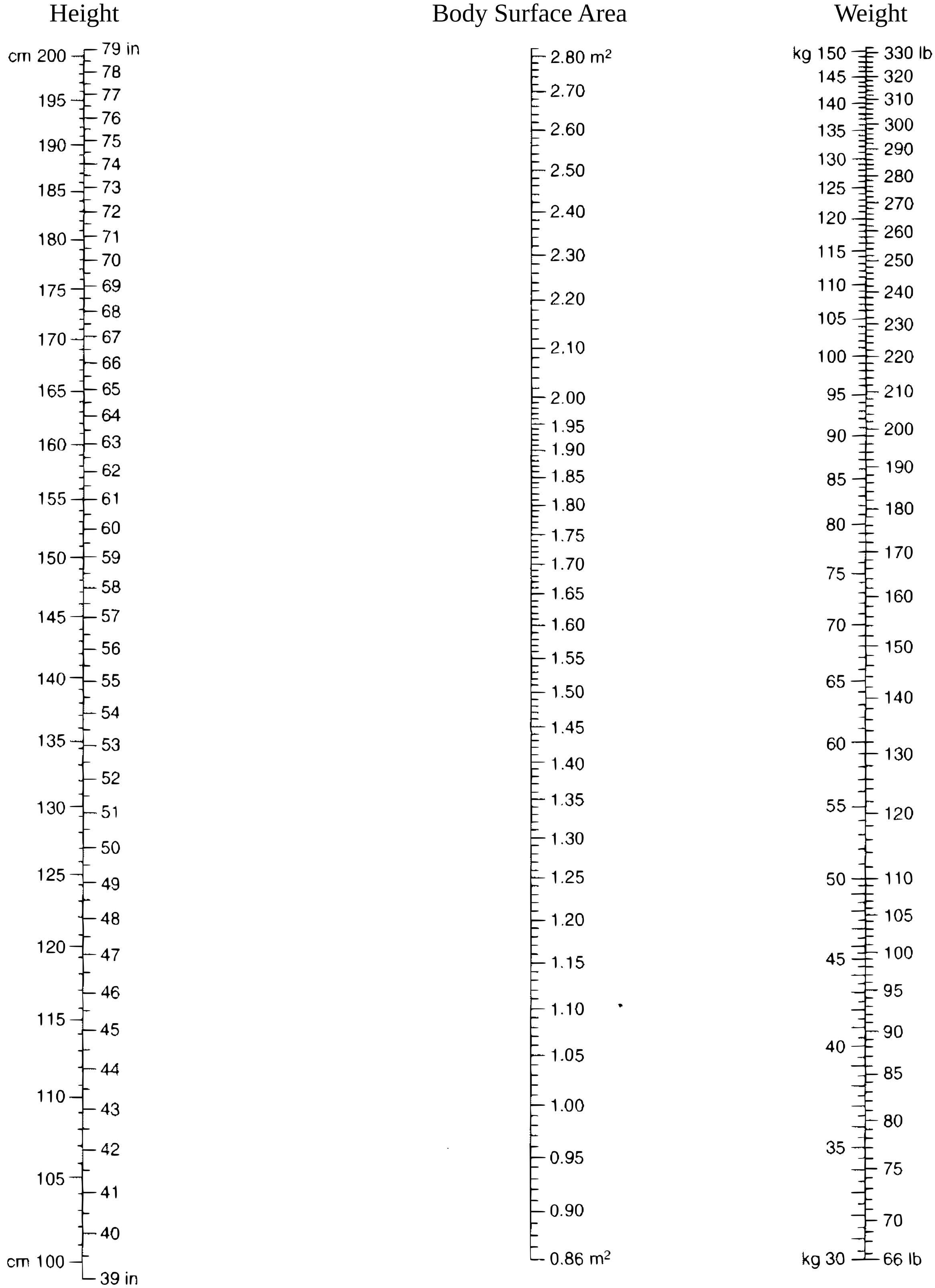
A nomogram is a common method and is the way we will concentrate on. A nomogram pictured on the next page has three columns:

- height based in both centimeters and inches,
- body surface area in m^2, and
- weight based in both kilograms and pounds.

How does someone use a nomogram?

The height and the weight of the patient are found on the nomogram and then a straight line is drawn connecting the two values. The BSA for that patient is found where the line intersects the BSA column. As an example find 5' 3" (63 inches) and 110 pounds. If you draw a line connecting the two values you should get a BSA of 1.5 m^2.

Nomogram for Determination of Body Surface Area from Height and Weight



Nomogram is based on the Dubois & Dubois formula.
BSA (m^2) = 0.007184 x weight in $kg^{0.425}$ x height in $cm^{0.725}$

Let's look at an example problem:

Example:

QUESTION

A physician orders a bolus dose of doxorubicin for a 6'1” patient that weighs 165 lbs. The drug dose is 75 mg/m^2. What is the bolus dose in mg?

DATA

6'1”

165 lbs

75 mg/m^2

FORMULA/METHOD

Use a nomogram to find BSA then use factor label to do the calculation.

MATH

BSA = 1.98 m^2

$$\frac{1.98\,m^2}{1} \times \frac{75\,mg}{m^2} = \mathbf{148.5\,\mathit{mg}}$$

DOES THE ANSWER MAKE SENSE?

Yes

Now you should attempt a practice problem.

Practice Problem:

1) If the dose of Taxol (paclitaxel) in the treatment of metastatic ovarian cancer is 135 mg/m^2, what would be the dose for a patient 155 cm tall and weighing 53 kg?

1) 202.5 mg

Worksheet 10-4

Name:

Date:

Solve the following problems.

1) Leukine (a drug used to increase neutrophils in patients receiving chemotherapy for Leukemia) is to be administered by IV at 250 mcg/m²/day for 21 days. How many mcg will a patient receive each day if they are 5'10” and weigh 156 lbs.

2) A patient weighs 176 lbs and is 71 inches tall. Their physician orders doxorubicin (an antineoplastic agent) 25 mg/m² in 50 ml of NS. The doxorubicin is supplied as 50 mg vials with a concentration of 4 mg/ml.

    a) How many mg will the patient need?

    b) How many ml of doxorubicin will you add to the NS bag?

    c) How many vials of doxorubicin will you need to gather to make this IV?

3) A 1 gram vial of methotrexate when reconstituted with Normal Saline has a concentration of 50 mg/ml. A patient with a BSA of 1.60 m² is ordered 6 g/m² by IV infusion every week. How many ml of the reconstituted solution will the patient receive?

4) A physician orders bleomycin in a dose of 20 units/m² twice weekly. The reconstituted bleomycin has a concentration of 30 units/ml. The patient is 5'3” tall and weighs 110 lbs. How many ml will the patient need for a single dose.

5) An order is received in the pharmacy for 5-FU IV for a 5'6" patient weighing 125 lbs. The 5-FU solution is available in a 50mg/ml concentration. The dosage schedule is as follows:

Initial dose: 400 $mg/m^2/day$ for 5 days IV push
How many grams of 5-FU has the patient received after the first 5 days?

Pediatric Dosing

We will be reviewing a multitude of ways to calculate a pediatric patient's medication dose.

Some pediatric doses may simply be calculated based on **body weight** or **body surface area** (BSA). Those kinds of problems are fairly straight forward in problems like:

> A neonate weighing 4000 g is ordered tobramycin q8h at 2.5 mg/kg/dose, how many mg of tobramycin should the neonate receive?
>
> $$\frac{4000\,g}{1}\times\frac{1\,kg}{1000\,g}\times\frac{2.5\,mg}{kg/dose}=10\,mg/dose$$
>
> A medication is dosed as 100 mg/m^2, what would be the dose if a pediatric patient had a BSA of 0.87 m^2?
>
> $$\frac{0.87\,m^2}{1}\times\frac{100\,mg}{m^2}=87\,mg$$

But, both of the aforementioned ways treat pediatric dosing as if children were simply miniature adults. We will take some time and look at other ways to calculate pediatric doses.

Clark's Rule
(based on weight for children ages 2-17)

$$\frac{Weight\,(in\ pounds)\times Adult\ dose}{150\,(average\ weight\ of\ adult\ in\ pounds)}=Dose\ for\ child$$

Young's Rule
(based on age for all children)

$$\frac{Age}{Age+12}\times Adult\,dose=Dose\ for\ child$$

Fried's rule
(based on age up to 24 months)

$$\frac{Age\,(in\,months)\times Adult\,dose}{150\,months}=Dose\ for\ infant$$

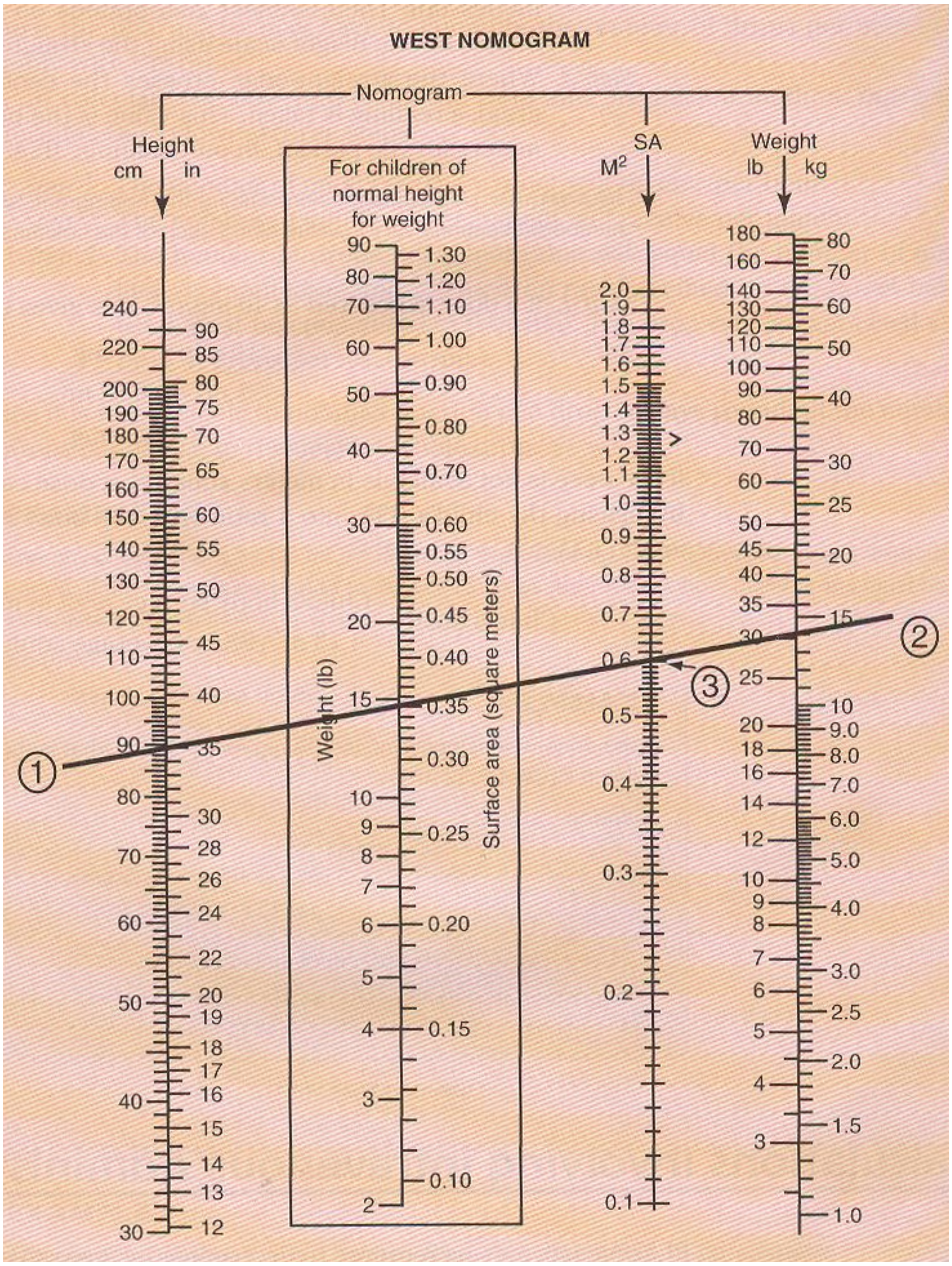
Cowling's rule

$$\frac{Age\ at\ next\ birthday\,(in\ years)\times Adult\ dose}{24\ years}=Dose\ for\,child$$

Pediatric nomogram, when adult dose is known
(based on BSA for all children while treating the average adult BSA as 1.73 m^2)

$$\frac{Child's\ BSA}{1.73\,m^2} \times Adult\ dose = Dose\ \ for\ child$$

You will need this nomogram to help you solve the problems on the next page.



In the example above we have a (1) 90 cm tall patient that weighs (2) 30 lbs, and their BSA is (3) 0.6 m^2.

Worksheet 10-5

Name:

Date:

Solve the following questions.

1) A newborn (we'll count them as 1 month for calculation purposes) weighs 5.6 lbs, has a height of 17 inches and is ordered gentamicin to treat a meningitis infection they've contracted.

    a) If based strictly on body weight, premature and full-term neonates should receive gentamicin 2.5 mg/kg every 12 hours. Based only on body weight how much gentamicin should the neonate receive each day?

    b) An average adult dose of gentamicin for treating meningitis is 350 mg/day given in three equally divided doses. Based on this information, what should this neonates daily gentamicin be based on Cowling's rule ?

    c) Using the above information, what would be the average daily quantity of gentamicin be based on Fried's rule?

    d) Using the above information, what would be the average daily quantity of gentamicin be based on a pediatric nomogram, when the adult dose is known?

2) Calculate the dose for a child 4 years of age, 39 in. in height, and weighing 32 lbs for a drug with an adult dose of 100 mg, using the following:

    a) Young's rule

    b) Cowling's rule

    c) Clark's rule

d) Pediatric nomogram when the adult dose is known

3) The daily dose of diphenhydramine HCl for a child may be determined on the basis of 5 mg/kg of body weight or on the basis of 150 mg/m^2. Calculate the dose on each basis for a 4 year old child weighing 55 lbs and measuring 3' 4” in height.

a) Based on weight?

b) Based on BSA?

An average adult dose of injectable diphenhydramine is 100 mg per day (often given in 2 divided doses). Based on this how much diphenhydramine should they receive according to Clark's rule and Young's rule?

c) Clark's rule

d) Young's rule

Worksheet 10-6

Name:

Date:

Solve the following problems.

1) How many milliliters of a 14.6% stock solution of sodium chloride would be required to make a 500 mL bag of 3% sodium chloride. How many mL of sterile water for injection (SWFI) will be required to make this bag?

2) How many mL of a 2% stock solution should be used to prepare 1 L of a 0.025% solution?

3) How many mL of 95% ethyl alcohol and how many mL of NS will be needed to prepare 2.5 L of 50% Ethyl Alcohol? (*NS will be used as the diluent in this problem*)

4) How many mL of a 10% cyclosporine solution would be required to make 1 fl. oz. of a 2% cyclosporine solution?

5) How many mL of 5% potassium permanganate stock solution and how many mL of diluent will be required to make 180 mL of 0.5% potassium permanganate solution?

6) A medication order calls for a 1 liter TPN to be infused over 6 hours. If the infusion set has a drop factor of 25, what drip rate should the drop chamber be set to (*in gtt/min*)?

7) A medication order calls for a 500 mL bag with 20 mEq of potassium chloride to be infused over 4 hours. What will be the infusion rate in mL per hour?

8) If the IV bag in the previous problem needed to be infused using a venoclysis set calibrated to 12 gtt/mL, what will be the drip rate?

9) If a 50 mL IVPB containing 1 gram of cefazolin is being infused at 200 mL/hr, how long will it take to infuse?

10) If a 1,500 mL IV solution is being infused over 24 hours, at what drip rate will you set the drip chamber if it has a drop factor of 25?

11) The daily dose of a drug is 12 mcg/kg of body weight. How many mg should be administered each day to a woman who weighs 55 kg?

12) If the dose of a drug is 0.25 mg/kg, how many milligrams should be administered to a man weighing 175 lbs?

13) The usual dose of lucanthone hydrochloride is 5 mg/kg/dose given t.i.d. for one week. How many g would be required to cover an entire week for a youth weighing 120 lbs?

14) Ceftazidime is ordered for a 66 pound pediatric patient at a dosage of 150 mg/kg/day to be infused over 24 hours. The drug when reconstituted has a concentration of 100 mg/mL. How many mL of the reconstituted solution will be required?

15) Gentamycin is ordered 5 mg/kg for a patient who weighs 165 pounds. Gentamycin is available in a 20 mL MDV with a concentration of 40 mg/mL. How many mL of Gentamycin should the

patient receive?

16) A physician orders a bolus dose of doxorubicin for a patient with a BSA of 1.56 m^2. The drug dose is 75 mg/m^2. What is the bolus dose in mg?

17) A patient weighs 117 lbs and is 5'2” tall. Using the nomogram on page 260 to determine their BSA, find the patient's dose of vincristine if the physician ordered it as 10 mg/m^2.

18) 5FU 400 mg/m^2 as IVP is ordered for a patient (73” and 165 lbs). 5FU is available as 50 mg/mL in 10 mL vials.

    a) What is the patient's dose in mg?

    b) How many mL will the patient receive?

    c) How many vials will be needed to prepare this dose?

19) A 1 gram vial of methotrexate when reconstituted with Normal Saline has a concentration of 50 mg/ml. A patient with a BSA of 1.60 m^2 is ordered 6 g/m^2 by IV infusion every week. How many mL of the reconstituted solution will the patient receive?

20) Robaxin injection is available in a 10 cc vial and has a concentration of 100 mg/mL. If a 98 lb, 4'10” tall patient receives an order for 500 mg/m^2, how many milligrams should the patient receive?

21) Is Young's rule or Clark's rule based on age?

Use the following information to solve problems 22-26:

A 9 year old child that is 4'2" and weighs 50 lbs is ordered diphenhydramine. The daily dose of diphenhydramine HCl for a child may be determined on the basis of 5 mg/kg/day of body weight or on the basis of 150 mg/m^2/day. Also, an average adult dose of injectable diphenhydramine is 100 mg per day (often given in 2 divided doses).

22) Based strictly on body weight, what should she receive daily?

23) Based strictly on BSA, what should she receive daily?

24) Using Clark's rule, what should she receive daily?

25) Using Young's rule, what should she receive daily?

26) Using Cowling's rule, what should she receive daily?

UNIT 3

COMMUNITY PHARMACY MATH

What does community pharmacy math consist of?

Despite popular belief, community pharmacy requires pharmacy technicians to do significantly more than just counting by fives. Pharmacy technicians need to translate the physician's prescribed quantity into the quantity that an insurance provider will cover, extemporaneous compounding requires a significant quantity of mathematical manipulations, thechnicians often need to maintain price databases and work with insurance pricing formulas, they need to maintain inventories, and streamline cash flow. A pharmacy technician can carry a lot of responsibility in today's community pharmacy and the goal of this unit is to provide a solid foundation for those skills.

What are the specific learning objectives in this unit?

- Days' supply,
- Adjusting refills and short-fills,
- Extemporaneous compounding,
- Billing for extemporaneous compounds,
- Calculating usual and customary prices,
- Common insurance reimbursement formulas,
- Gross profits and net profits,
- Medication inventory control,
- Medication storage,
- Daily cash reports,
- Calculating professional/dispensing fees, and
- Depreciating capitol expenditures.

CHAPTER 11

DAYS' SUPPLY

"They should really pay someone to do these calculations."
"True enough, but the person they're supposed to pay to do these calculations will be you."

--Classroom discussion between an instructor and one of his students.

In this chapter you'll be learning how to do the following calculations:

- Days' Supply
- Adjusting Refills, and
- Short-fills

Days' Supply

Physicians often write their prescriptions with various time frames in mind. Common prescribing time frames include 5 days, 1 week, 10 days, 2 weeks, 1 month, 50 days, 90 days or even 100 days. Physicians often just include a quantity of medication to dispense and directions on how frequently to use it. They usually don't include the actual intended time frame. As a pharmacy technician you will need to translate that into *Days' Supply*.

In this chapter *Days' Supply* is referring to how long a prescription order will last. Often it is not as simple as giving a tablet once a day for 30 days; you will frequently need to do calculations for oral liquid medications, injectables, nasal sprays, and inhalers, and make estimations for PRN's, ointments and creams, lotions, eye and ear drops, and ophthalmic ointments.

Days' Supply for tablets, capsules, and liquid medications

The first things to look at are tablets, capsules, and liquid medications both because they're the most common, and they're the most straight-forward to perform calculations with. Without wanting to over explain this process let's look at some example problems.

Examples:

1) A prescription is written for amoxicillin 250 mg capsules #30 i cap t.i.d. What is the days' supply?

$$\frac{30\,caps}{1}\times\frac{1\,dose}{1\,cap}\times\frac{day}{3\,doses}=\mathbf{10\ \mathit{days}}$$

2) A prescription is written for amoxicillin 250 mg/5 mL 150 mL i tsp tid. What is the days' supply?

$$\frac{150\,mL}{1} \times \frac{tsp}{5\,mL} \times \frac{dose}{1\,tsp} \times \frac{day}{3\,doses} = \mathbf{10\,days}$$

Now that you've seen a couple of examples, solve the following practice problems.

Practice Problems

1) A prescription is written for cephalexin 250 mg #28 i cap q6h. What is the days' supply?

2) A prescription is written for cephalexin 250 mg/5 mL 100 mL i tsp q6h. What is the days' supply?

1) 7 days 2) 5 days

The item to be careful about when it comes to tablets, capsules, and liquid medications are PRN medications, especially ones with variable doses and variable frequencies. In general, you should perform the calculations using the shortest interval with the highest dose. This will provide the shortest span of time in which they could use all the medication dispensed. Let's look at an example problem.

Example:

A prescription is written for Ultram 50 mg #60 i-ii tabs po q4-6h prn pain. What is the days' supply?

$$\frac{60\,tabs}{1} \times \frac{1\,dose}{2\,tabs} \times \frac{4\,hours}{1\,dose} \times \frac{1\,day}{24\,hours} = \mathbf{5\ days}$$

Conveniently, this example came out to an even number of days. Sometimes your calculations will come out to a decimal number of days and you may need to use some professional judgment to determine whether to drop the decimal or round up. If you are not sure, it is usually better to drop the decimal. Attempt the following practice problem working with a PRN medication.

Practice Problem

1) A prescription is written for hydromorphone 2 mg #30 i-ii tabs po q3-4h prn pain. What is the days' supply?

1) Eventhough the answer comes out to 1.875 days, I would expect the medication to last 2 days based on my own professional judgment

Days' Supply for insulins

Most insulins are called U-100 insulins meaning that each mL contains 100 units. Also most insulin vials are either 10 mL vials or boxes of 5 syringes containing 3 mL in each syringe for a total of 15 mL in a box. A 10 mL vial of U-100 strength insulin would contain 1000 units and a 15 mL box of syringes with U-100 insulin would contain 1500 units. This is good information to help you make quick work of the vast majority of insulin calculations. With insulin problems, whenever you come out with a decimal number of days you should always just drop the decimal as you never want a diabetic patient to run out of their insulin. The last thing to keep in mind with respect to insulin vials is that they should not be kept for longer than 30 days after it has been opened. Determining how long a box will last is different since each syringe is only good for 30 days after it is started but there are five syringes. Let's look at an example problem with insulin.

Example:

A prescription is written for Humulin N U-100 insulin 10 mL 35 units SC qd. What is the days' supply?

$\frac{10\,mL}{1}\times\frac{100\,units}{mL}\times\frac{1\,day}{35\,units}=28.57\,days$ which means **28 days** either because you dropped the decimal.

Let's look at some practice problems.

Practice Problems

When solving the next two problems, treat them as 10 mL vials with a U-100 concentration.

1) A prescription is written for Humulin R 1 vial 8 units SQ before breakfast, 8 units before lunch, and 11 units before supper. What is the days' supply?

2) A prescription is written for Novolin N prefilled syringes #1 box Sig: 22 units SC q am and 24 units q pm. What is the days' supply?

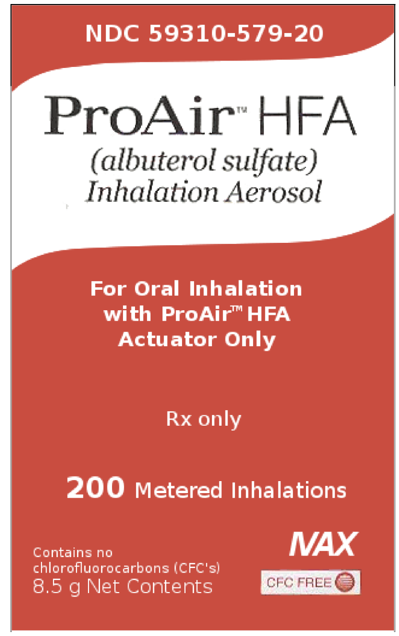
1) 30 days 2) 32 days

Days' Supply for inhalers and sprays

Whenever you see instructions on a product for a patient to receive a particular number of sprays or puffs of a given drug, you should stop and actually look at the packaging to discover how many metered inhalations or how many metered sprays are actually in the container. Lets look at an example problem accompanied by a rendering of what the front of the container actually looks like.

Example:

A prescription is written for ProAir HFA 8.5 g inhaler 2 puffs q.i.d. What is the days' supply? (*Hint: In order to solve this, you will need to look at the box pictured on the right.*)



After looking at the box, you should realize that this particular package contains 200 *puffs* (metered doses), and you now have enough information to solve this problem

$$\frac{200\,puffs}{1} \times \frac{1\,dose}{2\,puffs} \times \frac{day}{4\,doses} = \mathbf{25\,days}$$

Now that we've looked at an example, attempt the following practice problem.

Practice Problem

1) A prescription is written for Flonase 16 gm 2 sprays per nare qd for a total daily dose of 200 µg. What is the days' supply?

Days' Supply for ointments and creams

Calculations for creams and ointments are a little more tricky because you usually don't know exactly how much will be used in a dose. The amount will depend on how large of an area is affected and how many areas it needs to be applied to. The amount applied usually does not exceed 500 mg to 1 g, so unless you know otherwise, use 1 gram for the dose for each affected area.

Example:

A prescription is written for Mycolog II cream 15 g apply sparingly bid. What is the days' supply?

$$\frac{15\,g}{1}\times\frac{dose}{1\,g}\times\frac{1\,day}{2\,doses}=7.5\,days\left(drop\,the\,decimal\,so\,it\,equals\,\mathbf{7\ days}\right)$$

Practice Problem

1) A prescription is written for Nizoral cream 15 gm apply to the affected and surrounding areas once daily. What is the days' supply?

2) A prescription is written for Bactroban ung 15 gm apply a small amount to the affected area tid. What is the days' supply?

1) 7 days   2) 10 days (since the problem said *small amount* each dose can be treated as 500 mg)

Days' Supply for ophthalmic and otic preparations

To solve this type of problem, you need to know a conversion factor from milliliters to drops. Unfortunately (or fortunately since most students despise the apothecary system), you *cannot* use the conversion from the apothecary system. The USP[1] in chapter 1101 has written regulations on standardizations of medicine droppers. Unless your specific medication notes something different, a dropper should be calibrated by the manufacturer to deliver between 18 and 22 drops per milliliter. Most people just split the difference and estimate **20 gtt/mL**. With that in mind, we can get a good *estimate* on how long the medication should last.

Another odd thing to keep track of when dealing with eye preparations are ophthalmic ointments. An ophthalmic ointment is typically applied as a very thin strip. Treat each dose of an ophthalmic ointment as 100 mg. Let's look at some example problems with respect to ophthalmic and otic preparations.

1 This important standards is contained in a combined publication that is recognized as the official compendium, the United States Pharmacopeia (USP) and the National Formulary (NF)

Examples:

1) A prescription is written for timolol 0.25% Opth. Sol. 5 mL i gtt ou q.d. What is the days' supply?

$$\frac{5\,mL}{1} \times \frac{20\,gtt}{1\,mL} \times \frac{1\,dose}{2\,gtt} \times \frac{1\,day}{1\,dose} = \mathbf{50\ days}$$

2) A prescription is written for Neosporin Opth. ung 3.5 g apply a thin strip ou q3-4h. What is the days' supply?

$$\frac{3.5\,g}{1} \times \frac{1000\,mg}{1\,g} \times \frac{1\,dose}{200\,mg} \times \frac{3\,hours}{1\,dose} \times \frac{1\,day}{24\,hours} = \mathbf{2\ days}\ after\ you\ drop\ the\ decimal$$

Notice that both example problems were written for each eye, requiring the quantity of medication to be doubled in both cases.

Now, you should try a couple of practice problems.

Practice Problems

1) A prescription is written for Tobradex Opth. Susp. 5 ml 1-2 gtt os q4-6h. What is the days' supply?

2) A prescription is written for tobramycin Opth. Oint. 3.5 g apply od bid. What is the days' supply?

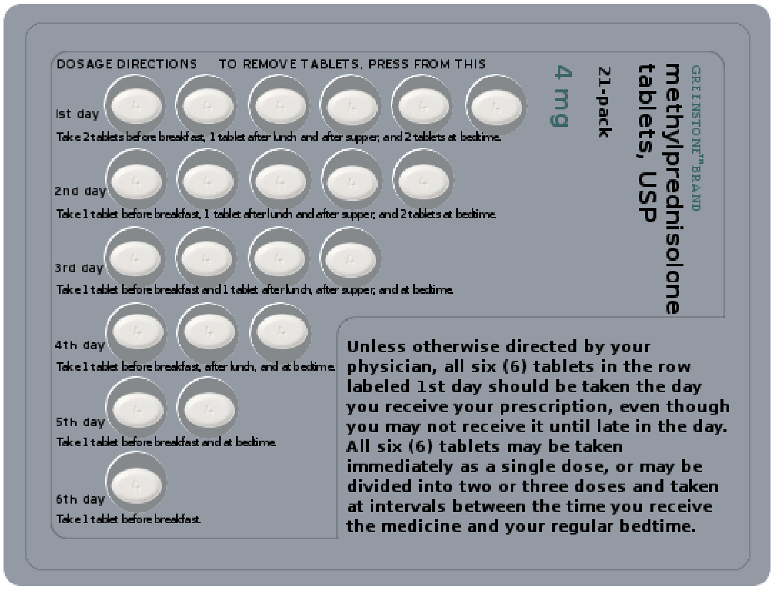
1) 8 days 2) 17 days

Days' Supply for various packs

Many medications (such as birth control, steroids, and antibiotics) may come in packs with very explicit instructions for use. These instructions often explain exactly how many days they will last and require no additional calculations. You must simply read the instructions on the package to know how long it will last. Let's look at an example problem on the next page.

Example:

1) A prescription is written for methylprednisolone 4 mg tabs taper pack use as directed. What is the days' supply?



It requires nothing more than observation to realize it will last **6 *days***.

Days' Supply for other miscellaneous medications

Unfortunately, there are many medications that have there own specific rules, such as estrogens given for hormone replacement therapy are cycled on and off. Either days 1-25 on, followed by five days off or it may be cycled for three weeks on, followed by one week off. Items like a vial of nitroglycerin sublingual tablets or spray are expected to last a patient 30 days. Items, like vaginal preparations, you'll need to know how much is delivered via the applicator. Lotions can be a challenge depending on their viscosity. A good rule of thumb for a lotion is to expect 2 mL to be used on each affected area per application. As you can tell, there are many individual little rules to try and work with when estimating how long a particular medication will last.

Worksheet 11-1

Name:

Date:

Solve how many days each of the following prescriptions will last.

1) Advair 250/50 #1 1 puff q12h (*Hint: use the image on the right hand side of the page.*)

2) Atrovent inhalation solution 0.02% 2.5 ml Disp 25 vials Sig: 1 vial per neb q.i.d.

3) Rx Augmentin 400 mg-57 mg/5 mL Disp. 100 mL Sig: i tsp po q12h till all of medicine is gone

4) Axid 150 mg #60 i cap po bid before meals

5) Rx Betoptic 0.5% Disp 10 mL Sig: 2 gtt OS b.i.d.

6) Cortisporin Otic 10 mL iv gtt ad qid

7) Crestor 10 mg #90 1 tab po qd

8) DexPak 13 day TaperPak take u.d.

9) Rx Duragesic 50 mcg/hr Disp: 10 patches Sig 1 patch q72h

10) E.E.S. 400 mg #42 i tab po tid c meals

11) Fentora 100 mcg #28 i tablet in buccal cavity q4-6h prn breakthrough pain

12) Fosamax 70 mg #4 i tab po q week

13) Rx Glucotrol 10 mg Disp: 120 tabs Sig: 20 mg po bid

14) Rx Humulin R 10 mL Disp: 1vial Sig: 11 units SQ before breakfast, 11 units before lunch, and 14 units before supper.

15) Ibuprofen 400 mg #60 i tab po q6-8h prn pain

16) Januvia 100 mg #30 1 tab po qd

17) ketorolac 10 mg #20 1 tab po q4-6h prn pain. Not to exceed 40 mg/day.

18) Lac Hydrin 12% Lotion 150 mL aa bid rub in thoroughly. (*Hint: Use 1-2 mL for amount used per application unless you know a larger area is being treated; let's treat the patient as having 2 affected areas.*)

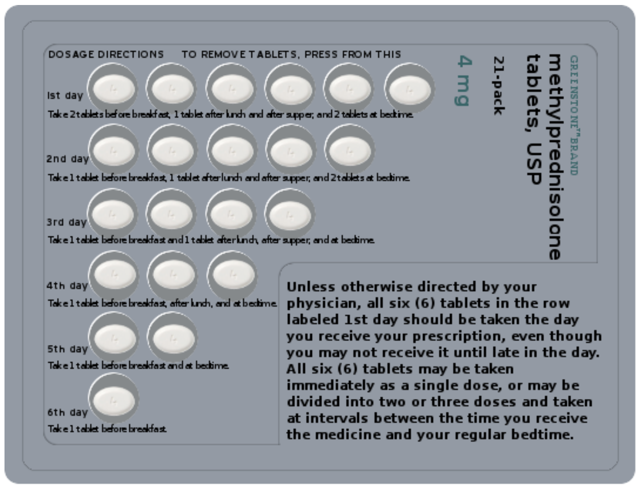
19) Lantus Insulin 10 mL #1 vial 40 units SQ q a.m.

20) Levothyroxine 100 mcg #100 i tab po qd

21) Rx Lexapro 20 mg Disp: 60 Sig: i cap po qd

22) Lipitor 20 mg #30 i tab po qd

23) methylprednisolone 4 mg tabs taper pack use ut dict (*Hint: Use the image below to determine how long it will last.*)



24) metoprolol tartrate 50 mg #180 i tab po b.i.d.

25) Rx MetroGel-Vaginal 0.75% Disp: 70 g tube Sig: 1 applicatorful pv bid ×5 days (*Hint: 1 applicator delivers 5 g of gel containing 37.5 mg of metronidazole.*)

26) Neosporin ophthalmic ointment 3.5 g apply thin strip od t.i.d ×10 days

27) Nexium 20 mg #28 i cap po bid

28) NitroDur 0.4 mg #30 i patch on 8 a.m., off 10 p.m. qd

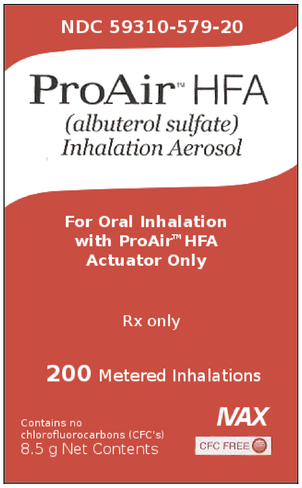
29) Nitrostat 0.4 mg #100 i tab SL q5min prn chest pain. May repeat up to 3×.

30) ofloxacin otic solution 10 mL 10 gtt as bid ×10 days

31) Rx Patanase Disp: 1 bottle Sig: ii sprays each nare bid (*Hint: a bottle contains 240 metered sprays.*)

32) Plavix 75 mg #60 1 tab po qd

33) ProAir HFA i-ii puffs q4-6h prn relief of asthma symptoms.



34) ProTopic 0.1% 100 g apply minimum amount to aa bid

35) Premarin 0.625 mg #63 i tab po qd cyclically (3 weeks on, 1 week off)

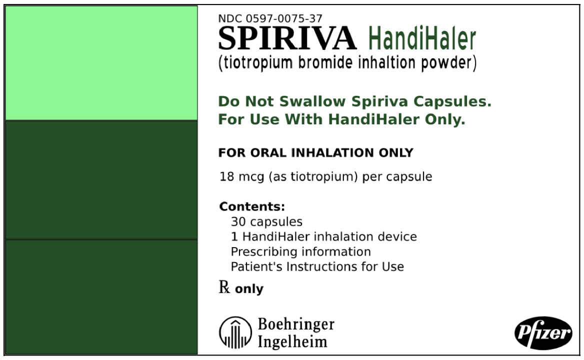
36) quinine 324 mg #42 2 caps po q8h

37) Requip 1 mg #270 1 tab po tid

38) simvastatin 20 mg #100 i tab po qd

39) Singulair 10 mg #30 i tab po q p.m.

40) Spiriva #30 inhale contents of 1 cap qd using HandiHaler



41) Terazol-7 cream 45 gm Insert 1 applicatorful (5 gm) hs × 7d

42) Rx theophylline elixir 80 mg/Tbs Disp 500 mL Sig: iv tsp po q6h atc

43) TobraDex opth. Susp 5 ml Instill 2 drops into the conjunctival sac os q6h

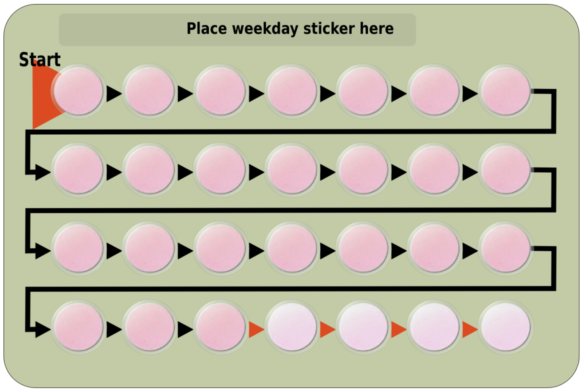
44) Valium 5 mg #180 i tab PO BID PRN anxiety

45) Vicodin #100 1-2 tabs q6h prn pain

46) wellbutrin 100 mg #90 i tab po tid

47) Xanax 0.25 mg #30 one t.i.d. prn

48) Rx Yaz Disp: 1 pack Sig: i tab po qd starting on first day of menstrual cycle (*Hint: look at pack below.*)



49) Z-Pak 500 mg PO on first day of therapy, then 250 mg PO once daily for 4 days. Total cumulative dose 1.5g

50) Zantac 150 mg #60 one b.i.d.

Adjusting Refills and Short-Fills

The amount of medication a pharmacy can dispense to a patient is restricted first, by the prescriber's guidelines and second by the insurer's guidelines. As we've previously stated, physicians tend to prescribe for the following time frames: 5 days, 1 week, 10 days, 2 weeks, 1 month, 50 days, 90 days or even 100 days. Meanwhile, insurances and other third party reimbursement plans tend to bill based on different time frames such as: 14 days, 21 days, 30 days, 32 days, 34 days, 90 days, etc. Calculations are often needed to adjust first the quantity dispensed to comply with the insurer's guidelines, and then the number of refills allowed. Pharmacy technicians often need to accurately estimate how long a medication will last with inadequate guidelines. Estimating days' supply is especially tricky when the dosage form is a lotion, cream, ointment, or inhalant.

When dispensing medications that come in handy convenience packages, such as a methylprednisolone dose-pack, estimate the days' supply when you have the package in your hand so you can visually examine how it is packaged and read from the labeling or package insert how long the contents of the package should last.

Let's look at a couple of example problems.

Examples:

1) A prescription is written for Dyazide #50 i cap p.o. q.d. + 3 refills. The insurance plan has a 30 day supply limitation. How many capsules can be dispensed using the insurance plan guidelines and how many refills are allowed with the adjusted quantity?

