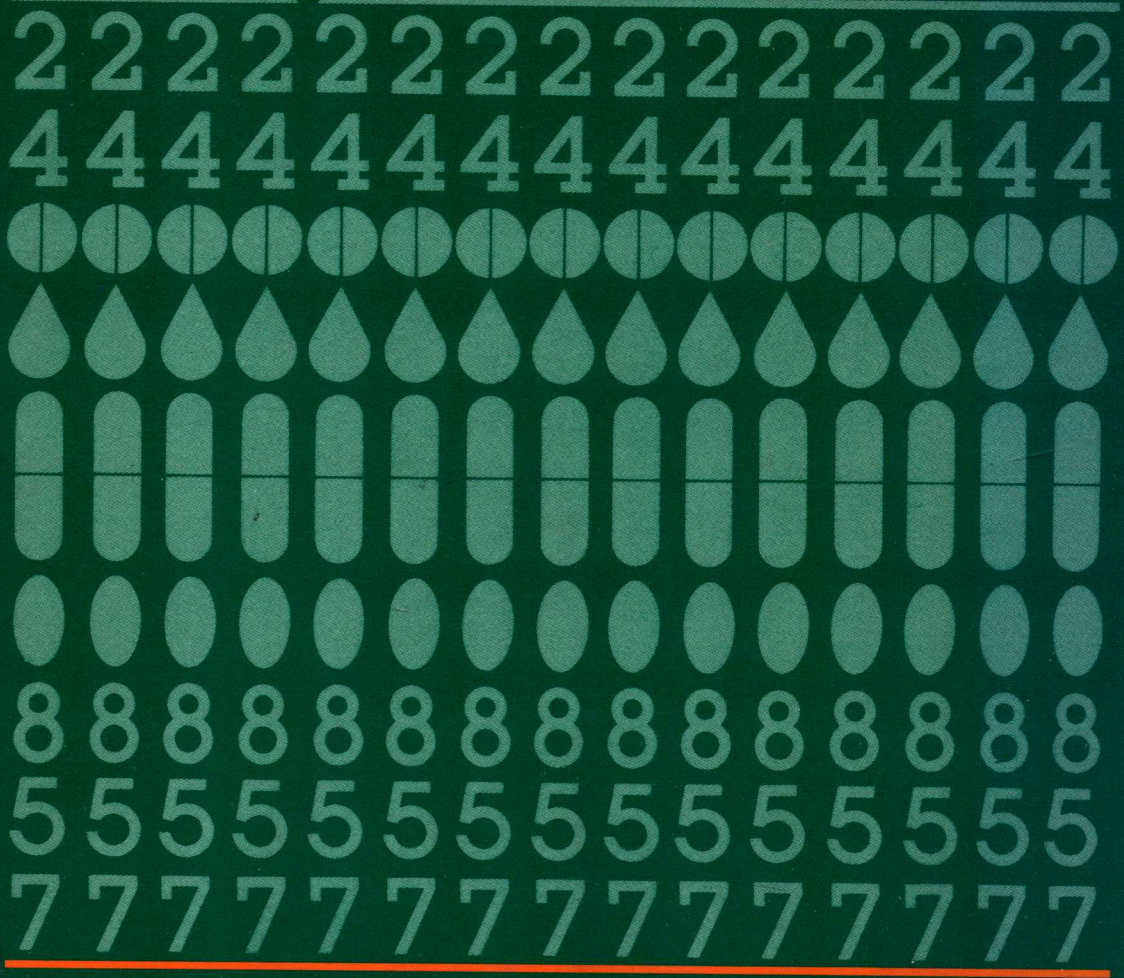
Sixth Edition

The Arithmetic of Dosages and Solutions

A Programmed Presentation



Laura K. Hart

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Dosages and Solutions
A Programmed Presentation

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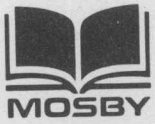

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THE ARITHMETIC OF

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PREFACE

This text has been compiled primarily to guide student nurses in the study of the arithmetic of dosages and solutions. The technique of programmed instruction used in this text offers students two main advantages: it requires that students become actively involved in the learning process, and it allows them to proceed at their own speed. The programs have been designed so that this course in the arithmetic of dosages and solutions can be completely self-directed. Students are given information in easy-to-digest pieces, a sentence or short paragraph at a time. The information is arranged in logical order, with each step building on the previous one and with the correct answer shown immediately.

