LESSON ASSIGNMENT

LESSON 1
Dosage Calculations

LESSON ASSIGNMENT
Paragraphs 1-1 through 1-25

LESSON OBJECTIVES
After completing this lesson, you should be able to:

1-1 Interpret drug orders.

1-2 Convert units within the metric system.

1-3 Convert units between the apothecary and metric systems.

1-4 Given the strength of a drug, calculate and measure an injection dose.

1-5 Given an antibiotic or other drug in dry powder form, dilute the vial with an appropriate diluent and calculate the necessary volume dose.

1-6 Calculate pediatric doses, given the body weight and either the dose per unit of body weight or the dose per unit of surface area.

SUGGESTIONS
If you need to review basic mathematics, it is recommended that you enroll in Subcourse MD0900, Basic Mathematics.

After studying this assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.
LESSON 1
DOSAGE CALCULATIONS
Section I. INTERPRETING MEDICAL ORDERS

1-1. COMMON MEDICAL ABBREVIATIONS

To calculate doses and administer drugs, you must be familiar with those abbreviations commonly used in medicine, especially those found in prescriptions and clients' charts. Table 1-1 is a list of common Latin terms and abbreviations used in medicine. Tables 1-2 and 1-3 are summaries of common abbreviations used to indicate times of administration, routes of administration, and dosage forms. Tables 1-4 and 1-5 give symbols or abbreviations for different units of measure.

1-2. ROMAN NUMERALS

Roman numerals are used in writing prescriptions. They are used to specify the amounts of ingredients when the apothecary system is being used. They are used to specify the number of units (capsules, tablets, powders, suppositories, and so forth) to be dispensed; for example, "Dispxxiv." And lastly, they are used in the signa or directions to the client. You should, therefore, be thoroughly familiar with the system of Roman numerals used in pharmacy. The basic symbols or numerals are:

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ss, ( \frac{1}{2} )</td>
<td>1/2</td>
</tr>
<tr>
<td>I</td>
<td>1</td>
</tr>
<tr>
<td>V</td>
<td>5</td>
</tr>
<tr>
<td>X</td>
<td>10</td>
</tr>
<tr>
<td>L</td>
<td>50</td>
</tr>
<tr>
<td>C</td>
<td>100</td>
</tr>
<tr>
<td>D</td>
<td>500</td>
</tr>
<tr>
<td>M</td>
<td>1000</td>
</tr>
</tbody>
</table>

These basic numerals may be combined to represent any number, and there are definite rules for the manner in which they are combined. Upper-case or lower-case letters may be used for Roman numerals. Prescribers usually prefer uppercase letters, but they dot the "I" for the sake of clarity. The rules for Roman numerals are as follows:

a. **Fractions.** Except for "ss" meaning one-half (1/2), all other fractions are represented by Arabic numerals (1/4, 3/8, 1/120, and so forth). (Note: The "ss" may be written with or without a bar--ss or \( \frac{1}{2} \))

b. **Repeating Numerals.** Numerals may be repeated. When they are, the value of the number is repeated. Thus, iii or III is 3 (1+1+1), XXX is 30 (10+10+10), and CCC is 300 (100+100+100). Any numeral that would be the same as another when
<table>
<thead>
<tr>
<th>TERM OR PHRASE</th>
<th>ABBREVIATION</th>
<th>MEANING</th>
</tr>
</thead>
<tbody>
<tr>
<td>ad</td>
<td>ad lib</td>
<td>to, up to</td>
</tr>
<tr>
<td>ad libitum</td>
<td></td>
<td>freely, at pleasure</td>
</tr>
<tr>
<td>ana</td>
<td>åå</td>
<td>of each</td>
</tr>
<tr>
<td>ante</td>
<td>a.</td>
<td>before</td>
</tr>
<tr>
<td>ante cibum</td>
<td>a.c.</td>
<td>before meals</td>
</tr>
<tr>
<td>bene</td>
<td>ben.</td>
<td>well, good</td>
</tr>
<tr>
<td>bis</td>
<td>b.i.d.</td>
<td>twice</td>
</tr>
<tr>
<td>bis in die</td>
<td></td>
<td>twice a day</td>
</tr>
<tr>
<td>capiat</td>
<td>Cap.</td>
<td>let the client take</td>
</tr>
<tr>
<td>capsula</td>
<td>caps.</td>
<td>capsule</td>
</tr>
<tr>
<td>cum</td>
<td>c</td>
<td>with</td>
</tr>
<tr>
<td>dentur tales doses</td>
<td>D.T.D., d.t.d.</td>
<td>give of such doses</td>
</tr>
<tr>
<td>dispensa</td>
<td>Disp.</td>
<td>dispense</td>
</tr>
<tr>
<td>et</td>
<td></td>
<td>and</td>
</tr>
<tr>
<td>ex modo praescripto</td>
<td>e.m.p.</td>
<td>after the manner prescribed (as directed)</td>
</tr>
<tr>
<td>fac, fiat, fiunt</td>
<td>ft.</td>
<td>make, let it be made</td>
</tr>
<tr>
<td>granum</td>
<td>gr.</td>
<td>grain</td>
</tr>
<tr>
<td>gutta, guttae</td>
<td>gt., gtt.</td>
<td>Drop, drops</td>
</tr>
<tr>
<td>hora</td>
<td>hor., h.</td>
<td>hour</td>
</tr>
<tr>
<td>hora somni</td>
<td>hor. som., h.s.</td>
<td>at the hour of sleep</td>
</tr>
<tr>
<td>injectio</td>
<td>inj.</td>
<td>injection</td>
</tr>
<tr>
<td>inter</td>
<td></td>
<td>between</td>
</tr>
<tr>
<td>lotio</td>
<td>lot.</td>
<td>lotion</td>
</tr>
<tr>
<td>non repetatur</td>
<td>non rep., non repetat.</td>
<td>do not repeat</td>
</tr>
</tbody>
</table>

Table 1-1. Common Latin terms and abbreviations (continued).
<table>
<thead>
<tr>
<th>TERM OR PHRASE</th>
<th>ABBREVIATION</th>
<th>MEANING</th>
</tr>
</thead>
<tbody>
<tr>
<td>octarius</td>
<td>O.</td>
<td>pint</td>
</tr>
<tr>
<td>oculus dexter</td>
<td>O.D.</td>
<td>right eye</td>
</tr>
<tr>
<td>oculus sinister</td>
<td>o.s., O.S.</td>
<td>left eye</td>
</tr>
<tr>
<td>oculi unitas</td>
<td>O.U.</td>
<td>both eyes</td>
</tr>
<tr>
<td>omni hora</td>
<td>Omn. hor.</td>
<td>every hour</td>
</tr>
<tr>
<td>per</td>
<td></td>
<td>through, by means of</td>
</tr>
<tr>
<td>per os</td>
<td>P.O.</td>
<td>by mouth</td>
</tr>
<tr>
<td>placebo</td>
<td></td>
<td>I will satisfy</td>
</tr>
<tr>
<td>post cibum</td>
<td>post cib., p.c.</td>
<td>after meals</td>
</tr>
<tr>
<td>pro re nata</td>
<td>p.r.n.</td>
<td>as needed, as circumstances require</td>
</tr>
<tr>
<td>pulvis</td>
<td>pulv.</td>
<td>powder</td>
</tr>
<tr>
<td>quantum satis</td>
<td>q.s.</td>
<td>a sufficient quantity</td>
</tr>
<tr>
<td>quantum satis ad</td>
<td>q.s. ad</td>
<td>a sufficient quantity to make</td>
</tr>
<tr>
<td>quaque</td>
<td>q.</td>
<td>every</td>
</tr>
<tr>
<td>quaque die</td>
<td>q.d.</td>
<td>every day</td>
</tr>
<tr>
<td>quaque hora</td>
<td>q.h.</td>
<td>every hour</td>
</tr>
<tr>
<td>quater in die</td>
<td>q.i.d.</td>
<td>four times a day</td>
</tr>
<tr>
<td>recipe</td>
<td>Rx</td>
<td>take thou</td>
</tr>
<tr>
<td>semi, semis</td>
<td>ss</td>
<td>a half</td>
</tr>
<tr>
<td>siga</td>
<td>sig.</td>
<td>write, label</td>
</tr>
<tr>
<td>sine</td>
<td>s</td>
<td>without</td>
</tr>
<tr>
<td>solve, solvere, solutus</td>
<td>solv.</td>
<td>dissolve</td>
</tr>
<tr>
<td>statim</td>
<td>stat</td>
<td>immediately</td>
</tr>
<tr>
<td>tabella</td>
<td>tab.</td>
<td>tablet</td>
</tr>
<tr>
<td>ter</td>
<td>t.</td>
<td>three</td>
</tr>
<tr>
<td>ter in die</td>
<td>t.i.d., tid</td>
<td>three times daily</td>
</tr>
<tr>
<td>unguentum</td>
<td>ung.</td>
<td>an ointment</td>
</tr>
<tr>
<td>ut dictum</td>
<td>Ut dict.</td>
<td>as directed</td>
</tr>
</tbody>
</table>

Table 1-1. Common Latin names and abbreviations (concluded).
### Table 1-2. Times of administration.