   First calculate the total number of capsules allowed by the prescriber:

   $$50\,capsules \times 4\;total\;fills(original\;fill + 3\,refills) = 200\,capsules$$

   Then, using dimensional analysis we can figure out how many capsules will be needed for each fill.

   $$\frac{1\,cap}{dose} \times \frac{1\,dose}{day} \times \frac{30\,days}{fill} = \frac{30\,caps}{fill}$$

   Next, using dimensional analysis we can figure out how many fills from the insurer will be required to dispense the quantity written for by the physician.

   $$\frac{200\,caps}{1} \times \frac{fill}{30\,caps} = 6.666\ldots fills$$

   Therefore, there will be 5 refills after the initial fill is dispensed, but there is still a partial fill left.

   Once again using dimensional analysis we will figure out how many capsules to dispense for the partial fill.

$$200\,capsules - \left(\frac{6\,fills}{1} \times \frac{30\,caps}{fill} \right) = 20\,capsules$$

Now, let's restate everything in short:

We are dispensing **30 caps for our initial fill**.
The patient can have **5 refills** of 30 caps,
and a **partial fill of 20 caps**.

2) A prescription is written for Rx Rondec-DM syrup Disp: 1 pint Sig: tsp i h.s. p.o. + 1 refill. The insurance plan has a 30 day supply limit. How many mL can be dispensed using the insurance plan guidelines and how many refills are allowed with the adjusted quantity?

First, calculate the total volume allowed by the prescriber in milliliters.

$$\frac{1\,pint}{prescriber\ fill} \times \frac{2\,prescriber\ fills}{1} \times \frac{480\,mL}{pint} = 960\,mL$$

Then, using dimensional analysis we can figure out how many milliliters we will be needed for each fill.

$$\frac{1\,tsp}{dose} \times \frac{5\,mL}{tsp} \times \frac{1\,dose}{day} \times \frac{30\,days}{fill} = \frac{150\,mL}{fill}$$

Next, using dimensional analysis we can figure out how many fills from the insurer will be required to dispense the quantity written for by the physician.

$$\frac{960\,mL}{1} \times \frac{fill}{150\,mL} = 6.4\,fills$$

Therefor, there will be 5 refills after the initial fill is dispensed, but there is still a partial fill left.

Once again using dimensional analysis we will figure out how many milliliters to dispense for the partial fill.

$$960\,mL - \left(\frac{6\,fills}{1} \times \frac{150\,mL}{fill} \right) = 60\,mL$$

Now, let's restate everything in short:

We are dispensing **150 milliliters for our initial fill**.
The patient can have **5 refills** of 150 milliliters,

and a **partial fill of 60 milliliters**.

Now let's stop and do a couple of practice problems.

Practice Problems

1) A prescription is written for Crestor 10 mg #100 i tab p.o. q.d. + 1 refill. The insurance plan has a 30 day dispensing limit. How many capsules can be dispensed using the insurance plan guidelines and how many refills are allowed with the adjusted quantity? Also, if there is a partial fill, how many tabs will be dispensed in this partial fill?

2) A prescription is written for Novolin N 10 mL #1 vial 22 units SC q am and 24 units q pm + 3 refills. The insurance plan has a 28 day supply limitation. How many vials can be dispensed using the insurance plan guidelines and how many refills are allowed with the adjusted quantity? Also, if there is a partial fill, how many vials will be dispensed in this partial fill?

1) We are dispensing 30 tabs for our initial fill. The patient can have 5 refills of 30 tabs, and a partial fill of 20 tabs.
2) We are dispensing 2 vials for our initial fill. The patient can have 1 refill of 2 vials, and there are no partial fills.

Worksheet 11-2

Name:

Date:

Appropriately adjust the following prescriptions to comply with the physician's prescribed quantities and the insurance guidelines in each scenario. In the following scenarios, treat each prescription as having a 30 day dispensing limit. Calculate the initially dispensed quantity, the number of refills, and any partial fills.

1) Rx Advair 250/50
   Disp: 1
   Sig: 1 puff q12h

   Refills: 3

2) Rx Atrovent inhalation sol. 0.02%
   Disp: 10 boxes (25 vials/box)
   Sig: 1 vial per neb q.i.d.

   Refills: 2

3) Rx Axid 150 mg
   Disp: 60
   Sig: i cap po bid before meals

   Refills: 5

4) Rx Crestor 10 mg
   #90
   Sig: i tab po qd

   Refills: 3

5) Rx Flonase 16 g
#1
Sig: 2 sprays per nare qd for a total daily dose of 200 mcg

Refills: 2

6) Rx Fosamax 70 mg
Disp: 4
Sig: i tab po q week

Refills: 2
(*Some medications, such as once a week medications and birth control are typically filled on 4 week cycles instead of 30 day cycles*)

7) Rx Glucotrol 10 mg tabs
Disp: 120
Sig: 20 mg po bid

Refills: 5

8) Rx Humulin R 10 mL
Disp: 1 vial
Sig: 11 units SC before breakfast, 9 units before lunch, and 13 units before supper

Refills: 2

9) Rx: Januvia 100 mg
#100
Sig: 1 tab po qd

Refills: 2

10) Rx Lantus 10 mL
Disp: 3 vials
Sig: 40 units SQ q a.m.

Refills: 1

11) Rx levothyroxine 100 mcg
#50
Sig: 1 tab po qd

Refills: 3

12) Rx Lexapro 20 mg
Disp: 60
Sig: i cap po qd

Refills: NR

13) Rx Lipitor 40 mg
#90
Sig: 1 tab po qd

Refills: 1

14) Rx metoprolol tartrate 25 mg tabs
#100
Sig: ss tab po bid

Refills: 2

15) Rx Nexium 20 mg
Disp: 112
Sig: i cap po bid

Refills: 1

16) Rx NitroDur 0.4 mg
#30 patches
Sig: i patch on 8 a.m., off 10 p.m. qd

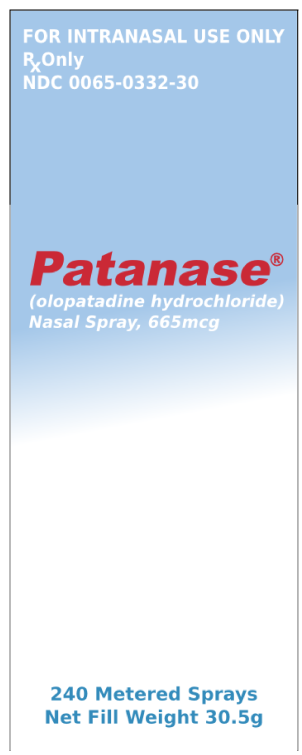
Refills: 2

17) Rx Nitrolingual pumpspray
#3 bottles
Sig: i-ii spray SL q5min prn chest pain. May repeat up to 3 doses/15 min.

Refills: 3

18) Rx Patanase
Disp: 1 bottle
Sig: ii sprays each nare bid

Refills: 2



19) Rx Plavix 75 mg
#60
Sig: 1 tab po qd

Refills: 4

20) Rx Requip 1 mg
#270
Sig: 1 tab po tid

Refills: 1

21) Rx simvastatin 20 mg
#100
Sig: i tab po qd

Refills: 2

22) Singulair 10 mg
#30
Sig: i tab po q p.m.

Refills: 11

23) Rx theophylline elixir 80 mg/Tbs 500 mL bottle
Disp 6 bottles
Sig: iv tsp po q6h atc (*Hint: dispense a whole number of bottles for this script.*)

Refills 2

24) Rx wellbutrin 100 mg
#90
Sig: i tab po tid

Refills: 5

25) Rx Zantac 150 mg
#50
Sig: one b.i.d.

Refills: 1

CHAPTER 12

COMPOUNDING MATH

Oh the things you can fill
For the folks who are ill.
With your bright shiny spatula
Oh, what a thrill.
-- *unknown author*

The art of pharmaceutical compounding has ancient roots dating back to early hunter gatherer societies. These ancient civilizations utilized pharmaceutical compounding for religion, grooming, keeping the healthy well, treating the ill and preparing the dead. These ancient compounders produced the first oils from plants and animals. They discovered poisons and the antidotes. They made ointments for wounded patients as well as perfumes for customers.

Today compounding is still a necessary skill for many pharmacists and pharmacy technicians. Extemporaneous compounding is required for prescription orders that are not commercially available in the requested strength or dosage form requested. It is part of a technicians responsibility to help facilitate these requests.

In this chapter you will learn about:

- Reconstituting powders for oral suspensions,
- Mixing liquid preparations,
- Compounding ointments, gels, and creams,
- Medications sticks, and
- Advanced compounding calculations.

While these problems will be more complex than what you've previously done, you will find that you already know all the mathematical principles required to solve these. You will find the following skills helpful:

- Dimensional Analysis (Factor Label)
- Ratios / Proportions / Parts
- Percentage Strength
- The '5 Step Method'

Reconstituting powders for oral suspensions

Reconstituting oral suspensions is a good skill to understand as all pharmacy technicians will need to do it at some point and it is good to have forewarning of a common pitfall. It is often very important to reconstitute oral suspensions properly or you will end up with an overfilled bottle with a great deal of medication stuck in the bottom of the bottle. Let's look at an example briefly.

Example

To reconstitute a 150 mL bottle of amoxicillin for oral suspension 250 mg/5 mL, the manufacturer recommends 88 mL of distilled water is added in two divided portions. First loosen the powder in the bottle, then add approximately 1/3 of the total volume of water and shake the suspension. After the powder is wet, add the remaining water. How much water should you add each time?

QUESTION

How much water should you add each time?

DATA

final volume = 150 mL	concentration = 250 mg/5 mL	total water = 88 mL
add 1/3 of water initially	then add the rest of the water	

MATHEMATICAL METHOD / FORMULA

Basic Math

DO THE MATH

$$\frac{88\,mL}{1}\times\frac{1}{3}=\boldsymbol{add\,29\,mL\,of\;water\;initially}$$

$$88\,mL-29\,mL=\boldsymbol{then\;add\;another\,59\,mL\,of\;water}$$

DOES THE ANSWER MAKE SENSE?

Yes

Now, you should attempt the following practice problem.

Practice Problem

1) To reconstitute a 100 mL bottle of Augmentin for oral suspension 400 mg/5 mL, the manufacturer recommends 90 mL of distilled water is added in two divided portions. First loosen the powder in the bottle, then add approximately 1/3 of the total volume of water and shake the suspension. After the powder is wet, add the remaining water. How much water should you add each time?

1) Initially add 30 mL of water, then add another 60 mL.

Mixing liquid preparations

Sometimes you will need to determine how much to use of various products to fulfill a recipe written by a physician, sometimes you may take a recipe for a liquid medication and modify it for a different final volume, and other times you may need to either open up capsules or crush tablets and dissolve or suspend them in a liquid vehicle. Let's look at an example of each scenario.

Examples

1) How much clindamycin phosphate (the stock vial concentration is 150 mg/mL) and how much Cetaphil Lotion are needed to make the following compound?

   Rx clindamycin phosphate 1200 mg in Cetaphil Lotion
   Disp: 120 mL
   Sig: aa hs ud

   First, we should figure out how many mL of the clindamycin phosphate stock solution we should use:

   $$\frac{1200\,mg}{1} \times \frac{mL}{150\,mg} = \mathbf{8}\,\boldsymbol{mL\ of\ clindamycin\ phosphate}$$

   Then, we should figure out how much Cetaphil Lotion we'll need to qs this to 120 mL:

   $$120\,mL - 8\,mL = \mathbf{112}\,\boldsymbol{mL\ of\ Cetaphil\ Lotion}$$

2) A prescription is written for a mouthwash containing 170 mL diphenhydramine elixir, 50 mL lidocaine viscous, 200 mL nystatin suspension, 52 mL erythromycin ethyl succinate suspension, and 28 mL of cherry syrup to make 500 mL of mouthwash. How much of each ingredient would be needed if you only wanted to prepare 240 mL of the mouthwash?

   First I would make a ratio comparing each ingredient and specifying the total volume:

   170:50:200:52:28 to make 500 mL mouthwash

   Then, I would solve for how much of each ingredient is needed to make 240 mL of mouthwash:

   $$\frac{170\,mL\,diphenhydramine\,elixir}{500\,mL\,mouthwash} = \frac{N}{240\,mL\,mouthwash}$$
   $$N = \mathbf{81.6}\,\boldsymbol{mL\ diphenhydramine\ elixir}$$

   $$\frac{50\,mL\,lidocaine\,viscous}{500\,mL\,mouthwash} = \frac{N}{240\,mL\,mouthwash}$$
   $$N = \mathbf{24}\,\boldsymbol{mL\ lidocaine\ viscous}$$

   $$\frac{200\,mL\,nystatin\,suspension}{500\,mL\,mouthwash} = \frac{N}{240\,mL\,mouthwash}$$
   $$N = \mathbf{96}\,\boldsymbol{mL\ nystatin\ suspension}$$

$$\frac{52\,mL\ erythromycin\ ethyl\ succinate\ suspension}{500\,mL\ mouthwash}=\frac{N}{240\,mL\ mouthwash}$$

$$N=\boldsymbol{25\ mL\ erythromycin\ ethyl\ succinate\ suspension}$$

$$\frac{28\,mL\ cherry\ syrup}{500\,mL\ mouthwash}=\frac{N}{240\,mL\ mouthwash}$$

$$N=\boldsymbol{13.4\,mL\ cherry\ syrup}$$

3) How many 25 mg tablets of metoprolol tartrate and how many milliliters of Ora-Plus and Ora Sweet are needed to compound the following prescription?

> Rx metoprolol tartrate 6.25 mg/tsp in a 50:50 mixture of Ora-Plus and Ora-Sweet
> Disp: 300 mL
> Sig: i tsp po bid

First let's determine how many metoprolol tartrate tablets are needed:

$$\frac{tablet}{25\,mg}\times\frac{6.25\,mg}{tsp}\times\frac{tsp}{5\,mL}\times\frac{300\,mL}{1}=\boldsymbol{15\,tablets}$$

You will often expect the powder volume from crushed tablets and opened capsules to be negligible, but since we don't know exactly we will simply do the math for both liquids as if all the volume was from our two suspending agents and since they are a 50:50 mixture it means that we only need half the volume for each suspension.

$$\frac{50}{100}=\frac{N}{300\,mL} \qquad N=\boldsymbol{150\ mL\ Ora-Plus}$$

$$\frac{50}{100}=\frac{N}{300\,mL} \qquad N=\boldsymbol{150\ mL\ Ora-Sweet}$$

Now you should try some practice problems.

Practice Problems

1) How much tobramycin (the stock vial concentration is 40 mg/mL) and how much Cetaphil Lotion are needed to prepare the following compound?

> Rx tobramycin 800 mg in Cetaphil Lotion
> Disp: 60 mL
> Sig: aa hs ud

2) A prescription is written for a G.I. Cocktail containing 120 mL Donnatal elixir, 120 mL of lidocaine viscous solution, 480 mL of Mylanta to make a total of 720 mL of G.I. Cocktail. How much of each ingredient would be needed if you only need to prepare 120 mL of G.I. Cocktail?

3) A prescription is written for allopurinol liquid 20 mg/mL in Ora-Plus:Ora-Sweet 1:1 (label with a shelf life of 60 days). How many tablets of allopurinol 100 mg are needed to prepare 200 mL and approximately how much Ora-Plus and Ora-Sweet are needed as well?

1) 20 mL tobramycin; 40 mL Cetaphil Lotion
2) 20 mL Donnatal elixir; 20 mL lidocaine viscous; 80 mL Mylanta
3) 40 allopurinol tablets; 100 mL Ora-Plus; 100 mL Ora-Sweet

Compounding ointments, gels, and creams

Sometimes compounding a semi-solid mixture (ointment, gel, or cream) can be as straight forward as mixing two semi-solids together and other times it may require incorporating a medication into a semi-solid base. Let's look at an example of each.

Examples

1) A prescription is written for equal parts triamcinolone 0.1% cream and Lamisil cream, dispense 30 grams. How many grams of triamcinolone 0.1% cream are needed to fill the prescription? How many grams of Lamisil cream are needed to fill the prescription? What is the final percentage strength of triamcinolone in the compound?

   To solve this we need to first recognize that the ratio between the ingredients are 1:1 for a total of 2 parts. With that in mind we know that half the total weight is how many grams of each ingredient we'll need.

   $$\frac{1}{2} = \frac{N}{30\,g}$$
   $$N = 15\,g$$

   Therefore, we will need **15 g of triamcinolone 0.1% cm** and **15 g of Lamisil cm**

Next, we need to evaluate the final percentage strength of triamcinolone in the compound. There are 2 ways to do it, one is to calculate just how much triamcinolone is in the mixture and then figure out its percentage strength, the other is to also divide by 2 like we did the total weight. Both ways will be demonstrated, but recognize that you only have to do it one way to achieve the correct answer.

$$\frac{0.1\,g}{100\,g}=\frac{N}{15\,g}$$
$$N=0.015\,g$$
$$\frac{0.015\,g}{30\,g}=\frac{N}{100\,g}$$
$$N=\mathbf{0.05\%\ \textit{triamcinolone}}$$

or

0.1% ÷ 2 = **0.05%** ***triamcinolone***

Obviously the second way was easier, but it is good to know that you will get the same answer either way.

It is also noteworthy that the methodology used in this example will apply to any compounding problem where you are mixing ingredients in equal parts.

2) If 50 g of salicylic acid ointment contains 10 grams of salicylic acid, what is the percentage strength of salicylic acid in the ointment?

This problem is just a simple w/w percentage strength problem:

$$\frac{10\,g\ salicylic\ acid}{50\,g\ ointment}=\frac{N}{100\,g\ ointment}$$
$$N=\mathbf{20\,\%\ \textit{salicylic acid}}$$

Now we should once again look at some practice problems.

Practice Problems

1) How much hydrocortisone powder and how much Eucerin cream must be weighed out to prepare the following compound?

Rx hydrocortisone 2.5% in Eucerin cream
Disp: 60 g
Sig: apply sparingly b.i.d. prn

2) A prescription is written for equal parts hydrocortisone 2.5% cream and Lamisil cream, dispense 60 grams. How many grams of hydrocortisone 2.5% cream are needed to fill the prescription? How many grams of Lamisil cream are needed to fill the prescription? What is the final percentage strength of hydrocortisone in this compound?

1) 1.5 g hydrocortisone powder; 58.5 g Eucerin cream
2) 30 g of hydrocortisone cream; 30 g of Lamisil cream; final mixture has 1.25% concentration of hydrocortisone

Medication Sticks

Medication sticks are a solid dosage form used in topical application of local anesthetics, sunscreens, antivirals, antibiotics, and of course cosmetics. Although cosmetic sticks are viewed as tools to improve appearance, they also may contain pharmaceutical active ingredients that serve to heal or protect. For example, a lip balm, which moisturizes the lips, may contain both an antiviral and a sunscreen for use in the treatment and prevention of herpes simplex outbreak. Sticks offer patients, physicians, and pharmacies a unique dosage form that is convenient , relatively stable, and fairly easy to prepare. The convenience comes from the fact that there are several formulas in which all you need to do is add your active ingredients. Let's look at an example problem.

Example

1) You receive the following prescription:

   Rx Acyclovir 1200 mg
   silica gel micronized 0.12 g
   PEG 4500 MW 6.5 g
   PEG 300 MW 15 mL
   Disp: tube i
   Sig: Apply to lips tid prn cold sores

   How many 200 mg acyclovir caps are needed to prepare this compound?

   If we look at this formula you realize all the calculations are done for us other than figuring out how many acyclovir caps we will need to use. This calculation is fairly straight forward:

$$\frac{1200\,mg}{1} \times \frac{capsule}{200\,mg} = \mathbf{6}\ \boldsymbol{acyclovir\ capsules}$$

Now let's look at a practice problem on the next page.

Practice Problem

1) A prescription is written for: valacyclovir 1000 mg, Silica gel micronized 0.12 gm, Polyethylene glycol 4500 MW 6.5 gm, Polyethylene glycol 300 MW 15 mL. How many 500 mg tablets of valacyclovir are needed to prepare this compound?

1) 2 valacyclovir tablets

With these basic compounding calculations you are well prepared for the majority of things you will likely come in contact with in a compounding pharmacy, but one of the things that always makes extemporaneous compounding exciting are the constant new and unique challenges.

Worksheet 12-1

Name:

Date:

Solve the following problems.

1) A prescription written for a toddler to receive:

   Rx cephalexin 125 mg/5 mL susp.
   Disp: 100 mL
   Sig: tsp ss po qid x10d

   When you retrieve the bottle from the shelf you find the following reconstitution instructions: To reconstitute cephalexin 125 mg/5 mL (100 mL after reconstitution) Add 68 mL of water in two equally divided portions to the dry mixture in the bottle. Shake well after each addition. How many mL of water will you add each time?

2) How much clindamycin phosphate (the stock vial concentration is 150 mg/mL) and how much Cetaphil Lotion are needed to prepare the following compound?

   Rx clindamycin phosphate 600 mg in Cetaphil Lotion
   Disp: 60 mL
   Sig: Apply aa hs ud

3) A prescription is written for a mouthwash containing 170 mL diphenhydramine elixir, 50 mL lidocaine viscous, 200 mL nystatin suspension, 52 mL erythromycin ethyl succinate suspension, and 28 mL of cherry syrup to make 500 mL of mouthwash. How much of each ingredient would be needed if you only wanted to prepare 4 fluid ounces of this mouthwash?

4) How many 300 mg rifampin capsules are needed to compound the following solution?

   Rx Rifampin 600 mg/60 mL in Simple Syrup
   Dispense 240 mL
   Sig: 600 mg qd x 4 days

5) A SMOG enema is equal parts sorbitol solution, magnesium hydroxide suspension, mineral oil, and glycerin solution. How may mL of each would you need if you received an order for a 1 liter SMOG enema?

6) A prescription is written for ibuprofen 7.5% cream. How much ibuprofen powder is needed to prepare 60 grams of this compound?

7) A prescription is written for: acyclovir 1000 mg, Silica gel micronized 0.12 gm, Polyethylene glycol 4500 MW 6.5 gm, Polyethylene glycol 300 MW 15 mL. How many 200 mg capsules of acyclovir are needed to prepare this compound?

8) How much of each ingredient must be weighed out to prepare the following ointment?

   Rx testosterone 2% and
   menthol 4.33% in hydrophilic petrolatum
   Disp: 120 g
   Sig: apply q.i.d.

9) After you complete your calculations for the previous problem, you realize you are out of hydrophilic petrolatum. You find the following recipe to make 1000 g of hydrophilic petrolatum: cholesterol 30 g, stearyl alcohol 30 g, white wax 80 g, white petrolatum 860 g. How much of each ingredient will you need if the pharmacist asks you to make only 4 ounces?

10) You need to prepare 200 mL of metformin 100 mg/mL suspension in Ora-Plus:Ora-Sweet 1:1. How many metformin 1000 mg/tablet will you need and approximately how much Ora-Plus and Ora-Sweet are needed as well?

Worksheet 12-2

Name:

Date:

Solve the following problems.

1) You are given the following recipe for compounding diclofenac gel: diclofenac sodium USP 4.8 g, ethanol 200 proof 4.8 mL, lipoil 28.8 mL, Polox 20% gel qs ad 120 g. What is the percentage strength of diclofenac sodium in this gel?

2) You are asked to compound 8 fl. oz. of glycopyrrolate 1% topical solution. Your recipe is as follows: glycopyrrolate 1 g, benzyl alcohol 0.96 mL, purified water qs 100 mL. How much of each ingredient will you need to compound 8 fluid ounces?

3) A prescription is written for phenytoin 10% in zinc oxide qs 60 gm. How many phenytoin 50 mg tablets are needed to prepare this compound?

4) You need to prepare 100 mL of potassium bromide 250 mg / mL. How much potassium bromide should you weigh?

5) You are preparing hydrocortisone 1.6 g in 160 mL Lubriderm lotion. What is the percent strength of the hydrocortisone?

6) A prescription for 240 mL of a syrup with a concentration of 10mg of promethazine and 6.25mg of codeine per teaspoonful is ordered. Promethazine is available in 50 mg / mL stock solution and codeine is available 12 mg / 5 mL stock solution. You will q.s. the syrup with cherry syrup. How many mL of codeine will you need. How much promethazine will you need? How much cherry syrup will you need?

7) You need to prepare 60 mL of baclofen 10 mg/mL. How many tablets of baclofen 10 mg/tablet will you need?

8) You need to prepare 160 mL of amiodarone 5 mg/mL suspension. How many tablets of amiodarone 200 mg/tablet will you need?

9) You need to prepare 60 mL of celecoxib 100 mg/5 mL. How many capsules of 200 mg celecoxib/capsule will you need?

10) You receive the following script:

    Rx Mudd Mixture
    Disp: 184 mL
    Sig: swish and swallow 23 mL q6h x 2 days

    For every 23 mL of Mudd mixture you have 20 mL of nystatin (100,000 units/mL), 2 mL of gentamicin (40 mg/mL), and 1 mL of colistimethate (20 mg/mL). How many milliliters of each ingredient are you going to need to fill this script?

11) You receive a prescription requesting 120 mL of an acetazolamide suspension 25 mg/mL in a 50:50 mixture of Ora-Plus and Ora-Sweet. How many 250 mg acetazolamide tablets and and approximately how many mL each of Ora-Plus and Ora-Sweet are needed to compound this prescription?

12) You receive a prescription requesting 4 fl oz of a 1 mg/mL amlodipine suspension in a 50:50 mixture of Ora-Plus and Ora-Sweet. How many 5 mg amlodipine tablets and and approximately how many mL each of Ora-Plus and Ora-Sweet are needed to compound this prescription?

13) You receive the following prescription for a pediatric patient:

Rx atenolol suspension 2 mg/mL
in Oral Diluent
Disp: 150 mL
Sig; i tsp po qd

How many atenolol 25 mg tablets will you need to compound this prescription?

14) You need to prepare 120 mL of azathioprine 50 mg/mL suspension by crushing 50 mg tablets of azathioprine and then qs with cherry syrup. How many azathioprine tablets do you need to prepare this suspension?

15) You are asked to make 60 mL of a 5 mg/mL baclofen suspension with 20 mg baclofen tablets, a small amount of glycerin to function as a levigating agent and then qs with simple syrup. How many baclofen tablets are needed?

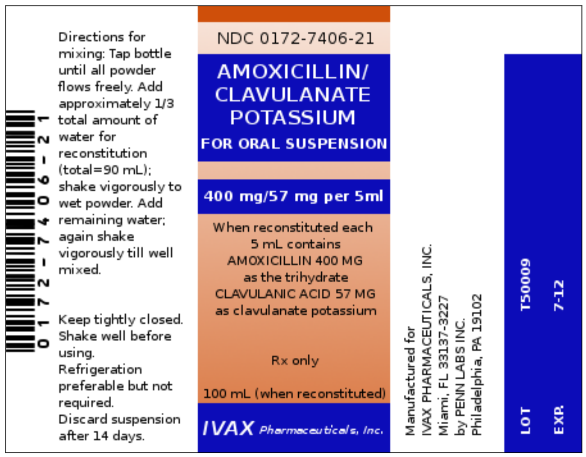
Worksheet 12-3

Name:

Date:

Solve the following problems.

1) Using the directions on the following label, how many mL of water will you add each time?



2) A prescription is written for a G.I. Cocktail containing 120 mL Donnatal elixir, 120 mL of lidocaine viscous solution, 480 mL of Mylanta to make a total of 720 mL of G.I. Cocktail. How much lidocaine viscous would be needed if you only need to prepare 120 mL of the G.I. Cocktail?

3) A prescription is written for ichthammol ointment 2 oz. How much of each ingredient is needed to prepare 2 oz. if you are using the following formula: 100 g of ichthammol, 100 g of lanolin and 800 g of white petrolatum to make 1000 g of ichthammol ointment.

4) You are asked to compound a pint of Schamberg's lotion. You are told to base your calculations off of the following formula: zinc oxide 8 g, menthol 0.25 g, phenol 0.5 g, calcium hydroxide solution 46 mL, olive oil qs ad 100 mL. How much of each ingredient will you need to prepare a pint of this compound.

5) You receive the following prescription:

Rx diclofenac sodium 8% in Pentravan cream
Disp: 60 grams
Sig: aa bid ut dict

How many grams of each ingredient will be needed to make this compound?

6) You receive the following prescription:

Rx tetracycline HCl susp. 125 mg/tsp in
50:50 mixture of Ora-Plus and Ora-Sweet
Disp: 300 mL
Sig: tsp i po bid

How many 250 mg tetracycline capsules and approximately how many mL of Ora-Plus and Ora-Sweet will you need to make this compound?

7) You receive the following prescription for hand rolled lozenges:

Rx benzocaine HCl	100 mg
acacia	700 mg
water	qs
food coloring and flavoring	gtt v aa

Disp: M et Ft 10 lozenges c 10 mg benzocaine each
Sig: dissolve in mouth prn mouth soars

The pharmacists suggests you do your calculations for 12 lozenges and when you're done you can simply discard the heaviest and the lightest lozenge. How much of each ingredient should you measure?

8) A prescription is written for: vitamin E 1,000 IU, zinc oxide 100 mg, Silica gel micronized 0.12 gm, Polyethylene glycol 4500 MW 6.5 gm, Polyethylene glycol 300 MW 15 mL. How many mL of vitamin E are needed to prepare this lip balm if your stock vitamin E has a concentration of 100 g/100 mL (1 mg = 1.1 IU)?

9) An erythromycin ophthalmic ointment requires you to mix 1 part erythromycin 2% (sterile) concentrate with 3 parts ophthalmic base (sterile) ointment. How many grams of each would you need to dispense 50 g of erythromycin ophthalmic ointment and what would be the percent concentration of erythromycin in the final product?

10) The pharmacy receives a prescription requesting 120 mL of a 0.1 mg/mL clonazepam suspension in a 50:50 mixture of Ora-Plus and Ora-Sweet. How many 1 mg clonazepam tablets and and approximately how many mL each of Ora-Plus and Ora-Sweet are needed to compound this prescription?

11) You receive a request for 120 mL of 1 mg/mL bethanechol solution and you are to qs it with sterile water for irrigation. How many 10 mg bethanechol tablets are needed to compound this solution?

12) The pharmacy receives a prescription requesting 2 fl oz of a 5 mg/mL bethanechol suspension in a 50:50 mixture of Ora-Plus and Ora-Sweet. How many 10 mg clonazepam tablets are needed to compound this prescription?

13) The pharmacy recieves the following prescription to prepare a 27 kg pediatric patient for a bone marrow transplant:

Rx busulfan suspension 2 mg/mL in Simple Syrup
Disp: 16 doses
Sig: 30 mg po q6h

a) How many milliliters of busulfan suspension will the patient receive for each dose?

b) How many milliliters of busulfan suspension will be needed to cover all 16 doses?

c) How many 2 mg busulfan tablets are required to make this suspension?

14) The pharmacy needs to prepare 300 mL of diltiazem suspension 12 mg/mL using 90 mg diltiazem tablets and a 50:50 mixture of Ora-Plus and Ora-Sweet. How many diltiazem tablets and approximately how many milliliters each of Ora-Plus and Ora-Sweet are needed to make this compound?

15) You receive the following prescription for a 9 lb 14 oz feline with lower back pain:

Rx Gabapentin suspension chicken flavor 10 mg/mL
Disp: 180 mL
Sig: Day 1 ~ 20 mg po, Day 2 ~ 20 mg po bid, then 20 mg po tid thereafter

Your recipe for 100 mL of this suspension is as follows: gabapentin 1g, xanthum gum 0.4 g, stevia 0.75 g, acesulfame 0.75 g, sodium saccharin 0.1 g, magnasweet solution 0.2 mL, 1% citric acid approximately 0.1 mL (use to obtain pH of 5.5 to 6.5), sodium chloride 0.5 g, bitter stopping agent flavor 1 mL, glycerin 2 mL, chicken flavor 3 mL, bacteriostatic water q.s. 100 mL. How much of each ingredient will you need to compound the requested 180 mL?

Advanced Compounding Calculations

There are several things to consider with respect to advanced compounding calculations including:

- calculations involving specific gravity,
- accounting for excipients when compounding,
- suppositories and density factors, and
- determining shell sizes for extemporaneously compounded capsules.

Calculations Involving Specific Gravity

Sometimes when compounding mixtures the recipes will provide you with weights of all the various ingredients including liquids. Obviously, it is easier to measure a liquid by volume than mass. Water has the unique advantage that 1 gram of water has a volume of 1 milliliter, but other liquids do not share this convenient conversion. When dealing with liquids other than water you will need to know their specific gravity.

Specific gravity is commonly defined as the mass of 1 milliliter of a particular substance. Therefore, if I stated that a particular liquid had a specific gravity of 0.8 it means that every milliliter of it weighs 0.8 grams. If a particular compound requested 5 grams of a liquid known to have a specific gravity of 0.8 I could determine the volume as follows:

$$\frac{5\,\mathrm{g}}{1} \times \frac{1\,\mathrm{mL}}{0.8\,\mathrm{g}} = \mathbf{6.25\,mL}$$

Some common specific gravities that you may end up working with include:

Substance	***Specific Gravity*** *(g/mL)*
glycerin	1.249
honey	1.40-1.45
mineral oil	0.845-0.905
olive oil	0.910-0.915
stearyl alcohol	0.805-0.815
water	1

You will notice that with the list above there is often a slight range for specific gravity. When dealing with this range it is generally acceptable to use the average value (add the low value of the range to the high value and divide by 2). As an example if a prescription required 5 grams of honey I would first determine the average specific gravity as follows:

$$\frac{1.40 + 1.45}{2} = 1.425$$

Then I would find the volume as follows:

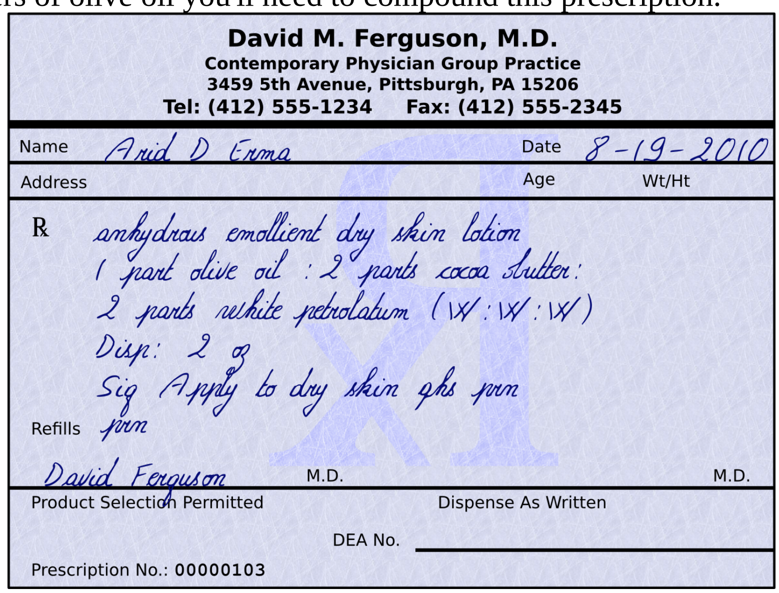
$$\frac{5\,g}{1}\times\frac{mL}{1.425\,g}=\mathbf{3.5\,mL}$$

Now let's attempt a couple of practice problems.

Practice Problems

1) A prescription is written for 60 g of zinc oxide ointment, USP. If the formula for zinc oxide ointment, USP is as follows: 200 g of zinc oxide powder, 650 g of white ointment, and 150 gram of mineral oil to make 1000 grams of zinc oxide ointment, USP; how much of each ingredient will you need to fill this order? Using the information from the previous page (mineral oil has a specific gravity of 0.845 to 0.905) determine your quantity of mineral oil required for this prescription in milliliters. (*Note, since this preparation is commercially available you would not ordinarily compound it. This problem is intended for educational purposes.*)

2) Use the prescription below and information from the specific gravity chart on the previous page to determine how many grams of cocoa butter, how many grams of white petrolatum, and how many milliliters of olive oil you'll need to compound this prescription.



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Name Arid D Erma Date 8-19-2010
Address Age Wt/Ht

℞ anhydrous emollient dry skin lotion
1 part olive oil : 2 parts cocoa butter :
2 parts white petrolatum ([illegible] : [illegible] : [illegible])
Disp: 2 ℥
Sig Apply to dry skin qhs prn
Refills prn

David Ferguson M.D. M.D.
Product Selection Permitted Dispense As Written
DEA No.
Prescription No.: **00000103**

1) 12 g of zinc oxide powder, 39 g of white ointment, and 10.3 mL of mineral oil 2) 22.72 g of cocoa butter, 22.72 g of white petrolatum, 12.4 mL of olive oil

Accounting for Excipients when Compounding

Before we start looking at how to do calculations where we need to account for excipients we should define what excipients are. Excipients are “inert” or inactive ingredients other than the active drug which are included in the manufacturing process or are contained in a finished pharmaceutical dosage form; they allow the proper delivery of the active compounds contained in nearly all over the counter and prescription medications.

At the risk of sounding like *'Mary Poppins'*, almost every drug needs a few inactive ingredients to help the medicine go down. Depending on the route of administration, and form of medication, various excipients may be used. According to the USP-NF, all excipients fit into one or more of 40 categories. The ingredients are classified by the functions they perform in a pharmaceutical dosage form. Some examples are antiadherents, binders, coatings, colors, disintegrants, fillers, flavors, glidants, lubricants, preservatives, sweeteners, and printing inks.

Example

1) A compound prescription order calls for 2200 mg of naproxen. You have available in your pharmacy 500 mg naproxen tablets. Each 500 mg naproxen tablet weighs 630 mg due to all the excipients required to manufacture it. To achieve this, we need to first figure out how many naproxen tablets you will need to pull out of stock to make this (you will need to automatically round up any decimal values). Then, you can triturate the naproxen tablets in a mortar and pestle and weigh out the required quantity of crushed naproxen tablets to provide the desired quantity of medication. Below is the math required to perform this task.

$$\frac{2200\,mg}{1}\times\frac{tablet}{500\,mg}=4.4\,tablets=\mathbf{5}\ \boldsymbol{tablets}\ will\ need\ removed\ from\ stock.$$

Now that we know we will need 5 tablets from stock, you can crush them up and use a ratio proportion to determine how much you will need to weigh out.

$$\frac{500\,mg\ naproxen}{630\,mg\ naproxen\ plus\ excipients}=\frac{2200\,mg\ naproxen}{N}$$

$$N=\mathbf{2772}\,\boldsymbol{mg\ naproxen\ plus\ excipients}$$

Therefore, after you triturate 5 naproxen tablets in your mortar and pestle, you will need to weigh out 2,772 mg of the crushed powder to acquire 2,200 mg of naproxen.

Let's proceed to the next page where you can do a practice problem involving calculations where you need to account for excipients.

Practice Problem

1) You need to prepare 120 mL of metronidazole suspension with a concentration of 59 mg/5 mL. How many 250 mg tablets will you need, and if each tablet weighs 430 mg how will you determine the appropriate weight of the tablets to use after you triturate them for the requested suspension?

You will need to use 6 tablets and after they are crushed you will weigh out 2,436 mg.

Suppositories and Density Factors

Suppositories are defined by the USP-NF as follows:

> *Suppositories are solid bodies of various weights and shapes, adapted for introduction into the rectal, vaginal, or urethral orifice of the human body. They usually melt, soften, or dissolve at body temperature. A suppository may act as a protectant or palliative to the local tissue at the point of introduction or as a carrier of therapeutic agents for systemic or local action.*

Suppositories may be used when a local effect is needed in the rectum, vagina, or urethra.

Rectal suppositories (and to a lesser extent, vaginal suppositories) may also be used as carriers of systemic drugs. Rectal suppositories offer an alternative for the systemic delivery of drugs in patients who can not take drugs orally. Examples include patients who are unconscious, those who are vomiting or having seizures, and those who have obstructions in the upper gastrointestinal tract.