The programs were developed on the assumption that all students at the beginning of this course possess the basic mathematical skills of addition, subtraction, multiplication, and division. However, for those who need to brush up on fractions, decimals, percentages, and ratios, a brief review has been included. The programs have been written to ensure that practically all students will get 95% of the answers correct.

In this sixth edition several changes were made to continue and increase the book's usefulness. In the introduction section the arithmetic review has been expanded with the addition of a 56 item arithmetic pretest. The metric unit now includes a discussion of the microgram. In the fractional dosages unit the material discussing insulin has been updated and the practice problem section has been increased. There is a new unit devoted exclusively to the calculation of intravenous flow rates. The appendix has been expanded to include more on the calculation of infants' and children's dosages, and a new practice problem section regarding the calculation of pediatric dosages has been added. These problems were written to serve as a summary for the entire text because they require an understanding of the metric system, household system, fractional dosage, intravenous flow rate calculation, and pediatric dosages. Also throughout the text problems were updated regarding drugs in current use.

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THE ARITHMETIC OF

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CONTENTS

INTRODUCTION

A BRIEF ARITHMETIC REVIEW

This section has been included for those who need a quick review of the basic rules for fractions, decimals, proportions, and ratios. Because this section is a review, it is not presented in the programmed learning format of the rest of the text. An arithmetic pretest is included to help you practice these skills before attempting to use them in dosage calculations. Examples of how these rules are used to calculate dosages are included in the programmed text where pertinent.

1. **A fraction** is a part of any object, quantity, or digit.

$$\begin{array}{r} 1 \quad \text{numerator} \\ / \quad \text{division line} \\ 4 \quad \text{denominator} \end{array}$$

2. **To reduce a fraction to its lowest term,** divide the numerator and the denominator by the largest number by which they are both evenly divisible. $2/4 = 1/2$
3. **To change a mixed number to a fraction,** multiply the denominator by the whole number, add the numerator, and place the sum over the denominator. $3\frac{1}{3} = 10/3$
4. **To change an improper fraction to a mixed number,** divide the numerator by the denominator. $10/3 = 3\frac{1}{3}$
5. **To add fractions with the same denominator,** add the numerators, write the sum over the common denominator, and reduce the fraction to its lowest term.

$$\begin{array}{r} 2/6 \\ +\,2/6 \\ \hline 4/6 = 2/3 \end{array}$$

6. **To add fractions with unlike denominators,** find their lowest common denominator (the lowest number evenly divisible by both denominators). When the numerator and denominator are divided or multiplied by the same number, the value of the fraction remains the same. The numerators are then added and placed over the common denominator.

$$\begin{array}{rcl} {}^{3}/_{4} & {}^{3}/_{4} & \\ \underline{+\,{}^{1}/_{2}} & = & \underline{{}^{2}/_{4}} \\ & & {}^{5}/_{4} = 1\,{}^{1}/_{4} \end{array} \quad \text{or} \quad \begin{array}{rcl} 3\,{}^{3}/_{4} & 3\,{}^{3}/_{4} & \\ \underline{+\,6\,{}^{1}/_{2}} & = & \underline{6\,{}^{2}/_{4}} \\ & & 9\,{}^{5}/_{4} = 10\,{}^{1}/_{4} \end{array}$$

7. **To subtract fractions with the same denominator,** find the difference between the numerators and write it over the common denominator. Reduce to lowest terms.

$$\begin{array}{r} {}^{5}/_{6} \\ \underline{-\,{}^{2}/_{6}} \\ {}^{3}/_{6} = {}^{1}/_{2} \end{array}$$