<table>
<thead>
<tr>
<th>ABBREVIATION</th>
<th>MEANING</th>
<th>ABBREVIATION</th>
<th>MEANING</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.c.</td>
<td>before meals</td>
<td>q.h.</td>
<td>every hour</td>
</tr>
<tr>
<td>b.i.d., bid</td>
<td>twice a day</td>
<td>q.i.d., qid</td>
<td>four times a day</td>
</tr>
<tr>
<td>h.s.</td>
<td>at bedtime</td>
<td>q.3h., q3h</td>
<td>every 3 hours</td>
</tr>
<tr>
<td>non rep</td>
<td>do not repeat</td>
<td>q.6h., q6h</td>
<td>every 6 hours</td>
</tr>
<tr>
<td>p.c.</td>
<td>after meals</td>
<td>stat.</td>
<td>Immediately</td>
</tr>
<tr>
<td>p.r.n.</td>
<td>as needed</td>
<td>t.i.d., tid</td>
<td>three times a day</td>
</tr>
</tbody>
</table>

### Table 1-3. Routes of administration and dosage forms.

<table>
<thead>
<tr>
<th>ABBREVIATION</th>
<th>MEANING</th>
<th>ABBREVIATION</th>
<th>MEANING</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.M., IM</td>
<td>intramuscularly</td>
<td>s.c., s.q.</td>
<td>subcutaneously</td>
</tr>
<tr>
<td>I.V., IV</td>
<td>intravenously</td>
<td>P.O.</td>
<td>by mouth</td>
</tr>
<tr>
<td>O.D.</td>
<td>right eye</td>
<td>caps.</td>
<td>capsule</td>
</tr>
<tr>
<td>o.s., O.S.</td>
<td>left eye</td>
<td>liq.</td>
<td>liquid, solution</td>
</tr>
<tr>
<td>O.U.</td>
<td>both eyes</td>
<td>tab.</td>
<td>tablet</td>
</tr>
</tbody>
</table>

### Table 1-4. Metric system abbreviations.

<table>
<thead>
<tr>
<th>WEIGHT</th>
<th>VOLUME</th>
</tr>
</thead>
<tbody>
<tr>
<td>milligram</td>
<td>mg.</td>
</tr>
<tr>
<td>gram</td>
<td>g., Gm.</td>
</tr>
<tr>
<td>kilogram</td>
<td>kg., Kg.</td>
</tr>
<tr>
<td>milliliter</td>
<td>ml.</td>
</tr>
<tr>
<td>cubic centimeter</td>
<td>cc.</td>
</tr>
<tr>
<td>liter</td>
<td>l., L.</td>
</tr>
</tbody>
</table>

### Table 1-5. Apothecary system abbreviations.

<table>
<thead>
<tr>
<th>WEIGHT</th>
<th>VOLUME</th>
</tr>
</thead>
<tbody>
<tr>
<td>grain</td>
<td>gr.</td>
</tr>
<tr>
<td>dram</td>
<td>℥</td>
</tr>
<tr>
<td>ounce</td>
<td>oz., ℥</td>
</tr>
<tr>
<td>fluid dram</td>
<td>fl. oz., ℥</td>
</tr>
<tr>
<td>fluid ounce</td>
<td>O., pt.</td>
</tr>
<tr>
<td>pint</td>
<td>qt.</td>
</tr>
<tr>
<td>quart</td>
<td>C., gal.</td>
</tr>
</tbody>
</table>

**NOTE:** The fluid dram and the fluid ounce are often abbreviated without the “f” being used. It can be assumed that when the dram symbol is used with a liquid, the fluid dram is intended.
repeated is NOT repeated. For example, VV is NOT used for 10 (5+5) because X is 10 and LL is NOT used for 100 (50+50) because C = 100).

c. **Smaller Numerals Before Larger.** When a smaller numeral placed before a larger one, the smaller value is subtracted from the larger one. Only one number can be subtracted in this way. Thus, IV (5 - 1) = 4; IX (10 - 1) = 9; and XC (100 - 10) = 90 are correct, but 3 is **never** written III.

d. **Smaller Numerals After Larger.** A smaller numeral placed after a larger one is added to the larger number. For example, VIII = (5+3) = 8; XIII = (10+3) = 13; CLX = (100+50+10) = 160.

e. **Smaller Numeral Between Two Larger.** A smaller numeral **between** two larger ones is ALWAYS subtracted from the larger numeral which follows it as CXL (100 + [50-10]) = 140; MCMLXXVI (1000 + [1000-100] + 50 + 10 + 10 + 5 + 1) = 1976.

f. **The Use of "j."** As a precaution against error, the last "i" may be replaced by a "j." When this method is used, 3 would be written as iij.

g. **Table of Roman Numerals.** Table 1-6 shows examples of Roman numerals and their equivalents.

<table>
<thead>
<tr>
<th>ss</th>
<th>1/2</th>
<th>x</th>
<th>10</th>
<th>xx</th>
<th>20</th>
<th>li</th>
<th>51</th>
</tr>
</thead>
<tbody>
<tr>
<td>i</td>
<td>1</td>
<td>xi</td>
<td>11</td>
<td>xxi</td>
<td>21</td>
<td>lix</td>
<td>59</td>
</tr>
<tr>
<td>ii</td>
<td>2</td>
<td>xii</td>
<td>12</td>
<td>xxii</td>
<td>22</td>
<td>lx</td>
<td>60</td>
</tr>
<tr>
<td>iii</td>
<td>3</td>
<td>xiii</td>
<td>13</td>
<td>xxiii</td>
<td>23</td>
<td>lxx</td>
<td>70</td>
</tr>
<tr>
<td>iv</td>
<td>4</td>
<td>xiv</td>
<td>14</td>
<td>xxiv</td>
<td>24</td>
<td>lxxx</td>
<td>80</td>
</tr>
<tr>
<td>v</td>
<td>5</td>
<td>xv</td>
<td>15</td>
<td>xxv</td>
<td>25</td>
<td>xc</td>
<td>90</td>
</tr>
<tr>
<td>vi</td>
<td>6</td>
<td>xvi</td>
<td>16</td>
<td>xxvi</td>
<td>26</td>
<td>c</td>
<td>100</td>
</tr>
<tr>
<td>vii</td>
<td>7</td>
<td>xvii</td>
<td>17</td>
<td>xxvii</td>
<td>27</td>
<td>ci</td>
<td>101</td>
</tr>
<tr>
<td>viii</td>
<td>8</td>
<td>xviii</td>
<td>18</td>
<td>xxviii</td>
<td>28</td>
<td>cxxi</td>
<td>121</td>
</tr>
<tr>
<td>ix</td>
<td>9</td>
<td>xix</td>
<td>19</td>
<td>xxix</td>
<td>29</td>
<td>d</td>
<td>500</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>m</td>
<td>1000</td>
</tr>
</tbody>
</table>

Table 1-6. Examples of Roman numerals.

h. **Number After Modified Noun.** When a number expressed in Roman numerals is used to modify a noun, the number follows the noun. The noun is likely to be a unit of the apothecary system or a unit of dosage. For example, "gr ii" would be interpreted as "two grains" and "caps i" would mean "one capsule."
1-3. INTERPRETATION OF ORDERS FOR DRUGS

Prescribers use abbreviations extensively in writing orders for drugs. The enlisted soldier must be able to read such orders accurately. Examples of some orders for drugs and the interpretations are given below.

a. Example 1.

**Order:** Tab ii stat, then tab i bid  
**Interpretation:** 2 tablets at once, then 1 tablet twice a day.

b. Example 2.

**Order:** Tsp i pc & hs  
**Interpretation:** 1 teaspoonful after meals and at bedtime.

c. Example 3.

**Order:** 2 ml IM stat & q12h  
**Interpretation:** 2 ml intramuscularly at once and every 12 hours.

d. Example 4.

**Order:** Tab iv stat, then tab ii q4h  
**Interpretation:** 4 tablets at once, then 2 tablets every 4 hours.

Section II. RATIO AND PROPORTION

1-4. BASIC MATHEMATICS

For a review of basic mathematics, you can enroll in Subcourse MD0900, Basic Mathematics, or Subcourse MED904, Pharmacology Math for the Practical Nurse. Subcourse MD0900 covers fundamental operations and practical problems in fractions, mixed numbers, decimals, percents, ratios, proportions, and square roots. Subcourse MD0904 covers basic arithmetic, fractions, decimals, percentages, ratio and proportion, and math required for pharmaceutical calculations.

1-5. IMPORTANCE OF RATIO AND PROPORTION

The principles of ratio and proportion are tools with which the student can solve many, if not all, dosage calculations. A firm understanding of these basics will enable the student to deal with later sections in which common dose problems are solved by applying simple ratio and proportion techniques.
1-6. RATIOS

a. A ratio is the relation between like numbers or values, or a way to express a fractional part of a whole. Ratios may be written:

As a fraction: $\frac{2}{3}$

As a division: $2 \div 3$

With the ratio or colon sign: 2:3

Using "per": 50 miles per hour (50mi/hr)

b. The strength or concentration of various drugs can be expressed as a ratio. First, read the label of the drug and find the strength or concentration. Express this strength as a ratio in fractional form, as in the following examples.