Some drugs that are ineffective orally may be successfully administered rectally or vaginally. Examples include drugs that are extensively metabolized by first-pass effect and drugs that are destroyed in the stomach or intestine. An example of a drug that is usually administered either rectally or vaginally for those reasons include progesterone.

Compounding suppositories is usually done as a last resort. This is because suppositories are, in general, more difficult to prepare than other dosage forms.

Suppositories are usually made of one of two bases:

- *polyethylene glycol (PEG)* which dissolves, or
- *cocoa butter* which melts at body temperature.

There are also two common methods for preparing suppositories:

- *hand-rolling suppositories* which does not require any special equipment but lacks pharmaceutical elegance, or

- *fusion suppositories* provide much greater pharmaceutical elegance but require either aluminum or disposable molds and also they require more calculations.

In this chapter we are going to look at the more common (although more complex to calculate) cocoa butter based fusion suppositories. When doing these calculations, you will need to know how many grams of your base can be held by the suppository molds and then figure out how much of your base to use when mixed with the active ingredients added to a suppository. Unfortunately I can not just subtract the weight of the active ingredient from the weight of our aforementioned total weight to figure out how much cocoa butter is needed because the active ingredient does not occupy the same volume as that mass of cocoa butter (they have different densities). We can use the table on this page to find the active ingredient's density factor (DF) when compared to cocoa butter.

Density Factors for Cocoa Butter Suppositories compared to the amount of weight (g) required to fill the same volume as 1 gram of cocoa butter.

Medication	Factor	Medication	Factor
Aloin	1.3	Iodoform	4.0
Alum	1.7	Menthol	0.7
Aminophylline	1.1	Morphine hydrochloride	1.6
Aminopyrine	1.3	Opium	1.4
Aspirin	1.1	Paraffin	1.0
Barbital	1.2	Pentobarbital	1.2
Belladonna extract	1.3	Perovian balsam	1.1
Benzoic acid	1.5	Phenobarbital	1.2
Bismuth carbonate	4.5	Phenol	0.9
Bismuth salicylate	4.5	Potassium bromide	2.2
Bismuth subgallate	2.7	Potassium iodide	4.5
Bismuth subnitrate	6.0	Procaine	1.2
Boric acid	1.5	Quinine hydrochloride	1.2
Castor oil	1.0	Resorcinol	1.4
Chloral hydrate	1.3	Salicylic acid	1.3
Cocaine hydrochloride	1.3	Secobarbital sodium	1.2
Codeine phosphate	1.1	Sodium bromide	2.3
Digitalis leaf	1.6	Spermaceti	1.0
Dimenhydrinate	1.3	Sulfathiazole	1.6
Diphenhydramine hydrochloride	1.3	Tannic acid	1.6
Gallic acid	2.0	White wax	1.0
Glycerin	1.6	Witch hazel fluid extract	1.1
Hydrocortisone acetate	1.5	Zinc oxide	4.0
Ichthammol	1.1	Zinc sulfate	2.8

Example

1) You receive a prescription requiring you to compound 6 cocoa butter based suppositories with 100 mg of aspirin in each. You know from previous work with these particular suppository

molds that they can each hold 2 grams of cocoa butter. How much cocoa butter and how much aspirin powder will you need to compound this order?

First, we should determine how much cocoa butter these six suppositories could hold.

$$\frac{6\,supp}{1} \times \frac{2\,g}{1\,supp} = 12\,g\,cocoa\,butter$$

Now we should look at how much aspirin powder is required.

$$\frac{6\,supp}{1} \times \frac{100\,mg}{1\,supp} = 600\,mg\,aspirin\ powder$$

Since cocoa butter and aspirin have different densities, we will need to look at the chart on the previous page to determine how much mass of cocoa butter is displaced by our 600 mg of aspirin powder.

$$\frac{600\,mg\,aspirin}{1} \times \frac{1\,g\,cocoa\,butter}{1.1\,g\,aspirin} = 545\,mg\,cocoa\,butter$$

Now we can subtract the 545 mg from our previous number of 12 g to determine how much cocoa butter we actually need.

$$12\,g - 0.545\,g = 11.455\,g\,cocoa\,butter\ required$$

So now we know how much of each ingredient we need.

11.455 g cocoa butter
600 mg aspirin

Now, you should attempt a practice problem.

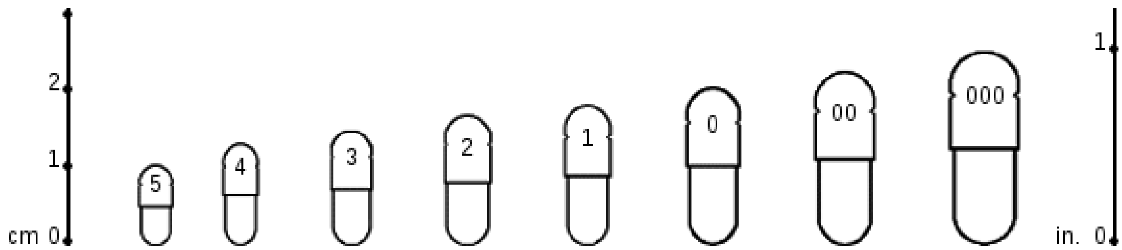
Practice Problem

1) You receive a prescription requiring you to compound 12 cocoa butter based suppositories with 30 mg of phenobarbital in each. You know from previous work with these particular suppository molds that they can each hold 2.08 grams of cocoa butter. How much cocoa butter and how much phenobarbital powder will you need to compound this order?

You will need to use 24.66 g of cocoa butter and 360 mg phenobarbital.

Determining Shell Sizes for Extemporaneously Compounded Capsules

The gelatin shells used in capsules are made of two parts. The base is the longer end and fits into the shorter end which is referred to as the cap. The cap is designed to fit over the base and then snap or lock into place with added pressure.



Capsules are oval in shape and available in eight different sizes for human use. These sizes are #5, #4, #3, #2, #1, #0, #00, and #000, with the smallest being a #5 and the largest being #000. The numbers used to designate size have no bearing on the volume that may be contained within. The capacity of a capsule is dependent on the density and physical characteristics of the powders used in the formula. (Larger capsules are available for veterinary use.)

The approximate capacity of various capsules can be found on the following chart:

	Capsule Size							
	5	4	3	2	1	0	00	000
Drug Substance	Capacity in grams of drug powder							
Acetaminophen	0.13	0.18	0.24	0.31	0.42	0.54	0.75	1.10
Aluminum hydroxide	0.18	0.27	0.36	0.47	0.64	0.82	1.14	1.71
Ascorbic acid	0.13	0.22	0.31	0.40	0.53	0.70	0.98	1.42
Aspirin	0.10	0.15	0.20	0.25	0.33	0.55	0.65	1.10
Bismuth subnitrate	0.12	0.25	0.40	0.55	0.65	0.80	1.20	1.75
Calcium carbonate	0.12	0.20	0.28	0.35	0.46	0.60	0.79	1.14
Calcium lactate	0.11	0.16	0.21	0.26	0.33	0.46	0.57	0.80
Corn starch	0.13	0.20	0.27	0.34	0.44	0.58	0.80	1.15
Lactose	0.14	0.21	0.28	0.35	0.46	0.60	0.85	1.25
Quinine sulfate	0.07	0.10	0.12	0.20	0.23	0.33	0.40	0.65
Sodium bicarbonate	0.13	0.26	0.32	0.39	0.52	0.70	0.97	1.43

When looking at the shell capacities for various drugs on the chart above note that the number listed is the maximum quantity that you can pack in a shell that size. For example if you wanted to place 300 mg (0.300 g) of acetaminophen in a capsule you could fit it in a size #2 capsule, but if you wanted to put 325 mg (0.325 g) of acetaminophen, you would need to use a size #1 capsule.

When determining capsule size it becomes more complex when looking at capsules with multiple drug additives. If one additive is going to take the majority of the volume, you may simply want to add the weights of all your drugs and then base your capsule size on the ingredient requiring majority of the room. Let's look at an example problem to demonstrate this.

Example

1) You receive an order for a hospice patient requesting compounded capsules with 15 mg of hydrocodone bitartrate and 325 mg of acetaminophen. What size capsule shell will you need?

   As acetaminophen is the ingredient that is going to make up the bulk of the capsule we will base our capsule size off that. First we need to determine our total weight.

   $325\,mg + 15\,mg = 340\,mg$

   Based on the chart from the previous page you will need to use a size #1 capsule shell.

Practice Problems

1) What size capsule shell will you need if a physician requests 2 grains of aspirin to be dispensed in a capsule for a patient?

2) You receive an order for a hospice patient requesting 30 compounded capsules with 20 mg of oxycodone, 120 mg aspirin, and 300 mg acetaminophen. What size capsule shell will you need?

1) Size #4 capsules 2) Size #0 capsules

Worksheet 12-4

Name:

Date:

Solve the following problems.

1) You receive a request to make 'Pittsburgh Paste', which gets its name from its golden yellow color. It consists of Aquaphor, cholestyramine powder, and mineral oil (which acts as a levigating agent). You find the following compounding recipe for it:

    PITTSBURGH PASTE

Aquaphor	80 g
Cholestyramine Powder	5.9 g
Mineral Oil	20 mL

    Auxiliary Labeling: TOPICAL USE ONLY

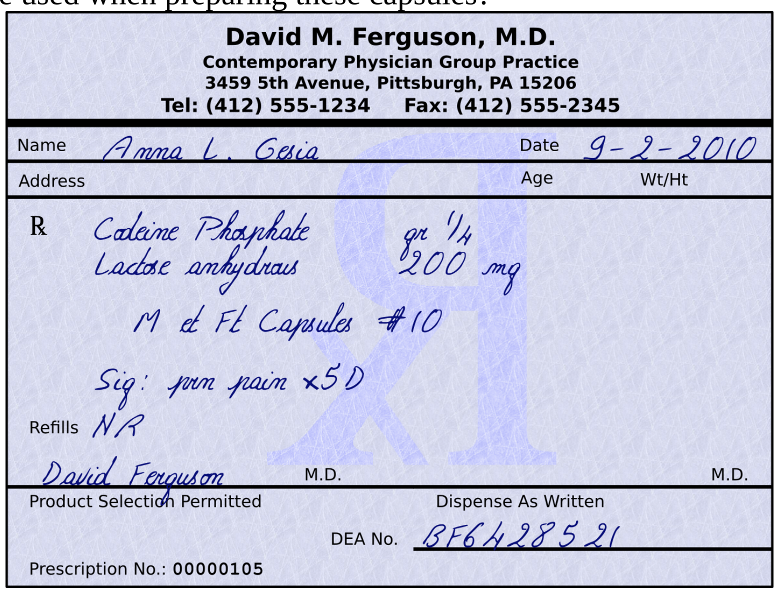
    Expiration: 28 DAYS

    Mineral oil has a specific gravity of 0.845-0.905, so what is the percent concentration of cholestyramine powder in this compound?

2) A prescription is written for ibuprofen 7.5% cream. You are out of ibuprofen powder and will need to crush 200 mg ibuprofen tablets (each tablet weighs 0.33 g) to prepare this compound. How many tablets are you going to triturate and how much weight of these crushed tablets are needed to prepare 30 grams of this compound?

3) A pharmacy receives a prescription for 12 cocoa butter based suppositories with 200 mg of procaine each. The suppository mold in the pharmacy can hold 2.27 g of cocoa butter per suppository. How much cocoa butter and how much procaine will be needed to make these suppositories?

4) Based on the prescription below and the capsule chart earlier in this chapter, what size capsule shell should be used when preparing these capsules?



David M. Ferguson, M.D.
Contemporary Physician Group Practice
3459 5th Avenue, Pittsburgh, PA 15206
Tel: (412) 555-1234 Fax: (412) 555-2345

Name Anna L. Gesia Date 9-2-2010
Address Age Wt/Ht

℞ Codeine Phosphate gr 1/4
Lactose anhydrous 200 mg
M et Ft Capsules #10
Sig: prn pain x5D

Refills NR

David Ferguson M.D. M.D.
Product Selection Permitted Dispense As Written

DEA No. BF6428521

Prescription No.: **00000105**

5) While rarely seen today, Brompton Cocktails are still occasionally ordered for terminally ill patients, to provide them with comfort and promote sociability at end of life. Brompton Cocktail's received their name from where it was originally created during the early 19th century at the Royal Brompton Hospital in London, England. The recipe for the cocktail tends to vary between institutions. You are working at a hospital with a terminally ill cancer patient and the physician wants to give the patient a Brompton Cocktail. After a brief discussion, the pharmacist and the physician settle on the following recipe:

BROMPTON'S COCKTAIL

Morphine Solution 10 mg/mL	6 mL
Cocaine HCl powder	67.2 mg
Simple Syrup	15 mL
90% Ethanol	39 mL
TOTAL VOLUME	60 mL

Auxiliary Labeling: Keep Refrigerated, Oral Use Only

Expiration: Seven Days

The pharmacist is very busy and needs you to calculate several things for labeling the bottle.

a) What is the new percentage strength of the ethanol?

b) How many mg of morphine are in a dose of 1 teaspoon?

c) You are told that 1.12 g of cocaine HCl equals 1 g of cocaine, so how many mg of cocaine are in 1 teaspoon?

6) A prescription is written for a patient that has a hard time swallowing tablets and suffers from hypothyroidism:

Rx: Levothyroxine Na Suspension
Disp: 30 day supply
Sig: 100 mcg po qd

You find the following recipe in your compounding log:

LEVOTHYROXINE NA 25 MCG / mL SUSPENSION

Levothyroxine Na 0.1 mg tablets	25 tabs
Glycerin	40 mL
Distilled Water	q.s. 100 mL

Instructions: Crush levothyroxine Na tablets and triturate with glycerin, which act as a levigating agent and rinse for mortar and pestle. Q.S. with distilled water to obtain a total volume of 100 mL.

Auxiliary Labeling: Shake Well, Oral Use Only, Protect From Light, Keep Refrigerated

How would you rewrite the recipe to provide the requested 30 day supply?

7) The pharmacist requests that you prepare 500 g of bentonite magma (used as a suspending medium for other drugs). The recipe for bentonite magma NF is as follows:

BENTONITE MAGMA

Bentonite	50 g
Purified Water	q.s. ad 1,000 g

Rewrite this recipe for 500 g, and how many mL of water will be needed since water has a specific gravity of 1?

8) A compound prescription order calls for 90 g of a 7% naproxen ointment. You have available in your pharmacy 500 mg naproxen tablets. Each 500 mg naproxen tablet weighs 630 mg due to all the excipients required to manufacture it. To achieve this, we need to first figure out how many naproxen tablets you will need to pull out of stock to make this. Then, you can triturate the naproxen tablets in a mortar and pestle and weigh out the required quantity of crushed naproxen tablets to provide the desired quantity of medication to compound this prescription. How many tablets will need triturated and what weight of crushed up tablets will then need to be weighed out?

9) A pharmacy receives a prescription for 12 cocoa butter based Rectal Rocket® suppositories with 200 mg of procaine, 100 mg of hydrocortisone acetate, and 60 mg of witch hazel fluid extract (witch hazel has a specific gravity of 0.979-0.983) each. These suppository molds can hold 4 g of cocoa butter per suppository.

   a) How many grams of procaine will be needed to make these suppositories?

   b) How many grams of hydrocortisone acetate will be needed to make these suppositories?

c) How many grams and how many milliliters of witch hazel fluid extract are needed to make these suppositories?

d) How many grams of cocoa butter will be needed to make these suppositories?

10) A physician has a patient with legitimate pain issues but also has a history of prescription drug abuse. After a brief discussion between the pharmacist and the patient's physician they decide on dispensing 30 capsules with 5 mg of hydrocodone bitartrate, 325 mg of acetaminophen, and 5 mg of capsaicin each. What size capsule shells will you need to compound this prescription?

Worksheet 12-5

Name:

Date:

Solve the following problems.

1) A prescription written for a pediatric patient to receive:

   Rx cefadroxil 250 mg/5 mL susp.
   Disp: 100 mL
   Sig: i tsp po bid x10d

   When you retrieve the bottle from the shelf you find the following reconstitution instructions: To reconstitute cefadroxil 250 mg/5 mL (100 mL after reconstitution) tap bottle lightly to loosen powder. Add 61 mL of water in two equally divided portions to the dry mixture in the bottle. Shake well after each addition. How many mL of water will you add each time?

2) A prescription written for a pediatric patient to receive:

   Rx cefixime 100 mg/5 mL susp.
   Disp: 75 mL
   Sig: iss tsp po qd x10d

   When you retrieve the bottle from the shelf you find the following reconstitution instructions: To reconstitute cefixime 100 mg/5 mL (75 mL after reconstitution) tap bottle lightly to loosen powder. Add 52 mL of water in two equally divided portions to the dry mixture in the bottle. Shake well after each addition. How many mL of water will you add each time?

3) How much lidocaine HCl (the stock vial concentration is 40 mg/mL) and how much Cetaphil Lotion are needed to prepare the following compound?

   Rx lidocaine HCl 1200 mg in Cetaphil Lotion
   Disp: 120 mL
   Sig: apply lightly to aa q4h prn itching and burning

4) From the following formula, calculate the number of grams of each ingredient required to prepare 60 grams of this ointment:

Precipitated sulfur	10 g
Salicylic acid	2 g
Hydrophilic ointment	88 g

5) Using the same formula as in the previous problem, determine how many grams of each ingredient would be required to prepare a pound of this ointment.

6) A patient comes in suffering from mouth soars and presents the following prescription:

Rx Magic Swizzle
Disp: 480 mL
Sig: i Tbs swish and spit q6h prn mouth pain

Magic Swizzle is a 1:1:1 ratio of mixing viscous lidocaine, diphenhydramine elixir, and magnesium aluminum hydroxide suspension. How many mL of each are needed to prepare this solution?

7) You receive the following script:

Rx Mudd Mixture
Disp: 4 day supply
Sig: swish and swallow 23 mL q6h

For every 23 mL of Mudd Mixture you have 20 mL of nystatin (100,000 units/mL), 2 mL of gentamicin (40 mg/mL), and 1 mL of colistimethate (20 mg/mL).

a) How many milliliters of Mudd Mixture do you need to dispense in total?

b) How many milliliters of each ingredient are you going to need to fill this script?

c) Nystatin is available in 1 pint bottles, gentamicin is available in 20 mL vials, and colistimethate comes as a lyophilized powder with 150 mg/vial. How many bottles of nystatin, vials of gentamicin, and vials of colistimethate will you need to compound this order?

8) Due to a product shortage the pharmacist asks you to compound 60 mL of a 15 mg/mL oseltamivir suspension using 75 mg capsules and cherry syrup. How many 75 mg oseltamivir capsules will be needed for compounding this suspension?

9) The following is a recipe intended for veterinary use:

METRONIDAZOLE AND SILVER SULFADIAZINE CREAM

Metronidazole	1 g
Silver sulfadiazine	1 g
Glycerin	5 g
Hydrophyllic ointment	q.s. 100 g

a) How many grams of each ingredient would be needed to prepare 2 oz of this cream?

b) Considering that glycerin has a specific gravity of 1.249, how many mL of glycerin will be needed for this preparation?

10) You receive the following prescription for hand rolled lozenges:

Rx lidocaine HCl	100 mg
acacia	700 mg
water	qs
food coloring and flavoring	gtt v aa

Disp: M et Ft 10 lozenges c 10 mg lidocaine each
Sig: dissolve in mouth prn mouth soars

The pharmacists suggests you do your calculations for 12 lozenges and when you're done you can simply discard the heaviest and the lightest lozenge.

a) How much of each ingredient should you measure?

b) If your stock lidocaine HCl solution has a concentration of 40 mg/mL how many milliliters will you need?

11) A prescription is written for: diphenhydramine 250 mg, Silica gel micronized 0.12 gm, Polyethylene glycol 4500 MW 6.5 g, Polyethylene glycol 300 MW 15 mL. How many 50 mg tablets of diphenhydramine are needed to prepare this compound?

12) The pharmacy needs to make a 150 mL of a 0.05 mg/mL alprazolam suspension. If each 2 mg alprazolam tablet weighs 80 mg, how many 2 mg alprazolam tablets will you need to pull out of stock and after they are triturated how many grams of crushed alprazolam tablets will you weigh out?

13) Calculate the quantities required to make six cocoa butter based suppositories (each mold can hold 2.17 g of cocoa butter), each containing 100 mg aminophylline (aminophylline has a density factor of 1.1 when compared to 1 g of cocoa butter).

14) A physician has a patient with legitimate pain issues but also has a history of prescription drug abuse. Because of other medications the patient may be taking that contain acetaminophen, the physician does not want any additional acetaminophen in this product. After a brief discussion between the pharmacist and the patient's physician they decide on dispensing 30 capsules with 5 mg of hydrocodone bitartrate, 325 mg of aspirin, and 5 mg of capsaicin each. What size capsule shells will you need to compound this prescription?

15) A pharmacist asks you to prepare a bottle of “Mile's Solution”. You find the following recipe in the book:

MILE'S SOLUTION

Prednisone Elixir 5 mg/5 mL	120 mL
Tetracycline 500 mg caps	3 caps
Cherry Syrup	60 mL
Nystatin Suspension 100,000 u/mL	30 mL
Diphenhydramine Elixir 12.5 mg/5 mL	75 mL
Sterile Water for Irrigation	240 mL
TOTAL VOLUME	525 mL

Auxiliary Labeling: Shake Well, Oral Use Only, Protect From Light

Expiration: Two Weeks

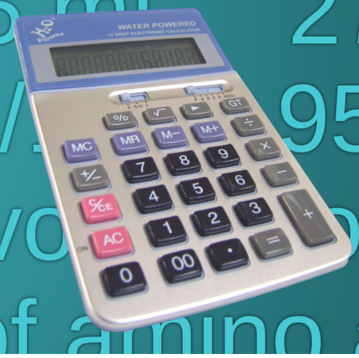
You gather all the supplies, and find that the only prednisone elixir you have in stock has a concentration of 5 mg/mL. You bring this to the pharmacist's attention and she tells you to adjust how much prednisone you add so that you end up with the correct concentration and change the amount of cherry syrup added to make up the difference in the total volume.

a) How much prednisone elixir 5 mg/mL are you going to add?

b) How much cherry syrup are you going to add?

Chapter 13

Calculations for Billing Compounds



You may have been thrilled
to help the folks who were ill,
but now you must bill
for the prescriptions you filled.
--*Sean Parsons*

Billing for compounded preparations can vary greatly from pharmacy to pharmacy, but the following formula is a common method for calculating the cost:

Cost of ingredients
\+ Dispensing fee
\+ Cost of time
Final Cost

Cost of ingredients – Just like the phrase implies, it is the cost of all the ingredients used to prepare a compound.

Dispensing fee – This represents the charge for the professional services provided by the pharmacy when dispensing a prescription and includes a distribution of the costs involved in running the pharmacy such as salaries, rent, utilities, costs associated with maintaining the computer system, etc. This is sometimes also referred to as a professional fee.

Cost of time – As compounding a prescription is often more time consuming then just filling a traditional prescription, the pharmacy will need to charge for the time required from the staff to make these preparations.

Let's look at a couple of example problems, one where we've already been given the cost of ingredients and another where we need to calculate the cost of ingredients.

Examples:

1) Calculate the cost of 50 g of a 20% salicylic acid ointment that took 15 minutes to prepare if the cost of ingredients were only $1.03, your pharmacy has a standard dispensing fee of $5.00, and your cost of time is based on $35.00 per hour.

   Since we already know our cost of ingredients and our dispensing fee the only thing we need to figure out before we add everything up is our cost of time.

$$\frac{15\,minutes}{1} \times \frac{\$35.00}{60\,minutes} = \$8.75$$

now we can simply add all of our costs together.

	Cost of ingredients	$ 1.03
+	Dispensing fee	$ 5.00
+	Cost of time	$ 8.75
	Final Cost	**$14.78**

2) You make the following compound in approximately 10 minutes:

Rx clindamycin phosphate 1200 mg in Cetaphil Lotion
Disp: 120 mL
Sig: aa hs ud

Use the following information to determine the final cost.

clindamycin phosphate 150 mg/mL, 4 mL vials, $4.12/vial
Cetaphil Lotion 480 mL bottle, $9.44/bottle
dispensing fee is $5.00
cost of time is $35.00/hour

We will need to determine the cost of each ingredient.

clindamycin phosphate

$$\frac{1200\,mg}{1}\times\frac{mL}{150\,mg}=8\,mL$$

$$\frac{8\,mL}{1}\times\frac{vial}{4\,mL}\times\frac{\$4.12}{vial}=\$8.24$$

Cetaphil Lotion

$$120\,mL-8\,mL=112\,mL$$

$$\frac{112\,mL}{1}\times\frac{bottle}{480\,mL}\times\frac{\$9.44}{bottle}=\$\,2.20$$

You've been given the dispensing fee, but you'll need to determine the cost of time.

$$\frac{10\,minutes}{1}\times\frac{\$35.00}{60\,minutes}=\$5.83$$

Now you can add all your costs up.

	Cost of ingredients	$ 8.24
+		$ 2.20
+	Dispensing fee	$ 5.00
+	Cost of time	$ 5.83
	Final Cost	**$21.27**

Now we should look at some practice problems.

Practice Problems:

1) Calculate the cost of 60 g of a 7.5% ibuprofen cream that took 20 minutes to prepare if the cost of ingredients were only $2.48, your pharmacy has a standard dispensing fee of $5.00, and your cost of time is based on $35.00 per hour.

2) You compound the following prescription in approximately 15 minutes:

    Rx metoprolol tartrate 6.25 mg/tsp in a 50:50 mixture of Ora-Plus and Ora-Sweet
    Disp: 300 mL
    Sig: i tsp po bid

    Use the following information to determine the final cost. (*Hint: expect the powder volume from the crushed up metoprolol tartrate tablets to be negligible*)

    metoprolol tartrate 25 mg/tablet, $0.08/tablet
    Ora-Plus 473 mL bottle, $33.02/bottle
    Ora-Sweet 473 mL bottle, $33.02/bottle
    dispensing fee is $5.00
    cost of time is $35.00/hour

1) $19.15   2) $35.89

Worksheet 13-1

Name:

Date:

Solve the following problems using the formula:

	Cost of ingredients
+	Dispensing fee
+	Cost of time
	Final Cost

Use $5.00 for the dispensing fee and a rate of $35.00 per hour for the cost of time calculations.

1) Calculate the cost for 60 g of a 10% phenytoin in zinc oxide ointment that takes 20 minutes to prepare if the cost of ingredients are $3.17.

2) Calculate the cost for 120 g of a 2% testosterone and 4.33% menthol in hydrophilic petrolatum that takes takes 30 minutes to prepare if the cost of ingredients are $11.09.

3) Calculate the cost for 60 mL of celecoxib 100 mg/5 mL suspension if it took 10 minutes to prepare and the ingredients to make it cost $22.97.

4) Calculate the cost for 50 g of erythromycin ophthalmic ointment that requires 35 minutes to prepare if the cost of ingredients come to $53.50.

5) Calculate the cost for 11 g of a 2% naproxen gel if it takes 20 minutes to prepare and the ingredients to compound it cost $21.86.

6) How much should you charge to dispense 300 mL of a mouthwash that has a recipe of 170 mL diphenhydramine elixir, 50 mL lidocaine viscous, 200 mL nystatin suspension, 52 mL erythromycin ethyl succinate suspension, and 28 mL cherry syrup to make 500 mL of mouthwash if it took you 20 minutes to prepare. (*Note: you will need to determine how much of each ingredient you actually needed to prepare this suspension in order to calculate your costs.*)

   diphenhydramine elixir 12.5 mg/5 mL, 120 mL/bottle, $7.36/bottle
   lidocaine viscous 2%, 100 mL/bottle, $3.42/bottle
   nystatin suspension 100,000 units/mL, 473 mL/bottle, $68.29/bottle
   erythromycin ethyl succinate suspension 200 mg/5 mL, 480 mL/bottle, $23.50/bottle
   cherry syrup, 480 mL/bottle, $6.24/bottle

7) You compound the following prescription in approximately 15 minutes:

   Rx allopurinol liquid 20 mg/mL in a 1:1 mixture of Ora-Plus and Ora-Sweet
   Disp: 200 mL
   Sig: 2/3 tsp po bid p meals

   Use the following information to determine the final cost. (*Hint: expect the powder volume from the crushed up allopurinol tablets to be negligible*)

   allopurinol 100 mg/tablet, $0.08/tablet
   Ora-Plus 473 mL bottle, $33.02/bottle
   Ora-Sweet 473 mL bottle, $33.02/bottle

8) You compound a prescription for 30 g of equal parts triamcinolone 0.1% cream and Lamisil cream in approximately 15 minutes. How much should you charge for this compound?

   triamcinolone 0.1% cream, $3.75/80 g
   Lamisil cream, $32.00/15 g

9) You compound a prescription for 60 g of 2.5% hydrocortisone in Eucerin cream in approximately 20 minutes. How much should you charge for this compound?

hydrocortisone powder, $175.00/100 g
Eucerin cream, $9.45/454 g

10) How much should the following compound cost if it took 10 minutes to prepare?

Rx Rifampin 600 mg/60 mL in Simple Syrup
Disp: 240 mL
Sig: 600 mg qd x 4 days

Rifampin 300 mg/capsule, $1.89/capsule
Simple Syrup 16 fl. oz./bottle, $16.45/bottle

Worksheet 13-2

Name:

Date:

Solve the following problems using the formula:

Cost of ingredients
\+ Dispensing fee
\+ Cost of time
Final Cost

Use $5.00 for the dispensing fee and a rate of $35.00 per hour for the cost of time calculations.

1) You compound a prescription for 60 g of equal parts hydrocortisone 2.5% cream and Lamisil cream in approximately 15 minutes. How much should you charge for this compound?

   hydrocortisone 2.5% cream, $5.46/30 g
   Lamisil cream, $32.00/15 g

2) The pharmacy prepared 300 mL of diltiazem suspension 12 mg/mL in approximately 15 minutes using 90 mg diltiazem tablets and a 50:50 mixture of Ora-Plus and Ora-Sweet. How much should you charge based on the following information?

   diltiazem 90 mg/tablet, $0.10/tablet
   Ora-Plus 473 mL bottle, $33.02/bottle
   Ora-Sweet 473 mL bottle, $33.02/bottle

3) You make the following compound in approximately 10 minutes:

    Rx tobramycin 800 mg in Cetaphil Lotion
    Disp: 60 mL
    Sig: aa hs ud

    Use the following information to determine the final cost.

    tobramycin 40 mg/mL, 30 mL MDV, $27.50/vial
    Cetaphil Lotion 480 mL bottle, $9.44/bottle

4) How much should you charge to dispense 120 mL of G.I. Cocktail that has a recipe of 120 mL Donnatal elixir, 120 mL lidocaine viscous, and 480 mL of Mylanta to make 720 mL of G.I. Cocktail if it took you 20 minutes to prepare. (*Note: you will need to determine how much of each ingredient you actually needed to prepare this suspension in order to calculate your costs.*)

    Donnatal elixir, 473 mL/bottle, $67.45/bottle
    lidocaine viscous 2%, 100 mL/bottle, $3.42/bottle
    Mylanta 720 mL/bottle, $8.89/bottle

5) How much should you charge to make the following medication stick if it took 30 minutes to prepare:

    Rx Acyclovir 1200 mg
    silica gel micronized 0.12 g
    PEG 4500 MW 6.5 g
    PEG 300 MW 15 mL
    Disp: tube i
    Sig: Apply to lips tid prn cold sores

    acyclovir 200 mg/capsule, $0.15/capsule
    silica gel micronized $30.00/100 g
    polyethylene glycol (PEG) 4500 MW $37.10/500 g
    polyethylene glycol (PEG) 300 MW $37.10/500 mL

6) The pharmacy prepared 200 mL of metformin 100 mg/mL suspension in approximately 15 minutes using 1000 mg metformin tablets and a 50:50 mixture of Ora-Plus and Ora-Sweet. How much should you charge based on the following information?

   metformin 1000 mg/tablet, $1.44/tablet
   Ora-Plus 473 mL bottle, $33.02/bottle
   Ora-Sweet 473 mL bottle, $33.02/bottle

7) The pharmacy prepared 60 mL of a 5 mg/mL baclofen suspension in 20 minutes with 20 mg baclofen tablets, 5 mL of glycerin, and a sufficient quantity of simple syrup. Assuming that the powder volume from crushing the baclofen tablets was negligible, how much should you charge for this compounded prescription?

   baclofen 20 mg/tablet, $0.09/tablet
   glycerin solution $2.97/480 mL
   Simple Syrup 16 fl. oz./bottle, $16.45/bottle

8) The pharmacy prepared 160 mL of amiodarone 5 mg/mL suspension in approximately 15 minutes using 200 mg amiodarone tablets and a 50:50 mixture of Ora-Plus and Ora-Sweet. How much should you charge based on the following information?

   amiodarone 200 mg/tablet, $3.30/tablet
   Ora-Plus 473 mL bottle, $33.02/bottle
   Ora-Sweet 473 mL bottle, $33.02/bottle

9) The pharmacy prepared 120 mL of acetazolamide suspension 25 mg/mL in approximately 15 minutes using 250 mg acetazolamide tablets and a 50:50 mixture of Ora-Plus and Ora-Sweet. How much should you charge based on the following information?

acetazolamide 250 mg/tablet, $0.44/tablet
Ora-Plus 473 mL bottle, $33.02/bottle
Ora-Sweet 473 mL bottle, $33.02/bottle

10) You make the following compound in approximately 10 minutes:

Rx atenolol suspension 2 mg/mL
in Cherry Syrup
Disp: 150 mL
Sig: i tsp po qd

Use the following information to determine the final cost.

atenolol 25 mg/tablet, $0.10/tablet
cherry syrup, 480 mL/bottle, $6.24/bottle

Worksheet 13-3

Name:

Date:

Solve the following problems using the formula:

Cost of ingredients
\+ Dispensing fee
\+ Cost of time
Final Cost

Some pharmacies may use a sliding scale for their dispensing fees based on the cost of the ingredients used. Use the following chart to determine the dispensing fee based on the cost of the ingredients used:

Cost of Ingredients	*Dispensing Fee*
Less than $20.00	$3.50
$20.00 - $50.00	$5.00
Greater than $50.00	$7.50

Continue using a rate of $35.00 per hour for the cost of time calculations.

1) How much should you charge for the following medication stick if it took 30 minutes to prepare:

   Rx valacyclovir 1000 mg
   silica gel micronized 0.12 g
   PEG 4500 MW 6.5 g
   PEG 300 MW 15 mL
   Disp: tube i
   Sig: Apply to lips tid prn cold sores

   Valtrex (valacyclovir) 500 mg/tablet, $5.93/tablet
   silica gel micronized $30.00/100 g
   polyethylene glycol (PEG) 4500 MW $37.10/500 g
   polyethylene glycol (PEG) 300 MW $37.10/500 mL

2) How much should be charged for a 1 liter SMOG enema if it takes 10 minutes to prepare? A SMOG enema is equal parts sorbitol solution, magnesium hydroxide suspension, mineral oil, and glycerin.

70% sorbitol solution, $5.40/480 mL
magnesium hydroxide suspension 400 mg/5 mL, $2.06/480 mL
mineral oil $65.98/1000 mL
glycerin solution $2.97/480 mL

3) You make the following compound in approximately 10 minutes:

Rx clindamycin phosphate 600 mg in Cetaphil Lotion
Disp: 60 mL
Sig: aa hs ud

Use the following information to determine the final cost.

clindamycin phosphate 150 mg/mL, 4 mL vials, $4.12/vial
Cetaphil Lotion 480 mL bottle, $9.44/bottle

4) The pharmacy prepared 160 mL of a 1% hydrocortisone in Lubriderm Lotion in approximately 15 minutes. When calculating the cost for this prescription assume the powder volume from the hydrocortisone powder to be negligible.

hydrocortisone powder, $175.00/100 g
Lubriderm Lotion, $7.36/480 mL

5) You make the following compound in approximately 25 minutes:

> Rx promethazine 30 mg and codeine 18.75 mg per Tbs
> q.s. with cherry syrup
> Disp: 20 fl oz
> Sig: Tbs i po q4º prn

Use the following information to determine the final cost.

promethazine 50 mg/mL, 1 mL/vial, $0.50/vial
codeine phosphate 15 mg/mL, 2 mL/vial, $2.24/vial
cherry syrup, 480 mL/bottle, $6.24/bottle

6) The pharmacy prepared 4 fluid ounces of a 1 mg/mL amlodipine suspension in approximately 20 minutes using 5 mg amlodipine tablets and a 50:50 mixture of Ora-Plus and Ora-Sweet. How much should you charge based on the following information?

amlodipine 5 mg/tablet, $1.85/tablet
Ora-Plus 473 mL bottle, $33.02/bottle
Ora-Sweet 473 mL bottle, $33.02/bottle

7) You make the following compound in approximately 20 minutes:

> Rx tetracycline HCl susp. 125 mg/tsp in
> 50:50 mixture of Ora-Plus and Ora-Sweet
> Disp: 300 mL
> Sig: tsp i po bid

Use the following information to determine the final cost.

tetracycline 250 mg/tablet, $0.07/tablet
Ora-Plus 473 mL bottle, $33.02/bottle
Ora-Sweet 473 mL bottle, $33.02/bottle

8) The pharmacy prepared 120 mL of a 0.1 mg/mL clonazepam suspension in approximately 20 minutes using 1 mg clonazepam tablets and a 50:50 mixture of Ora-Plus and Ora-Sweet. How much should you charge based on the following information?

clonazepam 1 mg/tablet, $0.90/tablet
Ora-Plus 473 mL bottle, $33.02/bottle
Ora-Sweet 473 mL bottle, $33.02/bottle

9) The pharmacy prepared 2 fluid ounces of a 5 mg/mL bethanechol suspension in approximately 20 minutes using 10 mg bethanechol tablets and a 50:50 mixture of Ora-Plus and Ora-Sweet. How much should you charge based on the following information?

bethanechol 10 mg/tablet, $0.08/tablet
Ora-Plus 473 mL bottle, $33.02/bottle
Ora-Sweet 473 mL bottle, $33.02/bottle

10) The pharmacy compounded 8 fluid ounces of 1% glycopyrrolate topical solution with an appropriate quantity of glycopyrrolate powder, 1.7 mL of benzyl alcohol, and q.s. of purified water. How much should you charge if this medication took 10 minutes to prepare?

glycopyrrolate powder, $75.46/1 g
benzyl alcohol, $19.60/500 mL
Pharmacy maintains own water purifier and does not charge for it.

Worksheet 13-4

Name:

Date:

Solve the following problems using the formula:

	Cost of ingredients
+	Dispensing fee
+	Cost of time
	Final Cost

Some pharmacies may use a sliding scale for their dispensing fees based on the cost of the ingredients used. Use the following chart to determine the dispensing fee based on the cost of the ingredients used:

Cost of Ingredients	*Dispensing Fee*
Less than $20.00	$3.50
$20.00 - $50.00	$5.00
Greater than $50.00	$7.50

Continue using a rate of $35.00 per hour for the cost of time calculations.