8. **To subtract fractions with unlike denominators,** find the lowest common denominator, subtract the numerators, and reduce to lowest terms.

$$\begin{array}{rcl} {}^{6}/_{8} & {}^{6}/_{8} & \\ \underline{-\,{}^{1}/_{4}} & = & \underline{{}^{2}/_{8}} \\ & & {}^{4}/_{8} = {}^{1}/_{2} \end{array} \quad \text{or} \quad \begin{array}{rcl} 6\,{}^{6}/_{8} & 6\,{}^{6}/_{8} & \\ \underline{-\,2\,{}^{1}/_{4}} & = & \underline{2\,{}^{2}/_{8}} \\ & & 4\,{}^{4}/_{8} = 4\,{}^{1}/_{2} \end{array}$$

$$\text{or} \quad \begin{array}{rcccl} 6\,{}^{1}/_{2} & & 6\,{}^{3}/_{6} & & 5\,{}^{9}/_{6} \\ \underline{-\,3\,{}^{2}/_{3}} & = & \underline{-\,3\,{}^{4}/_{6}} & = & \underline{-\,3\,{}^{4}/_{6}} \\ & & & & 2\,{}^{5}/_{6} \end{array}$$

9. **To multiply fractions,** multiply the numerator by the numerator and the denominator by the denominator. $\frac{1}{2} \times 6 = \frac{1}{2} \times \frac{6}{1} = \frac{6}{2} = 3$
10. **To divide fractions,** invert the divisor and multiply. $\frac{1}{2} \div 6 = \frac{1}{2} \div \frac{6}{1} = \frac{1}{2} \times \frac{1}{6} = \frac{1}{12}$
11. **To change a fraction to a decimal,** divide the numerator by the denominator. $\frac{1}{2} = .5$ $\quad 2\overline{)1.00}$
12. **A decimal** refers to ten. Any fraction whose denominator is 10 or a multiple of 10 may be written as a decimal fraction.

Ten millions	Millions	Hundred thousands	Ten thousands	Thousands	Hundreds	Tens	Unit of one	Decimal point	Tenths	Hundredths	Thousandths	Ten thousandths	Hundred thousandths	Millionths	Ten millionths
8	7	6	5	4	3	2	1	·	1	2	3	4	5	6	7
Whole numbers									Decimal numbers						

13. **To multiply decimals,** multiply as with whole numbers, but in the product, beginning at the right, point off as many places as there are in the multiplier and the multiplicand combined.

$$\begin{array}{r} 2.4 \text{ multiplicand} \\ \underline{1.2} \text{ multiplier} \\ 48 \\ \underline{24} \\ 2.88 \text{ product} \end{array}$$

14. **To divide a decimal by a decimal,** move the decimal point of the divisor to the right until the divisor becomes a whole number; then move the decimal point of the dividend the same number of places to the right, adding zeros if necessary.

$$.002\overline{)4.} = 002.\overline{)4000.}$$
$$2000.$$

15. **To change a decimal to a fraction,** use the number expressed as the numerator and the number represented by the decimal place as the denominator. .4 = $\frac{4}{10}$ or .44 = $\frac{44}{100}$
16. **To change a decimal to a ratio,** change the decimal to a fraction and then to a ratio. .4 = $\frac{4}{10}$ = 4:10 or 2:5 .5 = $\frac{5}{10}$ = 5:10 or 1:2
17. **A percent** is a fraction whose numerator is expressed and whose denominator is understood to be 100. 20% = $\frac{20}{100}$
18. **To change a percent to a decimal,** remove the percent sign and move the decimal point two places left. 30% = .30 2.5% = .025
19. **To change a decimal to a percent,** move the decimal point two places to the right and add the percent sign. .002 = .2% .025 = 2.5%
20. **To change a percent to a fraction,** divide the percent by 100 and reduce to lowest terms. 50% = $\frac{50}{100}$ = $\frac{1}{2}$ 25% = $\frac{25}{100}$ = $\frac{1}{4}$
21. **To change a percent to a ratio,** use the expressed numerator as the first term and the understood denominator (100) as the second. Reduce to lowest terms. 50% = 50:100 = 1:2
22. **To change a ratio to a decimal,** change the ratio to a fraction and then divide the numerator by the denominator. 1:2 = $\frac{1}{2}$ = $2\overline{)1.00}$
    .5
23. **A proportion** shows the relationship between two equal ratios. In a proportion, the product of the means equals the product of the extremes.