(1) Tolnaftate solution, 10 mg per ml $= \frac{10 \text{ mg}}{1 \text{ ml}}$

(2) Guinine injection, 0.3 gm per ml $= \frac{0.3 \text{ gm}}{1 \text{ ml}}$

(3) Kanamycin injection, 1.0 gm/3 ml $= \frac{1.0 \text{ gm}}{3 \text{ ml}}$

(4) Isoproterenol inhalation, 1:200 $= \frac{1}{200}$

(5) Epinephrine injection, 1:1000 $= \frac{1}{1000}$

(6) Phenoxyethyl penicillin tablets 200,000 units $= \frac{200,000 \text{ units}}{1 \text{ tablet}}$

Sulfisoxazole tablets, 0.5 gm $= \frac{0.5 \text{ gm}}{1 \text{ tablet}}$

1-7. PROPORTIONS

A proportion consists of two equal ratios and is essentially a statement of equality between two ratios. For example:

$$\frac{2}{5} = \frac{4}{10}$$
The value of the ratio on the right must always equal the value of the ratio on the left. A proportion may be written with the double colon, or proportion sign (::), or with the sign of equality (=).

\[ 2:5 :: 4:10 \quad \text{or} \quad \frac{2}{5} = \frac{4}{10} \]

a. **Parts of a Proportion.** In a proportion, there are four numbers. The two middle numbers are known as MEANS and the two end numbers are known as EXTREMES.

1. Example: You find a 10-ml vial of Aminophylline in supply labeled "25 mg per ml." Thus, there are 250 mg of drug in this 10-ml vial.

\[
\text{(extreme)} \quad 25 \text{ mg} = 250 \text{ mg} \quad \text{(mean)} \\
\text{(mean)} \quad 1 \text{ ml} \quad 10 \text{ ml} \quad \text{(extreme)}
\]

2. Notice that when you multiply the two extremes and the two means, the products are equal. For example: \(25 \times 10 = 250 \times 1\).

\[
\text{Multiply the extremes:} \quad 25 \times 10 = 250 \\
\text{Multiply the means:} \quad 1 \times 250 = 250
\]

**RULE:** In a proportion, the product of the means is always equal to the product of the extremes.

b. **Solving Problems with Proportions.** Using the above rule of proportion and knowing the value of three parts of a proportion, then the fourth unknown part, call it "X," can be found. When confronted with a calculation, use the following steps to solve for X.

1. **Step 1.** State problem in "if-then" form.

2. **Step 2.** Convert the problem to an equation.
   
   (a) Known information (labeled strength, and so forth) should be your IF ratio.

   (b) The unknown ratio including X will be your THEN ratio.

   (c) Put like units on the same side of each ratio. (For example, if the left side of the equation is expressed in mg/ml, then the right side must also be expressed in mg/ml).

3. **Step 3.** Cross multiply means and extremes.

4. **Step 4.** Solve for X.
c. **Example 1.** You have a 10-ml vial of aminophylline labeled "25 mg per ml". How many milliliters must be injected to administer a dose of 125 mg?

   (1) **Step 1.** If there are 25 mg of drug per 1 ml, then there are 125 mg of drug per X ml.

   (2) **Step 2.** IF \(\frac{25 \text{ mg}}{1 \text{ ml}}\) \(\Rightarrow\) THEN \(\frac{125 \text{ mg}}{X \text{ ml}}\)

   (3) **Step 3.** \(25 \times X = 125 \times 1\)

   (4) **Step 4.** \(25X = 125\)

   (5) **Solve for X.**
   \[
   \frac{25X}{25} = \frac{125}{25}
   \]
   \(X = 5 \text{ ml} \) (answer) \([125 \text{ divided by } 25 \text{ is } 5]\)

---

d. **Example 2.** How many milliliters must be injected from an ampule of Prochlorperazine labeled "10 mg/2 ml" in order to administer a dose of 7.5 mg?

   (1) **Step 1.** If there are 10 mg of drug per 2 ml, then there are 7.5 mg of drug per X ml.

   (2) **Step 2.** IF \(\frac{10 \text{ mg}}{2 \text{ ml}}\) \(\Rightarrow\) THEN \(\frac{7.5 \text{ mg}}{X \text{ ml}}\)

   (3) **Step 3.** \(10 \times X = 2 \times 7.5\)

   (4) **Step 4.** \(10X = 15\)

   (5) **Solve for X.**
   \[
   \frac{10X}{10} = \frac{15}{10}
   \]
   \(X = 1.5 \text{ ml} \) (answer) \([15 \text{ divided by } 10 \text{ is } 1.5]\)
Section III. THE METRIC SYSTEM

1-8. ADVANTAGES OVER OTHER SYSTEMS

a. Every weight and measure in the metric system bears a simple relation to the initial unit, the meter.

b. Every unit is multiplied or divided by the same number (that is, 10) to obtain the next higher or lower denomination, and an increase or decrease is expressed by moving the decimal point either to the right or to the left.

c. Its almost universal adoption makes it an international system.

1-9. VALUES OF PREFIXES

a. The three basic units of the metric system are the meter, the gram, and the liter. The names of the other units are formed by adding a prefix to one of these basic units. Each prefix has a corresponding numerical value. These are listed below.

<table>
<thead>
<tr>
<th>Prefix</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>micro (mc, μ)</td>
<td>1/1,000,000</td>
</tr>
<tr>
<td>milli (m)</td>
<td>1/1000</td>
</tr>
<tr>
<td>centi (c)</td>
<td>1/100</td>
</tr>
<tr>
<td>deci (d)</td>
<td>1/10</td>
</tr>
<tr>
<td>deka (dk)</td>
<td>10</td>
</tr>
<tr>
<td>hecto (h)</td>
<td>100</td>
</tr>
<tr>
<td>kilo (k)</td>
<td>1000</td>
</tr>
</tbody>
</table>

b. For example, a milliliter (ml) is equal to \( \frac{1}{1000} \) of a liter (l). A kilogram (kg) is equal to 1000 grams (g).
1-10. COMMONLY USED RELATIONSHIPS

a. **Length.** Three of the most commonly used length relationships in the metric system are:

\[
\begin{align*}
1 \text{ kilometer (km)} & = 1000 \text{ meters (m)} \\
1 \text{ meter (m)} & = 100 \text{ centimeters (cm)} = 1000 \text{ millimeters (mm)} \\
1 \text{ centimeter (cm)} & = 10 \text{ millimeters (mm)}
\end{align*}
\]

b. **Weight.** Two of the most commonly used weight relationships in the metric system are:

\[
\begin{align*}
1 \text{ kilogram (kg)} & = 1000 \text{ grams (gm)} \\
1 \text{ gram (gm)} & = 1000 \text{ milligrams (mg)}
\end{align*}
\]

**NOTE:** We occasionally need the following relationship:

\[
1 \text{ microgram (mcg)} = \frac{1}{1000} \text{ milligram (mg)}
\]

c. **Volume.** Three of the most commonly used volume relationships in the metric system are:

\[
\begin{align*}
1 \text{ liter (l)} & = 1000 \text{ milliliters (ml)} \\
1 \text{ liter (l)} & = 1000 \text{ cubic centimeters (cc)} \\
1 \text{ milliliter (ml)} & = 1 \text{ cubic centimeter (cc)}
\end{align*}
\]

**NOTE:** 1 milliliter of water weighs 1 gram

1-11. CONVERSION WITHIN THE METRIC SYSTEM

To convert a quantity in the metric system to a larger unit, we divide or move the decimal point to the left. To convert to a smaller unit, we multiply or move the decimal point to the right. Alternatively, we can use ratio and proportion as illustrated in the following examples:

a. **Example 1:** Convert 0.3 mg to grams. (There are 1000 mg in 1 gram.)

\[
\begin{align*}
\text{IF} & \quad \frac{1000 \text{ mg}}{1 \text{ gm}} \quad \text{THEN} & \quad \frac{0.3 \text{ mg}}{X \text{ gm}} \\
1000 \times X & = 0.3 \times 1 \\
\frac{1000X}{1000} & = \frac{0.3}{1000} \\
X & = 0.0003 \text{ gm (answer)}
\end{align*}
\]
b. **Example 2**: Express 30 liters in terms of milliliters. (There are 1000 ml in 1 liter.)

\[
\text{IF} \quad \frac{1000 \text{ ml}}{1 \text{ liter}} \quad \text{THEN} \quad \frac{X \text{ ml}}{30 \text{ liters}}. \\
1 \times X = 1000 \times 30 \text{ liters} \\
X = 30,000 \text{ ml (answer)}
\]

**Section IV. THE APOTHECARY SYSTEM**

**1-12. INTRODUCTION**

Several systems of weight and measure are used currently in the United States. This is an unfortunate situation in the medical field, but until the metric system is universally adopted in this country, you must remain flexible and familiar with some of the commonly encountered units from other systems of measurement. Ultimately, all calculations will be performed in the metric system. The metric system is the official system for use in the U.S. Army. Conversion factors or equivalents are discussed and presented later in this lesson to enable you to convert quickly and accurately from other systems to the metric system. **GIVEN A CALCULATION INVOLVING UNITS IN ANOTHER SYSTEM OF MEASURE, CONVERT TO AND WORK WITHIN THE METRIC SYSTEM.**

**1-13 APOTHECARY WEIGHT**

Several years ago, the apothecary system of measure was widely used in calculations pertaining to the administration of medications. Recently, the apothecary system has been used less and less in favor of the metric system. One unit in the apothecary system (see Table 1-7) is still seen on some drug labels. As you see from Table 1-7, the abbreviation for grain is gr.