1) How much should you charge to dispense a 4% diclofenac gel compounded with diclofenac powder, 4.8 mL of 200 proof ethanol, 28.8 mL of lipoil, qs ad 120 g with 20% Polox gel (this will require approximately 70 mL of 20% Polox gel). This preparation took 35 minutes to prepare and below are the average wholesale prices for each ingredient.

   diclofenac sodium, USP, $156.00/100 g
   denatured ethyl alcohol 200 proof, $13.65/118.25 mL
   lipoil, $18.20/473 mL
   Polox 20% gel, $21.35/473 mL

2) You need to charge for 2 ounces of ichthammol ointment that took 20 minutes to prepare. The recipe for 1 kilogram of ichthammol ointment is as follows: 100 g of ichthamol, 100 g of lanolin and 800 g of white petrolatum. Below are the AWPs for the ingredients.

   ichthammol powder USP $52.01/454 g
   lanolin powder USP $27.03/454 g
   white petrolatum USP $10.22/454 g

3) You make the following compound in 25 minutes:

Rx Mudd Mixture
Disp: 184 mL
Sig: swish and swallow 23 mL q6h x 2 days

For every 23 mL of Mudd mixture you use 20 mL of nystatin (100,000 units/mL), 2 mL of gentamicin (40 mg/mL), and 1 mL of colistimethate (20 mg/mL). Calculate the charge for this extemporaneous compound.

nystatin 100,000 units/mL, 473 mL/bottle, $68.29/bottle
gentamicin 40 mg/mL, 20 mL/vial, $8.25/vial
colistimethate 150 mg/vial, $54.72/vial

4) You need to charge for the following compound that took 15 minutes to prepare:

Rx diclofenac sodium 8% in Pentravan cream
Disp: 60 grams
Sig: aa bid ut dict

Use the prices below to determine how much to charge.

diclofenac sodium, USP, $156.00/100 g
Pentravan cream $33.29/454 g

5) The pharmacy prepared 30 mL of a 0.1 mg/mL clonidine suspension in approximately 15 minutes using 0.2 mg clonidine tablets and Simple Syrup. How much should you charge based on the following information?

clonidine 0.2 mg/tablet, $0.05/tablet
Simple Syrup 16 fl. oz./bottle, $16.45/bottle

6) How much should you charge for the following medication stick if it took 30 minutes to prepare:

Rx vitamin E 1000 IU
zinc oxide 100 mg
silica gel micronized 0.12 g
PEG 4500 MW 6.5 g
PEG 300 MW 15 mL
Disp: tube i
Sig: Apply to lips tid prn cold sores

vitamin E 100 g/100 mL (1 mg = 1.1 IU), $70.70/100 mL
zinc oxide powder USP $10.85/454 g
silica gel micronized $30.00/100 g
polyethylene glycol (PEG) 4500 MW $37.10/500 g
polyethylene glycol (PEG) 300 MW $37.10/500 mL

7) The pharmacy prepared 100 mL of a 2 mg/mL dapsone suspension in approximately 15 minutes using 25 mg dapsone tablets and a 50:50 mixture of Ora-Plus and Ora-Sweet. How much should you charge based on the following information?

dapsone 25 mg/tablet, $0.20/tablet
Ora-Plus 473 mL bottle, $33.02/bottle
Ora-Sweet 473 mL bottle, $33.02/bottle

8) The pharmacy compounded 4 fluid ounces of a 50 mg/tsp dipyridamole suspension in approximately 15 minutes using 50 mg dipyridamole tablets and a 50:50 mixture of Ora-Plus and Ora-Sweet. How much should you charge based on the following information?

dipyridamole 50 mg/tablet, $0.05/tablet
Ora-Plus 473 mL bottle, $33.02/bottle
Ora-Sweet 473 mL bottle, $33.02/bottle

9) The pharmacy prepared 100 mL of a 10 mg/mL disopyridamole suspension in approximately 10 minutes using 100 mg disopyridamole capsules and cherry syrup. How much should you charge based on the following information?

disopyridamole 100 mg/capsule, $0.06/capsule
cherry syrup, 480 mL/bottle, $6.24/bottle

10) The pharmacy compounded 120 mL of a levodopa/carbidopa suspension with a concentration of 25 mg of levodopa and 6.25 mg of carbidopa per teaspoonful in approximately 15 minutes using levodopa 100 mg/carbidopa 25 mg tablets and a 50:50 mixture of Ora-Plus and Ora-Sweet. How much should you charge based on the following information?

levodopa 100 mg/carbidopa 25 mg tablets, $0.05/tablet
Ora-Plus 473 mL bottle, $33.02/bottle
Ora-Sweet 473 mL bottle, $33.02/bottle

Chapter 14

Pharmacy Business Math

Money is always there, but the pockets change.
--unknown author

Being skilled in the art and practice of pharmacy is both exciting and important, but for the long term success of any pharmacy (even a non-profit pharmacy) it must achieve good cash flow and be able to meet its financial goals. This is an area where pharmacy technicians are rapidly expanding their roles in both community and institutional settings.

Today, technicians commonly handle inventory purchasing and receiving while assuring proper turnover and any necessary data maintenance involved with such responsibilities. They work with insurance companies on behalf of their pharmacy (sometimes technicians also work directly for insurance companies). Also, qualified technicians may have an opportunity to move into management positions where they need to give consideration to capital expenditures and justify professional fees. A pharmacy technician with solid business skills can achieve many things for the various practice settings they may work in.

In this chapter we will look at the following concepts:

- Terminology,
- Inventory management processes,
- Storage requirements,
- Markups/discounts,
- Gross profits and net profits,
- Third party reimbursement,
- Daily cash reports,
- Calculating dispensing fees, and
- Depreciation.

Terminology

To understand the concepts of this chapter you need to familiarize your self with some basic terminology as it relates to pharmacy business math.

inventory - This is simply the entire stock on hand for sale at a given time.

inventory value - The total value of the drugs and merchandise in stock on a given day.

perpetual inventory - A system that maintains a continuous count of every item in inventory so that it always shows the stock on hand. Some pharmacies maintain perpetual inventories on all products while others only do this with their schedule II medications.

reorder point - Minimum and maximum stock levels which determine when a reorder is placed and for how much.

formulary - A list of medications available for use within a health care system. There are two major types of formularies, open formularies and closed formularies.

open formulary - The pharmacy must stock or have ready access to, all drugs that may be written by the physicians in their practice area.

closed formulary - The drug inventory is limited to a list of approved medications.

purchasing - Purchasing is the ordering of products for use or sale by the pharmacy and is usually carried out by either an independent or group process.

direct purchasing - This entails ordering medications directly from the original drug manufacturer. This typically requires completion of a purchase order, generally a preprinted form with a unique number, on which the product name(s), amount(s), and price(s) are entered.

wholesaler purchasing - Wholesaler purchasing enables the pharmacy to use a single source to purchase numerous products from numerous manufacturers. Most drug ordering of this fashion is done on-line.

prime vendor purchasing - This involves an agreement made by a pharmacy for a specified percentage or dollar volume of purchases in exchange for being given lower acquisition costs.

schedule II medications - Schedule II medications must be stocked separately in a secure place or distributed throughout your inventory and require a DEA 222 form for reordering. Their stock must be continually monitored and documented.

Occupational Safety and Health Administration (OSHA) - OSHA is a government agency within the United States Department of Labor responsible for maintaining safe and healthy work environments.

Material Safety Data Sheet (MSDS) - OSHA required notices on hazardous substances which provide hazard, handling, clean-up, and first aid information.

gross profit - Gross profit is calculated as sales minus all costs directly related to those sales or in simpler terms we can think of it as the difference between the selling price and the acquisition price.

net profit - Net profit is the difference between the gross profit and the sum of all the costs associated with filling the prescription. The costs associated with filling the prescription are accounted for with a dispensing fee or a professional fee. With that in mind you can determine the net profit by subtracting a professional fee from the gross profit.

dispensing fee - This represents the charge for the professional services provided by the pharmacy when dispensing a prescription and includes a distribution of the costs involved in running the pharmacy such as salaries, rent, utilities, costs associated with maintaining the computer system, etc.

This is sometimes also referred to as a professional fee.

average wholesale price - This is the average price at which wholesalers typically sell medications to pharmacies.

usual and customary price – Usual and customary price is commonly known as the retail price and is the price paid for a prescription by a patient without insurance.

third party reimbursement - This is reimbursement for services rendered to a person in which an entity other than the receiver of the service is responsible for the payment. Third-party reimbursement for the cost of a subscriber's prescriptions are commonly paid in part by a health insurance plan or other prescription benefit manager, such as Highmark, Medco, Medicare, or Medicaid.

capitation fee - A method of payment for health services in which an individual or institutional provider is paid a fixed amount without regard to the actual number or nature of services provided to each patient. A common example would be a pharmacy in a long term care home receiving a fixed amount of money per month regardless of whether the patient required no pharmaceuticals or if there prescriptions exceeded the money allotted by a capitation fee.

capital expenditures - Money spent to acquire or upgrade physical assets such as property, fixtures, or machinery (i.e., a building, shelving, and computers). Capital expenditures are not for day-to-day operations such as payroll, inventory, maintenance and advertising. This is also called capital spending or capital expense.

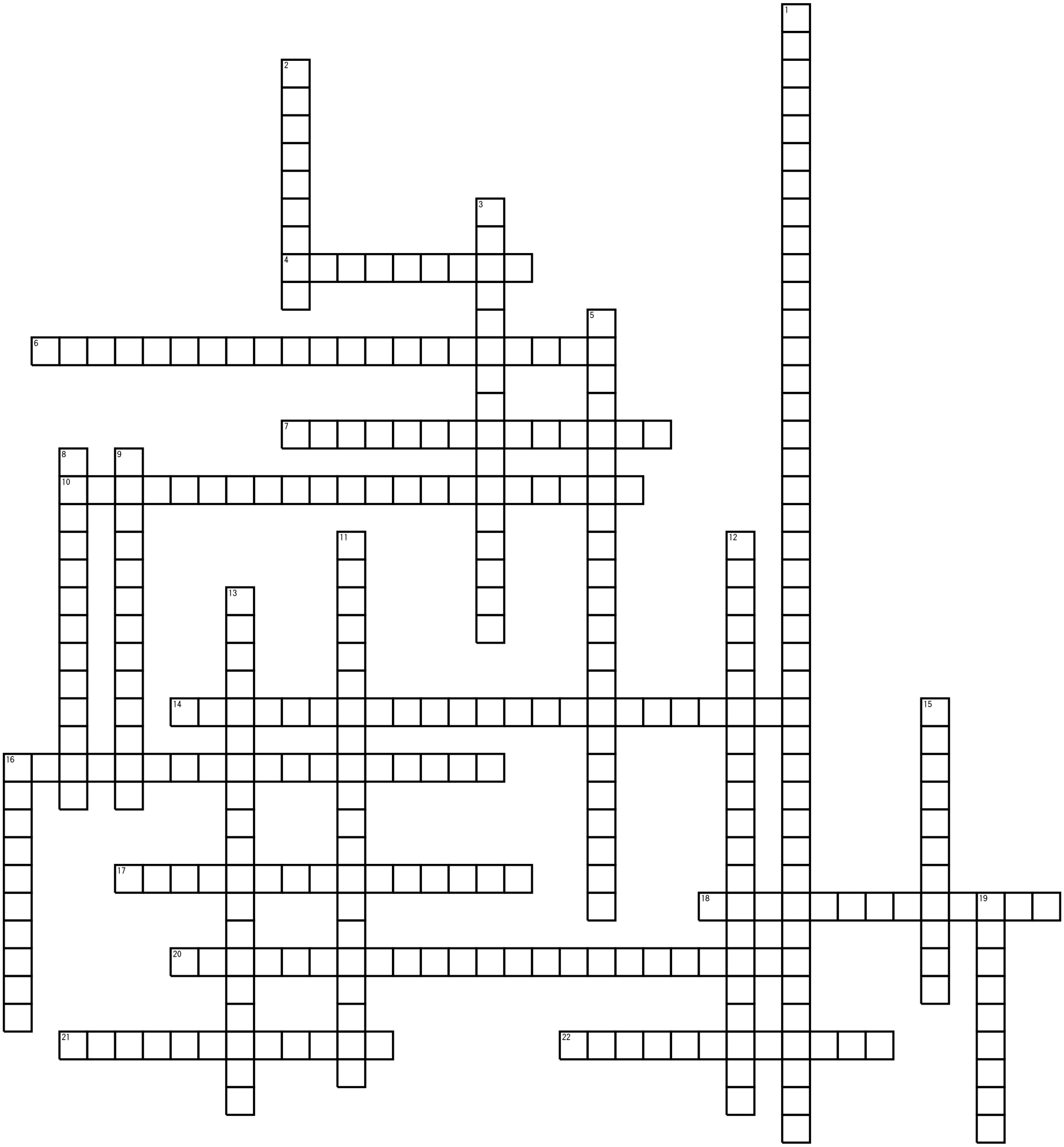
depreciation - This is the decline in value of assets. As an example, a pharmacy delivery car declines in value as it becomes older and obtains more mileage.

Worksheet 14-1

Name:

Date:

Fill in the following crossword puzzle using the terminology presented in this chapter. The clues are on the back of this worksheet.



Across

4) This is simply the entire stock on hand for sale at a given time.
6) These must be stocked separately in a secure place or distributed throughout your inventory and require a DEA 222 form for reordering. Their stock must be continually monitored and documented.
7) The total value of the drugs and merchandise in stock on a given day.
10) This involves an agreement made by a pharmacy for a specified percentage or dollar volume of purchases in exchange for being given lower acquisition costs.
14) OSHA required notices on hazardous substances which provide hazard, handling, clean-up, and first aid information.
16) A system that maintains a continuous count of every item in inventory so that it always shows the stock on hand.
17) The drug inventory is limited to a list of approved medications.
18) A method of payment for health services in which an individual or institutional provider is paid a fixed amount without regard to the actual number or nature of services provided to each patient.
20) This is reimbursement for services rendered to a person in which an entity other than the receiver of the service is responsible for the payment.
21) Minimum and maximum stock levels which determine when a reorder is placed and for how much.
22) This is the decline in value of assets.

Down

1) A government agency within the United States Department of Labor responsible for maintaining safe and healthy work environments.
2) This is the difference between the gross profit and the sum of all the costs associated with filling the prescription.
3) This entails ordering medications directly from the original drug manufacturer.
5) This is commonly known as the retail price and is the price paid for a prescription by a patient without insurance.
8) The pharmacy must stock or have ready access to, all drugs that may be written by the physicians in their practice area.
9) This represents the charge for the professional services provided by the pharmacy when dispensing a prescription and includes a distribution of the costs involved in running the pharmacy such as salaries, rent, utilities, costs associated with maintaining the computer system, etc.
11) This enables the pharmacy to use a single source to purchase numerous products from numerous manufacturers. Most drug ordering of this fashion is done on-line.
12) This is the average price at which wholesalers typically sell medications to pharmacies.
13) Money spent to acquire or upgrade physical assets such as property, fixtures, or machinery
15) This is calculated as sales minus all costs directly related to those sales or in simpler terms we can think of it as the difference between the selling price and the acquisition price.
16) This is the ordering of products for use or sale by the pharmacy and is usually carried out by either an independent or group process.
19) A list of medications available for use within a health care system.

Inventory management processes

The primary purpose of inventory management is the timely purchase and receipt of pharmaceuticals and to establish and maintain appropriate levels of materials in stock. Purchasing, receiving, and inventory should be as uncomplicated as possible so as not to disrupt or to interfere with the other activities of the pharmacy. Community pharmacies usually maintain an open formulary, which means they must stock or have ready access to all drugs that may be written by the physicians in their practice area. In the community pharmacy most pharmaceutical products are purchased through a local wholesaler. Specialty pharmacies and hospital pharmacies use a closed formulary, which means the drug inventory is limited to a list of approved medications. To minimize the cost of doing business, inventory levels must be adequate but not excessive with a rapid turnover of drug stock on the shelf. The purchasing, receipt, and inventory of controlled-drug substances requires special procedures and record-keeping requirements.

Purchasing

Purchasing is the ordering of products for use or sale by the pharmacy and is usually carried out by either an independent or group process. In independent purchasing, the pharmacist or technician deals directly with a drug wholesaler (or rarely the pharmaceutical manufacturer) regarding matters such as price and terms. In group purchasing, a number of pharmacies work together to negotiate a discount for high-volume purchases and more favorable contractual terms. Several purchasing methods are used in pharmacy including Direct Purchasing, Wholesaler Purchasing, and Prime Vendor Purchasing.

Direct purchasing entails ordering medications directly from the original drug manufacturer. This typically requires completion of a purchase order, generally a preprinted form with a unique number on which the product name(s), amount(s), and price(s) are entered.

Advantages to direct purchasing

- lower cost
- lack of add-on fees

Disadvantages to direct purchasing

- a commitment of time as it will take longer than other methods to receive drugs
- a commitment of staff since there are multiple requisitions to be completed and mailed to multiple pharmaceutical companies

Wholesaler purchasing enables the pharmacy to use a single source to purchase numerous products from numerous manufacturers. Most drug ordering of this fashion is done on-line, although gathering information may be done in a number of different ways such as writing items on a 'want book', walking the shelves and scanning items that need reordered into a portable bar code scanner (an example is pictured to the right), or many pharmacy management software programs will automatically populate a reorder list when the pharmacy stock reaches a predetermined reorder point. A system that maintains a continuous inventory record is known as perpetual inventory.

Advantages to wholesaler purchasing

- reduced turnaround time for orders
- lower inventory and associated costs
- reduced commitment of time and staff

Disadvantages to wholesaler purchasing

- a higher purchase cost
- supply difficulties
- loss of control provided by in-house purchase orders
- unavailability of some pharmaceuticals

Sometimes to offset some of the increased costs associated with using a wholesaler, as opposed to direct purchasing, pharmacies will establish a contract identifying a particular wholesaler as a prime vendor purchaser. Prime vendor purchasing involves an agreement made by a pharmacy for a specified percentage or dollar volume of purchases in exchange for being given lower acquisition costs.

Advantages to prime vendor purchasing

- lower acquisition costs
- competitive service fees
- electronic order entry
- often, emergency delivery services
- promotes just in time (JIT) purchasing

Disadvantages to prime vendor purchasing

- limits ability to use other wholesalers
- in term of JIT, it can only be used when supplies are readily available and needs can be accurately predicted

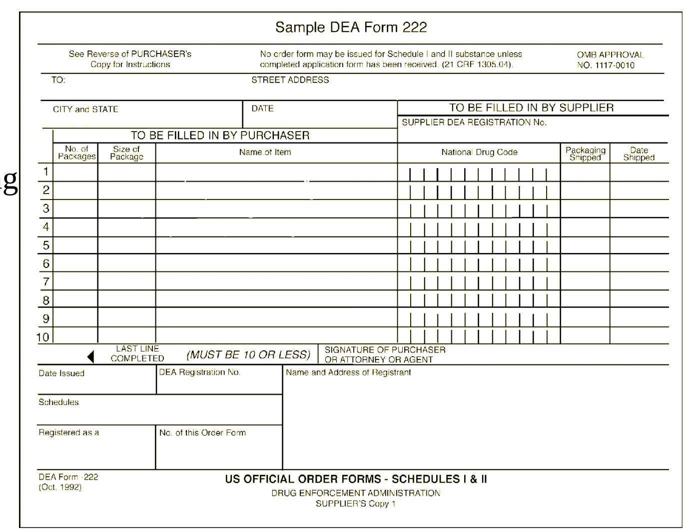
Controlled substances, as expected, require special consideration when it comes to purchasing. The Controlled Substance Act (CSA) defines procedures for purchasing and receiving and requirements for inventory and record keeping.

Schedule III – V drugs (see Chapter 8 for information on drug schedules) may be ordered by a pharmacy or other appropriate dispensary on a general order from a wholesaler and you should check the delivery in against the original order.

Schedule II drugs have much more stringent requirements. A pharmacy must register with the Drug Enforcement Administration (DEA) to purchase Schedule II medications. The purchase of such controlled substances must be authorized by a pharmacist and executed on either a triplicate DEA 222 order form or an electronic 222 form through a controlled substances ordering system (CSOS)

The DEA form 222 (pictured to the right) is a triplicate form. The pharmacy retains the third sheet while sending the first and second pages to the wholesaler. The wholesaler is responsible for sending the second page to the DEA while retaining the first page for its own records. When the Schedule II medications arrive in the pharmacy they should be checked in against the DEA form.

On the next page is a chart explaining how an electronic 222 form works using CSOS.


Sample DEA Form 222

See Reverse of PURCHASER's Copy for Instructions

No order form may be issued for Schedule I and II substance unless completed application form has been received. (21 CFR 1305.04)

OMB APPROVAL NO. 1117-0010

TO: | STREET ADDRESS

CITY and STATE | DATE

TO BE FILLED IN BY SUPPLIER

SUPPLIER DEA REGISTRATION No.

	TO BE FILLED IN BY PURCHASER			TO BE FILLED IN BY SUPPLIER		
	No. of Packages	Size of Package	Name of Item	National Drug Code	Packaging Shipped	Date Shipped
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

LAST LINE COMPLETED (MUST BE 10 OR LESS) | SIGNATURE OF PURCHASER OR ATTORNEY OR AGENT

Date Issued | DEA Registration No. | Name and Address of Registrant

Schedules

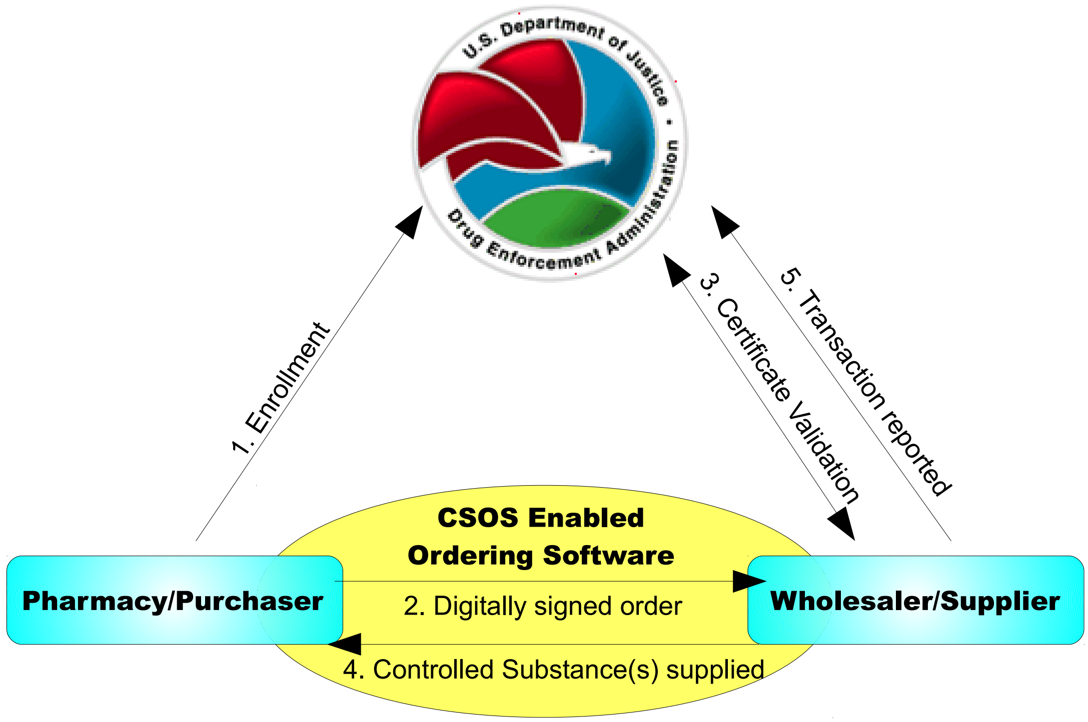
Registered as a | No. of this Order Form

DEA Form -222 (Oct. 1992)

US OFFICIAL ORDER FORMS - SCHEDULES I & II

DRUG ENFORCEMENT ADMINISTRATION

SUPPLIER'S Copy 1



1) An individual enrolls with the DEA and, once approved, is issued a personal CSOS Certificate.
2) The purchaser creates an electronic 222 order using an approved ordering software. The order is digitally signed using the purchaser's personal CSOS Certificate and then transmitted to the suppliers. The paper 222 is not required for electronic ordering.
3) The supplier receives the purchase order and verifies that the purchaser's certificate is valid with the DEA. Additionally, the supplier validates the electronic order information just like it would a paper order.
4) The supplier completes the order and ships to the purchaser. Any communications regarding the order are sent electronically.
5) The order is reported by the supplier to the DEA within two business days.

Receiving

The pharmaceutical received should be carefully checked in against the purchase order including product name, quantity, strength, and package size. Controlled substances are shipped in separate containers and should be checked in by a pharmacist, although pharmacy technicians may assist with this process under the direct supervision of a pharmacist. Schedule II medications need to be checked in against your DEA 222 form (whether the paper triplicate form, or the electronic form on your CSOS enabled software).

If something is damaged in shipment or improperly shipped, it must be reported to the pharmacist and vendor immediately.

Inventory

Inventory, simply put, is the entire stock on hand for sale at a given time. Inventory typically includes prescription drugs, over the counter medications, dietary supplements, and front end merchandise.

Traditionally, inventory is the single largest expense in pharmacy, and so proper management of it is essential to the success of any pharmacy. As such, inventory value is the total value of the drugs and merchandise in stock on a given day.

Several things a technician should keep in mind while working with their inventory are:

- appropriate maximum and minimum levels on products,
- turnover rates on inventory, and
- days' supply of inventory.

Most pharmacies must borrow and pay interest in order to keep an adequate quantity of medications on the shelves in order to meet anticipated needs. Most pharmacies establish maximum and minimum inventory levels to try and assure an adequate but not excessive quantity of medicines are on the shelf so that they do not need to borrow to much money (or even if they aren't using loans, they don't want to much money tied up in non moving inventory). Often, max and min levels are monitored by computer systems, but pharmacy staff will need to initially establish those levels and may occasionally need to intervene and adjust those levels. Furthermore, some pharmacies still do not have automated inventory systems. When you establish a max level, that is the most you want to have on the shelves and you should not exceed that quantity. When you establish a minimum level (or par level) that is the point when you order more (commonly called your reorder point), but not till you reach that minimum quantity. Based on this information fill in the chart below with the appropriate number of vials you should purchase.

Practice Problems

	Medications	***Package Size***	***Minimum # Units***	***Maximum # Units***	***Current Inventory***	***Re-order***
1)	tetracycline 250 mg cap	500	120	700	80	
2)	metronidazole 500 mg tab	50	30	120	12	
3)	doxycycline 50 mg cap	50	30	150	42	

1) 1 bottle 2) 2 bottles 3) 0 bottles

Determining the inventory turnover rate is a good method of measuring the overall effectiveness of the purchasing and inventory control programs. The inventory turnover rate is calculated by dividing the total dollars spent to purchase drugs for one year by the actual value of the pharmacy inventory at any point in time. The number produced by this calculation offers an indication of how many times a year the inventory may have been used or replaced.

Example

A pharmacy does a quarterly inventory count and has an average inventory value of $100,000.00. Annual inventory purchases are $500,000.00. What is the turnover rate, and what does that number mean?

$$\frac{\$500{,}000.00}{\$100{,}000.00} = \mathbf{5}\,\boldsymbol{turnovers}$$

Looking at that number we can say that this pharmacy turns over all its inventory approximately 5 times per year. Most community pharmacies usually have a goal of turning over their inventory 12 times a year and institutional pharmacies may push for even higher turnover rates. Solve the practice problem below.

Practice Problem

1) If Bidwell Pharmacy's average inventory for the last year was $132,936.00 and the annual cost total was $1,612,000.00, what was the turnover rate?

1) Bidwell Pharmacy has a turnover rate of 12.1

Often, pharmacies have $75,000.00 to $200,000.00 (or more) in inventory sitting on the shelves as drug products. Pharmacies often set goals for lowering the inventory to improve cash flow. A common method used is to set inventory goals called days' supply of inventory, which refers to making the value of the inventory approximately equal to the cost to the pharmacy sold in a certain number of days. A common number for pharmacies to shoot for is in the 25-35 day range. Let's look at an example problem.

Example

Bidwell Pharmacy has a total inventory value of $132,936.00. Last week it had sales of $45,813.00, and the cost to the pharmacy of the products sold came to $36,592.00. Bidwell's current goal is 25 days' supply. How close is Bidwell to its goal, and how much inventory value does this difference represent? (*Hint: Inventory value is based on how much you paid for it, not how much you can sell it for.*)

$$\frac{\$132{,}936.00}{1} \times \frac{7\,days}{\$36{,}592.00} = \mathbf{25.43}\,\boldsymbol{days}$$

The pharmacy is very close to achieving its goal but it is a little over where it wants to be. Let's calculate how much more money is invested in inventory than it wants.

$$\$\,132{,}936.00 - \left(\frac{25\,days}{1} \times \frac{\$\,36{,}592.00}{7\,days}\right) = \boldsymbol{\$}\,\mathbf{2{,}250.29}$$

Therefore the pharmacy has $2,250.29 more dollars tied up in inventory than it wants.

Let's go to the next page where you can attempt a practice problem with days' supply of inventory.

Practice Problem

1) Adam's Pharmacy has a total inventory value of $183,445.00. Last week the pharmacy had sales of $47,293.00, and the cost to the pharmacy for the products sold came to $38,207.00. Adam's goal is to have a 28 days' supply of inventory. How many days' supply does Adam have? How much is he over or under his goal in dollars?

1) Adam's Pharmacy has 33.6 days' supply of inventory which is $30,617.00 over Adam's goal.

Inventory requirements

While individual pharmacies may have various frequencies in which they verify their inventory levels it is worth mentioning the requirements that the DEA sets for controlled substances. A pharmacy is required by the DEA to take an inventory of controlled substances every 2 years (biennially). This inventory must be done on any date that is within 2 years of the previous inventory date. The inventory record must be maintained at the registered location in a readily retrievable manner for at least 2 years for copying and inspection by the Drug Enforcement Administration. An inventory record of all Schedule II controlled substances must be kept separate from those of other controlled substances. Submission of a copy of any inventory record to the DEA is not required unless requested.

When taking the inventory of Schedule II controlled substances, an actual physical count must be made. For the inventory of Schedule III, IV, and V controlled substances, an estimate count may be made. If the commercial container holds more than 1000 dosage units and has been opened, however, an actual physical count must be made.

State law may strengthen this requirement with annual actual physical counts of all controlled substances. It also may require such an inventory be submitted before reregistration by the board of pharmacy.

Worksheet 14-2

Name:

Date:

Determine how much of each medication to reorder based on the package size and the minimum and maximum quantities the pharmacy wants to stock. Reorder medications when they reach the minimum.

	Medications	***Package Size***	***Minimum # Units***	***Maximum # Units***	***Current Inventory***	***Re-order***
1)	albuterol inh sol vial-neb	25	50	150	25	
2)	carisoprodol 350 mg tab	20	24	100	48	
3)	E.E.S. 400 mg tab	100	60	240	57	
4)	fluoxetine 20 mg cap	100	2000	6000	1870	
5)	glyburide 5 mg tab	100	200	800	400	
6)	levothyroxine 100 mcg tab	100	180	720	140	
7)	metformin 500 mg tab	500	200	800	250	
8)	metoprolol tar. 50 mg tab	100	120	480	90	
9)	ondansetron 4 mg/5 mL	50	100	400	100	
10)	quetiapine 200 mg tab	100	200	800	100	
11)	risperidone 2 mg tab	100	120	480	60	
12)	sertraline 50 mg tab	100	200	800	120	
13)	sildenafil cit. 100 mg tab	30	60	240	69	
14)	tramadol 50 mg tab	100	200	800	150	
15)	zidovudine 300 mg tab	60	20	80	24	

Calculate how many times each of the following pharmacies turnover their inventory on an annual basis.

16) If Epocrates's Apothecary has an average inventory for the last year was $112,936.87 and the annual cost total was $1,298,774.13, what was the turnover rate?

17) If Frank's Pharmacy has an average inventory for the last year was $187,639.11 and the annual cost total was $2,251,669.30, what was the turnover rate?

18) If Lou's Legend Drug has an average inventory for the last year was $97,812.50 and the annual cost total was $1,222,656.33, what was the turnover rate?

Perform the following days' supply of inventory calculations.

19) Epocrates's Apothecary has a total inventory value of $112,937.00. Last week the pharmacy had sales of $29,971.71, and the cost to the pharmacy for the products sold came to $24,976.43. Epocrates's goal is to have a 35 days' supply of inventory. How many days' supply does Epocrates have? How much is he over or under his goal in dollars?

20) Frank's Pharmacy has a total inventory value of $187,638.87. Last week the pharmacy had sales of $51,061.60, and the cost to the pharmacy for the products sold came to $43,301.33. Frank's goal is to have a 30 days' supply of inventory. How many days' supply does Frank have? How much is he over or under his goal in dollars?

21) Lou's Legend Drug has a total inventory value of $97,812.50. Last week the pharmacy had sales of $28,215.14, and the cost to the pharmacy for the products sold came to $23,512.62. Lou's goal is to have a 25 days' supply of inventory. How many days' supply does Lou have? How much is he over or under his goal in dollars?

Answer the following questions.

22) Do you think most pharmacies use wholesaler purchasing or direct purchasing and why?

23) How are Schedule III – V medications ordered?

24) How are Schedule II medications ordered?

25) What should be done if something is damaged in shipment or improperly shipped?

26) Whom is allowed to check in controlled substances from the medication delivery?

Storage requirements

Now that we've discussed how to purchase and receive various pharmaceuticals we need to start looking at how to properly store our inventory as this is another area in which pharmacy technicians have great responsibility. There are three main concepts to discuss in this section:

- environmental considerations,
- security issues, and
- safety requirements.

Environmental considerations

Environmental considerations include proper temperature, ventilation, humidity, light and sanitation. Specific storage conditions are required to be printed in product literature, on drug packaging, and drug labels to ensure proper storage and product integrity. The conditions are defined by the following terms[1]:

Cold: any temperature not exceeding 8° C (45° F)
Freezer: -25° to -10° C (-13° to 14° F)
Refrigerator: 2° to 8° C (36° to 46° F)
Cool: 8° to 15° C (46° to 59° F)
Room temperature: the temperature prevailing in a working area
Controlled room temperature: 15° to 30° C (59° to 86° F)
Warm: 30° to 40° C (86° to 104° F)
Excessive heat: any temperature above 40° C (104° F)

The temperatures that you will need to be most concerned with are freezer, refrigerator, and controlled room temperature. Pharmacies should maintain some sort of daily log for the refrigerators and freezers that medications are stored within.

Volatile or flammable substances such as the alcohols that a pharmacy may use for compounding or other purposes must be stored in an area with proper ventilation to prevent build up of fumes in case of accidental spill or damaged storage container.

Humidity can cause a tablet to become moist and powdery. While all medications should not be exposed to excessive levels of humidity some medications, such as acyclovir, mycophenolate, and zidovudine, seem to be more sensitive to degradation from humidity.

There are more than 200 different medications which are light sensitive. The chemical composition of these medications can be altered by exposure to direct light. As an example, when nitroprusside is exposed to direct sun light it will breakdown into cyanide. Some common light sensitive medications include acetazolamide, doxycycline, linezolid, and zolmatriptan. While many drugs need to be protected from light while in storage, their original package from the manufacturer should suffice. If you need to repackage any medications always be sure to consult the manufacturers recommendations to determine if you need to place the medication in light resistant packaging or not.

1 These important standards are contained in a combined publication that is recognized as the official compendium, the *United States Pharmacopeia* (USP) and the *National Formulary* (NF).

Sanitation standards are usually set by the state that your pharmacy practices in. Below is an example of what various states request as a sanitation standard. The standard quoted comes from the Commonwealth of Pennsylvania[2].

> § 27.15. Sanitary standards.
>
> (a) The pharmacy and equipment shall be maintained in a clean and orderly condition and in good repair.
>
> (b) The pharmacy shall comply with the health and sanitation statutes of the Commonwealth and of the municipality and county in which the pharmacy is located.
>
> (c) Waste material may not be permitted to collect upon the floor, counter or other area of the pharmacy. The pharmacy shall have a waste removal system adequate to maintain clean and sanitary conditions.
>
> (d) The prescription area shall be dry and well ventilated, free from rodents, insects, dirt and foreign material, and well lighted.
>
> (e) Plumbing shall be in good repair and working order.
>
> (f) The prescription area shall contain only appliances, instruments, equipment, materials, drugs, medicines, chemicals and supplies necessary for the practice of pharmacy, as set forth in section 2(11) of the act (63 P. S. § 390-2(11)), and other equipment and supplies deemed reasonable for the operation and management of a pharmacy as established by the Board.
>
> (g) Persons working in the prescription area shall be required to keep themselves and their apparel in a clean, sanitary and professional manner.

Security issues

Security requirements that restrict access to medications to "authorized personnel only" is often the result of legal requirements, institutional policy, and established standards of practice. All drugs in an institutional setting must be maintained in restricted locations so that they are only accessible to professional staff who are authorized to receive, store, prepare, dispense, distribute, or administer such products. Whereas, in a community pharmacy the public has ready access to various over the counter medications.

Prescription (legend) drugs require a prescription and are otherwise restricted to "authorized personnel only" such as pharmacists and pharmacy technicians in all pharmacy settings.

As should be expected, there are additional security measures with respect to controlled substances. Schedule III – V medications must either be stored in a secured vault or be distributed throughout the pharmacy stock. By dispersing your controlled substances throughout your inventory you effectively prevent someone from being able to steal all your scheduled medications. Schedule II medications must also either be stored in a secured vault or be distributed throughout the pharmacy stock; although,

2 The Pennsylvania Code, Chapter 27. State Board of Pharmacy, The provisions of this § 27.15 amended September 4, 1998, effective September 5, 1998, http://www.pacode.com/secure/data/049/chapter27/s27.15.html

some states specifically require Schedule II medications to be stored in a secured vault.

Safety requirements

The safety requirements include everything from the proper inventory rotation to avoid dispensing expired products, to material safety data sheets to provide the necessary information for safe clean up after accidental spills, to appropriate handling of oncology materials, and proper storage of chemicals and flammable items.

Proper rotation of inventory and periodic checking of expirations help to reduce the potential for dispensing expired medications. It also maximizes the utilization of inventory before medications become outdated. When looking at expirations on medication vials it is important to note that if a medication only mentions the month and year but not the day, then you are to treat it as expiring at the end of the month. As an example, if a medication is marked as expiring on 02/2016 then you would treat it as expiring on February 29, 2016.

The Occupational Safety and Health Administration (OSHA) requires all work places, including pharmacies, to carry material safety data sheets (MSDS) for all hazardous substances that are stored on the premises. This includes oncology drugs and volatile chemicals along with other hazardous chemicals. The MSDS provide handling, clean-up, and first-aid information.

Segregating inventory by drug categories help to prevent potentially harmful errors. The Joint Commission on Accreditation of Healthcare Organizations (JCAHO) requires that internal and external medications must be stored separately. This reduces the potential that someone will dispense or administer an external product for internal use. The JCAHO also has requirements for separate storage of oncology drugs and volatile or flammable substances.

Hazardous drugs (i.e., oncology drugs) should have a separate space on the shelves and be labeled in such away that it will alert staff of the hazardous potential of these medications. Oncology drugs are often cytotoxic themselves and must be handled with extreme care. They should be received in a sealed protective outer bag that restricts dissemination of the drug if the container leaks or is broken. When potential exists for exposure to hazardous drugs all personnel involved must wear appropriate personal protective equipment while following a hazardous materials cleanup procedure. All exposed materials must be properly disposed of in hazardous waste containers.

Volatile or flammable substances (including tax free alcohol) require careful storage. They must have a cool location that is properly ventilated. Their storage area must be designed to reduce fire and explosion potential.

Worksheet 14-3

Name:

Date:

Fully answer the following questions.

1) What are the major environmental considerations for medications?

2) List the storage ranges in both Celsius and Fahrenheit for freezer, refrigerator, and controlled room temperature.

3) Approximately how many medications are considered light sensitive?

4) What happens to nitroprusside when it is exposed to direct sun light?

5) Whom usually sets the sanitation standards for your pharmacy?

6) What is a legend drug and who should have access to it?

7) How should Schedule III – V medications be stored in the pharmacy?

8) How should Schedule II medications be stored in the pharmacy?

9) Create a short list of safety requirements as pertaining to medication storage.

10) If a medication had an expiration of 10/2020, what day does it expire?

Markups and discounts

Most pharmacies need to provide a markup on their products in order to be profitable. Usually a product will be given a percent markup although an item may be given a flat rate markup instead. Even when the markup is given as a flat rate it is a common practice to want to determine what kind of percent markup it equals. Let's look at an example of each.