extremes

1:2::2:4

means

$1 \times 4 = 4$ extremes

$2 \times 2 = 4$ means

If one of the means is unknown, divide the product of the extremes by the known mean.

$1:?::2:4$ $\qquad 4 \div 2 = 2$

$1 \times 4 = 2 \times ?$ $\qquad 1:2::2:4$

If one of the extremes is unknown, divide the product of the means by the known extreme.

$1:2::2:?$ $\qquad 4 \div 1 = 4$

$1 \times ? = 2 \times 2$ $\qquad 1:2::2:4$

Arithmetic Pretest

A. **Reduce the following to their lowest terms.** (Rule 2)

1. $\frac{8}{24}$
2. $\frac{10}{20}$
3. $\frac{4}{12}$
4. $\frac{5}{20}$
5. $\frac{25}{100}$
6. $\frac{50}{60}$
7. $\frac{14}{16}$
8. $\frac{12}{16}$

B. **Convert to improper fractions.** (Rule 3)

1. $1\frac{6}{8}$
2. $3\frac{1}{3}$
3. $6\frac{2}{5}$
4. $8\frac{1}{6}$
5. $2\frac{1}{7}$
6. $3\frac{3}{5}$
7. $7\frac{1}{3}$
8. $6\frac{1}{4}$

C. **Convert to mixed numbers.** (Rule 4)

1. $\frac{10}{4}$
2. $\frac{25}{6}$
3. $\frac{17}{4}$
4. $\frac{26}{3}$
5. $\frac{33}{6}$
6. $\frac{24}{7}$
7. $\frac{38}{4}$
8. $\frac{30}{12}$

D. **Add and reduce to lowest terms.** (Rule 6)

1. $\frac{1}{4} + \frac{1}{3}$
2. $\frac{1}{2} + \frac{2}{3}$
3. $\frac{3}{4} + \frac{1}{8}$
4. $\frac{2}{3} + \frac{3}{5}$
5. $6\frac{1}{4} + 2\frac{1}{5}$
6. $3\frac{1}{5} + 1\frac{1}{2}$
7. $5\frac{1}{2} + \frac{1}{6}$
8. $4\frac{1}{2} + 3\frac{3}{4}$

E. **Subtract and reduce.** (Rule 8)

1. $\frac{5}{9} - \frac{1}{3}$
2. $\frac{5}{6} - \frac{2}{3}$
3. $\frac{2}{3} - \frac{1}{4}$
4. $\frac{3}{4} - \frac{1}{2}$
5. $6\frac{1}{4} - 4\frac{1}{8}$
6. $3\frac{1}{5} - 2\frac{1}{2}$
7. $4\frac{1}{3} - 1\frac{1}{6}$
8. $16\frac{2}{3} - 12\frac{1}{2}$

F. **Multiply and reduce.** (Rule 9)

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

G. **Divide and reduce.** (Rule 10)

1. $\frac{4}{5} \div \frac{3}{4}$
2. $\frac{3}{5} \div \frac{1}{3}$
3. $\frac{1}{4} \div \frac{1}{2}$
4. $\frac{1}{2} \div \frac{1}{4}$
5. $2 \div \frac{4}{5}$
6. $5 \div \frac{3}{4}$
7. $2\frac{2}{3} \div 1\frac{1}{4}$
8. $\frac{2}{5} \div 2\frac{1}{4}$