<table>
<thead>
<tr>
<th>Apothecary</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>grain</td>
<td>gr.</td>
</tr>
</tbody>
</table>

Table 1-7. A commonly encountered apothecary weight unit.
1-14. APOTHECARY VOLUME

The gallon, quart, pint, and fluid ounce of the apothecary system are the familiar units used in the United States to measure liquids such as milk, gasoline, and soft drinks. Table 1-8 provides some useful information on commonly encountered apothecary volume units.

<table>
<thead>
<tr>
<th>1 gallon (C. or gal.)</th>
<th>4 quarts</th>
<th>8 pints</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 quart (qt.)</td>
<td>2 pints</td>
<td>32 fluid ounces</td>
</tr>
<tr>
<td>1 pint (pt.)</td>
<td>16 fluid ounces (fl. oz. or fl. oz.)</td>
<td></td>
</tr>
</tbody>
</table>

Table 1-8. Commonly encountered apothecary volume units.

Section V. CONVERSIONS

1-15. CONVERSION BETWEEN SYSTEMS

a. To convert quantities from one system of measurement to another, a familiar tool, ratio and proportion, can be used. Table 1-9 contains some useful approximate conversion factors. Remember, the conversion factors are approximate. When the exact conversion factors are required (that is, when prescriptions are compounded), pharmaceutical texts or references should be consulted.

<table>
<thead>
<tr>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.2 pounds = 1 kilogram (kg.)</td>
</tr>
<tr>
<td>1 grain (gr.) = 60 milligrams (mg.)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fluid Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 fluid ounce (fl. oz., fl. oz.) = 30 milliliters</td>
</tr>
<tr>
<td>1 pint = 473 milliliters</td>
</tr>
</tbody>
</table>

Table 1-9. Approximate conversion factors.

b. The process of converting from one system to another can be done with ease if three steps are followed:

(1) Write the conversion factor as your IF ratio.

(2) Write the unknown factor as your THEN ratio.

(3) Solve for the unknown as in any ratio and proportion problem.
c. Let’s apply these principles in performing some conversions from other systems to the metric system.

(1) **Weight.** Express 5 grains as milligrams.

   (a) Step 1. Write the conversion factor as your **IF** ratio:

   \[
   \frac{1 \text{ gr}}{60 \text{ mg}}
   \]

   (b) Step 2. Write the unknown factor as your **THEN** ratio:

   \[
   \frac{5 \text{ gr}}{X \text{ mg}}
   \]

   (c) Step 3. Solve for the unknown as in any other ratio and proportion problem.

   \[
   \frac{1 \text{ gr}}{60 \text{ mg}} = \frac{5 \text{ gr}}{X \text{ mg}}
   \]

   \[
   1 \times X = 5 \times 60
   \]

   \[
   X = 300 \text{ mg} \quad \text{(answer)}
   \]

(2) **Volume.** Express 4 fluid ounces as milliliters.

   (a) Step 1. Write the conversion factor as your **IF** ratio:

   \[
   \frac{1 \text{ fl oz}}{30 \text{ ml}}
   \]

   (b) Step 2. Write the unknown factor as your **THEN** ratio:

   \[
   \frac{4 \text{ fl oz}}{X \text{ ml}}
   \]

   (c) Step 3. Solve for the unknown.

   \[
   \frac{1 \text{ fl oz}}{30 \text{ ml}} = \frac{4 \text{ fl oz}}{X \text{ ml}}
   \]

   \[
   1 \times X = 4 \times 30
   \]

   \[
   X = 120 \text{ ml} \quad \text{(answer)}
   \]
1-16. APPROXIMATE HOUSEHOLD EQUIVALENTS

a. It is often necessary to express the dose of a fluid medication in common household unit for self-administration by the client. Ratio and proportion principles can be used to perform these conversions.

<table>
<thead>
<tr>
<th>HOUSEHOLD MEASURE</th>
<th>APOTHECARY MEASURE</th>
<th>METRIC MEASURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Tablespoonsful</td>
<td>1 fluid ounce (fl. oz., (\frac{3}{4}))</td>
<td>30 milliliters (ml.)</td>
</tr>
<tr>
<td>1 Tablespoonful (tbsp.)</td>
<td>1/2 fluid ounce (fl. oz., (\frac{1}{2}))</td>
<td>15 milliliters (ml.)</td>
</tr>
<tr>
<td>1 teaspoonful (tsp.)</td>
<td>1 fluid dram ((\frac{1}{8}))</td>
<td>5 milliliters (ml.)</td>
</tr>
<tr>
<td>1/2 teaspoonful</td>
<td>1/2 fluid dram ((\frac{1}{16}))</td>
<td>2.5 milliliters (ml.)</td>
</tr>
</tbody>
</table>

Table 1-10. Approximate household equivalents.

b. Solve the following problem: A client is to receive 30 milliliters of a particular antacid preparation. Express this volume in tablespoons.

(1) **Step 1.** Write the conversion factor as your IF ratio:

\[
\text{IF} \quad \frac{15 \text{ ml}}{1 \text{Tbsp}}
\]

(2) **Step 2.** Write the unknown factor as your THEN ratio:

\[
\text{THEN} \quad \frac{30 \text{ ml}}{X \text{Tbsp}}
\]

(3) **Step 3.** Solve for the unknown as in any ratio and proportion problem.

\[
\text{IF} \quad \frac{15 \text{ ml}}{1 \text{Tbsp}} \quad \text{THEN} \quad \frac{30 \text{ ml}}{X \text{Tbsp}}
\]

\[
15 \times X = 1 \times 30
\]

\[
\frac{15X}{45} = \frac{30}{15}
\]

\[
X = 2 \text{Tbsp} \quad \text{(answer)}
\]
Section VI. PERCENTAGE SOLUTIONS

1-17. EXPLANATION

a. Variable Meaning of Percentage.

(1) The word percentage can have different meanings under different circumstances. In solution, we are dealing with solids that are weighed and liquids that can be weighed or measured; thus, it is necessary to define the expression of age concentration of solutions. There are three different percentage solutions.

(a) Percentage weight in weight (w/w)--expresses the number of grams of solute in 100 ml of solution.

(b) Percentage weight in volume (w/v)--expresses the number of grams of solute in 100 ml of solution, regardless of whether water or another liquid is used as the solvent. Table 1-11 is helpful in preparing weight-in-volume solutions.

(c) Percentage volume in volume (v/v)--expresses the number of milliliters of solute in 100 ml of solution.

(2) The strength of a certain solution expressed in one of the ways is likely to be different from the strength expressed another way. It is therefore important to know whether a particular desired percentage strength for a prescription is w/w, w/v, or v/v. Some helpful rules are given below.

b. Rules for Percentage Solutions.

(1) Unless specifically stipulated otherwise, the following rules hold true for percentage solutions.

(a) Mixtures of solids are weight in weight (w/w).

(b) Solids in liquids are weight in volume (w/v).

(c) Liquids in liquids are volume in volume (v/v).

(d) Gases in liquids are weight in volume (w/v).

(2) For example, to make a 10 percent solution, dissolve 10 gm of a solid or 10 ml of a liquid in the amount of solvent necessary to make 100 ml of finished solution.

c. Ratio Strengths. Often the strength of a preparation, particularly the strength of a weak solution, may be expressed in terms of a ratio. Ratio strengths are also volume in volume (v/v), weight in weight (w/w), or weight in volume (w/v).
NOTE: The table above may be used to find the weight of solute in GRAMS required to prepare the indicated volume of solution with the desired percentage strength.

Table 1-11. Percentage solutions (w/v) in the metric system.

<table>
<thead>
<tr>
<th>%W/V</th>
<th>5 ml</th>
<th>10 ml</th>
<th>15 ml</th>
<th>30 ml</th>
<th>60 ml</th>
<th>120 ml</th>
<th>180 ml</th>
<th>240 ml</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4 %</td>
<td>0.0125</td>
<td>0.025</td>
<td>0.0375</td>
<td>0.075</td>
<td>0.15</td>
<td>0.3</td>
<td>0.45</td>
<td>0.6</td>
</tr>
<tr>
<td>½ %</td>
<td>0.025</td>
<td>0.05</td>
<td>0.075</td>
<td>0.15</td>
<td>0.3</td>
<td>0.6</td>
<td>0.9</td>
<td>1.2</td>
</tr>
<tr>
<td>1 %</td>
<td>0.05</td>
<td>0.1</td>
<td>0.15</td>
<td>0.3</td>
<td>0.6</td>
<td>1.2</td>
<td>1.8</td>
<td>2.4</td>
</tr>
<tr>
<td>2 %</td>
<td>0.1</td>
<td>0.2</td>
<td>0.3</td>
<td>0.6</td>
<td>1.2</td>
<td>2.4</td>
<td>3.6</td>
<td>4.8</td>
</tr>
<tr>
<td>3 %</td>
<td>0.15</td>
<td>0.3</td>
<td>0.45</td>
<td>0.9</td>
<td>1.8</td>
<td>3.6</td>
<td>5.4</td>
<td>7.2</td>
</tr>
<tr>
<td>4 %</td>
<td>0.2</td>
<td>0.4</td>
<td>0.6</td>
<td>1.2</td>
<td>2.4</td>
<td>4.8</td>
<td>7.2</td>
<td>9.6</td>
</tr>
<tr>
<td>5 %</td>
<td>0.25</td>
<td>0.5</td>
<td>0.75</td>
<td>1.5</td>
<td>3.0</td>
<td>6.0</td>
<td>9.0</td>
<td>12.0</td>
</tr>
<tr>
<td>10 %</td>
<td>0.5</td>
<td>1.0</td>
<td>1.5</td>
<td>3.0</td>
<td>6.0</td>
<td>12.0</td>
<td>18.0</td>
<td>24.0</td>
</tr>
<tr>
<td>15 %</td>
<td>0.75</td>
<td>1.5</td>
<td>2.25</td>
<td>4.5</td>
<td>9.0</td>
<td>18.0</td>
<td>27.0</td>
<td>36.0</td>
</tr>
<tr>
<td>20 %</td>
<td>1.0</td>
<td>2.0</td>
<td>3.0</td>
<td>6.0</td>
<td>12.0</td>
<td>24.0</td>
<td>36.0</td>
<td>48.0</td>
</tr>
<tr>
<td>25 %</td>
<td>1.25</td>
<td>2.5</td>
<td>3.75</td>
<td>7.5</td>
<td>5.0</td>
<td>30.0</td>
<td>45.0</td>
<td>60.0</td>
</tr>
<tr>
<td>50 %</td>
<td>2.5</td>
<td>5.0</td>
<td>7.5</td>
<td>15.0</td>
<td>30.0</td>
<td>60.0</td>
<td>90.0</td>
<td>120.0</td>
</tr>
</tbody>
</table>