Examples

1) A tube of ointment that cost the pharmacy $10 is given a flat rate markup of $2.25. What is the selling price?

$$\textit{purchase price} + \textit{flat rate markup} = \textit{selling price}$$

$$\$10.00 + \$2.25 = \mathbf{\$12.25}$$

2) What is the percent markup in the previous problem?

$$\frac{(\textit{selling price} - \textit{purchase price})}{\textit{purchase price}} = \frac{\%\,\textit{markup}}{100}$$

$$\frac{(\$12.25 - \$10.00)}{\$10.00} = \frac{N}{100}$$
$$N = \boldsymbol{a\ markup\ of\ 22.5\,\%}$$

3) An unmedicated lip balm cost the pharmacy $0.83, and it wants to sell it for a 20% markup. What is the unmedicated lip balm's selling price?

$$\textit{purchase price} + (\textit{purchase price} \times \textit{percent markup}) = \textit{selling price}$$

$$\$0.83 + \left(\$0.83 \times \frac{20}{100}\right) = \mathbf{\$1.00}$$

As percent markups are more common, we will focus on those. Please attempt the following practice problems working with percent markups.

Practice Problems

Several items are listed below with the price that Bidwell Pharmacy paid for each item. Perform the appropriate markup calculations below.

1) Bidwell Pharmacy purchased a 120 mL bottle of acetaminophen elixir 160 mg/5 mL $3.15. What would its selling price be if it were marked up 200%?

2) Bidwell Pharmacy purchased 2 packets of Goody's extra strength headache powder extra for $0.39. What would its selling price be if it were marked up 200%?

3) Bidwell Pharmacy purchased a 120 mL bottle of guaifenesin syrup 100 mg/5 mL for $2.50 and sold it for $7.50. What is the percent markup on this product?

1) $9.45 2) $1.17 3) 200% markup

Another common concept in a pharmacy is to add a percent markup and a professional fee for prescription medications. The professional fee (or dispensing fee) is intended to displace the pharmacy's costs and then the markup would provide the pharmacy with its profit. Typically if a professional fee is included, then the percent markup tends to be lower. Let's look at an example problem.

Example

1) A pharmacy purchases a product for $10 adds a 50% markup and applies a $3.50 professional fee, how much will the product be sold for?

$$purchase\ price + (purchase\ price \times percent\ markup) + professional\ fee = selling\ price$$

$$\$\,10.00 + \left(\$\,10.00 \times \frac{50}{100}\right) + \$\,3.50 = \mathbf{\$\,18.50}$$

Let's look at a couple of practice problems.

Practice Problems

Calculate the selling price if the pharmacy is charging a 50% markup and a $5 professional fee.

1) The pharmacy purchases 500 tablets of 25 mg metoprolol tartrate for $40 and is dispensing 60 tablets to a patient. How much should the pharmacy charge?

2) The pharmacy purchases 30 capsules of 300 mg rifampin capsules for $56.70 and is dispensing 8 capsules to a patient. How much should the pharmacy charge?

1) $12.20 2) $27.68

Additionally, pharmacies may receive and/or offer various special discounts. There may be a reduced price offered by a wholesaler if a purchase exceeds a particular amount or some pharmacies may have a sale or reduced prices for various groups such as a discount for senior citizens. Maybe there is a discount for patients that transfer their prescriptions into a particular pharmacy. Let's look at several practice discount problems.

Examples

1) The pharmacy has switched wholesalers for its over the counter medications and want it wants to get rid of its old inventory. Normally the pharmacy sells its generic ibuprofen for $11.99 but is offering a flat rate discount of $3.00. What is the selling price?

$$retail\ price - flat\ rate\ discount = discount\ price$$

$$\$11.99 - \$3.00 = \mathbf{\$8.99}$$

2) For marketing purposes, the pharmacy wants to state what the percent discount is on the ibuprofen in the previous problem.

$$\frac{(retail\ price - discount\ price)}{retail\ price} = \frac{\%\ discount}{100}$$

$$\frac{(\$11.99 - \$8.99)}{\$11.99} = \frac{N}{100}$$
$$N = \mathbf{25\%\ \mathit{discount}}$$

3) The pharmacy offers a 10% discount to senior citizens on Wednesdays. On Wednesday a senior citizen purchases $32.87 worth of products. How much will they pay after their 10% discount?

$$retail\ price - (retail\ price \times percent\ percent) = discount\ price$$

$$\$32.87 - \left(\$32.87 \times \frac{10}{100}\right) = \mathbf{\$29.58}$$

Percent discounts tend to be very common and are therefore worth focusing on. Perform the necessary discount calculations below as we look at several practice problems.

Practice Problems

Several items are listed below with the price that Bidwell Pharmacy normally charges for each item. Perform the appropriate discount calculations below.

1) At Bidwell Pharmacy a 120 mL bottle of acetaminophen elixir 160 mg/5 mL retails for $9.45. What would the sale price be if it were given a 5% discount?

2) At Bidwell Pharmacy 2 packets of Goody's extra strength headache powder retail for $1.17. What would the sale price be if it were given a 5% discount?

3) Ordinarily Bidwell Pharmacy charges $7.50 for a 120 mL bottle of guaifenesin syrup 100 mg/5 mL 120 mL bottle but it is on sale for $7.13. What is the percent discount?

1) $8.98 2) $1.11 3) 5% discount

Worksheet 14-4

Name:

Date:

Perform the following markups for problems 1-10 with a 200% markup rate.

1) The purchase price for a medication is $4.99 after a 200% markup the selling price is __________

2) The purchase price for a medication is $12.47 after a 200% markup the selling price is __________

3) The purchase price for a medication is $35.20 after a 200% markup the selling price is __________

4) The purchase price for a medication is $89.90 after a 200% markup the selling price is __________

5) The purchase price for a medication is $120.47 after a 200% markup the selling price is __________

6) The purchase price for a medication is $27.50 after a 200% markup the selling price is __________

7) The purchase price for a medication is $68.50 after a 200% markup the selling price is __________

8) The purchase price for a medication is $153.50 after a 200% markup the selling price is __________

9) The purchase price for a medication is $67.12 after a 200% markup the selling price is __________

10) The purchase price for a medication is $127.30 after a 200% markup the selling price is __________

Perform the following markups for problems 11-20 with a 75% markup rate.

11) The purchase price for a medication is $25.50 after a 75% markup the selling price is __________

12) The purchase price for a medication is $118.70 after a 75% markup the selling price is __________

13) The purchase price for a medication is $195.20 after a 75% markup the selling price is __________

14) The purchase price for a medication is $162.50 after a 75% markup the selling price is __________

15) The purchase price for a medication is $188.95 after a 75% markup the selling price is __________

16) The purchase price for a medication is $135.20 after a 75% markup the selling price is __________

17) The purchase price for a medication is $199.41 after a 75% markup the selling price is __________

18) The purchase price for a medication is $207.33 after a 75% markup the selling price is __________

19) The purchase price for a medication is $211.65 after a 75% markup the selling price is __________

20) The purchase price for a medication is $472.50 after a 75% markup the selling price is __________

Determine the selling price of the prescriptions in problems 21-25 if the pharmacy is charging a 50% markup and a $5 professional fee.

21) The pharmacy purchases 100 tablets of diltiazem 90 mg for $10 and is dispensing 90 tablets to a patient. How much should the pharmacy charge?

22) The pharmacy purchases 90 capsules of acyclovir 200 mg for $13.50 and is dispensing 90 capsules to a patient. How much should the pharmacy charge?

23) The pharmacy purchases 1000 tablets of metformin 1000 mg for $50 and is dispensing 180 tablets to a patient. How much should the pharmacy charge?

24) The pharmacy purchases 30 tablets of amiodarone 200 mg for $99 and is dispensing 30 tablets to a patient. How much should the pharmacy charge?

25) The pharmacy purchases 100 tablets of atenolol 25 mg for $10 and is dispensing 30 tablets to a patient. How much should the pharmacy charge?

Perform the following discounts for problems 26-35 with a 5% discount rate.

26) The retail price for a medication is $14.97 after a 5% discount the discount price is __________

27) The retail price for a medication is $37.41 after a 5% discount the discount price is __________

28) The retail price for a medication is $105.60 after a 5% discount the discount price is __________

29) The retail price for a medication is $269.70 after a 5% discount the discount price is __________

30) The retail price for a medication is $361.41 after a 5% discount the discount price is __________

31) The retail price for a medication is $82.50 after a 5% discount the discount price is __________

32) The retail price for a medication is $205.50 after a 5% discount the discount price is __________

33) The retail price for a medication is $460.50 after a 5% discount the discount price is __________

34) The retail price for a medication is $201.36 after a 5% discount the discount price is __________

35) The retail price for a medication is $381.90 after a 5% discount the discount price is __________

Perform the following discounts for problems 36-45 with a 10% discount rate.

36) The retail price for a medication is $44.63 after a 10% discount the discount price is __________

37) The retail price for a medication is $207.73 after a 10% discount the discount price is __________

38) The retail price for a medication is $341.60 after a 10% discount the discount price is __________

39) The retail price for a medication is $284.38 after a 10% discount the discount price is __________

40) The retail price for a medication is $330.66 after a 10% discount the discount price is __________

41) The retail price for a medication is $236.60 after a 10% discount the discount price is __________

42) The retail price for a medication is $348.97 after a 10% discount the discount price is __________

43) The retail price for a medication is $362.83 after a 10% discount the discount price is __________

44) The retail price for a medication is $370.39 after a 10% discount the discount price is __________

45) The retail price for a medication is $826.88 after a 10% discount the discount price is __________

Solve the following problems.

46) If a medication is purchased for $25 and sold for $30 what was the percent markup?

47) If the purchase price for 100 tablets of a medication was $49.25 and the percent markup is 15%, then what is the selling price for 30 tablets?

48) If the discount on a wholesaler invoice for $9,300 was $310, what was the percent discount?

49) If your wholesaler offers you a 5% discount on orders over $5,000 how much would you expect your invoice to be for if you purchased $5,500 worth of product?

50) A senior citizen is paying for a prescription for penicillin VK 250 mg #30. The usual and customary price is $8.49. However this patient qualifies for a 10% discount. How much will the patient pay?

51) A wholesaler offers the pharmacy a 10% discount on orders of $14,400 or more, or a 15% discount on orders of $28,800. The pharmacy makes an $18,000 purchase, how much should its invoice be for?

Gross profits and net profits

In this section we will look at gross profits and net profits. Gross profit is calculated as sales minus all costs directly related to those sales or in simpler terms we can think of it as the difference between the selling price and the acquisition price.

$$\textit{selling price} - \textit{acquisition price} = \textbf{\textit{gross profit}}$$

Net profit is the difference between the gross profit and the sum of all the costs associated with filling the prescription. The costs associated with filling the prescription are accounted for with a dispensing fee or a professional fee. With that in mind you can determine the net profit by subtracting a professional fee from the gross profit.

$$\textit{gross profit} - \textit{dispensing fee} = \textbf{\textit{net profit}}$$

While many pharmacies will have a standard dispensing fee on all prescriptions, others may have a tiered dispensing fee placing a lower fee on less expensive medications and a higher fee on more expensive medications. Let's look at a couple of examples of each examples of each.

Examples

1) The pharmacy purchases 30 tablets of amiodarone 200 mg for $99 and is dispensing 30 tablets to a patient for $153.50. What is the gross profit? If the pharmacy charged a $5.00 dispensing fee what is the net profit?

$$\textit{selling price} - \textit{acquisition price} = \textbf{\textit{gross profit}}$$

$$\$153.50 - \$99 = \textbf{\$54.50}\ \textbf{\textit{gross profit}}$$

$$\textit{gross profit} - \textit{dispensing fee} = \textbf{\textit{net profit}}$$

$$\$54.50 - \$5.00 = \textbf{\$49.50}\ \textbf{\textit{net profit}}$$

2) The pharmacy purchases 100 tablets of diltiazem 90 mg for $10 and is dispensing 90 tablets to a patient for 18.50. What is the gross profit? If the pharmacy charged a $5.00 dispensing fee what is the net profit?

$$\textit{selling price} - \textit{acquisition price} = \textbf{\textit{gross profit}}$$

$$\$18.50 - \left(\frac{90\ \textit{tablets}}{1} \times \frac{\$10}{100\ \textit{tablets}}\right) = \textbf{\$9.50}\ \textbf{\textit{gross profit}}$$

$$\textit{gross profit} - \textit{dispensing fee} = \textbf{\textit{net profit}}$$

$$\$9.50 - \$5.00 = \textbf{\$4.50}\ \textbf{\textit{net profit}}$$

Some pharmacies may use a sliding scale for their dispensing fees based on the average wholesale price of a medication. Let's do a couple of example problems using this chart:

AWP	*Dispensing Fee*
Less than $20.00	$3.50
$20.00 - $50.00	$5.00
Greater than $50.00	$7.50

3) The pharmacy purchases 30 tablets of amiodarone 200 mg for $99 (its AWP is $112.00) and is dispensing 30 tablets to a patient for $153.50. What is the gross profit? If the pharmacy charges a tiered dispensing fee based on the average wholesale price what is the net profit?

$$\textit{selling price} - \textit{acquisition price} = \textbf{\textit{gross profit}}$$

$$\$\,153.50 - \$\,99 = \boldsymbol{\$\,54.50}\ \textbf{\textit{gross profit}}$$

$$\textit{gross profit} - \textit{dispensing fee} = \textbf{\textit{net profit}}$$

The AWP for 30 tablets is $112.00 so the dispensing fee is $7.50.

$$\$\,54.50 - \$\,7.50 = \boldsymbol{\$\,47.00}\ \textbf{\textit{net profit}}$$

4) The pharmacy purchases 100 tablets of diltiazem 90 mg for $10 (its AWP is $11 for 100 tablets) and is dispensing 90 tablets to a patient for 18.50. What is the gross profit? If the pharmacy charges a tiered dispensing fee based on the average wholesale price what is the net profit?

$$\textit{selling price} - \textit{acquisition price} = \textbf{\textit{gross profit}}$$

$$\$\,18.50 - \left(\frac{90\,\textit{tablets}}{1} \times \frac{\$\,10}{100\,\textit{tablets}}\right) = \boldsymbol{\$\,9.50}\ \textbf{\textit{gross profit}}$$

$$\textit{gross profit} - \textit{dispensing fee} = \textbf{\textit{net profit}}$$

The AWP for is $\frac{90\,\textit{tablets}}{1} \times \frac{\$\,11}{100\,\textit{tablets}} = \$\,9.90$ so the dispensing fee is $3.50.

$$\$\,9.50 - \$\,3.50 = \boldsymbol{\$\,6.00}\ \textbf{\textit{net profit}}$$

Now that we've looked at some examples you should try several practice problems.

Practice Problems

1) The pharmacy purchases 90 capsules of acyclovir 200 mg for $13.50 and is dispensing 90 capsules to a patient for $25.25. What is the gross profit? If the pharmacy charged a $5.00 dispensing fee what is the net profit?

2) The pharmacy purchases 1000 tablets of a medication for $50 and is dispensing 180 tablets to a patient for $18.50. What is the gross profit? If the pharmacy charged a $5.00 dispensing fee what is the net profit?

Some pharmacies may use a sliding scale for their dispensing fees based on the average wholesale price of a medication. Let's do a couple of practice problems using this chart:

AWP	*Dispensing Fee*
Less than $20.00	$3.50
$20.00 - $50.00	$5.00
Greater than $50.00	$7.50

3) The pharmacy purchases 90 capsules of acyclovir 200 mg for $13.50 (its AWP is $15.00) and is dispensing 90 capsules to a patient for $25.25. What is the gross profit? If the pharmacy charges a tiered dispensing fee based on the average wholesale price what is the net profit?

4) The pharmacy purchases 1000 tablets of a medication for $50 (its AWP is $55.00 for 1000 tablets) and is dispensing 180 tablets to a patient for $18.50. What is the gross profit? If the pharmacy charges a tiered dispensing fee based on the average wholesale price what is the net profit?

1) gross profit = $11.75; net profit = $6.75 2) gross profit = $9.50; net profit = $4.50
3) gross profit = $11.75; net profit = $8.25 4) gross profit = $9.50; net profit = $6.00

Worksheet 14-5

Name:

Date:

Solve for the gross profit and the net profit for problems 1-20 using a set dispensing fee of $5.

1) The pharmacy purchased 25 nebulizer vials of albuterol inhalation solution for $27.90 and sold 25 vials for $46.85. What is the gross profit? What is the net profit?

2) The pharmacy purchased 20 tablets of carisoprodol 350 mg for $37.26 and sold 20 tablets for $60.89. What is the gross profit? What is the net profit?

3) The pharmacy purchased 100 tablets of E.E.S. 400 mg for $21.06 and sold 28 tablets for $12.35. What is the gross profit? What is the net profit?

4) The pharmacy purchased 100 capsules of fluoxetine 20 mg for $223.56 and sold 30 capsules for $108.10. What is the gross profit? What is the net profit?

5) The pharmacy purchased 100 tablets of glyburide 5 mg for $25.48 and sold 30 tablets for $16.47. What is the gross profit? What is the net profit?

6) The pharmacy purchased 100 tablets of levothyroxine 100 mcg for $26.87 and sold 30 tablets for $15.59. What is the gross profit? What is the net profit?

7) The pharmacy purchased 1000 tablets of metformin 500 mg for $633.40 and sold 60 tablets for $62.01. What is the gross profit? What is the net profit?

8) The pharmacy purchased 100 tablets of metoprolol tartrate 25 mg for $6.48 and sold 60 tablets for $9.33. What is the gross profit? What is the net profit?

9) The pharmacy purchased a 50 mL bottle of ondansetron oral solution 4 mg/5 mL for $242.77 and sold 1 fl. oz. for $225.99. What is the gross profit? What is the net profit?

10) The pharmacy purchased 100 tablets of quetiapine 200 mg for $631.49 and sold 30 tablets for $291.67. What is the gross profit? What is the net profit?

11) The pharmacy purchased 100 tablets of risperidone 2 mg for $638.96 and sold 30 tablets for $295.03. What is the gross profit? What is the net profit?

12) The pharmacy purchased 100 tablets of sertraline 50 mg for $244.11 and sold 30 tablets for $117.35. What is the gross profit? What is the net profit?

13) The pharmacy purchased 30 tablets of sildenafil citrate 100 mg for $324.81 and sold 4 tablets for $72.46. What is the gross profit? What is the net profit?

14) The pharmacy purchased 100 tablets of tramadol 50 mg for $27.61 and sold 60 tablets for $28.34. What is the gross profit? What is the net profit?

15) The pharmacy purchased 60 tablets of zidovudine 300 mg for $197.12 and sold 60 tablets for $303.18. What is the gross profit? What is the net profit?

16) The pharmacy purchased 100 tablets of atenolol 50 mg for $9.52 and sold 30 tablets for $7.78. What is the gross profit? What is the net profit?

17) The pharmacy purchased 100 capsules of benzonatate 100 mg for $39.48 and sold 30 capsules for $21.27. What is the gross profit? What is the net profit?

18) The pharmacy purchased 100 tablets of cyclobenzaprine 5 mg for $147.81 and sold 30 tablets for $71.51. What is the gross profit? What is the net profit?

19) The pharmacy purchased 100 tablets of furosemide 20 mg for $5.07 and sold 30 tablets for $5.78. What is the gross profit? What is the net profit?

20) The pharmacy purchased 100 tablets of hydrochlorothiazide 25 mg for $1.58 and sold 60 tablets for $4.92. What is the gross profit? What is the net profit?

Solve for the gross profit and the net profit for problems 21-40 using the tiered dispensing fees on the chart below based on the average wholesale price.

AWP	*Dispensing Fee*
Less than $20.00	$3.50
$20.00 - $50.00	$5.00
Greater than $50.00	$7.50

21) The pharmacy purchased 25 nebulizer vials of albuterol inhalation solution for $27.90 (the AWP is $31.00 for 25 vials) and sold 25 vials for $46.85. What is the gross profit? What is the net profit?

22) The pharmacy purchased 20 tablets of carisoprodol 350 mg for $37.26 (the AWP for 20 tablets is $41.40) and sold 20 tablets for $60.89. What is the gross profit? What is the net profit?

23) The pharmacy purchased 100 tablets of E.E.S. 400 mg for $21.06 (the AWP for 100 tablets is $23.46) and sold 28 tablets for $12.35. What is the gross profit? What is the net profit?

24) The pharmacy purchased 100 capsules of fluoxetine 20 mg for $223.56 (the AWP for 100 capsules is $248.40) and sold 30 capsules for $108.10. What is the gross profit? What is the net profit?

25) The pharmacy purchased 100 tablets of glyburide 5 mg for $25.48 (the AWP for 100 tablets is $28.31) and sold 30 tablets for $16.47. What is the gross profit? What is the net profit?

26) The pharmacy purchased 100 tablets of levothyroxine 100 mcg for $26.87 (the AWP for 100 tablets is $29.85) and sold 30 tablets for $15.59. What is the gross profit? What is the net profit?

27) The pharmacy purchased 1000 tablets of metformin 500 mg for $633.40 (the AWP for 1000 tablets is $703.78) and sold 60 tablets for $62.01. What is the gross profit? What is the net profit?

28) The pharmacy purchased 100 tablets of metoprolol tartrate 25 mg for $6.48 (the AWP for 100 tablets is $7.20) and sold 60 tablets for $9.33. What is the gross profit? What is the net profit?

29) The pharmacy purchased a 50 mL bottle of ondansetron oral solution 4 mg/5 mL for $242.77 (the AWP for 50 milliliters is $269.74) and sold 1 fl. oz. for $225.99. What is the gross profit? What is the net profit?

30) The pharmacy purchased 100 tablets of quetiapine 200 mg for $631.49 (the AWP for 100 tablets is $701.65) and sold 30 tablets for $291.67. What is the gross profit? What is the net profit?

31) The pharmacy purchased 100 tablets of risperidone 2 mg for $638.96 (the AWP for 100 tablets is $709.96) and sold 30 tablets for $295.03. What is the gross profit? What is the net profit?

32) The pharmacy purchased 100 tablets of sertraline 50 mg for $244.11 (the AWP for 100 tablets is $271.23) and sold 30 tablets for $117.35. What is the gross profit? What is the net profit?

33) The pharmacy purchased 30 tablets of sildenafil citrate 100 mg for $324.81 (the AWP for 30 tablets is $360.90) and sold 4 tablets for $72.46. What is the gross profit? What is the net profit?

34) The pharmacy purchased 100 tablets of tramadol 50 mg for $27.61 (the AWP for 100 tablets is $30.68) and sold 60 tablets for $28.34. What is the gross profit? What is the net profit?

35) The pharmacy purchased 60 tablets of zidovudine 300 mg for $197.12 (the AWP for 60 tablets is $219.02) and sold 60 tablets for $303.18. What is the gross profit? What is the net profit?

36) The pharmacy purchased 100 tablets of atenolol 50 mg for $9.52 (the AWP for 100 tablets is $10.58) and sold 30 tablets for $7.78. What is the gross profit? What is the net profit?

37) The pharmacy purchased 100 capsules of benzonatate 100 mg for $39.48 (the AWP for 100 capsules is $43.87) and sold 30 capsules for $21.27. What is the gross profit? What is the net profit?

38) The pharmacy purchased 100 tablets of cyclobenzaprine 5 mg for $147.81 (the AWP for 100 tablets is $164.23) and sold 30 tablets for $71.51. What is the gross profit? What is the net profit?

39) The pharmacy purchased 100 tablets of furosemide 20 mg for $5.07 (the AWP for 100 tablets is $5.63) and sold 30 tablets for $5.78. What is the gross profit? What is the net profit?

40) The pharmacy purchased 100 tablets of hydrochlorothiazide 25 mg for $1.58 (the AWP for 100 tablets is $1.75) and sold 60 tablets for $4.92. What is the gross profit? What is the net profit?

Third party reimbursement

Currently, approximately 80% of Americans have health care insurance including some kind of prescription benefits and this number is expected to increase in coming years due to the Affordable Health Care for America Act. With this in mind we need to look at how we should be billing prescriptions for patients with insurance. Insurance companies know that for most medications the average wholesale price (AWP) is less than what the typical usual and customary (U&C) price, but they are also aware that some pharmacies offer certain prescriptions below their AWP (such as $4.00 generics offered by some of the chains). Most insurances are going to reimburse the pharmacy based on whichever is less.

Every pharmacy and insurance company may negotiate their own reimbursement rates, so there is no singular set formula for all insurances. A typical formula may be something along the lines of:

$$87\%\, AWP\ or\ 100\%\, U\&C\,(whichever\ is\ less)+a\ \$3.50\ dispensing\ fee=\boldsymbol{reimbursement\ rate}$$

Let's use the above formula for an example.

Example

1) A patient receives a prescription for thirty hydrochlorothiazide 25 mg. The retail price for 30 tablets is $0.72 whereas the AWP for 100 tablets is $1.75. Determine the charge for this medication based on the aforementioned insurance calculation.

   87% of AWP
   $$\frac{30\,tablets}{1}\times\frac{\$1.75}{100\,tablets}\times\frac{87}{100}=\$0.46$$

   100% of U&C
   $$\frac{30\,tablets}{1}\times\frac{\$0.72}{30\,tablets}=\$0.72$$

   87% of the AWP is less so then we can add our $3.50 dispensing fee.
   $\$0.46+\$3.50=\boldsymbol{\$3.96}$

Now you should attempt a couple of practice problems.

Practice Problems

Continue using the following sample equation for the practice problems:

$$87\%\, AWP\ or\ 100\%\, U\&C\,(whichever\ is\ less)+a\ \$3.50\ dispensing\ fee=\boldsymbol{reimbursement\ rate}$$

1) A patient receives a prescription for sixty 500 mg metformin tablets. The pharmacy offers certain medications on their $4.00 prescription plan including these 60 tablets. The AWP for this medication is $703.78 for 1000 tablets. How much will the patient's insurance reimburse for this medication?

2) A patient receives a prescription for thirty furosemide 20 mg tablets. The U&C on this product before a dispensing fee is added is $2.28. The AWP for 100 tablets is $5.07. How much should the patient's insurance reimburse for this prescription?

1) $7.50   2) $4.82

Capitation fee

A capitation fee is another concept to give consideration to for third-party reimbursement. A capitation fee is a method of payment for health services in which an individual or institutional provider is paid a fixed amount without regard to the actual number or nature of services provided to each patient. A common example would be a pharmacy in a long term care home receiving a fixed amount of money per month regardless of whether the patient required no pharmaceuticals or if there prescriptions exceeded the money allotted by a capitation fee.

To demonstrate this concept attempt the practice problems below.

Practice Problems

1) Bidwell Senior Care Pharmacy receives a monthly capitation fee of $250.00/month for Theophyllus Monk. Last month Mr. Monk's prescriptions totaled $198.75. How much did the pharmacy make off of his capitation fee?

2) Bidwell Senior Care Pharmacy receives a monthly capitation fee of $250.00/month for Alopecia Allen. Last month Mr. Allen's prescriptions totaled $301.25. How much did the pharmacy make off of his capitation fee?

1) The pharmacy had a profit margin of $51.25 on Theophyllus Monk's prescriptions.   2) The pharmacy had a loss of $51.25 on Alopecia Allen's prescriptions.

Worksheet 14-6

Name:

Date:

Solve problems 1-20 using the sample formula below for third-party reimbursement:

$$87\%\ AWP\ or\ 100\%\ U\&C\ (whichever\ is\ less) + a\ \$\,3.50\ dispensing\ fee = \textbf{reimbursement rate}$$

1) A pharmacy receives a prescription for 25 nebulizer vials of albuterol inhalation solution. The U&C on this product before a dispensing fee is added is $41.85. The AWP for 25 vials is $31.00. How much should the patient's insurance reimburse for this prescription?

2) A pharmacy receives a prescription for 20 tablets of carisoprodol 350 mg. The U&C on this product before a dispensing fee is added is $55.89. The AWP for 20 tablets is $41.40. How much should the patient's insurance reimburse for this prescription?

3) A pharmacy receives a prescription for 40 erythromycin 400 mg tablets. This product is part of this pharmacy's $4.00 plan. The AWP for 100 tablets is $23.46. How much should the patient's insurance reimburse for this prescription?

4) A pharmacy receives a prescription for 30 capsules of fluoxetine 20 mg. The U&C on this product before a dispensing fee is added is $100.60. The AWP for 100 capsules is $248.40. How much should the patient's insurance reimburse for this prescription?

5) A pharmacy receives a prescription for 30 tablets of 5 mg glyburide. This product is part of this pharmacy's $4.00 plan. The AWP for 100 tablets is $28.31. How much should the patient's insurance reimburse for this prescription?

6) A pharmacy receives a prescription for 30 tablets of levothyroxine 100 mcg tablets. The U&C on this product before a dispensing fee is added is $12.09. The AWP for 100 tablets is $29.85.

How much should the patient's insurance reimburse for this prescription?

7) A pharmacy receives a prescription for 30 tablets of metoprolol succinate 25 mg tablets. The U&C on this product before a dispensing fee is added is $35.29. The AWP for 1000 tablets is $871.40. How much should the patient's insurance reimburse for this prescription?

8) A pharmacy receives a prescription for 60 tablets of metoprolol tartrate 25 mg tablets. The U&C on this product before a dispensing fee is added is $5.83. The AWP for 100 tablets is $7.20. How much should the patient's insurance reimburse for this prescription?

9) A pharmacy receives a prescription for 1 fl. oz. of ondansetron oral solution 4 mg/5 mL. The U&C on this product before a dispensing fee is added is $218.49. The AWP for 50 mL is $269.74. How much should the patient's insurance reimburse for this prescription?

10) A pharmacy receives a prescription for thirty quetiapine 200 mg tablets. The U&C on this product before a dispensing fee is added is $284.17. The AWP for 100 tablets is $701.65. How much should the patient's insurance reimburse for this prescription?

11) A pharmacy receives a prescription for 30 tablets of risperidone 2 mg. The U&C on this product before a dispensing fee is added is $295.03. The AWP for 100 tablets is $709.96. How much should the patient's insurance reimburse for this prescription?

12) A pharmacy receives a prescription for 30 tablets of sertraline 50 mg. The U&C on this product before a dispensing fee is added is $109.85. The AWP for 100 tablets is $271.23. How much should the patient's insurance reimburse for this prescription?

13) A pharmacy receives a prescription for 4 tablets of sildenafil citrate 100 mg. The U&C on this product before a dispensing fee is added is $64.96. The AWP for 30 tablets is $72.46. How much should the patient's insurance reimburse for this prescription?

14) A pharmacy receives a prescription for 60 tablets of tramadol 50 mg. The U&C on this product before a dispensing fee is added is $23.34. The AWP for 100 tablets is $30.68. How much should the patient's insurance reimburse for this prescription?

15) A pharmacy receives a prescription for 60 tablets of zidovudine 300 mg. The U&C on this product before a dispensing fee is added is $295.68. The AWP for 60 tablets is $219.02. How much should the patient's insurance reimburse for this prescription?

16) A pharmacy receives a prescription for 30 tablets of atenolol 50 mg. This product is part of this pharmacy's $4.00 plan. The AWP for 100 tablets is $10.58. How much should the patient's insurance reimburse for this prescription?

17) A pharmacy receives a prescription for 30 capsules of benzonatate 100 mg. The U&C on this product before a dispensing fee is added is $17.77. The AWP for 100 capsules is $43.87. How much should the patient's insurance reimburse for this prescription?

18) A pharmacy receives a prescription for 30 tablets of cyclobenzaprine 5 mg. The U&C on this product before a dispensing fee is added is $64.01. The AWP for 100 tablets is $164.23. How much should the patient's insurance reimburse for this prescription?

19) A pharmacy receives a prescription for 30 tablets of furosemide 40 mg. This product is part of this pharmacy's $4.00 plan. The AWP for 100 tablets is $5.99. How much should the patient's insurance reimburse for this prescription?

20) A pharmacy receives a prescription for 60 tablets of hydrochlorothiazide 25 mg. The U&C on this product before a dispensing fee is added is $1.42. The AWP for 100 tablets is $1.75. How much should the patient's insurance reimburse for this prescription?

Determine the profit margin based on the capitation fees in problems 21 and 22.

21) Fred's Pharmacy receives a capitation fee of $500.00 for filling Senile Sally's prescriptions each month. Last month she required six medications with the following associated costs:

Aricept 10 mg = $200
Lipitor 40 mg = $125
Digoxin 250 mcg = $7
Furosemide 20 mg = $4
Celebrex 200 mg = $115
Nexium 40 mg = $170

What was the profit margin for Sally's prescriptions last month?

22) The Grainger House pays a capitation fee of $275.00 per month per patient to Epocrates's Apothecary. Epocrates's Apothecary services 10 patients for the Grainger House. The pharmacy filled prescriptions for five clients last month (the other five had no prescriptions). The costs for these patients' prescriptions are as follows:

Patient ABK: $89.63
Patient BTC: $126.54
Patient MBC: $420.45
Patient SEP: $170.85
Patient BRS: $39.90

a) What is the total capitation received?

b) What is the cost to the Epocrates's Apothecary?

c) What was the loss or gain to Epocrates's Apothecary for servicing the Grainger House?

Daily cash reports

In many community pharmacy settings you will be expected to assist with the the daily cash reports for the store. The process of counting the money, reconciling the receipts and balancing the cash drawer creates an accountability of the day's transactions.

In order to do the cash report you will need to collect the following data:

- opening and closing readings for each register
- cash and checks
- bank charges and credit cards
- other charges
- paid outs
- coupons
- discounts
- voids
- refunds
- and over-rings

Whenever you are balancing a cash report, you should always double check your vertical and horizontal totals. Below is an example cash report, please finish filling it in and compare it to the cash report on the next page to see if you filled everything out correctly. This report include operators to help.

	Register 1	Register 2	Register 3	Total
+ Cash and Checks	1513.12	45.12	2002.02	
+ Bank Charges	120.00	---	350.44	
+ House Charges	---	---	---	
+ Paid Outs	---	---	---	
Total				
+ Closing Reading	1,760.02	95.12	2402.50	
- Opening Reading	50.00	50.00	50.00	
= Difference				
- Coupons	1.10	---	---	
- Discounts	8.90	---	---	
- Voids	10.00	---	---	
- Refunds	---	---	---	
- Over-Rings	56.65	---	---	
Total				
Over + or Short -				

The following table is the completed version of the cash report on the previous page.

	Register 1	**Register 2**	**Register 3**	**Total**
+ Cash and Checks	1,513.12	45.12	2002.02	*3,560.26*
+ Bank Charges	120.00	---	350.44	*470.44*
+ House Charges	---	---	---	*0.00*
+ Paid Outs	---	---	---	*0.00*
Total	*1,633.12*	*45.12*	*2,352.46*	*4,030.70*
+ Closing Reading	1,760.02	95.12	2,402.50	*4,257.64*
- Opening Reading	50.00	50.00	50.00	*150.00*
= Difference	*1,710.02*	*45.12*	*2,352.50*	*4,107.64*
- Coupons	1.10	---	---	*1.10*
- Discounts	8.90	---	---	*8.90*
- Voids	10.00	---	---	*10.00*
- Refunds	---	---	---	*0.00*
- Over-Rings	56.65	---	---	*56.65*
Total	*1,633.37*	*45.12*	*2,352.50*	*4,030.99*
Over + or Short -	*-0.25*	*0.00*	*-0.04*	*-0.29*

All the answers that you should have filled in on the previous page are italicized above. You can achieve all of your vertical numbers by following the operators listed in the first column and then you can determine if the register is over or short by subtracting the total on the bottom half from the total on the top half. Horizontally all your numbers are achieved by adding across. The highlighted points on the table are excellent places to check your numbers both vertically and horizontally to make sure you didn't make any simple mistakes.

Something worth noting is that two of the registers are off (register 1 is short $0.25 and register 3 is short $0.04). Most stores are forgiving up to some small amount (typically $2.00 per register). If the register is off by more than that someone will have to figure out, “*Why?*”, which could range from a missing credit card receipt, to human error or even employee theft!

Worksheet 14-7

Name:

Date:

Balance the following cash reports.

1)	Register 1	Register 2	Register 3	Total
+ Cash and Checks	513.12	---	300.44	
+ Bank Charges	120.00	90.00	---	
+ House Charges	---	---	52.02	
+ Paid Outs	---	5.12	---	
Total				
+ Closing Reading	760.02	145.12	402.50	
- Opening Reading	50.00	50.00	50.00	
= Difference				
- Coupons	---	---	---	
- Discounts	8.90	---	---	
- Voids	10.00	---	---	
- Refunds	---	---	---	
- Over-Rings	56.65	---	---	
Total				
Over + or Short -				

2)	Register 1	Register 2	Register 3	Total
+ Cash and Checks	3,897.65	12.00	1,533.12	
+ Bank Charges	2,111.05	96.67	140.00	
+ House Charges	25.00	---	---	
+ Paid Outs	---	---	---	
Total				
+ Closing Reading	6,121.47	158.70	1,800.02	
- Opening Reading	50.00	50.00	50.00	
= Difference				
- Coupons	14.25	---	1.10	
- Discounts	23.47	---	8.90	
- Voids	---	---	10.00	
- Refunds	---	---	---	
- Over-Rings	---	---	56.65	
Total				
Over + or Short -				

3)	Register 1	Register 2	Register 3	Total
+ Cash and Checks	1,713.12	45.12	2,002.18	
+ Bank Charges	240.00	20.00	350.44	
+ House Charges	---	---	---	
+ Paid Outs	---	---	10.00	
Total				
+ Closing Reading	2,172.67	115.12	2,429.66	
- Opening Reading	50.00	50.00	50.00	
= Difference				
- Coupons	---	---	7.00	
- Discounts	130.00	---	---	
- Voids	27.50	---	---	
- Refunds	12.00	---	---	
- Over-Rings	---	---	10.00	
Total				
Over + or Short -				

4)	Register 1	Register 2	Register 3	Total
+ Cash and Checks	1234.56	789.01	234.56	
+ Bank Charges	789.01	234.56	78.90	
+ House Charges	---	---	25.00	
+ Paid Outs	20.00	10.00	---	
Total				
+ Closing Reading	2,116.45	1,091.03	390.43	
- Opening Reading	50.00	50.00	50.00	
= Difference				
- Coupons	2.50	1.75	---	
- Discounts	12.34	5.67	---	
- Voids	---	---	---	
- Refunds	8.00	---	---	
- Over-Rings	---	---	---	
Total				
Over + or Short -				

Calculating dispensing fees

Pharmacies need to offset the costs of doing business through dispensing fees. This represents the charge for the professional services provided by the pharmacy when dispensing a prescription and includes a distribution of the costs involved in running the pharmacy such as salaries, rent, utilities, costs associated with maintaining the computer system, etc. This is sometimes also referred to as a professional fee. While some pharmacies will create tiered dispensing fees (like we did in some of our earlier worksheets) most pharmacies will use just a flat rate dispensing fee for all prescriptions as it requires the same amount of labor to fill a low cost medication as it does to fill a higher cost medication.

A common formula for calculating a pharmacy's dispensing fee is:

$$\frac{Labor\ Expenses + Direct\ Expenses + Indirect\ Expenses}{Quantity\ of\ Prescriptions\ Filled\ Annually} = dispensing\ fee$$

- *Labor Expenses* = These are the wages paid to all pharmacy staff.
- *Direct Expenses* = This include items like the cost of the vials and the costs involved in maintaining the pharmacy computer system.
- *Indirect Expenses* = This are fixed items such as rent and utilities.

Let's use this formula for an example problem.

Example

1) Calculate the dispensing fee for a pharmacy with the following annual expenses if they filled 54,000 prescriptions annually.

   Labor Expenses:
   Wages for 1.6 pharmacists = $129,600.00
   Wages for 1.0 technician = $43,200.00
   5% match into 401k = $8,640.00
   Healthcare contribution = $29,664.00
   Total = $129,600.00 + $43,200.00 + $8,640.00 + $29,664.00 = **$211,104.00**
   Direct Expenses:
   Vials and caps = $\frac{\$0.12}{perscription} \times \frac{54{,}000\ prescriptions}{1}$ = $6,480.00
   Labels, patient information, bags = $5,614.39
   Computer system = $2,000.00
   Total = $6,480.00 + $5,614.39 + $2,000.00 = **$14,094.39**
   Indirect Expenses:
   Rent = $33,600.00
   Utilities = $9,000.00
   Property insurance = $1,800.00
   Total = $33,600.00 + $9,000.00 + $1,800.00 = **$44,400.00**

$$\frac{Labor\ Expenses + Direct\ Expenses + Indirect\ Expenses}{Quantity\ of\ \ Prescriptions\ Filled\ Annually} = dispensing\ fee$$

$$\frac{\$211{,}104.00 + \$14{,}094.39 + \$44{,}400.00}{54{,}000} = \boldsymbol{\$5.00\ dispensing\ fee}$$

Now that the calculation for determining a dispensing fee has been demonstrated, use the same method to calculate the dispensing fee in a practice problem below.