H. **Express the following percentages as common fractions, decimals, and ratios.**

	Percent	Common fraction (Use Rule 20)	Decimal (Use Rule 18)	Ratio (Use Rule 21)
1.	2%			
2.	10%			
3.	5%			
4.	50%			
5.	25%			
6.	200%			
7.	30%			
8.	16%			
		(Use Rules 20 and 10)	(Use Rules 11 and 18)	
9.	⅕%			
10.	¼%			
		(Use Rules 3, 20, and 10)	(Use Rules 3, 11, and 18)	
11.	12½%			
12.	6¼%			

I. **Compute the following means and extremes.** (Rule 23)

1. 5:20::10:?
2. 3:9::6:?
3. ?:4::5:10
4. ?:12::3:4
5. 6:?::5:20
6. 2:8::?:20
7. 5:6::?:12
8. 4:8::?:15

J. **Compute the following, using Rule 23.**

1. If property is taxed at $200 per $10,000, what is the tax on a house assessed at $70,000?
2. If there are 48 pieces of candy in 2 pounds, how many are there in 3½ pounds?
3. If there are 22 cookies in 4 boxes, how many are there in 6 boxes?
4. If a car traveled 75 miles in 3 hours, how far would it travel in 8 hours moving at the same rate?

Arithmetic Pretest Answers

A.
1. $\frac{1}{3}$
2. $\frac{1}{2}$
3. $\frac{1}{3}$
4. $\frac{1}{4}$
5. $\frac{1}{4}$
6. $\frac{5}{6}$
7. $\frac{7}{8}$
8. $\frac{3}{4}$

B.
1. $\frac{14}{8}$
2. $\frac{10}{3}$
3. $\frac{32}{5}$
4. $\frac{49}{6}$
5. $\frac{15}{7}$
6. $\frac{18}{5}$
7. $\frac{22}{3}$
8. $\frac{25}{4}$

C.
1. $2\frac{1}{2}$
2. $4\frac{1}{6}$
3. $4\frac{1}{4}$
4. $8\frac{2}{3}$
5. $5\frac{1}{2}$
6. $3\frac{3}{7}$
7. $9\frac{1}{2}$
8. $2\frac{1}{2}$

D.
1. $\frac{1}{4} + \frac{1}{3} = \frac{3}{12} + \frac{4}{12} = \frac{7}{12}$
2. $\frac{1}{2} + \frac{2}{3} = \frac{3}{6} + \frac{4}{6} = \frac{7}{6} = 1\frac{1}{6}$
3. $\frac{3}{4} + \frac{1}{8} = \frac{6}{8} + \frac{1}{8} = \frac{7}{8}$
4. $\frac{2}{3} + \frac{3}{5} = \frac{10}{15} + \frac{9}{15} = \frac{19}{15} = 1\frac{4}{15}$
5. $6\frac{1}{4} + 2\frac{1}{5} = 6\frac{5}{20} + 2\frac{4}{20} = 8\frac{9}{20}$
6. $3\frac{1}{5} + 1\frac{1}{2} = 3\frac{2}{10} + 1\frac{5}{10} = 4\frac{7}{10}$
7. $5\frac{1}{2} + \frac{1}{6} = 5\frac{3}{6} + \frac{1}{6} = 5\frac{4}{6} = 5\frac{2}{3}$
8. $4\frac{1}{2} + 3\frac{3}{4} = 4\frac{2}{4} + 3\frac{3}{4} = 7\frac{5}{4} = 8\frac{1}{4}$