1-18. FIELD DILUTION OF ISOPROPYL ALCOHOL

Isopropyl alcohol is widely used in a 70 percent concentration as an antiseptic-disinfectant. Since its effective range of activity is 70 percent to 90 percent, great accuracy is not required in the dilution of stock 99 percent isopropyl alcohol. The field method is to:

a. Fill container (pt, qt, or gal) approximately three-fourths full with 99 percent isopropyl alcohol.

b. Using distilled water, finish filling container to mark. The finished product is 70 percent to 75 percent isopropyl alcohol, which is suitable for field use.
Section VII. INJECTION DOSE CALCULATIONS

1-19. INTRODUCTION

    a. Forms in Which Injections are Supplied. Injections are found in supply either (1) in dry powder for reconstitution or (2) in a ready-made sterile solution or suspension.

    b. Labeling of Concentrations. Drugs for injection are labeled with concentrations in various ways. Some examples might be:

       (1) Morphine injection  8 mg/cc
       (2) Thorazine injection  25 mg/ml
       (3) Phenobarbital injection  1 grain/ml
       (4) Lorfan injection  1 mg = 1 cc
       (5) Kantrex injection  1 gram/3 cc
       (6) Tetanus antitoxin  1500 units/cc
       (7) Aramine injection one percent

    NOTE: Remember that 1 cc = 1 ml

    c. Choice of Syringe. After calculating the dose volume in milliliters, round off your answer to the nearest tenth of a milliliter. It is generally best to choose the smallest syringe capable of delivering the entire dose. For example, a 1-ml syringe would be used for doses of 1 ml or less, a 2.5-ml syringe for doses between 1.0 and 2.5 ml, a 5-ml syringe for doses between 2.6 and 5.0 ml, and a 10-ml syringe for doses between 5.0 and 10.0 ml.

1-20. SOLVING BY RATIO AND PROPORTION

    a. Like Units. In using ratio and proportion to solve injection dose problems, we must especially remember the necessity of using like units on the same side of each ratio. For example, if our known concentration is expressed in milligrams/milliliter and we want to find the number of milliliters required to provide a 1-gram dose, it would be easiest to first express this dose as 1000 milligrams. In this manner, both the left and right sides of the equation are expressed in mg/ml.
b. Method. The left, or IF, side of the equation should be the concentration of the drug in stock. The right, or THEN, side of the equation should be the ratio solute dose/solution dose, or ordinarily weight dose/volume dose.

c. Example 1. The labeled strength of a 30 ml vial of Meperidine (Demerol) injection is 50 mg/ml. How many milliliters must be injected to provide a 75 mg dose?

\[
\begin{align*}
\text{IF} & \quad 50 \text{ mg} & \text{THEN} & \quad 75 \text{ mg} \\
1 \text{ ml} & \quad = & X \text{ ml} \\
50 \times X & = 1 \times 75 \\
50X & = 75 \\
X & = \frac{75}{50} \\
X & = 1.5 \text{ ml, answer}
\end{align*}
\]

d. Example 2. A preparation of Morphine is labeled with a concentration of 30 mg/cc. How many milliliters must be injected to provide a 1/8 grain dose?

First, we must convert 1/8 grain to the metric system. Using a conversion factor (1 gr = 60 mg), we calculate that 1/8 gr = 7.5 mg.

\[
\begin{align*}
\text{IF} & \quad 30 \text{ mg} & \text{THEN} & \quad 7.5 \text{ mg} \\
1 \text{ ml} & \quad = & X \text{ ml} \\
30 \times X & = 7.5 \times 1 \\
30X & = 7.5 \\
X & = \frac{7.5}{30} \\
X & = 0.25 \text{ (Rounding off, } X = 0.3 \text{ ml, answer)}
\end{align*}
\]

1-21. ANTIBIOTIC DILUTIONS

a. Antibiotic drugs such as Penicillins, Streptomycin, and the Tetracyclines often are manufactured and supplied to you in the form of a sterile powder in a vial which must be reconstituted with sterile water for injection, normal saline solution, or other suitable diluent (solvent) (Table 1-12). This presents special problems and considerations not normally seen with prepared injection solutions. Specifically, you must STOP and consider each of the following problems when handling antibiotics for reconstitution.
Sterile Water for Injection (SWI), 5 ml and 50 ml ampules.
Sodium Chloride Injection (Normal Saline Solution, N/S), 5 ml.
5 % Dextrose Injection (D5W).
Special diluents supplied by manufacturer.

Table 1-12. Sterile diluents for reconstitution.

(1) The volume of the vial.

(2) Stability of the dry powder.

(3) Volume of diluent (or how much water do I use?).

(4) Stability of reconstituted solution or suspension.

(5) Calculation of the volume dose.

b. It is recommended that all antibiotics that are reconstituted and are to be used later, should be labeled in the following way (see example):

<table>
<thead>
<tr>
<th>(1) Hour and date reconstituted.</th>
<th>1400 hrs 9 Mar 01</th>
</tr>
</thead>
<tbody>
<tr>
<td>(2) Strength of reconstituted antibiotic</td>
<td>GMcK 50,000 units/cc</td>
</tr>
<tr>
<td>(3) Initials of the preparer.</td>
<td>(2)</td>
</tr>
</tbody>
</table>

(3) Once the antibiotic has been reconstituted, we solve for the fraction to be used as follows:

(1) What you WANT is your DOSE!

(2) What you HAVE is the LABELED STRENGTH of the antibiotic!

(3) Place the DOSE over your LABELED STRENGTH and solve as a fraction. This is the fractional part of your vial, which is your dose.
d. An example is given below:

(1) Dilute a vial of procaine penicillin G for aqueous injection labeled 300,000 units so that you can administer a dose of 75,000 units. How many milliliters must be withdrawn and injected IM to give this dose?

\[
\begin{align*}
\text{WHAT (DOSE)} & = \frac{75,000 \text{ units}}{300,000 \text{ units}} = \frac{25}{100} = \frac{1}{4} \text{ of vial is your dose} \\
\text{HAVE (LABEL)} & = 75,000 \text{ units} \\
\end{align*}
\]

(2) Thus, it might be possible to dilute a vial with:

(a) Four ml and withdraw 1 ml for your dose.

(b) Eight ml and withdraw 2 ml for your dose.

(c) Two ml and withdraw 1/2 ml for your dose.

(d) One ml and withdraw 1/4 ml for your dose.

(3) All of the above are technically correct; however, you must consider the size of the vial and how easily the antibiotic is reconstituted to a solution or suspension. The manufacturer suggests and recommends that 1 ml be used to dilute this product (see Table 1-13). The vial is actually too small to accept 8 ml of diluent.
<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>Trade Name (Other Names)</th>
<th>Supply</th>
<th>Diluent I.M.</th>
<th>Diluent I.V. Push</th>
<th>Diluent I.V. Infusion</th>
<th>Stability Once Reconstituted</th>
<th>Refrigerated</th>
</tr>
</thead>
<tbody>
<tr>
<td>sodium ampicillin</td>
<td>Polycillin-N</td>
<td>0.5 gram</td>
<td>1.2 ml. SWI</td>
<td>5 ml. SWI</td>
<td>5 ml. SWI</td>
<td>1 hr. (I.M.)</td>
<td>Not suitable for storage</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.0 gram</td>
<td>2.4 ml. SWI</td>
<td>10 ml. SWI</td>
<td>10 ml. SWI</td>
<td>1 hr. (I.M.)</td>
<td>Not suitable for storage</td>
</tr>
<tr>
<td>sodium cephalothin</td>
<td>Keflin</td>
<td>1.0 gram</td>
<td>4 ml. SWI, expand or N/S</td>
<td>10 ml. SWI</td>
<td>6 hr. (I.M.)</td>
<td>6-24 hr. (I.V.)</td>
<td>48 hr.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.0 grams</td>
<td>For I.V. use only</td>
<td>N/A</td>
<td>20-40 ml. SWI, N/S, or DSW</td>
<td>6 hr. (I.M.)</td>
<td>6-24 hr. (I.V.)</td>
</tr>
<tr>
<td>erythromycin lactobionate for injection</td>
<td>Erythrocin</td>
<td>1.0 gram</td>
<td>Do not use I.M.</td>
<td>20 ml. SWI only*</td>
<td>20 ml. SWI only*</td>
<td>Not suitable for storage</td>
<td>Not suitable for storage</td>
</tr>
<tr>
<td>sodium methicillin for injection</td>
<td>Staphcillin</td>
<td>1.0 gram</td>
<td>1.2 ml. SWI, expands to 2 ml.</td>
<td>500 mg/mL. diluted with 25 ml. N/S per ml.</td>
<td>1.2 ml. SWI, then add to I.V. solution</td>
<td>24 hr.</td>
<td>4 days</td>
</tr>
</tbody>
</table>