Practice Problem

1) Calculate the dispensing fee for a pharmacy with the following annual expenses if they filled 79,800 prescriptions annually.

Labor Expenses:
- Wages for pharmacists = $132,192.00
- Wages for technicians = $58,752.00
- Cost of benefits = $50,088.00

Direct Expenses:
- Vials and caps = $\frac{\$0.12}{perscription} \times \frac{79{,}800\ prescriptions}{1}$ = $9,576.00
- Labels, patient information, bags = $8,296.83
- Computer system = $2,000.00

Indirect Expenses:
- Rent = $33,600.00
- Utilities = $9,000.00
- Property insurance = $1,800.00

1) $3.83 dispensing fee

Depreciation

Depreciation is the decline in value of assets over time. Some items in a pharmacy lose value and eventually need to be replaced due to use, obsolescence, and the passage of time. The straight-line method of calculating depreciation uses the total cost, the estimated life of the property (in years), and the disposal value. Below is the formula you will need for this method:

$$\frac{total\ cost - disposal\ value}{estimated\ life} = \boldsymbol{annual\ depreciation}$$

Let's look at an example using the aforementioned formula.

Example

1) A pharmacy purchases a 4 cylinder sedan for drug deliveries to customers. The cost of the car is $11,965.00. Its estimated useful life is five years, and the resale value after five years is expected to be $2,632.30. What is the annual depreciation?

$$\frac{\$11{,}965.00 - \$2{,}632.30}{5} = \boldsymbol{\$\,1{,}866.54\,\textit{is}\,\textbf{the}\,\textit{annual depreciation}}$$

Now you should attempt a practice problem below.

Practice Problem

1) A Pharmacy purchases 3 workstations, a server, a printer, and various scanners in order to process prescriptions, maintain medication inventories, and various other functions related to running the pharmacy. These items cost the pharmacy approximately $6,000.00. The pharmacy's expectations is that this equipment will last five years and have negligible value after those five years are up (use $0.00 for the disposal value). What is the annual depreciation?

1) $1,200.00 is the annual depreciation of this computer equipment

Worksheet 14-8

Name:

Date:

Solve the following problems.

1) Calculate the dispensing fee for a pharmacy with the following annual expenses if they filled 54,900 prescriptions annually.

   Labor Expenses:

   Wages for pharmacists = $108,000.00

   Wages for technicians = $48,000.00

   Cost of benefits = $35,772.00

   Direct Expenses:

   Vials and caps = $\frac{\$0.12}{perscription} \times \frac{54{,}900\ prescriptions}{1}$ = $6,588.00

   Labels, patient information, bags = $5,707.97

   Computer system = $2,000.00

   Indirect Expenses:

   Rent = $12,600.00

   Utilities = $2,400.00

   Insurances = $5,520.00

2) Calculate the dispensing fee for a pharmacy with the following annual expenses if they filled 79,800 prescriptions annually.

   Labor Expenses:

   Wages for pharmacists = $132,192.00

   Wages for technicians = $58,752.00

   Cost of benefits = $50,088.00

   Direct Expenses:

   Vials and caps = $\frac{\$0.12}{perscription} \times \frac{79{,}800\ prescriptions}{1}$ = $9,576.00

   Labels, patient information, bags = $8,296.83

   Computer system = $2,000.00

   Indirect Expenses:

   Rent = $12,600.00

   Utilities = $2,400.00

   Insurances = $5,520.00

3) The pharmacy has a new point of sale (POS) system. The system cost $8,294.00 and should last six years. Its disposal value is $2,138.00. What is the annual depreciation?

4) A pharmacy purchased a new barrier isolator for $9,175.00 and is expected to last 12 years if properly maintained. Its disposal value is $1,567.00. What is the annual depreciation?

Worksheet 14-9

Name:

Date:

Match the definitions with their proper terms.

_____ 1) This represents the charge for the professional services provided by the pharmacy when dispensing a prescription.

_____ 2) The pharmacy must stock or have ready access to, all drugs that may be written by the physicians in their practice area.

_____ 3) This is reimbursement for services rendered to a person in which another entity is responsible for the payment.

_____ 4) OSHA required notices on hazardous substances.

_____ 5) This is calculated as sales minus all costs directly related to those sales.

_____ 6) A system that maintains a continuous count of every item in inventory so that it always shows the stock on hand.

_____ 7) This involves an agreement for a specified percentage or dollar volume of purchases.

_____ 8) The ordering of products for use or sale by the pharmacy and is carried out an independent or group process.

_____ 9) This enables the pharmacy to use a single source to purchase products from numerous manufacturers.

_____ 10) This is the difference between the gross profit and the sum of all the costs associated with filling the prescription.

_____ 11) A government agency within the U.S. Department of Labor responsible for maintaining safe & healthy work places.

_____ 12) The total value of the drugs and merchandise in stock on a given day.

_____ 13) This is commonly known as the retail price and is the price paid for a prescription by a patient without insurance.

_____ 14) This is the decline in value of assets.

_____ 15) These require a DEA 222 form for reordering. Their stock must be continually monitored and documented.

_____ 16) This is the average price at which wholesalers typically sell medications to pharmacies.

_____ 17) Money spent to acquire or upgrade physical assets such as property, fixtures, or machinery

_____ 18) The drug inventory is limited to a list of approved medications.

_____ 19) A list of medications available for use within a health care system.

_____ 20) This entails ordering medications directly from the original drug manufacturer.

_____ 21) This is simply the entire stock on hand for sale at a given time.

_____ 22) Minimum and maximum stock levels which determine when a reorder is placed and for how much.

_____ 23) A method of payment for health services in which an individual or institutional provider is paid a fixed amount without regard to the actual number or nature of services provided to each patient.

a) average wholesale price
b) capital expenditures
c) capitation fee
d) closed formulary
e) depreciation
f) direct purchasing
g) dispensing fee
h) formulary
i) gross profit
j) inventory
k) inventory value
l) Material Safety Data Sheet (MSDS)
m) net profit
n) Occupational Safety and Health Administration (OSHA)
o) open formulary
p) perpetual inventory
q) prime vendor purchasing
r) purchasing
s) reorder point
t) schedule II medications
u) third party reimbursement
v) usual and customary price
w) wholesaler purchasing

Determine how much of each medication to reorder based on the package size and the minimum and maximum quantities the pharmacy wants to stock. Reorder medications when they reach the minimum.

	Medications	Package Size	Minimum # Units	Maximum # Units	Current Inventory	Re-order
24)	ramipril 5 mg cap	100	120	240	64	
25)	captopril 50 mg tab	100	150	300	76	
26)	doxazosin 2 mg tab	100	80	240	83	
27)	simvastatin 20 mg tab	100	360	500	190	
28)	simvastatin 40 mg tab	100	180	440	304	

Calculate how many times each of the following pharmacies turnover their inventory on an annual basis.

29) If April's Apothecary has an average inventory for the last year was $101,643.18 and the annual cost total was $1,168,896.70, what was the turnover rate?

30) If Drummond's Drug Store has an average inventory for the last year was $168,875.20 and the annual cost total was $2,026,402.40, what was the turnover rate?

Perform the following days' supply of inventory calculations.

31) April's Apothecary has a total inventory value of $101,643.30. Last week the pharmacy had sales of $26,974.54, and the cost to the pharmacy for the products sold came to $22,478.79. April's goal is to have a 35 days' supply of inventory. How many days' supply does April have? How much is she over or under her goal in dollars?

32) Drummond's Drug Store has a total inventory value of $168,874.98. Last week the pharmacy had sales of $45,955.44, and the cost to the pharmacy for the products sold came to $38,971.20. Drummond's goal is to have a 30 days' supply of inventory. How many days' supply does Drummond have? How much is he over or under his goal in dollars?

Answer the following questions.

33) How are Schedule II medications ordered?

34) How are Schedule III-V medications ordered?

35) How are controlled substances checked into the pharmacy?

36) How are controlled substances to be stored?

37) What are the major environmental considerations with respect to medications?

38) Define freezer, refrigerated, and controlled room temperature.

39) If two medications had an expiration of 02/2020 and 02/28/2020 which medication would expire first and why?

Solve the following markup and discount questions.

40) If a medication is purchased for $25 and sold for $35 what was the percent markup?

41) If the purchase price for 100 tablets of a medication was $49.25 and the percent markup is 25%, then what is the selling price for 30 tablets?

42) If the discount on a wholesaler invoice for $12,300 was $369, what was the percent discount?

43) If your wholesaler offers you a 5% discount on orders over $5,000 how much would you expect

your invoice to be for if you purchased $6,500 worth of product?

44) A senior citizen is paying for a prescription for furosemide 30 mg #30. The usual and customary price is $5.00. However this patient qualifies for a 10% discount. How much will the patient pay?

45) A wholesaler offers the pharmacy a 10% discount on orders of $14,400 or more, or a 15% discount on orders of $28,800. The pharmacy makes an $19,800 purchase, how much should its invoice be for?

Solve for the gross profit and the net profit for problems 46-51 using a set dispensing fee of $5.

46) The pharmacy purchased 25 nebulizer vials of albuterol inhalation solution for $25.90 and sold 25 vials for $46.85. What is the gross profit? What is the net profit?

47) The pharmacy purchased 20 tablets of carisoprodol 350 mg for $35.26 and sold 20 tablets for $60.89. What is the gross profit? What is the net profit?

48) The pharmacy purchased 100 tablets of E.E.S. 400 mg for $19.06 and sold 28 tablets for $12.35. What is the gross profit? What is the net profit?

49) The pharmacy purchased 100 capsules of fluoxetine 20 mg for $213.56 and sold 30 capsules for $108.10. What is the gross profit? What is the net profit?

50) The pharmacy purchased 100 tablets of glyburide 5 mg for $22.48 and sold 30 tablets for $16.47. What is the gross profit? What is the net profit?

51) The pharmacy purchased 100 tablets of levothyroxine 100 mcg for $24.87 and sold 30 tablets for $15.59. What is the gross profit? What is the net profit?

Solve the following problems using the sample formula below for third-party reimbursement:

$$87\%\, AWP\ or\ 100\%\, U\&C\,(whichever\ is\ less) + a\,\$\,3.50\ dispensing\ fee = \boldsymbol{reimbursement\ rate}$$

52) A pharmacy receives a prescription for 125 nebulizer vials of albuterol inhalation solution. The U&C on this product is $129.00. The AWP for 25 vials is $31.00. How much should the patient's insurance reimburse for this prescription?

53) A pharmacy receives a prescription for 20 tablets of carisoprodol 350 mg. The U&C on this product before a dispensing fee is added is $38.12. The AWP for 20 tablets is $41.40. How much should the patient's insurance reimburse for this prescription?

54) A pharmacy receives a prescription for 40 erythromycin 400 mg tablets. This product's usual and customary price is 12.51. The AWP for 100 tablets is $23.46. How much should the patient's insurance reimburse for this prescription?

55) A pharmacy receives a prescription for 30 capsules of fluoxetine 20 mg. The U&C on this product before a dispensing fee is added is $64.62. The AWP for 100 capsules is $248.40. How much should the patient's insurance reimburse for this prescription?

56) A pharmacy receives a prescription for 30 tablets of 5 mg glyburide. This product's usual and customary price is $11.79. The AWP for 100 tablets is $28.31. How much should the patient's insurance reimburse for this prescription?

Determine the profit margin for the following capitation fee problem.

57) April's Apothecary receives a monthly capitation fee of $210.00/month for Nauseous Nancy. Last month Nancy's prescriptions totaled $188.75. How much did the pharmacy make off of her capitation fee?

Solve the following depreciation problem using the straight-line method.

58) The pharmacy a 1 year old compact car for drug deliveries. The car cost $9,420.00 and is expected to last four years from date of purchase. Its disposal value is $4,867.00. What is the annual depreciation?

Balance the following cash report.

59)	Register 1	Register 2	Register 3	Total
+ Cash and Checks	1264.56	790.01	233.56	
+ Bank Charges	789.03	235.56	78.90	
+ House Charges	---	---	25.00	
+ Paid Outs	20.00	10.00	---	
Total				
+ Closing Reading	2,151.47	1,095.03	389.47	
- Opening Reading	50.00	50.00	50.00	
= Difference				
- Coupons	7.50	1.75	---	
- Discounts	12.34	7.67	---	
- Voids	---	---	---	
- Refunds	8.00	---	---	
- Over-Rings	---	---	---	
Total				
Over + or Short -				

Solve the following dispensing fee problem.

60) Calculate the dispensing fee for a pharmacy with the following annual expenses if they filled 80,000 prescriptions annually.

Labor Expenses:

Wages for pharmacists = \$138,801.60

Wages for technicians = \$61,689.60

Cost of benefits = \$51,340.20

Direct Expenses:

$$\text{Vials and caps} = \frac{\$0.12}{perscription} \times \frac{80{,}000\ prescriptions}{1} = \$9{,}600.00$$

Labels, patient information, bags = \$8,317.63

Computer system = \$2,000.00

Indirect Expenses:

Rent = \$13,860.00

Utilities = \$2,400.00

Insurances = \$5,520.00

UNIT 4

INSTITUTIONAL PHARMACY MATH

What does institutional pharmacy math consist of?

In order to explain what institutional pharmacy math is, we should first define what an institutional pharmacy is. An institutional pharmacy is a pharmacy practice that provides drugs, devices, and other materials used in the diagnosis and treatment of patients in any of the following settings: hospitals, long term care facilities, convalescent homes, nursing homes, extended care facilities, mental health facilities, rehabilitation centers, psychiatric centers, developmental disability centers, drug abuse treatment centers, family planning clinics, penal institutions, hospice, public health facilities, and athletic facilities. The technician in this practice setting may need to use math for anything from compounding sterile products and chemotherapy to calculating radioactive decay of an isotope for a stress test.

What are the specific learning objectives in this unit?

- Parenteral routes of administration,
- Parenteral dosage calculations,
- Working with insulins,
- MilliMoles, milliEquivalents, millicuries, and international units,
- Reconstituting lyophilized powders,
- Percentage strength,
- Ratio strength,
- Reducing and enlarging formulas,
- Dosage calculations based on body weight,
- Dosage calculations based on body surface area,
- Infusion rates,
- Dilutions and alligations,
- Parenteral nutrition,
- Aliquots, and
- Pediatric and geriatric dosing.

Chapter 15

Parenteral Dosage Calculations

"What is it he keeps saying about their parents?"
"He's not talking about parents, he's saying 'parenteral'."
--A discussion between one of my students and her spouse.

To get started, we should define the term parenteral. In order to define this we should look at its root words:

para/o = despite, other than, or beside
enteron = meaning the alimentary canal, more commonly referred to as the GI tract
-al = a suffix meaning pertaining to

So, based on that we can define parenteral as a route of administration other than the GI tract. Technically this includes everything from topical medications and inhalation therapies to ear drops and injections, but today the term parenteral is intended to mean various kinds of injections and infusions and generally excludes all other routes of administration.

In this chapter our goals are to learn about:
- parenteral routes of administration,
- perform basic dosage calculations using dimensional analysis and/or ratio proportions,
- and using medication labels to perform necessary calculations.

Parenteral routes of administration

The following is a short list of parenteral routes of administration and is by no means considered comprehensive but is instead intended to make you start thinking about these various routes[1].

- Intravenous - (IV) into a vein
- Intramuscular - (IM) into a muscle
- Subcutaneous - (SC, SQ) under the skin
- Intraarterial - (IA) into an artery
- Intracardiac - (IC) into the heart
- Intrathecal - (IT) into the spinal canal
- Intradermal - (ID) into the skin itself
- Intraperitoneal - infusion or injection into the peritoneum
- Epidural - infusion or injection into the epidural space (the outermost part of the spinal canal)
- Intravitreal - through the eye
- Intraosseus infusion - through the bone marrow
- Intrahepatic - into the liver
- Intracerebral - into the cerebrum
- Intracerebroventricular - into the cerebral ventricles
- Intravesical infusion - into the urinary bladder
- Intracavernosal injection - into the base of the penis

1 Some references will also include inhalation and ophthalmic as they also need to be sterile.

Additional precautions need to be kept in mind when preparing parenterals because they are able to avoid many of a patient's barriers to absorption due to how they are administered. These special considerations are that:

- solutions for injection must be sterile – i.e., free from bacteria and other microorganisms,
- solutions must be free of all visible particulate material,
- all parenteral solutions must be pyrogen-free,
- the solution must be stable for its intended use,
- the pH of an intravenous solution should not vary significantly from physiological pH (approximately 7.4), and
- intravenous solutions should be formulated to have an osmotic pressure similar to that of blood (isotonic).

Basic dosage calculations

Often, as a pharmacy technician, you will receive a label for a medication you will need to make in the IV room. The medication will request a specific patient dose in milligrams, grams, units, milliEquivalents, etc. You will need to use information on the vial or in the literature to determine how many milliliters you will need to draw up in order to fulfill the requested dose. Conveniently, you already know the problem solving methods you will need to employ to solve these kinds of problems. The challenge is filtering through all the information on the label to decide what you need to use and what you don't need. Let's look at an example.

Example

Magnesium sulfate 2 g in 100 mL of 5% dextrose in water (D5W) is ordered by the physician. How many milliliters magnesium sulfate will be added to the bag that patient receives if the magnesium sulfate vial provides the following information: 50% magnesium sulfate (500 mg/mL), 4.06 mEq/mL, 10 mL single dose vial?

QUESTION

How many milliliters will be added to the bag?

DATA

2 g of magnesium sulfate wanted

medication is being added to a 100 mL bag of D5W

50% magnesium sulfate = $\frac{50\,g\,magnesium\,sulfate}{100\,mL}$

500 mg magnesium sulfate/mL

4.06 mEq magnesium sulfate/mL

10 mL single dose vial

MATHEMATICAL METHOD/FORMULA

dimensional analysis or ratio-proportion

DO THE MATH

dimensional analysis

$$\frac{2\,g}{1} \times \frac{1000\,mg}{1\,g} \times \frac{mL}{500\,mg} = \boldsymbol{4\,mL}$$

ratio-proportion

$$\frac{2\,g}{N} = \frac{50\,g}{100\,mL}$$

$N = \boldsymbol{4\,mL}$

DOES THE ANSWER MAKE SENSE?

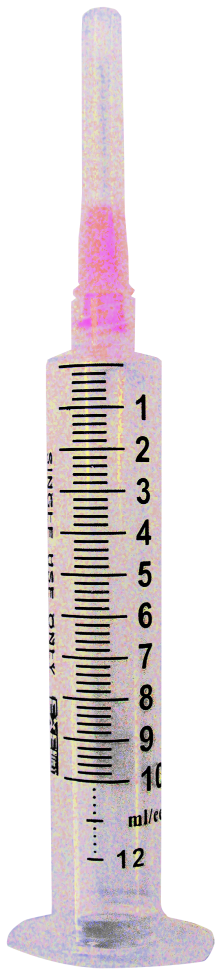
Yes

When you look at the example problem, you can identify multiple ways to solve it (even more than the two ways demonstrated). It is also important to note that there were many aspects of the example problem that could be completely ignored such as the diluent (100 mL of D5W), the size of the vial being used (10 mL), and even some of the information on its concentration (4.06 mEq/mL).

Try and solve the practice problem below using the images presented with the problem. Notice that there is much more information presented then what you need for the practice problem below.

Practice Problem

A 250 mL bag of Sterile Water For Injection (SWFI) needs the addition of 19.4 mEq of sodium chloride. How many milliliters should be added to the SWFI bag? Draw a line on the syringe pictured below to demonstrate how much of the stock sodium chloride you will need.



The syringe should be marked at approximately 7.8 mL.

Worksheet 15-1

Name:

Date:

Solve the following problems.

1) A 1,500 mL TPN being infused intravenously through a central line needs the addition of 99 mEq of sodium chloride. The label on the vial of concentrated sodium chloride injection has the following information: 30 mL single dose vial, 234 mg/mL, 4 mEq/mL, and 23.4%. How many milliliters should be added to the TPN bag?

2) Digoxin injection is available in a concentration of 0.5 mg/2 mL. The physician orders a 250 mcg dose in 250 mL of D5W. How many milliliters will the patient need?

3) Tobramycin injection is available in a concentration of 80 mg/2 mL. The patient received 1.25 mL in 100 mL of 0.9% sodium chloride. What was the dose in mg that the patient received?

4) Twelve units of Humulin R are to be added to a 2 liter TPN. The 10 mL vial of Humulin R has a U-100 concentration (100 units/mL). How many milliliters of Humulin R are required?

5) Morphine sulfate 12 mg is ordered by the physician. The label on the morphine sulfate vial reads 15 mg/mL. How many milliliters will the patient receive?

6) Atropine sulfate injection 0.4 mg per mL is available in the pharmacy. The doctor orders 1 mg. How many milliliters will complete this order?

7) A patient requires potassium chloride 25 mEq in a 1000 mL bag of lactated ringers solution.

The pharmacy has on hand potassium chloride for injection 40 mEq in 20 mL vials. How many milliliters will be needed in the IV bag?

8) Aminophylline injection is available in a 20 mL vial containing 500 mg (25 mg/mL). The physician orders a dose of 350 mg. How many milliliters will be needed to fill this order?

9) A 500 mL bag of D5W with 16,000 units of heparin is ordered for a patient. A 5 mL vial of heparin contains 10,000 units per mL. How many milliliters of heparin are needed for this patient?

10) A physician orders 25 mg of theophylline to be given orally to a pediatric patient. If the elixir of theophylline contains 80 mg per tablespoonful, how many milliliters of the elixir should be administered?

11) A 1,000 ml bag of Sterile Water For Injection needs the addition of 77.5 mEq of sodium

chloride. How many milliliters should be added to the SWFI bag?

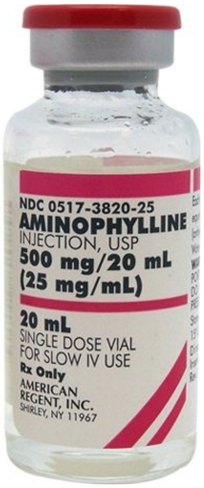
12) A patient is to receive gentamicin in 50 ml of 0.9% sodium chloride. Look at the syringe and check what the dose is in mg that the patient is to receive.

13) Humulin R 50 units is to be added to a 50 mL bag of NS. How many milliliters of Humulin R are required to make this infusion?

14) Magnesium sulfate 2 g in 100 mL of D5W is ordered by the physician. How many milliliters magnesium sulfate will be added to the bag that patient receives?

15) A patient requires potassium chloride 15 mEq in a 5,000 mL bag of prismasate solution. How many milliliters will need to be withdrawn from the 10 mL vial below?

16) The physician orders 300 mg of aminophylline. How many milliliters will be needed to fill this order?



17) 600 units of Heparin is ordered for a patient. How many milliliters of heparin are needed for this patient?

Worksheet 15-2

Name:

Date:

Answer the following questions.

1) What does the word '*parenteral*' mean?

2) Correctly match the following terms to their meaning.

_____ Intravenous (IV)

_____ Intramuscular (IM)

_____ Subcutaneous (SC, SQ)

_____ Intraarterial (IA)

_____ Intracardiac (IC)

_____ Intrathecal (IT)

_____ Intradermal (ID)

_____ Intraperitoneal

_____ Epidural

_____ Intravitreal

_____ Intraosseus infusion

_____ Intrahepatic

_____ Intracerebral

_____ Intracerebroventricular

_____ Intravesical infusion

_____ Intracavernosal injection

a) infusion or injection into the epidural space (the outermost part of the spinal canal)
b) infusion or injection into the peritoneum
c) into a muscle
d) into a vein
e) into an artery
f) into the base of the penis
g) into the cerebral ventricles
h) into the cerebrum
i) into the heart
j) into the liver
k) into the skin itself
l) into the spinal canal
m) into the urinary bladder
n) through the bone marrow
o) through the eye
p) under the skin

3) Name two other routes of administration that require sterile products.

4) Make a short list of precautions/considerations when dealing with compounded sterile preparations (CSPs).

5) You receive an order for heparin 12,500 units in 250 mL of D5W. If the strength of the heparin available is 5,000 units/mL, how man mL of heparin will you need?

6) A TPN requires the addition of 15 units of regular insulin. If you are using the insulin vial pictured below, how many mL of insulin will you need to add to the TPN?

7) Calculate the number of milliliters required to prepare the following concentrations:
   a) 25 mEq potassium chloride

   b) 37.5 mg methotrexate

c) 1050 mg fluorouracil

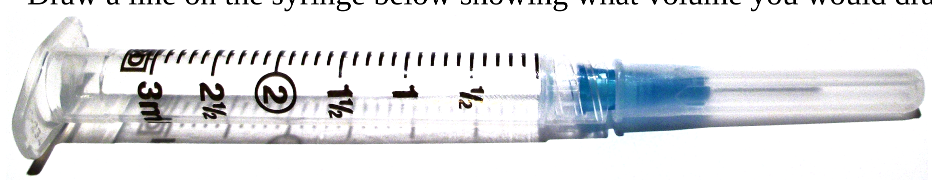
d) 62.5 mg doxorubicin

e) 30 units Novolin N

f) 200 mcg scopolamine

g) 17.6 mEq potassium phosphate

8) Levothyroxine comes in 500 mcg vials. If the powder is diluted with 10 mL of sterile water (the medication has negligible powder volume), how many mL are required to provide 0.1 mg? Draw a line on the syringe below showing what volume you would draw up in the syringe.

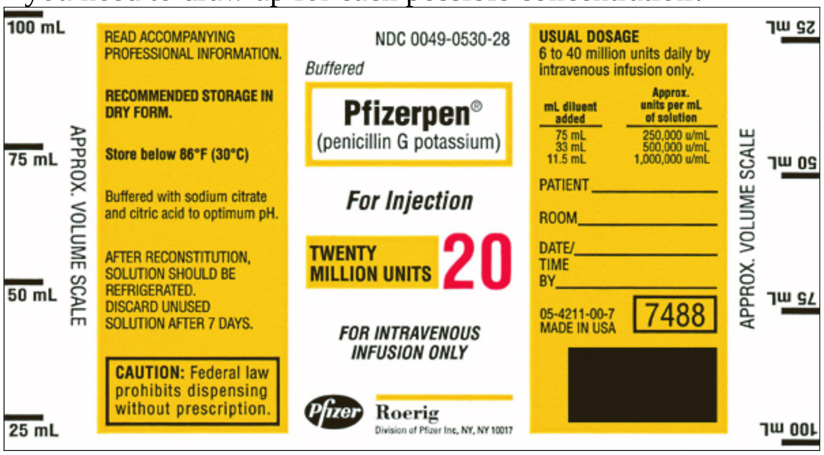


9) Clindamycin phosphate comes as 600 mg/4 mL. How many mL are needed to make an IVPB of 750 mg in 100 mL of NS?

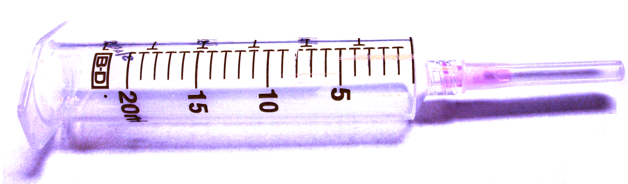
10) A patient requires 30 units of oxytocin by IV infusion in a liter of D5W. Oxytocin is available as 10 units per mL. How many mL should be added to the IV bag?

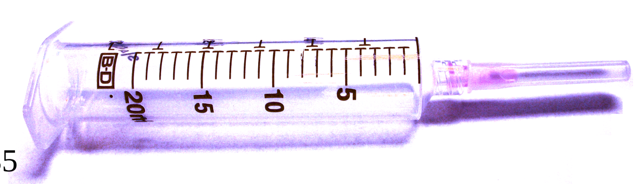
11) Tobramycin is available in a concentration of 80 mg/2 mL. The patient received 2.5 mL in 100 mL of NS infused over 1 hour. How many mg did the patient receive?

12) A physician orders 6.5 MU of penicillin G potassium. The stock vial has three different possible concentrations depending as to how much volume it is reconstituted with. How many mL would you need to draw up for each possible concentration?



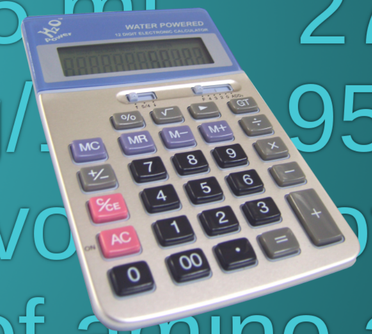
13) A physician orders 16 mg of norepinephrine in 234 mL of D5W. On the syringes below mark how many mL will need to be removed from the D5W bag and how many mL of norepinephrine will need to be added to it.





Chapter 16

Insulin



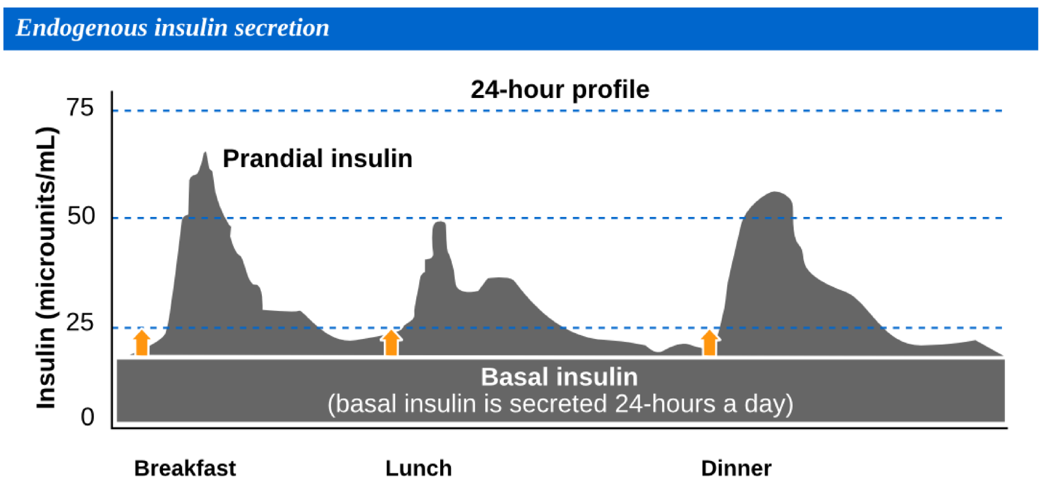
"How did she get the nickname of 'Sweet Pea'?"
"When her class mates discovered the Greek and Latin roots for diabetes mellitus they thought it would be a good pet name for her as a diabetic."
--A discussion between two instructors.

Ideally, the human body will effectively create its own insulin and make proper utilization of it in order to regulate its blood glucose level. When the human body fails to regulate it effectively a patient may end up receiving some form of insulin therapy from a pharmacy.

In this chapter we will look at the following concepts with respect to insulin therapy:

- Categories of patients receiving insulin therapy,
- Definitions,
- Dosing and types of insulins,
- Insulin syringes, and
- Mixing insulins.

Categories of patients receiving insulin therapy



Conceptual depiction of insulin profiles

Insulin therapy is required in type 1 diabetes (insulin dependent diabetes mellitus, IDDM), and may be necessary in some individuals with type 2 diabetes (non-insulin dependent diabetes mellitus). The general objective of insulin replacement therapy is to approximate the physiological pattern of insulin secretion. This requires a basal insulin throughout the day, supplemented by prandial insulin at mealtime. Insulin injections are intended to mimic the natural process shown in the image above:

Definitions

Insulin is a hormone central to regulating carbohydrate and fat metabolism in the body. Insulin causes cells in the liver, muscle, and fat tissue to take up glucose from the blood, storing it as glycogen in the liver and muscle. Ideally it will be created endogenously in the pancreas and effectively used by the body's cells, but when either one or both of those situations are not occurring an exogenous source of insulin may be required.

Basal insulin may also sometimes be called "background" insulin, that is, the insulin working behind the scenes. Basal insulin may be covered with a long-acting insulin like glargine insulin, or an intermediate-acting insulin like isophane (NPH) insulin.

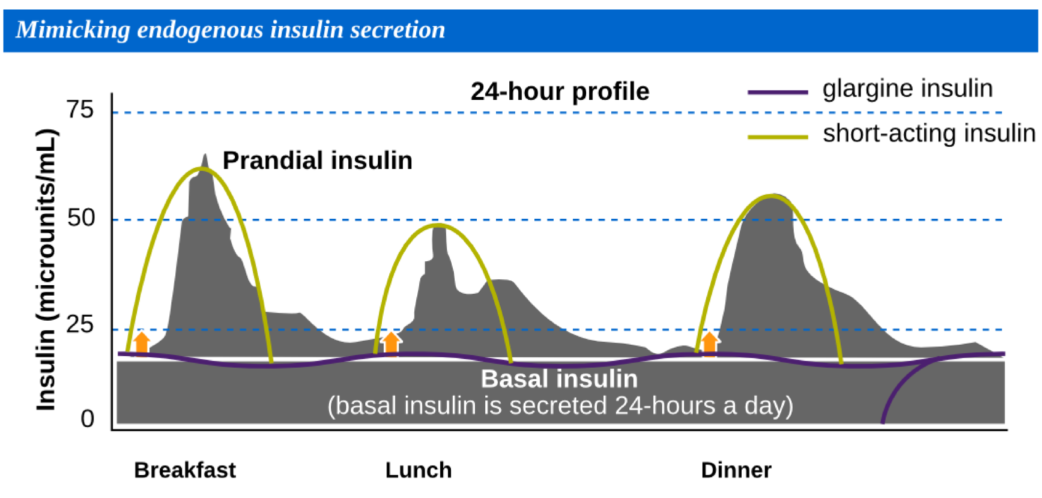
Prandial insulin, also known as nutritional insulin, is the insulin used to cover the spike in blood sugar from consuming food. Prandial insulin may be covered with regular insulin (a short-acting insulin), or a rapid-acting insulin like lispro insulin.

Dosing and types of insulin

Although some patients may receive a continuous infusion of insulin in an institutional setting, multiple daily doses guided by blood glucose monitoring are the standard of diabetes care. Combinations of insulins are commonly used. The number and size of daily doses, time of administration, and diet and exercise require continuous medical supervision. In addition, specific formulations may require distinct administration procedures/timing.

There is solid scientific documentation of the benefit of tight glucose control, either by insulin pump or multiple daily injections (4-6 times daily). However, the benefits must be balanced against the risk of hypoglycemia, the patient's ability to adhere to the regimen, and other issues regarding the complexity of management. Diabetic education and nutritional counseling are essential to maximize the effectiveness of therapy. Patients should also be instructed in administration techniques, timing of administration, and sick day management.

Type 1 diabetics (IDDM) will traditionally use either a rapid or short-acting insulin prior to each meal simulating prandial insulin and they will often take an intermediate or long-acting insulin either once or twice a day simulating basal insulin. The image to the right demonstrates this concept.



Conceptual depiction of insulin profiles

The chart on the following page lists the onset, peak, and duration of various insulin products. Combination products include either rapid or short-acting insulin in combination with an intermediate-acting insulin.

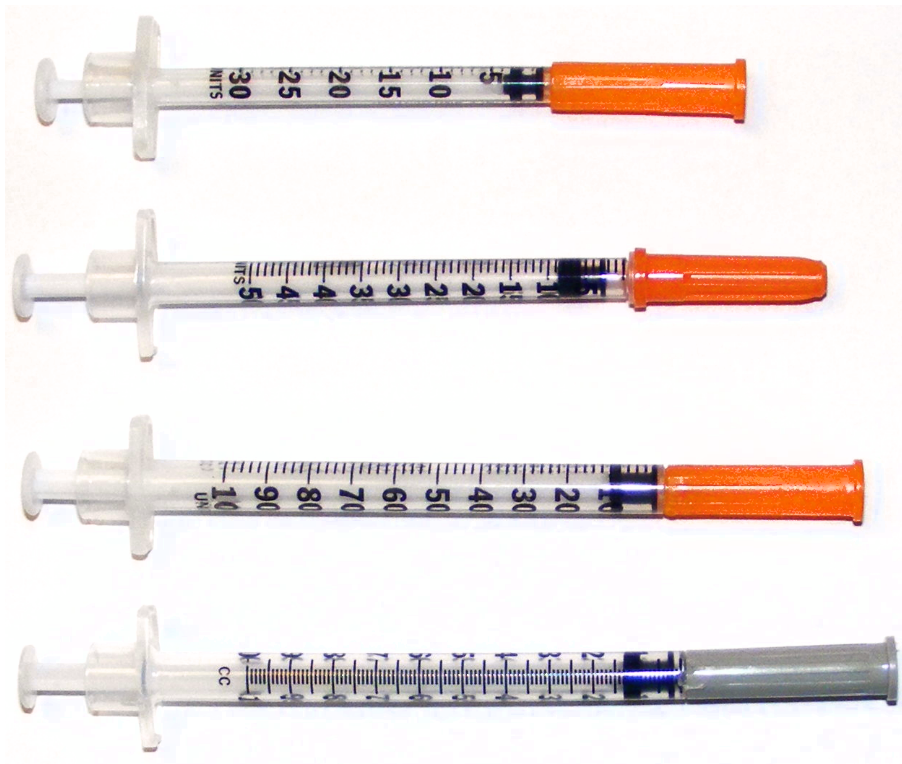
Types of Insulin	*Onset (h)*	*Peak (h)*	*Duration (h)*
Rapid-acting			
lispro insulin - Humalog	0.2-0.5	0.5-1.5	3-4
aspart insulin - NovoLog	0.2-0.5	1-3	3-5
glulisine insulin - Apidra	0.2-0.5	0.5-1.5	3-4
Short-acting			
regular insulin (clear) - Humulin R, NovolinR	0.5-1	2-4	6-8
Intermediate-acting			
isophane (NPH) insulin (cloudy) - Humulin N, Novolin N	1-2	6-12	18-24
Intermediate to long-acting			
detemir insulin - Levemir	3-4	6-8	6-23
Long-acting			
glargine insulin - Lantus	3-4	*	24
Combinations			
70% isophane (NPH) insulin & 30% regular insulin - Humulin 70/30, Novolin 70/30	0.5	2-12	18-24
aspart protamine insuline & aspart insulin - Humalog Mix 50/50, Humalog Mix 75/25	0.2-0.5	1-4	18-24
lispro protamine insulin & lispro insulin - NovoLog Mix 70/30	0.2-0.5	2-12	18-24

* glargine insulin has no pronounced peak

Insulin syringes

Insulin dosing is very customized for various patients and therefore flexible delivery systems allowing for a wide range of required doses make it common place for the use of insulin syringes and vials. Insulin vials are marked with their concentration in two ways 100 units per mL and U-100. Most insulins have this same concentration but occasionally pharmacies need to carry a concentration of 500 units per mL / U-500 regular insulin for patients that need very high doses of insulin. Pictured below are both concentrations.

Insulin syringes (easily identifiable by their orange caps) are intended for the much more common dosing of U-100 insulins. Note, insulin syringes should only be used for insulins with a concentration of U-100 as the higher concentration of of U-500 insulin will lead to a medication error. The following are images providing examples of various insulin syringes and a 1 cc syringe for dosing a U-500 insulin.

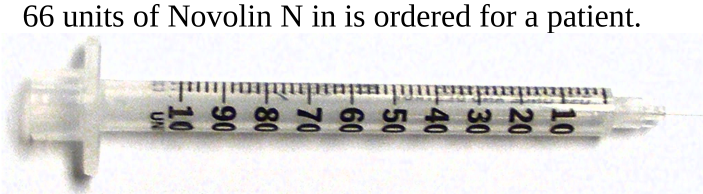


When selecting a syringe choose the one that will most closely compliment the dose being given to the patient.