E.
1. $\frac{5}{9} - \frac{1}{3} = \frac{5}{9} - \frac{3}{9} = \frac{2}{9}$
2. $\frac{5}{6} - \frac{2}{3} = \frac{5}{6} - \frac{4}{6} = \frac{1}{6}$
3. $\frac{2}{3} - \frac{1}{4} = \frac{8}{12} - \frac{3}{12} = \frac{5}{12}$
4. $\frac{3}{4} - \frac{1}{2} = \frac{3}{4} - \frac{2}{4} = \frac{1}{4}$
5. $6\frac{1}{4} - 4\frac{1}{8} = 6\frac{2}{8} - 4\frac{1}{8} = 2\frac{1}{8}$
6. $3\frac{1}{5} - 2\frac{1}{2} = 3\frac{2}{10} - 2\frac{5}{10} = 2\frac{12}{10} - 2\frac{5}{10} = \frac{7}{10}$
7. $4\frac{1}{3} - 1\frac{1}{6} = 4\frac{2}{6} - 1\frac{1}{6} = 3\frac{1}{6}$
8. $16\frac{2}{3} - 12\frac{1}{2} = 16\frac{4}{6} - 12\frac{3}{6} = 4\frac{1}{6}$

F.
1. $3 \times \frac{2}{3} = \frac{3}{1} \times \frac{2}{3} = \frac{6}{3} = 2$
2. $25 \times \frac{1}{5} = \frac{25}{1} \times \frac{1}{5} = \frac{25}{5} = 5$
3. $8 \times \frac{3}{4} = \frac{8}{1} \times \frac{3}{4} = \frac{24}{4} = 6$
4. $2 \times \frac{4}{5} = \frac{2}{1} \times \frac{4}{5} = \frac{8}{5} = 1\frac{3}{5}$
5. $\frac{2}{3} \times \frac{5}{10} = \frac{10}{30} = \frac{1}{3}$
6. $\frac{1}{4} \times \frac{4}{5} = \frac{4}{20} = \frac{1}{5}$
7. $3\frac{2}{3} \times 2\frac{5}{6} = \frac{11}{3} \times \frac{17}{6} = \frac{187}{18} = 10\frac{7}{18}$
8. $2\frac{5}{6} \times 1\frac{3}{5} = \frac{17}{6} \times \frac{8}{5} = \frac{136}{30} = 4\frac{16}{30} = 4\frac{8}{15}$

G. 1. $\frac{4}{5} \div \frac{3}{4} = \frac{4}{5} \times \frac{4}{3} = \frac{16}{15} = 1\frac{1}{15}$

2. $\frac{3}{5} \div \frac{1}{3} = \frac{3}{5} \times \frac{3}{1} = \frac{9}{5} = 1\frac{4}{5}$

3. $\frac{1}{4} \div \frac{1}{2} = \frac{1}{4} \times \frac{2}{1} = \frac{2}{4} = \frac{1}{2}$

4. $\frac{1}{2} \div \frac{1}{4} = \frac{1}{2} \times \frac{4}{1} = \frac{4}{2} = 2$

5. $2 \div \frac{4}{5} = \frac{2}{1} \times \frac{5}{4} = \frac{10}{4} = 2\frac{2}{4} = 2\frac{1}{2}$

6. $5 \div \frac{3}{4} = \frac{5}{1} \times \frac{4}{3} = \frac{20}{3} = 6\frac{2}{3}$

7. $2\frac{2}{3} \div 1\frac{1}{4} = \frac{8}{3} \times \frac{4}{5} = \frac{32}{15} = 2\frac{2}{15}$

8. $\frac{2}{5} \div 2\frac{1}{4} = \frac{2}{5} \times \frac{4}{9} = \frac{8}{45}$

H.

	Common fraction (See Rule 20)	Decimal (See Rule 18)	Ratio (See Rule 21)
1.	$\frac{2}{100}$ or $\frac{1}{50}$	.02	2:100 or 1:50
2.	$\frac{10}{100}$ or $\frac{1}{10}$	.1	10:100 or 1:10
3.	$\frac{5}{100}$ or $\frac{1}{20}$	.05	5:100 or 1:20
4.	$\frac{50}{100}$ or $\frac{1}{2}$	.5	50:100 or 1:2
5.	$\frac{25}{100}$ or $\frac{1}{4}$	.25	25:100 or 1:4
6.	$\frac{200}{100}$ or 2	2.0	200:100 or 2:1
7.	$\frac{30}{100}$ or $\frac{3}{10}$	.3	30:100 or 3:10
8.	$\frac{16}{100}$ or $\frac{4}{25}$	.16	16:100 or 4:25
	(See Rules 20 and 10)	(See Rules 11 and 18)	
9.	$\frac{1}{500}$	.2% = .002	1:500
10.	$\frac{1}{400}$	.25% = .0025	1:400
	(See Rules 3, 20, and 10)	(See Rules 3, 11, and 18)	
11.	$\frac{1}{8}$	.125	1:8
12.	$\frac{1}{16}$	.0625	1:16