*Once reconstituted with sterile water for injection, it can then be added to N/S, DSW, or other compatible solutions.

v Never mix another drug with solutions of methicillin.
SWI = sterile water for injection
N/S = sodium chloride injection
DSW = 5% dextrose injection
<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>Trade Name (Other Names)</th>
<th>Supply</th>
<th>Diluent</th>
<th>I.V.</th>
<th>I.V.</th>
<th>Stability Once Reconstituted</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>I.M.</td>
<td>Push</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>I.V. Infusion</td>
</tr>
<tr>
<td>potassium penicillin G for injection</td>
<td>crystalline, buffered penicillin G</td>
<td>1,000,000 units</td>
<td>3.6-9.6 ml.</td>
<td>3.6-9.6 ml.</td>
<td>3.6-9.6 ml.</td>
<td>24 hr.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SWI, expands</td>
<td>N/S</td>
<td>D5W</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.4 ml.</td>
<td>N/S</td>
<td>D5W</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>5,000,000 units</td>
<td>3-23 ml. of SWI, expands</td>
<td>3-23 ml.</td>
<td>3-23 ml.</td>
<td>24 hr.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2 ml.</td>
<td>N/S</td>
<td>N/S or D5W</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>20,000,000 units</td>
<td>Do not use I.M.</td>
<td>N/A</td>
<td>32 ml.</td>
<td>24 hr.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>D5W or N/S, expands to 40 ml.</td>
</tr>
<tr>
<td>procaline penicillin for aqueous injection</td>
<td>procaline penicillin G</td>
<td>300,000 units</td>
<td>1 ml. SWI</td>
<td>Not for I.V. use</td>
<td>Not for I.V. use</td>
<td>1 week</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>I.V. use</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1,500,000 units</td>
<td>4.5 ml. SWI, expands to 5 ml.</td>
<td>Not for I.V. use</td>
<td>Not for I.V. use</td>
<td>1 week</td>
</tr>
<tr>
<td>Antibiotic</td>
<td>Trade Name (Other Names)</td>
<td>Supply</td>
<td>Diluent</td>
<td>Stability Once Reconstituted</td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------------------</td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>I.M.</td>
<td>Room Temp.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>I.V. Push</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>I.V. Infusion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Refrigerated</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>streptomycin sulfate</td>
<td>none</td>
<td>1.0 gram.</td>
<td>2 ml. SWI or N/S</td>
<td>Not for I.V. use</td>
<td>Not for I.V. use</td>
<td>4 weeks</td>
</tr>
<tr>
<td>tetracycline HCl for injection</td>
<td>various</td>
<td>0.1 gram for I.M. use</td>
<td>2 ml. SWI or N/S</td>
<td>Not for I.V. use</td>
<td>Not for I.V. use</td>
<td>24 hr.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.5 gram for I.V. use</td>
<td>N/A</td>
<td>10 ml. SWI then dilute to 100 ml.</td>
<td>12 hr. (initial dilution) Final dilution is adm. STAT</td>
</tr>
</tbody>
</table>

SWI = sterile water for injection
N/S = sodium chloride injection
DSW = 5% dextrose injection
Section VIII. PEDIATRIC DOSE CALCULATIONS

1-22. INTRODUCTION

a. Premature babies and other very young infants may be unusually responsive to many drugs because of the immaturity of the following.

(1) Renal function.
(2) Enzymatic mechanisms for drug inactivation.
(3) The blood-brain barrier.
(4) The brain.

NOTE: Children are often more sensitive than adults to drugs which alter the acid-base metabolism or the water-and-electrolyte balance.

b. Pediatric doses based on formal experiments or the experience of the prescriber are better than those calculated according to a general rule or formula. Unfortunately, optimal pediatric doses have not been established for most drugs. Thus, where possible, doses for younger children, and especially for infants, should be learned as such and not based merely on a formula; doses calculated with a formula (as a fraction of the adult dose based on the body weight or body surface area) are very unreliable for premature infants, but more reliable for children at least 2 years old.

1-23. DOSAGE RULES INVOLVING A FRACTION OF THE ADULT DOSE


<table>
<thead>
<tr>
<th>AGE (IN YEARS)</th>
<th>DOSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 or older</td>
<td>the adult dose</td>
</tr>
<tr>
<td>10</td>
<td>1/2 the average adult dose</td>
</tr>
<tr>
<td>5</td>
<td>1/4 the average adult dose</td>
</tr>
<tr>
<td>2 1/2</td>
<td>1/8 the average adult dose</td>
</tr>
<tr>
<td>1</td>
<td>1/12 the average adult dose</td>
</tr>
</tbody>
</table>
b. **Clark's Rule.**

\[
\frac{\text{weight of child (lb)}}{150} \times \text{adult dose} = \text{approximate child's dose}
\]

c. **Young's Rule.**

\[
\frac{\text{age of child (yr)}}{\text{age} + 12} \times \text{adult dose} = \text{approximate child's dose}
\]

d. **Fried's Rule.**

\[
\frac{\text{age in months}}{150} \times \text{adult dose} = \text{approximate child's dose}
\]

**1-24. PEDIATRIC DOSE CALCULATION BASED ON BODY WEIGHT**

a. A more reliable method of pediatric dose calculation than the preceding dosage rules bases the dosage on a given amount of drug per pound or kilogram of body weight.

**NOTE:** Round off all body weights in kilograms to the nearest whole number.

b. Example: The parenteral dose of erythromycin injection is 10 mg/kg/24 hours. Calculate the daily dose of this drug for a 44-pound child.

(1) **Step 1.** Convert 44 pounds to kilograms.

\[
\frac{44 \text{ pounds}}{2.2} = 20 \text{ kilograms}
\]

(2) **Step 2.** Multiply the client's weight by the dose.

\[
\text{CHILD'S DOSE} = 20 \text{ kg} \times 10 \text{ mg/kg} = 200 \text{ mg/24 hrs} \ (\text{answer})
\]

**1-25. PEDIATRIC DOSE CALCULATIONS BASED ON SURFACE AREA**

A newer and possibly more accurate method of pediatric dose calculation is based on body surface area. Although this method is not as widely used or accepted as calculations based on body weight, most if not all drugs may have their dosage expressed per square meter of body surface area (m²). This method of relating the surface area of individuals to dosage is simplified using a surface area nomogram in dose calculations (figure 1-1).

\[
\text{CHILD'S DOSE} = \text{surface area of child (m²)} \times \text{dose per m²}.
\]
Figure 1-1. Body surface area nomogram.
a. **Example 1.** A thirty-pound child of average size is to receive Kanamycin injection with a dosage expressed as 150-450 mg/m²/24 hr.

   (1) Using a nomogram, calculate the client's body surface area.

   \[ \text{SURFACE AREA} = 0.6 \text{ m}^2 \]

   (2) Multiply body surface area by the dose.

   \[ \text{CHILD'S DOSE} = 0.6 \text{ m}^2 \times \frac{150-450 \text{ mg}}{\text{m}^2} \]

   \[ \text{CHILD'S DOSE} = 90.0-270 \text{ mg/24 hours} \]

b. **Example 2.** A three-month old boy who is 24.5 inches long and weighs 11 pounds, 8 ounces, is to receive Phenobarbital elixir labeled 20 mg/5 ml. The anticonvulsant dose of Phenobarbital is 125 mg/m² dose.

   (1) Calculate the single dose of Phenobarbital in mg.

   \[ \text{SURFACE AREA} = 0.31 \text{ m}^2 \]

   \[ \text{CHILD'S DOSE} = 0.31 \times 125 \text{ mg} = 40 \text{ mg}, \text{ approximately} \]

   (2) How many milliliters will be administered for each single dose?

   \[ \frac{20 \text{ mg}}{5 \text{ ml}} \text{ THEN } \frac{40 \text{ mg}}{X \text{ ml}} \]

   \[ 20 \times X = 5 \times 40 \]

   \[ X = \frac{200}{20} = 10 \text{ ml} \text{ (answer)} \]

**NOTE:** If the usual adult is assumed to have a surface area of 1.7 m², we can use the following formula for the pediatric dose if only the usual adult dose is known:

\[ \text{CHILD'S DOSE} = \frac{\text{surface area (m}^2\text{)}}{1.7} \times \text{ adult dose} \]

*Continue with Exercises*

*Return to Table of Contents*
EXERCISES, LESSON 1

INSTRUCTIONS. Answer the following exercises by marking the lettered response that best answers the question or completes the incomplete statement.

After you have completed all of these exercises, turn to "Solutions to Exercises" at the end of the lesson and check your answers. For each exercise answered incorrectly, reread the material referenced with the solution.