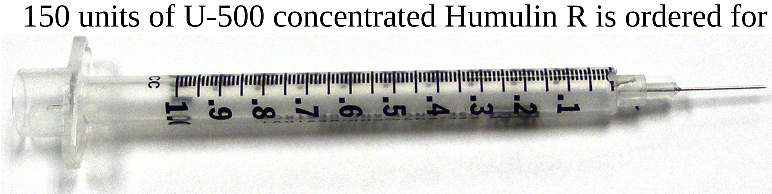
Practice Problems

Mark on the syringes near each problem how many units or mL you should draw up for each scenario.

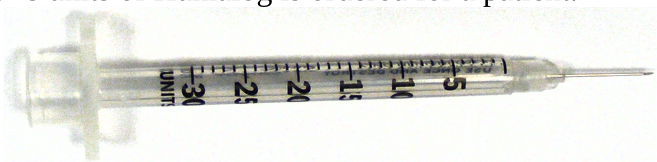
1) 66 units of Novolin N in is ordered for a patient.



2) 150 units of U-500 concentrated Humulin R is ordered for a patient.



3) 8 units of Humalog is ordered for a patient.



1) The syringe should be marked at 66 units
2) The syringe should be marked at 0.3 cc
3) The syringe should be marked at 8 units

Mixing insulins

As previously mentioned, a physician will often order two kinds of insulin. In order to decrease the number of injections a patient might need to take in a day a physician may order a combination vial such as Novolin 70/30 or Humalog Mix 75/25 in order to allow a patient to receive both kinds at the same time. If a patient's needs can not be met that way with premixed combination vials some solutions can be mixed together by the patient immediately before administration and injected. Isophane (NPH) insulin may be mixed with the following insulins: regular insulin, lispro insulin, aspart insulin, or glulisine insulin. Below is a list explaining the procedure for drawing up two different insulins into the same syringe.

1) Calculate the total dose of both insulins combined.
2) Draw up a volume of air equivalent to the volume of isophane (NPH) insulin desired and inject the air into the isophane (NPH) insulin vial, but do not draw up the dose. Withdraw the needle from the vial.
3) Draw up a volume of air equivalent to the volume of the rapid or short-acting insulin and inject it into the rapid or short-acting insulin vial. Draw up the appropriate quantity of this insulin.
4) Carefully insert the needle through the stopper of the isophane (NPH) insulin vial. Invert the vial without injecting any of the rapid or short-acting insulin into the vial.
5) Slowly draw up the isophane (NPH) insulin until the syringe reaches the appropriate dose for both insulins combined.

A good memory trick to help with memorization of this pattern is *'clear before cloudy'* as the clear rapid or short-acting insulin is actually drawn into the syringe prior to adding the cloudy isophane (NPH) insulin.

Example

A patient requires 42 units of Humulin N and 10 units of Humulin R to be given at the same time. To minimize the number of needle sticks the patient needs to endure they should be drawn up at the same time.

First, calculate the total dose.

$$42\,\mathrm{U} + 10\,\mathrm{U} = 52\,\text{units}$$

Then draw up 42 units of air and inject it into the Humulin N vial, but do not draw up any solution yet. Withdraw the needle from the vial.

Next, draw up 10 units of air, inject it into the Humulin R, and draw 10 units of regular insulin.

Next, insert the needle into the Humulin N vial and carefully invert the vial without injecting any solution into the Humulin N.

Lastly, slowly withdraw insulin from the Humulin N vial until the vial contains a total of 52 units of insulin.

Practice Problem

Using the above example as a guide, explain how to prepare an insulin syringe with 43 units of Novolin N and 22 units of NovoLog.

First, calculate the total dose. (43 units + 22 units = 65 units) Then draw up 43 units of air and inject it into the Novolin N vial, but do not draw up any solution yet. Withdraw the needle from the vial. Next, draw up 22 units of air, inject it into the NovoLog, and draw 22 units of aspart insulin. Next, insert the needle into the Novolin N vial and carefully invert the vial without injecting any solution into the isophane (NPH) insulin. Lastly, slowly withdraw insulin from the Novolin N vial until the vial contains a total of 65 units of insulin.

Worksheet 16-1

Name:

Date:

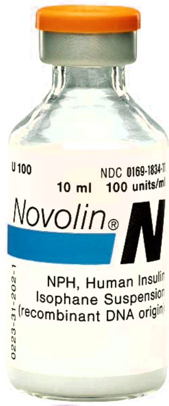
Select the vial or box that corresponds with each order in problems 1-14 and 16-17. Also mark the syringes pictured in problems 1-14 with the correct volume for the ordered dose.

A)

B)

C)

D)



E)

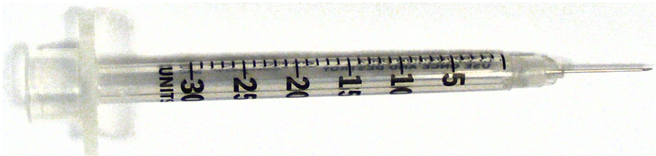
F)

G)

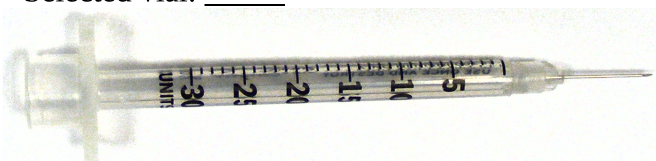
H)

I)

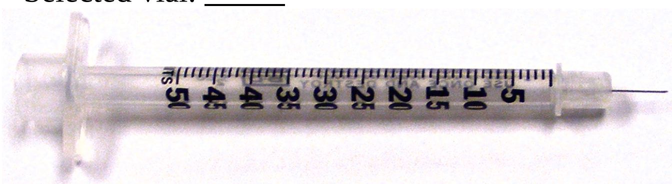
1) A patient is ordered 12 units of Humulin R SQ before breakfast.
Selected vial: _____



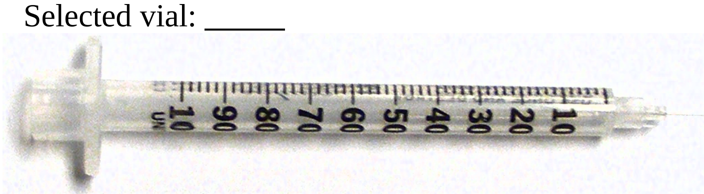
2) A patient is ordered 5 units of Humalog SQ 15 minutes before lunch.
Selected vial: _____



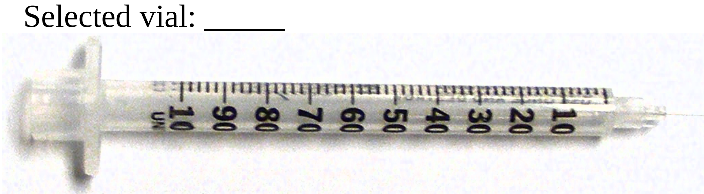
3) A patient is ordered 35 units of Novolin N SQ every morning.
Selected vial: _____



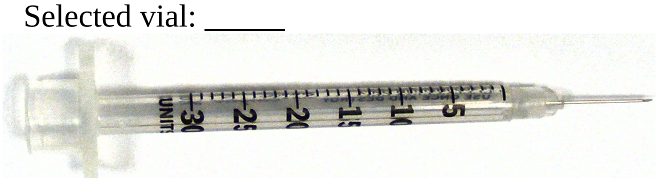
4) A patient is ordered 72 units of Lantus SQ every evening.
Selected vial: _____



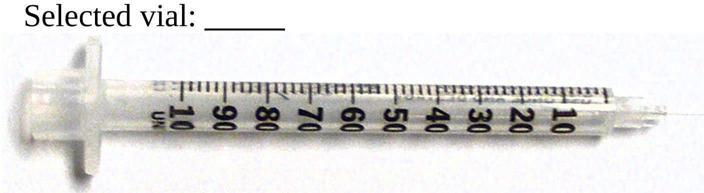
5) A patient is ordered 55 units of Humulin N SQ every evening.
Selected vial: _____



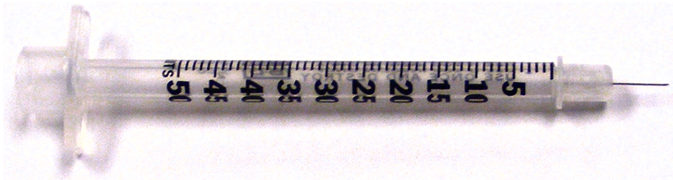
6) A patient is ordered 22 units of Levemir SQ every morning.
Selected vial: _____



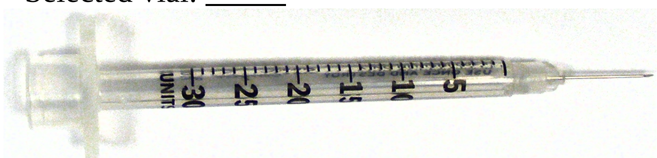
7) A patient is ordered 80 units of Humulin 70/30 SQ every morning.
Selected vial: _____



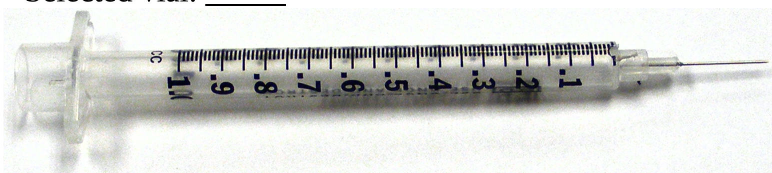
8) A patient is ordered 45 units of Humalog Mix 75/25 SQ every evening.
Selected vial: _____



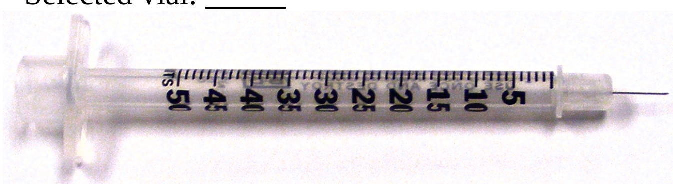
9) A patient is ordered 25 units of Humalog SQ daily before lunch.
Selected vial: _____



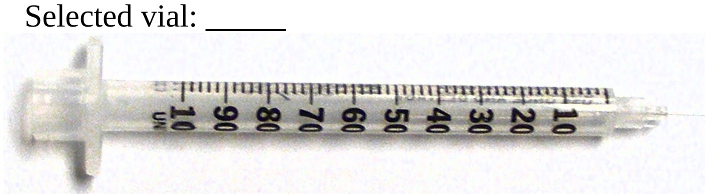
10) A patient is ordered 170 units of U-500 Humulin R every morning.
Selected vial: _____



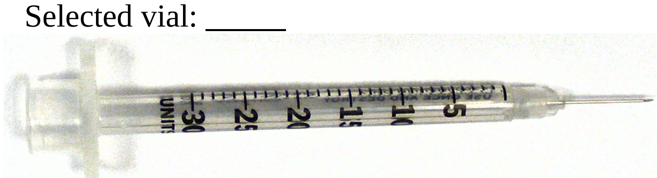
11) A patient is ordered 40 units of Novolin N SQ every evening.
Selected vial: _____



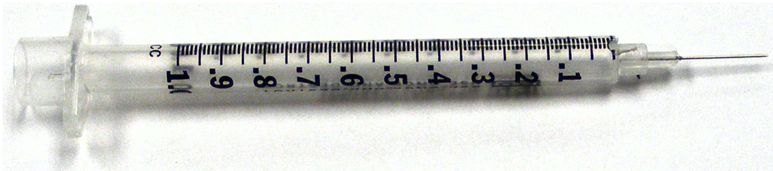
12) A patient is ordered 77 units of Humulin 70/30 SQ every morning 30 minutes before breakfast.
Selected vial: _____



13) A patient is ordered 21 units of Lantus SQ every evening.
Selected vial: _____



14) A patient is ordered 50 units of Humulin R in a 50 mL bag of normal saline. Use sliding scale to maintain appropriate blood glucose levels. *Note: It's easier to use a 1 cc syringe than an insulin syringe for this as you need a needle long enough to pierce the injection port on an IV bag.*
Selected vial: _____



15) When mixing insulins explain what the phrase 'clear before cloudy' means.

16) A patient is to receive 15 units of Humulin R and 30 units of Humulin N. Explain how the two insulins can be drawn up at the same time.
Selected vials: _____ & _____

17) A patient is to receive 20 units of Humalog and 45 units of Humulin N. Explain how the two insulins can be drawn up and injected at the same time.
Selected vials: _____ & _____

Chapter 17

mmol, mEq, mCi, & IU

"So if I get exposed to enough radiation at our field trip to a nuclear pharmacy, could I turn into the Hulk?"
"Probably not, but if you did it would be fairly short-lived since they primarily work with technetium-99 and that only has a 6 hour half-life."
--A discussion between a student and his instructor.

Many systems of measures for drugs are easily understandable, such as mass of drug (30 grams of ointment), volume of a solution (250 mL of NS), concentration as mass of drug per quantity of volume (400 mg E.E.S./tsp), percentage strength (50% Magnesium Sulfate = 50 g/100 mL), etc. Other forms require more manipulation to arrive at how they are calculated such as

- millimoles,
- milliEquivalents,
- millicuries, and
- international units.

Due to the concepts in this chapter, we need to take a brief moment and explain how to read a chemical formula. A chemical formula (or molecular formula) is a way of expressing information about the atoms that constitute a particular chemical compound. The chemical formula identifies each constituent element by its chemical symbol and indicates the number of atoms of each element found in each discrete molecule of that compound. If a molecule contains more than one atom of a particular element, this quantity is indicated using a subscript after the chemical symbol. Therefore, if you were to look at the chemical formula for water, H_2O, you would know that there are 2 hydrogen atoms and one oxygen atom in a single water molecule. (If you are not sure of the proper abbreviations for various elements, you may reference the periodic table that appears on the next page.)

Practice Problems

To ensure that you are comfortable with reading chemical formulas please attempt the following practice problems. Determine how many of each type of atom are present in the following molecules.

1) Salt - NaCl

2) Dextrose - $C_6H_{12}O_6$

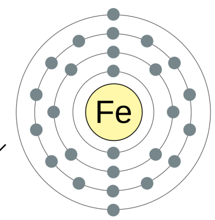
3) Dibasic sodium phosphate - Na_2HPO_4

4) Calcium hydroxide - $Ca(OH)_2$

1) 1 sodium, 1 chloride 2) 6 carbon, 12 hydrogen, 6 oxygen
3) 2 sodium, 1 hydrogen, 1 phosphorous, 4 oxygen 4) 1 calcium, 2 oxygen, 2 hydrogen

The Periodic Table of the Elements

atomic mass or most stable mass number — 55.845
atomic number — 26
most common oxidation states — +3 +2
chemical symbol — Fe
name — Iron
electron configuration — [Ar] $3d^6 4s^2$



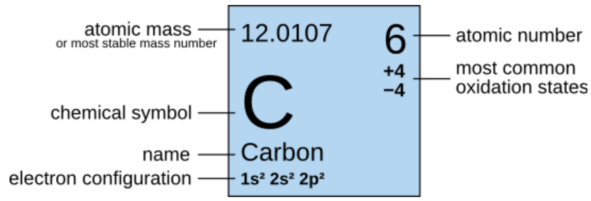
period	group 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1.00794 1 H Hydrogen $1s^1$ +1 −1																	4.002602 2 He Helium $1s^2$
2	6.941 3 Li Lithium $1s^2 2s^1$ +1	9.012182 4 Be Beryllium $1s^2 2s^2$ +2											10.811 5 B Boron $1s^2 2s^2 2p^1$ +3	12.0107 6 C Carbon $1s^2 2s^2 2p^2$ +4 −4	14.0067 7 N Nitrogen $1s^2 2s^2 2p^3$ +5 −3	15.9994 8 O Oxygen $1s^2 2s^2 2p^4$ −2	18.998403 9 F Fluorine $1s^2 2s^2 2p^5$ −1	20.1797 10 Ne Neon $1s^2 2s^2 2p^6$
3	22.98976 11 Na Sodium [Ne] $3s^1$ +1	24.3050 12 Mg Magnesium [Ne] $3s^2$ +2											26.98153 13 Al Aluminium [Ne] $3s^2 3p^1$ +3	28.0855 14 Si Silicon [Ne] $3s^2 3p^2$ +4 −4	30.97696 15 P Phosphorus [Ne] $3s^2 3p^3$ +5 +3 −3	32.065 16 S Sulfer [Ne] $3s^2 3p^4$ +6 +4 +2 −2	35.453 17 Cl Chlorine [Ne] $3s^2 3p^5$ +7 +5 +3 +1 −1	39.948 18 Ar Argon [Ne] $3s^2 3p^6$
4	39.0983 19 K Potassium [Ar] $4s^1$ +1	40.078 20 Ca Calcium [Ar] $4s^2$ +2	44.95591 21 Sc Scandium [Ar] $3d^1 4s^2$ +3	47.867 22 Ti Titanium [Ar] $3d^2 4s^2$ +4	50.9415 23 V Vanadium [Ar] $3d^3 4s^2$ +5	51.9962 24 Cr Chromium [Ar] $3d^5 4s^1$ +6 +3	54.93804 25 Mn Manganese [Ar] $3d^5 4s^2$ +7 +4 +2	55.845 26 Fe Iron [Ar] $3d^6 4s^2$ +3 +2	58.93319 27 Co Cobalt [Ar] $3d^7 4s^2$ +3 +2	58.6934 28 Ni Nickel [Ar] $3d^8 4s^2$ +2	63.546 29 Cu Copper [Ar] $3d^{10} 4s^1$ +2	65.38 30 Zn Zinc [Ar] $3d^{10} 4s^2$ +2	69.723 31 Ga Gallium [Ar] $3d^{10} 4s^2 4p^1$ +3	72.64 32 Ge Germanium [Ar] $3d^{10} 4s^2 4p^2$ +4 +2 −4	74.92160 33 As Arsenic [Ar] $3d^{10} 4s^2 4p^3$ +5 +3 −3	78.96 34 Se Selenium [Ar] $3d^{10} 4s^2 4p^4$ +6 +4 +2 −2	79.904 35 Br Bromine [Ar] $3d^{10} 4s^2 4p^5$ +7 +5 +3 +1 −1	83.798 36 Kr Krypton [Ar] $3d^{10} 4s^2 4p^6$ +2
5	85.4678 37 Rb Rubidium [Kr] $5s^1$ +1	87.62 38 Sr Strontium [Kr] $5s^2$ +2	88.90585 39 Y Yttrium [Kr] $4d^1 5s^2$ +3	91.224 40 Zr Zirconium [Kr] $4d^2 5s^2$ +4	92.90638 41 Nb Niobium [Kr] $4d^4 5s^1$ +5	95.96 42 Mo Molybdenum [Kr] $4d^5 5s^1$ +6 +4	(98) 43 Tc Technetium [Kr] $4d^5 5s^2$ +7 +4	101.07 44 Ru Ruthenium [Kr] $4d^7 5s^1$ +4 +3	102.9055 45 Rh Rhodium [Kr] $4d^8 5s^1$ +3	106.42 46 Pd Palladium [Kr] $4d^{10}$ +4 +2	107.8682 47 Ag Silver [Kr] $4d^{10} 5s^1$ +1	112.441 48 Cd Cadmium [Kr] $4d^{10} 5s^2$ +2	114.818 49 In Indium [Kr] $4d^{10} 5s^2 5p^1$ +3	118.710 50 Sn Tin [Kr] $4d^{10} 5s^2 5p^2$ +4 +2 −4	121.760 51 Sb Antimony [Kr] $4d^{10} 5s^2 5p^3$ +5 +3 −3	127.60 52 Te Tellurium [Kr] $4d^{10} 5s^2 5p^4$ +6 +4 +2 −2	126.9044 53 I Iodine [Kr] $4d^{10} 5s^2 5p^5$ +7 +5 +3 +1 −1	131.293 54 Xe Xenon [Kr] $4d^{10} 5s^2 5p^6$ +6 +4 +2
6	132.9054 55 Cs Cæsium [Xe] $6s^1$ +1	137.327 56 Ba Barium [Xe] $6s^2$ +2	174.9668 71 Lu Lutetium [Xe] $4f^{14} 5d^1 6s^2$ +3	178.49 72 Hf Hafnium [Xe] $4f^{14} 5d^2 6s^2$ +4	180.9478 73 Ta Tantalum [Xe] $4f^{14} 5d^3 6s^2$ +5	183.84 74 W Tungsten [Xe] $4f^{14} 5d^4 6s^2$ +6 +4	186.207 75 Re Rhenium [Xe] $4f^{14} 5d^5 6s^2$ +4	190.23 76 Os Osmium [Xe] $4f^{14} 5d^6 6s^2$ +4	192.217 77 Ir Iridium [Xe] $4f^{14} 5d^7 6s^2$ +4 +3	195.084 78 Pt Platinum [Xe] $4f^{14} 5d^9 6s^1$ +4 +2	196.9665 79 Au Gold [Xe] $4f^{14} 5d^{10} 6s^1$ +3	200.59 80 Hg Mercury [Xe] $4f^{14} 5d^{10} 6s^2$ +2 +1	204.3833 81 Tl Thallium [Xe] $4f^{14} 5d^{10} 6s^2 6p^1$ +3 +1	207.2 82 Pb Lead [Xe] $4f^{14} 5d^{10} 6s^2 6p^2$ +4 +2	208.9804 83 Bi Bismuth [Xe] $4f^{14} 5d^{10} 6s^2 6p^3$ +3	(210) 84 Po Polonium [Xe] $4f^{14} 5d^{10} 6s^2 6p^4$ +4 +2 −2	(210) 85 At Astatine [Xe] $4f^{14} 5d^{10} 6s^2 6p^5$ +1	(220) 86 Rn Radon [Xe] $4f^{14} 5d^{10} 6s^2 6p^6$
7	(223) 87 Fr Francium [Rn] $7s^1$ +1	(226) 88 Ra Radium [Rn] $7s^2$ +2	(262) 103 Lr Lawrencium [Rn] $5f^{14} 7s^2 7p^1$ +3	(261) 104 Rf Rutherfordium [Rn] $5f^{14} 6d^2 7s^2$ +4	(262) 105 Db Dubnium +5	(266) 106 Sg Seaborgium +6	(264) 107 Bh Bohrium +7	(277) 108 Hs Hassium +8	(268) 109 Mt Meitnerium	(271) 110 Ds Darmstadium	(272) 111 Rg Roentgenium	(285) 112 Cn Copernicium	(284) 113 Uut Ununtrium	(289) 114 Uuq Ununquadium	(288) 115 Uup Ununpentium	(292) 116 Uuh Ununhexium	117 Uus Ununseptium	(294) 118 Uuo Ununoctium

Lanthanide Series	138.9054 57 La Lanthanum [Xe] $5d^1 6s^2$ +3	140.116 58 Ce Cerium [Xe] $4f^1 5d^1 6s^2$ +4 +3	140.9076 59 Pr Praseodymium [Xe] $4f^3 6s^2$ +3	144.242 60 Nd Neodynium [Xe] $4f^4 6s^2$ +3	(145) 61 Pm Promethium [Xe] $4f^5 6s^2$ +3	150.36 62 Sm Samarium [Xe] $4f^6 6s^2$ +3	151.964 63 Eu Europium [Xe] $4f^7 6s^2$ +3 +2	157.25 64 Gd Gadolinium [Xe] $4f^7 5d^1 6s^2$ +3	158.9253 65 Tb Terbium [Xe] $4f^9 6s^2$ +3	162.500 66 Dy Dysprosium [Xe] $4f^{10} 6s^2$ +3	164.9303 67 Ho Holmium [Xe] $4f^{11} 6s^2$ +3	167.259 68 Er Erbium [Xe] $4f^{12} 6s^2$ +3	168.9342 69 Tm Thulium [Xe] $4f^{13} 6s^2$ +3	173.054 70 Yb Ytterbium [Xe] $4f^{14} 6s^2$ +3
Actanide Series	(227) 89 Ac Actinium [Rn] $6d^1 7s^2$ +3	232.0380 90 Th Thorium [Rn] $6d^2 7s^2$ +4	231.0358 91 Pa Protactinium [Rn] $5f^2 6d^1 7s^2$ +5	238.0289 92 U Uranium [Rn] $5f^3 6d^1 7s^2$ +6	(237) 93 Np Neptunium [Rn] $5f^4 6d^1 7s^2$ +5	(244) 94 Pu Plutonium [Rn] $5f^6 7s^2$ +4	(243) 95 Am Americium [Rn] $5f^7 7s^2$ +3	(247) 96 Cm Curium [Rn] $5f^7 6d^1 7s^2$ +3	(247) 97 Bk Berkelium [Rn] $5f^9 7s^2$ +3	(251) 98 Cf Californium [Rn] $5f^{10} 7s^2$ +3	(252) 99 Es Einsteinium [Rn] $5f^{11} 6s^2$ +3	(257) 100 Fm Fermium [Rn] $5f^{12} 7s^2$ +3	(258) 101 Md Mendelevium [Rn] $5f^{13} 7s^2$ +3	(259) 102 No Nobelium [Rn] $5f^{14} 7s^2$ +3

radioactive elements have masses in parenthesis

Millimoles

The mole (symbol: mol) is the System International (SI) base unit that measures an amount of substance. One mole contains Avogadro's number (approximately 6.022×10^{23}) entities. A mole is much like "a dozen" in that both are absolute numbers (having no units) and can describe any type of elementary object, although the mole's use is usually limited to measurement of subatomic, atomic, and molecular structures. The goal is to acquire a sufficient quantity of a material to be able to measure it and since individual atoms and molecules are so small having an entire mole of a substance makes it easier to work with. Once you acquire a mole of a particular substance you may reference its atomic mass to know how much its mass in grams is. Let's look at carbon as an example:



A mole of carbon-12 (which has an atomic mass of 12) would have a mass of 12 g.

In medicine we tend to look at items in slightly smaller quantities, hence the need to measure some substances in millimoles (symbol: mMol). A mMol is one-one thousandth (1/1000) of a mole and mass would be measured in milligrams instead; therefore **1 mol = 1,000 mMol** and a mMol of carbon 12 would weigh 12 mg.

Let's look at an example problem with dibasic sodium phosphate (Na_2HPO_4).

Example:

A patient needs an infusion with 15 mMol of dibasic sodium phosphate (Na_2HPO_4) in 150 mL of NS. How many milligrams of dibasic sodium phosphate do you need to make this infusion?

Na = 23×2 = 46
H = 1
P = 31
O = 16×4 = 64

$46+1+31+64=132$ atomic mass units in a molecule of Na_2HPO_4.

Therefore, a mMol of Na_2HPO_4 would have a mass of 146 mg. With that in mind the problem becomes pretty straight forward to solve from there.

$$\frac{15\ \text{mMol}}{1} \times \frac{146\ \text{mg}}{1\ \text{mMol}} = \mathbf{2190\ mg\ of\ Na_2HPO_4}$$

Attempt the practice problem on the next page to verify you comprehension of this concept.

Practice Problem

> A patient needs an infusion with 12 mMol of monobasic potassium phosphate (KH_2PO_4) in 150 mL of NS. How many milligrams of monobasic potassium phosphate do you need to make this infusion?

1,632 mg of monobasic potassium phosphate

MilliEquivalents

The equivalent (symbol: Eq or eq) is a measurement unit used in chemistry and the biological sciences such as pharmacy. It is a measure of a substance's ability to combine with other substances and is a comparison of an ion's charge in comparison to a mole of the product. As an example if you look at potassium on a periodic table you will find that it typically has an ionic charge of +1 when it binds to other ions. Therefore 1 mole of potassium would equal 1 equivalent of potassium. Likewise, if we look at oxygen it typically has a charge of -2 when it combines with other elements so 1 mole of oxygen equals 2 equivalents of oxygen.

Much like pharmacy typically looks at items in slightly smaller quantities than moles, you'll find that it also looks at quantities slightly smaller than Eq. Just like 1,000 mMol are equal to 1 mole, 1,000 milliequivalents (symbol: mEq or meq) are equal to 1 Eq. Therefore 1 mMol of potassium equals 1 mEq of potassium and 1 mMol of oxygen equals 2 mEq of oxygen. Before expanding on this concept, try a couple of practice problems.

Practice Problems

Determine how many mEq are in a millimole of each of the following elements.

1) 1 mMol H
2) 1 mMol Ca
3) 1 mMol Cl

1) 1 mEq H 2) 2 mEq Ca 3) 1 mEq Cl

Now, let's add a some steps to this concept using volume of a solution, mass of a compound, millimoles of that compound, and milliequivalents of a particular ion. Procede to the next page for examples of using these concepts.

Example:

1) If a patient required 4.2 g of sodium bicarbonate ($NaHCO_3$), how many mEq of sodium (Na) is the patient receiving?

    Na = 23
    H = 1
    C = 12
    O = 16×3 = 48

    $23+1+12+48=84$ is the atomic mass of $NaHCO_3$, therefore 1 mMol = 84 mg.

    Also, a mMol of $NaHCO_3$ contains 1 mMol of Na and 1 mMol of Na = 1 mEq, so you can solve the problem as follows:

    $$\frac{4.2\text{ g}}{1} \times \frac{1000\text{ mg}}{1\text{ g}} \times \frac{1\text{ mMol}}{84\text{ mg}} \times \frac{1\text{ mEq}}{1\text{ mMol}} = \textbf{50 mEq of sodium}$$

2) How many mEq of sodium and how many mEq of chloride are in one liter of normal saline (0.9% w/v NaCl)?

    Na = 23
    Cl = 35.5

    23+35.5=58.5 is the atomic mass of NaCl, therefore 1 mMol = 58.5 mg.

    1 mMol Na = 1 mEq
    1 mMol Cl = 1 mEq

    $$\frac{1\text{ L}}{1} \times \frac{1000\text{ mL}}{1\text{ L}} \times \frac{0.9\text{ g}}{100\text{ mL}} \times \frac{1000\text{ mg}}{1\text{ g}} \times \frac{1\text{ mMol}}{58.5\text{ mg}} \times \frac{1\text{ mEq}}{1\text{mMol}} = 154\text{ mEq}$$

    154 mEq sodium
    154 mEq chloride

Now that you've seen a couple of example problems, attempt the following practice problems.

Practice Problem

1) How many mEq of calcium are in 111 mg of $Ca(OH)_2$.

2) How many mEq of sodium and how many mEq of chloride are in a 50 mL minibag of half-normal saline (0.45% w/v NaCl)?

1) 3 mEq Ca   2) 3.85 mEq Na & 3.85 mEq Cl

Millicurie

A curie (Ci) is a unit measuring the activity of radioactive isotopes and is named after french born scientists Pierre and Marie Curie whom did a significant quantity of early research on radioactive isotopes.

Nuclear pharmacy involves the preparation of radioactive materials that will be used to diagnose and treat specific diseases. Nuclear pharmacies typically work with weak radioactive isotopes and will commonly measure the activity level of the substances they are working with a smaller unit known as a millicurie (symbol: mc or mCi).

In nuclear pharmacy, radioactive isotopes with relatively short half-lives are typically used in order to limit a patient's exposure. This also creates an added challenge for those actually preparing the kits as they need to know not just what the activity level is when they are preparing it, but that it will have the correct activity level when given to the patient. While software exists to help pharmacy personnel perform these calculations, it is a good idea to understand the formula being used. The following is the exponential decay formula:

$$a_t = a_0 e^{-\lambda t}$$

a_t = quantity at end of time(t)
a_0 = quantity at beginning of time(t)
e = the value of base e from a natural logarithm (2.71828...)
λ = the exponential decay constant for a particular substance
t = time

Some common values for lambda (λ) when time (t) is provided in hours would include:

Technetium-99m (^{99m}Tc) = 0.11514
Iodine-131 (^{131}I) = 0.00359
Thalium-201 (^{201}Tl) = 0.00950

Example:

A common request for a stress test is to take a drug called sestamibi and reconstitute it with either technetium-99m or thalium-201 as the sestamibi is drawn to the heart and then the isotope helps it to show up for imaging. If a physician requests a dose of sestamibi with 10 millicuries of ^{99m}Tc for 0900 how many mCi would you need if you were drawing this dose up at 0100?

a_t = 10 mCi
a_0 = quantity at beginning of time, this is what you are solving for.
e = 2.71828...
λ = 0.11514
t = 8 hours

$$10\,\text{mCi} = a_0 e^{-0.11514 \times 8}$$

$$\frac{10\,\text{mCi}}{e^{-0.11514 \times 8}} = a_0$$

$$a_0 = \mathbf{25.1\,mCi}$$

Now that you know you need 25.1 mCi of ^{99m}Tc you find that your stock bottle has an activity level of 57.9 mCi/mL when you are ready to draw it up how many mL would you add to the sestamibi vial?

$$\frac{25.1\,\text{mCi}}{1} \times \frac{\text{mL}}{57.9\,\text{mCi}} = \mathbf{0.43\,mL}$$

Practice Problem:

A physician requests a dose of tetrofosmin with 30 millicuries of ^{99m}Tc for 1100. How many mCi would you need if you were also drawing this dose up at 0100? If your stock bottle has an activity level of 57.9 mCi/mL when you are ready to draw it up how many mL would you add to the tetrofosmin?

94.9 mCi and 1.64 mL

International Units

In pharmacology, the International unit (IU, alternatively abbreviated UI, from French unit internationale) is a unit of measurement for the amount of a substance, based on measured biological activity (or effect). It is used for vitamins, hormones, some drugs, vaccines, blood products and similar biologically active substances. Despite its name, the IU is not part of the International System of Units used in physics and chemistry.

The precise definition of one IU differs from substance to substance and is established by international agreement. To define an IU of a substance, the Committee on Biological Standardization of the World Health Organization provides a reference preparation of the substance, (arbitrarily) sets the number of IUs contained in that preparation, and specifies a biological procedure to compare other preparations to the reference preparation. The goal here is that different preparations with the same biological effect will contain the same number of IUs.

For some substances, the equivalent mass of one IU is later established, and the IU is then officially abandoned for that substance. However, the unit often remains in use nevertheless, because it is convenient. For example, Vitamin E exists in a number of different forms, all having different biological activities. Rather than specifying the precise type and mass of vitamin E in a preparation, for the purposes of pharmacology it is sufficient to simply specify the number of IUs of vitamin E.

Below are examples mass equivalents of 1 IU for selected substances:

> 1 IU Insulin: the biological equivalent of about 45.5 mcg pure crystalline insulin (1/22 mg exactly)
> 1 IU Vitamin A: the biological equivalent of 0.3 mcg retinol, or of 0.6 µg beta-carotene
> 1 IU Vitamin C: 50 mcg L-ascorbic acid
> 1 IU Vitamin D: the biological equivalent of 0.025 mcg cholecalciferol/ergocalciferol
> 1 IU Vitamin E: the biological equivalent of about 0.667 mg d-alpha-tocopherol (2/3 mg exactly), or of 1 mg of dl-alpha-tocopherol acetate

Example:

A vial of insulin with 1000 units of insulin contains how many actual mg of insulin?

$$\frac{1000\text{ units}}{1} \times \frac{45.5\text{ mcg}}{1\text{ unit}} \times \frac{1\text{ mg}}{1000\text{ mcg}} = \mathbf{45.5\,mg}$$

Practice Problem:

A vitamin E softgel capsule contains 500 IU of d-alpha-tocopherol and 500 IU of dl-alpha-tocopherol acetate. How many milligrams of each are in the capsule?

333 mg of d-alpha-tocopherol and 500 mg of dl-alpha-tocopherol acetate

Worksheet 17-1

Name:

Date:

Solve the following problems.

1) Determine how many of each type of atom are present in the following molecules:

   a) Calcium gluconate - $C_{12}H_{22}CaO_{14}$

   b) Monobasic sodium phosphate - NaH_2PO_4

   c) Potassium acetate - CH_3CO_2K

   d) Ethanol - C_2H_5OH

2) A patient needs an infusion with 7.5 mMol of monobasic potassium phosphate (KH_2PO_4) and 7.5 mMol of dibasic potassium phosphate (K_2HPO_4) in 150 mL of NS.

   a) How many mg monobasic potassium phosphate (KH_2PO_4) of are in the infusion?

   b) How many mg monobasic potassium phosphate (KH_2PO_4) of are in the infusion?

3) If a gram of calcium gluconate ($C_{12}H_{22}CaO_{14}$) was added to an IV bag:

   a) How many mMol of calcium gluconate ($C_{12}H_{22}CaO_{14}$) were added to the IV bag?

   b) How many mEq of calcium were added to the IV bag? (Calcium has a charge of +2)

4) A 10 mL potassium chloride (KCl) vial has a concentration of 2 mEq of potassium/mL. How many mg of KCl are in the vial?

5) A physician requests a dose of tetrofosmin with 30 millicuries of ^{201}Tl for 1100.

   a) How many mCi would you need if you were also drawing this dose up at 0100?

   b) If your stock bottle has an activity level of 59.7 mCi/mL when you are ready to draw it up, how many mL would you add to the tetrofosmin vial?

6) Whenever dealing with radioactive iodine nuclear pharmacy typically measures the activity level with Grays (Gy) instead of millicuries, but all the calculations are still done the same way. If a patient with thyroid cancer required a capsule of ^{131}I with a activity level of 150 Gy 72 hours from now, what should the activity level be when preparing the capsule?

7) A vitamin D-400 tablet contain 400 IU of cholecalciferol. How many mcg of cholecalciferol are in the tablet?

8) A particular vitamin C (ascorbic acid) injection has a concentration of 500 mg/mL. How many IU are in 1 mL of this ascorbic acid preparation?

Chapter 18

Powder Volume Calculations

An oddity of understanding this chapter is that you'll realize that Bill Cosby lied when he said, "There's always room for JELL-O."

--Sean Parsons

As we start this chapter we should take a moment and consider why some medications come in lyophilized (freeze-dried) powders. The reasons are fairly straight forward such as improved stability, longer expiration, and easier storage with concern to temperature requirements. There are some concepts we need to thoroughly address in this chapter such as:

- powder volume,
- diluent volume,
- total volume,
- final concentration, and
- how to obtain different concentrations.

As this chapter is obviously primarily focused on powder volume we should explore this concept. The volume or space that the powdered drug occupies after it is reconstituted is called powder volume. For some drugs, the powder volume is so small that it is considered negligible. Other drugs have substantial powder volume which needs to be taken into consideration when reconstituting.

A common comparison is that most people do not leave significant, if any, room for the sugar they add to their morning coffee. In this scenario we can say that powder volume is negligible. But an interesting experiment to do is to take two containers that can hold three liters of volume. In one container add enough gelatin mix to make three liters of gelatin. In the other container fill it with three liters of fluid. Then using a funnel add all the water from the one container to the other one with the gelatin. If you pour out all the fluid, a significant amount of fluid will spill everywhere. In this case we can say that the gelatin mix has a significant amount of powder volume that we should have accounted for.

From this basic idea we can ascertain the following formula:

$$\text{Powder Volume} + \text{Diluent Added} = \text{Total Volume}$$

We should consider several different ways that we can find powder volume. Sometimes the package insert or vials will tell you. Other times you will be told how much to reconstitute it with and be given either the concentration or the total volume. From there you can find the powder volume by taking the total volume and subtracting the amount of diluent added.

Without wanting to over explain a simple concept, let's go to the next page and look at an example problem.

Example:

If 95 mL of sterile water for injection (SWFI) is added to a 10 g bulk powdered drug pharmacy container, the concentration obtained is 100 mg/mL. What is the powder volume of the drug?

QUESTION

What is the powder volume of the drug?