I. 1. $5x = 200$
$x = 40$

2. $3x = 54$
$x = 18$

3. $10x = 20$
$x = 2$

4. $4x = 36$
$x = 9$

5. $5x = 120$
$x = 24$

6. $8x = 40$
$x = 5$

7. $6x = 60$
$x = 10$

8. $8x = 60$
$x = 7.5$

J. 1. $10{,}000:200::70{,}000:x$
$10{,}000x = 14{,}000{,}000$
$x = 1400$

2. $48:2::x:3.5$
$2x = 168$
$x = 84$

3. $22:4::x:6$
$4x = 132$
$x = 33$

4. $75:3::x:8$
$3x = 600$
$x = 200$

ABBREVIATIONS COMMONLY USED IN MEDICATION ORDERS

aa	of each (equal parts)	PO	by mouth
ac	before meals	PR	by rectum
AD	right ear	prn	when required
ad lib	as much as desired	q	every
Aq	water	qd	every day
AS or AL	left ear	qh	every hour
AU	both ears	q2h	every two hours
bid	twice a day	q3h	every three hours
$\bar{c}$	with	q4h	every four hours
cap	capsules	qid	four times a day
dil	dilute	qod	every other day
fl	fluid	$\bar{s}$	without
h	hour	ss	a half
hs	hours of sleep (bedtime)	Sol	solution
IM	intramuscular	Stat	immediately
IV	intravenous	SQ, SC, or H	subcutaneous
OD	right eye	supp	suppository
OS or OL	left eye	tab	tablet
os	mouth	tid	three times a day
OU	both eyes	tr or tinct	tincture
pc	after meals	ung	ointment
per	by		

UNIT ONE METRIC SYSTEM

In order to administer medications accurately, a nurse must understand the systems used for weighing and measuring drugs. During the past 10 years, use of the metric system for weighing and measuring drugs has increased rapidly. Efforts to have the metric system used exclusively are intensifying. However, a number of places in the United States still make limited use of the apothecaries' system. For this reason, a nurse must still understand both systems and how they may be interchanged.

1. The metric system, which employs the decimal scale, is composed of units measuring *length, volume,* and *weight*. Because the metric system employs the decimal scale, is its numerical scale based on units of 4, 10, or 22? _____

10

2. Before considering the metric system's three units of measure, those of length, volume, and _____, let us first examine the use of the decimal scale in the metric system.

weight

3. A prefix (the first syllable or part of a word) is used to modify word's meaning. The prefixes attached to metric designations of length, volume, and weight indicate the unit of 10 that applies to that metric measure. The words used to designate a metric measure identify both the type of measure being used (length, _____, or weight), and the multiple of _____ that applies to that measure in the given situation.

volume

10

4. The numerical scale of the metric system is divided into six units of 10. Because the prefixes attached to metric measures indicate which unit of 10 applies, only _____ prefixes are needed to modify metric measures.

6

5. Three of the six prefixes indicate multiples of 10, and three indicate fractional units. The prefixes indicating multiples of 10 are deka, designating units of 10; hecto, designating units of 100; and kilo, designating units of 1000. A _____ of a unit would be 100 times larger than a deka.

kilo

6. Of the three prefixes used to indicate multiples of 10, the one most frequently used by the nurse is the prefix that refers to 1000 units. This prefix is _____.

kilo