1. The Roman numerals LXXVII express what Arabic number?
   a. 78
   b. 77
   c. 67
   d. 64

2. The Roman numerals IVss signify what amount?
   a. 6 1/2
   b. 5 1/2
   c. 5
   d. 4 1/2

3. An order for an eye medication reads, "gtt II o.s. tid." How many times during a 24-hour period should the drug be administered?
   a. Two.
   b. Three.
   c. Four.
   d. Ten.
4. In the following equation, what is the value of \( X \)?
\[
\frac{3 \times 5}{10} = X
\]
- a. 1.5
- b. 3
- c. 6
- d. 17

5. In the following equation, what is the value of \( X \)?
\[
\frac{1/2 \times 30}{0.6} = X
\]
- a. 6
- b. 9
- c. 18
- d. 36

6. In the following equation, what is the value of \( X \)?
\[
\frac{0.8 \times 2}{5} = X
\]
- a. 0.8
- b. 1.25
- c. 8
- d. 12.5

7. In the following equation, what is the value of \( X \)?
\[
\frac{0.25 \times 1}{1.5} = X
\]
- a. 6
- b. 10
- c. 15
- d. 25
8. How many milliliters of Promethazine Hydrochloride injection labeled 25 mg/ml must be administered to provide a dose of 12.5 mg?
   a. 0.5 ml.
   b. 6.25 ml.
   c. 12.5 ml.
   d. 25 ml.

9. A 120 ml bottle of Thiabendazole oral suspension labeled 500 mg per 5 cc contains how many grams of Thiabendazole?
   a. 1.2 gm.
   b. 12 gm.
   c. 120 gm.
   d. 1200 gm.

10. Which of the following units of measure is/are expressed in the system that is official for use in the U.S. Army?
    a. Both c and d below.
    b. Both d and e below.
    c. Grain.
    d. Gram.
    e. Pound.
11. What is 0.5 gm in terms of milligrams?
   a. 5 mg.
   b. 50 mg.
   c. 500 mg.
   d. 5000 mg.

12. What is 27.3 ml in terms of liters?
   a. 0.0273 liters.
   b. 0.273 liters.
   c. 2.73 liters.
   d. 27,300 liters.

13. Approximately how many milliliters are in 8 fluid ounces?
   a. 3.75 milliliters.
   b. 240 milliliters.
   c. 128 milliliters.
   d. 120 milliliters.

14. A 10-grain dose of aspirin expressed in milligrams is approximately:
   a. 10,000 mg.
   b. 30 mg.
   c. 60 mg.
   d. 600 mg.
15. How many milliliters are there in 3 pints?
   a. 1500 ml.
   b. 1419 ml.
   c. 195 ml.
   d. 90 ml.

16. An outpatient is given a drug, which has a dosage of ten milliliters. How should the dosage be written on the label?
   a. $3x$
   b. 10 drams.
   c. 2 teaspoonsful.
   d. 2 tablespoonsful.

17. You must administer 20 grams of Mannitol from a 150 ml bottle of 15 percent (w/v) Mannitol injection. How many milliliters are required?
   a. 30 ml.
   b. 75 ml.
   c. 133.3 ml.
   d. 300 ml.

18. How many grams of dextrose are in a 250 ml bottle of five percent dextrose injection?
   a. 2.0 gm.
   b. 12.5 gm.
   c. 50 gm.
   d. 250 gm.
19. How many milliliters must be injected from a vial labeled 60 mg/cc. to give the client a dose of 1/4 grain?
   a. 0.25 ml.
   b. 1.5 ml.
   c. 2.7 ml.
   d. 15 ml.

20. Chlordiazepoxide hydrochloride (Librium) injection is supplied as a dry powder labeled 100 mg with a separate 2-ml vial of special diluent. How many should be used to administer a 30 mg dose?
   a. 13.5 milliliters.
   b. 2.7 milliliters.
   c. 0.6 milliliters.
   d. 3.3 milliliters.

21. For cyanide poisoning, a 0.3 gram dose of sodium nitrite must be administered intravenously. Your supply is a 10-ml ampule of a three percent sodium nitrite solution. What volume of the solution must you use?
   a. 0.3 ml.
   b. 1.0 ml.
   c. 3.0 ml.
   d. 10 ml.
22. You wish to infuse 50 mg of Metaraminol Bitartrate (Aramine) in 500 ml of five percent dextrose injection. How many milliliters of one percent Metaraminol Bitartrate injection must be used?
   a. 5 ml.
   b. 10 ml.
   c. 100 ml.
   d. 500 ml.

23. After reconstituting a 1 gram vial of Erythromycin Lactobionate with SWI, what fraction of the dilution must be used to provide a 350 mg dose?
   a. 0.035
   b. 0.05
   c. 0.35
   d. 0.5

24. How much sterile water for injection (SWI) should be used to reconstitute 1 gram of Erythromycin Lactobionate for injection?
   a. 5 ml.
   b. 10 ml.
   c. 15 ml.
   d. 20 ml.
25. How many milliliters of Sodium Ampicillin, reconstituted for IV administration according to table 1-13 in the subcourse, should be injected to provide a 250 mg dose?
   a. 2.5 ml.
   b. 25 ml.
   c. 250 ml.
   d. 2500 ml.

26. The pediatric antipyretic dose of Aspirin is 65 mg/kg/24 hr, divided into 4-6 doses. What should be the total daily dose of aspirin for a 55-pound child?
   a. 425 mg.
   b. 525 mg.
   c. 715 mg.
   d. 1625 mg.

27. The pediatric dose of Ampicillin for moderately severe infections in children weighing 40 kg is given as 50-100 mg/kg/24 hr, divided into 4 doses. What is the range in daily dose for a 66-pound child?
   a. 2.0-4.0 gm/24 hr.
   b. 3.0-4.5 gm/24 hr.
   c. 4.5-6.0 gm/24 hr.
   d. 6.0-7.5 gm/24 hr.
28. What is the approximate surface area of a 15-pound child whose height is normal for his weight?
   a. 0.25 m².
   b. 0.36 m²
   c. 0.42 m²
   d. 0.83 m²

29. What is the approximate surface area of a 22-pound, 18-month-old child who is 31 inches long?
   a. 0.4 m²
   b. 0.44 m²
   c. 0.48 m²
   d. 0.51 m²

30. A 17-pound child of normal length with a resistant staphylococcal infection is to receive Sodium Oxacillin (Prostaphlin) for injection. The usual four doses and administered well-diluted, by slow IV drip. What should be the range of a single dose for this child?
   a. 146-293 mg.
   b. 212-424 mg.
   c. 375-750 mg.
   d. 431-863 mg.
SPECIAL INSTRUCTIONS FOR EXERCISES 31 THROUGH 35.

SITUATION: A 45-pound, 7-year-old girl of average height is to begin Griseofulvin therapy. The dose of this drug is 10mg/kg/24 -4 doses, orally. The average adult dose is 500 mg daily in divided doses.

Each numbered term in column A below indicates a method of solving the daily child's dose. Once you have solved the child's dose according to each method, find it in column B and enter the corresponding letter in the blank.

<table>
<thead>
<tr>
<th>Column A (Method)</th>
<th>Column B (Daily Dose)</th>
</tr>
</thead>
<tbody>
<tr>
<td>31. ___ Clark's Rule.</td>
<td>a. 184 mg</td>
</tr>
<tr>
<td>32. ___ Young's Rule.</td>
<td>b. 243 mg</td>
</tr>
<tr>
<td>33. ___ Calculation using mg/kg dose.</td>
<td>c. 205 mg</td>
</tr>
<tr>
<td>34. ___Calculation using mg/m² dose.</td>
<td>d. 238 mg</td>
</tr>
<tr>
<td>35. ___Calculation as fraction of adult dose based on surface area.</td>
<td>e. 150 mg</td>
</tr>
</tbody>
</table>

*Check Your Answers on Next Page*
SOLUTIONS TO EXERCISES, LESSON 1

1. b (para 1-2)

2. d (para 1-2)

3. b (para 1-2; table 1-1)

4. c (para 1-7) \[
\frac{3}{5} = \frac{X}{10}
\]

   \[5X = 3 \times 10\]

   \[\frac{5X}{-5} = \frac{30}{5}\]

   \[X = 6\]

5. d (para 1-7) \[
\frac{1/2}{30} = \frac{0.6}{X}
\]

   \[1/2 \times X = 0.6 \times 30\]

   \[\frac{1/2X}{1/2} = \frac{18}{1/2}\]

   \[X = (18/1 \div 1/2) = (18/1 \times 2/1) = 36\]

6. d (para 1-7) \[
\frac{0.8}{2} = \frac{5}{X}
\]

   \[0.8 \times X = 2 \times 5\]

   \[\frac{0.8X}{0.8} = \frac{10}{0.8}\]

   \[X = 12.5\]
7. a (para 1-7) \[ \frac{0.25}{1} = \frac{1.5}{X} \]
\[ 0.25X = 1 \times 1.5 \]
\[ \frac{0.25X}{0.25} = \frac{1.5}{0.25} \]
\[ X = 6 \]

8. a (para 1-7) IF \[ \frac{25 \text{ mg}}{1 \text{ ml}} \] THEN \[ \frac{12.5 \text{ mg}}{X \text{ ml}} \]
\[ 25X = 1 \times 12.5 \]
\[ \frac{25X}{25} = \frac{12.5}{25} \]
\[ X = 0.5 \text{ ml} \]