DATA

95 mL SWFI added (this is the diluent added)
10 g powdered drug (this is the weight of drug)
100 mg/mL (this is our final concentration)

FORMULA/METHOD

$$\begin{array}{r} \text{Powder Volume} \\ \underline{+\ \ \text{Diluent Added}} \\ \text{Total Volume} \end{array}$$

MATH

We know the diluent added is 95 mL, and since we have the weight of the drug in the vial and the final concentration after reconstitution we can find the total volume as follows:

$\dfrac{\text{mL}}{100\text{ mg}} \times \dfrac{1000\text{ mg}}{1\text{ g}} \times \dfrac{10\text{ g}}{1} = 100\text{ mL}$ total volume, often referred to as final volume.

$$\begin{array}{r} \text{Powder Volume} = \ \ ??? \\ \underline{+\ \ \text{Diluent Added} = \ \ 95\text{ mL}} \\ \text{Total Volume} = 100\text{ mL} \end{array}$$

$100\text{ mL} - 95\text{ mL} = \mathbf{5\ mL\ Powder\ Volume}$

DOES THE ANSWER MAKE SENSE

Yes

It is noteworthy focusing on how we obtained the total volume. The final concentration and the quantity of drug in the vial are both reflective of what will be in the vial immediately after reconstitution is complete and therefore are appropriate to use when determining the total volume in the vial after reconstitution.

Now, you should attempt some problems to ensure that the concepts are making sense thus far.

Practice Problems:

1) You want to prepare a 500 mg dose of ceftriaxone for IM injection. If you reconstitute it with 1.8 ml of 2% lidocaine you attain a concentration of 250 mg/ml. What is the powder volume of the drug?

2) A 20 million unit (MU) vial of penicillin g potassium has 8 mL of powder volume. *(Notice that this problem has already given you the powder volume)*

   a) How many mL will you reconstitute it with to attain a concentration of 500,000 unit/mL? *(Hint: You can use the concentration to determine the total volume, which will be necessary to determine the volume of diluent needed.)*

   b) How many mL of the reconstituted solution will you draw up for a 12 MU dose? *(Hint: This is similar to what you did in Chapter 15, so all you will need is the dose and the concentration to solve this.)*

1) 0.2 mL powder volume 2-a) 32 mL of diluent 2-b) 24 mL

One more concept to cover is the idea of changing the quantity of diluent used to reconstitute a preparation in order to obtain a different concentration. Let's look at an example problem to explain this scenario.

Example:

Ordinarily IVIG is reconstituted to a concentration of 50 mg/mL. To obtain this concentration a 5 g vial is reconstituted with 93 mL of diluent. What is the powder volume for a 5 g vial of IVIG? How much would you reconstitute it with if the patient was fluid restricted and the physician requested a concentration of 100 mg/mL?

To find the powder volume by doing the same steps as we have already done on previous problems. The first step is to determine what the total volume would be, and conveniently the problem already gave us a volume for diluent added if reconstituted to a concentration of 50 mg/mL.

$$\frac{\text{mL}}{50\,\text{mg}}\times\frac{1000\,\text{mg}}{1\,\text{g}}\times\frac{5\,\text{g}}{1}=100\,\text{mL total volume}$$

Powder Volume = ???
\+ Diluent Added = 93 mL
Total Volume = 100 mL

100 mL – 93 mL = **7 mL powder volume**

Now that we've answered the first question about powder volume we can determine the amount of diluent to add to obtain the desired concentration of 100 mg/mL. We will once again need to determine the total volume, but this time for our new concentration.

$$\frac{\text{mL}}{100\ \text{mg}} \times \frac{1000\ \text{mg}}{1\ \text{g}} \times \frac{5\ \text{g}}{1} = 50\ \text{mL total volume}$$

Powder Volume = 7 mL
+ Diluent Added = ???
Total Volume = 50 mL

50 mL – 7 mL = **43 mL of diluent** to obtain the requested concentration.

Now, using the example problem as a template, solve the practice problem below.

Practice Problem:

A 1 g vial of vancomycin ordinarily is reconstituted with 19.5 mL of sterile water for injection (SWFI) to obtain a concentration of 50 mg/mL. What is the powder volume and how much should you reconstitute it with if you needed a concentration of 100 mg/mL?

The vial has 0.5 mL of powder volume and 9.5 mL of SWFI should be used to obtain a concentration of 100 mg/mL.

Worksheet 18-1

Name:

Date:

Solve the following powder volume problems.

1) If 192 mL of sterile water for injection (SWFI) is used to reconstitute a 20 g vial of cefazolin Na, the concentration obtained is 100 mg/mL. What is the powder volume of this drug?

2) Using another 20 g vial of cefazolin Na, how many mL of SWFI should be added to obtain a concentration of 200 mg/mL instead? *(Hint: The powder volume from the previous question is required to solve this.)*

3) A vial contains a combination drug of ampicillin/sulbactam. There is 1 g of ampicillin and 0.5 g of sulbactam in the vial. When the vial is reconstituted with 3.2 mL of sterile water you end up with a total volume of 4.0 mL.

   a) How many mL of powder volume are there?

   b) What is the concentration of each drug?

4) The label on a bottle of oral amoxicillin suspension states you are to add 39 mL of purified or distilled water to the bottle to obtain a suspension with a concentration of 150 mg/tsp. The total amount of active ingredient in the bottle is 2 g. What is the powder volume?

5) The directions for a vial containing 1 g of lyophilized ceftriaxone states that the addition of 3.6 mL of SWFI will yield a solution with a concentration of 250 mg/mL. What is the powder volume of the drug?

6) If you dissolve 5 MU of penicillin with 8 mL of SWFI and you know that this vial contains 2 mL of powder volume, what is the concentration of the drug in the solution?

7) A 4 g vial of a powdered drug is reconstituted with 4.9 mL of SWFI to obtain a concentration of 800 mg/mL.

   a) What is the powder volume of the drug?

   b) If 2.6 mL of the reconstituted solution is added to a 500 mL bag of D5W, how much medication is in the IV bag?

8) If a 20 MU vial of penicillin g potassium has a powder volume of 8 mL, what would be concentration obtained if each of the possible volumes of SWFI listed below were used to reconstitute the vial?

   a) 32 mL

   b) 42 mL

   c) 72 mL

   d) 92 mL

9) You add 4.3 mL of diluent to a 1 g vial and have a final volume of 5 mL.

   a) What is the powder volume?

b) What is the final concentration in mg/mL?

c) How many mL would you need to add to a 50 mL bag of NS if a dose of 250 mg were required.

10) A pharmacists asks you to prepare cefazolin eye drops. You will need to add 9.8 mL of NSS to a 500 mg vial of cefazolin which has 0.2 mL of powder volume according to the package insert. You will draw up 1 mL of the reconstituted solution and filter through a 0.5 micron filter into a sterile eye dropper. Then you will add 9 mL of NSS to the eye dropper (this will also need filtered). What is the final concentration of cefazolin in the eye dropper? *(Hint: You will first need to figure out the concentration of the solution in the vial before you can calculate the concentration in the eye dropper.)*

Worksheet 18-2

Name:

Date:

Solve the following powder volume problems.

1) If 95 mL of sterile water for injection (SWFI) is used to reconstitute a 10 g vial of vancomycin, the concentration obtained is 100 mg/mL. What is the powder volume of this drug?

2) Using another 10 g vial of vancomycin, how many mL of SWFI should be added to obtain a concentration of 200 mg/mL instead?

3) A bulk pharmacy vial contains 40.5 g of a combination drug of Zosyn (piperacillin/tazobactam). There are 36 g of piperacillin and 4.5 g of sulbactam in the vial. When the vial is reconstituted with 152 mL of sterile water you end up with a concentration of 225 mg/mL of piperacillin and tazobactam combined.

    a) What is the powder volume in the vial?

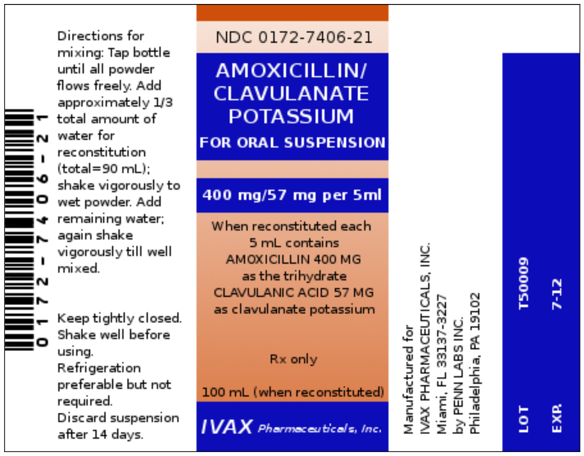
    b) What is the concentration (in mg/mL) of each active ingredient separately?

    c) If a physician ordered 4.5 g of Zosyn (piperacillin/tazobactam) in 100 mL of 0.45% sodium chloride, how many mL would you need to transfer from the bulk vial after reconstitution to the 100 mL minibag?

4) The package insert for a 1 g streptomycin vial instructs you to add 4.2 mL SWFI to obtain a concentration of 200 mg/mL. What is the powder volume for a 1 g vial of sreptomycin powder?

5) If you add 10 mL of SWFI to a 1 g vial of powdered drug that has a powder volume of 0.5 mL, what is the resulting concentration going to be in mg/mL?

6) Review the amoxicillin/clavulanate label below carefully:



a) What is the powder volume?

b) How many grams of amoxicillin are in the bottle?

c) How many grams of clavulanate are in the bottle?

7) The directions for a preparing a vial containing 1 g of lyophilized cefepime HCl for IM injection suggests the addition of 2.4 mL of 1% lidocaine HCl which will yield a solution with a concentration of 280 mg/mL.

a) What is the powder volume of the drug?

b) If a patient required only 500 mg to be given IM, how many mL would be needed to administer the desired dose?

8) An 8 g vial of a powdered drug is reconstituted with 19.6 mL of SWFI to obtain a concentration of 400 mg/mL.

a) What is the powder volume of the drug?

b) If a physician requests that 12 g of the reconstituted solution is to be added to a 500 mL bag of D5W, how many mL will you need to add to the IV bag?

9) If a 10 MU vial of medication has a powder volume of 4 mL, what would be concentration obtained if each of the possible volumes of SWFI listed below were used to reconstitute the vial?

a) 16 mL

b) 21 mL

c) 36 mL

d) 46 mL

10) A 6 g bulk vial of ceftazidime has a final volume of 30 mL when reconstituted with 26 mL.

a) What is the powder volume?

b) What is the concentration in mg/mL?

c) How many mL of the reconstituted solution would be required to fill an order for 2 g of ceftazidime?

11) A 3.2 g vial of Timentin (ticarcillin/clavulanic acid) has 2.2 mL of powder volume.

a) If you reconstitute it with 17.8 mL of SWFI, what is the cocnentration in mg/mL?

b) How many mL of the reconstituted solution will you need for a dose of 1.6 g of Timentin?

12) Ordinarily IVIG is reconstituted to a 5% (w/v) concentration and is available in vials of various quantities. For standard reconstitution a 2.5 g vial is reconstituted with 46.5 mL of diluent, a 5 g vial is reconstituted with 93 mL of diluent, and a 10 g vial is reconstituted with 186 mL of diluent.

a) What does 5% (w/v) mean?

b) How much powder volume is in each size of vial?

c) If a patient needed 27.5 g of IVIG how many of each size vial would be needed to fill this order? (I'm looking for the combination with the fewest possible vials that won't waste any drug.)

d) If the patient is fluid restricted and needs a 10% concentration of the drug instead, how many mL of diluent would you reconstitute each size vial with?

e) What would be the final volume of a 27.5 g solution at a 10% concentration?

Worksheet 18-3

Name:

Date:

Solve the following powder volume problems.

1) A 10 g bulk vial of vancomycin is supposed to be reconstituted with 95 mL of SWFI to achieve a concentration of 100 mg/mL. A technician receives an order for 1.5 g of vancomycin in 250 mL of 0.9% sodium chloride. The technician accidentally reconstitutes the vial with 100 mL of SWFI, instead of 95 mL but does not want to waste the drug vial; therefore we will need to do some calculations to figure out how to still use this solution.

    a) First you will need to know the powder volume in the vial. This is easiest to calculate by using the suggested reconstitution information.

    b) Second, you will need to determine the total volume actually in the vial once it was incorrectly reconstituted.

    c) Third, you will want to know the concentration of the drug in the vial after it was reconstituted incorrectly.

    d) Fourth, you can now determine the quantity of reconstituted solution that was added to the bag.

    e) Often, you will want to know whether an IV can be infused peripherally or if it requires a central line. Vancomycin when given IV requires a central line if the IV bag has a concentration >5 mg/mL. Can this bag be infused peripherally or does it require a central line? Why or why not?

2) A vial contains 200 mg of gemcitabine and after being reconstituted with 5 mL of NS it has a concentration of 38 mg/mL. What is the powder volume of the gemcitabine in a 200 mg vial?

3) Another vial contains 1000 mg of gemcitabine and after being reconstituted with 25 mL of NS it has a concentration of 38 mg/mL. What is the powder volume of the gemcitabine in a 1000 mg vial?

4) The pharmacy must add water to an oral suspension before it can be dispensed to the patient. The dose is to be 750 mg/Tbs, and the dry powder is 5g with a powder volume of 8.6 mL. How much water must you add?

5) The directions for a bulk pharmacy vial containing 10 g of oxacillin states that the addition of 93 mL of SWFI will provide a final concentration of 100 mg/mL.

   a) What is the powder volume?

   b) How many mL would be needed to fulfill a physician order for 1 g of oxacillin in 100 mL of half normal saline?

6) Using another 10 g vial of oxacillin you receive a request to prepare a bottle with a final concentration of 200mg/mL.

   a) How many mL of SWFI will you need to reconstitute it with?

   b) How many mL would be needed to fulfill a physician order for 1 g of oxacillin in 100 mL of half normal saline using this new concentration?

7) A 3 g vial of powdered drug is reconstituted with 4.8 mL of SWFI to obtain a concentration of 600 mg/mL.

   a) What is the powder volume of the drug?

   b) If 3 mL of the reconstituted solution is added to a 150 mL bag of D5W, how much medication is in the IV bag?

8) You dissolve 5 MU of penicillin with 18 mL of SWFI and according to the package the vial contains 2 mL of powder volume.

   a) What is the concentration of penicillin (in units/mL) in the vial after reconstitution?

   b) How many mL would be required to fill an order for 3.5 MU?

9) You add 8.6 mL of diluent to a 2 g vial and have a final volume of 10 mL.

   a) What is the powder volume?

   b) What is the final concentration in mg/mL

   c) How many many mL would you add to a 50 mL bag of NS if a dose of 1.5 g were required?

10) A bulk pharmacy vial contains 40.5 g of a combination drug of Zosyn (piperacillin/tazobactam). There are 36 g of piperacillin and 4.5 g of sulbactam in the vial. When the vial is reconstituted with 62 mL of sterile water you end up with a concentration of 450 mg/mL of piperacillin and tazobactam combined.

   a) What is the powder volume in the vial?

   b) What is the concentration (in mg/mL) of each active ingredient separately?

   c) If a physician ordered 3.375 g of Zosyn (piperacillin/tazobactam) in 100 mL of 0.45% sodium chloride, how many mL would you need to transfer from the bulk vial after reconstitution to the 100 mL minibag?

Chapter 19

Percentage Strength

Famous last words, "This chapter should be easy."
--Sean Parsons

Back in chapter 9 you learned that there are three kinds of percentage strength that you will frequently use when doing dosage calculations:

weight/weight (w/w) – examples include ointments, creams, etc.
volume/volume (v/v) – a common example is an alcohol preparation or an oil in water preparation.
weight/volume (w/v) – this is the most common group and includes items such as solutions, suspensions, etc.

Another kind of percentage strength that you should acquire knowledge about is called:

milligram percent (mg%) - a measurement frequently used when looking at lab values for patients.

When these concepts are well understood you can:

- calculate the percentage strength of a mixture when you know know both the quantity of the active ingredient and the total mixture,
- determine how much of a mixture can be prepared from a given weight of ingredient when trying to prepare a compound with a specific percentage strength,
- determine the amount of an ingredient that is present in a mixture if you already know its percentage strength,
- determine whether a patient's lab values are within the appropriate range.

We should start off reviewing the first three kinds of percentage strength. You probably remember that:

w/w% is *typically* measured as g/100 g so a 1% hydrocortisone cream would mean that there is 1 gram of hydrocortisone in every 100 g of cream
v/v% is *typically* measured as mL/100 mL so a 70% isopropyl alcohol solution would mean that there are 70 milliliters of isopropyl alcohol in every 100 milliliters of solution.
w/v% is *always* measured as g/100 mL so a 0.9% sodium chloride solution would mean that there 0.9 grams of sodium chloride for every 100 milliliters of solution.

Weight/Weight (w/w)

A weight/weight percentage strength expresses the number of parts in 100 parts of a preparation . As mentioned above it is usually expressed as number of grams per 100 grams, but it could be expressed in any unit of weight (grams, grains, ounces, pounds, etc.) as long as the units on the top and bottom match. Let's look at an example to help this make more sense.

Example

What would be the weight, expressed in grams, of zinc oxide (zinc oxide is the active ingredient) in 120 grams of a 20% zinc oxide ointment (the ointment is the total mixture)?

QUESTION

How many grams of zinc oxide are in the ointment?

DATA

$120\ g\ of\ \ ointment$ $\quad 20\% = \dfrac{20\ g\ zinc\ oxide}{100\ g\ ointment}$

MATHEMATICAL METHOD / FORMULA

Ratio Proportion (This can be done other ways, but this is the easiest method to explain thoroughly.)

DO THE MATH

$$\frac{N}{120\ g\ ointment} = \frac{20\ g\ zinc\ oxide}{100\ g\ ointment}$$

$$N = \mathbf{24\ g\ zinc\ oxide}$$

DOES THE ANSWER MAKE SENSE?

Yes

By using the ratio-proportion method for solving the problem, it largely lines itself up because the active ingredient goes on top and the total mixture belongs on the bottom. Also, remember that a percent is always out of 100.

Let's look at a couple of practice problems based on w/w percentage strength.

Practice Problems

1) What would be the percentage strength of a zinc oxide ointment if you prepared 90 grams of an ointment that contained 4.5 grams of zinc oxide? *(Hint: In this problem you have the weight of the active ingredient and the weight of the mixture, you need to find the percentage strength which would be out of 100 grams of mixture)*

2) If you had 2.5 grams of hydrocortisone powder on hand, how many grams of 0.5% hydrocortisone cream could you prepare?

1) 5% zinc oxide ointment 2) 50 grams of hydrocortisone cream

Volume/Volume (v/v)

Volume/volume percentage strength problems are worked out in a similar manner to w/w percentage strength problems, except now the ingredients are liquid form. Typically it is expressed as number of milliliters per 100 milliliters, but it could be expressed in any unit of volume (liters, pints, fluid ounces, etc.) as long as the units on the top and bottom match. Look at the example problem below, and then complete the practice problem.

Example

How mL of isopropyl alcohol are in a 1 pint bottle of 70% isopropyl alcohol? Also, if the isopropyl alcohol solution is in sterile water for irrigation, how much water is in the solution?

QUESTION

How many mL of isopropyl alcohol and how many mL of water are in the bottle?

DATA

$1\ pint = 480\ mL\ of\ mixture$ $\quad 70\%\ isopropyl\ alcohol = \frac{70\ mL\ isopropyl\ alcohol}{100\ mL\ mixture}$

MATHEMATICAL METHOD / FORMULA

Ratio Proportion (This can be done other ways, but this is the easiest method to explain thoroughly.)

DO THE MATH

$$\frac{N}{480\ mL\ mixture} = \frac{70\ mL\ isopropyl\ alcohol}{100\ mL\ mixture}$$

$$N = \mathbf{336\ mL\ isopropyl\ alcohol}$$

480 *mL* – 336 *mL* = ***144 mL SWFI***

DOES THE ANSWER MAKE SENSE?

Yes

Practice Problems

1) How many liters of 2% lysol solution could be made with 80 mL of lysol and how many mL of SWFI would be required to make this preparation?

2) A pharmacy elixir recipe calls for a fluid ounce of 90% ethanol. How many milliliters of pure ethanol are going to be in this preparation?

1) 4 liters of 2% lysol solution; 3,920 mL of SWFI 2) 27 mL of ethanol

Weight/Volume (w/v)

Weight/volume (w/v) percentage strengths are the most common percentages worked with in institutional pharmacy. The units in this type of problem are **always** grams of drug in 100 milliliters of solution (or suspension). Let's look at a practice problem.

Example

How many grams of sodium chloride are in a 500 mL bag of half-normal saline (0.45% sodium chloride)?

QUESTION

How many g of sodium chloride are in the bag?

DATA

$500\ mL\ of\ mixture$ $\quad 0.45\%\, sodium\ chloride = \frac{0.45\ g\ sodium\ chloride}{100\ mL\ mixture}$

MATHEMATICAL METHOD / FORMULA

Ratio Proportion

DO THE MATH

$$\frac{N}{500\ mL\ mixture} = \frac{0.45\ g\ sodium\ chloride}{100\ mL\ mixture}$$

$$N = \mathbf{2.25\ g\ sodium\ chloride}$$

DOES THE ANSWER MAKE SENSE?

Yes

As w/v percentage strength problems are the ones we will be working with most frequently it is worth pointing out that our ratio proportions for w/v percentage strength problems always have grams on top and milliliters on the bottom. Let's look at some practice problems.

Practice Problems

1) A physician orders a TPN with 20 grams of dextrose. The pharmacy has a stock solution of 70% dextrose in water (D70W). How many milliliters of D70W are required to make the requested TPN?

2) An order for 1 liter of a 0.05% (w/v) solution is received in the pharmacy. In stock is 525 mg of the powdered drug. Is there enough drug to be able to fill this order?

1) 28.57 mL of D70W 2) Yes, there is enough drug on hand to fill the order.

Worksheet 19-1

Name:

Date:

Solve the following problems.

1) You need to prepare 120 g of a 2% zinc oxide ointment. How many grams of zinc oxide will be needed to prepare this ointment?

2) How many liters of a 0.02% solution of cinnamon oil in alcohol could be made from 5 mL of cinnamon oil?

3) A patient is to be given 1 g of magnesium sulfate IM. The label on a 10 mL vial reads "50% solution of Mag Sulf." How many mL will you need?

4) You have 20 mL of 2% lidocaine on the shelf. The order calls for 100 mg. How many mL do you need to use?

5) You have in stock a 250 mL stock bottle of 23.4% concentrated sodium chloride injection.

   a) How many grams of sodium chloride are in the bottle?

   b) How many mg are in 1 mL?

6) Calcium gluconate is available as a 10% solution. You receive an order for 1.25 g of calcium gluconate. How many mL of the solution should be used?

7) You have 50 mg of chloramphenicol powder in the pharmacy. How many mL of a 1% ophthalmic solution will you be able to prepare?

8) Hydrocortisone topical cream is available as a 0.2% concentration in a 1 pound jar. How many milligrams of hydrocortisone are in the product?

9) How many mL of ethanol are in 35 ml of a 50% ethanol solution?

10) How many grams of amino acid are in a 500 mL bottle of 5.2% amino acid?

11) How many mg of potassium chloride are in 2 tablespoonfuls of 10% KCl solution?

12) How many 150 mg capsules of clindamycin are needed to prepare 2 fluid ounces of 1% clindamycin solution?

13) Devonex is a topical ointment available in a 0.005% concentration. How many milligrams of active ingredient would be in 45 grams of ointment?

14) An order for 500 mL of a 1.5% (w/v) solution is received in the pharmacy. In stock is 7 grams of the powdered drug. Is there enough drug to be able to fill this order?

15) A powdered drug comes in a vial containing 1.8 g. If the total volume after the diluent is injected is 6 mL, what is the percentage strength of this solution?

16) A patient order calls for a liter bottle of acetic acid irrigation solution 0.25% (v/v).

   a) How many milliliters of pure acetic acid is in a liter of 0.25% acetic acid?

   b) How many milliliters of pure acetic acid is in a 30 mL dose of 0.25% acetic acid?

17) If you dissolve 12.5 g of a drug in 500 mL of sterile water, what will be the percentage strength of the final solution (assuming that powder volume is negligible)?

18) Sulfatrim suspension is a combination product that contains 200 mg of sulfamethoxazole and 40 mg of trimethoprim in every teaspoon. What are the percentage strengths of each drug?

19) Sulfatrim suspension uses ethanol as an excipient. The suspension is approximately 0.5% ethanol. How many milliliters of alcohol would be present in a teaspoonful of this medication?

20) You receive an order to prepare 2 fluid ounces of a 0.025% solution. How many mg of powder will you need to prepare this solution?

Milligram Percent (mg%)

If you are working lab values, you will sometimes see another type of percentage strength referred to as a milligram percent (mg%). Milligram percents are not routinely used for dosing, but they are frequently used in reporting clinical laboratory test results. They are intended for reporting various chemicals that are present in the body in small quantities. Several examples are cholesterol, glucose, creatinine, and even some drugs.

You are already familiar with weight-in-volume percents, which were measured as g/100 mL. The only difference with milligram percent problems is that the numerator is in milligrams instead of grams. Also, instead of seeing the 100 mL in the denominator, you will see the letters dL, which stands for a "deciliter" and is the same as 100 mL. Sometimes, instead of being written as mg% you will see it written as mg/dL.

Let's look at an example problem below involving mg%.

Example

A patient in the ER was in a car accident, you receive the urine analysis and find that he had a blood alcohol content of 90 mg%. While individual states may set more stringent standards, the United States considers an individual legally intoxicated when their blood alcohol content is above 0.08%. Is the patient legally intoxicated based on federal standards?

$$\frac{90\,\text{mg}}{1}\times\frac{1\,\text{g}}{1000\,\text{mg}}=0.09\,\text{g}$$

$$90\,\text{mg}\,\%=\frac{90\,\text{mg}}{100\,\text{mL}}=\frac{0.09\,\text{g}}{100\,\text{mL}}=\mathbf{0.09\,\%}$$

The patient **is** legally intoxicated.

Now, attempt a couple of practice problems prior to starting the next worksheet.

Practice Problems

Based on a patient with a reported serum glucose of 165 mg/dL answer the following questions.

1) What would her serum glucose be if it were recorded as a mg%?

2) What would her serum glucose be if it were recorded as a traditional weight/volume percentage strength?

1) 165 mg%   2) 0.165%

Worksheet 19-2

Name:

Date:

Solve the following problems.

1) A patient has a blood glucose of 130 mg/dL. What would the patients blood glucose be if you recorded it as a mg%?

2) A patient has a serum creatinine of 0.15% (w/v). Express this as a mg%.

3) An order calls for a pint of 2.5% suspension. How many 200 mg tablets will be required to compound this suspension?

4) A physician order 500 mcg of a medication. The drug is available in a concentration of 0.025%. How many milliliters of this 0.025% solution will be required to fill this order?

5) A 0.1% Protopic (tacrolimus) cream is temporarily unavailable from the manufacturer. How many 5 mg capsules of tacrolimus will you need to prepare 30 grams of this cream?

6) Pharmacies often use 70% isopropyl alcohol for wiping down items that need to maintain sterility. How many milliliters of isopropyl alcohol is in a pint of 70% isopropyl alcohol?

7) If a patient has a serum cholesterol level of 95 mg%, how many micrograms of cholesterol would be in 1 milliliter of serum?

8) If you dissolved 180 g of a drug in enough diluent to make a liter, what would be the resulting percentage strength?

9) The pharmacy has in stock a 50 mL vial of 25% mannitol injection. If an order request 4 g of mannitol, how many mL of solution will you need to withdraw from the vial?

10) How many mg of zinc sulfate are found in 8 oz. of a 0.02% solution?

11) How much of each ingredient must be weighed out to prepare the following ointment?

Rx testosterone 2% and
menthol 4.33% in hydrophilic petrolatum
Disp: 90 g
Sig: apply lightly q.i.d.

12) A patient is admitted to the hospital for a health condition unrelated to alcohol consumption. The physician decides to allow the patient to enjoy a 12 oz beer every evening. If the beer has an alcohol concentration of 5.9%, how much alcohol is this patient receiving every evening?

13) An order for 250 mL of a 2% (w/v) solution is received in the pharmacy. In stock is 5.5 grams of the powdered drug. Is there enough drug to be able to fill this order?

14) A child got into their parents' acetaminophen, and they aren't sure how much the child ingested. You checked a chart and saw that the blood serum for acetaminophen is not considered toxic till it reaches 15 mg%. If the child's acetaminophen level is high enough to be considered toxic the physician will want to start an acetylcysteine infusion to try and prevent permanent damage to the child's liver, but the drug has the potential of damaging his kidneys in the process. The lab results show his serum concentration of acetaminophen to be 100 mcg/mL. Has the child reached a toxic level?

15) Someone signs out 100 mg of cocaine for you to prepare a 0.4% ophthalmic solution. How many mL of this ophthalmic solution will you be able to prepare?

16) You have 250 mg of chloramphenicol powder in the pharmacy. How many mL of a 1% ophthalmic solution will you be able to prepare?

17) A 50 mL vial of sulfamethoxazole and trimethoprim injection contains a concentration of 80 mg of sulfamethoxazole and 16 mg of trimethoprim per mL. What are the percentage strengths of each of the drugs?

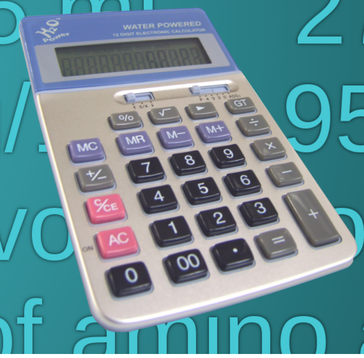
18) A vial of lyophilized powder with 2 g of ampicillin and 1 g of sulbactam is reconstituted to have a volume of 8 mL. What are the percentage strengths of each of the drugs?

19) An insulin resistant patient is admitted and given the following insulin sliding scale to follow:

150-199 mg%: 2 unit bolus regular insulin
200-249 mg%: 4 units bolus regular insulin
250-299 mg%: 7 units bolus regular insulin
300-349 mg%: 10 units bolus regular insulin
Over 350 mg%: 12 units bolus regular insulin

If the patient has a blood glucose reading of 260 mg/dL how many units of insulin should that patient receive?

20) What would be the percentage strength of a zinc oxide ointment if you prepared 60 grams of an ointment that contained 4.5 grams of zinc oxide?



Chapter 20

Ratio Strength

When it comes to the ratio of technicians to pharmacists some might find it interesting that there are 16 states that have no limits on this ratio, 6 states allow a 4 to 1 ratio, and all the others allow either 3 to 1 or 2 to 1 technicians to pharmacist ratios.
--National Association of Boards of Pharmacy

Ratios are sometimes used to express the concentrations of particular drugs and are primarily used with very dilute solutions (although it may be used with creams and other mixtures as well). Similar to the three major types of percentage strength, we also have three types of ratio strength in pharmacy:

- **weight : weight** (w:w) ~ This is typically expressed as grams of active ingredient to grams of mixture. This is sometimes referred to as *solids in solids*.
- **volume : volume** (v:v) ~ This is typically expressed as milliliters of active ingredient to milliliters of solution. This is sometimes referred to as *liquids in liquids*.
- **weight : volume** (w:v) ~ This is always expressed as grams of active ingredient to milliliters of solution. This is sometimes referred to as *solids in liquids*.

You have already learned about various other ways to measure the concentration of various preparations. In the previous chapter we looked at percentage strength which expressed concentration per 100. Ratio strength is merely another way of expressing concentration. A 5% concentration could be expressed as a ratio by saying 5:100; although, you will typically see ratios expressed a one to something. Therefore, 5:100 would be reduced down to 1:20. Let's look at some examples of concentrations in various preparations and look at the corresponding ratio strength.

Examples

1) Determine the ratio strength of 20% mannitol.

$$\frac{20\,\text{g}}{100\,\text{mL}} = \frac{1\,\text{g}}{\text{N}}$$

N = 5 mL

The ratio strength is **1:5**.

2) A cefazolin vial has a concentration of 500 mg/10 mL. What is the ratio strength of the cefazolin solution?

First we need to convert our milligrams into grams:

$$\frac{500\,\text{mg}}{1} \times \frac{1\,\text{g}}{1000\,\text{mg}} = 0.5\,\text{g}$$

Now we can set-up our ratio:

$$\frac{0.5\,\text{g}}{10\,\text{mL}} = \frac{1\,\text{g}}{\text{N}}$$

N=20 mL

The ratio strength is **1:20**.

3) Epinephrine is available as a 1:1000 w:v solution. If the patient dose is 0.5 mg, how many mL are needed?

First we need to convert our milligrams into grams:

$$\frac{0.5\,\text{mg}}{1} \times \frac{1\,\text{g}}{1000\,\text{mg}} = 0.0005\,\text{g}$$

Now we can set-up our ratio:

$$\frac{0.0005\,\text{g}}{\text{N}} = \frac{1\,\text{g}}{1000\,\text{mL}}$$

N=0.5 mL

The volume that needs withdrawn to fill this order is **0.5 mL**.

Now that you have seen some examples you should attempt the following practice problems.

Practice Problems

1) You need to prepare 1.5 liters of a 1:1000 neomycin bladder irrigation. How many grams of neomycin are required?

2) If you added 500 mcg of octreotide to a minibag with a final volume of 50 mL what would be both the resulting percentage strength and ratio strength? (*Hint: You are looking for two different answers.*)

3) If 150 mg of strychnine sulfate is intimately mixed with 7.35 g of lactose, what is the ratio strength of the strychnine sulfate compared to the total mixture?

1) 1.5 g of neomycin 2) 0.001%; 1:100,000 3) 1:50

Worksheet 20-1

Name:

Date:

Solve the following problems.

1) A physician orders a 1 liter polymixin-b sulfate bladder irrigation with a concentration of 1:1000. How many grams of polymyxin-b sulfate will be needed for the irrigation?

2) A technician is to prepare 200 mL of a 1:10,000 w/v solution. How many mg of the required drug will be needed to prepare the solution?

3) A drug solution is labeled 1:40 w/v. What is the percentage strength of the solution?

4) A medication is labeled with a 0.05% concentration.

   a) What is the ratio strength of this solution?

   b) What is the concentration of this solution in mcg/mL?

5) An order for 500 mL of a 1:1000 w:v solution is received in the pharmacy. There are 0.55 g of this medication available in the pharmacy. Will the pharmacy be able to prepare this order?

6) An order for 1 liter of a 1:2000 w:v solution is received in the pharmacy. In stock is 480 mg of the powdered drug. Will the technician be able to fill this order?

7) An order is received in the pharmacy for 5 mL of a 1:100,000 w:v solution. How many mcg are needed to fill this order?

8) An order is received in the pharmacy for 22.5 mL of a 1:50,000 solution. How many mcg of active ingredient are required to fulfill this request.

9) A physician uses the hospital's CPOE software to prescribe Racepinephrine inhale 0.5 mg per neb q3h prn asthma attack. If Racepinephrine has a concentration of 1:1000, how many milliliters will be required for a dose?

10) A patient is ordered 16 mg of norepinephrine in 250 mL of D5W. There are 4 mL ampules of norepinephrine with a concentration of 1:1000 available.

    a) How many mL of norepinephrine will you need to add to the D5W bag?

    b) How many ampules of norepinephrine will you need to prepare this solution?

11) The OR needs 0.5 mg of neostigmine to reverse the rocuronium that was used during surgery. The neostigmine you have on hand has a concentration of 1:2000 and comes in 10 mL vials. How many milliliters of neostigmine will you need?

12) You need to add 1.3 mg of a medication to a 50 mL bag of half-normal saline (0.45% NaCl), if the 2 mL ampule of this particular medication on your shelf has a ratio strength of 1:750, how many mL will you need to add to the half-normal saline bag?

13) If you have a 1:50 dilution of hydrocortisone lotion, what is the percentage strength?

14) If you have a 1:60 dilution of atropine in a petrolatum ointment, what is its percentage strength?

15) If you have 100 mg of drug dissolved in 100 mL of solution, what is its ratio strength?

16) If a particular vaccine contains 50 mcg of thimerosal in 0.5 mL of solution, answer the following.

   a) What is the percentage strength?

   b) What is its ratio strength?

17) Four hundred milligrams of drug is mixed with 4600 milligrams of sterile ophthalmic ointment base.

   a) How many grams is the final mixture?

   b) What is the resulting ratio strength?

18) If 140 mg of strychnine sulfate is intimately mixed with 1.26 g of lactose, what is the w/w ratio strength of the strychnine sulfate compared to the total mixture?

19) How many liters of a 1:5000 solution of cinnamon oil in alcohol can be made from 5 mL of cinnamon oil?

20) What is the ratio strength of a liquid in liquid solution if 130 mL of solution contains 0.65 mcL of active ingredient?

Worksheet 20-2

Name:

Date:

Solve the following problems.

1) A physician orders a 1 liter irrigation with 50 mg of amphotericin b. What is the ratio strength of this irrigation?

2) A technician is to prepare 250 mL of a 1:100,000 w/v solution. How many mg of the required drug will be needed to prepare the solution?

3) A drug solution is labeled 1:250 w/v. What is the percentage strength of the solution?

4) A medication is labeled with a 0.025% concentration.

    a) What is the ratio strength of this solution?

    b) What is the concentration of this solution in mcg/mL?

5) An order for 150 mL of a 1:1000 w:v solution is received in the pharmacy. There are 150 mg of this medication available in the pharmacy. Will the pharmacy be able to prepare this order?

6) An order for two bags, each bag being 1 liter in size, with a concentration of a 1:2000 w:v solution is received in the pharmacy. In stock is 960 mg of the powdered drug. Will the pharmacy be able to fill this order?

7) An order is received in the pharmacy for 7.5 mL of a 1:100,000 w:v solution. How many mcg are needed to fill this order?

8) An order is received in the pharmacy for 15 mL of a 1:50,000 solution. How many mcg of active ingredient are required to fulfill this request.

9) A physician uses the hospital's CPOE software to prescribe Racepinephrine inhale 1 mg per neb q3h prn asthma attack. If Racepinephrine has a concentration of 1:1000, how many milliliters will be required for a dose?

10) A patient is ordered 16 mg of epinephrine in 250 mL of NS. There are 30 mL vials of epinephrine with a concentration of 1:1000 available.

a) How many mL of epinephrine will you need to add to the NS bag?

b) How many vials of epinephrine will you need to prepare this solution?

c) What is the ratio strength of epinephrine in the final NS bag?

11) The OR needs 1.5 mg of neostigmine to reverse the vecuronium that was used during surgery. The neostigmine you have on hand has a concentration of 1:2000 and comes in 10 mL vials. How many milliliters of neostigmine will you need?

12) You need to add 2.5 mg of a medication to a 100 mL bag of half-normal saline (0.45% NaCl), if the 2 mL ampule of this particular medication on your shelf has a ratio strength of 1:750, how many mL will you need to add to the half-normal saline bag?

13) If you have a 1:40 dilution of hydrocortisone lotion, what is the percentage strength?

14) If you have a 1:80 dilution of atropine in a petrolatum ointment, what is its percentage strength?

15) If you have 200 mg of drug dissolved in 100 mL of solution, what is its ratio strength?

16) If a particular vaccine contains 5 mcg of thimerosal in 0.5 mL of solution, answer the following.

    a) What is the percentage strength?

    b) What is its ratio strength?

17) Two hundred fifty milligrams of drug is mixed with 4750 milligrams of sterile ophthalmic ointment base.

    a) How many grams is the final mixture?

    b) What is the resulting ratio strength?

18) If 1400 mg of strychnine sulfate is intimately mixed with 12.6 g of lactose, what is the w/w ratio strength of the strychnine sulfate compared to the total mixture?

19) How many liters of a 1:5000 solution of cinnamon oil in alcohol can be made from 2.5 mL of cinnamon oil?

20) What is the ratio strength of a liquid in liquid solution if 250 mL of solution contains 0.5 mcL of active ingredient?

21) The OR wants you to make 25 phenylephrine syringes (10 mL/syringe) with a concentration of 1:12,500. You are to mix the phenylephrine (which is available in 10mg/mL 1 mL vials) with normal saline.

a) How many vials of phenylephrine will you need to make these syringes?

b) How many mL of normal saline will you need to make these syringes?

c) What is the final concentration of the phenylephrine in the syringes in mcg/mL?