9. b (paras 1-7, 1-10c, 1-11) 5 cc = 5 ml
IF \[ \frac{500 \text{ mg}}{5 \text{ ml}} \] THEN \[ \frac{X \text{ mg}}{120 \text{ ml}} \]
\[ 5 \times X = 120 \times 500 \]
\[ \frac{5X}{5} = 60,000 \]
\[ X = 12,000 \text{ mg} = 12 \text{ gm} \]

10. d (paras 1-9, 1-12)

11. c (para 1-11) IF \[ \frac{1000 \text{ mg}}{1 \text{ gm}} \] THEN \[ \frac{X \text{ mg}}{0.5 \text{ gm}} \]
\[ 1 \times X = 0.5 \times 1000 \]
\[ X = 500 \text{ mg} \]
12. a (para 1-11) IF \( \frac{1000 \text{ ml}}{1 \text{ liter}} \) THEN \( \frac{27.3 \text{ ml}}{X \text{ liter}} \)

\[
1000 \times X = 1 \times 27.3
\]

\[
\frac{1000 \times X}{1000} = \frac{27.3}{1000}
\]

\[X = 0.0273 \text{ liter}\]

13. b (paras 1-15b, c(2)) \( \frac{1 \text{ fluid ounce}}{30 \text{ milliliters}} = \frac{8 \text{ fluid ounces}}{X \text{ milliliters}} \)

\[
1 \times X = 30 \times 8
\]

\[X = 240 \text{ milliliters}\]

14. d (paras 1-15b, c(1)) \( \frac{1 \text{ grain}}{60 \text{ milligrams}} = \frac{10 \text{ grains}}{X \text{ milligrams}} \)

\[
1 \times X = 60 \times 10
\]

\[X = 600 \text{ milligrams}\]

15. b (para 1-15c(2)) \( \frac{1 \text{ pint}}{473 \text{ milliliters}} = \frac{3 \text{ pints}}{X \text{ milliliters}} \)

\[
1 \times X = 473 \times 3
\]

\[X = 1419 \text{ milliliters}\]

16. c (para 1-16; table 1-10) \( \frac{1 \text{ teaspoonful}}{5 \text{ milliliters}} = \frac{X \text{ teaspoonsful}}{10 \text{ milliliters}} \)

\[
5 \times X = 1 \times 10
\]

\[
\frac{5X}{5} = \frac{10}{5}
\]

\[X = 2 \text{ teaspoonsful}\]
17. c (paras 1-7, 1-17) IF \( \frac{15 \text{ gm}}{100 \text{ ml}} \) THEN \( \frac{20 \text{ gm}}{X \text{ ml}} \)

\[ 15 \times X = 20 \times 100 \]

\[ \frac{15X}{45} = \frac{200}{15} \]

\[ X = 133.3 \text{ ml, approximately} \]

18. b (paras 1-7, 1-17) IF \( \frac{5 \text{ gm}}{100 \text{ ml}} \) THEN \( \frac{X \text{ gm}}{250 \text{ ml}} \)

\[ 100 \times X = 5 \times 250 \]

\[ \frac{100X}{400} = \frac{1250}{100} \]

\[ X = 12.5 \text{ gm} \]

19. a (paras 1-10c, 1-20; table 1-9) \( 60 \text{ mg/cc} = 60 \text{ mg/ml} \).

\[ \frac{60 \text{ mg}}{1 \text{ gr}} = \frac{X \text{ mg}}{1/4 \text{ gr}} \]

\[ X = 15 \text{ mg} \]

IF \( 60 \text{ mg} \) THEN \( 15 \text{ mg} \)

\[ \frac{1 \text{ ml}}{X \text{ ml}} = \frac{60 \times X}{1 \times 15} \]

\[ \frac{60X}{60} = \frac{15}{60} \]

\[ X = 0.25 \text{ ml} \]
20. c (paras 1-15b(2), 1-20)  IF \( \frac{100 \text{ mg}}{2 \text{ ml}} \) THEN \( \frac{30 \text{ mg}}{X \text{ ml}} \)

\[
100 \times X = 2 \times 30
\]

\[
\frac{100X}{100} = \frac{60}{100}
\]

\[
X = 0.6 \text{ ml}
\]

21. d (paras 1-17, 1-20)  3 percent = \( \frac{3 \text{ gm}}{100 \text{ ml}} \).

\[
\text{IF } \frac{3 \text{ gm}}{100 \text{ ml}} \text{ THEN } \frac{0.3 \text{ gm}}{X \text{ ml}}
\]

\[
3 \times X = 0.3 \times 100
\]

\[
\frac{3X}{3} = \frac{30}{3}
\]

\[
X = 10 \text{ ml}
\]

22. a (paras 1-17, 1-20)  1 = \( \frac{1 \text{ g}}{100 \text{ ml}} = \frac{1000 \text{ mg}}{100 \text{ ml}} = 10 \text{ mg/ml} \)

\[
\text{IF } \frac{10 \text{ mg}}{1 \text{ ml}} \text{ THEN } \frac{50 \text{ mg}}{X \text{ ml}}
\]

\[
10 \times X = 1 \times 50
\]

\[
\frac{40X}{10} = \frac{50}{10}
\]

\[
X = 5 \text{ ml}
\]

23. c (paras 1-10b, 1-21)  1 gram = 1000 mg

\[
\text{WANT} = \frac{350 \text{ mg}}{1000 \text{ mg}} = 0.35
\]

24. d (table 1-13)
25. a (paras 1-11, 1-21; table 1-13)  

0.5 g = 500 mg.

\[
\text{WANT} = 250 \text{ mg} = 1 \\
\text{HAVE} = 500 \text{ mg} = 2
\]

Volume of diluent = 5 ml

\[1/2 \times 5 \text{ ml} = 2.5 \text{ ml} \quad \text{(answer)}\]

26. d (para 1-24)  

\[
\frac{55-\text{lb}}{2.2-\text{lb/kg}} = 25 \text{ kg.}
\]

\[25 \text{ kg} \times 65 \text{ mg/kg} = 1625 \text{ mg} \quad \text{(answer)}\]

27. a (paras 1-11, 1-24)  

\[40 \text{ kg} \times 50 \text{ mg/kg} = 2000 \text{ mg}\]

\[40 \text{ kg} \times 100 \text{ mg/kg} = 4000 \text{ mg}\]

Range: 2000 - 4000 mg/24 hr

\[= 2.0 - 4.0 \text{ gm/24 hr} \quad \text{(answer)}\]

28. b (fig 1-1) Note on the enclosed column of the nomogram that the number 15 on the left scale is adjacent to the notch for 0.36 on the right scale.

29. c (fig 1-1) A straight edge, connecting the 22-pound mark on the weight column and the 31-inch mark on the height column, intersects

30. a (paras 1-11, 1-25; fig 1-1) The surface area corresponding to 17 pounds on the enclosed column of the nomogram is about 0.39 m².

\[0.39 \text{ m}^2 \times 1.5 \text{ gm/m}^2 = 0.585 \text{ gm} = 585 \text{ mg}\]

\[0.39 \text{ m}^2 \times 3.0 \text{ gm/m}^2 = 1.17 \text{ gm} = 1170 \text{ mg}\]

\[
\frac{585 \text{ mg}}{4} = 146 \text{ mg}
\]

\[
\frac{1170 \text{ mg}}{4} = 292.5 \text{ mg} = 293 \text{ mg}, \text{ approximately}
\]
31. e (para 1-23b) \[
\text{CHILD'S DOSE} = \frac{\text{weight of child (lb)}}{150} \times \text{adult dose}
\]
\[
= \frac{45 \times 500 \text{ mg}}{150} = \frac{22,500 \text{ mg}}{150} = 150 \text{ mg}
\]

32. a (para 1-23c) \[
\text{CHILD'S DOSE} = \frac{\text{age of child (yrs)}}{\text{age + 12}} \times \text{adult dose}
\]
\[
= \frac{7 \times 500 \text{ mg}}{7 + 12} = \frac{3500 \text{ mg}}{19} = 184 \text{ mg}, \text{ approximately}
\]

33. c (para 1-24) \[
\frac{45-\text{lb}}{2.2-\text{lb/kg}} = 20.5 \text{ kg}
\]
\[
\text{CHILD'S DOSE} = 20.5 \text{ kg} \times 10 \text{ mg/kg} = 205 \text{ mg}
\]

34. b (para 1-25; fig 1-1) Note on the enclosed column of the nomogram that a point for 45 on the left scale would correspond to a point for 0.81 on the right. Thus, a 45-lb child of normal height has a surface area of about 0.81 m².
\[
\text{CHILD'S DOSE} = 0.81 \text{ m}^2 \times 300 \text{ mg/m}^2 = 243 \text{ mg}
\]

35. d (para 1-25; fig 1-1) Note on the enclosed column of the nomogram that a point for 45 on the left scale would correspond to a point for 0.81 on the right scale. Thus, a 45-lb child of normal height has a surface area of about 0.81 m².
\[
\text{CHILD'S DOSE} = \frac{\text{surface area (m}^2\text{)}}{1.7} \times \text{adult dose}
\]
\[
= \frac{0.81 \times 500 \text{ mg}}{1.7} = \frac{405 \text{ mg}}{1.7} = 238 \text{ mg}
\]

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